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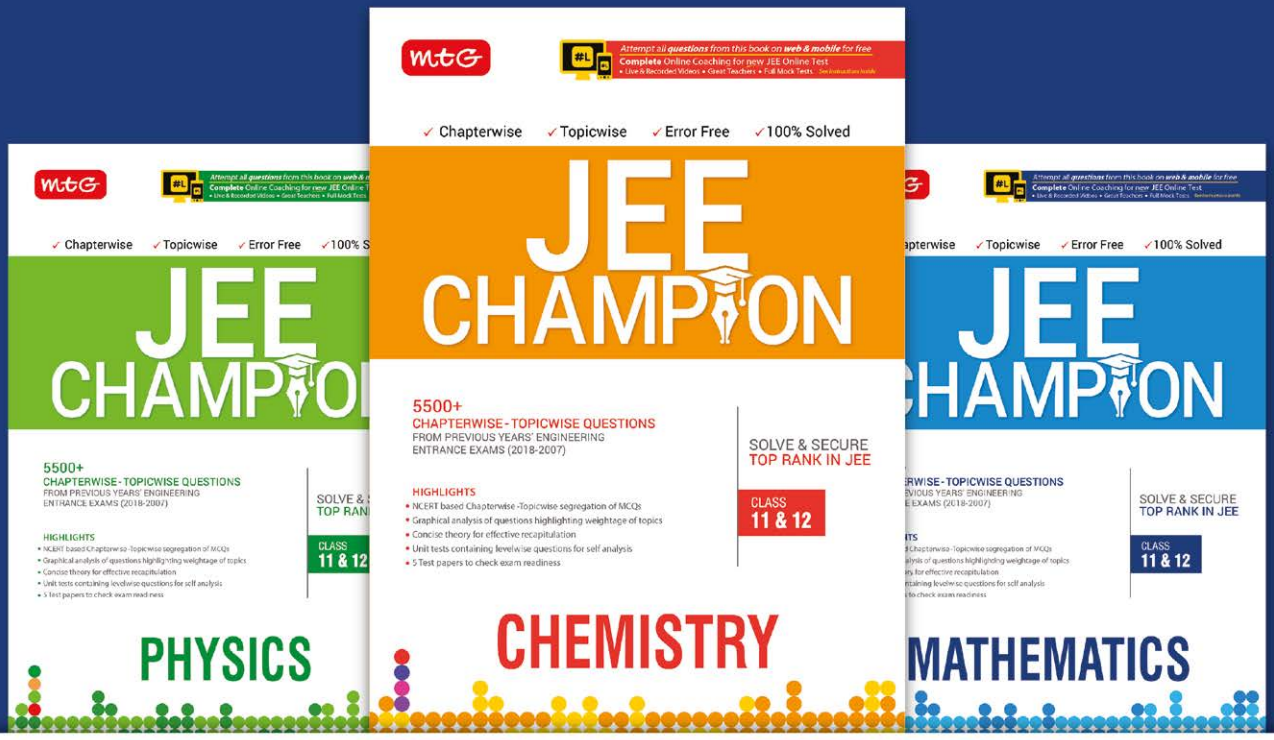

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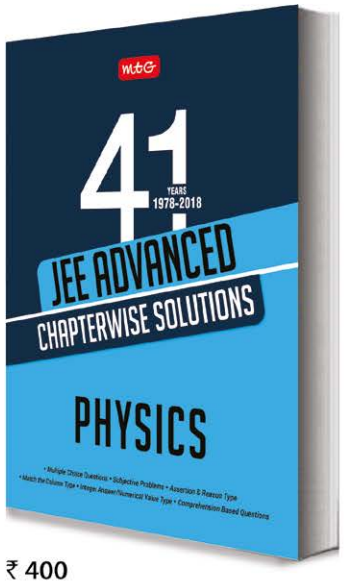

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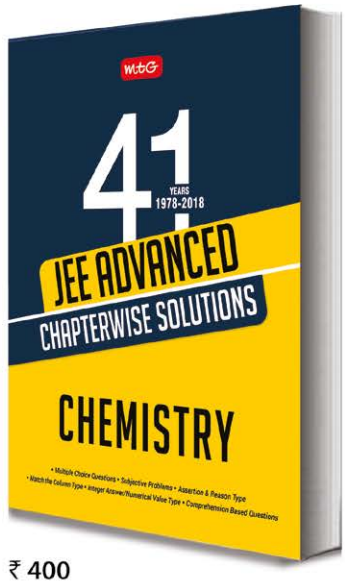

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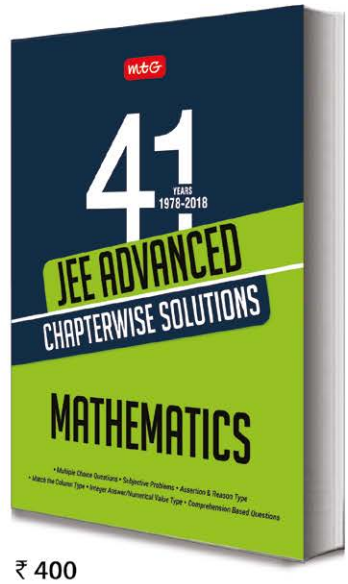

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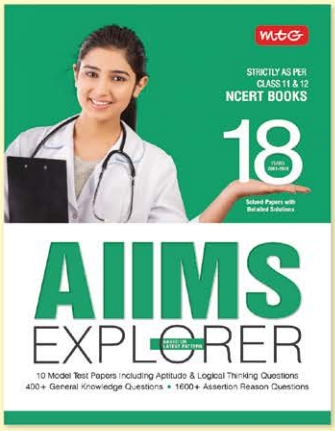

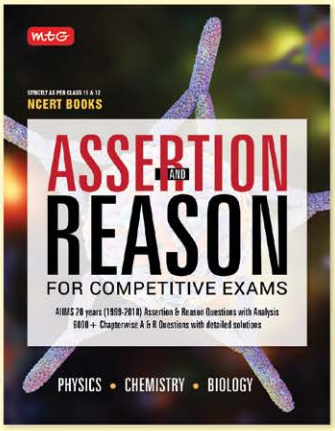

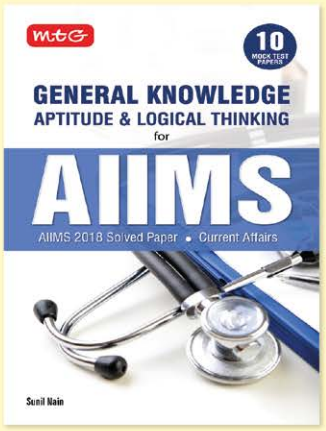

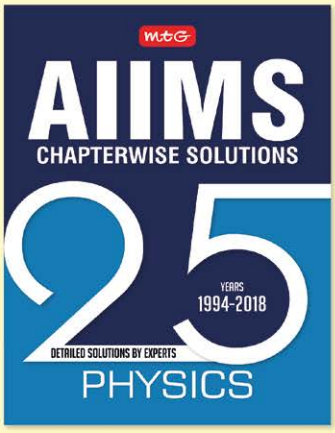

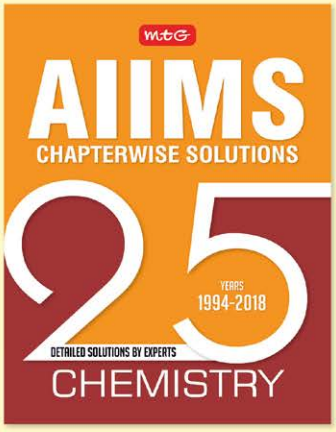

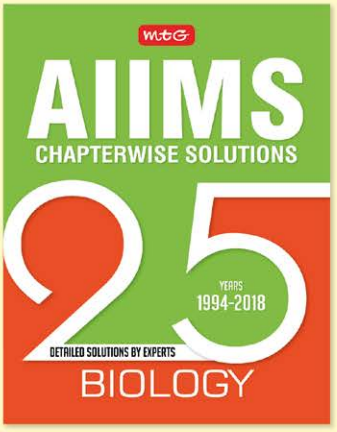

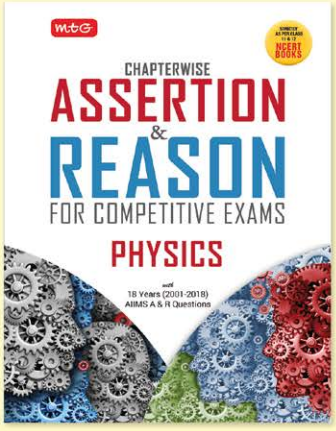

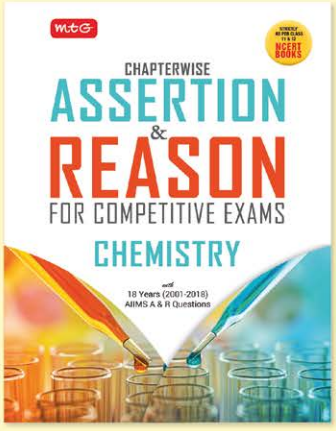

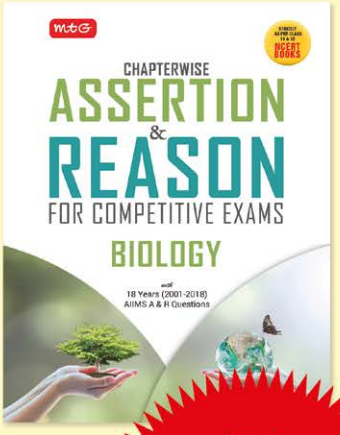

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यशवंत अवारे	यश गाडे	तुषार भोसले	संजिवनी तळेकर	अजय केदार	गणेश कोनाळे	जयंद्र देशमुख	अक्षय गारगोटे	भगवंत शिर्के	महेश कोळेकर	प्रसाद कुलकर्णी	जयराम लांडगे	ऋषीकेश भुते
Chem 157	Chem 156	Chem 155	Chem 152	Chem 152	Chem 150	Chem 147	Chem 147	Chem 147	Chem 146	Chem 145	Chem 145	Chem 143

दिपाली कोव्हाले	दिपांजली भंडारे	अज्मा शेख	राहुल मुळे	प्राज्वल तनगडी	प्राज्वल सारडा	लक्ष्मण इंगळे	विशाल हिंगरूपे	अशिष मडके	चंद्रशेखर बोगले	किशोर सावंत	मोनाली थोरात	वेदांती शेंडगे	नम्रता राजेनिंबाळकर
Chem 142	Chem 142	Chem 142	Chem 142	Chem 141	Chem 141	Chem 141	Chem 141	Chem 141	Chem 140	Chem 140	Chem 140	Chem 140	Chem 140

• JEE Main 2019 (Jan.1st stage) Chemistry Result In Percentile •

Sarthak Deshpande	Simarpreet kaur khalsa	Hake Shivam	Chidrawar Sairaj	Wadikar Gajanan	Bodhankar Sumant	Agrawal Yash	Munde Adinath	Wadkar Bhimashankar	Narwade Tejas	Garudkar Vinayak	Sanket Parshewar	Loharkar Kedar
99.17	97.34	96.66	96.59	95.36	95.32	94.29	93.60	93.53	93.18	93.02	93.00	93.47

Yeilwad Somnath	Shinde Rushikes Parsewar Vaibhav	Pande Sanket	Gundawar Aditya	Madale Ganesh	Goradwar Vijay	Uplanchwar Shreyas	Kattawar Hariharan	Wattamwar Yash	Uplanchwar Shreyas	Kattawar Hariharan	Joshi Janhavi	Devthankar Kedar
93.30	92.00	92.58	92.76	92.88	91.54	91.35	91.35	90.83	91.40	91.35	90.83	90.29	90.11

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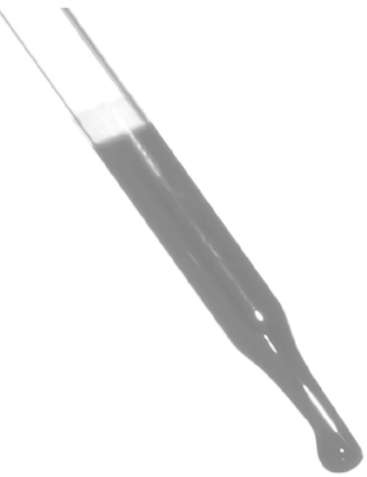

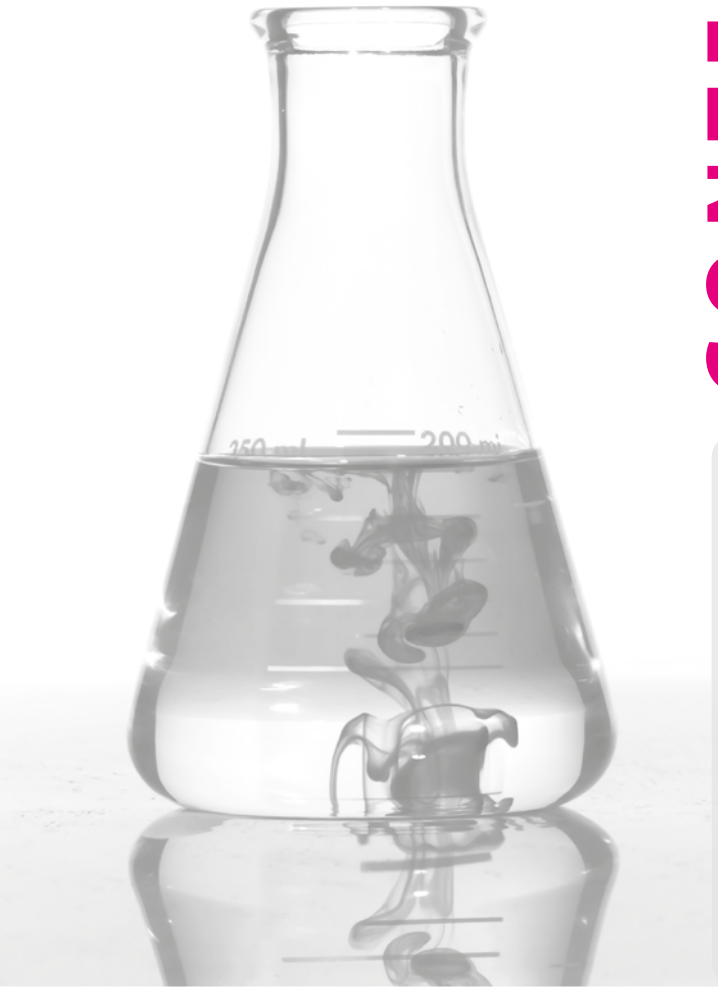

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CHEMISTRY MUSING

PROBLEM SET 70

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JEE MAIN/NEET

1. Two beakers *A* and *B* are present in a closed vessel. Beaker *A* contains 152.4 g aqueous solution of urea, containing 12 g of urea. Beaker *B* contains 196.2 g glucose solution, containing 18 g of glucose. Both solutions are allowed to attain the equilibrium. Determine mass % of glucose in its solution at equilibrium.

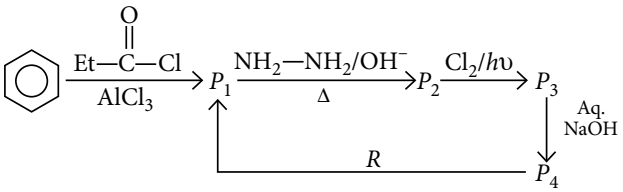
(a) 6.71 (b) 14.49 (c) 16.94 (d) 20

2. When radioactive sulphur is added to an alkaline sodium sulphite solution, radioactive thiosulphate ion is formed. Upon adding Ba^{2+}, a precipitate of BaS_2O_3 is formed. The precipitate is filtered, dried and then treated with acid, producing solid sulphur, SO_2 gas and water. The correct set of product is (* indicates radioactive sulphur)

(a) $SO_2 + S_8$ (b) $SO_2 + S_8^*$

(c) $S^*O_2 + S_8$ (d) $S^*O_2 + S_8^*$

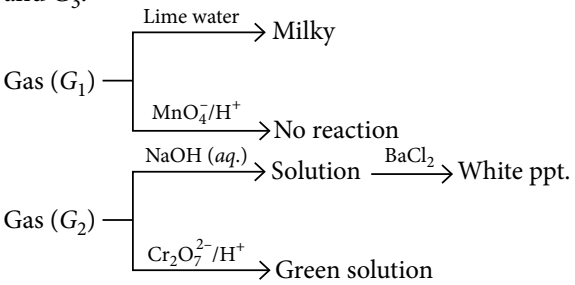
3. Here, reagent "*R*" is

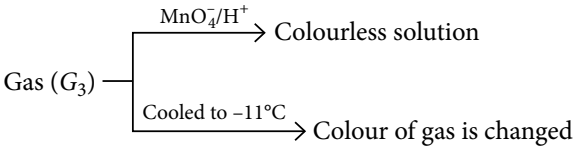


(a) H_2CrO_4 (b) $LiAlH_4$

(c) PCC in CH_2Cl_2 (d) Al_2O_3/623 K

4. Consider the following three dioxide gases G_1, G_2 and G_3.





Which of the following statements is correct?

(a) Gas G_2 is colourless, non-polar, the central atom is sp^3 hybridised.

(b) Gas G_1 is polar, paramagnetic and has linear structure.

(c) Gas G_3 is paramagnetic, coloured and has V-shaped structure.

(d) All of these.

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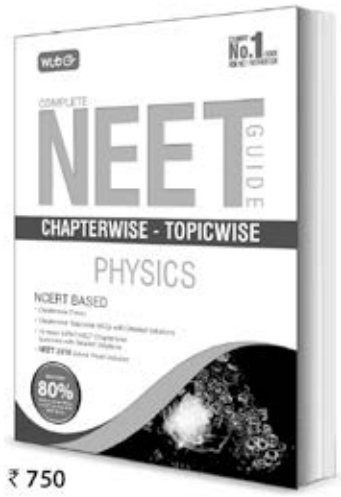

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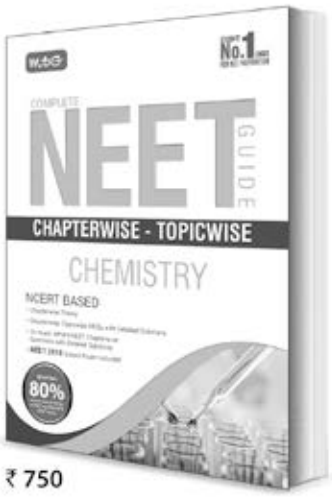

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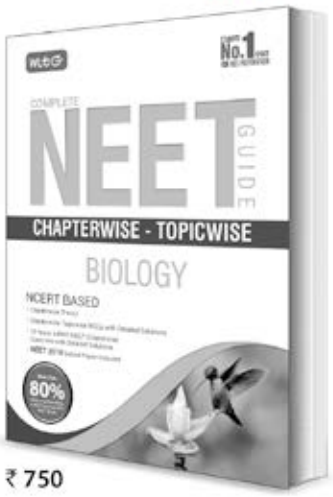

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5. One mole of CH_3COOH undergoes dimerisation in vapour phase at 127 °C as:

$2CH_3COOH_{(g)} \rightleftharpoons (CH_3COOH)_{2(g)}$

Calculate the change in standard entropy during dimerisation, if dimer formation is due to the formation of two H-bonds in dimer, each of 33 kJ strength and the degree of dimerisation of acetic acid is 98.2%.

(a) 52.51 J/mol (b) 85.34 J/mol
(c) 104.10 J/mol (d) 21.60 J/mol

JEE ADVANCED

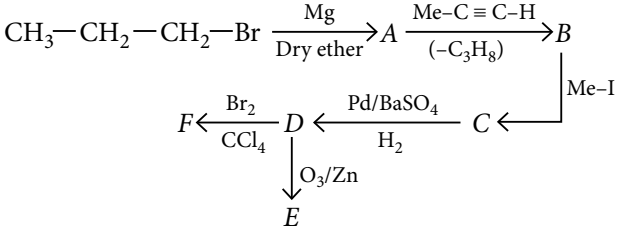
6. A gas mixture of volumetric composition 45% CO, 50% CO_2 and 5% N_2 was passed over ZnO at 1380 K, so that Zn vapours was produced according to the reaction :

$ZnO_{(s)} + CO_{(g)} \rightleftharpoons Zn_{(g)} + CO_{2(g)}$

Under steady condition, the rate of input gas flow at STP is 0.224 $dm^3\ min^{-1}$. The rate of loss of mass of ZnO is 5×10^{-4} mol min^{-1}, $P = 770$ torr. Find K_P at 1380 K assuming ideal gas behaviour.

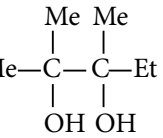
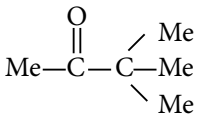
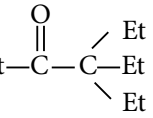
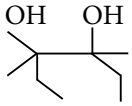
(a) 0.507 atm (b) 0.0664 atm
(c) 0.664 atm (d) 0.325 atm

COMPREHENSION

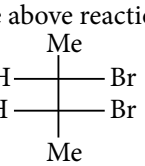
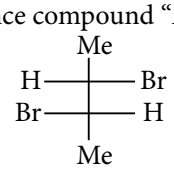
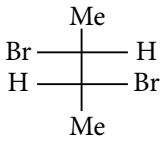


7. $X \xrightarrow[\text{Benzene}]{\text{Mg – Hg}} Y \xrightarrow{H^+} Z$

where X is a functional isomer of "W" which is next higher homologue of "E". Identify Z.

(a) 
(b) 
(c) 
(d) 

8. In the above reaction sequence compound "F" is

(a) 
(b) 
(c) 
(d) both (b) and (c)

NUMERICAL VALUE

9. Hydrolysis of an alkyl halide (RX) by dilute alkali ($\bar{O}H$) takes place simultaneously by S_N2 and S_N1 pathways. A plot of $-\frac{1}{[RX]}\frac{d[RX]}{dt}$ *vs* $[\bar{O}H]$ is a straight line of the slope equal to 2×10^3 $mol^{-1}\ L\ hr^{-1}$ and intercept equal to 1×10^2 hr^{-1}. Calculate the initial rate (mole L^{-1} sec^{-1}) of consumption of RX when the reaction is carried out taking 1 mol L^{-1} of RX and 0.1 mol L^{-1} of $\bar{O}H$ ions.

10. Consider the following complex :

Dichloro*bis*(ethylenediamine)chromium (III) chloride

Number of electrons in e_g orbital = X

One mole complex $\xrightarrow[\text{(Excess)}]{AgNO_3}$ Y mole of AgCl

Total stereoisomeric forms of above complex = Z

Find the sum of $(X + Y + Z)$.

NEET score now valid for three years for undergraduate foreign medical degree

National Eligibility cum Entrance Test (NEET) score is valid for three years for Indian students wanting to pursue undergraduate medical course abroad.

Clearing the long-existing confusion about the validity of NEET score, a notification by the Medical Council of India — Board of Governors stated: "Result of NEET shall be valid for a period of three years from the date of declaration of result, entitling a candidate to pursue MBBS or equivalent medical course including pre-medical/language course, if any, followed by MBBS or equivalent medical course." About 7,000 students opt for foreign medical degree from India annually. The notification further said that "these regulations may be called the "Eligibility Requirement for Taking Admission in an Undergraduate Medical Course in a Foreign Medical Institution (Amendment) Regulation, 2019."

Meanwhile, these latest amendments are to come into force from March 14, 2019, the date of publication in the official Gazette. Last March the MCI, in its notification said: "Indian Citizens/Overseas Citizen of India intending to obtain primary medical qualification from any medical institution outside India, on or after May 2018, shall have to mandatorily qualify the NEET for admission to MBBS course besides fulfilling the eligibility criteria for admission to the MBBS course prescribed in the Regulations on Graduate Medical Education, 1997." The MCI got 18,383 applications in 2017-18 against 10,555 applications in the previous year. The council issued 14,118 eligibility certificates in 2017-18, compared to 8,737 in 2016- 2017.

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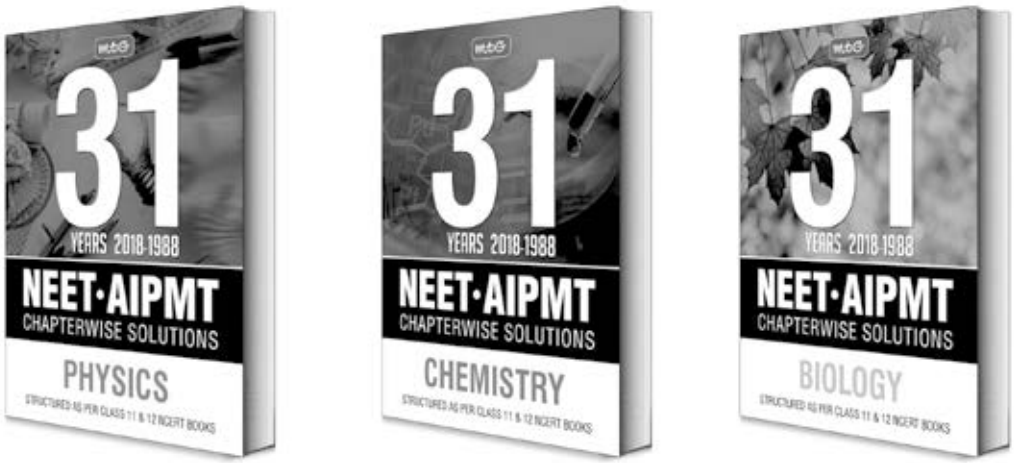

31 Years' NEET• AIPMT Physics, Chemistry & Biology contain not only chapterwise questions that have appeared over the last 31 years in NEET/AIPMT, but also full solutions, that too by experts. Needless to say, these question banks are essential for any student to compete successfully in NEET.

HIGHLIGHTS:

- Chapterwise questions of last 31 years' (2018-1988) of NEET/AIPMT
- Chapterwise segregation of questions to help you assess the level of effort required to succeed
- An unmatched question bank series with close to 1,000 pages having detailed solutions by experts
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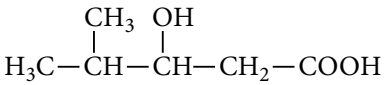
JEE 2019 MAIN

Held on 8th April (Morning Shift)

SOLVED PAPER

1. The IUPAC name of the following compound is

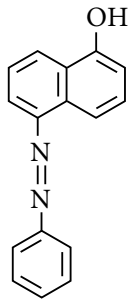


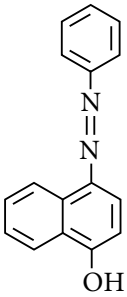
(a) 2-methyl-3-hydroxypentan-5-oic acid
(b) 4,4-dimethyl-3-hydroxybutanoic acid
(c) 4-methyl-3-hydroxypentanoic acid
(d) 3-hydroxy-4-methylpentanoic acid.

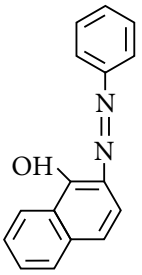
2. Which is wrong with respect to our responsibility as a human being to protect our environment?
(a) Avoiding the use of floodlighted facilities
(b) Setting up compost tin in gardens
(c) Using plastic bags
(d) Restricting the use of vehicles.

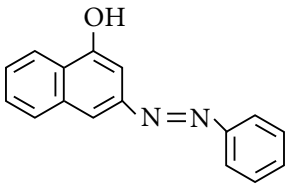
3. In the following compounds, the decreasing order of basic strength will be
(a) $(C_2H_5)_2NH > NH_3 > C_2H_5NH_2$
(b) $(C_2H_5)_2NH > C_2H_5NH_2 > NH_3$
(c) $C_2H_5NH_2 > NH_3 > (C_2H_5)_2NH$
(d) $NH_3 > C_2H_5NH_2 > (C_2H_5)_2NH$

4. Coupling of benzene diazonium chloride with 1-naphthol in alkaline medium will give

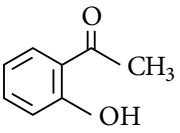
(a) 

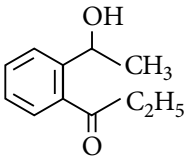
(b) 

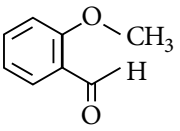
(c) 

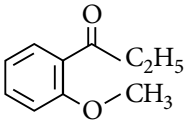
(d) 

5. An organic compound neither reacts with neutral ferric chloride solution nor with Fehling solution. It however, reacts with Grignard reagent and gives positive iodoform test. The compound is

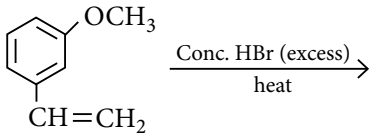
(a) 

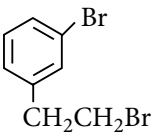
(b) 

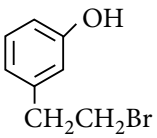
(c) 

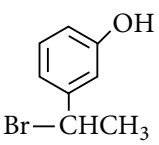
(d) 

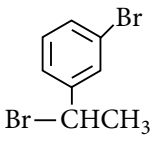
6. The major product of the following reaction is



(a) 

(b) 

(c) 

(d) 

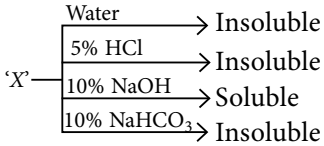
7. Maltose on treatment with dilute HCl gives
(a) *D*-glucose and *D*-fructose
(b) *D*-fructose
(c) *D*-glucose
(d) *D*-galactose.

8. Given that $E^{\circ}_{O_2/H_2O} = +1.23$ V;
$E^{\circ}_{S_2O_8^{2-}/SO_4^{2-}} = 2.05$ V;
$E^{\circ}_{Br_2/Br^-} = +1.09$ V ; $E^{\circ}_{Au^{3+}/Au} = +1.4$ V
The strongest oxidizing agent is
(a) $S_2O_8^{2-}$ (b) O_2 (c) Br_2 (d) Au^{3+}

9. Element '*B*' forms *ccp* structure and '*A*' occupies half of the octahedral voids, while oxygen atoms occupy all the tetrahedral voids. The structure of bimetallic oxide is
(a) AB_2O_4 (b) A_4B_2O (c) A_2B_2O (d) A_2BO_4

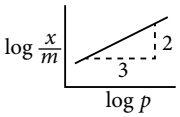
10. In order to oxidise a mixture of one mole of each of FeC_2O_4, $Fe_2(C_2O_4)_3$, $FeSO_4$ and $Fe_2(SO_4)_3$ in acidic medium, the number of moles of $KMnO_4$ required is
(a) 2 (b) 1.5 (c) 3 (d) 1

11. An organic compound '*X*' showing the following solubility profile is



(a) *o*-toluidine (b) oleic acid
(c) benzamide (d) *m*-cresol.

12. Adsorption of a gas follows Freundlich adsorption isotherm. *x* is the mass of the gas adsorbed on mass *m* of the adsorbent.

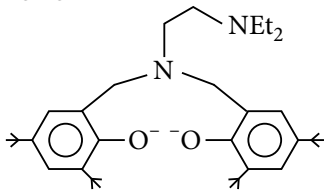


The plot of $\log \frac{x}{m}$ versus $\log p$ is shown in the given graph. $\frac{x}{m}$ is proportional to
(a) p^2 (b) p^3 (c) $p^{2/3}$ (d) $p^{3/2}$

13. The quantum numbers of four electrons are given below :
I. $n = 4, l = 2, m_l = -2, m_s = -1/2$
II. $n = 3, l = 2, m_l = -2, m_s = +1/2$
III. $n = 4, l = 1, m_l = 0, m_s = +1/2$
IV. $n = 3, l = 1, m_l = 1, m_s = -1/2$
The correct order of their increasing energies will be
(a) IV < II < III < I (b) IV < III < II < I
(c) I < III < II < IV (d) I < II < III < IV

14. With respect to ore, Ellingham diagram helps to predict the feasibility of its
(a) zone refining (b) thermal reduction
(c) electrolysis (d) vapour phase refining.

15. The following ligand is



(a) hexadentate (b) tetradentate
(c) bidentate (d) tridentate.

16. The correct order of hydration enthalpies of alkali metal ions is
(a) $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$
(b) $Na^+ > Li^+ > K^+ > Rb^+ > Cs^+$
(c) $Na^+ > Li^+ > K^+ > Cs^+ > Rb^+$
(d) $Li^+ > Na^+ > K^+ > Cs^+ > Rb^+$

17. For silver, $C_p(J\ K^{-1}\ mol^{-1}) = 23 + 0.01\ T$. If the temperature ($T$) of 3 moles of silver is raised from 300 K to 1000 K at 1 atm pressure, the value of ΔH will be close to
(a) 13 kJ (b) 16 kJ (c) 62 kJ (d) 21 kJ

18. If solubility product of $Zr_3(PO_4)_4$ is denoted by K_{sp} and its molar solubility is denoted by *S*, then which of the following relations between *S* and K_{sp} is correct?
(a) $S = \left(\frac{K_{sp}}{144}\right)^{1/6}$ (b) $S = \left(\frac{K_{sp}}{216}\right)^{1/7}$
(c) $S = \left(\frac{K_{sp}}{929}\right)^{1/9}$ (d) $S = \left(\frac{K_{sp}}{6912}\right)^{1/7}$

EXAM ALERT 2019

Exam	Date
NEET	5th May
COMEDK (Engg.)	12th May
MHT-CET	2nd to 13th May
BITSAT	16th to 26th May
AIIMS	25th & 26th May
AMU (Engg.)	26th May **(Revised)**
WB JEE	26th May
JEE Advanced	27th May **(Revised)**
JIPMER	2nd June

19. Which one of the following equations does not correctly represent the first law of thermodynamics for the given processes involving an ideal gas? (Assume non-expansion work is zero)

(a) Adiabatic process : $\Delta U = -w$

(b) Isochoric process : $\Delta U = q$

(c) Isothermal process : $q = -w$

(d) Cyclic process : $q = -w$

20. The correct order of the spin-only magnetic moment of metal ions in the following low-spin complexes, $[V(CN)_6]^{4-}$, $[Fe(CN)_6]^{4-}$, $[Ru(NH_3)_6]^{3+}$, and $[Cr(NH_3)_6]^{2+}$, is

(a) $Cr^{2+} > Ru^{3+} > Fe^{2+} > V^{2+}$

(b) $V^{2+} > Ru^{3+} > Cr^{2+} > Fe^{2+}$

(c) $Cr^{2+} > V^{2+} > Ru^{3+} > Fe^{2+}$

(d) $V^{2+} > Cr^{2+} > Ru^{3+} > Fe^{2+}$

21. The lanthanide ion that would show colour is

(a) Lu^{3+} (b) Sm^{3+} (c) La^{3+} (d) Gd^{3+}

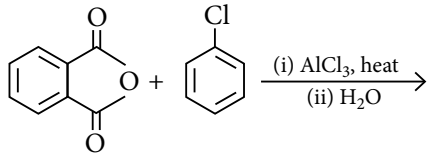
22. For the reaction $2A + B \rightarrow C$, the values of initial rate at different reactant concentrations are given in the table below. The rate law for the reaction is

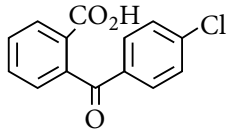
$[A]$ (mol L^{-1})	$[B]$ (mol L^{-1})	Initial Rate (mol L^{-1} s^{-1})
0.05	0.05	0.045
0.10	0.05	0.090
0.20	0.10	0.72

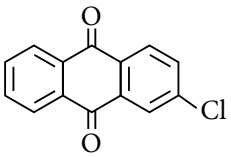
(a) Rate = $k[A]^2[B]^2$ (b) Rate = $k[A][B]$

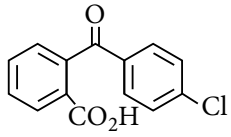
(c) Rate = $k[A][B]^2$ (d) Rate = $k[A]^2[B]$

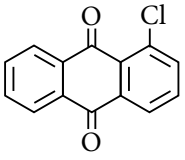
23. The major product of the following reaction is



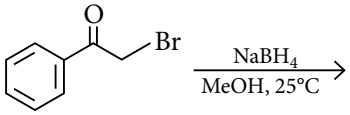
(a) 

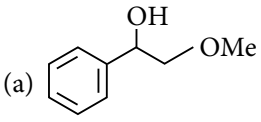
(b) 

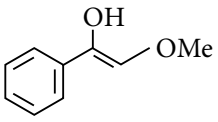
(c) 

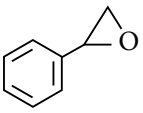
(d) 

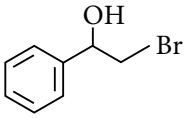
24. The major product of the following reaction is



(a) 

(b) 

(c) 

(d) 

25. Which of the following amines can be prepared by Gabriel phthalimide reaction?

(a) Triethylamine (b) *n*-Butylamine

(c) *t*-Butylamine (d) *neo*-Pentylamine

26. The size of the iso-electronic species Cl^-, Ar and Ca^{2+} is affected by

(a) principal quantum number of valence shell

(b) nuclear charge

(c) electron-electron interaction in the outer orbitals

(d) azimuthal quantum number of valence shell.

27. Diborane (B_2H_6) reacts independently with O_2 and H_2O to produce, respectively

(a) HBO_2 and H_3BO_3 (b) B_2O_3 and H_3BO_3

(c) B_2O_3 and $[BH_4]^-$ (d) H_3BO_3 and B_2O_3

28. **Assertion :** Ozone is destroyed by CFCs in the upper stratosphere.

Reason : Ozone holes increase the amount of UV radiation reaching the earth.

(a) Assertion and reason are correct, but the reason is not the explanation for the assertion.

(b) Assertion is false, but the reason is correct.

(c) Assertion and reason are incorrect.

(d) Assertion and reason are both correct and the reason is the correct explanation for the assertion.

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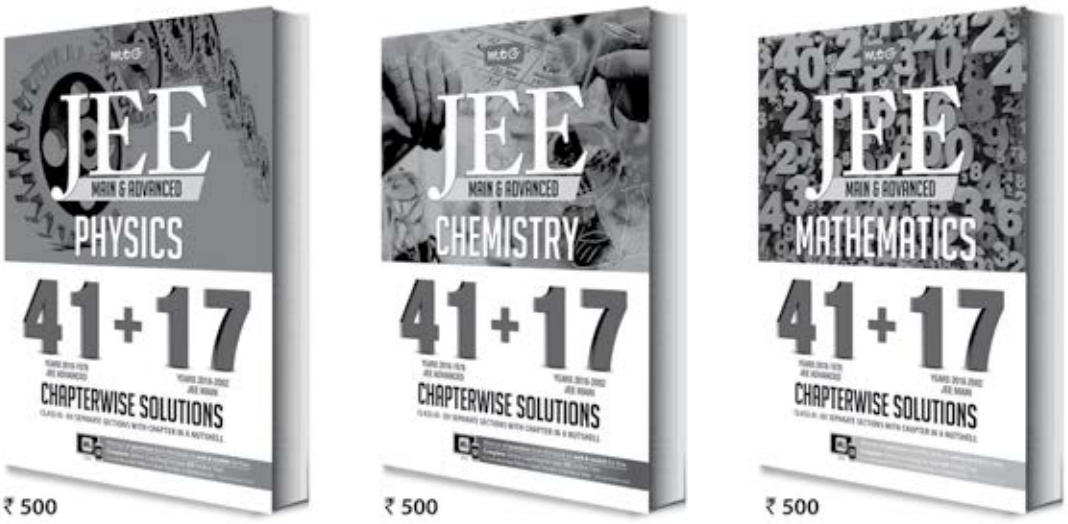

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29. The vapour pressures of pure liquids *A* and *B* are 400 and 600 mmHg, respectively at 298 K. On mixing the two liquids, the sum of their initial volumes is equal to the volume of the final mixture. The mole fraction of liquid *B* is 0.5 in the mixture. The vapour pressure of the final solution, the mole fractions of components *A* and *B* in vapour phase, respectively are

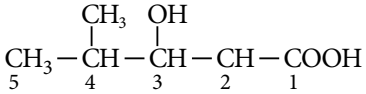
(a) 450 mmHg, 0.5, 0.5
(b) 450 mmHg, 0.4, 0.6
(c) 500 mmHg, 0.5, 0.5
(d) 500 mmHg, 0.4, 0.6

30. 100 mL of a water sample contains 0.81 g of calcium bicarbonate and 0.73 g of magnesium bicarbonate. The hardness of this water sample expressed in terms of equivalents of $CaCO_3$ is
(Molar mass of calcium bicarbonate is 162 g mol^{-1} and magnesium bicarbonate is 146 g mol^{-1}.)

(a) 10,000 ppm (b) 100 ppm
(c) 1,000 ppm (d) 5,000 ppm

SOLUTIONS

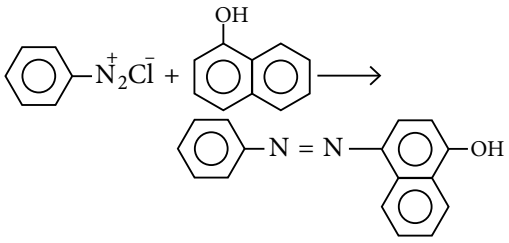
1. (d) :



3-Hydroxy-4-methylpentanoic acid

2. (c) **3. (b)**

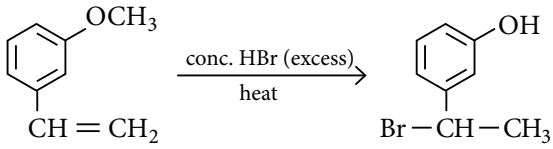
4. (b) :



(Orange-solution, red dye)

5. (b) : As the compound does not react with $FeCl_3$ thus it is not phenol. As the compound reacts with Grignard reagent, but does not react with Fehling solution so it should be a ketone.
As it gives positive iodoform test, so it should contain $CH_3-\underset{\underset{O}{\|}}{C}-$ or $CH_3-\underset{\underset{OH}{|}}{CH}-$ group. Thus, the correct answer is (b).

6. (c) : Ether undergoes cleavages on reaction with HBr and addition of HBr takes place on alkene according to Markovnikov's rule.



7. (c) : Maltose is formed by the condensation of two molecules of *D*-glucose. Thus it will give *D*-glucose on treatment with dil. HCl.

8. (a) : Greater is the reduction potential (+ve), more easily is the substance (element or ion) reduced or in other words, strongest oxidising agent it is. Thus the strongest oxidising agent among the given substances is $S_2O_8^{2-}$.

9. (a) : Number of atoms per unit cell in *ccp* = $N = 4$
Number of octahedral voids = $N = 4$
A occupies half of the octahedral voids, thus *A* atoms per unit cell = 4/2 = 2
Tetrahedral voids = $2 \times N = 8$
So number of oxygen atoms = 8
A:*B*:O :: 2 : 4 : 8
Thus, structure of bimetallic oxide is AB_2O_4.

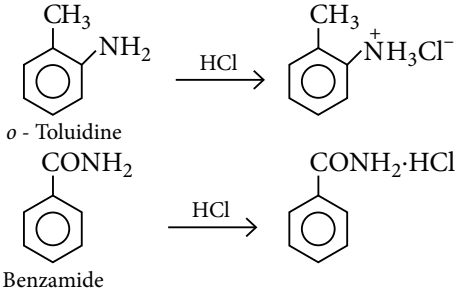
10. (a) : $FeC_2O_4 \rightleftharpoons Fe^{2+} + C_2O_4^{2-}$
For 1 mol of Fe^{2+}, 2/10 mol of $KMnO_4$ is needed and for 1 mol of $C_2O_4^{2-}$, 2/5 mol of $KMnO_4$ is needed.
So for 1 mol FeC_2O_4,

moles of $KMnO_4$ required = $\frac{2}{10}+\frac{2}{5}=\frac{6}{10}$

$Fe_2(C_2O_4)_3 \rightleftharpoons 2Fe^{3+} + 3C_2O_4^{2-}$
Fe^{3+} is not affected by $KMnO_4$.
For 3 $C_2O_4^{2-}$, moles of $KMnO_4$ needed = $3\times\frac{2}{5}$ moles
1 Mole of $FeSO_4$ requires = 2/10 moles of $KMnO_4$
$Fe_2(SO_4)_3$ is not oxidised by $KMnO_4$.

So total moles of $KMnO_4$ = $\frac{6}{10}+\frac{6}{5}+\frac{2}{10}=\frac{6+12+2}{10}$
= 2 moles

11. (d) : Organic compounds are mostly insoluble in water. As the compound is insoluble in HCl, thus it should be an acid, as bases are soluble in acid (HCl).



o - Toluidine

Benzamide

Oleic acid, $CH_3(CH_2)_7CH = CH(CH_2)_7 COOH$ being an acid can react with both NaOH and $NaHCO_3$. But *m*-cresol being weakly acidic, is soluble only in NaOH but not in $NaHCO_3$.

12. (c) : For a plot between log x/m and log p slope is given by $1/n$.

Thus from the plot $\frac{1}{n} = \frac{y_2 - y_1}{x_2 - x_1} = 2/3$

and $x/m \propto p^{1/n} \propto p^{2/3}$

13. (a) : Higher the value of n, higher will be the energy. If n is same, then higher the value of $(n + l)$, higher will be the energy. Thus the increasing order of energy is IV < II < III < I

14. (b) : Ellingham diagrams help us in predicting the feasibility of thermal reduction of an ore.

15. (b)

16. (a) : As the degree of hydration decreases from Li^+ to Cs^+, the hydration energy of alkali metal ions also decreases from Li^+ to Cs^+.

17. (c) : $\Delta H = nC_p\Delta T = 3(23 + 0.01T)\ \Delta T$

ΔH for heating 3 moles of silver from 300 K (T_1) to 1000 K (T_2)

$$\Delta H = \int_{T_1}^{T_2} 3(23+0.01T)\Delta T = 3\left(23T + 0.01\frac{T^2}{2}\right)_{T_1}^{T_2}$$

$$= 3\left[\left(23\times1000 + 0.01\times\frac{1000\times1000}{2}\right) - \left(23\times300 + 0.01\times\frac{300\times300}{2}\right)\right]$$

$= 3[(23000 + 5000) - (6900 + 450)]$

$= 3 \times 20650 = 61950\ J \approx 62\ kJ$

18. (d) : $Zr_3(PO_4)_4 \rightleftharpoons 3Zr^{4+} + 4PO_4^{3-}$

$3s \qquad 4s$

$K_{sp} = (3s)^3\ (4s)^4$

$= (27s^3)(256s^4) = 6912s^7$

$S = (K_{sp}/6912)^{1/7}$

19. (a) : According to first law of thermodynamics

$\Delta U = q + w$

For adiabatic process, $q = 0$

$\Delta U = w$

For isochoric process, $\Delta V = 0$, $w = 0$

thus, $\Delta U = q$

For isothermal process, $\Delta U = 0$, thus $q = -w$

For cyclic process, $\Delta U = 0$; thus $q = -w$

20. (d) : $[V(CN)_6]^{4-}$ *i.e.*, $V^{2+} \Rightarrow 3d^3$

Magnetic moment (μ) = $\sqrt{3(3+2)} = \sqrt{15} = 3.87$ B.M.

$[Fe(CN)_6]^{4-}$ *i.e.* $Fe^{2+} \Rightarrow 3d^6$

Unpaired electrons = 0

$\mu = 0$

$[Ru(NH_3)_6]^{3+}$ *i.e.* $Ru^{3+} \Rightarrow 4d^5$

Unpaired electron = 1

$\mu = \sqrt{1(1+2)} = \sqrt{3} = 1.73$

$[Cr(NH_3)_6]^{2+}$ *i.e.* $Cr^{2+} \Rightarrow 3d^4$

Unpaired electrons = 2

$\mu = \sqrt{2(2+2)} = \sqrt{6} = 2.45$

Thus, the correct order is,

$V^{2+} > Cr^{2+} > Ru^{3+} > Fe^{2+}$

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21. (b) : La^{3+} $(4f^0)$
Gd^{3+} $(4f^7)$ ⎫ ⎬ Colorless
Lu^{3+} $(4f^{14})$ ⎭
Sm^{3+} $(4f^5)$ $\Rightarrow$ Yellow coloured

22. (c) : From the given experiments,

$\text{Rate}_1 = k(0.05)^a\ (0.05)^b = 0.045$ ...(i)

$\text{Rate}_2 = k(0.10)^a\ (0.05)^b = 0.090$ ...(ii)

$\text{Rate}_3 = k(0.20)^a\ (0.10)^b = 0.72$ ...(iii)

From eq. (i) and (ii)

$$\frac{0.090}{0.045} = \frac{(0.10)^a}{(0.05)^a} \Rightarrow = 2^a \Rightarrow a = 1$$

From eq. (ii) and (iii)

$$\frac{0.72}{0.090} = \frac{(0.20)^a}{(0.10)^a}\frac{(0.10)^b}{(0.05)^b}$$

$8 = 2^a 2^b$ $(\because 2^a = 2)$

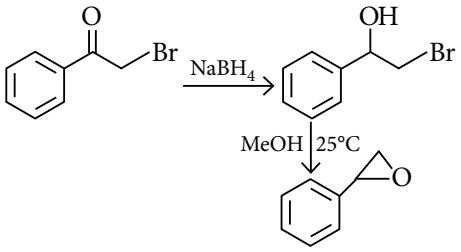
$$\frac{8}{2} = 2^b \Rightarrow 2^b = 4 \Rightarrow b = 2$$

Thus rate law is,

$\text{Rate} = k[A]\ [B]^2$

23. (c)

24. (c) :



25. (b)

26. (b) : As nuclear charge increases, the electrons are attracted more strongly and drawn inwards, so in isoelectronic ions the size of ion decreases as the nuclear charge increases.

27. (b) : $B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O + \text{heat}$

$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$

28. (a)

29. (d) : According to Raoult's law:

$P = P^\circ_A X_A + P^\circ_B X_B$

If $X_B = 0.5$ then $X_A = 1 - 0.5 = 0.5$

$P^\circ_A = 400$ mmHg $P^\circ_B = 600$ mmHg

$P = 0.5\ (400) + 0.5\ (600)$

$P = 200 + 300 = 500$ mmHg

Mole fraction in vapour phase can be given as

$$Y_A = \frac{X_A P^\circ_A}{P} = \frac{0.5 \times 400}{500} = 0.4$$

$$Y_B = \frac{X_B P^\circ_B}{P} = \frac{0.5 \times 600}{500} = 0.6$$

30. (a) : ppm of $CaCO_3$ =

$$\frac{\left(\frac{0.73}{146} + \frac{0.81}{162}\right) \times 100}{100} \times 10^6 = 10^4 \text{ ppm}$$

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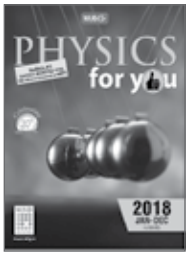

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PRACTICE PAPER

Exam on 27th May

PAPER - I

Section 1 (Maximum Marks : 24)

- *This section contains SIX (06) questions.*
- *Each question has FOUR options for correct answer(s). ONE OR MORE THAN ONE of these four option(s) is (are) correct option(s).*
- *For each question, choose the correct option(s) to answer the question.*

Answer to each question will be evaluated according to the following marking scheme :

Full Marks :	+4	*If only (all) the correct option(s) is (are) chosen.*
Partial Marks :	+3	*If all the four options are correct but ONLY three options are chosen.*
Partial Marks :	+2	*If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
Partial Marks :	+1	*If two or more options are correct but ONLY one option is chosen and it is a correct option.*
Zero Marks :	0	*If none of the options is chosen (i.e. the question is unanswered).*
Negative Marks :	–2	*In all other cases.*

- *For Example : If first, third and fourth are the ONLY three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in -2 marks.*

1. In which of the following reaction(s), complete inversion takes place?

(a) $CH_3-\underset{\underset{H}{|}}{\overset{\overset{C_2H_5}{|}}{C}}-OH + SOCl_2 \xrightarrow{\text{pyridine}} CH_3-\underset{\underset{H}{|}}{\overset{\overset{C_2H_5}{|}}{C}}-Cl$

(b) $CH_3\underset{\underset{Br}{|}}{\overset{\overset{O}{\|}}{C}}HCO^- \xrightarrow{Ag^+} CH_3CH-\overset{\overset{O}{\diagup\diagdown}}{C}=O$

$CH_3\underset{\underset{OH}{|}}{C}HCOO^- \xleftarrow{\bar{O}H}$

(c) $C_6H_5CH_2\underset{\underset{OH}{|}}{C}HCH_3 \xrightarrow{\text{Base}} C_6H_5CH_2\underset{\underset{O^-}{|}}{C}HCH_3$

$C_6H_5CH_2\underset{\underset{OCH_3}{|}}{C}HCH_3 \xleftarrow{CH_3Br}$

(d) $C_6H_5CH_2CH_2CH_2OTs \xrightarrow{C_2H_5O^-} C_6H_5CH_2CH_2CH_2OC_2H_5$

2. A powdered substance (*A*) on treatment with fusion mixture gives a green coloured compound (*B*). The compound (*B*) on acidification with dilute H_2SO_4 gives a pink coloured compound (*C*). When (*A*) is treated with excess of NaOH and bromine water, (*D*) is obtained. Solution of (*A*) in dilute HCl on treatment with a solution of barium chloride gave a white precipitate of (*E*), which was insoluble in conc. HNO_3 and conc. HCl.

Then, which of the following is/are correct?

(a) *B* is Na_2MnO_4 (b) *E* is $MnSO_4$

(c) *D* is MnO_2 (d) *C* is $NaMnO_4$

3. In the following reactions,

I. $FeSO_4 + NO + H_2O \rightarrow X$

II. Sodium nitroprusside + $Na_2S \rightarrow Y$

Which of the following statement(s) is (are) correct?

(a) Products *X* and *Y* both are paramagnetic.

(b) In the reaction I change of oxidation state of central atom occurs while in reaction (II) there is no change in oxidation state.

(c) *X* is brown and *Y* is violet in colour.

(d) Magnetic moment of compound *X* is $\sqrt{15}$.

4. 11.2 g of a mixture of *M*Cl (volatile) and NaCl gave 28.7 g white ppt. with excess of $AgNO_3$ solution. 11.2 g of same mixture on heating gave a gas that on passing through $AgNO_3$ solution gave 14.35 g white ppt. Hence,
   (a) atomic mass of *M* is 18
   (b) mixture has 5.35 g of *M*Cl
   (c) weight of NaCl in the mixture is 5.35 g.
   (d) atomic mass of *M* is 10.

5. In which of the following option(s) all species contains *X* — O — *X* bond(s) in the structure?
   (*X* = central atom)
   (a) $H_2S_2O_6$, S_3O_9, $S_2O_6^{2-}$
   (b) P_4O_{10}, P_4O_6, $H_5P_3O_{10}$
   (c) N_2O_5, N_2O, N_2O_4
   (d) S_3O_9, P_4O_6, $Si_2O_7^{6-}$

6. Which of the following statements is/are incorrect?
   (a) Cassiterite, chromite and pitchblende are concentrated by hydraulic washing (Tabling)
   (b) Pure Al_2O_3 is obtained from the bauxite ore by leaching in the Baeyer's process
   (c) Sulphide ore is concentrated by calcination method
   (d) Roasting can convert sulphide into oxide or sulphate and part of sulphide may also act as a reducing agent

Section 2 (Maximum Marks : 24)

- *This section contains EIGHT (08) questions. The answer to each question is a NUMERICAL VALUE.*
- *For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g., 6.25, 7.00, -0.33, -.30, 30.27, -127.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.*

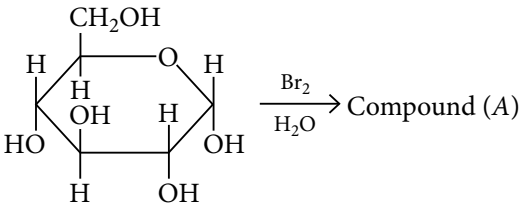
Answer to each question will be evaluated according to the following marking scheme :

Full Marks : +3 *If ONLY the correct numerical value is entered as answer.*

Zero Marks : 0 *In all other cases.*

7. The wavelength of photoelectric threshold energy of a metal is 230 nm. The *K.E.* (in Joule) of the photoelectron ejected from the surface by U.V. radiation emitted from the 2nd longest wavelength transition of electron in Lyman series of atomic spectrum of hydrogen is _____.
   ($R = 1.09677 \times 10^7\ m^{-1}$)

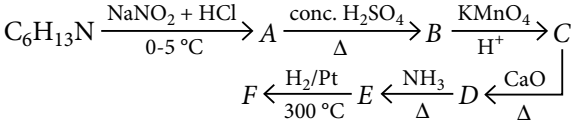
8. Number of chiral centre in compound *A* is _____.



9. A first order reaction $A \rightarrow B$, requires activation energy of 70 kJ mol^{-1}. When a 20% solution of *A* was kept at 25°C for 20 minutes, 25% decomposition took place. The per cent decomposition in same time of a 30% solution maintained at 40°C is ____. (Assume that activation energy remains constant in this range of temperature.)

10. If the melting point of water decreases by 0.0075 K atm^{-1} for every increase in pressure by 1 atm, then the enthalpy of fusion of ice (in kJ) is ____. (Given : the density of water is 1000 g/dm^3 and that of ice is 916.96 g/dm^3, 1 J = 9.87×10^{-7} dm^3 atm)

11. A cyclic 1° amine, $C_6H_{13}N$ undergoes the following sequence of reactions and the end product *F* is an *x*-membered ring. The value of *x* is_____.



12. When 3.06 g of solid NH_4HS is introduced into a two litre evacuated flask at 27°C, 30% of the solid decomposes into gaseous ammonia and hydrogen sulphide. K_p for the reaction at 27°C is_____.

13. A compound (*X*) when heated with conc. H_2SO_4 gives a gaseous product, which under pressure forms sodium methanoate with NaOH. The number of compounds from the following which can act as *X* is _____.
    HCOOH, $K_4[Fe(CN)_6]$, $H_2C_2O_4$, $CH_2(COOH)_2$

14. Ionic solid Na^+A^- crystallise in rock salt type structure. 2.592 g of ionic solid salt Na*A* dissolved in water to make 2 L solution. The pH of this solution is 8.5. If distance between cation and anion is 300 pm, the density of ionic solid (in g/cm^3) is _____.
    (Given : $pK_w = 14$, $pK_a(HA) = 5$, $N_A = 6 \times 10^{23}$)

Section 3 (Maximum Marks : 12)

- *This section contains TWO (02) paragraphs. Based on each paragraph, there are TWO (02) questions.*
- *Each question has FOUR options. ONLY ONE of these four options corresponds to the correct answer.*
- *For each question, choose the option corresponding to the correct answer.*

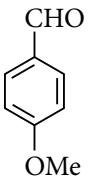
Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	*+3*	*If ONLY the option corresponding to the correct matching is chosen.*
Zero Marks :	*0*	*If none of the options is chosen (i.e., the question is unanswered).*
Negative Marks :	*–1*	*In all other cases.*

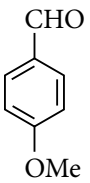
PARAGRAPH-I

A compound (*X*) having the molecular formula $C_{10}H_{12}O$ when reacted with HI followed by reaction with $AgNO_3$ gave AgI. It was found that one mole of the compound gave one mole of AgI during the above process. Compound (*X*) gives only one mononitro product. Compound (*X*) on ozonolysis followed by reaction with H_2O in the presence of Zn gave compound (*Y*) and (*Z*). Compound (*Z*) gave a yellow ppt. on reaction with I_2 in the presence of NaOH. Also compound (*Z*) on reaction with Tollens' reagent gave compound (*A*) which on decarboxylation gave CH_4. Compound (*Y*) on reaction with CH_3NO_2 gave a compound (*U*) in the presence of OH^-, on heating. Compound (*U*) was hydrogenated using Ni as catalyst to give compound (*V*). Compound (*V*) on heating with HI and followed by acidification gave a *p*-amine (*W*) containing a phenolic group.

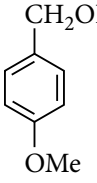
15. The compounds (*Y*) and (*Z*) must be

(a) 

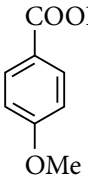
and HCHO respectively

(b) 

and CH_3CHO respectively

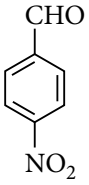
(c) 

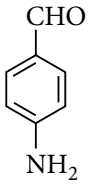
and CH_3CHO respectively

(d) 

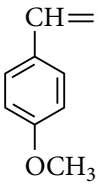
and CH_3CHO respectively.

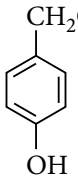
16. The compounds (*U*) and (*W*) must be

(a) 

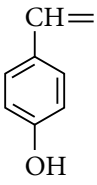
and 

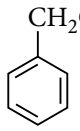
respectively

(b) 

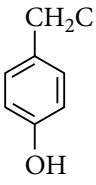
and 

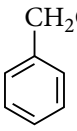
respectively

(c) 

and 

respectively

(d) 

and 

respectively.

PARAGRAPH-II

A colourless water soluble crystalline solid (*A*) on heating gives O_2 and gives a water soluble crystalline solid (*B*). Both *A* and *B* impart violet coloration to the Bunsen flame. When *B* is heated with NH_4Cl, inactive gas (*C*) is obtained but when *A* is heated with NH_4Cl, a gas (*D*) which supports combustion is formed. When gas (*D*) is heated with sodium amide, solid substance (*E*) is obtained. The solid (*E*), when heated with dil. H_2SO_4, forms a monobasic acid (*F*), *F* and its salts are explosive.

17. *A* and *C* respectively are

(a) $AgNO_3$ and NO_2
(b) KNO_3 and N_2
(c) $NaNO_2$ and N_2
(d) KNO_2 and N_2

18. The solid substance *E* is

(a) $NaHSO_4$ (b) N_3H
(c) NaN_3 (d) $NaNO_2$

Section 1 (Maximum Marks : 24)

- *This section contains SIX (06) questions.*
- *Each question has FOUR options for correct answer(s). ONE OR MORE THAN ONE of these four option(s) is (are) correct option(s).*
- *For each question, choose the correct option(s) to answer the question.*

Answer to each question will be evaluated according to the following marking scheme:

Full Marks :	*+4*	*If only (all) the correct option(s) is (are) chosen.*
Partial Marks :	*+3*	*If all the four options are correct but ONLY three options are chosen.*
Partial Marks :	*+2*	*If three or more options are correct but ONLY two options are chosen, both of which are correct options.*
Partial Marks :	*+1*	*If two or more options are correct but ONLY one option is chosen and it is a correct option.*
Zero Marks :	*0*	*If none of the options is chosen (i.e., the question is unanswered).*
Negative Marks :	*–2*	*In all other cases.*

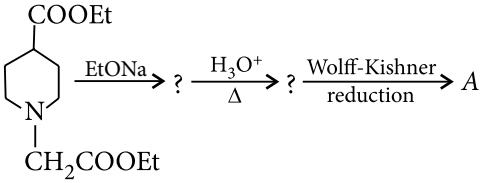
- *For Example: If first, third and fourth are the ONLY three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g., the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option) ,without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in –2 marks.*

1. Successive ionization energies (in kJ/mol) of element *A* are given below :

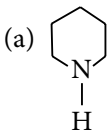
I.E.$_1$	*I.E.*$_2$	*I.E.*$_3$
520	7300	12000

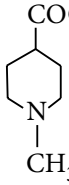
If *A* reacts with different elements, which compound(s) is/are possible ?

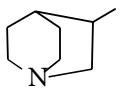
(a) *AF* (b) A_2O (c) A_3N (d) A_3N_2

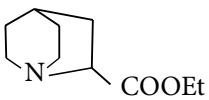
2. 

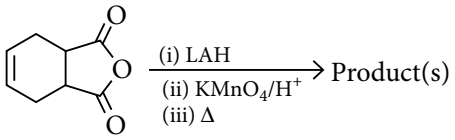
The final product (*A*) in the reaction is

(a) 

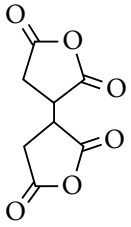
(b) 

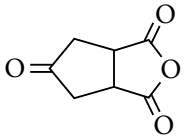
(c) 

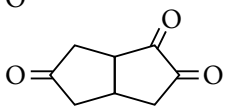
(d) 

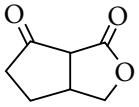
3. 

The possible product(s) is/are

(a) 

(b) 

(c) 

(d) 

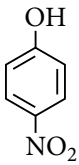
4. Which of the following statements is/are false?

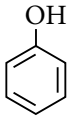
(a) Cr^{2+} ion has greater magnetic moment compared to Co^{3+}.

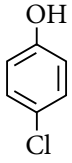
(b) The magnitude of ionization potential of iron anion (monoanion) would be equal to electron gain enthalpy of iron.

(c) Lanthanoids contraction is cause of higher *I.P.* of Pb than Sn.

(d) In the highest oxidation states, the transition metals show basic character and form cationic complexes.

5. I. 

II. 

III. 

The reactivity order of the given substituted phenols (I, II and III) towards $R-\underset{\underset{O}{\|}}{C}-Cl$ for

(i) electrophilic substitution reaction and

(ii) phenyl ester formations, are

(a) I > II > III for (ii) (b) I > III > II for (ii)

(c) II > III > I for (i) (d) II > I > III for (i)

6. Which of the following orders is/are correct?

(a) Thermal stability order : $NH_3 > SbH_3 > AsH_3 > PH_3$

(b) Boiling point order : Liquid hydrogen < liquid helium

(c) Order of K_p value during their thermal dissociation in closed container : $BeCO_3 < SrCO_3 < BaCO_3$

(d) Magnetic moment order : $O_2 > KO_2 > K_2O_2$

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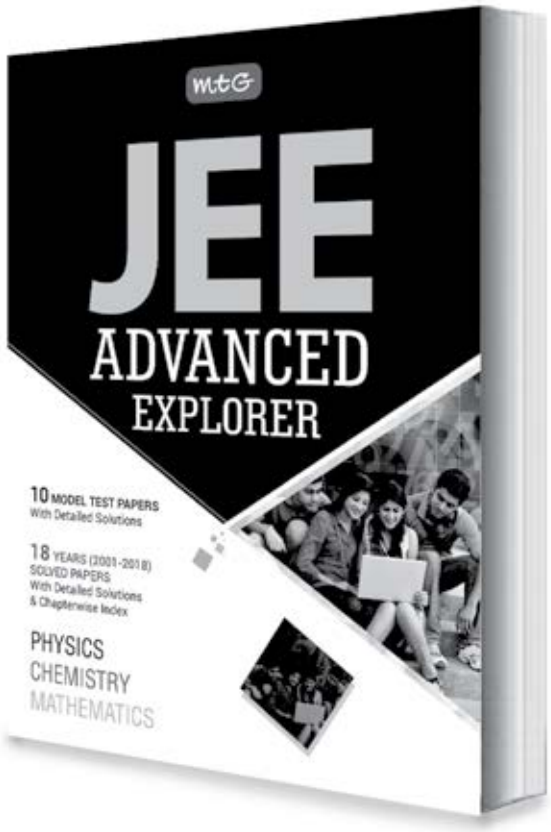

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Section 2 (Maximum Marks : 24)

- *This section contains EIGHT (08) questions. The answer to each question is a NUMERICAL VALUE.*
- *For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.*

Answer to each question will be evaluated according to the following marking scheme:

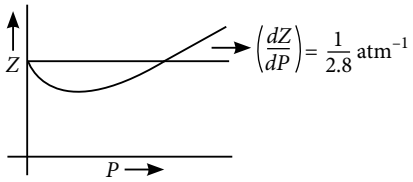
Full Marks : +3 *If ONLY the correct numerical value is entered as answer.*
Zero Marks : 0 *In all other cases.*

7. A complex of Fe^{2+} has magnetic moment value of 4.89 B.M. The number of electrons in the t_{2g} level of Fe^{2+} is_____.

8. An aromatic hydrocarbon (*A*) $C_{16}H_{16}$ shows following reactions :
(i) It decolourizes both Br_2 in CCl_4 and cold aq. $KMnO_4$.
(ii) It adds an equimolar amount of H_2.
(iii) Oxidation with $KMnO_4$ gives a dicarboxylic acid (*B*) $C_6H_4(COOH)_2$ which gives only one monobromo substitution product.
The number of stereoisomers of the compound (*A*) is_____.

9. The dissociation constant of a weak acid is 1.6×10^{-5} and the molar conductivity at infinite dilution is 380×10^{-4} S m^2 mol^{-1}. If the cell constant is 0.01 m^{-1} then conductance (in S) of 0.01 M acid solution is_____.

10. The graph of compressibility factor (*Z*) *vs P* for one mole of a real gas is shown below. The graph is plotted at constant temperature 273 K. If the slope of graph at very high pressure $\left(\frac{dZ}{dP}\right)$ is $\left(\frac{1}{2.8}\right)$atm^{-1}, then the volume of one mole of real gas molecules (in L/mol) is_____.

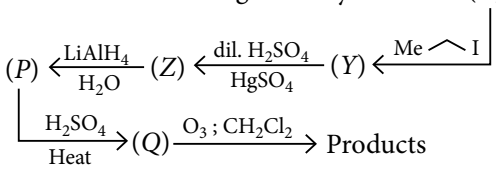


11. A solution contains 0.05 M of Ba^{2+} ions and 0.002 M of Ag^+ ions. The metals are to be precipitated by adding of chromate ions. What percentage of ion that precipitate first will remain in the solution when second ion begins to precipitate?
(K_{sp} of $Ag_2CrO_4 = 3 \times 10^{-12}$, K_{sp} of $BaCrO_4 = 1 \times 10^{-10}$)

12. The freezing point of an aqueous solution of KCN containing 0.1892 mol kg^{-1} was –0.74 °C. On adding 0.095 mol of $Hg(CN)_2$ the freezing point of solution was –0.53 °C. Assuming that the following complex is formed according to the equation :
$Hg(CN)_2 + xCN^- \longrightarrow [Hg(CN)_{x+2}]^{x-}$
The value of *x* is ____. (Given, $K_f = 1.86$ K kg mol^{-1})

13. The number of pairs in which, the first compound is more soluble in H_2O than second compound is _____.
(i) $PbCl_2$, $PbCl_4$ (ii) AlF_3, AlI_3
(iii) $NaHCO_3$, $KHCO_3$
(iv) NaF, KF (v) CsCl, KCl

14. For the given sequence of reactions,



Number of products obtained finally is_____.

Section 3 (Maximum Marks : 12)

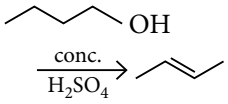
- *This section contains FOUR (04) questions.*
- *Each question has TWO (02) matching lists: LIST-I and LIST-II.*
- *FOUR options are given representing matching of elements from LIST-I and LIST-II. ONLY ONE of these four options corresponds to a correct matching.*
- *For each question, choose the option corresponding to the correct matching.*

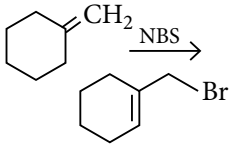
For each question, marks will be awarded according to the following marking scheme:

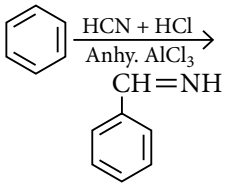
Full Marks : +3 *If ONLY the option corresponding to the correct matching is chosen.*
Zero Marks : 0 *If none of the options is chosen (i.e., the question is unanswered).*
Negative Marks : –1 *In all other cases.*

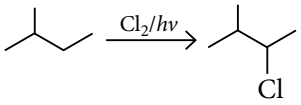
15. Match List-I with List-II.

List-I

A. 

B. 

C. 

D. 

List-II

p. Free radical intermediate with rearrangement
q. Electrophilic substitution reaction
r. Carbocation intermediate with rearrangement
s. Paramagnetic intermediate

The correct option is

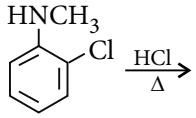
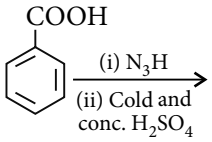
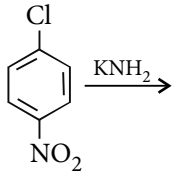
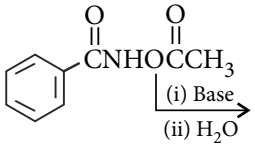
(a) A → r ; B → p, s ; C → q ; D → s

(b) A → q ; B → p, s ; C → r ; D → s

(c) A → p ; B → r, s ; C → q ; D → s

(d) A → s ; B → p, s ; C → q ; D → r

16. Match List-I with List-II.

List-I (Reactants)	**List-II (Characteristics of reaction)**
A. 	p. *Para* substituted product
B. 	q. Intramolecular rearrangement
C. 	r. Reaction involves Ph—N=C=O as an intermediate
D. 	s. Intermolecular rearrangement

The correct option is

(a) A → q, r ; B → p ; C → p, s ; D → q, r

(b) A → p, s ; B → q, r ; C → p ; D → q, r

(c) A → r, s ; B → q, r ; C → p, s ; D → s, r

(d) A → q, s ; B → s, r ; C → q, s ; D → q, r

17. Match List-I with List-II.

List-I	**List-II**
A. $KHCO_3$	(p) Exists in solid state
B. $NaHCO_3$	(q) Evolve CO_2 on heating
C. $LiHCO_3$	(r) Shows hydrogen bonding
D. NH_4HCO_3	(s) Forms dimeric anion

The correct option is

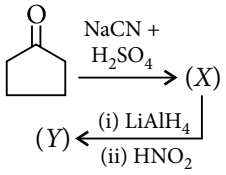
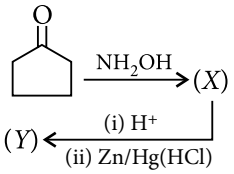
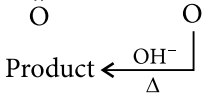
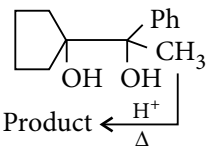
(a) A → p, q, r ; B → q, r, s ; C → p, q ; D → p, q

(b) A → p, q, s ; B → p, q, r ; C → q ; D → p

(c) A → p, q, r, s ; B → p, q, r ; C → q,r ; D → p, q

(d) A → p, q ; B → p, q, r, s ; C → q ; D → p, q

18. Match List-I with List-II.

List-I	**List-II**
A. 	p. Formation of six membered ring takes place
B. 	q. Final product is a ketone
C. $CH_3-\overset{\overset{O}{\|}}{C}-(CH_2)_3-\overset{\overset{O}{\|}}{C}-H$ 	r. Final product formed will give positive Tollens' test
D. 	s. Final product will react with 2, 4-DNP

The correct option is

(a) A → p, q, s ; B → p ; C → p, q, s ; D → p, q, s

(b) A → p, q ; B → q ; C → p, q, s ; D → p, q, s

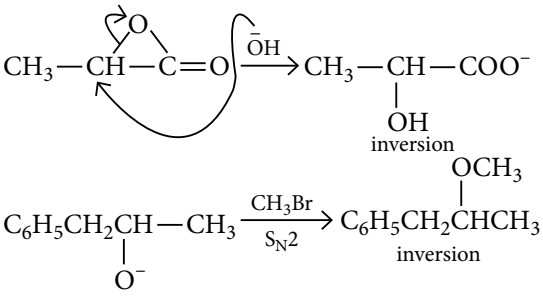
(c) A → p, q, s ; B → r ; C → p, q, s ; D → p, q, s

(d) A → q, p, s ; B → s ; C → p, q, s ; D → p, q, s

SOLUTIONS

PAPER - I

1. (b,c) :



2. (a,c,d) : $\underset{(A)}{MnSO_4} + 2Na_2CO_3 + 2KNO_3 \xrightarrow{\text{Fuse}} \underset{(B)\ (\text{Green})}{Na_2MnO_4} + 2KNO_2 + Na_2SO_4 + 2CO_2$

$3\underset{(B)}{Na_2MnO_4} + 2H_2SO_{4(\text{dil.})} \rightarrow 2NaMnO_4 + \underset{(C)}{MnO_2} + 6Na_2SO_4 + 4H_2O$

$\underset{(A)}{MnSO_4} + 8NaOH + 3Br_{2(aq.)} \rightarrow \underset{(D)}{MnO_2} + Na_2SO_4 + 6NaBr + 4H_2O$

$\underset{(A)}{MnSO_4\ (\text{in dil.HCl})} + BaCl_2 \rightarrow \underset{(E)}{BaSO_4}\downarrow + MnCl_2$

3. (b,c,d) :

$X = [Fe(H_2O)_5NO]SO_4$ and $Y = Na_4[Fe(CN)_5NOS]$
(Brown) (Violet)

There is change in the oxidation state of iron in X due to electron transfer from NO to Fe^{2+}.

$[Fe(H_2O)_5NO]SO_4$ contains 3 unpaired electrons.

4. (a,b) : $MCl + AgNO_3 \rightarrow AgCl + MNO_3$
$(m + 35.5)$g 143.5 g

According to equation $(m + 35.5)$ g MCl gives 143.5 g AgCl

Then, x g of MCl gave = $\frac{143.5x}{(m+35.5)}$ g of AgCl

Weight of NaCl in mixture = $(11.2 - x)$ g

Same way, $NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$
58.5 g 143.5 g

$(11.2 - x)$ of NaCl gave = $\frac{143.5\,(11.2-x)}{58.5}$ g of AgCl

Total weight of AgCl = $\frac{143.5x}{(m+35.5)} + \frac{143.5\,(11.2-x)}{58.5}$

$= 28.7$ ...(i)

On heating, MCl is decomposed (being volatile), hence

$$\frac{143.5x}{(m+35.5)} = 14.35 \quad \text{...(ii)}$$

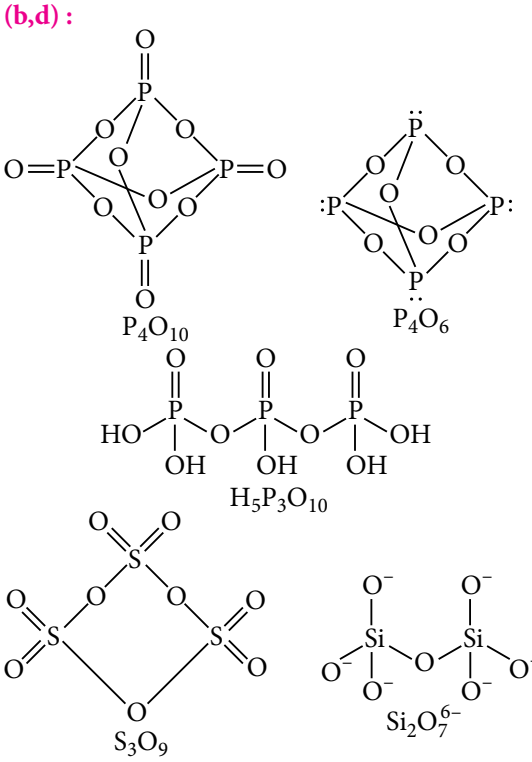
From equations (i) and (ii), we get

Weight of MCl (x) = 5.35 g

Weight of NaCl $(11.2 - x)$ = 5.85 g

From equation (ii), m = 18

5. (b,d) :



6. (c) : Sulphide ore is concentrated by froth floatation method.

7. (10.73×10^{-19}) : $E_0 = h\nu_0 = \frac{hc}{\lambda_0}$

$$= \frac{6.625\times10^{-34}\times3\times10^{8}}{230\times10^{-9}} = 8.64 \times 10^{-19}$$

For spectral line in Lyman series of H-atom

$$\frac{1}{\lambda} = R\left[1-\frac{1}{n^2}\right]$$

For the second longest wavelength, n = 3

$$\frac{1}{\lambda} = \frac{8}{9}R = \frac{8}{9}(1.09677\times10^{7}) \Rightarrow \lambda = 1.026 \times 10^{-7}\ \text{m}$$

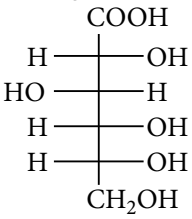
Energy of photon corresponding to this wavelength is

$$E = \frac{hc}{\lambda} = \frac{6.625\times10^{-34}\times3\times10^{8}}{1.026\times10^{-7}} = 1.937\times10^{-18}\ \text{J}$$

K.E. of photoelectron = $E - E_0$

$= 19.37 \times 10^{-19} - 8.64 \times 10^{-19} = 10.73 \times 10^{-19}$ J

8. (4) : After ring opening oxidation of α - *D* - glucose leads to the formation of gluconic acid.



9. (67.10) : Given : a = 20, $(a - x) = 20\times\frac{75}{100} = 15$; t = 20 min.

For first order reaction, $k = \frac{2.303}{t}\log\frac{a}{(a-x)}$

At 25 °C (298 K),

$$k_1 = \frac{2.303}{20}\log\frac{20}{15} = 0.014386\ \text{min}^{-1}$$

At 40 °C (313 K); k_2 = ?

We know that, $\log\frac{k_2}{k_1} = \frac{E_a}{2.303\,R}\left[\frac{T_2 - T_1}{T_1 \times T_2}\right]$

$$\therefore \quad \log\frac{k_2}{0.014386} = \frac{70\times10^{3}}{2.303\times8.314}\times\left(\frac{313-298}{298\times313}\right)$$

$$\log\frac{k_2}{0.014386} = \frac{70\times10^{3}}{2.303\times8.314}\times\frac{15}{298\times313} = 0.588$$

$$\frac{k_2}{0.014386} = 3.864 \quad \text{or} \quad k_2 = 0.0556$$

Now, for per cent decomposition at 40 °C (313 K),

Given, a = 30, $(a - x) = m$, t = 20 min, k = 0.0556

Thus, $k_{313} = \frac{2.303}{20}\log\frac{30}{m}$

or $0.0556 = \frac{2.303}{20}\log\frac{30}{m} \Rightarrow m = 9.869$

% decomposition $= \frac{a-m}{a} = \frac{30-9.869}{30} \times 100 = 67.10$

10. (5.90) : For solid $\rightleftharpoons$ liquid equilibrium the Clausius-Clapeyron equation is $\frac{dP}{dT} = \frac{\Delta H_f}{T_f(V_l - V_s)}$

$\Rightarrow \frac{dP}{dT} \times T_f(V_l - V_s) = \Delta H_f$

Given that, $\frac{dT}{dP} = -0.0075$

$\frac{dP}{dT} = -\frac{1}{0.0075} = -\frac{10000}{75}$ ...(i)

$-\frac{10000}{75} \times T_f(V_l - V_s) = \Delta H_f$

$-\frac{10000}{75} \times 273(V_l - V_s) = \Delta H_f$ ...(ii)

Density $= \frac{\text{Mass}}{\text{Volume}}$

Volume of liquid water $(v_l) = \frac{\text{Mass}}{\text{Density}} = \frac{18}{1000}$
$= 0.018$ dm^3/mol

$V_s = \frac{18}{D_s} = \frac{18}{916.96} = 0.0196$ dm^3/mol

Substituting the values in eqn (ii)

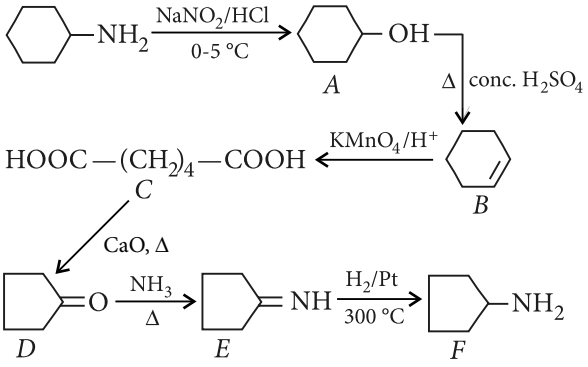
$\Delta H_f = \frac{-10000}{75} \times 273\,(0.018 - 0.0196)$

$= \left(\frac{-10000}{75}\right) 273\ (-0.0016) = 58.24$ dm^3 atm

As, 1 J = 9.87×10^{-3} dm^3 atm

$\Delta H_f = 5.90 \times 10^3$ J = 5.90 kJ

11. (5) :



12. (4.9×10^{-2}) : Moles of NH_4HS introduced

$= \frac{\text{Weight of } NH_4HS}{\text{Mol. Wt. of } NH_4HS} = \frac{3.06}{51} = 0.06$ mol

Hence molar conc. of NH_4HS in solution

$= \frac{0.06}{2} = 0.03$ mol L^{-1}

Degree of dissociation of NH_4HS = 30%

So, moles of NH_4HS dissociated $= \frac{0.03 \times 30}{100}$
$= 0.009$ mol

	$NH_4HS_{(s)}$	$\rightleftharpoons$	$NH_{3(g)}$	+	$H_2S_{(g)}$
Initial	0.03		0		0
Equilibrium	0.03 – 0.009 = 0.021		0.009		0.009

$\therefore \quad K_c = [NH_{3(g)}]\,[H_2S_{(g)}] = 0.009 \times 0.009$
[Conc. of solid = 1]
$= 8.1 \times 10^{-5}$ mol^2 L^{-2}

$K_p = K_c \times (RT)^{\Delta n_g} = 8.1 \times 10^{-5} \times (0.082 \times 300)^2$
[$\because \Delta n_g = 2 - 0 = 2$]
$= 4.9 \times 10^{-2}$ atm^2

13. (2) : With conc. H_2SO_4, $K_4[Fe(CN)_6]$ and HCOOH give one gaseous product, CO which on passing over NaOH under pressure gives HCOONa.

14. (4) : Na*A* is salt of strong base and weak acid.

$pH = \frac{pK_w}{2} + \frac{1}{2}(pK_a + \log C)$

$8.5 = 7 + \frac{1}{2}(5 + \log C)\,;\ 1.5 \times 2 = 5 + \log C$

$\log C = -2$

$C = 0.01 = \frac{2.592}{M \times 2} \Rightarrow M = \frac{2.592}{2 \times 0.01} = 129.6$

$d = \frac{ZM}{N_A a^3}$, $(Z = 4, a = 2 \times 300 = 600$ pm$) \Rightarrow d = 4$ g/cm^3

15. (b) : From the observation, it is clear that compound (*X*) contains — OMe group.

Thus *X* can be represented as C_9H_9OMe

$\Rightarrow \quad C_9H_9OMe$

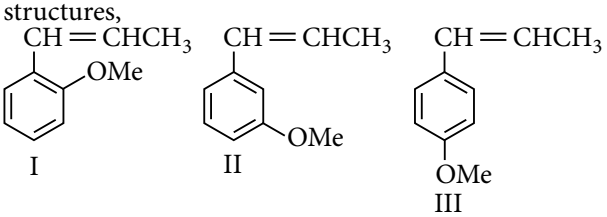
$X \xrightarrow[H_2O/Zn]{\text{Ozonolysis}} Y + Z\,;\ Z \xrightarrow{I_2/NaOH}$ yellow ppt.

This shows presence of $CH_3-\overset{\overset{O}{\|}}{C}-$ group in *Z*.

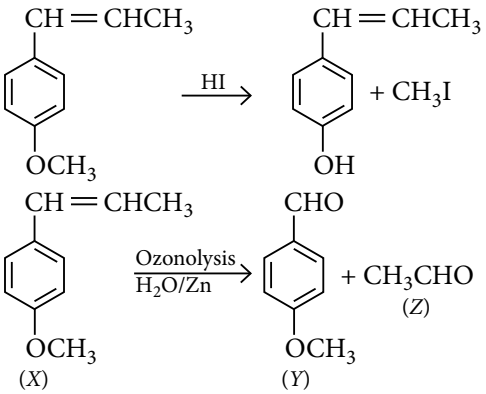
$Z \xrightarrow{\text{Tollens' reagent}} A \xrightarrow{\text{decarboxylation}} CH_4$

Thus, *A* must be CH_3COOH so, *Z* must be CH_3CHO

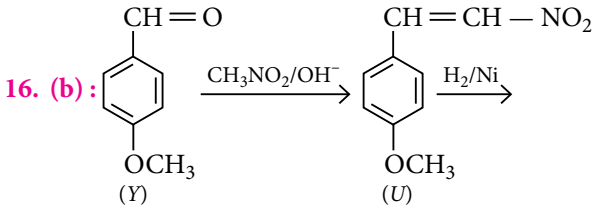
From the inference it is clear that *X* must contain CH_3CH = group. Thus, *X* can be following three structures,

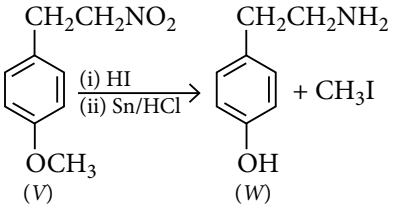


As compound (*X*) gives only one mononitro product. Hence, (*X*) must be (III).



16. (b) :





17. (b) : $\underset{(A)}{KNO_3} \xrightarrow{\Delta} \underset{(B)}{KNO_2} + \frac{1}{2}O_2$

$KNO_2 + NH_4Cl \longrightarrow NH_4NO_2 + KCl$

$NH_4NO_2 \xrightarrow{\Delta} \underset{(C)}{N_2} + 2H_2O$

18. (c) : $\underset{(A)}{KNO_3} + NH_4Cl \longrightarrow NH_4NO_3 + KCl$

$NH_4NO_3 \xrightarrow{\Delta} \underset{(D)}{N_2O} + 2H_2O$

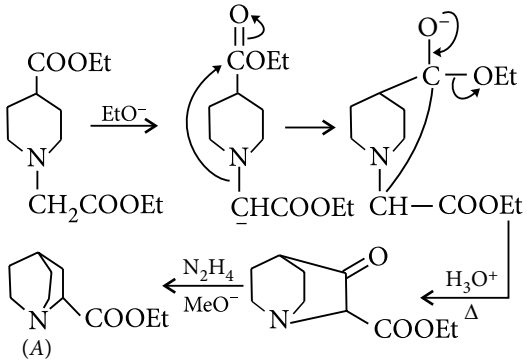
$N_2O + NaNH_2 \xrightarrow{\Delta} \underset{(E)}{NaN_3} + H_2O$

$2NaN_3 + H_2SO_4 \xrightarrow{\Delta} \underset{(F)}{2N_3H} + NaSO_4$

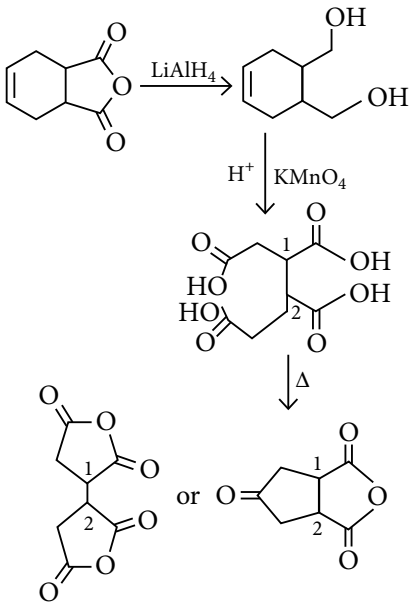
PAPER - II

1. (a,b,c) : The energy required to pull out another electron from A^+ is very high *i.e.*, $I.E._2$ is very high. Consequently it is not possible for *A* to form A^{2+} ion under ordinary conditions. Therefore, *A* will be ionized only once and thus will form compounds with valency one like *A*F, A_2O, and A_3N.

2. (d):

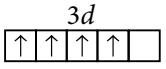


3. (a,b) :



4. (a,d) : (a) $Cr^{2+} \longrightarrow [Ar]3d^4\,4s^0$

$3d$

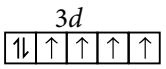


, 4 unpaired electrons

Magnetic moment = $\sqrt{n(n+2)} = \sqrt{4(4+2)} = \sqrt{24}$

$Co^{3+} \longrightarrow [Ar]3d^6 4s^0$

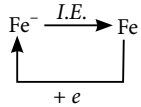
$3d$



, 4 unpaired electrons,

$\mu = \sqrt{4(4+2)} = \sqrt{24}$

(b)



So ionization energy of Fe^- is equal to ΔH_{eg} of Fe.

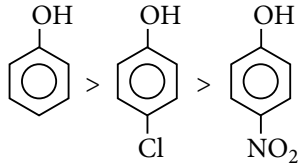
(c) Pb has more ionization potential than Sn due to poor shielding of 4*f*-orbitals.

(d) In higher oxidation states, transition metals show acidic properties and form anionic complexes.

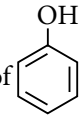
5. (b,c) : Phenol is electron rich hence can undergo electrophilic substitution reaction easily but introducing electron withdrawing group will decrease the reactivity towards electrophilic substitution reaction.

The deactivating nature of $-NO_2$ group is stronger than the deactivating nature of $-Cl$ group.

Hence, the reactivity order will be



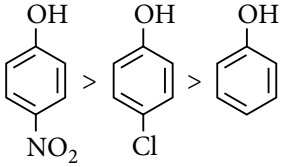
i.e., II > III > I.

The reaction of  with $R-\underset{\underset{O}{\|}}{C}-Cl$ gives

$R-\underset{\underset{O}{\|}}{C}-O-C_6H_5$ in presence of NaOH.

Thus, the reactivity depends upon $Ph-O\dot{-}H$ bond cleavage. This cleavage will increase if the $O-H$ bond is highly acidic or a strong electron withdrawing group is introduced in the benzene ring.

Thus, the reactivity order will be

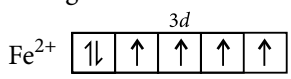


i.e., I > III > II

6. (d)

7. (4) : $\mu = 4.89 = \sqrt{n(n+2)} \Rightarrow n = 4$

Since, Fe^{2+} has four unpaired electrons so, its configuration will be



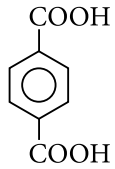
Hence, it is a weak field complex.

In weak field complexes, first the t_{2g} and e_g levels are singly occupied and then the pairing of electrons in t_{2g} level takes place. Thus, there are 4 electrons in t_{2g} level.

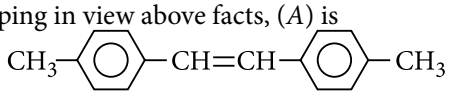
8. (2) : (i) Aromatic hydrocarbon (*A*) decolourizes Br_2 in CCl_4 and cold aq. $KMnO_4$ and thus (*A*) must have unsaturated aliphatic C=C bond in the chain.

(ii) Addition of one mole of H_2 also confirms one C=C bond in the chain.

(iii) Oxidation of (*A*) by hot $KMnO_4$ gives (*B*), $C_6H_4(COOH)_2$ which gives only one monobromo substitution product, *i.e.*, it should be *p*-isomer.

Thus, (*B*) is 

keeping in view above facts, (*A*) is



(*A*) shows geometrical isomerism,

$(CH_3)C_6H_4-\underset{\underset{(CH_3)C_6H_4-C-H}{\|}}{C-H}$ and $\underset{\underset{(CH_3)C_6H_4-C-H}{\|}}{H-C-C_6H_4(CH_3)}$

cis-form *trans*-form

9. (1.52) : $K_a = \dfrac{C\alpha^2}{1-\alpha} \Rightarrow 1.6\times10^{-5} = \dfrac{0.01\times\alpha^2}{1-\alpha}$

$\alpha = \sqrt{\dfrac{1.6\times10^{-5}}{0.01}} = 0.04$

[$\because$ $(1-\alpha) \simeq 1$ when α is small.]

$\alpha = \dfrac{\Lambda_m}{\Lambda_m^\infty} \Rightarrow \Lambda_m = 0.04\times380\times10^{-4}$

$= 15.2\times10^{-4}\ S\ m^2\ mol^{-1}$

$\kappa = \Lambda_m \times C = 15.2\times10^{-4}\times10^3\times10^{-2} = 1.52\times10^{-2}\ S\ m^{-1}$

($\because$ 1 m^3 = 1000 litre)

$\kappa = G.G^*$ and $G^* = 0.01\ m^{-1}$,

$\therefore\ G = \dfrac{1.52\times10^{-2}}{0.01} = 1.52\ S$

10. (2) : $Z = 1 + \dfrac{Pb}{RT}$ (at high pressure)

$\dfrac{dZ}{dP} = \dfrac{b}{RT} = \dfrac{1}{2.8}$

$b = \dfrac{RT}{2.8} = \dfrac{0.082\times273}{2.8} = 8$

Now, b = 4 V

$\left[\left(\because\ V = N_A \times \dfrac{4}{3}\pi r^3\right) = \text{volume of 1 mole gas}\right]$

$V = \dfrac{b}{4} = \dfrac{8}{4} = 2$

11. (0.26) : $[CrO_4^{2-}]$ required to precipitate $BaCrO_4$

$= \dfrac{K_{sp}\text{ of }BaCrO_4}{[Ba^{2+}]} = \dfrac{1\times10^{-10}}{0.05} = 2\times10^{-9}\ M$

$[CrO_4^{2-}]$ required to precipitate Ag_2CrO_4

$= \dfrac{K_{sp}\text{ of }Ag_2CrO_4}{[Ag^+]^2} = \dfrac{3\times10^{-12}}{(2\times10^{-3})^2} = 7.5\times10^{-7}\ M$

Ba^{2+} ions require low concentration of CrO_4^{2-} ions for precipitation. So, Ba^{2+} ion will precipitate first. When Ag^+ ions start precipitating as Ag_2CrO_4, the concentration of CrO_4^{2-} ion will be 7.5×10^{-7} M

$$[Ba^{2+}]_{\text{remaining in solution}} = \frac{K_{sp} \text{ of } BaCrO_4}{[CrO_4^{2-}]} = \frac{1\times10^{-10}}{7.5\times10^{-7}}$$

$$= 1.33 \times 10^{-4} \text{ M}$$

% of Ba^{2+} remaining in solution

$$= \frac{1.33\times10^{-4}}{0.05} \times 100 = 0.26\%$$

12. (2) : $\Delta T_f = iK_f m$

$$0.74 = i \times 1.86 \times 0.1892 \Rightarrow i = \frac{0.74}{1.86\times0.1892} \simeq 2$$

Value of i shows that KCN is 100% ionic.

Solution contains 0.1892 mol of K^+ and 0.1892 of CN^-.

After the addition of $Hg(CN)_2$ the mol of different species will be

$[K^+] = 0.1892$, $[CN^-] = 0.1892 - 0.095x$

$[Hg(CN)_{x+2}]^{x-} = 0.095$

$\Delta T_f = K_f m$

$0.53 = 1.86\ (0.1892 + 0.1892 - 0.095x + 0.095)$

$\Rightarrow \quad x = 2$

13. (3)

14. (4) : $X : CH_3-C\equiv\overset{-}{C}\overset{+}{M}gBr$

$Y : CH_3-C\equiv C-CH_2-CH_3$

$Z : CH_3-\underset{\underset{O}{\|}}{C}-CH_2-CH_2-CH_3$

$P : CH_3-\underset{\underset{OH}{|}}{CH}-CH_2-CH_2-CH_3$

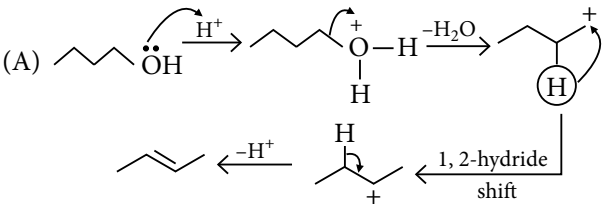
$Q : CH_2=CHCH_2CH_2CH_3 + CH_3CH=CHCH_2CH_3$

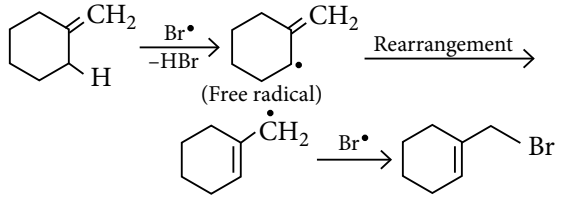
Ozonolysis (left) Ozonolysis (right)

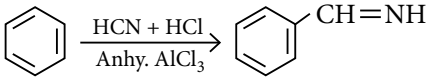
$HCHO + CH_3CH_2CH_2CHO \quad CH_3CHO + CH_3CH_2CHO$

(a) (b) (c) (d)

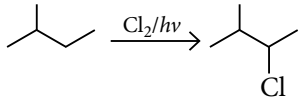
15. (a) :



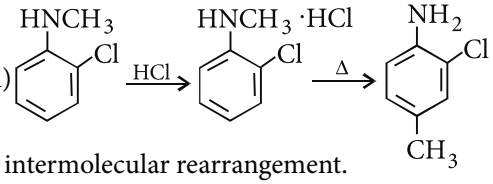
(B) 

(C) 

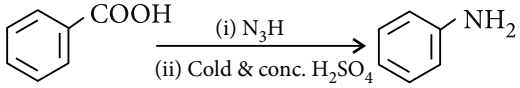
It is a electrophilic aromatic substitution.

(D) 

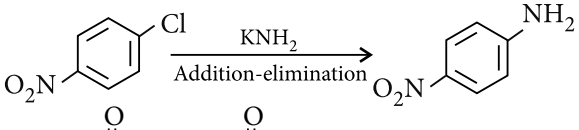
Involve free radical intermediate which is paramagnetic.

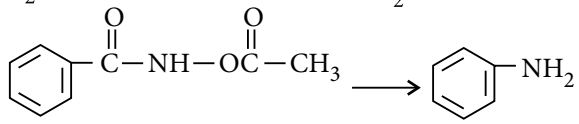
16. (b) : (A) 

Reaction is intermolecular rearrangement.

(B) 

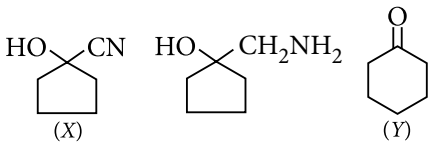
It is Schmidt rearrangement.

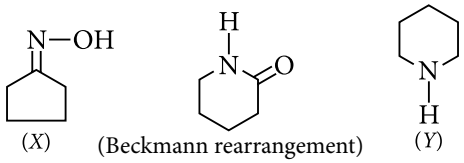
(C) 

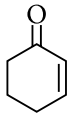
(D) 

It is Lossen rearrangement.

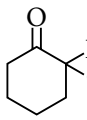
17. (c)

18. (a) : (A) 

(B) 

(C) 

(Intramolecular aldol condensation)

(D) 

(Pinacol-pinacolone rearrangement)

☺☺

FULL LENGTH PRACTICE PAPER

AIIMS

Exam on 25th & 26th May 2019

PHYSICS

1. A coil, a capacitor and an AC source of voltage 24 V (rms) are connected in series. By varying the frequency of the source, a maximum rms current of 6 A is observed. If this coil is connected to a battery of emf 12 V and internal resistance 4 Ω, the current through it will be
(a) 2.0 A (b) 1.5 A (c) 3.0 A (d) 2.5 A

2. According to Bohr's theory of hydrogen atom, the product of the binding energy of the electron in the n^{th} orbit and its radius in the n^{th} orbit
(a) is proportional to n^2
(b) is inversely proportional to n^3
(c) has a constant value of 10.2 eV Å
(d) has a constant value of 7.2 eV Å.

3. A boat crosses a river from port A to port B, which are just on the opposite sides. The speed of the water is v_W and that of the boat is v_B relative to water. Assume $v_B = 2v_W$. What is the time taken by the boat, if it has to cross the river directly on the AB line?
(a) $\frac{2D}{v_B\sqrt{3}}$ (b) $\frac{\sqrt{3}D}{2v_B}$ (c) $\frac{D}{v_B\sqrt{2}}$ (d) $\frac{D\sqrt{2}}{v_B}$

4. A uniform wire 20 metre long and weighing 50 N hangs vertically. If $g = 10\ m\ s^{-2}$, then the speed of the transverse wave at the middle point of the wire is
(a) 4 m s^{-1} (b) $10\sqrt{2}$ m s^{-1}
(c) 10 m s^{-1} (d) zero m s^{-1}

5. A prism of refractive index 1.5 is placed in water of refractive index 1.33. The refracting angle of the prism is 60°. What is the angle of minimum deviation in water? (Given sin 34° = 0.56)
(a) 4° (b) 8° (c) 12° (d) 16°

6. Light takes t_1 second to travel a distance x in vacuum and the same light takes t_2 second to travel $10x$ in a medium. Critical angle for corresponding medium will be
(a) $\sin^{-1}\left(\frac{10t_2}{t_1}\right)$ (b) $\sin^{-1}\left(\frac{t_2}{10t_1}\right)$
(c) $\sin^{-1}\left(\frac{10t_1}{t_2}\right)$ (d) $\sin^{-1}\left(\frac{t_1}{10t_2}\right)$

7. Two weights w_1 and w_2 are suspended from the ends of a light string over a smooth fixed pulley. If the pulley is pulled up with acceleration g, the tension in the string will be
(a) $\frac{4w_1w_2}{w_1+w_2}$ (b) $\frac{2w_1w_2}{w_1+w_2}$
(c) $\frac{w_1-w_2}{w_1+w_2}$ (d) $\frac{w_1w_2}{2(w_1+w_2)}$

8. A gas bubble from an explosion under water oscillates with a time period T, depends upon static pressure p, density of water ρ and the total energy of explosion E. Find the expression for the time period T. k is a dimensionless constant.
(a) $T = kp^{-5/6}\rho^{1/2}E^{1/3}$ (b) $T = kp^{-4/7}\rho^{1/2}E^{1/3}$
(c) $T = kp^{-5/6}\rho^{1/2}E^{1/2}$ (d) $T = kp^{-4/7}\rho^{1/3}E^{1/2}$

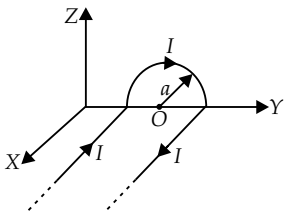
9. In Young's double slit experiment, the aperture screen distance is 2 m. The fringe width is 1 mm. Light of 600 nm is used. If a thin plate of glass (μ = 1.5) of thickness 0.06 mm is placed over one of the slits, then there will be a lateral displacement of the fringes by
(a) 0 cm (b) 5 cm (c) 10 cm (d) 15 cm

10. A 15 g ball is shot from a spring gun whose spring has a force constant 600 N m^{-1}. The spring is compressed by 5 cm. What is the greatest possible horizontal range of the ball for this compression (Take $g = 10\ m\ s^{-2}$) ?
(a) 6 m (b) 8 m (c) 10 m (d) 12 m

11. A wheel is subjected to uniform angular acceleration about its axis. Initially, its angular velocity is zero. In the first 2 s, it rotates through an angle θ_1, in the next 2 s, it rotates through an angle θ_2. The ratio of $\frac{\theta_2}{\theta_1}$ is

(a) 1 (b) 2 (c) 3 (d) 5

12. A long wire bent as shown in the figure carries current I. If the radius of the semi-circular portion is a, the magnetic field at the centre O is



(a) $\frac{\mu_0 I}{4a}$ (b) $\frac{\mu_0 I}{4\pi a}\sqrt{(\pi^2+4)}$

(c) $\frac{\mu_0 I}{4a}+\frac{\mu_0 I}{2\pi a}$ (d) $\frac{\mu_0 I}{4\pi a}\sqrt{(\pi^2-4)}$

13. A physical quantity, $y=\frac{a^4b^2}{(cd^4)^{1/3}}$ has four observables a, b, c and d. The percentage error in a, b, c and d are 2%, 3%, 4% and 5% respectively. The error in y will be

(a) 6% (b) 11% (c) 12% (d) 22%

14. A stone is dropped from the 25th storey of a multistoreyed building and it reaches the ground in 5 sec. In the first second, it passes through how many storeys of the building?
(Take g = 10 m s^{-2})

(a) 1 (b) 2 (c) 3 (d) 5

15. The work done by electric field during the displacement of a negatively charged particle towards a fixed positively charged particle is 9 J. As a result the distance between the charges has been decreased by half. What work is done by the electric field over the first half of this distance?

(a) 3 J (b) 1.5 J (c) 6 J (d) 9 J

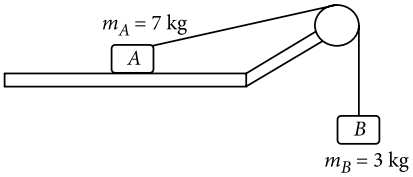
16. A variable condenser is permanently connected to a 100 V battery. If capacity is changed from 2 μF to 10 μF, then energy change is equal to

(a) 2×10^{-2} J (b) 2.5×10^{-2} J
(c) 6.5×10^{-2} J (d) 4×10^{-2} J

17. Two resistances 3 Ω and 6 Ω are connected in parallel and a 4 Ω resistance is connected in series with this combination. The current through 3 Ω resistance is 0.8 A. Then the potential drop across 4 Ω resistance is

(a) 9.6 V (b) 2.6 V (c) 4.8 V (d) 1.2 V

18. A block A of mass 7 kg is placed on a frictionless table. A thread tied to it passes over a frictionless pulley and carries a body B of mass 3 kg at the other end, as shown in figure. The acceleration of the system is (Take g = 10 m s^{-2})

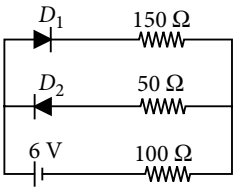


(a) 100 m s^{-2} (b) 3 m s^{-2}
(c) 10 m s^{-2} (d) 20 m s^{-2}

19. The mass of the moon is 1/81 of earth's mass and its radius is 1/4th that of the earth. If the escape velocity from the earth's surface is 11.2 km s^{-1}, its value for the moon will be

(a) 0.15 km s^{-1} (b) 5 km s^{-1}
(c) 2.5 km s^{-1} (d) 0.5 km s^{-1}

20. The circuit shown in the figure contains two diodes each with a forward resistance of 50 ohm and with infinite backward resistance. If the battery voltage is 6 V, the current through the 100 ohm resistance (in ampere) is



(a) zero (b) 0.02 (c) 0.03 (d) 0.033

21. A Ge specimen is doped with Al. The concentration of acceptor atoms is 10^{21} atoms m^{-3}. Given that the intrinsic concentration of electron-hole pair is equivalent to 10^{19} m^{-3}, the concentration of electrons in the specimen is

(a) 10^{17} m^{-3} (b) 10^{15} m^{-3}
(c) 10^{4} m^{-3} (d) 10^{2} m^{-3}

22. A body cools from 80°C to 64°C in 5 min and same body cools from 80°C to 52°C in 10 min, what is the temperature of the surrounding?

(a) 24°C (b) 28°C (c) 22°C (d) 25°C

23. Speeds of two identical cars are u and $4u$ at a specific instant. The ratio of the respective distances at which the two cars are stopped from that instant is

(a) 1 : 1 (b) 1 : 4 (c) 1 : 8 (d) 1 : 16

24. The magnitude of the magnetic field required to accelerate protons (mass = 1.67×10^{-27} kg) in a cyclotron that is operated at an oscillator frequency 12 MHz is approximately

(a) 0.8 T (b) 1.6 T (c) 2.0 T (d) 3.2 T

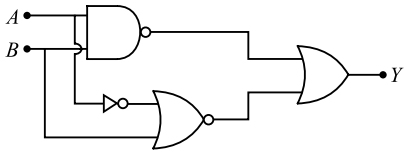
25. A pure inductor of 25 mH is connected to an ac source of 220 V. Given the frequency of the source as 50 Hz, the rms current in the circuit is
(a) 7 A (b) 14 A (c) 28 A (d) 42 A

26. A cubical block is heated from 0°C to 100°C. The percentage increase in its length is 0.10%. What will be the percentage increase in its volume?
(a) 0.03% (b) 0.10%
(c) 0.30% (d) None of these

27. A block of mass 0.50 kg is moving with a speed of 2.0 m s^{-1} on a smooth surface. It strikes another stationary block of mass 1.0 kg and then move together as a single body. The energy loss during the collision is
(a) 0.16 J (b) 1.00 J (c) 0.67 J (d) 0.34 J

28. A plane electromagnetic wave travels in free space along x-direction. If the value of $\vec{B}$ (in tesla) at a particular point in space and time is $1.2 \times 10^{-8}\,\hat{k}$. The value of $\vec{E}$ (in V m^{-1}) at that point is
(a) $1.2\,\hat{j}$ (b) $3.6\hat{k}$ (c) $1.2\hat{k}$ (d) $3.6\,\hat{j}$

29. The Boolean expression for the given circuit is



(a) $\overline{A \cdot B}$ (b) $A + B$ (c) $\bar{A} + B$ (d) $A + \bar{B}$

30. A large horizontal surface moves up and down in SHM with an amplitude of 1 cm. If a mass of 10 kg (which is placed on the surface) is to remain continuously in contact with it, the maximum frequency of SHM will be
(a) 5 Hz (b) 0.5 Hz (c) 1.5 Hz (d) 10 Hz

31. An open organ pipe has a length of 5 cm. The highest harmonic of such a tube that is in the audible range (20 Hz - 20000 Hz) is (speed of sound in air is 340 m s^{-1})
(a) 4 (b) 5 (c) 6 (d) 7

32. The current gain of a transistor in a common base arrangement is 0.98. Find the change in collector current corresponding to a change of 5.0 mA in emitter current.
(a) 4.9 mA (b) 2.2 mA (c) 3.3 mA (d) 3.9 mA

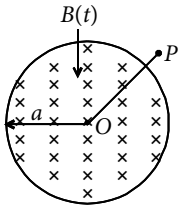
33. The equation of a wave is represented by $Y = 10^{-5} \sin\left[100t - \frac{x}{10}\right]$ m, then the velocity of the wave will be
(a) 100 m s^{-1} (b) 4 m s^{-1}
(c) 1000 m s^{-1} (d) zero

34. From the following data, find the magnitude of Joule's mechanical equivalent of heat. C_P for hydrogen = 3.409 cal g^{-1} °C^{-1}; C_V for hydrogen = 2.409 cal g^{-1} °C^{-1} and molecular weight of hydrogen = 2.
(a) J = 2.11 J cal^{-1} (b) J = 1.11 J cal^{-1}
(c) J = 3.11 J cal^{-1} (d) J = 4.11 J cal^{-1}

35. A spherical soap bubble of radius 1 cm is formed inside another bubble of radius 3 cm. The radius of a single soap bubble which maintains the same pressure difference as inside the smaller and outside the bigger soap bubble is
(a) 0.75 cm (b) 0.75 m (c) 7.5 cm (d) 7.5 m

36. In an experiment on photoelectric emission from a metallic surface, wavelength of incident light is 2×10^{-7} m and stopping potential is 2.5 V. The threshold frequency of the metal is approximately
(Charge of electron $e = 1.6 \times 10^{-19}$ C, Planck's constant $h = 6.6 \times 10^{-34}$ J s)
(a) 12×10^{15} Hz (b) 9×10^{15} Hz
(c) 9×10^{14} Hz (d) 12×10^{13} Hz

37. A uniform but time-varying magnetic field $B(t)$ exists in a circular region of radius a and is directed into the plane of the paper, as shown in the figure. The magnitude of the induced electric field at point P at a distance r from the centre of the circular region



(a) is zero (b) decreases as $\frac{1}{r}$
(c) increases as r (d) decreases as $\frac{1}{r^2}$.

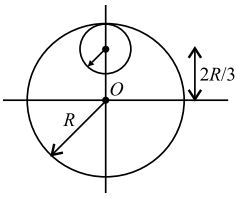
38. From a circular disc of radius R and mass $9M$, a small disc of radius $R/3$ is removed. The moment of inertia of the remaining disc about an axis perpendicular to the plane of the disc and passing through O is

(a) $4MR^2$

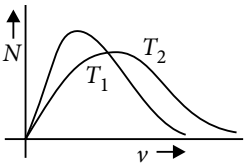
(b) $\frac{40}{9}MR^2$

(c) $10MR^2$

(d) $\frac{37}{9}MR^2$



39. Maxwell's velocity distribution curve is given for the same quantity for two different temperatures. For the given curves



(a) $T_1 > T_2$ (b) $T_1 < T_2$ (c) $T_1 \leq T_2$ (d) $T_1 = T_2$

40. In an experiment, a magnet with its magnetic moment along the axis of a circular coil and directed towards the coil, is withdrawn away from the coil and parallel to itself. The current in the coil, as seen by the withdrawing magnet, is

(a) zero (b) clockwise

(c) anticlockwise (d) first (a) then (b)

Directions : In the following questions (41-60), a statement of assertion is followed by a statement of reason. Mark the correct choice as

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If both assertion and reason are false.

41. **Assertion :** Stopping potential depends upon the frequency of incident light but is independent of the intensity of the light.
Reason : The maximum kinetic energy of the photoelectrons is proportional to stopping potential.

42. **Assertion :** Work done by friction on a body sliding down an inclined plane is negative.
Reason : Work done is less than zero, if angle between force and displacement is acute or both are in same direction.

43. **Assertion :** When a cyclist doubles his speed of turning, the chance of his skidding becomes nearly four times.
Reason : When the speed of the vehicle increases, the angle of bending also increases.

44. **Assertion :** A current carrying conductor produces only an electric field.
Reason : Electrons in motion give rise to only an electric field.

45. **Assertion :** A body becomes weightless at the centre of earth.
Reason : As the distance from centre of earth decreases, acceleration due to gravity increases.

46. **Assertion :** Converging property of convergent lens does not remain same in all mediums.
Reason : Property of lens whether the ray is diverging or converging depends on the surrounding medium.

47. **Assertion :** The energy stored in the inductor of 2 H, when a current of 10 A flows through it is 100 J.
Reason : Energy stored in an inductor is directly proportional to its inductance.

48. **Assertion :** The electric field and hence electric field lines are everywhere at right angle to an equipotential surface.
Reason : Equipotential surfaces are closer together where the electric field is stronger and farther apart where the field is weaker.

49. **Assertion :** When temperature difference across the two sides of a wall is increased, its thermal conductivity remains constant.
Reason : Thermal conductivity depends on nature of material of the wall.

50. **Assertion :** Young's modulus for a perfectly plastic body is zero.
Reason : For a perfectly plastic body, restoring force is zero.

51. **Assertion :** Thin films such as soap bubble or a thin layer of oil on water show beautiful colours when illuminated by white light.
Reason : It happens due to the interference of light reflected from the upper surface of the thin film.

52. **Assertion :** The centre of mass of a two particle system lies on the line joining the two particles, being closer to the heavier particle.
Reason : Product of mass of one particle and its distance from centre of mass is numerically equal to product of mass of other particle and its distance from centre of mass.

53. **Assertion :** As the drift velocity decreases the current flowing through the conductor decreases.
Reason : The current flowing through a conductor is directly proportional to the drift velocity.

54. **Assertion :** We can change the temperature of a system without giving (or taking) heat to (or from) it.

Reason : According to principle of conservation of energy, total energy of a system should remain conserved.

55. **Assertion:** A piece of ice, with a stone frozen inside it, floats on water in a beaker. When the ice melts, the level of water in the beaker decreases.
Reason : Density of stone is more than that of water.

56. **Assertion :** Adding a scalar to a vector of the same dimensions is a meaningful algebraic operation.
Reason : The displacement can be added with distance.

57. **Assertion :** The mass of a nucleus can be either less than or more than the sum of the masses of nucleons present in it.
Reason : The density of nuclear matter is dependent on the size of the nucleus.

58. **Assertion :** Earth's magnetic field inside a closed iron box is less as compared to its walls.
Reason : The magnetic permeability of iron is low.

59. **Assertion :** Most amplifiers use common emitter circuit configuration.
Reason : Its input resistance is comparatively higher.

60. **Assertion :** Magnetic force between two short magnets, when they are co-axial follows inverse square law of distance.
Reason : The magnetic forces between two poles do not follow inverse square law of distance.

CHEMISTRY

61. Magnetic separation is used for increasing concentration of the
(a) horn silver (b) calcite
(c) haematite (d) magnesite

62. What is the molarity of H_2SO_4 solution that has a density of 1.84 g/cc at 35 °C and contains 98% by weight?
(a) 4.18 M (b) 8.14 M (c) 18.4 M (d) 18 M

63. Two labels sticked upon the two bottles containing conc. H_2SO_4 are shown below :

Conc. H_2SO_4 (90% by volume) Density = 1.98 g/mL	Conc. H_2SO_4 (93% by volume) Density = 1.84 g/mL
A	*B*

Molalities of acids *A* and *B* are respectively
(a) 8.5, 10.4 (b) 10.4, 8.5
(c) 4.2, 5.2 (d) 5.2, 4.2

64. Which of the following is correct for the given reaction?
$NH_4OH{\cdot}HCl + NaNO_2 \longrightarrow (A) \xrightarrow{Cu} (B) + (X)_{gas}$
(a) (*B*) is an amphoteric oxide.
(b) (*X*) is a colourless, diamagnetic gas which combines with Al on heating.
(c) (*X*) can be produced by action of (Zn + NaOH) on $NaNO_2$.
(d) None of the above.

65. $CH \equiv CH + 2HCHO \xrightarrow{CH_3O^-} X$, *X* is
(a) $HOH_2CC \equiv CCH_2OH$
(b) $HOH_2CC \equiv CCH_2OCH_3$
(c) both of these (d) none of these

66. If phosphorous acid is allowed to react with sufficient quantity of KOH, the product obtained is
(a) K_3PO_3 (b) KH_2PO_3
(c) K_2HPO_3 (d) $KHPO_3$

67. Among the following the most reactive towards alcoholic KOH is
(a) $CH_2 = CHBr$ (b) $CH_3COCH_2CH_2Br$
(c) CH_3CH_2Br (d) $CH_3CH_2CH_2Br$

68. The factor $\Delta T_f/K_f$ represents
(a) molarity (b) formality
(c) normality (d) molality.

69. A yellow product is formed when an organic compound C_3H_8O is warmed with aqueous sodium carbonate and iodine solution. The product is
(a) sodium iodide (b) sodium iodate
(c) iodoform
(d) adduct of NaI and C_3H_8O.

70. Smallest internuclear distance is found in
(a) O_2 (b) O_2^{2+} (c) O_2^- (d) O_2^{2-}

71. Consider the following complex,
$Na[Cr(NH_3)_2(ox)_2].3H_2O$
The coordination number, oxidation number, number of *d*-electrons, number of unpaired electrons on the metal and magnetic moment are respectively
(a) 6, +2, 4, 0, 0 (b) 4, +3, 3, 3, 3.87
(c) 6, +3, 3, 3, 3.87 (d) 4, +2, 4, 0, 0

72. A bulb of 3 L capacity filled with air is heated from 27 °C to *t* °C. The air thus, expelled measured 1.45 L at 17 °C. Considering the pressure to be 1 atm throughout the experiment and ignoring the expansion of bulb, the value of *t* is
(a) 300 K (b) 300 °C (c) 327 K (d) 327 °C

73. $-NH_2$ group in aniline is
(a) *m*-directing and deactivating
(b) *o*, *p*-directing and deactivating
(c) *o*, *p*-directing and activating
(d) *m*-directing and activating.

74. A binary solid (A^+B^-) has a zinc blende structure with B^- ions constituting the lattice and A^+ ions occupying 25% tetrahedral holes. The formula of solids is
(a) AB (b) A_2B (c) AB_2 (d) AB_4

75. Which of the following does not undergo benzoin condensation?
(a) C_6H_5CHO
(b) *p*-Methoxybenzaldehyde
(c) *o*-Tolualdehyde (d) $C_6H_5CH_2CHO$.

76. In a reaction at equilibrium, '*x*' mole of the reactant, *A* decomposes to give 1 mole each of *C* and *D*. It has been found that the fraction of *A* decomposed at equilibrium is independent of initial concentration of *A*. Value of *x* is
(a) 1 (b) 2 (c) 3 (d) 4

77. Which of the following salt has the same value of van't Hoff factor as that of $K_3[Fe(CN)_6]$?
(a) Na_2SO_4 (b) $Al(NO_3)_3$
(c) $Al_2(SO_4)_3$ (d) Fe_3O_4

78. Dry air was passed successively through a solution of 5 g of a solute in 180 g of water and then through pure water. The loss in mass of solution was 2.50 g and that of pure solvent 0.04 g. The molecular mass of the solute is
(a) 31.25 (b) 3.125
(c) 312.5 (d) none of these

79. Heroin is diacetyl derivative of
(a) caffeine (b) cocaine
(c) nicotine (d) morphine.

80. Ammonium carbamate decomposes as,

$$NH_2COONH_{4\,(s)} \rightleftharpoons 2NH_{3\,(g)} + CO_{2\,(g)}$$

For the reaction, $K_p = 2.9 \times 10^{-5}$ atm^3. If we start with 1 mole of the compound, the total pressure at equilibrium would be
(a) 0.0766 atm (b) 0.0582 atm
(c) 0.0388 atm (d) 0.0194 atm

81. Which of the following is the life saving mixture for an asthma patient?
(a) Mixture of helium and oxygen
(b) Mixture of neon and oxygen
(c) Mixture of xenon and nitrogen
(d) Mixture of argon and oxygen

82. Which of the following alcohols on oxidation give carboxylic acids with lesser number of carbon atoms ?
(a) $(CH_3)_3C-CH_2OH$ (b) $(CH_3)_3COH$
(c) $CH_3CH_2CHOHCH_3$ (d) Both (b) and (c).

83. The wavelength of a spectral line for an electronic transition is inversely related to
(a) the number of electrons undergoing transition
(b) the nuclear charge of the atom
(c) the velocity of an electron undergoing transition
(d) the difference in the energy levels involved in the transition.

84. The hormone that helps in the conversion of glucose to glycogen is
(a) cortisone (b) bile acids
(c) adrenaline (d) insulin.

85. A big irregular shaped vessel contained water, the conductivity of which was 2.56×10^{-5} S cm^{-1}. 500 g of NaCl was then added to the water and the conductivity after the addition of NaCl, was found to be 3.1×10^{-5} S cm^{-1}. Find the capacity of the vessel if it is completely filled with water.
($\Lambda^\circ_{NaCl} = 149.9$)
(a) 2.372×10^6 L (b) 4.133×10^5 L
(c) 2.372×10^5 L (d) 4.133×10^6 L

86. Siderite and sphalerite are the ores of the metals
(a) Al and Zn (b) Fe and Cu
(c) Cu and Zn (d) Fe and Zn.

87. Product *C* in the reaction,

$$C_2H_5Br \xrightarrow{NaOH(aq)} A \xrightarrow{Na} B \xrightarrow{CH_3I} C \text{ will be}$$

(a) propane (b) ethyl iodide
(c) ethane (d) ethyl methyl ether.

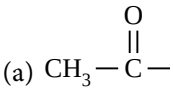
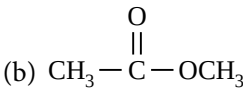
88. The $(CH_3)_3C$ – group in *t*-butylacetylene exerts
(a) $-I$ effect (b) $+I$ effect
(c) hyperconjugation (d) both (b) and (c).

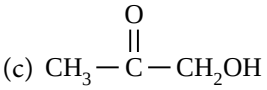
89. In a solid lattice the cation and anion both have left a lattice site. The lattice defect is known as
(a) interstitial defect (b) valency defect
(c) Frenkel defect (d) Schottky defect.

90.

$$CH_3-\overset{\overset{O}{\|}}{C}-CH_3 \xrightarrow{SeO_2} X + Se + H_2O$$

Here *X* is

(a)  (b) 

(c)  (d) none of these

91. The rate constant is numerically the same for three reactions of first, second and third order respectively. Which one is true for rate of three reaction, if concentration of reactant is greater than 1 *M* ?

(a) $r_1 = r_2 = r_3$ (b) $r_1 > r_2 > r_3$

(c) $r_1 < r_2 < r_3$ (d) All of these

92. Which of the following alkyl halides will not undergo dehydrohalogenation unless the conditions are drastic?

(a) 2-Chloro-2, 3-dimethylbutane

(b) 1-Chloro-2, 2-dimethylpropane

(c) 3-Chloro-2, 2-dimethylbutane

(d) 1-Chloro-2, 3-dimethylbutane

93. Increasing pK_a of *o*-, *m*-and *p*-nitrobenzoic acid is

(a) $p < m < o$ (b) $o < m < p$

(c) $o < p < m$ (d) $m < p < o$

94. The molecular mass of a volatile substance may be measured by

(a) Liebig's method (b) Hofmann's method

(c) Victor Meyer's method

(d) Both (b) and (c).

95. The enolic form of acetone contains

(a) nine σ-bonds, one π-bond and two lone pairs

(b) eight σ-bonds, two π-bonds and two lone pairs

(c) nine σ-bonds, one π-bond and one lone pair

(d) nine σ-bonds, two π-bonds and one lone pair

96. The formula of microcosmic salt and the product obtained by heating it is

(a) $Na(NH_4)PO_4$; $NaPO_3$

(b) $Na(NH_4)_2HPO_4$; $NaPO_3$

(c) $Na(NH_4)HPO_4$; $NaPO_4$

(d) $Na(NH_4)HPO_4$; $NaPO_3$

97. Oxidation state of "V" in $Rb_4K[HV_{10}O_{28}]$ is

(a) +5 (b) +6 (c) $+\frac{7}{5}$ (d) +4

98. For which half-reaction, a 1.0 unit increase in pH will cause the greatest increase in half-cell potential?

(a) $V^{2+}_{(aq)} \longrightarrow V^{3+}_{(aq)} + e^-$

(b) $VO_3^- + 2H^+ \longrightarrow VO_2^+ + H_2O$

(c) $VO^{2+} + 2H^+ + e^- \longrightarrow V^{3+} + H_2O$

(d) $VO^{2+} + H_2O + e^- \longrightarrow VO_2^+ + 2H^+ + e^-$

99. Which of the following is strongest Bronsted base?

(a) ClO^- (b) ClO_2^-

(c) ClO_3^- (d) ClO_4^-

100. The heat of formation is the change in enthalpy accompanying the formation of a substance from its elements at 298 K and 1 atm pressure. Since the ethalpies of elements in their most stable state are taken to be zero, the heat of formation of compounds is

(a) always negative (b) always positive

(c) standard heat enthalpy of that compound

(d) zero.

Directions : In the following questions (101-120), a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If both assertion and reason are false.

101. **Assertion :** Alkenes and cycloalkanes series of hydrocarbons have same general formula.

Reason : Either insertion of a double bond or formation of a ring reduce the number of hydrogen atoms of corresponding alkane by 2.

102. **Assertion :** Graphite is used as anode but diamond is not.

Reason : There exist free electrons between two parallel sheets of graphite, hence it helps in electrode conduction.

103. **Assertion :** $NC - CH_2CH_2COOH$ is called 3-cyano- propanoic acid while $OHC - CH_2CH_2COOH$ is called 4-oxobutanoic acid.

Reason : While naming polyfunctional compounds, — COOH group gets preference over cyano and oxo groups.

104. **Assertion :** The presence of nitro group facilitates nucleophilic substitution reactions in aryl halides.

Reason : The intermediate carbanion is stabilised due to the presence of nitro group.

105. **Assertion :** A spectral line will be seen for a $2p_x \rightarrow 2p_y$ transition.

Reason : Energy is released in the form of waves of light when the electron drops from $2p_x$ to $2p_y$ orbital.

106. **Assertion :** The difference in the boiling point of equimolar solution of HCl and HF decreases as their molarity is decreased.
Reason : The extent of dissociation decreases steadily with increasing dilution.

107. **Assertion :** $SeCl_4$ does not have a tetrahedral structure.
Reason : Se in $SeCl_4$ has two lone pairs.

108. **Assertion :** Aniline is a weaker base than ammonia.
Reason : In aniline, the non-bonding electron pair is delocalised into benzene ring by resonance.

109. **Assertion :** The geometrical isomers of the complex $[M(NH_3)_4Cl_2]$ are optically inactive.
Reason : The geometrical isomers of the complex $[M(NH_3)_4Cl_2]$ possess axis of symmetry.

110. **Assertion :** *N*, *N*-Diethylbenzene sulphonamide is insoluble in alkali.
Reason : Sulphonyl group is attached to electronegative nitrogen atom.

111. **Assertion :** Compressibility factor for hydrogen varies with pressure with positive slope at all pressures.
Reason : Even at low pressures, repulsive forces dominate for hydrogen gas.

112. **Assertion :** Borazole is aromatic in nature.
Reason : Nitrogen contributes π-electrons to the system.

113. **Assertion :** HOCl is a stronger acid than HOBr.
Reason : More the electronegativity of the halogen stronger is the acid.

114. **Assertion :** Phenol is less acidic than *p*-nitrophenol.
Reason : Phenolate ion is more stable than *p*-nitrophenolate ion.

115. **Assertion :** Many reactions occuring on solid surface are zero order reactions.
Reason : $N_2O_{(g)} \xrightarrow{Au} N_{2(g)} + \frac{1}{2}O_{2(g)}$; rate $= k$

116. **Assertion :** The enthalpy of formation of gaseous oxygen molecules at 298 K under a pressure of one atm is zero.
Reason : The entropy of formation of gaseous oxygen molecules under the same conditions is zero.

117. **Assertion :** HCHO reacts with NH_3 to give urotropine.
Reason : Urotropine is a medicine for troubles in urinary track.

118. **Assertion :** Actinoids show greater number of oxidation states than lanthanoids.
Reason : Actinoids are radioactive.

119. **Assertion :** Formaldehyde cannot be prepared by Rosenmund's reduction.
Reason : Acid chlorides can be reduced into aldehydes with hydrogen in boiling xylene using palladium or platinum as a catalyst supported on barium sulphate. This is known as Rosenmund's reduction.

120. **Assertion :** Sodium ions are discharged in preference to hydrogen ions at mercury electrode.
Reason : The nature of cathode can affect the order of discharge of cations.

BIOLOGY

121. Match column I with column II and choose the correct option.

Column I	Column II
A. *Rhizopus*	1. Ascomycetes
B. *Penicillium*	2. Basidiomycetes
C. *Ustilago*	3. Deuteromycetes
D. *Alternaria*	4. Phycomycetes

(a) A–4; B–3; C–1; D–2 (b) A–2; B–3; C–4; D – 1
(c) A–4; B–1; C–2; D–3 (d) A–3; B–4; C–2; D–1

122. Which of the following statements is true with regard to the light reaction of photosynthesis?
(a) In PSII the reaction centre chlorophyll *a* has an absorption peak at 700 nm, hence is called P 700.
(b) In PSI the reaction centre chlorophyll *a* has an absorption maxima at 680 nm and is called P 680.
(c) Lamellae of the grana have PSI and PSII and stroma lamellae membranes have PSII only.
(d) Photosystems I and II are involved in Z scheme.

123. The correct floral formula of chilli is
(a) $\oplus\ \female\ K_{(5)}\ C_5\ A_5\ \underline{G}_{(2)}$ (b) $\oplus\ \female\ K_{(5)}\ \overset{\frown}{C_{(5)}\ A_5}\ \underline{G}_{(2)}$
(c) $\oplus\ \female\ K_{(5)}\ C_{(5)}\ A_{(5)}\ \underline{G}_2$ (d) $\oplus\ \female\ K_5\ \overset{\frown}{C_5\ A_{(5)}}\ \underline{G}_2$.

124. One very special feature in the earthworm (*Pheretima*) is that
(a) fertilisation of eggs occurs inside the body
(b) the typhlosole greatly increases the effective absorption area of the digested food in the intestine
(c) the S-shaped setae embedded in the integument are the defensive weapons used against the enemies
(d) it has a long dorsal tubular heart.

125. Match the following and choose the correct combination from the options given.

Column I (Organic Compound)	Column II (Example)
A. Fatty acid	1. Glutamic acid
B. Phospholipid	2. Tryptophan
C. Aromatic amino acid	3. Lecithin
D. Acidic amino acid	4. Palmitic acid

(a) A-1; B-2; C-3; D-4 (b) A-4; B-3; C-2; D-1
(c) A-2; B-3; C-4; D-1 (d) A-3; B-4; C-1; D-2

126. Which of the following statements is incorrect about G_0 phase?
(a) Mitosis occurs after G_0 phase.
(b) Biocatalysts can be used to exit G_0 phase.
(c) Cell volume keeps on increasing during this phase.
(d) Cell metabolism occurs continuously in G_0 phase.

127. Oxidative decarboxylation occurs during the formation of
(a) citric acid and succinic acid
(b) citric acid and oxaloacetic acid
(c) acetyl CoA and succinyl CoA
(d) oxaloacetic acid and oxalosuccinic acid.

128. C_4 plants have bundle sheath cells which possess
(a) few chloroplasts with thin walls so that gaseous exchange can take place
(b) large number of chloroplasts with thick walls impervious to gaseous exchange
(c) large number of chloroplasts and intercellular spaces
(d) few chloroplasts with thick walls and no intercellular spaces.

129. Choose the schematic diagram which properly represents pulmonary circulation in humans.
(a) Left auricle $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Lungs $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Right ventricle
(b) Left auricle $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Lungs $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Right ventricle
(c) Right ventricle $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Lungs $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Left auricle
(d) Right ventricle $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Lungs $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Left auricle

130. Which of the following statements is correct in relation to the endocrine system?
(a) Non-nutrient chemicals produced by the body in trace amounts that act as intercellular messenger are known as hormones.
(b) Releasing and inhibitory hormones are produced by the pituitary gland.
(c) Adenohypophysis is under direct neural regulation of the hypothalamus.
(d) Organs in the body like gastrointestinal tract, heart, kidney and liver do not produce any hormones.

131. Choose the wrong statement.
(a) Teeth in Chondrichthyes are modified ctenoid scales.
(b) Air bladder in fishes regulates buoyancy.
(c) Long bones in birds are pneumatic.
(d) Reptiles are poikilotherms.

132. Taxonomic hierarchy refers to
(a) stepwise arrangement of all categories for classification of plants and animals
(b) a group of senior taxonomists who decide the nomenclature of plants and animals
(c) a list of botanists or zoologists who have worked on taxonomy of a species or group
(d) classification of a species based on fossil record.

133. Which of the following pairs is correct?
(a) Annelida-polychaeta-leech
(b) Mollusca-cephalopoda-*Octopus*
(c) Arthropoda-crustacea-cockroach
(d) Protozoa-*Hydra*.

134. Plasmodesmata are usually observed between
(a) sieve tubes and bast fibres
(b) tracheids and phloem fibres
(c) xylem parenchyma and xylem fibres
(d) sieve tubes and companion cells.

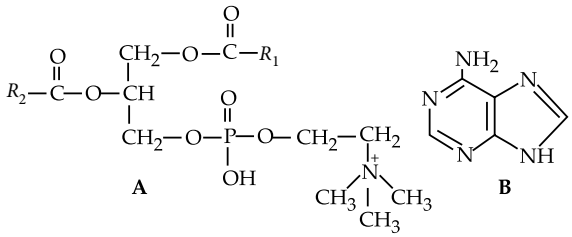
135. Which of the following statements is/are not correct regarding connective tissues?
(i) Connective tissues are most abundant and widely distributed in the body of complex animals.
(ii) They connect and support other tissues.
(iii) They include such diverse tissues as bone, cartilage, tendons, adipose and loose connective tissues.
(iv) They form the internal and external lining of many organs.
(v) In all connective tissues except blood, the cells secrete fibres of structural proteins called collagen or elastin.
(a) (iv) only (b) (v) only
(c) (i) and (ii) (d) (iii) and (v)

136. Read the following statements and choose the correct option.

A. Blood cells secrete fibres of structural proteins called collagen or elastin.
B. Neuroglial cells protect and support the nephrons.
C. Osteocytes are present in spaces called lacunae.
D. Striated muscle fibres are bundled together in a parallel fashion.
E. Biceps are involuntary and striated.

(a) C and D are wrong
(b) B and D are wrong
(c) A and C are wrong
(d) A, B and E are wrong

137. Which one of the following structural formulae of two organic compounds is correctly identified along with its related function?



(a) B : adenine - a nucleotide that makes up nucleic acids
(b) A : triglyceride - major source of energy
(c) B : uracil - a component of DNA
(d) A : lecithin - a component of cell membrane

138. Which one of the following pairs is incorrectly matched?

(a) Adenine derivative	–	kinetin
(b) Carotenoid derivative	–	ABA
(c) Terpenes	–	IAA
(d) Indole compounds	–	IBA

139. Which one of the following four glands is correctly matched with the accompaning description ?

(a) Thyroid - hyperactivity in young children causes cretinism
(b) Thymus - starts undergoing atrophy after puberty
(c) Parathyroid - secretes parathormone which promotes movement of calcium ions from blood into bones during calcification
(d) Pancreas - delta cells of the islets of Langerhans secrete a hormone which stimulates glycolysis in liver.

140. The inspiratory reserve volume + tidal volume + expiratory reserve volume is the same as

(a) inspiratory capacity + expiratory reserve volume
(b) total lung capacity – functional residual capacity
(c) inspiratory capacity + functional residual capacity
(d) inspiratory capacity + residual volume.

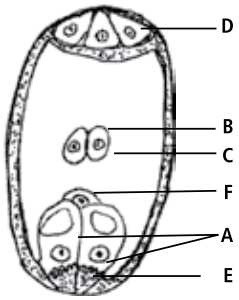
141. Formation of activation calyx in the egg takes place

(a) before fertilisation (b) after fertilisation
(c) at the time of cleavage
(d) at the time of amphimixis.

142. In a normal pregnant woman, the amount of total gonadotropin activity was assessed. The result expected was

(a) high level of circulating FSH and LH in the uterus to stimulate implantation of the embryo
(b) high level of circulating hCS to stimulate endometrial thickening
(c) high levels of FSH and LH in uterus to stimulate endometrial thickening
(d) high level of circulating hCG to stimulate estrogen and progesterone synthesis.

143. In the diagram given above, parts labelled as '*A*', '*B*', '*C*', '*D*', '*E*' and '*F*' are respectively identified as:



(a) synergids, polar nuclei, central cell, antipodals, filiform apparatus and egg
(b) polar nuclei, egg, antipodals, central cell, filiform apparatus and synergids
(c) egg, synergids, central cell, filiform apparatus, antipodals and polar nuclei
(d) central cell, polar nuclei, filiform apparatus, antipodals, synergids and egg

144. In double fertilisation

(a) two male gametes fuse with two eggs
(b) one male gamete fuses with the egg and the other fuses with the secondary nucleus
(c) one male gamete fuses with the egg and the other fuses with the antipodal
(d) one male gamete fuses with the antipodal and the other fuses with the diploid nucleus

145. Read the following four statements (A – D).

(A) In transcription, adenosine pairs with uracil.

(B) Regulation of *lac* operon by repressor is referred to as positive regulation.

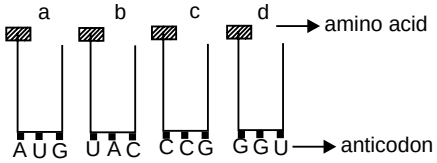
(C) The human genome has approximately 50,000 genes.

(D) Haemophilia is a sex-linked recessive disease.

How many of the above statements are correct?

(a) Two (b) Three (c) Four (d) One.

146. Find the sequence of binding of the following amino acyl-*t*RNA complexes during translation of a *m*RNA transcribed by a DNA segment having the base sequence 3′TACATGGGTCCG 5′. Choose the answer showing the correct order of alphabets.



(a) a, b, d, c (b) b, a, d, c

(c) a, b, c, d (d) b, a, c, d

147. Read the following statements and choose the correct option.

A. Increase in melanised moths after industrialisation in Great Britain is a proof for natural selection.

B. When more individuals of a population acquire a mean character value, it is called disruption.

C. Changes in allelic frequency in a population will lead to Hardy-Weinberg equilibrium.

D. Genetic drift changes the existing gene or allelic frequency in future generations.

(a) B only is correct.

(b) D only is correct.

(c) A and D both are correct

(d) A and C both are correct.

148. What kind of evidences suggested that man is more closely related with chimpanzee than with other hominoid apes?

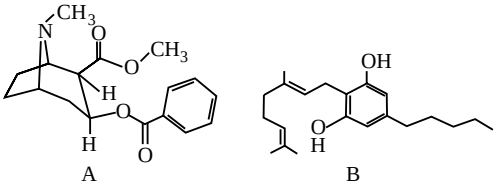
(a) Evidence from DNA from sex chromosomes only

(b) Comparison of chromosome morphology only

(c) Evidence from fossil remains, and the fossil mitochondrial DNA alone

(d) Evidence from DNA extracted from sex chromosomes and autosomes.

149. Identify the molecules (A) and (B) shown below and select the right option giving their source and use.



	Molecule	Source	Use
(a)	A-Cocaine	*Erythro-xylum coca*	Accelerates the transport of dopamine
(b)	B-Heroin	*Cannabis sativa*	Depressant and slows down body functions
(c)	B-Canna-binoid	*Atropa belladonna*	Produces hallucinations
(d)	A-Morphine	*Papaver somniferum*	Sedative and pain killer

150. Match the microbes in Column I with their commercial/industrial products in Column II and choose the correct answer.

Column I	Column II
A. *Aspergillus niger*	1. Ethanol
B. *Clostridium butylicum*	2. Statins
C. *Saccharomyces cerevisiae*	3. Citric acid
D. *Trichoderma polysporum*	4. Butyric acid
E. *Monascus purpureus*	5. Cyclosporin A

(a) A – 4, B – 5, C – 2, D – 1, E – 3

(b) A – 5, B – 4, C – 1, D – 2, E – 3

(c) A – 3, B – 4, C – 1, D – 5, E – 2

(d) A – 3, B – 4, C – 5, D – 1, E – 2

151. Which of the following is a correct match between crop, variety and resistance to diseases?

	Crop	Variety	Resistance to diseases
(a)	Wheat	himgiri	white rust
(b)	*Brassica*	Pusa sadabahar	black rot
(c)	Cowpea	Pusa komal	bacterial blight
(d)	Chilli	Pusa swarnim	chilly mosaic virus

152. Which one of the following options gives the correct matching of a disease with its causative organism and mode of infection?

	Disease	Causative	Mode of infection
(a)	Typhoid	*Salmonella typhi*	with inspired air
(b)	Pneumonia	*Streptococcus pneumoniae*	droplet infection
(c)	Elephan-tiasis	*Wuchereria bancrofti*	with infected water and food
(d)	Malaria	*Plasmodium vivax*	bite of male *Anopheles* mosquito

153. Which one of the following palindromic base sequences in DNA can be easily cut at about the middle by a particular restriction enzyme?

(a) 5′ —— CGTTCG —— 3′
3′ —— ATGGTA —— 5′

(b) 5′ —— GATATG —— 3′
3′ —— CTACTA —— 5′

(c) 5′ —— GAATTC —— 3′
3′ —— CTTAAG —— 5′

(d) 5′ —— CACGTA —— 3′
3′ —— CTCAGT —— 5′

154. What is it that forms the basis of DNA fingerprinting?

(a) The relative proportions of purines and pyrimidines in DNA.

(b) The relative difference in the DNA occurrence in blood, skin and saliva.

(c) The relative amount of DNA in the ridges and grooves of the fingerprints.

(d) Satellite DNA occurring as highly repeated short DNA segments.

155. Cryogene is obtained from

(a) *Agrobacterium tumefaciens*

(b) *Rhizobium phaseoli*

(c) *Bacillus thuringiensis*

(d) *Rhizobium leguminosarum.*

156. Read the following four statements (A-D) about certain mistakes in two of them.

A. The first transgenic buffalo, Rosie produced milk which was human alpha-lactalbumin enriched.

B. Restriction enzymes are used in isolation of DNA from other macromolecules.

C. Downstream processing is one of the steps of rDNA technology.

D. Disarmed pathogen vectors are also used in transfer of rDNA into the host.

Which of the two statements have mistakes?

(a) B and C (b) C and D

(c) A and C (d) A and B

157. What is true about Bt toxin?

(a) Bt protein exists as active toxin in the *Bacillus*.

(b) The activated toxin enters the ovaries of the pest to sterilise it and thus prevent its multiplication.

(c) The concerned *Bacillus* has antitoxins.

(d) The inactive protoxin gets converted into active form in the insect gut.

158. Find the correct order of biomagnification of DDT in an aquatic food chain.

(a) Water (0.003 ppm), zooplankton (0.5 ppm), small fish (0.04 ppm), large fish (2 ppm), fish eating birds (25 ppm).

(b) Water (0.003 ppm), zooplankton (0.04 ppm), small fish (0.5 ppm), large fish (2 ppm), fish eating birds (25 ppm).

(c) Water (0.003 ppm), fish eating birds (25 ppm), zooplankton (0.5 ppm), small fish (0.04 ppm), large fish (25 ppm).

(d) Water (0.003 ppm), small fish (0.04 ppm), zooplankton (0.5 ppm), large fish (2 ppm), fish eating birds (25 ppm).

159. Standing crop refers to

(a) all the photosynthetic living forms in an area

(b) all the living forms in an area

(c) the amount of living matter in a component population of an ecosystem at any time

(d) all the crop plants in an area.

160. Appropriate measures to reduce overall greenhouse gas emissions are the commitments of the

(a) Montreal Protocol (b) Environment Act

(c) Kyoto Protocol (d) Beijing Protocol.

Direction : In the following questions (161-180), a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If both assertion and reason are false.

161. **Assertion :** Though the bacterial structure is very simple, they are very complex in behaviour.
Reason : Compared to many other organisms, bacteria as a group show the most extensive metabolic diversity.

162. **Assertion :** Molluscs have a segmented body with a distinct head, muscular foot and visceral hump.
Reason : Their gills, present in mantle cavity have only respiratory functions.

163. **Assertion :** Epidermal hairs on stem are called trichomes.
Reason : They help in absorbing water vapour by the stem.

164. **Assertion :** Cell junctions fuse the plasma membranes of cardiac muscle cells and make them stick together.
Reason : Communication junctions or intercalated discs at some fusion points allow the cells to contract as a unit.

165. **Assertion :** A single human cell has approximately 4 metre long thread of DNA distributed among its forty six chromosomes.
Reason : Chromosomes contain DNA and some basic proteins only.

166. **Assertion :** Proteins are polypeptides consisting of linear chains of amino acids linked by dipeptide bonds between two amino acids.
Reason : Each protein is a homopolymer consisting of 20 types of amino acids.

167. **Assertion :** Bulk flow is the movement of substances in bulk or en masse from one point to another.
Reason : Bulk flow can be achieved only by positive hydrostatic pressure.

168. **Assertion :** In photosynthesis, protons accumulate in the intermembrane space of granum.
Reason : In respiration, proton accumulation is towards the inner side of the membrane, *i.e.*, in the lumen.

169. **Assertion :** Gastric and intestinal secretions are stimulated by neural signals and hormonal control.
Reason : These are mediated by neural mechanisms and hormones produced locally only.

170. **Assertion :** Cardiac output is defined as the volume of blood pumped out by both ventricles per minute.
Reason : The body does not have the ability to alter the cardiac output.

171. **Assertion :** The process of formation of megaspores from megaspore mother cells is called megasporogenesis.
Reason : All the four megaspores formed by the meiotic division of megaspore mother cell are ususally functional.

172. **Assertion :** Spermatogenesis starts at puberty due to significant increase in the secretion of GnRH.
Reason : LH acts on Sertoli cells and stimulates secretion of factors which help in spermiogenesis.

173. **Assertion :** In *trans*-arrangement of linked genes, the dominant alleles of both the genes are present on one chromosome, while their recessive alleles occur over the homologous chromosome.
Reason : In *cis*-arrangement, a chromosome contains dominant allele of one gene and recessive allele of the other, while the reverse arrangement is present over its homologue.

174. **Assertion :** Radioactive C-14 occurs in all living beings, as it enters through the food chain.
Reason : C-14 decays to form nitrogen-14.

175. **Assertion :** Smoking causes oxygen deficiency in the body.
Reason : It increases carbon monoxide content in the blood and reduces the concentration of haembound oxygen.

176. **Assertion :** MOET is a herd improvement programme.
Reason : In this method, a cow is administered hormones with LH-like activity to induce follicular maturation and super ovulation.

177. **Assertion :** There is indiscriminate addition of weedicide resistance genes into crop plants.
Reason : Any accidental or natural transfer of weedicide resistance gene from GM crops to weeds will convert the latter into 'super weeds'.

178. **Assertion :** Restriction enzyme digestions are performed by incubating purified DNA molecules with restriction enzyme.
Reason : Agarose gel electrophoresis is employed to check the progression of a restriction enzyme digestion.

179. **Assertion :** Darwin postulated that in the struggle for existence, intraspecific competition is a potent force in organic evolution.
Reason : In general, herbivores and plants appear to be less adversely affected by competition than carnivores.

180. **Assertion :** Thermal wastewaters may enhance the growth of plants and fish in extremely cold areas, but only after causing damage to the indigenous flora and fauna.
Reason : Thermal wastewaters do not constitute an important category of pollutants.

GENERAL KNOWLEDGE AND APTITUDE & LOGICAL THINKING

181. 'Pulitzer' prizes are awarded to Americans for excellence in
(a) films (b) social work
(c) journalism (d) medicines.

182. The first of the 'GAEL' (Global Alliance for the Elimination of Leprosy) was held in
(a) New Delhi (b) Mumbai
(c) Kolkata (d) Paris.

183. Tehri Dam is being built on the river
(a) Yamuna (b) Godavari
(c) Kaveri (d) Bhagirathi.

184. Megger is an instrument to measure
(a) very low resistance
(b) insulation resistance
(c) inductance of a coil
(d) all of these.

185. 'Alpha and Omega' means
(a) come and go
(b) the beginning and the end
(c) to win and to loose
(d) none of these.

186. Match List-I (Books) with List II (Authors) and select the correct answer using the codes given below the Lists :

List I	List II
A. My music, My life	1. Khushwant Singh
B. Adha Gaon	2. Rahi Massom Raza
C. Eternal India	3. Indira Gandhi
D. We Indians	4. Ravi Shankar

(a) A-3, B-2, C-4, D-1 (b) A-4, B-2, C-3, D-1
(c) A-4, B-1, C-3, D-2 (d) A-3, B-1, C-4, D-2

187. Which of the following is not a Fundamental Right?
(a) Right to equality
(b) Right to property
(c) Right against exploitation
(d) Right to freedom of speech and expression

188. Hiroshima day in Japan is remembered on
(a) August 6 (b) August 16
(c) October 7 (d) August 13.

189. Another name for the inherited blood disease thalassemia?
(a) Cooley's anemia (b) Grave's disease
(c) Hemophilia (d) Dyspnoea

190. The longest railway platform in the world is in
(a) India (b) United states
(c) Italy (d) Australia.

191. Select a figure from the options which when placed in the blank space of Fig. (X) would complete the pattern.

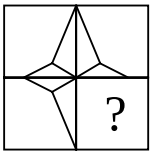
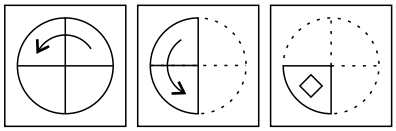


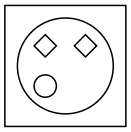
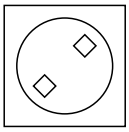
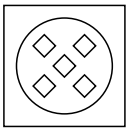
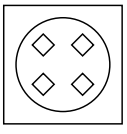
Fig. (X)

(a) (b) (c) (d)

192. If A is to the south of B and C is to the east of B, in what direction is A with respect to C?
(a) North-east (b) North-west
(c) South-east (d) South-west

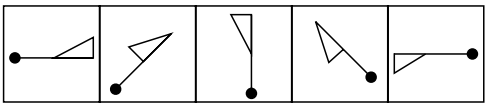
193. Three figures (X), (Y), (Z) shows a sequence of folding of a sheet of paper. Out of them, fig. (Z) shows the manner in which the folded paper has been cut. Select a figure from the options which would most closely resemble the unfolded form of fig. (Z).

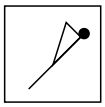
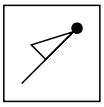
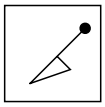

X Y Z

(a)  (b) 
(c)  (d) 

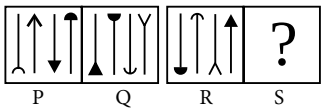
194. Select a figure from the options which will continue the given series established by the Problem Figures.

Problem Figures



(a) 
(b) 
(c) 
(d)

195. Figures P and Q are related in a particular manner. Establish the same relationship between figures R and S by selecting a figure from the options, which would replace the question mark in Fig. (S).

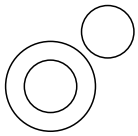
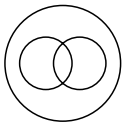
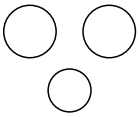
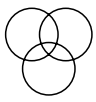


(a) (b) (c) (d)

196. Shobha is the niece of Ashish. Ashish's mother is Priya. Kamla is Priya's mother. Kamla's husband is Hari. Krishna is the mother-in-law of Hari. How is Shobha related to Hari?

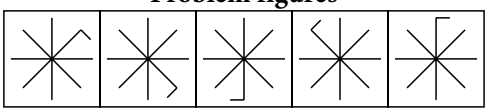
(a) Daughter
(b) Great grand daughter
(c) Grand niece
(d) Great grandson's daughter

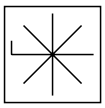
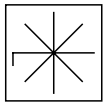
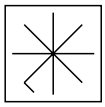
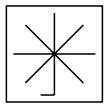
197. Choose the Venn diagram which best illustrates the relationship amongst
Earth, Moon, Planet

(a) 
(b) 
(c) 
(d) 

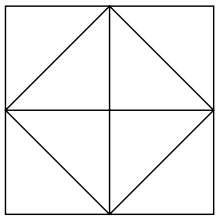
198. Select a figure from the options which will continue the same series as established by the five Problem Figures.

Problem figures



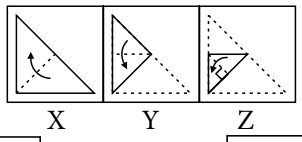
(a) 
(b) 
(c) 
(d) 

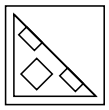
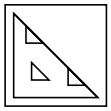
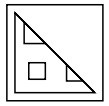
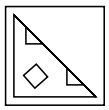
199. Find the number of triangles in the given figure.



(a) 8 (b) 10 (c) 12 (d) 14

200. A set of figures X, Y and Z showing a sequence of folding of a piece of paper. Fig. (Z) shows the manner in which the folded paper has been cut. Select a figure from the options which would most closely resemble the unfolded form of fig. (Z).



(a) 
(b) 
(c) 
(d) 

SOLUTIONS

1. (b) : With an ac source, current in the circuit is maximum when,

$Z = Z_{min} = R$ (the resistance of coil)

$\therefore \quad R = \frac{24}{6} = 4\ \Omega$

When connected with a dc source of emf 12 V then current through the coil,

$$I = \frac{12}{r + R}$$

(where r is the internal resistance of source)

$$\therefore \quad I = \frac{12}{4 + 4} = 1.5\ A$$

2. (d) : $E_n \propto \frac{1}{n^2}$ and $r_n \propto n^2$

$E_n r_n$ is independent of n.

Hence, $E_1 r_1$ = (13.6 eV) (0.53Å)

= 7.2 eV Å which is constant.

CONCEPT MAP

INTERCONVERSIONS OF ORGANIC FUNCTIONAL GROUPS

Note : R, R_1, R_2 and R' have different meanings at different places, they could be alkyl or H.

ALKANE $R-H$

ALKENE $R_1-HC=CH-R_2$

ALKYNE $R_1-C\equiv C-R_2$

ACID ANHYDRIDE $(R_1CO)_2O$

ETHER R_1-O-R_2

HALOALKANE $R-X$

ALCOHOL $R-OH$

ALDEHYDE $RCHO$

KETONE R_1COR_2

CARBOXYLIC ACID R_1COOH

NITRILE $R-C\equiv N$

ACYL CHLORIDE $RCOCl$

AMIDE $RCONH_2$

ESTER R_1COOR_2

AMINE $R'-NH_2$

X_2, $h\nu$, 520-670 K / KOH alc., Δ,
Cracking (variety of products)

H_2/Ni cat. 523-573 K, 5 atm
Raney Ni or Pt or Pd

$Br_2(CCl_4)$/alc. KOH or $NaNH_2$/liq NH_3, Δ

H_2/Ni cat., 523-573 K,
H_2/Pd-$BaSO_4$ + S (Lindlar's catalyst) (gives *cis*-alkene),
Na/Liq.NH_3, 196-200 K (Birch reduction) (gives *trans*-alkene)

Halogen / hυ or 520-670 K

Na, dry ether (Wurtz reaction),
Zn /dil.HCl or Zn / NaOH,
Li/Dry ether / CuI } (Corey- house reaction)

Hydrogen halide, room temperature

Alc. KOH, Δ

conc. H_2SO_4 (cold) / H_2O, Δ

Al_2O_3/623-633 K, or conc. H_2SO_4 reflux

Conc. H_2SO_4, heat (1° alcohols only)

H_2O in presence of
H_2SO_4 or $HgSO_4$ / Δ
(For acetylene)

[O], $KMnO_4$,
KOH,
373-383 K

$Cr_2O_7^{2-}$, H^+ (1° only),
$C_5H_5NH^+CrO_3Cl^-$, CH_2Cl_2
(Corey's reagent)

$NaBH_4$(aq.) or $LiAlH_4$ (ether) or H_2/Ni,
$RMgX$ (dry ether)/H_3O^+ (for 2° alcohol)

MnO (573 K)

$Cr_2O_7^{2-}$, H^+ reflux

conc. HNO_3,
$KMnO_4/H_2SO_4$

KOH (*aq.*), reflux

Hydrogen halide (gas)/anhyd. $ZnCl_2$, Δ,
HI/Reflux (Grove's Method),
$SOCl_2$/Pyridine

$Cr_2O_7^{2-}$, H^+, ($C_5H_5NH^+CrO_3Cl^-$), CH_2Cl_2 (2° only)

$NaBH_4$ or $LiAlH_4$ (ether) or H_2/Ni,
$RMgX$ (dry ether)/H_3O^+ (for 3° alcohol)

P_2O_5, distill or conc. H_2SO_4, Δ

H_2O

ROH, conc. H_2SO_4 cat.

PX_3 alc. KCN

$Cr_2O_7^{2-}$, H^+/$KMnO_4$, OH^-, Δ/H_3O^+

$LiAlH_4$ (ether) or B_2H_6 (ether)/H_3O^+

MnO (573 K)

H^+ (*aq.*) H_2O, reflux

NH_3, Δ

KCN. ethanolic solution, reflux

Conc. NH_3, heat in sealed tube

H_2O/H^+ or OH^-

P_2O_5/distill

H_2O/Alk·H_2O_2

Reflux, H^+ or OH^-

ROH, conc. H_2SO_4

Cu or Ni, 773 K

H_2/Raney Ni or $LiAlH_4$/ether
or Na-Hg/C_2H_5OH

Conc. NH_3, room temp. (gives 1° amide),
RNH_2, reflux (gives 2° amide),
R_2NH, reflux (gives 3° amide)

H_2O

$SOCl_2$, PCl_3 or PCl_5/reflux

ROH, Pyridine

NH_3

CH_3OH/HCl/Δ

NH_3, reflux (gives 1° amide); RNH_2, reflux (gives 2° amide)

$LiAlH_4$ (ether)/H_2O,
Br_2 + KOH

3. (a) : To move straight along AB,

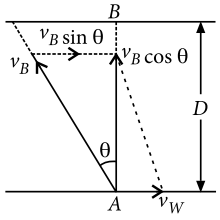
$v_B \sin\theta = v_W$

$$\sin\theta = \frac{v_W}{v_B} = \frac{v_W}{2v_W} = \frac{1}{2}$$

$\therefore \quad \theta = 30°$

Time taken to cross the river,

$$t = \frac{D}{v_B\cos\theta} = \frac{D}{v_B\cos 30°} = \frac{2D}{v_B\sqrt{3}}.$$



4. (c) : From the question,

Weight of wire = 50 N

Mass of wire = (50/10) = 5 kg ; Length = 20 m

$\therefore$ Mass per unit length, m = (5/20) = 0.25 kg m^{-1}

At the middle point, T = 25 N

The velocity of the transverse wave is $v = \sqrt{\frac{T}{m}}$, where T is the tension in the wire and m is the mass per unit length of the wire

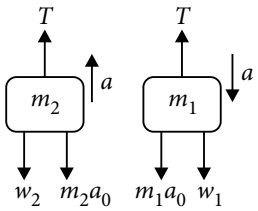
$$\therefore \quad v = \sqrt{\frac{25}{0.25}} = \sqrt{100} = 10 \text{ m s}^{-1}$$

5. (b)

6. (c) : As $c = \frac{x}{t_1}$, $v = \frac{10x}{t_2}$

$$\sin C = \frac{1}{\mu} = \frac{v}{c} = \frac{10x}{t_2} \times \frac{t_1}{x} \text{ or } C = \sin^{-1}\left(\frac{10t_1}{t_2}\right)$$

7. (a) : For solving the problem, we assume that observer is situated in the frame of pulley (non-inertial reference frame).



$m_1g = w_1$

$m_2g = w_2$

From force diagram, $T - m_2a_0 - w_2 = m_2a$

or $T - m_2g - w_2 = m_2a$ ($\because a_0 = g$)

or $T - 2w_2 = m_2a$ ... (i)

From force diagram, $m_1a_0 + w_1 - T = m_1a$

or $m_1g + w_1 - T = m_1a$ ($\because a_0 = g$)

or $2w_1 - T = m_1a$ ... (ii)

From eqs. (i) and (ii), we get

$$T = \frac{4w_1w_2}{w_1 + w_2}$$

8. (a) : Time period, $T \propto p^a\rho^bE^c$ or $T = kp^a\rho^bE^c$

k is a dimensionless constant.

According to homogeneity of dimensions, LHS = RHS

$\therefore \quad [T] = [ML^{-1}T^{-2}]^a[ML^{-3}]^b[ML^2T^{-2}]^c$

$[T] = [M^{a+b+c}][L^{-a-3b+2c}][T^{-2a-2c}]$

Comparing the powers, we obtain

$a + b + c = 0$; $-a - 3b + 2c = 0$; $-2a - 2c = 1$

On solving, we get

$$a = -\frac{5}{6},\ b = \frac{1}{2},\ c = \frac{1}{3}$$

9. (b) : When thin plate of glass is introduced, then lateral displacement of fringes

$$= \frac{\beta}{\lambda}(\mu - 1)t = \frac{1 \times 10^{-3}}{600 \times 10^{-9}}(1.5 - 1) \times 0.06 \times 10^{-3}$$

$$= \frac{1}{20} \text{ m} = 5 \text{ cm}$$

10. (c) : Here, $R_{max} = \frac{u^2}{g} = \frac{1}{2}mu^2 \times \frac{2}{mg}$

But $\frac{1}{2}mu^2 = \frac{1}{2}kx^2$

$$\therefore \quad R_{max} = \frac{1}{2}kx^2 \times \frac{2}{mg} = \frac{kx^2}{mg} = \frac{600 \times (0.05)^2}{0.015 \times 10} = 10 \text{ m}$$

11. (c) : As $\theta_1 = \omega_0 t + \frac{1}{2}\alpha t^2 = 0 + \frac{1}{2}\alpha(2)^2 = 2\alpha$

$$(\theta_1 + \theta_2) = \omega_0 t + \frac{1}{2}\alpha t^2 = 0 + \frac{1}{2}\alpha(4)^2 = 8\alpha$$

Thus, $\theta_2 = 6\alpha$ or $\frac{\theta_2}{\theta_1} = 3$

12. (b) : $B_1 = \frac{\mu_0}{4\pi} \times \frac{2\pi I}{a} \times \frac{1}{2}$ (due to the semicircular part)

$B_2 = \frac{\mu_0}{4\pi} \times \frac{2I}{a}$ (due to parallel parts of currents)

These two fields are at right angles to each other. Hence, resultant field at point O is

$$B = \sqrt{B_1^2 + B_2^2} = \frac{\mu_0 I}{4\pi a}\sqrt{\pi^2 + 4}$$

13. (d)

14. (a) : Suppose h be the height of each storey, then

$$25h = 0 + \frac{1}{2} \times 10 \times t^2 = \frac{1}{2} \times 10 \times 5^2 \quad \therefore \quad h = 5 \text{ m}$$

In first second, let the stone passes through n storeys. So,

$$n \times 5 = \frac{1}{2} \times 10 \times (1)^2 \quad \text{or} \quad n = 1$$

15. (a) : As $U_1 = \frac{1}{4\pi\varepsilon_0}\frac{Q(-q)}{r}$; $U_2 = \frac{1}{4\pi\varepsilon_0}\frac{Q(-q)}{(r/2)}$

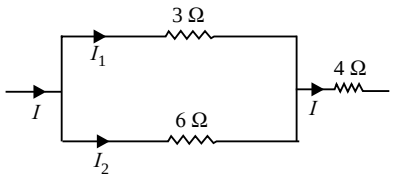
$$U_1 - U_2 = \frac{Qq}{4\pi\varepsilon_0 r}[-1 + 2] = \frac{Qq}{4\pi\varepsilon_0 r} = 9 \text{ J}$$

$$U_3 = \frac{Q(-q)}{4\pi\varepsilon_0(3r/4)} = \frac{Q(-q)}{4\pi\varepsilon_0 r} \times \frac{4}{3}$$

$\therefore \quad U_1 - U_3 = \frac{Qq}{4\pi\varepsilon_0 r} \times \frac{1}{3} = 9 \times \frac{1}{3} = 3$ J

16. (d)

17. (c) :



Here, $I_1 = 0.8$ A

As the resistances 3 Ω and 6 Ω are connected in parallel. Therefore potential drop across these resistances is same.

$\therefore \quad 3I_1 = 6I_2$ or $(0.8) \times 3 = I_2 \times 6$ or $I_2 = 0.4$ A

The current flowing through 4 Ω resistor is

$I = I_1 + I_2 = 0.8$ A + 0.4 A = 1.2 A

Potential drop across 4 Ω resistance = $I \times 4$

$= (1.2) \times 4 = 4.8$ V

18. (b) : For body A, $T = m_A a = 7a$

For body B, $m_B g - T = m_B a$

or $3g - 7a = 3a$ or $10a = 3g$ or $a = 3$ m s^{-2}

19. (c) : Acceleration due to gravity of a planet,

$$g = \frac{GM}{R^2}$$

$$\therefore \quad \frac{g_m}{g_e} = \frac{M_m}{M_e} \times \left(\frac{R_e}{R_m}\right)^2 = \frac{1}{81} \times (4)^2 = \frac{16}{81}$$

$$g_m = \frac{16}{81} g_e$$

$$v_m = \sqrt{2 g_m R_m} = \sqrt{2 \times \frac{16}{81} g_e \times \frac{1}{4} R_e}$$

$$= \frac{2}{9}\sqrt{2 g_e R_e} = \frac{2}{9} \times 11.2 = 2.5 \text{ km s}^{-1}$$

20. (b)

21. (a) : Here, $n_i = 10^{19}$ m^{-3}, $n_h = 10^{21}$ m^{-3}

As $n_i^2 = n_e n_h$

$$\therefore \quad n_e = \frac{n_i^2}{n_h} = \frac{10^{19} \times 10^{19}}{10^{21}} = 10^{17} \text{ m}^{-3}.$$

22. (a) : According to Newton's law of cooling,

$$\frac{80 - 64}{5} = \alpha\left[\frac{80 + 64}{2} - T\right] \quad \text{...(i)}$$

and $$\frac{80 - 52}{10} = \alpha\left[\frac{80 + 52}{2} - T\right] \quad \text{...(ii)}$$

where T is the temperature of the surrounding.

Solving eqs. (i) and (ii), we get $T = 24°$ C

23. (d)

24. (a) : The oscillator frequency should be same as proton's cyclotron frequency.

Cyclotron frequency, $\upsilon_c = \frac{qB}{2\pi m}$

or $$B = \frac{2\pi m \upsilon_c}{q} = \frac{2 \times 3.14 \times 1.67 \times 10^{-27} \times 12 \times 10^6}{1.6 \times 10^{-19}}$$

$= 78.6 \times 10^{-2}$ T ≈ 0.8 T

25. (c) : The inductive reactance is

$$X_L = 2\pi\upsilon L = 2 \times \frac{22}{7} \times 50 \times 25 \times 10^{-3} \ \Omega$$

The rms current in the circuit is

$$I_{\text{rms}} = \frac{V_{\text{rms}}}{X_L} = \frac{220}{2 \times \frac{22}{7} \times 50 \times 25 \times 10^{-3}} = 28 \text{ A}$$

26. (c) : As $\frac{\Delta L}{L} = 0.10\% = 0.001$ and $\Delta T = 100°$C,

hence using $\frac{\Delta L}{L} = \alpha \Delta T$, we get $\alpha = \frac{0.001}{100} = 10^{-5}/°\text{C}$

$\therefore \quad \gamma = 3\alpha = 3 \times 10^{-5}/°\text{C}$

and $$\frac{\Delta V}{V} = \gamma \Delta T = 3 \times 10^{-5} \times 100 = 3 \times 10^{-3} = 0.30\%$$

27. (c) : Momentum after collision

= Momentum before collision

$(m_1 + m_2)v = m_1 u_1 + m_2 u_2$

$(0.5 + 1.0)v = 0.5 \times 2.0 + 1.0 \times 0$ or $v = \frac{2}{3}$ m s^{-1}

Loss of energy, $= \frac{1}{2} m_1 u_1^2 - \frac{1}{2}(m_1 + m_2) v^2$

$$= \frac{1}{2} \times 0.5 \times 2^2 - \frac{1}{2}(0.50 + 1.0)\left(\frac{2}{3}\right)^2 = 1 - \frac{1}{3} = 0.67 \text{ J}.$$

28. (d) : Here, $\vec{B} = 1.2 \times 10^{-8} \hat{k}$ T

The magnitude of $\vec{E}$ is

$E = Bc = (1.2 \times 10^{-8}$ T$)(3 \times 10^8$ m s$^{-1}) = 3.6$ V m^{-1}

$\vec{B}$ is along z-direction and the wave propagates along x-direction. Therefore $\vec{E}$ should be in a direction perpendicular to both x and z axes. Using vector algebra $\vec{E} \times \vec{B}$ should be along x-direction.

Since $(+\hat{j}) \times (+\hat{k}) = \hat{i}$, $\vec{E}$ is along the y-direction.

Thus, $\vec{E} = 3.6\hat{j}$ Vm^{-1}.

29. (a)

30. (a) : Here, a = 1 cm = 0.01 m; The mass will remain in contact with surface, if

$mg = m\omega^2 a$ or $\omega = \sqrt{g/a}$

or $2\pi\upsilon = \sqrt{g/a}$ or $\upsilon = \frac{1}{2\pi}\sqrt{\frac{g}{a}} = \frac{7}{2\times 22}\sqrt{\frac{980}{1}}$

$= 4.9 \text{ Hz} \approx 5 \text{ Hz}$

31. (b) : For an open pipe,

$$\upsilon = \frac{n\cdot c}{2L} = \frac{n\cdot(340 \text{ m s}^{-1})}{2 \times (5 \times 10^{-2} \text{ m})} = n\cdot 3400 \text{ Hz}$$

$3400\cdot n < 20000;\ \therefore\ n < \left(\frac{20000}{3400}\right);\ n < 5.9$

$\Rightarrow$ The greatest integral value of $n = 5$.

32. (a) : From the definition, $\alpha = \frac{\Delta I_C}{\Delta I_E}$

Change in collector current

$\Delta I_C = \alpha \times \Delta I_E = 0.98 \times 5.0 \text{ mA} = 4.9 \text{ mA}$

33. (c) : Here, $Y = 10^{-5}\sin\left[100t - \frac{x}{10}\right]$

Comparing it with standard equation of wave motion,

$$Y = r\sin\left[\frac{2\pi}{T}t - \frac{2\pi}{\lambda}x\right]$$

$\frac{2\pi}{T} = 100 \Rightarrow T = \frac{2\pi}{100} = \frac{\pi}{50}$ s; $\frac{2\pi}{\lambda} = \frac{1}{10} \Rightarrow \lambda = 20\pi$

Velocity, $v = \frac{\lambda}{T} = \frac{20\pi}{\pi/50} = 1000 \text{ m s}^{-1}$

34. (d) : Here, $J = ?$; $C_P = 3.409$ cal $g^{-1}{}^{\circ}C^{-1}$

$C_V = 2.409$ cal $g^{-1}{}^{\circ}C^{-1}$, $M = 2$; $R = 8.31$ J mol^{-1} K^{-1}

As $C_p - C_V = \frac{r}{J} = \frac{R}{MJ}$

$\therefore\ 3.409 - 2.409 = \frac{8.31}{2J}$ or $J = 4.11$ J cal^{-1}

35. (a) : Pressure outside the bigger bubble = P_1

Pressure inside the bigger bubble = P_2

Radius of bigger bubble, $r_1 = 3$ cm

Excess pressure $= P_2 - P_1 = \frac{4S}{r_1} = \frac{4S}{3}$

Pressure inside small bubble = P_3

Excess pressure = $P_3 - P_2 = \frac{4S}{r_2} = \frac{4S}{1}$

Pressure difference between inner side of small bubble and outer side of bigger bubble

$$= P_3 - P_1 = \frac{4S}{3} + \frac{4S}{1} = \frac{16S}{3}$$

This pressure difference should exist in a single bubble of radius r.

$\therefore\ \frac{4S}{r} = \frac{16S}{3}$ or $r = \frac{3}{4}$ cm $= 0.75$ cm

36. (c) : Energy of incident photon, $E = \frac{hc}{\lambda}$

$$E = \frac{6.6\times10^{-34}\times3\times10^{8}}{2\times10^{-7}} \text{ J} = \frac{9.9\times10^{-19}}{1.6\times10^{-19}} \text{ eV} = 6.2 \text{ eV}$$

$K_{max} = eV_s = e \times 2.5 \text{ V} = 2.5 \text{ eV}$

According to Einstein's photoelectric equation

$K_{max} = \frac{hc}{\lambda} - \phi_0$

or $\phi_0 = \frac{hc}{\lambda} - K_{max} = 6.2 \text{ eV} - 2.5 \text{ eV} = 3.7 \text{ eV}$

Threshold frequency, $\upsilon_0 = \frac{\phi_0}{h}$

$$\upsilon_0 = \frac{3.7\times1.6\times10^{-19}}{6.6\times10^{-34}} = 0.9 \times 10^{15} \text{ Hz} = 9 \times 10^{14} \text{ Hz}$$

37. (b)

38. (a) : Mass per unit area of disc $= \frac{9M}{\pi R^2}$

Mass of removed portion of disc $= \frac{9M}{\pi R^2} \times \pi\left(\frac{R}{3}\right)^2 = M$

Moment of inertia of removed portion about an axis passing through centre of disc and perpendicular to the plane of disc, using theorem of parallel axis is

$$I_1 = \frac{M}{2}\left(\frac{R}{3}\right)^2 + M\left(\frac{2R}{3}\right)^2 = \frac{1}{2}MR^2$$

when portion of disc is not removed, then the moment of inertia of complete disc about the given axis is

$$I_2 = \frac{9}{2}MR^2$$

So moment of inertia of the disc with removed portion, about the given axis is

$$I = I_2 - I_1 = \frac{9}{2}MR^2 - \frac{1}{2}MR^2 = 4MR^2$$

39. (b) : Higher is the temperature, greater is the most probable velocity.

40. (b) : As magnet is withdrawn from the coil, field into the coil decreases. To increase this field, current induced in the coil must be clockwise as seen by the withdrawing magnet.

41. (b) **42. (c)** **43. (b)** **44. (d)** **45. (c)**
46. (a) **47. (b)** **48. (b)** **49. (a)** **50. (a)**
51. (c) **52. (a)** **53. (a)** **54. (a)** **55. (a)**
56. (d) **57. (d)** **58. (c)** **59. (b)** **60. (d)**

61. (c) : Haematite Fe_2O_3, is a magnetic ore.

62. (c) : Molarity

$$= \frac{\text{wt. of solute}}{\text{mol. wt.}} \times \frac{1000}{\text{vol. of solution (in mL)}}$$

$$\text{Volume of solution} = \frac{\text{mass}}{\text{density}} = \frac{100}{1.84} = 54.35 \text{ mL}$$

$$\text{Now, molarity} = \frac{98}{98} \times \frac{1000}{54.35} = 18.4 \text{ M}$$

63. (a) : For acid A

$w_{acid} = 90$ g, $V_{solution} = 100$ mL,

$d = 1.98$/mL, $w_{solution} = 1.98 \times 100 = 198$ g

$$\therefore \quad m = \frac{n_A}{W_{solvent(g)}} \times 1000 = \frac{90}{98} \times \frac{1000}{(198-90)} = 8.50$$

For acid B

$w_{acid} = 93$ g, $V_{solution} = 100$ mL

$d = 1.84$ g/mL, $w_{solution} = 1.84 \times 100 = 184$ g

$$\therefore \quad m = \frac{n_B \times 1000}{W_{solvent(g)}} = \frac{93}{98} \times \frac{1000}{(184-93)} = 10.4$$

64. (b) : $NH_4OH \cdot HCl + NaNO_2 \longrightarrow$

$$\underset{(A)}{N_2O} \xrightarrow{Cu} \underset{(B)}{CuO} + \underset{(X)}{N_2}$$

CuO is a basic oxide. N_2 is a colourless, diamagnetic gas which combines with Al.

$2Al + N_2 \longrightarrow 2AlN$

Zn + NaOH $\longrightarrow$ evolve H_2 gas which reduce $NaNO_2$ to form NH_3 gas.

$NaNO_2 + 6H \longrightarrow NaOH + NH_3 + H_2O$

65. (a) : $CH \equiv CH + CH_3O^- \longrightarrow CH \equiv C^- + CH_3OH$

$O = CH_2 + {}^-C \equiv CH \longrightarrow O^- - CH_2 - C \equiv CH$

$\downarrow CH_3OH$

$$HOCH_2C \equiv CCH_2OH \xleftarrow[CH_2O]{CH_3O^-} HO - CH_2 - C \equiv CH$$

66. (c) : $H_3PO_3 + 2KOH \longrightarrow K_2HPO_3 + 2H_2O$

67. (d) **68. (d)** **69. (c)**

70. (b) : In O_2, the bond order = 2

In O_2^{2+}, the bond order = 3

In O_2^-, the bond order = 1.5

In O_2^{2-}, the bond order = 1

As the bond order in O_2^{2+} is highest, so its internuclear distance is smallest.

71. (c) : NH_3 is monodentate while *ox* is a bidentate ligand. Thus, coordination number of metal is

$= 2 \times 1 + 2 \times 2 = 6$

Oxidation number of metal = +3

Cr = [Ar] $3d^5, 4s^1$; $Cr^{3+} = 3d^3$

All the three electrons are unpaired.

$$\text{Magnetic moment} = \sqrt{n(n+2)} = \sqrt{3 \times 5} = \sqrt{15} = 3.87 \text{ B.M.}$$

72. (d) : Given that, $T = 300$ K, $V = 3$ L

Suppose on heating to T_1K, the volume of gas increases to $(3 + V_1)$ L, then

$$\frac{3}{300} = \frac{3+V_1}{T_1} \qquad \ldots(i)$$

Where V_1 is volume expelled out at T_1K.

The expelled out volume at 290 K is measured as 1.45 L.

$$\text{Thus, } \frac{1.45}{290} = \frac{V_1}{T_1} \Rightarrow V_1 = \frac{1.45T_1}{290}$$

Putting value of V_1 in equation (i),

$$\therefore \quad \frac{3}{300} = \frac{3 + \frac{1.45T_1}{290}}{T_1} \; ; \; T_1 = 300 + \frac{145T_1}{290}$$

$\therefore \quad T_1 = 600$ K or 327 °C

73. (c)

74. (c) : No. of B^- (fcc) ions in unit cell

$$= 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$$

$$\text{Now } A^+ \text{ ion occupies 25\% of tetrahedral holes} = \frac{8 \times 25}{100} = 2$$

Thus, ratio of B^- to A^+ is 2 : 1 and formula is AB_2.

75. (d) : $C_6H_5CH_2CHO$ is not an aromatic aldehyde and hence does not undergo benzoin condensation.

76. (b) :

$$\underset{a(1-\alpha)}{xA} \rightleftharpoons \underset{(a\alpha/x)}{C} + \underset{(a\alpha/x)}{D}$$

$$\therefore \quad K_c = \frac{a^2\alpha^2}{V^2 \cdot x^2 \left[\frac{a(1-\alpha)}{V}\right]^x} = \frac{\alpha^2 \cdot a^{2-x}}{x^2(1-\alpha)^x \cdot V^{2-x}}$$

Since α is independent of a.

$\therefore \quad 2 - x = 0 \Rightarrow x = 2$

77. (b) : $K_3[Fe(CN)_6]$ on ionisation gives 4 species ($3K^+$ and 1 $[Fe(CN)_6]^{3-}$) and $Al(NO_3)_3$ also gives 4 species ($1Al^{3+}$ and $3NO_3^-$), thus both will have same value of van't Hoff factor.

78. (a) : $P^\circ - P_s \propto$ loss in mass of water chamber and $P_s \propto$ loss in mass of solution chamber.

$$\frac{P^\circ - P_s}{P_s} = \frac{n}{N} = \frac{w \times M}{m \times W} \quad \Rightarrow \quad \frac{0.04}{2.50} = \frac{5 \times 18}{m \times 180}$$

$m = 31.25$ g

79. (d) : Heroin is diacetyl derivative of morphine.

80. (b) : $NH_2COONH_{4\,(s)} \rightleftharpoons 2NH_{3\,(g)} + CO_{2\,(g)}$

At eqm, if partial pressure of $CO_2 = p$, then that of $NH_3 = 2p$.

$K_p = p_{NH_3}^2 \times p_{CO_2} = (2p)^2 \times p = 4p^3$

$2.9 \times 10^{-5} = 4p^3$ or $p^3 = 7.25 \times 10^{-6} \Rightarrow p = 1.935 \times 10^{-2}$

Hence total presure $= 3p = 5.81 \times 10^{-2} = 0.0581$ atm

81. (a)

82. (d) : Secondary and tertiary alcohols on oxidation gives carboxylic acids with lesser number of carbon atoms.

83. (d) : $\Delta E = \frac{hc}{\lambda}$ or $\Delta E \propto \frac{1}{\lambda}$

84. (d)

85. (c) : Equivalent of NaCl $= \frac{500}{58.5} = 8.547$

Let 8.547 eq. of NaCl be present in V L.

$\therefore \quad N = \frac{8.547}{V}$

The conductivity of the NaCl solution (only due to presence of Na^+ and Cl^- ions) is

$\kappa_{NaCl} = 3.10 \times 10^{-5} - 2.56 \times 10^{-5} = 0.54 \times 10^{-5}$

$\therefore \quad \Lambda_{NaCl} = 0.54 \times 10^{-5} \times \frac{1000 \times V}{8.547}$

$0.54 \times 10^{-5} \times \frac{1000 \times V}{8.547} = 149.9$

$V = 2.372 \times 10^5$ L

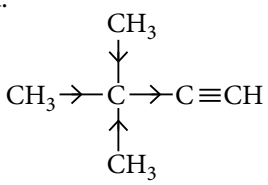
86. (d) : Siderite is $FeCO_3$ while, Sphalerite is zinc sulphide.

87. (d) : $C_2H_5Br \xrightarrow{NaOH_{(aq)}} \underset{(A)}{C_2H_5OH} \xrightarrow{Na} \underset{(B)}{C_2H_5ONa}$

$\xrightarrow[\text{Williamson's synthesis}]{CH_3I} \underset{\text{Ethyl methyl ether}}{C_2H_5 - O - CH_3} + NaI$

(C)

88. (b) : Hyperconjugation is not possible because C — H bond of *t*-butyl group is not directly attached to C ≡ C bond.



89. (d) : In Schottky defect equal number of cations and anions leave the lattice site.

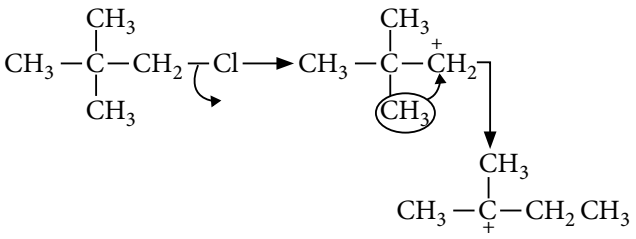
90. (a) : SeO_2 oxidises compounds containing active methylene (*i.e.* CH_2 next to the carbonyl group) to another CO group.

$CH_3-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow{SeO_2} \underset{(X)}{CH_3-\underset{\underset{O}{\|}}{C}-CHO} + Se + H_2O$

91. (c) : $r_1 = k[A]^1$, $r_2 = k[A]^2$, $r_3 = k[A]^3$

If $[A] > 1$; then $r_3 > r_2 > r_1$

92. (b) :



The initially formed carbocation does not have β-hydrogen atom. Therefore, its elimination is possible only through the rearranged carbocation.

93. (c) : The K_a of *o*-, *m*- and *p*-nitrobenzoic acid increase in the order $m < p < o$, therefore, pK_a increases in the reverse order $o < p < m$.

94. (d) 95. (a) 96. (d) 97. (a)

98. (d) : (a) $E_{cell} = E° - \frac{0.059}{1}\log_{10}\left[\frac{V^{3+}}{V^{2+}}\right]$

(c) $E_{cell} = E° - \frac{0.059}{1}\log_{10}\frac{[V^{3+}]}{[VO^{2+}]} - 2 \times 0.059\ pH$

(d) $E_{cell} = E° - \frac{0.059}{1}\log_{10}\frac{[VO_2^+]}{[VO^{2+}]} + 2 \times 0.059\ pH$

In (d) only, as pH↑, E_{cell}↑.

99. (a)	**100. (c)**	**101. (a)**	**102. (a)**	**103. (b)**
104. (a)	**105. (d)**	**106. (c)**	**107. (c)**	**108. (a)**
109. (a)	**110. (b)**	**111. (a)**	**112. (a)**	**113. (a)**
114. (c)	**115. (b)**	**116. (c)**	**117. (b)**	**118. (b)**
119. (b)	**120. (a)**	**121. (c)**	**122. (d)**	**123. (b)**
124. (b)	**125. (b)**	**126. (a)**	**127. (c)**	**128. (b)**
129. (c)	**130. (a)**	**131. (a)**	**132. (a)**	**133. (b)**
134. (d)	**135. (a)**	**136. (d)**	**137. (d)**	**138. (c)**
139. (b)	**140. (a)**	**141. (b)**	**142. (d)**	**143. (a)**
144. (b)	**145. (a)**	**146. (b)**	**147. (c)**	**148. (d)**
149. (d)	**150. (c)**	**151. (c)**	**152. (b)**	**153. (c)**
154. (d)	**155. (c)**	**156. (d)**	**157. (d)**	**158. (b)**
159. (c)	**160. (c)**	**161. (b)**	**162. (d)**	**163. (c)**
164. (b)	**165. (d)**	**166. (d)**	**167. (c)**	**168. (d)**
169. (c)	**170. (d)**	**171. (c)**	**172. (c)**	**173. (d)**
174. (b)	**175. (a)**	**176. (c)**	**177. (b)**	**178. (b)**
179. (d)	**180. (c)**	**181. (c)**	**182. (a)**	**183. (d)**
184. (b)	**185. (b)**	**186. (b)**	**187. (b)**	**188. (a)**
189. (a)	**190. (a)**	**191. (c)**	**192. (d)**	**193. (d)**
194. (c)	**195. (d)**	**196. (b)**	**197. (a)**	**198. (d)**
199. (c)	**200. (a)**			

Quotable Quote

"Dreams are often most profound when they seem the most crazy."

SIGMUND FREUD

PRACTICE PAPER
JIPMER

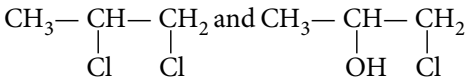
Exam on
2nd June 2019

1. High density polyethylene (HDPE) can be prepared from ethylene by
(a) Ziegler-Natta process
(b) heating with peroxides
(c) condensing in sealed tubes
(d) condensing with styrenes.

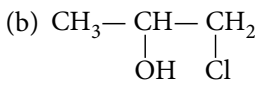
2. Identify '*Z*' in the following reaction series:

$$CH_3CH_2CH_2Br \xrightarrow{\text{Aq. NaOH}} (X) \xrightarrow[\text{Heat}]{Al_2O_3} (Y) \xrightarrow{HOCl} (Z)$$

(a) Mixture of



(b)



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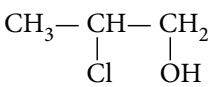

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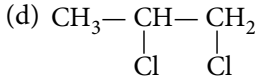


3. In basic medium, H_2O_2 acts as an oxidising agent in its reactions with
(a) $K_3[Fe(CN)_6]$ (b) Ag_2O
(c) $Cr_2(SO_4)_3$ (d) $K_2Cr_2O_7$

4. KBr has NaCl type structure. What is the distance between K^+ and Br^- in KBr, if the density is 2.75 g cm^{-3}?
(a) 3.3×10^{-8} cm (b) 5.2×10^{-8} cm
(c) 3.3×10^{-12} cm (d) 5.2×10^{-12} cm

5. Anthraquinone is prepared by the oxidation of anthracene by chromic acid. The crude reaction product is usually purified by
(a) fractional crystallization
(b) distillation
(c) steam distillation
(d) sublimation.

6. In the reaction,

$$4NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O_{(l)}$$

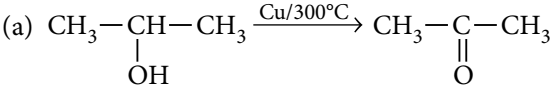
when 1 mole of ammonia and 1 mole of O_2 are made to react to completion, then
(a) all the oxygen will be consumed
(b) 1.0 mole of NO will be produced
(c) 1.0 mole of H_2O is produced
(d) all the ammonia will be consumed.

7. Which has maximum number of equivalents per mole of the oxidant?
(a) $I^-_{(aq)} + IO^-_{3(aq)} \longrightarrow I^-_{3(aq)}$
(b) $Ag_{(s)} + NO^-_{3(aq)} \longrightarrow NO_{2(g)} + Ag^+_{(aq)}$
(c) $Mg_{(s)} + VO^{3-}_{4(aq)} \longrightarrow Mg^{2+}_{(aq)} + V^{2+}_{(aq)}$
(d) $Zn_{(s)} + VO^{2+}_{(aq)} \longrightarrow V^{3+}_{(aq)} + Zn^{2+}_{(aq)}$

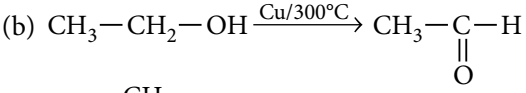
8. The capacity of an ion to coagulate a colloidal solution depends on
(a) its shape
(b) the amount of its charge
(c) the sign of the charge
(d) both the amount and the sign of the charge.

9. Which of the following reactions is incorrect?

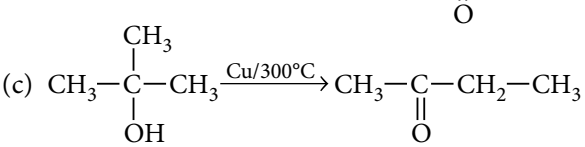
(a)



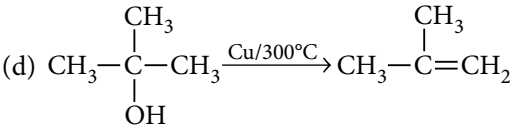
(b)



(c)



(d)



10. In the reaction,

$$HC{\equiv}CH + H_2 \xrightarrow{X} CH_2{=}CH_2,\ X \text{ is}$$

(a) Lindlar's catalyst (b) $NaBH_4$
(c) Raney nickel
(d) concentrated HI in presence of red P.

11. Magenta dye is
(a) alkaline phenolphthalein
(b) red litmus
(c) *p*-rosaniline hydrochloride
(d) methyl red.

12. 'Oil of mirbane' is
(a) aniline (b) nitrobenzene
(c) *p*-nitroaniline (d) *p*-aminoazobenzene.

13. Phenol forms coloured water soluble complex compound in the presence of
(a) basic $FeCl_3$ (b) cold and dilute $FeCl_3$
(c) acidic $FeCl_3$ (d) neutral $FeCl_3$

14. Aliphatic aldehydes react with Fehling's solution to give red ppt. but benzaldehyde does not produce red precipitate with Fehling's solution because
(a) of a bulky ring, —CHO is hindered
(b) of resonance, oxidation of benzaldehyde is difficult
(c) —CHO is present in cyclic structure
(d) of all the above statements.

15. Ionic radii are
(a) inversely proportional to effective nuclear charge
(b) inversely proportional to square of effective nuclear charge
(c) directly proportional to effective nuclear charge
(d) directly proportional to square of effective nuclear charge.

16. $CH_3CONH_2 \xrightarrow{P_2O_5}$ is an example of
(a) dehydration (b) deamination
(c) dehydrogenation (d) none of these.

17. Terylene is
(a) an addition polymer with a benzene ring in every repeating unit
(b) a condensation polymer with a benzene ring in every repeating unit
(c) an addition polymer with two carbon atoms in every repeating unit
(d) a condensation polymer with two nitrogen atoms in every repeating unit.

18. Fires, that result from the combustion of alkali metals can be extinguished by
(a) CCl_4 (b) sand
(c) water (d) kerosene.

19. The amide contains
(a) sigma bonds only
(b) sigma bonds and one π-bond
(c) dative bond
(d) 2 π-bonds and sigma bonds.

20. To obtain chromium from chromic oxide (Cr_2O_3), the method used is
(a) carbon reduction
(b) carbon monoxide reduction
(c) aluminothermic
(d) electrolytic reduction.

21. The standard reduction potentials in acidic conditions are 0.77 V and 0.54 V respectively for Fe^{3+}/Fe^{2+} and I_3^-/I^- couple.

$2Fe^{3+} + 3I^- \rightleftharpoons 2Fe^{2+} + I_3^-$

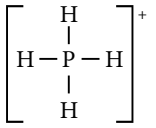
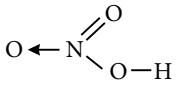
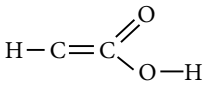
What will be the equilibrium constant for the reaction?
(a) 7.07×10^8 (b) 7.07×10^3
(c) 6.07×10^9 (d) 6.07×10^7

22. Which of the following are not state functions?
(I) $q + w$ (II) q
(III) w (IV) $H - TS$
(a) (I), (II) and (III) only
(b) (II) and (III) only
(c) (I) and (IV) only
(d) (II), (III) and (IV) only

23. When aniline is heated with glacial acetic acid in presence of anhydrous $ZnCl_2$, the product is
(a) acetamide (b) acetanilide
(c) phenyl acetamide (d) chlorobenzene.

24. Benzoyl chloride is prepared from benzoic acid by
(a) Cl_2, *hv* (b) SO_2Cl_2
(c) $SOCl_2$ (d) Cl_2, H_2O

25. Which one of the following formulae does not correctly represent the bonding capacities of the atoms involved?

(a) 
(b)
(c) 
(d) 

26. Write the missing product in the following reaction:
$HNO_3 + P_4O_{10} \longrightarrow$ ..... + HPO_3
(a) N_2O_5 (b) N_2O_3 (c) NO_2 (d) N_2O

27. A 500 g toothpaste sample has 0.2 g fluoride concentration. What is the concentration of F^- in ppm?
(a) 250 (b) 200 (c) 400 (d) 1000

28. Which of the following alkaline earth metals has highest ionic mobility in aqueous solution?
(a) Be^{2+} (b) Ca^{2+} (c) Ba^{2+} (d) Mg^{2+}

29. A buffer solution is prepared by mixing equal concentration of acid (ionisation constant K_a) and a salt. The pH of buffer is
(a) $pK_a + 7$ (b) $14 - pK_a$
(c) pK_a (d) $pK_a + 1$

30. The vapour of a carboxylic acid H*A* when passed over MnO at 573 K yields propanone. The acid H*A* is
(a) methanoic acid (b) ethanoic acid
(c) propanoic acid (d) butanoic acid.

31. XeF_6 on hydrolysis gives
(a) XeO_3 (b) XeO (c) XeO_2 (d) Xe

32. In metal carbonyl having general formula $M(CO)_x$, where M = metal, $x = 4$ and the metal is bonded to
(a) carbon and oxygen (b) C ≡ O
(c) oxygen (d) carbon.

33. Hydrogen sulphide reacts with lead acetate forming a black compound which reacts with H_2O_2 to form another compound (*X*). The colour of the compound (*X*) is
(a) black (b) yellow (c) white (d) pink.

34. When a few typical solutes are separated by a particular selective membrane such as protein particles, blood corpuscles, this process is called
(a) transpiration (b) endosmosis
(c) dialysis (d) diffusion.

35. The lanthanoids contraction is responsible for the fact that
(a) Zr and Y have about the same radius
(b) Zr and Nb have similar oxidation state
(c) Zr and Hf have about the same radius
(d) Zr and Zn have same oxidation state.

36. Aluminium hydroxide is soluble in excess of sodium hydroxide forming the ion
(a) AlO_2^{3+} (b) AlO_2^- (c) AlO_2^{3-} (d) AlO_3^-

37. The pK_{a_1} and pK_{a_2} of an amino acid are 2.3 and 9.7 respectively. The isoelectric point of the amino acid is
(a) 6.0 (b) 3.7 (c) 12.0 (d) 7.4

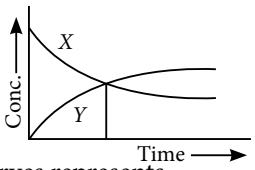
38. Ozone is readily dissolved in
(a) water (b) turpentine oil
(c) carbon disulphide (d) ammonia.

39. 0.01 M solution has 3% sucrose, 4% $BaCl_2$, 2% KCl and 1% $FeCl_3$. Then the correct order of freezing point at 1 atm pressure is
(a) Sucrose < KCl < $BaCl_2$ < $FeCl_3$
(b) $FeCl_3$ < $BaCl_2$ < KCl < Sucrose
(c) $BaCl_2$ < $FeCl_3$ < Sucrose < KCl
(d) KCl < Sucrose < $FeCl_3$ < $BaCl_2$

40. In the reaction,
$C_6H_5CHO + C_6H_5NH_2 \rightarrow C_6H_5N{=}CHC_6H_5 + H_2O$
the compound $C_6H_5N{=}CHC_6H_5$ is known as
(a) aldol (b) Schiff's reagent
(c) Schiff's base (d) Benedict reagent.

41. A current of 1.70 ampere is passed through 300 mL of 0.160 M solution of zinc sulphate for 230 seconds with a current efficiency of 90 per cent. Find out the molarity of Zn^{2+} ions after the deposition of zinc. Assume the volume of the solution to remain constant during electrolysis.
(a) 0.192 M (b) 0.102 M
(c) 0.021 M (d) 0.154 M

42. The given figure depicts the change in concentration of species *X* and *Y* for the reaction $X \longrightarrow Y$, as a function of time. The point of intersection of the two curves represents



(a) $t_{1/2}$ (b) $t_{3/4}$
(c) $t_{2/3}$
(d) data is insufficient to predict.

43. Heterolysis of a carbon-carbon bond gives
(a) carbanion (b) carbocation
(c) both carbanion and carbocation
(d) free radical.

44. A cell with two electrodes, one of grey tin and the other white tin, both dipping in solution of $(NH_4)_2SnCl_6$ showed zero e.m.f. at 18 °C. What conclusion may be drawn from this?
(a) The e.m.f. developed at the electrode-solution phase boundary cancels the normal e.m.f.
(b) Grey tin being non-metallic ceases to provide a reversible electrode reaction.
(c) Electrode surface develops a protective layer and the cell develops a very large internal resistance.
(d) The free energy change of the cell becomes zero.

45. The primary structure of a protein refers to
(a) whether the protein is fibrous or globular
(b) the amino acid sequence in the polypeptide
(c) the orientation of the amino acid side chains in space
(d) the presence or absence of an α-helix.

46. $RCOOH + N_3H \xrightarrow{\text{conc. } H_2SO_4} RNH_2 + CO_2 + N_2$
The above reaction is called
(a) HVZ reaction (b) Hunsdiecker reaction
(c) Schmidt reaction (d) Wurtz reaction.

47. The pair of amphoteric hydroxides is
(a) $Be(OH)_2$, $Al(OH)_3$ (b) $Al(OH)_3$, LiOH
(c) $B(OH)_3$, $Be(OH)_2$ (d) $Be(OH)_2$, $Mg(OH)_2$

48. The given reaction, $2NH_3 \xrightarrow{Mo} N_2 + 3H_2$ is an example of
(a) third order reaction
(b) first order reaction
(c) second order reaction
(d) zero order reaction.

49. The straight chain polymer is formed by
(a) hydrolysis of CH_3SiCl_3 followed by condensation polymerisation
(b) hydrolysis of $(CH_3)_4Si$ by addition polymerisation
(c) hydrolysis of $(CH_3)_2SiCl_2$ followed by condensation polymerisation
(d) hydrolysis of $(CH_3)_3SiCl$ followed by condensation polymerisation.

50. 50 mL of an aqueous solution of glucose contains 6.02×10^{22} molecules. The concentration of solution is
(a) 0.1 M (b) 1.0 M (c) 0.2 M (d) 2.0 M

51. The alkyl halide is converted into an alcohol by
(a) elimination (b) dehydrohalogenation
(c) addition (d) substitution.

52. For a reaction to be spontaneous at all temperatures
(a) ΔH = –ve, ΔS = +ve (b) ΔH = + ve, ΔS = +ve
(c) ΔH = –ve, ΔS = –ve (d) ΔH = +ve, ΔS = –ve

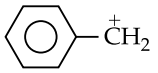
53. If an element is found to have an atomic number 106, its electronic configuration will be
(a) [Rn] $5f^{14}, 6d^4, 7s^2$ (b) [Rn] $5f^{14}, 6d^1, 7s^2 7p^3$
(c) [Rn] $5f^{14}, 6d^6, 7s^0$ (d) [Rn] $5f^{14}, 6d^5, 7s^1$

54. Aspirin is an acetylation product of
(a) *m*-hydroxybenzoic acid
(b) *o*-dihydroxybenzene
(c) *o*-hydroxybenzoic acid
(d) *p*-dihydroxybenzene.

55. The process of 'eutrophication' is due to
(a) increase in concentration of insecticide in water
(b) increase in concentration of fluoride ion in water
(c) the reduction in concentration of the dissolved oxygen in water due to phosphate pollution in water
(d) attack of younger leaves of a plant by peroxyacetyl nitrate.

56. Among the following outermost configurations of transition metals which shows the highest oxidation state?
(a) $3d^3\,4s^2$ (b) $3d^5\,4s^1$ (c) $3d^5\,4s^2$ (d) $3d^6\,4s^2$

57. Which order is correct in spectrochemical series of ligands ?
(a) $Cl^- < F^- < [C_2O_4]^{2-} < NO_2^- < CN^-$
(b) $CN^- < [C_2O_4]^{2-} < Cl^- > NO_2^- < F^-$
(c) $[C_2O_4]^{2-} < F^- < Cl^- > NO_2^- < CN^-$
(d) $F^- < Cl^- < NO_2^- < CN^- < [C_2O_4]^{2-}$

58. Most stable carbocation is
(a)  (b) $(CH_3)_3\overset{+}{C}$
(c) $CH_3CH_2\overset{+}{C}H_2$ (d) $CH_3\overset{+}{C}HCH_3$

59. Cannizzaro's reaction involves
(a) conversion of aldehyde into acid only
(b) conversion of aldehyde into alcohol only
(c) redox system reaction
(d) aromatic transformation.

60. For orthorhombic system axial ratios are $a \neq b \neq c$ and the axial angles are
(a) $\alpha = \beta = \gamma \neq 90^\circ$ (b) $\alpha = \beta = \gamma = 90^\circ$
(c) $\alpha = \gamma = 90^\circ, \beta \neq 90^\circ$ (d) $\alpha \neq \beta \neq \gamma \neq 90^\circ$

SOLUTIONS

1. (a)

2. (b) : $CH_3CH_2CH_2Br \xrightarrow{NaOH\,(aq.)} \underset{(X)}{CH_3CH_2CH_2OH}$

$\xrightarrow[\Delta]{Al_2O_3} \underset{(Y)}{CH_3CH=CH_2} \xrightarrow{HOCl} \underset{\underset{OH}{|}\\ (Z)}{CH_3CHCH_2Cl}$

3. (c) : $Cr_2(SO_4)_3 + 3H_2O_2 + 10NaOH \longrightarrow 2Na_2CrO_4 + 3Na_2SO_4 + 8H_2O$

or $2Cr^{3+} + 3H_2O_2 + 10OH^- \longrightarrow 2CrO_4^{2-} + 8H_2O$

4. (a) : Edge length '*a*' of the unit cell can be calculated as

$$a^3 = \frac{MZ}{\rho N_A} \qquad \left[\begin{matrix} M = 119, Z = 4 \\ \rho = 2.75\ g\ cm^{-3},\ N_A = 6.023 \times 10^{23} \end{matrix}\right]$$

$$a = \left(\frac{MZ}{\rho N_A}\right)^{1/3} = \left(\frac{119 \times 4}{2.75 \times 6.023 \times 10^{23}}\right)^{1/3} = 6.6 \times 10^{-8}\ cm$$

Distance between K^+ and $Br^- = \frac{a}{2} = \frac{6.6 \times 10^{-8}}{2}$

$= 3.3 \times 10^{-8}$ cm

5. (d) : Anthracene being sublimable can be separated from anthraquinone by sublimation.

6. (a) : $\underset{4\ mole}{4NH_{3(g)}} + \underset{5\ mole}{5O_{2(g)}} \longrightarrow \underset{4\ mole}{4NO_{(g)}} + \underset{6\ mole}{6H_2O_{(l)}}$

$\Rightarrow$ 1 mole of NH_3 requires = 5/4 = 1.25 mole of oxygen while 1 mole of O_2 requires = 4/5 = 0.8 mole of NH_3. As there is 1 mole of NH_3 and 1 mole of O_2, so all oxygen will be consumed.

7. (a) : Oxidant is the oxidising agent (which has been reduced)

	Change in ON	Equivalent per mol
$\overset{+4}{VO^{2+}} \rightarrow \overset{+3}{V^{3+}}$	1	1
$\overset{+5}{NO_3^-} \rightarrow \overset{+4}{NO_2}$	1	1
$\overset{+5}{VO_4^{3-}} \rightarrow \overset{+3}{V^{3+}}$	2	2
$\overset{+5}{IO_3^-} \rightarrow \overset{0}{I_2}\,(\text{in } I_3^-)$	5	5

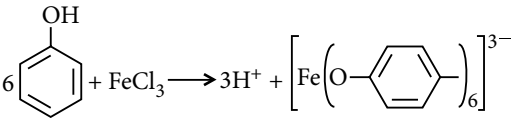
8. (d)

9. (c) : 3° alcohols at 300 °C give alkenes.

10. (a)

11. (c) : Magenta dye is *p*-rosaniline hydrochloride.

12. (b) : Nitrobenzene is called oil of mirbane.

13. (d) : 

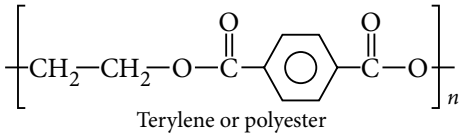
+ 3HCl

14. (b) : Resonance gives rise to stability in molecule.

15. (a)

16. (a) : $CH_3CONH_2 \xrightarrow[-H_2O]{P_2O_5} CH_3CN$

17. (b) : Terylene is a condensation polymer with a benzene ring in every repeating unit



Terylene or polyester

18. (a)

19. (b) : Amide is, $R-\underset{\underset{O}{\|}}{C}-NH_2$.

20. (c)

21. (d) : $E^\circ_{cell} = E_{cathode} - E_{anode} = 0.77 - 0.54 = 0.23$ V

$\Delta G = -nFE^\circ_{cell} = -RT\ln K$ or $E^\circ_{cell} = \frac{0.0591}{n}\log K$

$$\log K = \frac{0.23 \times 2}{0.0591} = 7.783$$

or $K = \text{Antilog}\,(7.783) = 6.07 \times 10^7$

22. (b) : State functions or state variables are those which depend only on the state of the system and not on how the state was reached.

$q + w = \Delta E$ (internal energy)
$H - TS = G$ (free energy) } State functions

$w \rightarrow$ work done, $q \rightarrow$ amount of heat

Both do not depend upon the state of the system hence, they are not state functions.

23. (b) : $C_6H_5NH_2 \xrightarrow[ZnCl_2]{CH_3COOH} \underset{\text{Acetanilide}}{C_6H_5NHCOCH_3}$

24. (c) : $C_6H_5COOH + SOCl_2 \rightarrow C_6H_5COCl + SO_2 + HCl$

25. (d)

26. (a) : $4HNO_3 + P_4O_{10} \rightarrow 2N_2O_5 + 4HPO_3$

27. (c) : $\text{ppm of F} = \frac{\text{Wt. of F}}{\text{Wt. of toothpaste}} \times 10^6$

$$= \frac{0.2}{500} \times 10^6 = 400$$

28. (c) : Due to high heat of hydration of small cations, ionic mobility for the small cations is low. Order of ionic mobility is :

$Be^{2+} < Mg^{2+} < Ca^{2+} < Ba^{2+}$

29. (c) : pH of buffer is $pH = pK_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$

Since, [Salt] = [Acid], $pH = pK_a$

30. (b) : $2CH_3COOH \xrightarrow[573\ K]{MnO} CH_3COCH_3 + CO_2 + H_2O$

31. (a) : $XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$

32. (d) : In $M(CO)_4$, metal is bonded to the ligands *via* carbon atoms with both σ and π-bond. Both metal to ligand and ligand to metal bonding are possible.

33. (c) : $Pb(CH_3COO)_2 + H_2S \rightarrow PbS + 2CH_3COOH$

$PbS + 4H_2O_2 \rightarrow \underset{(X)}{PbSO_4} + 4H_2O$

34. (c)

35. (c) : It is a fact developed due to lanthanoid contraction, otherwise size of Hf should have been greater than Zr.

36. (b) : $Al(OH)_3 + NaOH \rightarrow NaAlO_2 + 2H_2O$

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37. (a) : Isoelectric point = $\frac{2.3+9.7}{2}=6$

38. (b)

39. (b) : Depression in freezing point is directly proportional to van't Hoff factor *i*, and *i* is directly proportional to number of ions furnished by a molecule. Higher the ions furnished, higher is the depression in freezing point and so lower is the freezing point.

Compound	***i***
Sucrose	1
$BaCl_2$	3
KCl	2
$FeCl_3$	4

So, the order of freezing point is
$FeCl_3 < BaCl_2 < KCl <$ Sucrose

40. (c)

41. (d) : Amount of charge passed = 1.70×230 coulomb

Amount of actual charge passed $= \frac{90}{100} \times 1.70 \times 230$

$= 351.9$ coulomb

No. of moles of Zn deposited by passing 351.9 coulomb of charge

$= \frac{1}{2 \times 96500} \times 351.9 = 0.00182$

Molarity of Zn^{2+} ions after deposition of zinc

$= \left[0.160 - \frac{0.00182 \times 1000}{300}\right] M = 0.154\ M$

42. (a) : The intersection point indicates that half of the reactant *X* is converted into *Y*.

43. (c)

44. (d) : At equilibrium if $E° = 0$, then $\Delta G° = -nE°F = 0$.

45. (b) **46. (c)**

47. (a) : Beryllium hydroxide and aluminium hydroxide are amphoteric in nature.

$Be(OH)_2 + 2HCl \rightarrow BeCl_2 + 2H_2O$

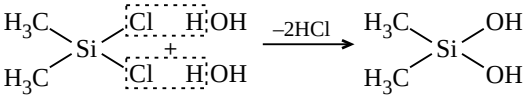
$Be(OH)_2 + 2NaOH + Na_2BeO_2 + 2H_2O$

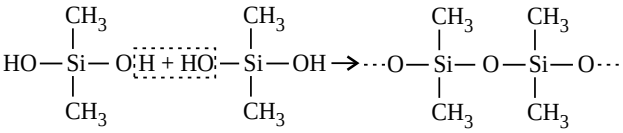
$Al(OH)_3 + 3HCl \rightarrow AlCl_3 + 3H_2O$

$Al(OH)_3 + NaOH \rightarrow NaAlO_2 + 2H_2O$

48. (d)

49. (c) : Hydrolysis of substituted chlorosilanes yields corresponding silanols which undergo polymerisation. Out of the given chlorosilanes, only $(CH_3)_2SiCl_2$ will give linear polymer on hydrolysis followed by polymerisation.





50. (d) : Mole of glucose = $\frac{6.02 \times 10^{22}}{6.02 \times 10^{23}} = 0.1$

$\therefore\ M_{glucose} = \frac{0.1 \times 1000}{50} = 2$

51. (d) : $C_2H_5Br + KOH_{(aq.)} \rightarrow C_2H_5OH + KBr$

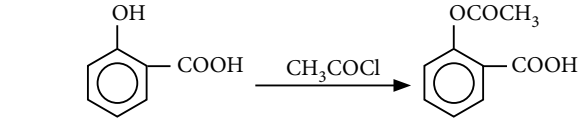
Ethyl bromide — Ethyl alcohol

52. (a) : $\Delta G = \Delta H - T\Delta S$

For spontaneous reaction at all temperatures,
ΔH = –ve ; ΔS = +ve. So, ΔG = –ve

53. (a)

54. (c) : Aspirin is acetyl salicylic acid, which is formed by acetylation of *o*-hydroxybenzoic acid.



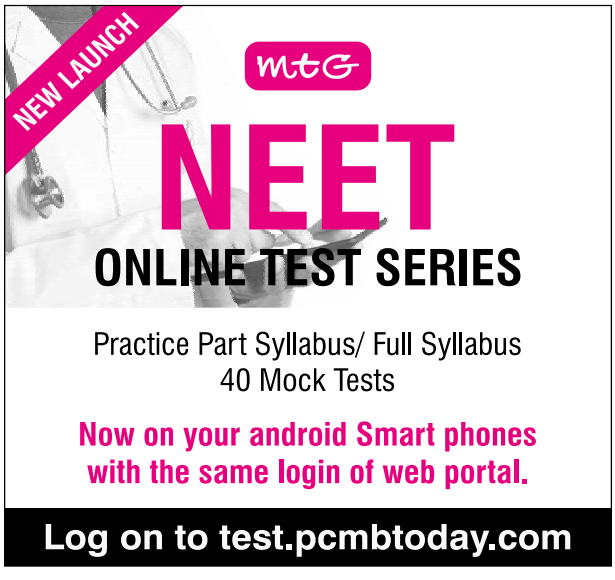
o-Hydroxybenzoic acid — Aspirin

55. (c) : The presence of excessive nutrients in a lake due to in flow (land run off) of nutrients from fertilizers results in the increase of phosphate ions in water. As a result, algal growth is accelerated which covers the water surface and decreases the concentration of dissolved oxygen.

56. (c) **57. (a)**

58. (a) : It is a benzylic carbocation and it is highly stabilized by resonance.

59. (c) **60. (b)**



EXAM CAFE

USEFUL FOR VARIOUS COMPETITIVE EXAMINATIONS

One Option Correct Type

1. Mark the correct statement.

(a) $[Co(C_2O_4)_3]^{3-}$ is paramagnetic, inner orbital complex.

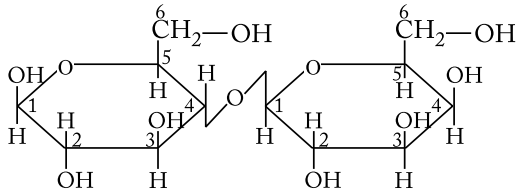
(b) $[Co(C_2O_4)_3]^{3-}$ is diamagnetic, outer orbital complex.

(c) $[Co(C_2O_4)_3]^{3-}$ is paramagnetic, outer orbital complex.

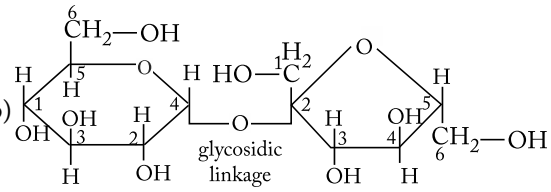
(d) $[Co(C_2O_4)_3]^{3-}$ is diamagnetic, inner orbital complex.

2. Which of the following is maltose ?

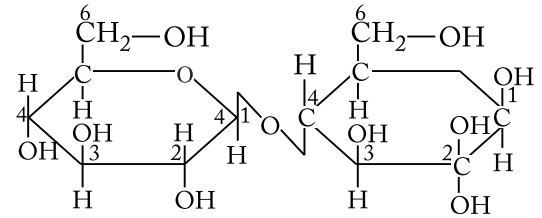
(a)



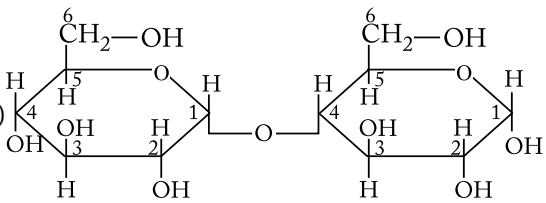
(b)



(c)



(d)



3. The data for the reaction : $A + B \rightarrow C$, is

Exp.	$[A]_0$	$[B]_0$	Initial rate
1	0.012	0.035	0.10
2	0.024	0.070	0.80
3	0.024	0.035	0.10
4	0.012	0.070	0.80

The rate law corresponds to the above data is

(a) rate = $k[A][B]^3$ (b) rate = $k[A]^2[B]^2$

(c) rate = $k[B]^3$ (d) rate = $k[B]^4$

4. Often a glass stopper gets stuck in the neck of a glass bottle containing NaOH solution. This is due to

(a) the presence of dirt particles in between

(b) the formation of solid silicate in between by the reaction of SiO_2 of glass with NaOH

(c) glass contains a boron compound which forms a precipitate with the NaOH solution

(d) none of these.

5. $E°$ values for Ti^{2+}/Ti, V^{2+}/V, Mn^{3+}/Mn^{2+}, V^{3+}/V^{2+} and Co^{3+}/Co^{2+} are – 1.63 V, – 1.18 V, +1.57 V, – 0.26 V and + 1.97 V respectively.

Identify the incorrect statement.

(a) Ti^{2+} and V^{2+} are strongest reducing agents and liberate hydrogen gas from dilute acids.

(b) Mn^{3+} and Co^{3+} are strongest oxidising agents in aqueous solution.

(c) Mn^{2+} is very stable due to the stable d^5 configuration.

(d) V^{2+} is less stable than V^{3+}.

6. For the reaction of phenol with $CHCl_3$ in presence of KOH, the electrophile is

(a) $\overset{+}{C}HCl_2$ (b) $:CCl_2$

(c) $\dot{C}HCl_2$ (d) CCl_4

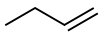
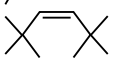
7. Calculate the mass of compound (molar mass = 256 g mol^{-1}) to be dissolved in 75 g of benzene to lower its freezing point by 0.48 K.

(K_f = 5.12 K kg mol^{-1})

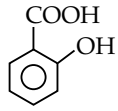
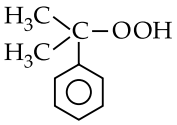
(a) 1.8 g (b) 2.8 g (c) 1.0 g (d) 2.5 g

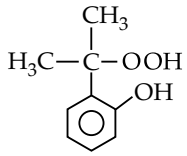
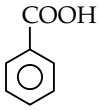
8. In which of the following alkene hyperconjugation does not take place?

(a) (b)

(c)  (d) 

9. Phenol is distilled with Zn dust followed by Friedel—Crafts alkylation with propyl chloride in the presence of $AlCl_3$ to give a compound (*B*). (*B*) is oxidised in the presence of air to form the compound (*C*). The structural formula of (*C*) is

(a)  (b) 

(c)  (d) 

10. In Langmuir's model of adsorption of a gas on a solid surface

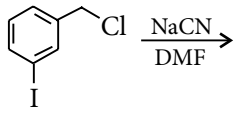
(a) the rate of dissociation of adsorbed molecules from the solid surface does not depend on the surface covered

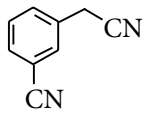
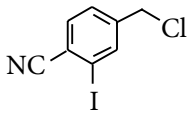
(b) the adsorption at a single site on the surface may involve multiple molecules at the same time

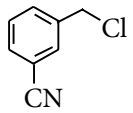
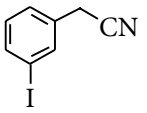
(c) the mass of gas striking on a given area of surface is proportional to the pressure of the gas

(d) the mass of gas striking on a given area of surface is independent of the pressure of the gas.

11. The structure of the major product formed in the following reaction is



(a)  (b) 

(c)  (d) 

12. The electrons, identified by quantum numbers *n* and *l*,
(I) $n = 3, l = 2$ (II) $n = 5, l = 0$ (III) $n = 4, l = 1$
(IV) $n = 4, l = 2$ (V) $n = 4, l = 0$
can be placed in order of increasing energy, as

(a) I < V <III< IV <II (b) I < V <III< II <IV

(c) V < I <III< II < IV (d) V < I <II< III < IV

13. Which class of drugs are used in sleeping pills?

(a) Analgesics (b) Tranquilizers

(c) Antibiotics (d) Antihistamines

14. Polycondensation products of dicarboxylic acids and diols are

(a) polyamides (b) neoprene

(c) caprolactam (d) polyesters.

15. Match list I with list II and select the correct answer using the codes given below the lists :

List I	**List II**
A. Heavy water	1. Bicarbonates of Mg and Ca in water
B. Temporary hard water	2. No foreign ions in water
C. Soft water	3. D_2O
D. Permanent hard water	4. Sulphates and chlorides of Mg and Ca in water

(a) A-1, B-3, C-4, D-2 (b) A-2, B-1, C-3, D-4

(c) A-4, B-1, C-3, D-2 (d) A-3, B-1, C-2, D-4

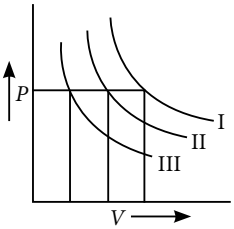
16. I, II, and III are three isotherms, respectively, at T_1, T_2 and T_3. Then,

(a) $T_1 = T_2 = T_3$

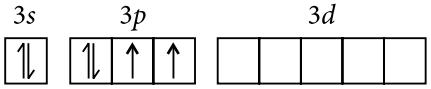
(b) $T_1 < T_2 < T_3$

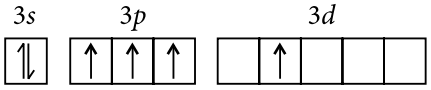
(c) $T_1 > T_2 > T_3$

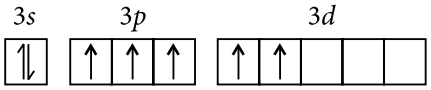
(d) $T_1 > T_2 = T_3$

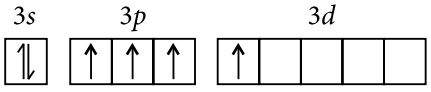


17. Which of the following has maximum energy?

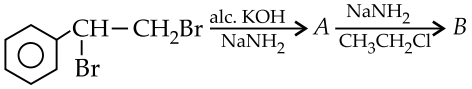
(a) 

(b) 

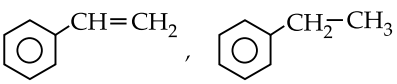
(c) 

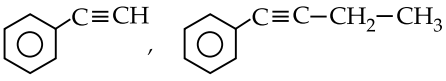
(d) 

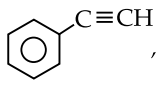
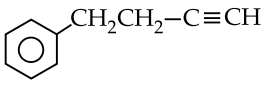
18. In the following reaction sequence,

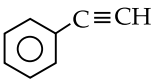
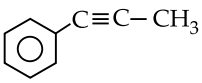


A and *B* respectively are

(a) 

(b) 

(c)  , 

(d)  , 

19. For two ionic solids, CaO and KI, which of the following statements is false?
(a) Lattice enthalpy of CaO is much higher than that of KI.
(b) CaO has high melting point.
(c) CaO is soluble in water.
(d) KI is soluble in benzene.

20. A chemical reaction proceeds following the formula $k = PZe^{-E_a/RT}$. Which of the following processes will increase the rate of reaction?
(a) Lowering of E_a (b) Lowering of P
(c) Lowering of Z
(d) Independent of all the above factors.

21. Anhydrous cobalt (II) chloride is blue in colour but on dissolving in water it changes to pink in colour because
(a) its oxidation state changes
(b) its magnetic character changes
(c) its coordination number changes
(d) in water it shows fluorescence.

22. Geometry, hybridisation and magnetic moment of the ions $[Ni(CN)_4]^{2-}$, $[MnBr_4]^{2-}$ and $[FeF_6]^{3-}$ respectively are
(a) tetrahedral, square planar, octahedral ; sp^3, dsp^2, sp^3d^2 ; 5.9, 0, 5.9
(b) tetrahedral, square planar, octahedral ; dsp^2, sp^3, sp^3d^2 ; 0, 5.9, 4.9
(c) square planar, tetrahedral, octahedral dsp^2, sp^3, d^2sp^3 ; 5.9, 4.9, 0
(d) square planar, tetrahedral, octahedral ; dsp^2, sp^3, sp^3d^2 ; 0, 5.9, 5.9

23. If Al^{3+} ions replace Na^+ ions at the edge centres of NaCl lattice, then the number of vacancies in one mole of NaCl will be
(a) 3.01×10^{23} (b) 6.02×10^{23}
(c) 9.03×10^{23} (d) 12.04×10^{23}

24. Two elements A and B form compounds having molecular formulae AB_2 and AB_4, when dissolved in 20 g of C_6H_6. 1 g AB_2 lowers the freezing point by 2.3 K whereas 1.0 g of AB_4 lowers it by 1.3 K. The molal depression constant for benzene is 5.1 K kg mol^{-1}. The atomic masses of A and B are, respectively
(a) $A = 25.59$; $B = 42.64$ (b) $A = 31.72$; $B = 47.02$
(c) $A = 13.11$; $B = 24.25$ (d) $A = 19.17$; $B = 35.01$

25. Acetone is treated with excess of ethanol in the presence of hydrochloric acid. The product obtained is
(a) $CH_3CH_2CH_2-\overset{\overset{O}{\|}}{C}-CH_3$
(b) $CH_3CH_2CH_2-\overset{\overset{O}{\|}}{C}-CH_2CH_2CH_3$
(c) $(CH_3)_2C(OH)(OC_2H_5)$
(d) $(CH_3)_2C(OC_2H_5)_2$

26. Photochemical smog consists of excessive amount of X in addition to aldehydes, ketones, PAN etc. X is
(a) methane (b) sulphur dioxide
(c) carbon dioxide (d) ozone.

27. Among the following, the correct statement is
(a) between NH_3 and PH_3, NH_3 is a better electron donor because the lone pair of electrons occupies spherical s-orbital and is less directional
(b) between NH_3 and PH_3, NH_3 is a better electron donor because the lone pair of electrons occupies sp^3-orbital and is less directional
(c) between NH_3 and PH_3, NH_3 is a better electron donor because the lone pair of electrons occupies sp^3-orbital and is more directional
(d) between NH_3 and PH_3, PH_3 is a better electron donor because the lone pair of electrons occupies s-orbital and is less directional.

28. Which type of interactions are responsible for making the α-helix structure stable?
(a) Peptide bonds between —NH_2 and —CO groups of adjacent carbon chains.
(b) Hydrogen bonds between —NH of amino acid in one turn with —CO of amino acid to adjacent turn.
(c) Hydrogen bonds between —OH group of one amino acid with —CO group of other amino acid.
(d) Hydrogen bonds between adjacent amino acids.

29. A compound of Xe and F is found to have 53.5% Xe. What is the oxidation number of Xe in this compound?
(a) – 4 (b) 0 (c) + 4 (d) + 6

30. Which of the following produces one mononitro and three isomeric dinitro derivatives?
(a) *p*-Xylene (b) Ethyl benzene
(c) *o*-Xylene (d) *m*-Xylene

31. When 0.1 mol of CH_3NH_2 (ionisation constant, $K_b = 5 \times 10^{-4}$) is mixed with 0.08 mol HCl and the volume is made up to 1 L, find the $[H^+]$ of resulting solution.
(a) 8×10^{-2} (b) 2×10^{-11}
(c) 1.23×10^{-4} (d) 8×10^{-11}

32. The following equation shows a method used in the concentration of an ore of aluminium:

$$Al_2O_3 + 2NaOH \longrightarrow 2NaAlO_2 + H_2O$$
$$NaAlO_2 + 2H_2O \longrightarrow Al(OH)_3 + NaOH$$
$$2Al(OH)_3 \longrightarrow Al_2O_3 + 3H_2O$$

It represents
(a) gravity process
(b) froth-floatation process
(c) electromagnetic separation
(d) leaching.

33. The structure of alkane or cycloalkane with molecular formula C_8H_{18} that has only 1° H atoms is
(a) 2,2,3,3-tetramethylbutane
(b) 2,2,3-trimethylpentane
(c) 2,2,4-trimethylpentane
(d) 2,3,3-trimethylpentane.

34. The first (Δ_iH_1) and second (Δ_iH_2) ionisation enthalpies (in kJ mol^{-1}) and the electron gain enthalpy ($\Delta_{eg}H$) (in kJ mol^{-1}) of the elements I, II and III are given below:

Element	Δ_iH_1	Δ_iH_2	$\Delta_{eg}H$
I	419	3051	– 48
II	1681	3374	– 328
III	2372	5251	+ 48

The most reactive metal and the least reactive non-metal of these are respectively
(a) I and II
(b) II and III
(c) I and III
(d) all are equally reactive.

35. During boiling of a liquid, bubbles are formed because
(a) the vapour pressure inside the bubbles is equal to the atmospheric pressure
(b) the vapour pressure inside the bubbles is slightly greater than the atmospheric pressure
(c) the vapour pressure inside the bubbles is slightly less than the atmospheric pressure
(d) the dissolved air gets entrapped which is being expelled.

36. In a polar molecule, the ionic charge is 4.8×10^{-10} e.s.u. If the interionic distance is one Angstrom unit, then the dipole moment is
(a) 0.48 debyes (b) 4.18 debyes
(c) 4.8 debyes (d) 41.8 debyes.

37. In the reaction $2A + 4B \rightarrow 3C + 4D$, when 5 moles of *A* react with 6 moles of *B*, then which is the limiting reagent and what would be the amount of *C* formed respectively?
(a) *C*, 4.5 mol (b) *B*, 4.5 mol
(c) *B*, 3.5 mol (d) *C*, 4.0 mol

38. When sulphur is boiled with strong caustic soda solution, we get
(a) Na_2SO_3 (b) Na_2SO_4
(c) $Na_2S_2O_3$ (d) $Na_2S_4O_6$

39. Identify the product *Z* in the given sequence of reactions:

$$CH_3CN \xrightarrow{Na/C_2H_5OH} X \xrightarrow[\Delta]{HNO_2} Y \xrightarrow[\text{reagent}]{\text{Baeyer's}} Z$$

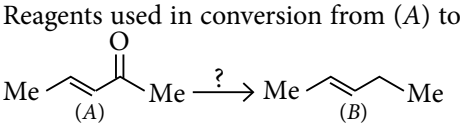
(a) CH_3CHO (b) CH_3CONH_2
(c) CH_3COOH (d) CH_3CH_2NHOH

40. In conversion of limestone to lime, $CaCO_{3(s)} \longrightarrow CaO_{(s)} + CO_{2(g)}$, the values of $\Delta H°$ and $\Delta S°$ are +179.1 kJ mol^{-1} and 160.2 J/K respectively at 298 K and 1 bar. Temperature above which conversion of limestone to lime will be spontaneous is (Assuming that $\Delta H°$ and $\Delta S°$ do not change with temperature)
(a) 1118 K (b) 1008 K
(c) 1200 K (d) 845 K

More Than One Option(s) Correct Type

41. Formic acid and acetic acid can be distinguished by the action of
(a) conc. H_2SO_4 (b) Tollens' reagent
(c) Fehling's solution
(d) heat on its sodium salt.

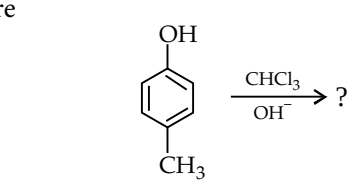
42. Reagents used in conversion from (*A*) to (*B*) is/are

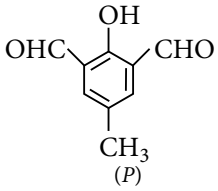


(*A*) (*B*)

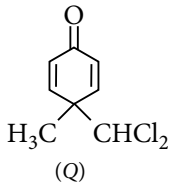
(a) $LiAlH_4$/ether (b) HI + red P
(c) Zn(Hg)/conc. HCl
(d) $PhNHNH_2$, glycol/$\bar{O}H$

43. In the following reaction, the product(s) formed is/are

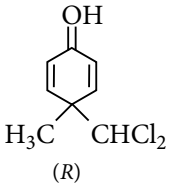




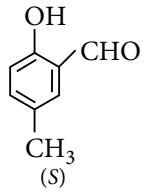
(*P*)



(*Q*)



(*R*)



(*S*)

(a) *P* (major) (b) *Q* (minor)
(c) *R* (minor) (d) *S* (major)

44. Given :

Oxidation : $H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$ $E° = -0.69$ V;

$2F^- \rightarrow F_2 + 2e^-$ $E° = -2.87$ V;

Reduction : $H_2O_2 + 2H^+ + 2e^- \rightarrow 2H_2O$ $E° = 1.77$ V;

$2I^- \rightarrow I_2 + 2e^-$ $E° = -0.54$ V;

Which of the following statements is/are correct?

(a) H_2O_2 behaves as an oxidant for I^-.
(b) H_2O_2 behaves as a reductant for I_2.
(c) H_2O_2 behaves as an oxidant for F^-.
(d) H_2O_2 behaves as a reductant for F_2.

45. Consider the rate law expression for a reaction :
rate = $k[NO_2^-][I^-][H^+]^2$
Which of the following is/are not correct?

(a) When concentrations of both NO_2^- and I^- are doubled rate becomes 4 times.
(b) When concentration of H^+ is tripled, rate becomes nine times.
(c) When concentration of each of H^+, NO_2^- and I^- are tripled, rate becomes nine times.
(d) When concentration of NO_2^- is doubled, of I^- is halved and of H^+ is doubled rate becomes 16 times.

46. If 100 mL of 1 M H_2SO_4 solution is mixed with 100 mL of 98% (*W*/*W*) of H_2SO_4 solution (d = 0.1 g mL^{-1}), then

(a) concentration of solution becomes half
(b) volume of solution becomes 200 mL
(c) mass of H_2SO_4 in the solution is 98 g
(d) mass of H_2SO_4 in the solution is 19.6 g.

47. The dissociation of ammonium carbamate may be represented by the equation,

$NH_2COONH_{4(s)} \rightleftharpoons 2NH_{3(g)} + CO_{2(g)}$

$\Delta H°$ for the forward reaction is negative. The equilibrium will shift from right to left if there is

(a) a decrease in pressure
(b) an increase in temperature
(c) an increase in the concentration of ammonia
(d) an increase in the concentration of carbon dioxide.

48. Potassium manganate (K_2MnO_4) is formed when

(a) hydrogen sulphide is passed into aqueous $KMnO_4$ solution
(b) manganese dioxide is fused with potassium hydroxide in air
(c) pyrolusite is fused with potassium carbonate in presence of air.
(d) potassium permanganate reacts with concentrated sulphuric acid.

49. Identify the incorrect statement(s).

(a) The equivalent mass of $KMnO_4$ in acidic medium is one third of its molecular mass.
(b) The mass of oxalic acid dihydrate required to prepare 500 mL of 0.02 N solution is 6.3 g.
(c) The volume of 0.1 M $K_2Cr_2O_7$ solution required to oxidise 35 mL of 0.5 M $FeSO_4$ solution in acidic medium is 29.17 mL.
(d) Phenolphthalein can be used as an indicator in iodometry.

50. Which statement(s) is/are true about osmotic pressure (π)?

(a) $\pi \propto \frac{1}{V}$ if T is constant.
(b) $\pi \propto C$ if T is constant.
(c) $\pi \propto V$ if T is constant.
(d) π/C is constant if T is constant.

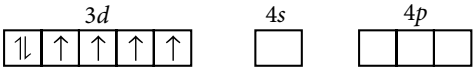
UNSCRAMBLED WORDS

APRIL 2019

1-j- FLORISIL	2-e- DIORITE
3-a- PATINA	4-f- VERDIGRIS
5-b- REALGAR	6-h- PYROTECHNICS
7-d- GETTER	8-g- ELUTRIATION
9-c- FERRITES	10-i- LYSOL

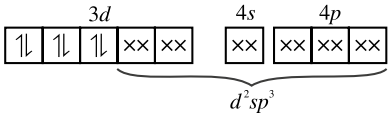
SOLUTIONS

1. (d) : Co^{3+} :



Since oxalate will form a chelate ring, hence will increase CFSE thus pairing of electron will occur,

$[Co(C_2O_4)_3]^{3-}$:



Thus, it is inner orbital complex with no unpaired electron *i.e.*, diamagnetic.

2. (d)

3. (c) : $A + B \rightarrow C$

Let, rate = $k[A]^x\,[B]^y$

where order of reaction is $(x + y)$.

Putting the values of exp. 1, 2, and 3, we get following equations.

$0.10 = k\,[0.012]^x\,[0.035]^y$ ... (i)

$0.80 = k\,[0.024]^x\,[0.070]^y$ ... (ii)

$0.10 = k\,[0.024]^x\,[0.035]^y$ ... (iii)

Dividing (ii) by (iii), we get

$$\frac{0.80}{0.10} = \left(\frac{0.070}{0.035}\right)^y \Rightarrow 2^y = 8 \Rightarrow y = 3$$

Keeping $[A]$ constant, $[B]$ is doubled, rate becomes 8 times.

Dividing eq. (iii) by eq. (i), we get

$$\frac{0.10}{0.10} = \left(\frac{0.024}{0.012}\right)^x \Rightarrow 2^x = 1 \Rightarrow x = 0$$

Keeping $[B]$ constant, $[A]$ is doubled, rate remains unaffected. Hence, rate is independent of $[A]$.

$\therefore$ rate = $k[B]^3$

4. (b) : $SiO_2 + 2NaOH \longrightarrow \underset{\text{Sodium silicate}}{Na_2SiO_3} + H_2O$

5. (d) **6. (b)**

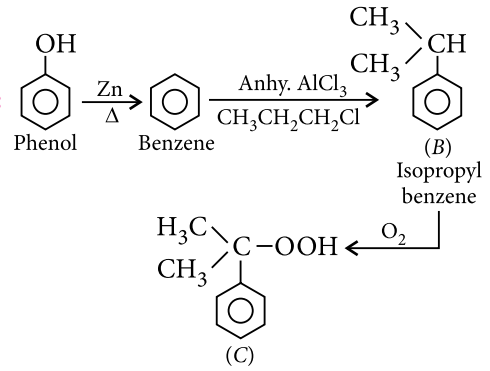
7. (a) : Given : $w_2 = ?$, $M_2 = 256\ g\ mol^{-1}$, $\Delta T_f = 0.48\ K$, $w_1 = 75\ g$, $K_f = 5.12\ K\ kg\ mol^{-1}$

$$\Delta T_f = \frac{K_f \times w_2 \times 1000}{M_2 \times w_1}$$

$$w_2 = \frac{\Delta T_f \times M_2 \times w_1}{K_f \times 1000} = \frac{0.48 \times 256 \times 75}{5.12 \times 1000} = 1.8\ g$$

8. (d) : Due to absence of α-hydrogen.

9. (b) :



10. (c) : Langmuir adsorption is unimolecular which state that the mass of the gas adsorbed per gram of the adsorbent is related to the equilibrium pressure, according to the equation : $\frac{x}{m} = \frac{aP}{1+bP}$

For the
SCIENTIST in
YOU

Novel role of water in production of renewable fuels!!

Energy and water are interconnected in the production of renewable fuels. On the one hand, energy is needed to extract, purify and distribute water. On the other hand, water is useful in producing energy. "It is known that water plays an important role as an environment-friendly solvent, replacing organic solvents. The novelty is that it can accelerate the rate of hydrogenation."

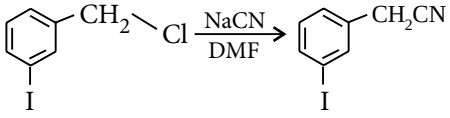
In the chemical production of energy in conventional refining, the presence of water in the reactors is undesirable. Normally, when water is present in a reacting system where a catalytic reaction is taking place, it typically absorbs where the reaction should occur, which inhibits the rate of conversion.

"A group of chemical engineering students participated in the discovery of water as a participant in the catalytic conversion of furfural without inhibiting the reaction and leading to a great rate enhancement in the process.

Furfural is a biomass-derived compound that is considered a valuable platform for production of fuels and chemicals. An important strategy is to hydrogenate the molecule so it can be used in the chemical industry later. The group has shown that when the molecule contains an oxygenated group, hydrogenation occurs from the liquid phase instead of the catalyst surface.

In the absence of water, all steps in the reaction occur on the catalyst surface. In the presence of water as a solvent, the hydrogen can be 'shuttled' through the water molecule in a higher rate for the reaction. This latter path requires a lower energy barrier to take place and is faster.

where, x is the mass of the gas adsorbed on m gram of the adsorbent, P is the pressure and a, b are constants.

11. (d) : 

12. (c) : Applying $(n + l)$ rule

(I) $n + l = 3 + 2 = 5$ (II) $n + l = 5 + 0 = 5$

(III) $n + l = 4 + 1 = 5$ (IV) $n + l = 4 + 2 = 6$

(V) $n + l = 4 + 0 = 4$

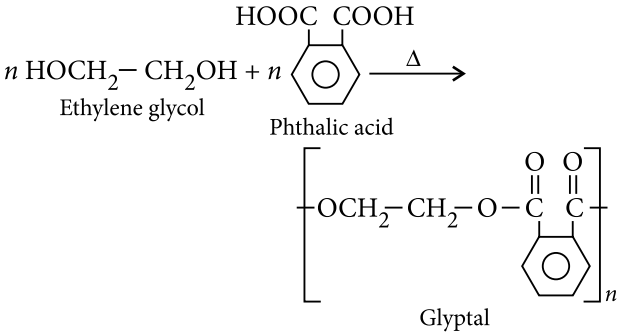
Higher the value of $(n + l)$, more is the energy associated with it. In case of same value of $(n + l)$, the electron with higher value of n has higher energy.

$\therefore$ Hence, the increasing order of energy is

V < I < III < II < IV.

13. (b)

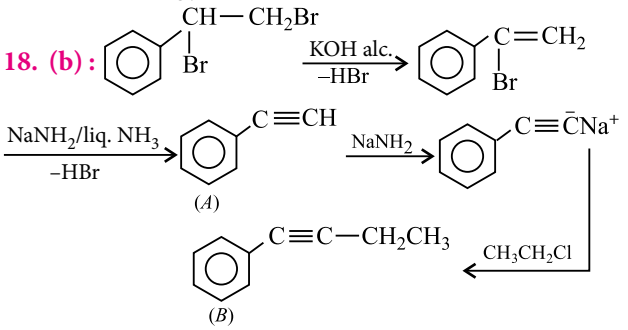
14. (d) : In polycondensation reaction, the two bi-functional monomers *i.e.*, dicarboxylic acids and diols react and form the high molecular mass condensation polymers *i.e.*, polyesters. *e.g.*, glyptal.



15. (d) : Heavy water is D_2O, temporary hardness is due to bicarbonates of Mg and Ca in water, soft water does not contain any foreign ions and permanent hardness is due to sulphates and chlorides of Mg and Ca in water.

16. (c)

17. (c) : The order of increasing energy of the subatomic orbitals is $s < p < d < f$. The energy in excited state is more than that in the ground state. In option (c) two electrons are in excited states therefore, it has maximum energy.

18. (b) : 

19. (d) : Due to lower lattice enthalpy of KI as compared to CaO, the melting point of KI is lower than that of CaO. KI is ionic, so insoluble in benzene.

20. (a) : Lowering of E_a, raises the rate of reaction.

21. (c) **22. (d)**

23. (a) : There are 12 edge centres.

Contribution of Na^+ ions at edge centres $= 12 \times \frac{1}{4} = 3$

Besides, there is one Na^+ ion at body centre.

Thus, there are four Na^+ ions per unit cell.

$\frac{3}{4}$ are replaced by Al^{3+} ions.

Total Na^+ ions in 1 mole of NaCl $= 6.023 \times 10^{23}$

Na^+ ion replaced by $Al^{3+} = 3/4 \times 6.023 \times 10^{23}$

1 Al^{3+} replaces 3 Na^+ ions, thereby creating 2 vacancies.

$\therefore$ No. of vacancies created $= \frac{2}{3} \times \left(\frac{3}{4} \times 6.023 \times 10^{23} \right)$

$= 3.01 \times 10^{23}$

24. (a) : Suppose atomic masses of A and B are x and y, respectively.

Molar mass of $AB_2 = x + 2y$; $1\text{ g } AB_2 = \frac{1}{x+2y}$ mol

Molar mass of $AB_4 = x + 4y$; $1\text{ g } AB_4 = \frac{1}{x+4y}$ mol

$$m(AB_2) = \frac{1/(x+2y)}{20} \times 1000 = \frac{50}{x+2y}$$

$$\Delta T_f = K_f \times m$$

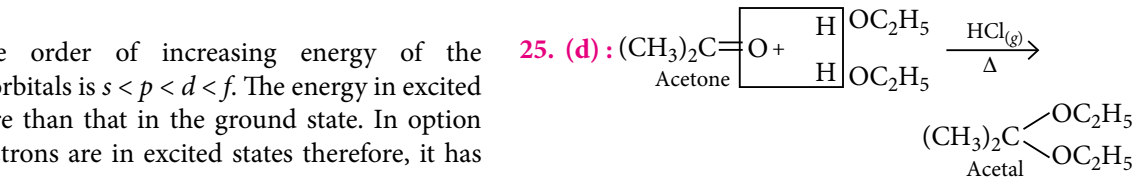
$$2.3 = 5.1 \times \frac{50}{x+2y} \Rightarrow x + 2y = 110.87 \quad \text{...(i)}$$

Similarly, for the 2nd case

$x + 4y = 196.15$ ...(ii)

Solving Eqs. (i) and (ii), we get

$x = 25.59$; $y = 42.64$

25. (d) : 

26. (d) **27. (c)** **28. (b)**

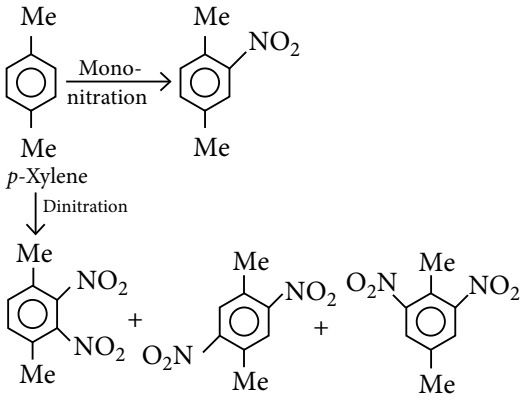
29. (d) :

Element	%	At. mass	Relative number of atoms	Simplest ratio
Xe	53.5	131	0.408	1
F	46.5	19	2.44	6

$\therefore$ The empirical formula is XeF_6

$\therefore$ Oxidation state of Xe is +6.

30. (a) :



31. (d) : $CH_3NH_2 + HCl \rightleftharpoons CH_3NH_3^+ Cl^-$

Initial moles	0.1	0.08	0

Resulting solution contains [Salt] = 0.08;
[Base] = 0.1 – 0.08 = 0.02

Applying $pOH = pK_b + \log\frac{[salt]}{[base]}$

$pK_b = -\log K_b = -\log 5 \times 10^{-4} = 4 - \log 5 = 3.30$

$pOH = 3.30 + \log\frac{0.08}{0.02} = 3.30 + 0.60 = 3.90$

$pH + pOH = 14$, $pH = 14 - 3.90 = 10.1$

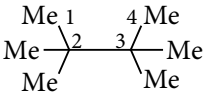
$pH = -\log [H^+] = \log\frac{1}{[H^+]} = 10.1$

Taking antilog, $\frac{1}{[H^+]} = 1.259 \times 10^{10}$

$[H^+] \approx 8 \times 10^{-11}$

32. (d)

33. (a) :



2,2,3,3-Tetramethylbutane

34. (c) : From the data we can say that I represents alkali metal, II represents halogen and III represents noble gase. Thus, the most reactive metal is I and least reactive non-metal is III.

35. (b) : During boiling, vapour pressure inside the bubble is greater than atmospheric pressure.

36. (c) : Dipole moment =
Unit electric charge × Bond length
$= 4.8 \times 10^{-10} \times 1 \times 10^{-8}$
$= 4.8 \times 10^{-18}$ esu cm = 4.8 D

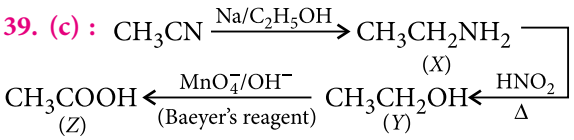
37. (b) : In the reaction, $2A + 4B \rightarrow 3C + 4D$
According stoichiometry of the reaction,
2 moles of *A* react with 4 moles of *B*

5 moles of *A* will react with $\frac{4}{2} \times 5 = 10$ moles of *B*

Since in the reaction only 6 moles of *B* are there, hence *B* is the limiting reagent.
Now, 4 moles of *B* will give 3 moles of *C*
6 moles of *B* will give 3/4 × 6 = 4.5 mol of *C*

38. (c) : $6NaOH + 4S \rightarrow Na_2S_2O_3 + 2Na_2S + 3H_2O$

39. (c) :



40. (a) : $\Delta G° = \Delta H° - T\Delta S°$
For a spontaneous process, $\Delta G° < 0$
i.e., $\Delta H° - T\Delta S° < 0$ or $\Delta H° < T\Delta S°$ or $T\Delta S° > \Delta H°$

or $T > \frac{\Delta H°}{\Delta S°}$ *i.e.*, $T > \frac{179.1 \times 1000}{160.2}$

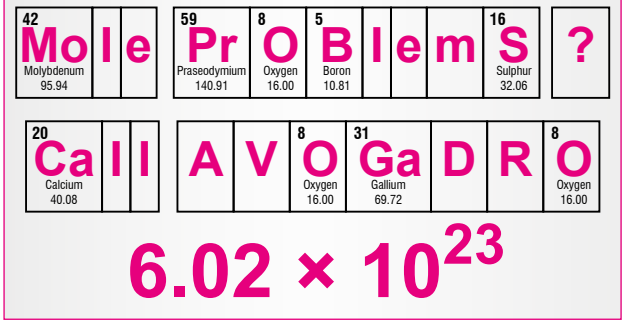
or $T > 1117.9$ K ≈ 1118 K

41. (a, b, c, d) :

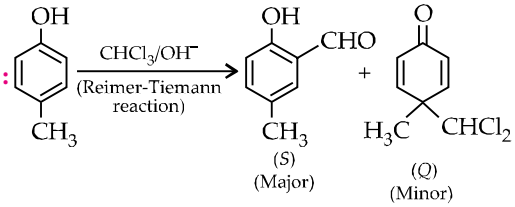
	Formic acid	Acetic acid
Conc. H_2SO_4	$HCOOH \xrightarrow[H_2SO_4]{conc.} CO + H_2O$	No effect
Tollens' Reagent	$HCOOH + Ag_2O \longrightarrow 2Ag\downarrow + CO_2 + H_2O$ (Silver mirror)	No effect
Fehling's solution	$HCOOH + 2CuO \longrightarrow Cu_2O\downarrow + CO_2 + H_2O$ (Red ppt.)	No effect
Sodium Salt	$2HCOONa \xrightarrow{\Delta} \begin{matrix}COONa\\ \vert\\ COONa\end{matrix} + H_2$	No effect

42. (b,c,d) : All these reagents convert $\left(\rangle\!=\!O\right)$ group to $(—CH_2—)$ group.

COMIC CAPSULE



43. (b, d) :



44. (a,d)

45. (c,d) : (c) rate becomes 81 times.
(d) rate becomes 4 times.

46. (b,d) : 100 mL of 1 M H_2SO_4 + 100 mL (98%, $d = 0.1$) H_2SO_4

$$\Rightarrow \quad 100 \times 1 + 100 \times \left(\frac{98 \times 10 \times 0.1}{98}\right)$$

$$\Rightarrow \quad 100 \times 1 + 100 \times 1$$

$$\therefore \quad [H_2SO_4] = \frac{100 \times 1 + 100 \times 1}{200} = 1 \text{ M} = 98 \text{ g/1000 mL}$$

$$\text{Mass of } H_2SO_4 = \frac{98 \text{ g} \times 200 \text{ mL}}{1000 \text{ mL}} = 19.6 \text{ g}$$

Concentration of each component becomes half of the initial value.

47. (b, c, d)

48. (b, c) : $2MnO_2 + 4KOH + O_2 \xrightarrow{\text{heat}} 2K_2MnO_4 + 2H_2O$

$2MnO_2 + 2K_2CO_3 + O_2 \xrightarrow{\Delta} 2K_2MnO_4 + 2CO_2$

49. (a,d) : (a) The equivalent mass of $KMnO_4$ in acidic medium $= \frac{\text{molecular mass}}{5}$

(b) Mass of oxalic acid $= \frac{63 \times 0.02 \times 500}{1000} = 6.3$ g

(c) $K_2Cr_2O_7 + 7H_2SO_4 + 6FeSO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + 3Fe_2(SO_4)_3 + 7H_2O$

$0.1 \times V = 1/6\ [35 \times 0.5]$
$V = 29.17$
(d) Phenolphthalein is used as indicator in acid-base titrations.

50. (a, b, d) : $\pi \propto C$ (at constant T)

i.e. $\frac{\pi}{C}$ = constant (at constant T)

Again $C = \frac{n}{V}$ *i.e.* $C \propto \frac{1}{V}$ (at constant T)

i.e., $\pi \propto \frac{1}{V}$ (at constant T)

3 AMAZING FACTS YOU MUST KNOW

Chalk is Made up of Planktons!!

Chalk is an essential part of childhood, from school to playing on the sidewalk, and surely you've tasted it at some point. Its pretty damn dry, and this may have something to do with its makeup. It is made of trillions of fossilized plankton. Maybe its a part of Sheldon J. Plankton's plan to steal the Krabby Patty recipe.

No, We Were First !!

Oganessian is one of only two periodical elements to be named after a living person, the other being Seaborgium, which is another synthetic element, known for being the most stable isotope. Atoms of this element were found by both Soviet and American scientists in 1974, which led to a dispute that would last 23 years between the two countries.

The Diamond Tears !!

The word carbon was comes from the French word for coal—charbon. It was named in the 18th century after Antoine Lavoisier figured out that a diamond consisted of carbon. He did this by building a tool to focus sun rays (a solar furnace) and then used it to burn a diamond and analyze the residue. It wasn't until then that people realized that carbon wasn't just coal, but a unique chemical substance.

10 MIND BLOWING PROBLEMS

OLYMPIAD CORNER

OBJECTIVE PROBLEMS

1. When NH_3 is heated in a 0.50 L vessel at 430°C and 100 atm pressure it decomposes into nitrogen and hydrogen.

$2NH_{3(g)} \rightleftharpoons N_{2(g)} + 3H_{2(g)}$

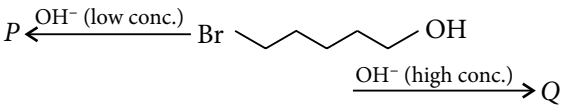
If after heating a pure sample of NH_3 the equilibrium mixture is found to contain 0.30 moles of $NH_{3(g)}$, 0.90 moles of $H_{2(g)}$, 0.30 moles of $N_{2(g)}$. Which of the following pair of values is correct?

Initial moles of NH_3	**K_c at 430°C for NH_3 formation**
(a) 0.80	0.37
(b) 0.90	0.92
(c) 0.80	0.92
(d) 0.90	0.10

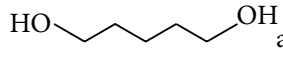
2. A 1.0 g sample of Fe_2O_3 solid of 55.2% purity is dissolved in an acid and reduced by heating the solution with zinc dust. The resultant solution is cooled and made upto 100 mL. An aliquot of 25.0 mL of this solution requires 17.0 mL of 0.0167 M solution of an oxidant for titration. Calculate the number of electrons taken up by the oxidant in the reaction of the above titration.

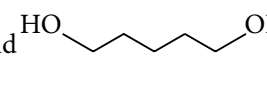
(a) 3 (b) 6 (c) 4 (d) 8

3. In the given reaction,

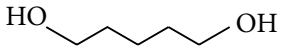


P and *Q* are

(a)  and respectively

(b) and  respectively

(c) Both

(d) Both 

4. 100 mL of a buffer of 1 M $NH_{3(aq)}$ and 1 M $NH_4^+{}_{(aq)}$ is placed in two voltaic cells separately. A current of 1.5 A is passed through both the cells for 20 minutes. If electrolysis of water only takes place

$2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$ (RHS)

$2H_2O \longrightarrow 4H^+ + O_2 + 4e^-$ (LHS)

then pH of the

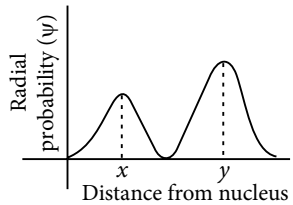
(a) LHS half-cell will increase

(b) RHS half-cell will increase

(c) Both half-cells will increase

(d) Both half-cells will decrease.

5. If the given radial probability curve indicates 2*s* orbital, the distance between the peak points *x* and *y* is



(a) 2.07 Å (b) 1.59 Å (c) 0.53 Å (d) 2.12 Å

SUBJECTIVE PROBLEMS

6. $C_5H_8O_3$ [*A*] on heating with soda lime gives [*B*] which reacts with HCN to give [*C*]. [*C*] reacts with thionyl chloride to give [*D*] which on reacting with KCN gives [*E*] alkaline hydrolysis of [*E*] gives a salt [*F*] which on heating with soda lime gives *n*-butane. Oxidation of [*A*] with dichromate gives acetic and malonic acid. Give the structures of [*A*] to [*F*] with proper reasoning.

7. The pressure exerted by 12 g of an ideal gas at temperature t°C in a vessel of volume V litre is one atm. When the temperature is increased by 10 degrees at the same volume, the pressure increases by 10%. Calculate the temperature t and volume V. (Molecular weight of the gas = 120).

8. An organic compound (A) (C_7H_6O), gives positive Tollens' test. $[A]$ on treatment with alcoholic potassium cyanide yields $[B]$ $(C_{14}H_{12}O_2)$. Compound $[B]$ on reduction with amalgamated Zn and conc. HCl gives unsaturated compound $[C]$ which adds a molecule of bromine. $[B]$ can be oxidised with nitric acid to a compound $[D]$ $(C_{14}H_{10}O_2)$. Compound $[D]$ on heating with KOH undergoes rearrangement and subsequent acidification of rearranged product yields an acidic compound $[E]$ $(C_{14}H_{12}O_3)$. Identify $[A]$ to$[E]$ by giving the reactions.

9. A certain salt (X) gives the following tests :
(a) Its aqueous solution is alkaline to litmus.
(b) On strong heating it swells to give a glassy material.
(c) When conc. H_2SO_4 is added to a hot concentrated solution of (X), white crystals of a weak acid separate out. Identify (X) and give the reactions.

10. When 10 g anhydrous $CaCl_2$ were dissolved in water, 6.82 kJ enthalpy was evolved, while when 10 g of the crystal hydrate $CaCl_2 \cdot 6H_2O$ were dissolved in water, 0.87 kJ enthalpy was absorbed. Calculate the enthalpy of formation of the crystal hydrate from the anhydrous salt and water.

SOLUTIONS

1. (d)

2. (b) : Mass of Fe_2O_3 in the given sample

$= \frac{55.2}{100} \times 1 = 0.552$ g

Number of moles of $Fe_2O_3 = \frac{0.552}{159.8}$

(mol wt. of $Fe_2O_3 = 159.8$)

$= 3.454 \times 10^{-3}$

Number of moles of Fe^{3+} ions $= 2 \times 3.454 \times 10^{-3}$

[1 mole of Fe_2O_3 = 2 moles of Fe^{3+}]

$= 6.908 \times 10^{-3}$ mol = 6.908 mmol

Since the conversion of Fe^{2+} to Fe^{3+} involves only 1 electron change ($Fe^{2+} \longrightarrow Fe^{3+} + e^-$) so the molecular weight is same as equivalent weight.

$\therefore$ Amount of Fe^{2+} ion in 100 mL of solution

= 6.908 meq.

Volume of oxidant used for 100 mL of Fe^{2+} solution

$= 17 \times 4$ mL = 68 mL

Amount of oxidant used = 68×0.0167 mmoles

= 1.1356 mmoles

Let the number of electrons taken up by oxidant = n

Number of meq of oxidant used = $1.1356 \times n$

Thus, $1.1356 \times n = 6.908$ or $n = \frac{6.908}{1.1356} = 6$

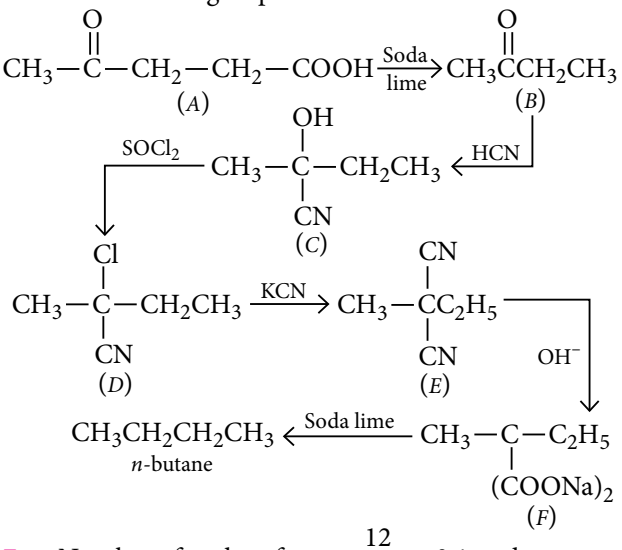
3. (b) **4. (b)** **5. (a)**

6. (i) $(A) \xrightarrow[\Delta]{\text{Soda lime}} (B)$ detects the presence of $-COOH$ in (A).

(ii) $C_5H_8O_3 \xrightarrow{\text{Oxidation}}$

$\underset{\text{Acetic acid}}{CH_3COOH} + \underset{\text{Malonic acid}}{HOOCCH_2COOH}$

n-Butane as final products proved that (A) is a straight carbon chain compound and the above equation shows that the oxidisable group is present at C_2 and that should be ketonic group.



7. Number of moles of gas $= \frac{12}{120} = 0.1$ mol

$P = 1$ atm, $T = (t + 273)$ K

$PV = nRT$

$1 \times V = 0.1 \times R \times (273 + t)$ ...(i)

Under new condition,

$1.1\ V = 0.1 \times R \times (273 + 10 + t)$

$1.1\ V = 0.1 \times R \times (283 + t)$ ...(ii)

Dividing (ii) by (i), we get,

$$\frac{1.1\ V}{1\ V} = \frac{0.1 \times R \times (283 + t)}{0.1 \times R \times (273 + t)} \Rightarrow 1.1 = \frac{283 + t}{273 + t}$$

$1.1\,t + 1.1 \times 273 = t + 283 \Rightarrow 0.1\,t = 283 - 300.3$

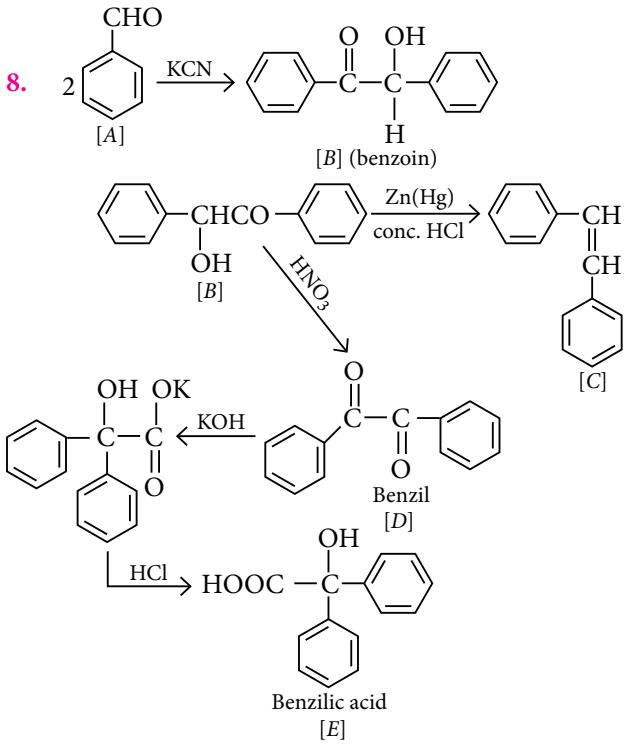
$t = -\dfrac{17.3}{0.1}$ or 173°C $\Rightarrow (-173 + 273) = 100$ K

Substituting this value of t in equation (i), we get

$1 \times V = 0.1 \times 0.082 \times (273 - 173)$

$V = 0.1 \times 0.082 \times 100 = 0.82$ L

8.



9. The compound swells on heating and gives a glassy mass hence, it should be borax.

Borax undergoes hydrolysis in water to give an alkaline solution.

Compound (X) is further confirmed to be borax as it gives white crystals of boric acid with conc. H_2SO_4.

Alkaline aqueous solution of (X) :

$$\underset{(X)}{Na_2B_4O_7} + 7H_2O \rightleftharpoons \underset{\text{(strong alkali)}}{2NaOH} + \underset{\text{(weak acid)}}{4H_3BO_3}$$

Effect of heat :

$$Na_2B_4O_7.10H_2O \xrightarrow{\Delta} Na_2B_4O_7 + 10H_2O$$

$$Na_2B_4O_7 \xrightarrow{\Delta} \underbrace{2NaBO_2 + B_2O_3}_{\text{(glassy mass)}}$$

With conc. H_2SO_4 :

$$Na_2B_4O_7.10H_2O + H_2SO_4 \longrightarrow Na_2SO_4 + \underset{\text{(weak acid)}}{4H_3BO_3} + 5H_2O$$

Thus, the given compound (X) is Borax ($Na_2B_4O_7.10H_2O$).

10. To dissolve anhydrous salt

$CaCl_{2(s)} + 6H_2O_{(l)} \rightarrow CaCl_2.6H_2O_{(s)} + \Delta H_1$

$CaCl_2.6H_2O_{(s)} + nH_2O_{(l)} \rightarrow CaCl_{2(aq)} - \Delta H_2$

ΔH_1 is the enthalpy of formation of the crystal hydrate and ΔH_2 is that of it's solution.

Now,

$CaCl_{2(s)} + (n + 6)H_2O_{(l)} \rightarrow CaCl_{2(aq)} + \Delta H_3$

Where ΔH_3 is the enthalpy of solution of the anhydrous salt.

Now, according to Hess's law, $\Delta H_3 = \Delta H_1 + \Delta H_2$

$\Rightarrow \quad \Delta H_1 = \Delta H_3 - \Delta H_2$

To find the required quantity (ΔH_1), we must consequently calculate the enthalpy of solution of the anhydrous salt (ΔH_3 and of the crystal hydrate ΔH_2)

The molar mass of $CaCl_2$ is 111 g/mol.

Since the change in the enthalpy when dissolving 10 g of $CaCl_2$ is 6.82 kJ.

Again,

$$\Delta H_3 = \frac{-6.82 \times 111}{10} = -75.7 \text{ kJ/mol.}$$

The molar mass of $CaCl_2.6H_2O$ is 219 g/mol.

Now,

$$\Delta H_2 = \frac{0.87 \times 219}{10} = 19.05 \text{ kJ/mol.}$$

For the enthalpy of formation of the crystal hydrate, we finally get

$\Delta H_1 = \Delta H_3 - \Delta H_2 = -75.7 - 19.05 = -94.75$ kJ/mol

NEET mandatory to study MBBS from abroad, current students exempted

"MCI informed that the regulations prescribe that the Indian citizens or Overseas Citizen of India intending to obtain primary medical qualification from any medical institution outside India, on or after May 2018, shall have to mandatorily qualify the National Eligibility-cum-Entrance Test (NEET), for admission to MBBS course abroad.

After making the decision public, the Ministry received grievances of the students requesting that those who have already gone abroad may be exempted from the requirement of qualifying NEET.

Clearing the confusion, the Union Health Ministry has said students who have already taken admission under present regulations to pursue primary medical courses by taking eligibility certificate from Medical Council of India (MCI) were "exempted" from qualifying NEET.

Every year, around 7,000 students go outside India to study medicine. Most of the students go to China and Russia. "As per the data, the percentage of graduates who have studied abroad and have cleared the FMGE has ranged between 13 and 26.9 per cent in the last five years. This is really a matter of concern as they go out, spend lot of money of their parents and are not able to contribute to the healthcare in India once they come back," an official said.

NEET के ENTRANCE EXAM में हिंदी माध्यम विद्यार्थियों के लिए सफलता मंत्र

NCERT TEXTBOOK पर BASED भौतिकी, रसायन और जीव विज्ञान की OBJECTIVE पुस्तकें

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- प्रश्नों को शीघ्रता और सरलता से हल करने के लिए CHAPTERWISE SNAPSHOTS (महत्वपूर्ण बिंदु)
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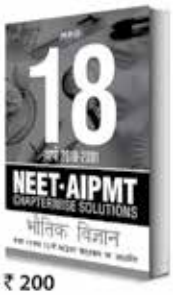

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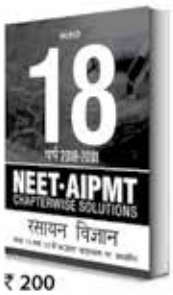

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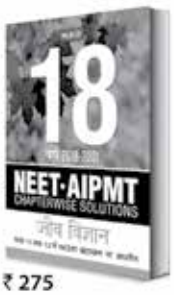

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- 18 वर्षों (2018-2001) के NEET/AIPMT के CHAPTERWISE प्रश्नों के उत्तर सरल व्याख्या सहित

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CONCEPT BOOSTER

Hello Friends!! This month I am presenting something special which you can't avoid in this exam time. I have demonstrated CHEMICAL KINETICS. You can see I have taken up important formulas, short cuts, tricks (for other chapters you can keep mnemonics also) all together. The effect of this is that you can revise them any time as all are aggregated at a single place. This will boost your confidence and will help you to recall it at the time of the examination. I will suggest you to do this practice for all chapters specially in Inorganic Chemistry. All the best for your exams & future.

*Arunava Sarkar

POINTS & TOPICS THAT YOU CAN'T MISS.

1. Rate of reactions

$$= \frac{\text{Change in concentration of the initially taken substance}}{\text{Course of time}}$$

$$= \frac{\text{Change in presence of the gaseous substance initially taken}}{\text{Course of time}}$$

2. $\frac{dP}{dt} = \frac{dC}{dt} \times RT$

i.e, Rate of reaction in atm sec^{-1}
= Rate of reaction in mol L^{-1} s^{-1} $\times$ RT

Proof :– $PV = nRT \Rightarrow P = \left(\frac{n}{V}\right)RT$

$\Rightarrow P = CRT \Rightarrow dP = dC\,RT$

$\Rightarrow \frac{dP}{dt} = \frac{dC}{dt}RT$

3. $\lim_{\Delta t \to 0} \frac{\Delta[A]}{\Delta t} = \frac{d[A]}{dt}$

where, $\frac{\Delta[A]}{\Delta t}$ = average rate of reaction

$\frac{d[A]}{dt}$ = instantaneous rate of reaction

4. For a reaction of order n,
half-life $t_{½} \propto [a_0]^{1-n}$
{$[a_0]$ is the initial concentration}

5. If n is the order of the reaction,
then, unit of rate constant

$$= \left[\frac{1}{\text{unit of concentration}}\right]^{n-1} \times \text{time}^{-1}$$

$$= \left(\frac{\text{Litre}}{\text{mol}}\right)^{n-1} (\text{time})^{-1}$$

For a gaseous reaction,

$$\text{Unit of rate constant} = \left[\frac{1}{\text{unit of pressure}}\right]^{n-1} \times \text{time}^{-1}$$

$$= (\text{atm})^{1-n}\,\text{time}^{-1}$$

6. $t_{½} = \frac{1}{2}t_{75\%} = \frac{1}{3}t_{87.5\%} = \frac{1}{3.22}t_{90\%}$

$= \frac{1}{6.644}t_{99\%} = \frac{1}{9.967}t_{99.9\%} = \frac{1}{13.29}t_{99.99\%}$

i.e., $t_{90\%} = \frac{1}{2}t_{99\%} = \frac{1}{3}t_{99.9\%} = \frac{1}{4}t_{99.99\%}$

Hint :- $t_{90\%} = \frac{2.303}{k}$ (k = rate constant)

7. $t_{93.75\%} = 2t_{75\%} = 4t_{50\%}$

8. $t_{19\%} = t_{10\%} \times 2$

9. $2t_{½} = t_{¾}$

*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

5 MOST FREQUENTLY ASKED CHAPTERS IN JEE ADVANCED

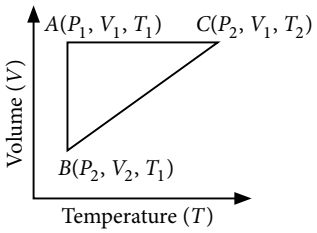
1. Chemical Energetics
2. Equilibrium
3. The *p*-Block Elements
4. Coordination Compounds
5. Aldehydes, Ketones, Carboxylic Acids and their Derivatives

Last 3 years (2018-2016) questions along with important formula/concepts are covered here to give you an idea of the pattern of questions asked.

Chemical Energetics

- According to first law of thermodynamics,
  $\Delta E = q + w$
- Enthalpy, $H = E + PV$
- Enthalpy change,
  $\Delta H = \Delta E + P\Delta V$
- $C_P - C_V = P\Delta V = R$
- Work done in reversible isothermal expansion
  $= -2.303nRT \log \frac{P_1}{P_2}$
  $W_{compression} = 2.303nRT \log \frac{P_2}{P_1}$
- $q_V = \Delta E$ and $q_P = \Delta H$, $q_P = q_V + \Delta n_g RT$
  or $\Delta H = \Delta E + \Delta n_g RT$ where, $\Delta n_g = n_P - n_R$
- **Entropy change,** $\Delta S = q_{rev}/T$
  $\Delta S_{fus} = \Delta H_{fus}/T_f$ and $\Delta S_{vap} = \Delta H_{vap}/T_b$
- **Gibbs energy,** $G = H - TS$
  Gibbs energy change, $\Delta G = \Delta H - T\Delta S$
  $\Delta G° = \Sigma G°$ (Products) $- \Sigma G°$ (Reactants)
- **van't Hoff reaction isotherm :** $\Delta G = \Delta G° + RT \ln K_p$
  $\Delta G° = -nFE°_{cell}$; $\Delta G° = -RT \ln K$

1. A reversible cyclic process for an ideal gas is shown below. Here, P, V and T are pressure, volume and temperature, respectively. The thermodynamic parameters q, w, H and U are heat, work, enthalpy and internal energy, respectively.



The correct option(s) is (are)
(a) $q_{AC} = \Delta U_{BC}$ and $w_{AB} = P_2(V_2 - V_1)$
(b) $w_{BC} = P_2(V_2 - V_1)$ and $q_{BC} = \Delta H_{AC}$
(c) $\Delta H_{CA} < \Delta U_{CA}$ and $q_{AC} = \Delta U_{BC}$
(d) $q_{BC} = \Delta H_{AC}$ and $\Delta H_{CA} > \Delta U_{CA}$ *(2018)*

2. A closed tank has two compartments *A* and *B*, both filled with oxygen (assumed to be ideal gas). The partition separating the two compartments is fixed and is a perfect heat insulator (Figure 1). If the old partition is replaced by a new partition which can slide and conduct heat but does not allow the gas to leak across (Figure 2), the volume (in m^3) of the compartment *A* after the system attains equilibrium is _____.

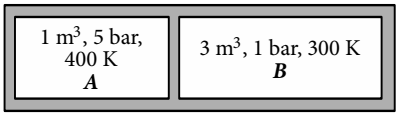


Figure 1

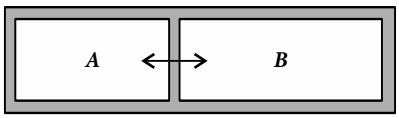


Figure 2

(2018)

3. The surface of copper gets tarnished by the formation of copper oxide. N_2 gas was passed to prevent the oxide formation during heating of copper at 1250 K. However, the N_2 gas contains 1 mole % of water vapour as impurity. The water vapour oxidises copper as per the reaction given below :

$2Cu_{(s)} + H_2O_{(g)} \rightarrow Cu_2O_{(s)} + H_{2(g)}$

p_{H_2} is the minimum partial pressure of H_2 (in bar) needed to prevent the oxidation at 1250 K. The value of $\ln(p_{H_2})$ is _____ .

(Given: total pressure = 1 bar, R (universal gas constant) = 8 J K^{-1} mol^{-1}, ln(10) = 2.3, $Cu_{(s)}$ and $Cu_2O_{(s)}$ are mutually immiscible.

At 1250 K: $2Cu_{(s)} + 1/2O_{2(g)} \rightarrow Cu_2O_{(s)}$; $\Delta G^\circ = -78{,}000$ J mol^{-1}

$H_{2(g)} + 1/2O_{2(g)} \rightarrow H_2O_{(g)}$; $\Delta G^\circ = -1{,}78{,}000$ J mol^{-1} ;

(G is the Gibbs energy.) *(2018)*

4. The standard state Gibbs free energies of formation of $C_{(graphite)}$ and $C_{(diamond)}$ at T = 298 K are $\Delta_f G^\circ[C_{(graphite)}]$ = 0 kJ mol^{-1}; $\Delta_f G^\circ[C_{(diamond)}]$ = 2.9 kJ mol^{-1}. The standard state means that the pressure should be 1 bar and substance should be pure at a given temperature. The conversion of graphite $[C_{(graphite)}]$ to diamond $[C_{(diamond)}]$ reduces its volume by 2×10^{-6} m^3 mol^{-1}. If $C_{(graphite)}$ is converted to $C_{(diamond)}$ isothermally at T = 298 K, the pressure at which $C_{(graphite)}$ is in equilibrium with $C_{(diamond)}$, is

[Useful information : 1 J = 1 kg m^2s^{-2}; 1 Pa = 1 kg $m^{-1}s^{-2}$; 1 bar = 10^5 Pa]

(a) 29001 bar (b) 58001 bar

(c) 14501 bar (d) 1450 bar *(2017)*

5. An ideal gas is expanded from (p_1, V_1, T_1) to (p_2, V_2, T_2) under different conditions. The correct statement(s) among the following is(are)

(a) if the expansion is carried out freely, it is simultaneously both isothermal as well as adiabatic

(b) the work done by the gas is less when it is expanded reversibly from V_1 to V_2 under adiabatic conditions as compared to that when expanded reversibly from V_1 to V_2 under isothermal conditions

(c) the work done on the gas is maximum when it is compressed irreversibly from (p_2, V_2) to (p_1, V_1) against constant pressure p_1

(d) the change in internal energy of the gas is (i) zero, if it is expanded reversibly with $T_1 = T_2$, and (ii) positive, if it is expanded reversibly under adiabatic conditions with $T_1 \neq T_2$. *(2017)*

6. One mole of an ideal gas at 300 K in thermal contact with surroundings expands isothermally from 1.0 L to 2.0 L against a constant pressure of 3.0 atm. In this process, the change in entropy of surroundings (ΔS_{surr}) in J K^{-1} is (1 L atm = 101.3 J)

(a) 5.763 (b) 1.013

(c) –1.013 (d) –5.763 *(2016)*

Equilibrium

- **Law of chemical equilibrium for a reaction :**

$aA + bB \rightleftharpoons cC + dD$

$$\frac{[C]^c[D]^d}{[A]^a[B]^b} = \frac{k_f}{k_b} = K_c \text{ = equilibrium constant}$$

- **Equilibrium constant in terms of pressure :**

$$K_P = \frac{p_C^c \; p_D^d}{p_A^a \; p_B^b}$$

- **Relationship between K_P and K_C :**

$K_P = K_C(RT)^{\Delta n}$,

where $\Delta n = n_p - n_r$ *i.e.,* no. of moles of gaseous products – no. of moles of gaseous reactants.

- **Solubility product** of a sparingly soluble salt A_xB_y is given by

$A_xB_y \rightleftharpoons xA^{y+} + yB^{x-}$; $K_{sp} = [A^{y+}]^x \cdot [B^{x-}]^y$

- **For salts of weak acid and strong base :**

Hydrolysis constant, $K_h = \frac{K_w}{K_a}$

$$pH = \frac{1}{2}(pK_w + pK_a + \log C) = 7 + \frac{1}{2}(pK_a + \log C)$$

- **For salts of strong acid and weak base :**

Hydrolysis constant, $K_h = \frac{K_w}{K_b}$

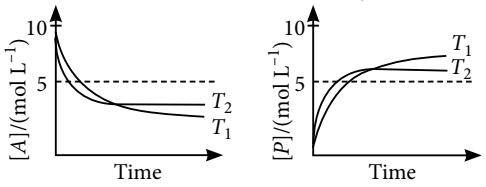
$$pH = \frac{1}{2}(pK_w - pK_b - \log C) = 7 - \frac{1}{2}(pK_b + \log C)$$

- **For salt of weak acid and weak base :**

Hydrolysis constant, $K_h = \frac{K_w}{K_aK_b}$

$$pH = \frac{1}{2}(pK_w + pK_a - pK_b) = 7 + \frac{1}{2}(pK_a - pK_b)$$

7. For a reaction, $A \rightleftharpoons P$, the plots of $[A]$ and $[P]$ with time at temperatures T_1 and T_2 are given below.



If $T_2 > T_1$, the correct statement(s) is (are) (Assume $\Delta H°$ and $\Delta S°$ are independent of temperature and ratio of ln$K$ at T_1 to ln$K$ at T_2 is greater than T_2/T_1. Here H, S, G and K are enthalpy, entropy, Gibbs energy and equilibrium constant, respectively.)

(a) $\Delta H° < 0, \Delta S° < 0$ (b) $\Delta G° < 0, \Delta H° > 0$

(c) $\Delta G° < 0, \Delta S° < 0$ (d) $\Delta G° < 0, \Delta S° > 0$

(2018)

8. The solubility of a salt of weak acid (AB) at pH 3 is $Y \times 10^{-3}$ mol L^{-1}. The value of Y is ____.

(Given that the value of solubility product of AB (K_{sp}) = 2×10^{-10} and the value of ionization constant of HB (K_a) = 1×10^{-8}) *(2018)*

9. Dilution processes of different aqueous solutions, with water, are given in List-I. The effects of dilution of the solutions on $[H^+]$ are given in List-II.

(Note: Degree of dissociation (α) of weak acid and weak base is <<1; degree of hydrolysis of salt<<1; $[H^+]$ represents the concentration of H^+ ions)

	List-I		**List-II**
P.	(10 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 60 mL	1.	The value of $[H^+]$ does not change on dilution.
Q.	(20 mL of 0.1 M NaOH + 20 mL of 0.1 M acetic acid) diluted to 80 mL	2.	The value of $[H^+]$ changes to half of its initial value on dilution.
R.	(20 mL of 0.1 M HCl + 20 mL of 0.1 M ammonia solution) diluted to 80 mL	3.	The value of $[H^+]$ changes to two times of its initial value on dilution.
S.	10 mL saturated solution of $Ni(OH)_2$ in equilibrium with excess solid $Ni(OH)_2$ is diluted to 20 mL (solid $Ni(OH)_2$ is still present after dilution).	4.	The value of $[H^+]$ changes to $\frac{1}{\sqrt{2}}$ times of its initial value on dilution.
		5.	The value of $[H^+]$ changes to $\sqrt{2}$ times of its initial value on dilution

Match each process given in List-I with one or more effect(s) in List-II.

The correct option is

(a) P → 4; Q → 2; R → 3; S → 1

(b) P → 4; Q → 3; R → 2; S → 3

(c) P → 1; Q → 4; R → 5; S → 3

(d) P → 1; Q → 5; R → 4; S → 1 *(2018)*

10. For a reaction taking place in a container in equilibrium with its surroundings, the effect of temperature on its equilibrium constant K in terms of change in entropy is described by

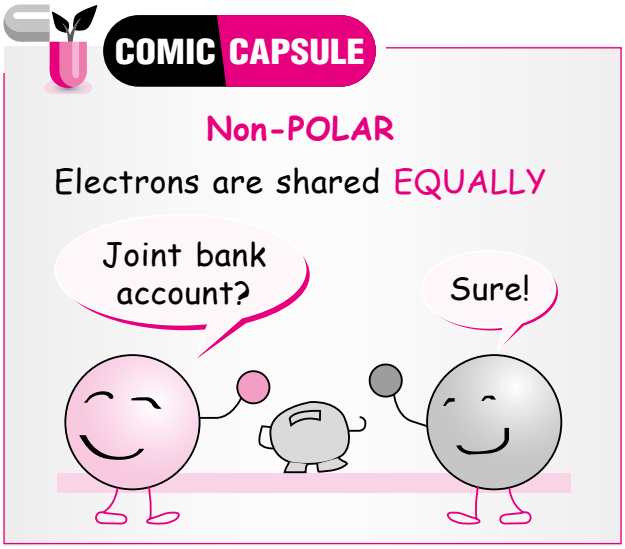
(a) with increase in temperature, the value of K for endothermic reaction increases because unfavourable change in entropy of the surroundings decreases

(b) with increase in temperature, the value of K for exothermic reaction decreases because favourable change in entropy of the surroundings decreases

(c) with increase in temperature, the value of K for exothermic reaction decreases because the entropy change of the system is positive

(d) with increase in temperature, the value of K for endothermic reaction increases because the entropy change of the system is negative.

(2017)



Comprehension-1

For Q. No. 11 and 12 : Read the given comprehension carefully and answer the following questions.

Thermal decomposition of gaseous X_2 to gaseous X at 298 K takes place according to the following equation :

$$X_{2(g)} \rightleftharpoons 2X_{(g)}$$

The standard reaction Gibbs energy, $\Delta_r G°$, of this reaction is positive. At the start of the reaction, there is one mole of X_2 and no X. As the reaction proceeds, the number of moles of X formed is given by β. Thus, $\beta_{equilibrium}$ is the number of moles of X formed at equilibrium. The reaction is carried out at a constant total pressure of 2 bar. Consider the gases to behave ideally.

(Given : $R = 0.083$ L bar K^{-1} mol^{-1})

11. The equilibrium constant K_p for this reaction at 298 K, in terms of $\beta_{equilibrium}$, is

(a) $\frac{8\beta^2_{equilibrium}}{2-\beta_{equilibrium}}$ (b) $\frac{8\beta^2_{equilibrium}}{4-\beta^2_{equilibrium}}$

(c) $\frac{4\beta^2_{equilibrium}}{2-\beta_{equilibrium}}$ (d) $\frac{4\beta^2_{equilibrium}}{4-\beta^2_{equilibrium}}$

12. The incorrect statement among the following, for this reaction, is

(a) decrease in the total pressure will result in formation of more moles of gaseous X

(b) at the start of the reaction, dissociation of gaseous X_2 takes place spontaneously

(c) $\beta_{equilibrium} = 0.7$

(d) $K_c < 1$ *(2016)*

The *p*-Block Elements

General Trends (Group-13) :

- Basic nature of oxides and hydroxides shows the following order : B < Al < Ga < In < Tl.
- Power of accepting lone pairs of electrons (Lewis acid character) of boron trihalides follows the order : $BI_3 > BBr_3 > BCl_3 > BF_3$.
- Ionization enthalpies of group 13 elements follow the trend : B > Tl > Ga > Al > In

General Trends (Group-14) :

- Stability of tetrahalides : $CX_4 > SiX_4 > GeX_4 > SnX_4 > PbX_4$
- Acidic strength of oxides of group 14 elements decreases down the group :

$\underbrace{CO_2, SiO_2}_{\text{Acidic}}$	$\underbrace{GeO_2}_{\text{Less acidic}}$	$\underbrace{SnO_2, PbO_2}_{\text{Amphoteric}}$
$\underbrace{CO, SiO}_{\text{Neutral}}$	$\underbrace{GeO}_{\text{Acidic}}$	$\underbrace{SnO, PbO}_{\text{Amphoteric}}$

General Trends (Group-15) :

Hydrides :

- **Bond angle, Thermal stability and Basic strength :** $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
- **B.Pt. :** $PH_3 < AsH_3 < NH_3 < SbH_3 < BiH_3$
- **M.Pt. :** $PH_3 < AsH_3 < SbH_3 < NH_3$
- **Reducing nature :** $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$

General Trends (Group-16) :

Hydrides :

- **Bond angle and Thermal stability :** $H_2O > H_2S > H_2Se > H_2Te$
- **Volatility :** $H_2S > H_2Se > H_2Te > H_2O$
- **Acidic strength and Reducing nature :** $H_2O < H_2S < H_2Se < H_2Te$

General Trends (Group-17) :

- **Oxidizing power :** $F_2 > Cl_2 > Br_2 > I_2$
- **Bond energy :** $Cl_2 > Br_2 > F_2 > I_2$
- **Electron gain enthalpy :** Cl > F > Br > I

Hydrogen halides :

- **B.Pt. and M.Pt.** : HF > HI > HBr > HCl
- **Dipole moment, Bond dissociation energy and Thermal stability :** HF > HCl > HBr > HI
- **Bond length, Acidic strength and Reducing nature :** HF < HCl < HBr < HI

General Trends (Group 18) :

- **M.Pt., B.Pt., Ease of liquefaction, Solubility, Adsorption and Polarizability :** He < Ne < Ar < Kr < Xe
- **Thermal Conductivity :** He > Ne > Ar > Kr > Xe

13. The compound(s) which generate(s) N_2 gas upon thermal decomposition below 300 °C is (are)

(a) NH_4NO_3 (b) $(NH_4)_2Cr_2O_7$

(c) $Ba(N_3)_2$ (d) Mg_3N_2 *(2018)*

14. Based on the compounds of group 15 elements, the correct statement(s) is (are)

(a) Bi_2O_5 is more basic than N_2O_5

(b) NF_3 is more covalent than BiF_3

(c) PH_3 boils at lower temperature than NH_3

(d) the N—N single bond is stronger than the P—P single bond. *(2018)*

15. The total number of compounds having at least one bridging oxo group among the molecules

given below is _____ .
N_2O_3, N_2O_5, P_4O_6, P_4O_7, $H_4P_2O_5$, $H_5P_3O_{10}$, $H_2S_2O_3$, $H_2S_2O_5$ *(2018)*

16. The order of the oxidation state of the phosphorus atom in H_3PO_2, H_3PO_4, H_3PO_3, and $H_4P_2O_6$ is
(a) $H_3PO_4 > H_3PO_2 > H_3PO_3 > H_4P_2O_6$
(b) $H_3PO_2 > H_3PO_3 > H_4P_2O_6 > H_3PO_4$
(c) $H_3PO_3 > H_3PO_2 > H_3PO_4 > H_4P_2O_6$
(d) $H_3PO_4 > H_4P_2O_6 > H_3PO_3 > H_3PO_2$ *(2017)*

17. The colour of the X_2 molecules of group 17 elements changes gradually from yellow to violet down the group. This is due to
(a) the physical state of X_2 at room temperature changes from gas to solid down the group
(b) decrease in HOMO-LUMO gap down the group
(c) decrease in $\pi^*-\sigma^*$ gap down the group
(d) decrease in ionization energy down the group. *(2017)*

18. The correct statement(s) about the oxoacids, $HClO_4$ and HClO, is(are)
(a) the conjugate base of $HClO_4$ is weaker base than H_2O
(b) the central atom in both $HClO_4$ and HClO is sp^3 hybridized
(c) $HClO_4$ is formed in the reaction between Cl_2 and H_2O
(d) $HClO_4$ is more acidic than HClO because of the resonance stabilization of its anion. *(2017)*

19. Among the following, the correct statement(s) is(are)
(a) $Al(CH_3)_3$ has the three-centre two-electron bonds in its dimeric structure
(b) BH_3 has the three-centre two-electron bonds in its dimeric structure
(c) the Lewis acidity of BCl_3 is greater than that of $AlCl_3$
(d) $AlCl_3$ has the three-centre two-electron bonds in its dimeric structure. *(2017)*

Comprehension-2

For Q. No. 20 and 21 : Read the given comprehension carefully and answer the following questions.

Upon heating $KClO_3$ in the presence of catalytic amount of MnO_2, a gas *W* is formed. Excess amount of *W* reacts with white phosphorus to give *X*. The reaction of *X* with pure HNO_3 gives *Y* and *Z*.

20. *Y* and *Z* are, respectively
(a) N_2O_5 and HPO_3 (b) N_2O_3 and H_3PO_4
(c) N_2O_4 and H_3PO_3 (d) N_2O_4 and HPO_3

21. *W* and *X* are, respectively
(a) O_2 and P_4O_6 (b) O_2 and P_4O_{10}
(c) O_3 and P_4O_6 (d) O_3 and P_4O_{10} *(2017)*

22. The nitrogen containing compound produced in the reaction of HNO_3 with P_4O_{10}
(a) can also be prepared by reaction of P_4 and HNO_3
(b) is diamagnetic
(c) contains one N—N bond
(d) reacts with Na metal producing brown gas. *(2016)*

23. The increasing order of atomic radii of the following group 13 elements is
(a) Al < Ga < In < Tl (b) Ga < Al < In < Tl
(c) Al < In < Ga < Tl (d) Al < Ga < Tl < In *(2016)*

24. The crystalline form of borax has
(a) tetranuclear $[B_4O_5(OH)_4]^{2-}$ unit
(b) all boron atoms in the same plane
(c) equal number of sp^2 and sp^3 hybridized boron atoms
(d) one terminal hydroxide per boron atom. *(2016)*

Coordination Compounds

- **Valence bond theory :** According to this theory, the metal atom/ion makes available empty orbitals equal to its coordination number.
- **Magnetic properties :** Low spin complexes are generally diamagnetic and high spin complexes are paramagnetic.

  Paramagnetism ∝ No. of unpaired electrons

  Magnetic moment = $\sqrt{n(n+2)}$ B.M.

  where, *n* = number of unpaired electrons.
- **Crystal field theory :** For complexes in a ligand field, *d*-orbital occupancy depends on Δ_o and pairing energy, *P*.

  If $\Delta_o > P$ (*i.e.*, Δ_o large, strong field ligand) → electrons pair-up in lower energy *d*-subshell first → forms low spin complex.

  If $\Delta_o < P$ (*i.e.*, Δ_o small, weak field ligand) → electrons spread out among all *d*-orbitals before pairing up → forms high spin complex.

  $$\Delta_t = \frac{4}{9}\Delta_o$$

- **In octahedral complexes**

  Strong field ligand → High Δ_o value → Low spin complexes

  Weak field ligand → Low Δ_o value → High spin complexes

25. The correct statement(s) regarding the binary transition metal carbonyl compounds is (are)
(Atomic numbers : Fe = 26, Ni = 28)
(a) total number of valence shell electrons at metal centre in $Fe(CO)_5$ or $Ni(CO)_4$ is 16
(b) these are predominantly low spin in nature
(c) metal–carbon bond strengthens when the oxidation state of the metal is lowered
(d) the carbonyl C — O bond weakens when the oxidation state of the metal is increased.

(2018)

26. The correct option(s) regarding the complex $[Co(en)(NH_3)_3(H_2O)]^{3+}$ ($en = H_2NCH_2CH_2NH_2$) is (are)
(a) it has two geometrical isomers
(b) it will have three geometrical isomers if bidentate '*en*' is replaced by two cyanide ligands
(c) it is paramagnetic
(d) it absorbs light at longer wavelength as compared to $[Co(en)(NH_3)_4]^{3+}$.

(2018)

27. The ammonia prepared by treating ammonium sulphate with calcium hydroxide is completely used by $NiCl_2.6H_2O$ to form a stable coordination compound. Assume that both the reactions are 100% complete. If 1584 g of ammonium sulphate and 952 g of $NiCl_2.6H_2O$ are used in the preparation, the combined weight (in grams) of gypsum and the nickel-ammonia coordination compound thus produced is ____.
(Atomic weights in g mol^{-1}: H = 1, N = 14, O = 16, S = 32, Cl = 35.5, Ca = 40, Ni = 59)

(2018)

28. Match each set of hybrid orbitals from List-I with complex(es) given in List-II.

List-I		List-II	
P.	dsp^2	1.	$[FeF_6]^{4-}$
Q.	sp^3	2.	$[Ti(H_2O)_3Cl_3]$
R.	sp^3d^2	3.	$[Cr(NH_3)_6]^{3+}$
S.	d^2sp^3	4.	$[FeCl_4]^{2-}$
		5.	$Ni(CO)_4$
		6.	$[Ni(CN)_4]^{2-}$

The correct option is
(a) P → 5; Q → 4,6; R → 2, 3; S → 1
(b) P → 5,6; Q → 4; R → 3; S → 1, 2
(c) P → 6; Q → 4, 5; R → 1; S → 2,3
(d) P → 4, 6; Q → 5, 6; R → 1, 2; S → 3

(2018)

29. Among $[Ni(CO)_4]$, $[NiCl_4]^{2-}$, $[Co(NH_3)_4Cl_2]Cl$, $Na_3[CoF_6]$, Na_2O_2 and CsO_2, the total number of paramagnetic compounds is
(a) 2 (b) 3 (c) 4 (d) 5

(2016)

30. The geometries of the ammonia complexes of Ni^{2+}, Pt^{2+} and Zn^{2+}, respectively, are
(a) octahedral, square planar and tetrahedral
(b) square planar, octahedral and tetrahedral
(c) tetrahedral, square planar and octahedral
(d) octahedral, tetrahedral and square planar.

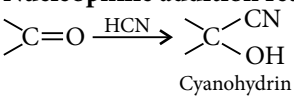
(2016)

31. The number of geometric isomers possible for the complex $[CoL_2Cl_2]^-$ ($L = H_2NCH_2CH_2O^-$) is _____.

(2016)

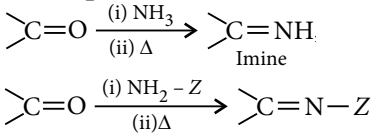
Aldehydes, Ketones, Carboxylic Acids and their Derivatives

- **Nucleophilic addition reactions :**



Cyanohydrin

- **Nucleophilic addition-elimination reactions :**

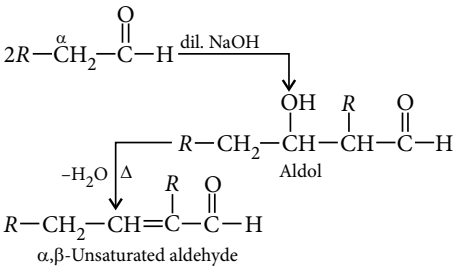


Imine

- **Haloform reaction :**

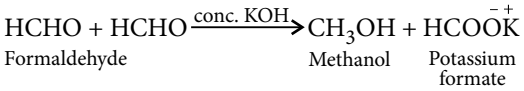
$$RCOCH_3 + 3NaOI \longrightarrow RCOONa + \underset{\text{Iodoform (yellow ppt.)}}{CHI_3\downarrow} + 2NaOH$$

- **Aldol condensation :**



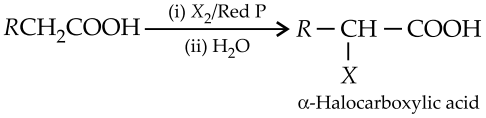
α,β-Unsaturated aldehyde

- **Cannizzaro reaction :**



(aldehydes which do not have an α-hydrogen atom)

- **Hell-Volhard-Zelinsky reaction :**

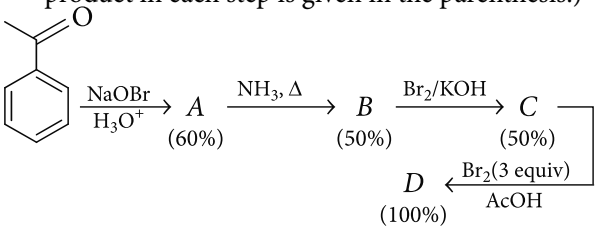


Distinction Tests (For aldehydes and ketones) :

- **Tollens' reagent :** Both aliphatic and aromatic aldehydes give silver mirror but ketones do not.
- **Fehling's solution :** Aliphatic aldehydes reduce Fehling's solution to give red ppt. of Cu_2O while aromatic aldehydes and ketones do not.
- **Schiff's reagent :** Aldehydes restores the pink colour while ketones do not give this test.
- **Iodoform test :** Methyl ketones give yellow ppt of iodoform on treatment with I_2/NaOH. Aldehydes (except acetaldehyde) do not give this test.

32. In the following reaction sequence, the amount of *D* (in g) formed from 10 moles of acetophenone is _____ .

(Atomic weights in g mol^{-1} : H = 1, C = 12, N = 14, O = 16, Br = 80. The yield (%) corresponding to the product in each step is given in the parenthesis.)



(2018)

Comprehension-3

For Q. No. 33 and 34 : Read the given comprehension carefully and answer the following questions.

Treatment of benzene with CO/HCl in the presence of anhydrous $AlCl_3$/CuCl followed by reaction with Ac_2O/NaOAc gives compound *X* as the major product. Compound *X* upon reaction with Br_2/Na_2CO_3, followed by heating at 473 K with moist KOH furnishes *Y* as the major product. Reaction of *X* with H_2/Pd-C, followed by H_3PO_4 treatment gives *Z* as the major product.

Scientist of the Month

Victor Grignard

(06 May 1871 – 13 December 1935)

Early Life and Education

François Auguste Victor Grignard was born in Cherbourg on May 6, 1871. He attended local schools during 1883-87 and in 1889 he won a scholarship to the École Normale Spécial at Cluny. He was unsuccessful in the licentiate examination in mathematics and in 1892 he left to fulfil his military service.

He obtained the degree Licencié-ès-Sciences Physiques and in 1898 he became chef des travaux pratiques and also wrote his first paper. In 1901 he submitted his brilliant thesis on organic magnesium compounds.

He was appointed Maître de Conférences, University of Besançon in 1905. In 1909 he took charge of the Department of Organic Chemistry at Nancy. In 1921 he took an additional post as Director of l'École de Chimie Industrielle de Lyons, becoming a member of the University Council, and in 1929 he became Dean of the Faculty of Sciences.

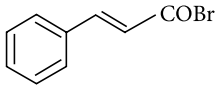
Research and Contributions

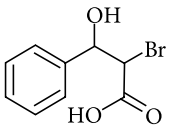
- Grignard's first investigations concerned "ethyl β-isopropylacetobutyrate and the stereoisomeric diisopropylbutenedicarboxylic acids" and studies of branched unsaturated hydrocarbons. In 1899, he studied organomagnesium compounds and his discovery of the classic preparation of magnesium alkyl halides was first communicated by Henri Moissanto the Académie des Sciences on May 11, 1900. He quickly developed the immediate applications of these elegant and simple reagents, which were destined to play such an important part in organic synthesis. He used the agents to prepare and study the more exotic alcohols, ketones, keto-esters, nitriles and terpene compounds and he developed a method for the synthesis of fulvenes.
- Grignard was the author of some 170 publications on his researches in the French language.
- He has also been concerned with work on the constitution of unsaturated compounds by quantitative ozonization, condensation of aldehydes and ketones, ketone splitting of tertiary alcohols, the cracking of hydrocarbons in presence of aluminium chloride and catalytic hydrogenation and dehydrogenation processes under reduced pressures.

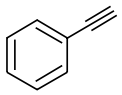
Awards and Honours

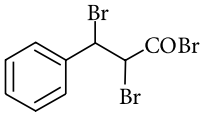
- Cahours Prize (1901)
- Berthelot Medal (1902)
- Prix Jecker Award (1905)
- Lavoisier Medal (1912)
- Nobel Prize for Chemistry (1912)
- He was appointed Chevalier (1912), Officier (1920) and Commandeur (1933).
- He was also Honorary Professor, University of Nancy (1931); he held the honorary doctorate of the Universities of Brussels and Louvain, and he was Honorary Fellow of the Chemical Society (London) and foreign member of the Royal Swedish Academy of Sciences.

33. The compound *Y* is

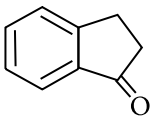
(a) 

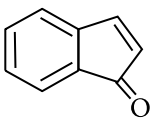
(b) 

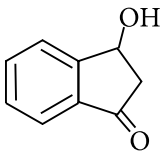
(c) 

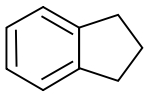
(d) 

34. The compound *Z* is

(a) 

(b) 

(c) 

(d) 

(2018)

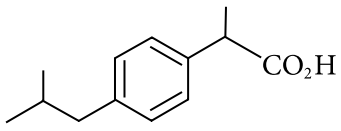
Comprehension-4

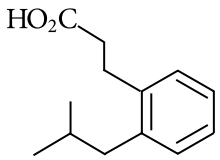
For Q. No. 35 and 36 : Read the given comprehension carefully and answer the following questions.

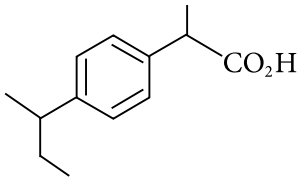
An organic acid $P(C_{11}H_{12}O_2)$ can easily be oxidized to a dibasic acid which reacts with ethylene glycol to produce a polymer dacron. Upon ozonolysis, *P* gives an aliphatic ketone as one of the products. *P* undergoes the following reaction sequences to furnish *R* via *Q*. The compound *P* also undergoes another set of reactions to produce *S*.

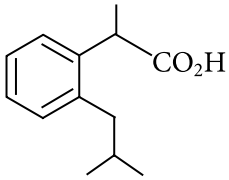
$$S \xleftarrow[4)\ CHCl_3,\ KOH,\ \Delta\\ 5)\ H_2/Pd\text{-}C]{1)\ H_2/Pd\text{-}C\\ 2)\ NH_3/\Delta\\ 3)\ Br_2/NaOH} P \xrightarrow[3)\ MeMgBr, CdCl_2\\ 4)\ NaBH_4]{1)\ H_2/Pd\text{-}C\\ 2)\ SOCl_2} Q \xrightarrow[3)\ CO_2\ (Dry\ ice)\\ 4)\ H_3O^+]{1)\ HCl\\ 2)\ Mg/Et_2O} R$$

35. The compound *R* is

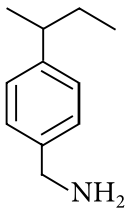
(a) 

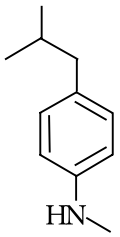
(b) 

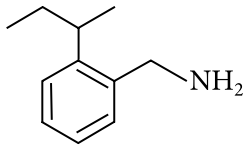
(c) 

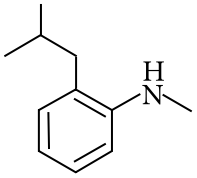
(d) 

36. The compound *S* is

(a) 

(b) 

(c) 

(d) 

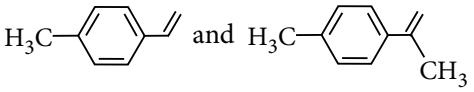
(2018)

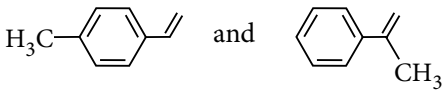
37. Compounds *P* and *R* upon ozonolysis produce *Q* and *S* respectively. The molecular formula of *Q* and *S* is C_8H_8O. *Q* undergoes Cannizzaro reaction but not haloform reaction, whereas *S* undergoes haloform reaction but not Cannizzaro reaction.

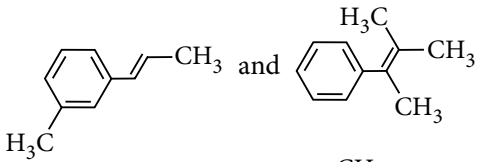
(i) $P \xrightarrow[ii)\ Zn/H_2O]{i)\ O_3/CH_2Cl_2} Q\ (C_8H_8O)$

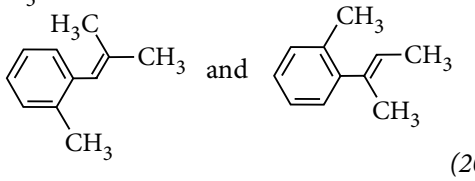
(ii) $R \xrightarrow[ii)\ Zn/H_2O]{i)\ O_3/CH_2Cl_2} S\ (C_8H_8O)$

The option(s) with suitable combination of *P* and *R*, respectively, is (are)

(a) 

(b) 

(c) 

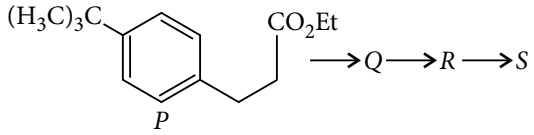
(d) 

(2017)

Comprehension-5

For Q.No. 38 and 39 : Read the given comprehension carefully and answer the following questions.

The reaction of compound *P* with CH_3MgBr (excess) in $(C_2H_5)_2O$ followed by addition of H_2O gives *Q*. The compound *Q* on treatment with H_2SO_4 at 0 °C gives *R*. The reaction of *R* with CH_3COCl in the presence of anhydrous $AlCl_3$ in CH_2Cl_2 followed by treatment with H_2O produces compound *S*. [Et in compound *P* is ethyl group]



38. The reactions, *Q* to *R* and *R* to *S*, are

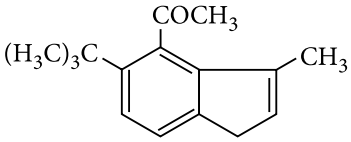
(a) Friedel–Crafts alkylation and Friedel–Crafts acylation

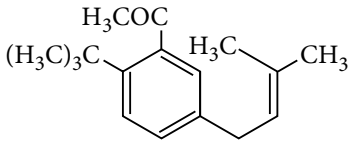
(b) dehydration and Friedel–Crafts acylation

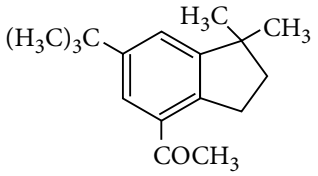
(c) Friedel–Crafts alkylation, dehydration and Friedel–Crafts acylation

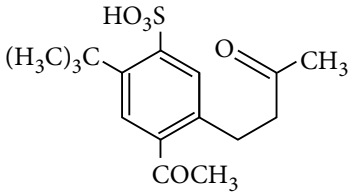
(d) aromatic sulphonation and Friedel–Crafts acylation.

39. The products *S* is

(a) 

(b) 

(c) 

(d) 

(2017)

Comprehension-6

Answer Q. 40, Q. 41 and Q. 42 by appropriately matching the information given in the three columns of the following table.

Columns 1, 2, and 3 contain starting materials, reaction conditions, and type of reactions, respectively.

Column 1	Column 2	Column 3
(I) Toluene	(i) $NaOH/ Br_2$	(P) Condensation
(II) Acetophenone	(ii) $Br_2/h\nu$	(Q) Carboxylation
(III) Benzaldehyde	(iii) $(CH_3CO)_2O/ CH_3COOK$	(R) Substitution
(IV) Phenol	(iv) $NaOH/ CO_2$	(S) Haloform

40. The only correct combination in which the reaction proceeds through radical mechanism is

(a) (II) (iii) (R) (b) (III) (ii) (P)

(c) (IV) (i) (Q) (d) (I) (ii) (R)

41. For the synthesis of benzoic acid, the only correct combination is

(a) (III) (iv) (R) (b) (IV) (ii) (P)

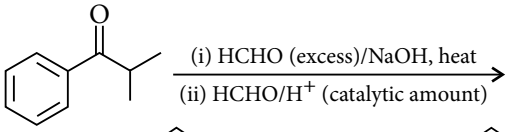
(c) (II) (i) (S) (d) (I) (iv) (Q)

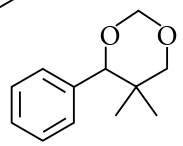
42. The only correct combination that gives two different carboxylic acids is

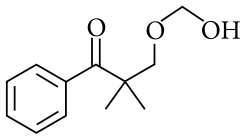
(a) (IV) (iii) (Q) (b) (I) (i) (S)

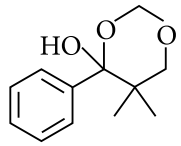
(c) (III) (iii) (P) (d) (II) (iv) (R) *(2017)*

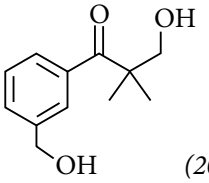
43. The major product of the following reaction sequence is



(a) 

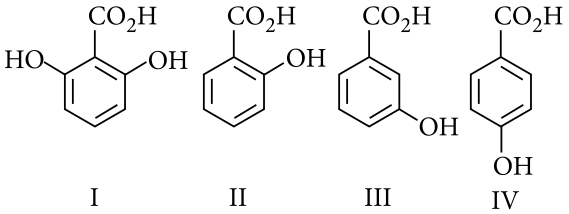
(b) 

(c) 

(d) 

(2016)

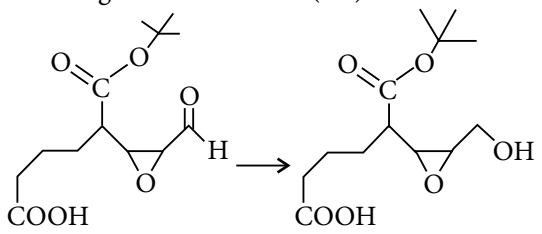
44. The correct order of acidity for the following compounds is



(a) I > II > III > IV (b) III > I > II > IV

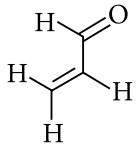
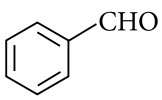
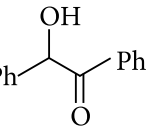
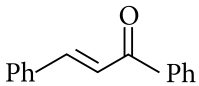
(c) III > IV > II > I (d) I > III > IV> II *(2016)*

45. Reagent(s) which can be used to bring about the following transformation is(are)



(a) $LiAlH_4$ in $(C_2H_5)_2O$
(b) BH_3 in THF
(c) $NaBH_4$ in C_2H_5OH
(d) Raney Ni/H_2 in THF. *(2016)*

46. Positive Tollens' test is observed for

(a) 
(b) 
(c) 
(d) 

(2016)

47. The correct statement(s) about the following reaction sequence is(are)

$$\text{Cumene}(C_9H_{12}) \xrightarrow[(ii)\ H_3O^+]{(i)\ O_2} P \xrightarrow[NaOH]{CHCl_3/} \underset{\text{(Major)}}{Q} + \underset{\text{(Minor)}}{R}$$

$$Q \xrightarrow[PhCH_2Br]{NaOH} S$$

(a) *R* is steam volatile
(b) *Q* gives dark violet colouration with 1% aqueous $FeCl_3$ solution
(c) *S* gives yellow precipitate with 2, 4-dinitro-phenylhydrazine
(d) *S* gives dark violet colouration with 1% aqueous $FeCl_3$ solution. *(2016)*

ANSWER KEY

1.	(b, c)	**2.**	(2.22)	**3.**	(–14.6)	**4.**	(c)	**5.**	(a,b,c)
6.	(c)	**7.**	(a, c)	**8.**	(4.47)	**9.**	(d)	**10.**	(a, b)
11.	(b)	**12.**	(c)	**13.**	(b, c)	**14.**	(a,b,c)		
15.	(5 or 6)	**16.**	(d)	**17.**	(b, c)	**18.**	(a,b,d)	**19.**	(a,b,c)
20.	(a)	**21.**	(b)	**22.**	(b, d)	**23.**	(b)	**24.**	(a,c,d)
25.	(b, c)	**26.**	(a,b,d)	**27.**	(2992)	**28.**	(c)	**29.**	(b)
30.	(a)	**31.**	(5)	**32.**	(495)	**33.**	(c)	**34.**	(a)
35.	(a)	**36.**	(b)	**37.**	(b, c)	**38.**	(a)	**39.**	(c)
40.	(d)	**41.**	(c)	**42.**	(c)	**43.**	(a)	**44.**	(a)
45.	(c)	**46.**	(a,b,c)	**47.**	(b, c)				

UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I		Column II
1. GINAL	(a)	It is a ferrite that is used for making permanent magnet.
2. GANADMUR	(b)	An iron alloy containing Si, Mn, Cr and C. It is an acid resistant alloy and used in chemical plants.
3. VOKAR	(c)	It is a red crystalline solid that is obtained by oxidation of indigotin with nitric acid.
4. RIRUNOD	(d)	A colloidal substance derived from brown see-weeds, produces a viscous solution with water, is used as stabilizer for food products.
5. GIDRISVER	(e)	It is used as a developer in photography. it consists of an alkaline solution of *para*-amino-phenol, $H_2NC_6H_4OH$ with sodium sulphite.
6. SAINIT	(f)	It is an alloy containing Co, Fe and Ni. It is used for glass to metal seals specially in thermionic valves and transistors.
7. RITDEVINTFIACOI	(g)	Its chemical formula is $LiAlSi_4O_{10}$ or $Li_2O \cdot Al_2O_3 \cdot 8SiO_2$; Aluminosilicates (2-4.5% Li_2O). It is used as a source of Li.
8. TALIPETE	(h)	It is the process of crystallization of glass which makes glass opaque.
9. NIDALOR	(i)	It refers to the green deposit that is formed on copper vessels and it consists of basic copper carbonates or chloride. It has variable composition.
10. HOMRSENDIA	(j)	Dye stuffs formed by Friedel-Crafts reactions wherein phthalic anhydride and aminophenol are used.

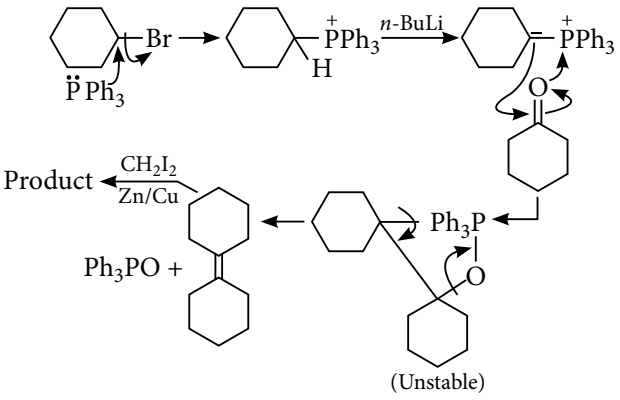
Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month.
Names of solution senders will be published in next issue.

CHEMISTRY MUSING

SOLUTION SET 69

1. **(b) :** The IUPAC name of $Cr(C_6H_6)_2$ is *bis* (η^6-benzene) chromium (II).

2. **(c) :**



3. **(a) :** Let α, β be degree of ionisation at same concentration.

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$
$$1-\alpha \qquad \alpha \qquad \alpha+\beta$$

$$C_2H_5COOH \rightleftharpoons C_2H_5COO^- + H^+$$
$$1-\beta \qquad \beta \qquad \alpha+\beta$$

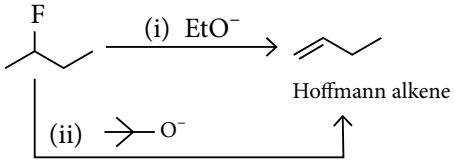
$$\therefore \quad K_{AA} = \frac{[\alpha][\alpha+\beta]}{[1-\alpha]}$$

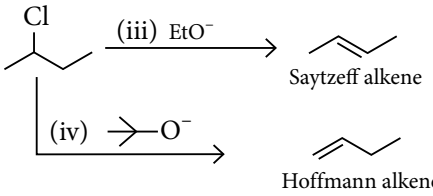
$$K_{PA} = \frac{[\beta][\alpha+\beta]}{[1-\beta]}$$

$$\therefore \quad \frac{K_{AA}}{K_{PA}} = \frac{\alpha}{1-\alpha} \times \frac{1-\beta}{\beta}$$

$$\text{or} \quad \frac{\alpha}{1-\alpha} = \frac{1.75}{1.3} \times \left[\frac{\beta}{1-\beta}\right]$$

4. **(b) :** Alkyl fluoride gives Hoffmann alkene (less substituted) whether base is bulky or non-bulky, whereas *RX* (*X* = Cl, Br, I) gives Saytzeff alkene (more substituted) if base is non-bulky and gives Hoffmann alkene if base is bulky.





5. **(c) :** Consider the equation,

$2Ag^+_{(aq)} + Cu_{(s)} \rightleftharpoons Cu^{2+}_{(aq)} + 2Ag_{(s)}$

At equilibrium: $[Cu^{2+}] = x$ M ; $[Ag^+] = y$ M

$$K_{eq} = K_c = \frac{[Cu^{2+}]}{[Ag^+]^2} = \frac{x}{y^2}$$

Now volume is doubled by adding water. As a result, the concentration of ions will become half and the system will no longer be in equilibrium. In order to check the direction of equilibrium, let us find the value of reaction quotient, *Q*.

$$Q = Q_c = \frac{[Cu^{2+}]}{[Ag^+]^2} = \frac{x/2}{(y/2)^2} = \frac{2x}{y^2}$$

$\Rightarrow \quad Q > K_{eq}$

This means that the system will move in backward direction in order to re-establish the equilibrium state.

$$\Rightarrow \quad [Ag^+]_{\text{at new eq.}} > \frac{y}{2} \text{ and } [Cu^{2+}]_{\text{at new eq.}} < \frac{x}{2}$$

6. **(a) :** Let V_1 mL of $NaNO_3$ is mixed with V_2 mL of $Ca(NO_3)_2$.

mM of $NaNO_3$ mixed = $0.2 \times V_1$

mM of $Ca(NO_3)_2$ mixed = $0.1 \times V_2$

$\because$ Mole ratio of $Ca^{2+} : NO_3^-$ in $Ca(NO_3)_2$ is 1 : 2

$\therefore$ Molarity of NO_3^- in mixture = $[NO_3^-]$ of $NaNO_3$ + $[NO_3^-]$ of $Ca(NO_3)_2$

$$= \frac{0.2 \times V_1}{(V_1+V_2)} + \frac{0.1 \times 2 \times V_2}{(V_1+V_2)} = \frac{(0.2\,V_1 + 0.2\,V_2)}{V_1+V_2}$$

Solution Senders of Unscrambled Words

- Devjit Acharjee, West Bengal
- Debashish Roy, Odisha

Solution Senders of Chemistry Musing

Set - 69

- Arjun Goenka, Uttar Pradesh
- Sonal Chatterji, Haryana

Similarly, molarity of cations *i.e.* Na^+ and Ca^{2+} in mixture

$$= \frac{0.2\times V_1}{V_1+V_2}+\frac{0.1\times V_2}{V_1+V_2} = \frac{(0.2\,V_1+0.1\,V_2)}{(V_1+V_2)}$$

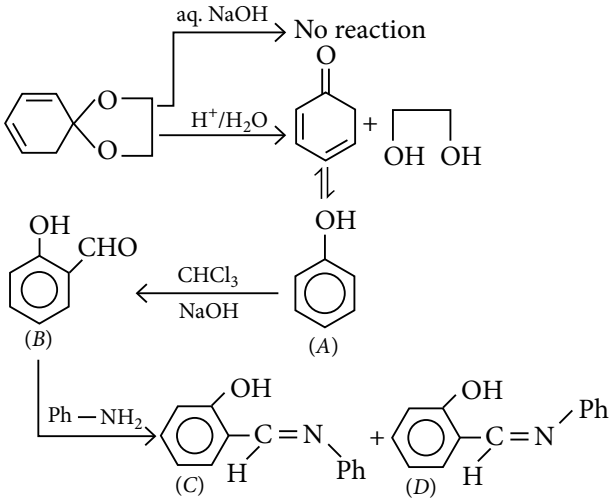
Given that,

$$\text{Molarity of } NO_3^- = \frac{3}{2} \text{ Molarity of } Na^+ \text{ and } Ca^{2+}$$

$$\therefore \quad \frac{0.2\,V_1+0.2\,V_2}{(V_1+V_2)} = \frac{3}{2}\left[\frac{(0.2\,V_1+0.1\,V_2)}{(V_1+V_2)}\right]$$

$$\therefore \quad \frac{V_1}{V_2} = \frac{1}{2}$$

7. (a) :



8. (b)

9. (6) : Acidified $K_2Cr_2O_7$, $CuSO_4$, H_2O_2, Cl_2, O_3 and $FeCl_3$ can oxidize iodide to iodine.

10. (282) : Both are first order reactions (unit of k being s^{-1})

Given that, $k_1 = k_2$

$$10^{13}\, e^{-152.3\ \text{kJmol}^{-1}/RT} = 10^{14}\, e^{-157.7\ \text{kJ mol}^{-1}/RT}$$

$$10 = e^{(157.7-152.3)\ \text{kJmol}^{-1}/RT}$$

$$\log_e 10 = \log_e e^{5.4\ \text{kJmol}^{-1}/RT}$$

$$2.303\log_{10} 10 = \frac{5.4\ \text{kJmol}^{-1}}{RT}$$

$$1 = \frac{5.4\ \text{kJ mol}^{-1}}{8.314\times10^{-3}\ \text{kJ mol}^{-1}\text{K}^{-1}\times 2.303\times T}$$

$$\therefore \quad T = \frac{5.4}{8.314\times10^{-3}\times 2.303} = 282\ \text{K}$$

☺☺

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1. What is the chemistry behind disappearing inks?

(Rajat Bhatnagar, Uttar Pradesh)

Ans. Disappearing ink is also known as *security ink*. Disappearing ink is a water based acid-base indicator (pH indicator) that changes from a coloured to colourless solution upon exposure to air. It is a mixture of thymolphthalein indicator, ethyl alcohol, sodium hydroxide, and water at pH 11. Thymolphthalein is a weak organic acid that behaves as an acid-base indicator in the pH range 9.3 (colourless) to 10.5 (blue). It exists in two different forms—an acid form HIn, which is colourless, and a corresponding conjugate base form In^-, which is blue.

$$\underset{\text{Colourless}}{HIn} \rightleftharpoons \underset{\text{Blue}}{H^+ + In^-}$$

The colour change is due to the changing proportion of the indicator molecules in the acid or base form. When the blue ink is applied to paper, the blue colour quickly vanishes. The disappearance of the blue ink colour in air is due to the effect of CO_2, which reacts with moisture in the air to form carbonic acid (H_2CO_3)—the pH change is enough to push the basic form of the indicator (In^-) back to its colourless acidic form (HIn).

$$CO_2 + H_2O \rightleftharpoons H_2CO_3$$

$$\underset{\text{Blue}}{H_2CO_3 + In^-} \longrightarrow HCO_3^- + \underset{\text{Colourless}}{HIn}$$

2. Why does ice melt faster in water than air?

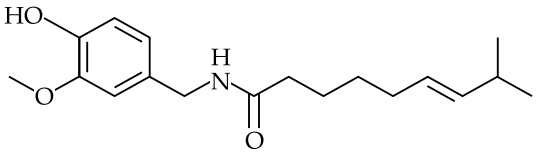
(Kiran Rastogi, Punjab)

Ans. Ice melts when heat energy causes the molecules to move faster, breaking the hydrogen bonds between molecules to form liquid water. In the melting process, the water molecules absorb energy. Water has higher thermal conductivity than air, hence when ice cubes are exposed to the water, lot of heat energy transferred from the surroundings than in air. This heat transfer causes the breakdown of H-bonds between H_2O molecules, and the solid (ice) turned into liquid (water). Hence, the ice melts faster in water than in air at the same temperature.

3. Which chemical is responsible for burning sensation that we get from chilli pepper sprays?

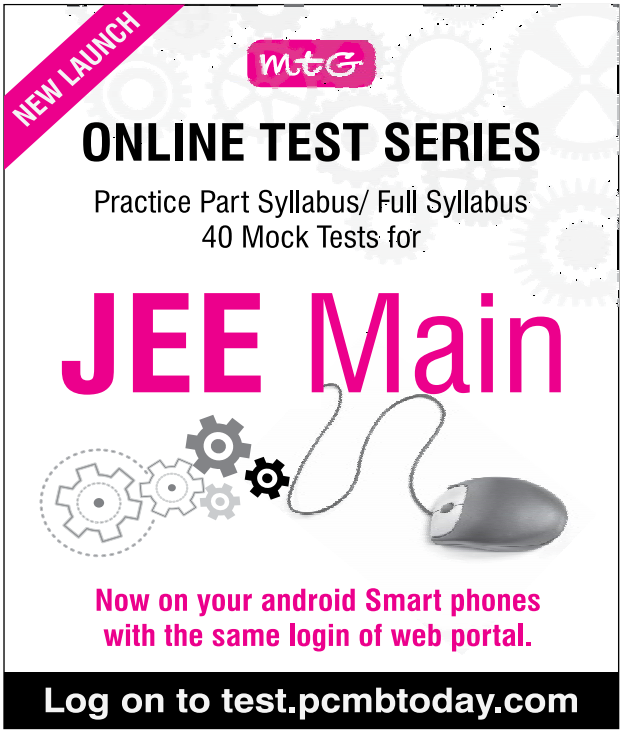
(V.S. Ramakrishnan, Kerala)

Ans. Chilli pepper spray is a lachrymatory agent, meaning that it stimulates the eyes to produce tears. An oil known as *oleoresin capsicum* is the main component of pepper spray. Capsaicin is an inflammatory agent in the oil. Capsaicin is the active ingredient of chilli pepper, having chemical name 8-methyl-*N*-vanillyl-6-nonenamide. It is colourless, odourless, highly pungent, crystalline to waxy and source of the hotness of pepper.



Capsaicin

It produces a burning sensation when it comes in contact with any tissue. Hence, now-a-days, it is used as pepper sprays, to ward off attacking muggers, dogs and bears.



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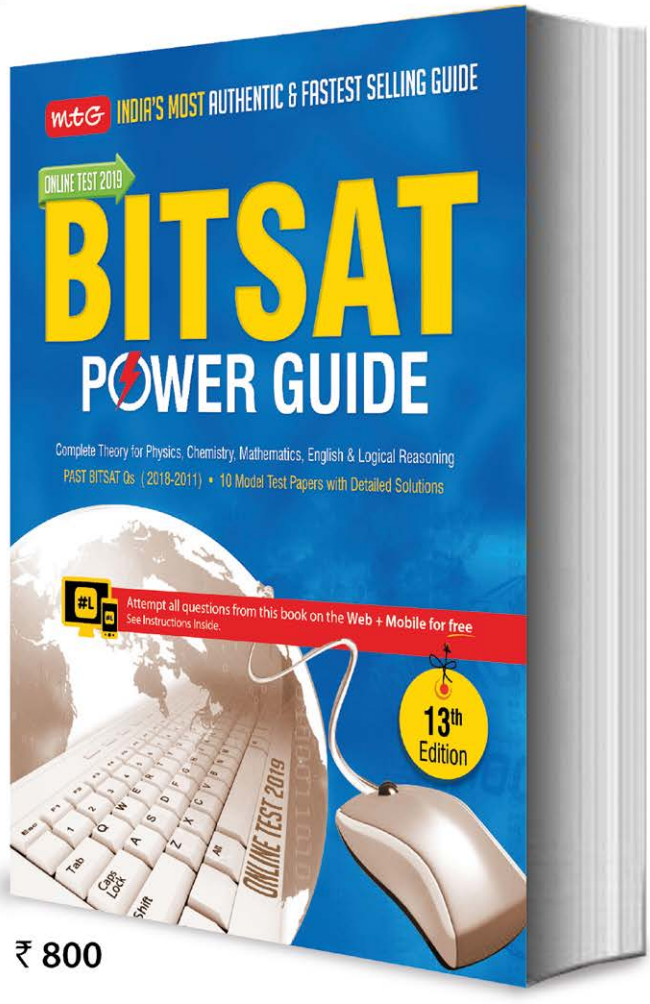

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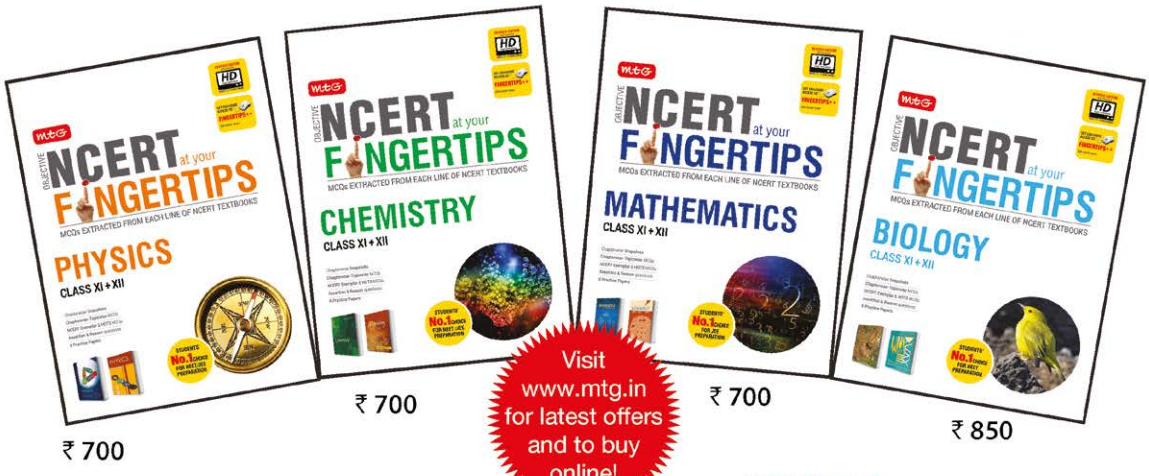

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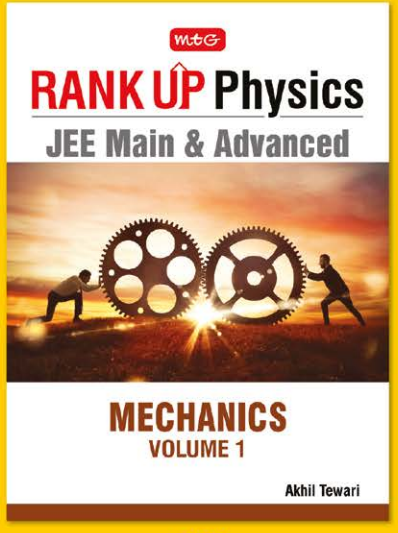

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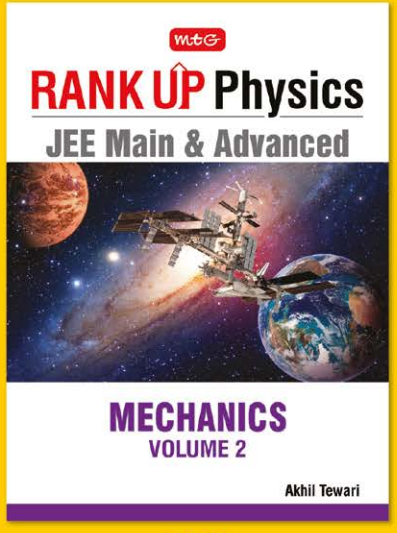

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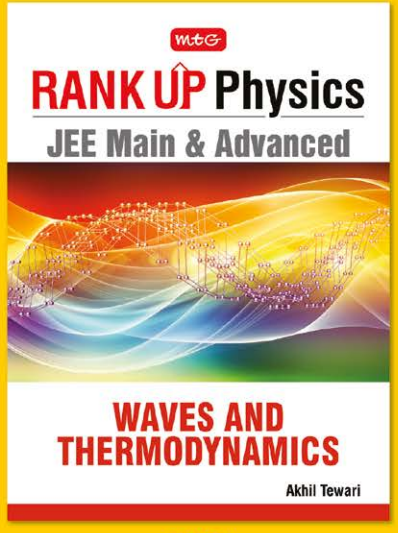

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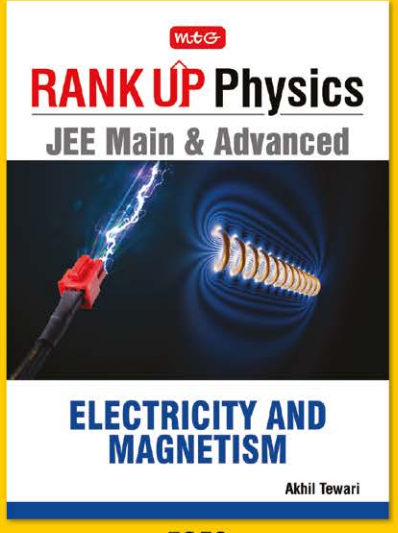

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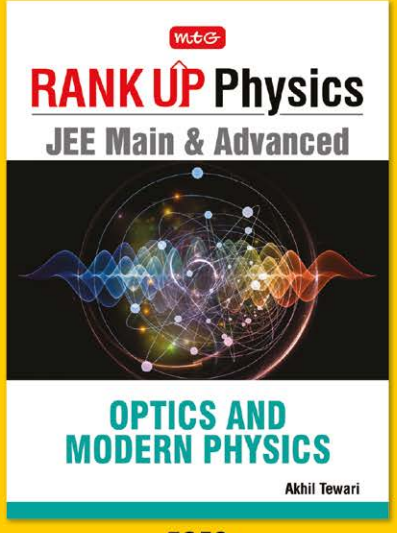

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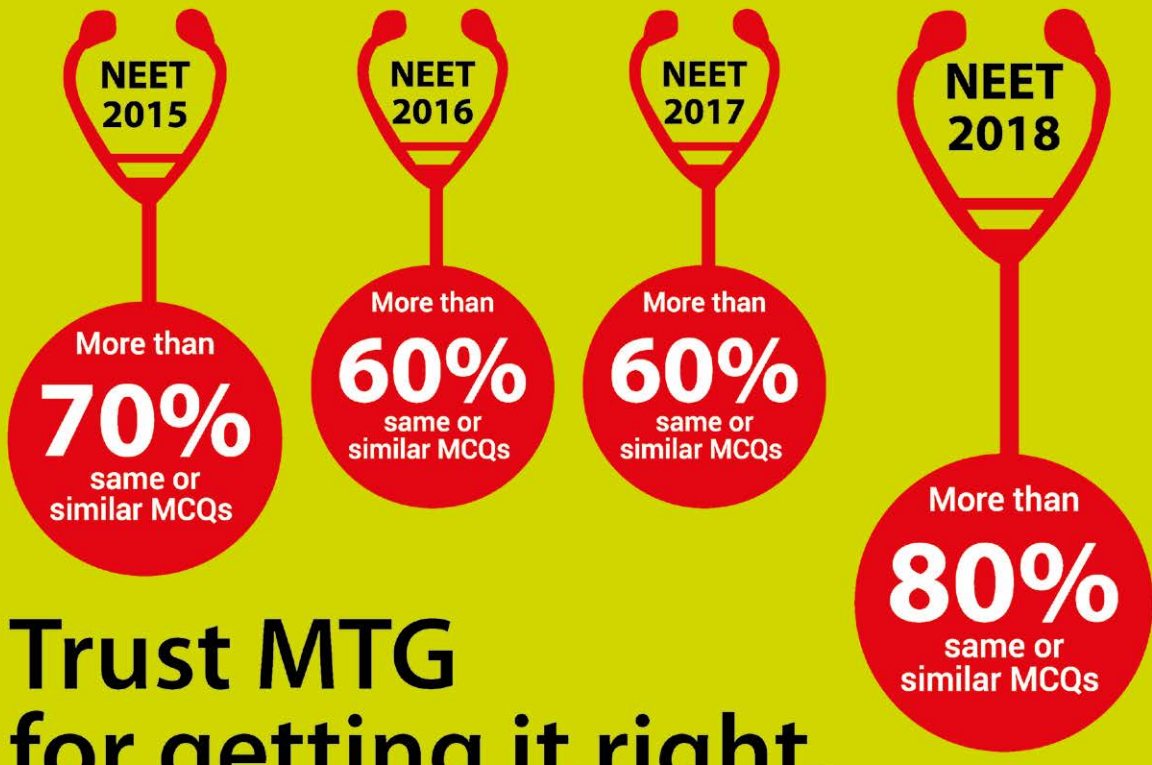

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