CHEMISTRY

31. The amount of arsenic pentasulphide that can be obtained when 35.5 g arsenic acid is treated with excess H_2S in the presence of conc. HCl (assuming 100% conversion) is :

    (1) 0.50 mol

    (2) 0.25 mol

    (3) 0.125 mol

    (4) 0.333 mol

32. At very high pressures, the compressibility factor of one mole of a gas is given by :

    (1) $\dfrac{pb}{RT}$

    (2) $1 + \dfrac{pb}{RT}$

    (3) $1 - \dfrac{pb}{RT}$

(4) $1 - \dfrac{b}{(VRT)}$

33. The total number of orbitals associated with the principal quantum number 5 is :

    (1) 5

    (2) 10

    (3) 20

    (4) 25

34. Which intermolecular force is most responsible in allowing xenon gas to liquefy ?

    (1) Dipole - dipole

    (2) Ion - dipole

    (3) Instantaneous dipole - induced dipole

    (4) Ionic

35. A reaction at 1 bar is non-spontaneous at low temperature but becomes spontaneous at high temperature. Identify the correct statement about the reaction among the following :

(1) Both ΔH and ΔS are negative.

(2) Both ΔH and ΔS are positive.

(3) ΔH is positive while ΔS is negative.

(4) ΔH is negative while ΔS is positive.

36. The solubility of N_2 in water at 300 K and 500 torr partial pressure is 0.01 g L^{-1}. The solubility (in g L^{-1}) at 750 torr partial pressure is :

(1) 0.0075

(2) 0.015

(3) 0.02

(4) 0.005

37. For the reaction, $A(g) + B(g) \rightarrow C(g) + D(g)$, ΔH and ΔS are, respectively, -29.8 kJ mol-1 and -0.100 kJ K-1 mol-1 at 298 K. The equilibrium constant for the reaction at 298 K is :

(1) 1.0×10^{-10}

(2) 1.0×10^{10}

(3) 10

(4) 1

38. What will occur if a block of copper metal is dropped into a beaker containing a solution of 1M $ZnSO_4$?
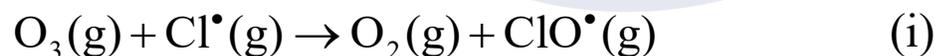
(1) The copper metal will dissolve and zinc metal will be deposited.

(2) The copper metal will dissolve with evolution of hydrogen gas.
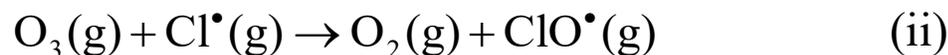
(3) The copper metal will dissolve with evolution of oxygen gas.

(4) No reaction will occur.

39. The reaction of ozone with oxygen atoms in the presence of chlorine atoms can occur by a two step process shown below :
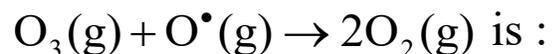
$$O_3(g) + Cl^\bullet(g) \rightarrow O_2(g) + ClO^\bullet(g) \qquad (i)$$

$$k_i = 5.2 \times 10^9 \text{ L mol}^{-1} \text{ s}^{-1}$$

$$O_3(g) + Cl^\bullet(g) \rightarrow O_2(g) + ClO^\bullet(g) \qquad (ii)$$

$$k_{ii} = 2.6 \times 10^{10} \text{ L mol}^{-1} \text{ s}^{-1}$$

The closest rate constant for the overall reaction

$$O_3(g) + O^\bullet(g) \rightarrow 2O_2(g) \text{ is :}$$

(1) $5.2 \times 10^9 \ L\,mol^{-1}s^{-1}$

(2) $2.6 \times 10^{10} \ L\,mol^{-1}s^{-1}$

(3) $3.1 \times 10^{10} \ L\,mol^{-1}s^{-1}$

(4) $1.4 \times 10^{20} \ L\,mol^{-1}s^{-1}$

40. A particular adsorption process has the following characteristics : (i) It arises due to van der Waals forces and (ii) it is reversible. Identify the correct statement that describes the above adsorption process :

(1) Enthalpy of adsorption is greater than 100 kJ mol^{-1}.

(2) Energy of activation is low.

(3) Adsorption is monolayer.

(4) Adsorption increases with increase in temperature.

41. The non-metal that does not exhibit positive oxidation state is :
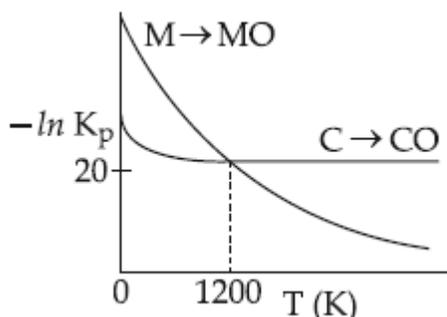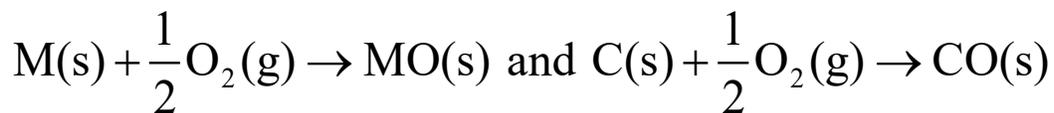
(1) Oxygen

(2) Iodine

(3) Chlorine

(4) Fluorine

42. The plot shows the variation of $-\ln K_p$ versus temperature for the two reactions.

$$M(s) + \frac{1}{2}O_2(g) \rightarrow MO(s) \text{ and } C(s) + \frac{1}{2}O_2(g) \rightarrow CO(s)$$

Identify the correct statement :

(1) At T >1200 K, carbon will reduce MO(s) to M(s).

(2) At T <1200 K, the reaction $MO(s) + C(s) \rightarrow M(s) + CO(g)$ is spontaneous.

(3) At T <1200 K, oxidation of carbon is unfavourable.

(4) Oxidation of carbon is favourable at all temperatures.

43. Identify the incorrect statement regarding heavy water :

(1) It reacts with Al_4C_3 to produce CD_4 and $Al(OD)_3$.

(2) It is used as a coolant in nuclear reactors.

(3) It reacts with CaC_2 to produce C_2D_2 and $Ca(OD)_2$.

(4) It reacts with SO_3 to form deuterated sulphuric acid (D_2SO_4).

44. The correct order of the solubility of alkaline-earth metal sulphates in water is :

(1) Mg < Ca < Sr < Ba

(2) Mg < Sr < Ca < Ba

(3) Mg > Sr > Ca > Ba

(4) Mg > Ca > Sr > Ba

45. Match the items in Column I with its main use listed in Column II :

Column I	Column II
(A) Silica gel	(i) Transistor
(B) Silicon	(ii) Ion-exchanger
(C) Silicone	(iii) Drying agent
(D) Silicate	(iv) Sealant

(1) (A)-(iii), (B)-(i), (C)-(iv), (D)-(ii)

(2) (A)-(iv), (B)-(i), (C)-(ii), (D)-(iii)

(3) (A)-(ii), (B)-(iv), (C)-(i), (D)-(iii)

(4) (A)-(ii), (B)-(i), (C) -(iv), (D)-(iii)

46. The group of molecules having identical shape is :

(1) SF_4 , XeF_4 , CCl_4

(2) ClF_3 , $XeOF_2$, XeF_3^+

(3) BF_3 , PCl_3 , XeO_3

(4) PCl_5 , IF_5 , XeO_2F_2

47. Which one of the following species is stable in aqueous solution?

(1) Cr^{2+}

(2) Cu^+

(3) MnO_4^{3-}

(4) MnO_4^{2-}

48. Which one of the following complexes will consume more equivalents of aqueous solution of $Ag(NO_3)$?

(1) $Na_3[CrCl_6]$

(2) $[Cr(H_2O)_5Cl]Cl_2$

(3) $[Cr(H_2O)_6]Cl_3$

(4) $Na_2[CrCl_5(H_2O)]$

49. Identify the correct trend given below :

(Atomic No.=Ti : 22, Cr : 24 and Mo : 42)

(1) Δo of $[Cr(H_2O)_6]^{2+}$ > $[Mo(H_2O)_6]^{2+}$ and Δo of $[Ti(H_2O)_6]^{3+}$ > $[Ti(H_2O)_6]^{2+}$

(2) Δo of $[Cr(H_2O)_6]^{2+}$ > $[Mo(H_2O)_6]^{2+}$ and Δo of $[Ti(H_2O)_6]^{3+}$ < $[Ti(H_2O)_6]^{2+}$

(3) Δo of $[Cr(H_2O)_6]^{2+}$ < $[Mo(H_2O)_6]^{2+}$ and Δo of $[Ti(H_2O)_6]^{3+}$ > $[Ti(H_2O)_6]^{2+}$

(4) Δo of $[Cr(H_2O)_6]^{2+}$ < $[Mo(H_2O)_6]^{2+}$ and Δo of $[Ti(H_2O)_6]^{3+}$ < $[Ti(H_2O)_6]^{2+}$

50. BOD stands for :

(1) Biological Oxygen Demand

(2) Bacterial Oxidation Demand

(3) Biochemical Oxygen Demand

(4) Biochemical Oxidation Demand

51. An organic compound contains C, H and S. The minimum molecular weight of the compound containing 8% sulphur is : (atomic weight of S=32 amu)

(1) 200 g mol^{-1}

(2) 400 g mol^{-1}

(3) 600 g mol^{-1}

(4) 300 g mol^{-1}

52. The hydrocarbon with seven carbon atoms containing a neopentyl and a vinyl group is :

(1) 2, 2-dimethyl-4-pentene

(2) Isopropyl-2-butene

(3) 4, 4-dimethylpentene

(4) 2, 2-dimethyl-3-pentene

53. 5 L of an alkane requires 25 L of oxygen for its complete combustion. If all volumes are measured at constant temperature and pressure, the alkane is :

(1) Ethane

(2) Propane

(3) Butane

(4) Isobutane

54. The gas evolved on heating CH3MgBr in methanol is :

(1) HBr

(2) Methane

(3) Ethane

(4) Propane

55. Bouveault-Blanc reduction reaction involves :

(1) Reduction of an acyl halide with H_2/Pd.

(2) Reduction of an ester with Na/C_2H_5OH.

(3) Reduction of a carbonyl compound with Na/Hg and HCl.

(4) Reduction of an anhydride with $LiAlH_4$.

56. The test to distinguish primary, secondary and tertiary amines is:

(1) Carbylamine reaction

(2) $C_6H_5SO_2Cl$

(3) Sandmeyer's reaction

(4) Mustard oil test

57. Assertion : Rayon is a semisynthetic polymer whose properties are better than natural cotton.

Reason : Mechanical and aesthetic properties of cellulose can be improved by acetylation.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion.

(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion.

(3) Assertion is incorrect statement, but the reason is correct.

(4) Both assertion and reason are incorrect.

58. Consider the following sequence for aspartic acid :
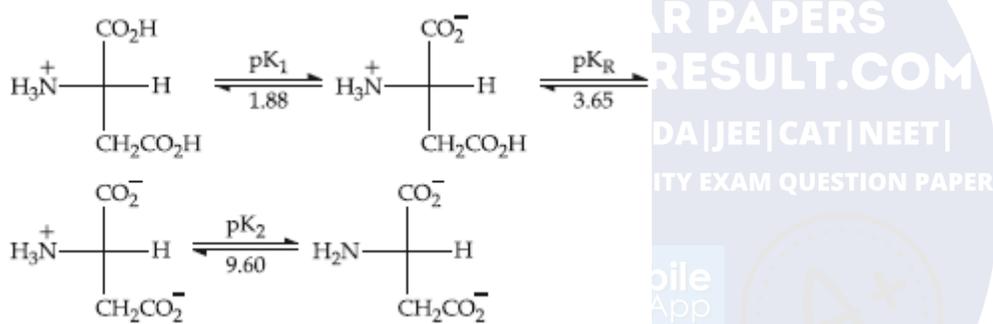
The *pI* (isoelectric point) of aspartic acid is :

(1) 1.88

(2) 3.65

(3) 5.74

(4) 2.77

59. The artificial sweetener that has the highest sweetness value in comparison to cane sugar is :

(1) Aspartane

(2) Saccharin

(3) Sucralose

(4) Alitame

60. The most appropriate method of making egg-albumin sol is :

(1) Break an egg carefully and transfer the transparent part of the content to 100 mL of 5% w/V saline solution and stir well.

(2) Break an egg carefully and transfer only the yellow part of the content to 100 mL of 5% w/V saline solution and stir well.

(3) Keep the egg in boiling water for 10 minutes. After removing the shell, transfer the white part of the content to 100 mL of 5% w/V saline solution and homogenize with a mechanical shaker.

PART-2

31. The reaction of arsenic acid with excess of H_2S in the presence of HCl is given by the following reaction.

$$2H_3AsO_4 + 5H_2S \xrightarrow{\text{Conc. HCl}} As_2S_5 + 8H_2O$$

Two moles of arsenic acid forms one mole of arsenic pentasulphide.

Therefore, one moles of arsenic acid forms half mole of arsenic pentasulphide.

1 mole of arsenic acid $\rightarrow 1/2$ mole of arsenic pentasulphide

The molar mass of H_3AsO_4 is 142 g/mol.

Calculate the total number of moles of H_3AsO_4,

$$\frac{35.5}{142} = 0.25 \,\text{mol}.$$

Calculate the total number of moles of As_2S_5,

$$\frac{0.25}{2} = 0.125 \,\text{mol}$$

32. The van der Waals equation for one mole of gas is given by,

$$\left(p + \frac{a}{V^2}\right)(V - b) = RT$$

At very high pressure,

$$p > \frac{a}{V^2}$$

Thus,

$$p(V - b) = RT$$
$$pV - pb = RT$$
$$pV = RT + pb$$

On division by RT on both the sides, the above equation becomes,

$$Z\,(\text{compressibility factor}) = 1 + \frac{pb}{RT}$$

33. The total number of orbitals associated with principal quantum number $n = 5$ is given by the relation,

$$n^2 = (5)^2$$
$$= 25$$

34. London dispersion force is the instantaneous dipole induced dipole force. It is responsible for allowing xenon gas to liquefy.

35. If the value of ΔH is greater than 0 and ΔS is greater than 0 , only then the reaction is feasible at high temperature and non-feasible at low temperature.

36. The expression to calculate the partial pressure is given by,

$$\text{Partial pressure}(p) = \text{mole fraction} \times \text{solubility}(s)$$

If the solubility of N_2 at $750\,\text{torr}$ is x,

Therefore,

$$\frac{p_1}{s_1} = \frac{p_2}{s_2}$$

$$\frac{500}{0.01} = \frac{750}{x}$$

$$x = 0.015\,\text{g/L}$$

37. The expression to calculate the gibbs free energy is given by,

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$\Delta G^\circ = -29.8\,\text{kJ/mol} + (0.1 \times 298\,\text{kJ/mol})$$

$$= 0$$

The equilibrium constant is calculated by the equation,

$$\Delta G^{\circ} = -2.303\,RT\log K$$
$$0 = -2.303\,RT\log K$$
$$\log K = 0$$
$$K = 1$$

38. No reaction will take place if a block of copper metal is dropped into a beaker containing a solution of $1\text{M}\,ZnSO_4$ because $E^{\circ}_{Zn^{2+}/Zn} = -0.76\,V$ and $E^{\circ}_{Cu^{2+}/Cu} = +0.34\,V$. Therefore, copper is not able to displace zinc from $1\text{M}\,ZnSO_4$ solution.

39. The following reaction is formed by the addition of equation (i) and (ii).
$$O_3(g) + O^{\bullet}(g) \rightarrow 2O_2(g)$$
Calculate the overall value of rate constant,
$$K_{overall} = k_i \times k_{ii}$$
$$= 5.2 \times 10^9 \times 2.6 \times 10^{10}$$
$$= 1.325 \times 10^{20}$$
$$\simeq 1.4 \times 10^{20}\,\text{L}\,\text{mol}^{-1}\text{s}^{-1}$$

40. Physisorption is a adsorption process which is reversible and occurs due to Vander walls forces. The enthalpy of physisorption is always low. Physisorption decreases with increase in temperature as shown in the figure below.
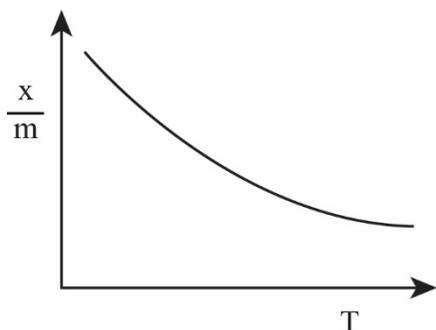
Thus, the energy of activation is low for physisorption.

41. Fluorine is a non-metal that does not exhibit positive oxidation state as it is the most electronegative element of the periodic table. Therefore, it always exhibits -1 oxidation state in all of its compounds.

42. The diagram that is given by Ellingham is shown below.
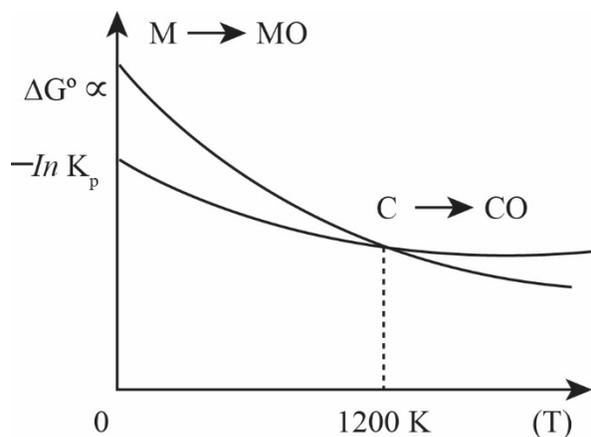
It is clearly seen in the graph that at $T < 1200$, carbon will reduce $MO(s)$ to $M(s)$

Thus, the reaction $C(s) + MO(s) \rightarrow M(s) + CO(g)$ is spontaneous.

43. Heavy water is represented by D_2O. It acts as a moderator and slows down the speed of neutrons in the nuclear reactor. It cannot act as coolant. Therefore, the statement that heavy water is used as coolant in nuclear reactor is not true.

44. The size of the atom increases and hydration enthalpy decreases down the group. Therefore the solubility of alkaline earth metals decreases down the group. Thus the correct solubity order is,

$Mg > Ca > Sr > Ba$
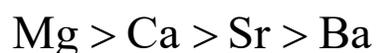
45. Silica gel is used as a drying agent. Silicon has its usage .in transistors. Silicone is a sealant and silicates are used as zeolites in ion exchangers.

46. The group of molecules that have identical shape are $ClF_3, XeOF_2, XeF_3^+$. The structure of the molecules is shown below.
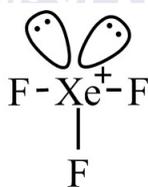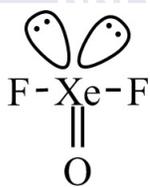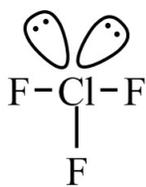
All the three molecules have sp^3d hybridisation with two lone pairs of electrons. Thus, they all have T-shaped structure.

47. MnO_4^{2-} undergoes disproportionation in neutral and acidic solutions, therefore it is stable in aqueous solution. The reaction of disproportionation is shown below.

$$3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^{2-} + MnO_2 + 2H_2O$$

Manganese is present in +6 oxidation state and is highly stable.

48. more equivalents of aqueous solution of $Ag(NO_3)$ will be consumed by a complex that gives higher number of chlorine ions in the solution. Therefore, the complex that will consume more equivalent of aqueous solution of $Ag(NO_3)$ is $\left[Cr(H_2O)_6\right]Cl_3$.
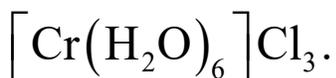
49. As, $\Delta_\circ$ is directly proportional to crystal field stabilization energy (CFSE). Thus, $\Delta_\circ$ of $\left[Cr(H_2O)_6\right]^{2+} < \Delta_\circ$ of $\left[Mo(H_2O)_6\right]^{2+}$ because in this case $\Delta_\circ$ is dependent upon the Z_{eff}. In this case Z_{eff} of $4d$ series is greater than $3d$ series.

The stability of the complex is inversely proportional to the size of the cations. Thus,

$\Delta_\circ$ of $\left[Ti(H_2O)_6\right]^{3+} < \Delta_\circ$ of $\left[Ti(H_2O)_6\right]^{2+}$

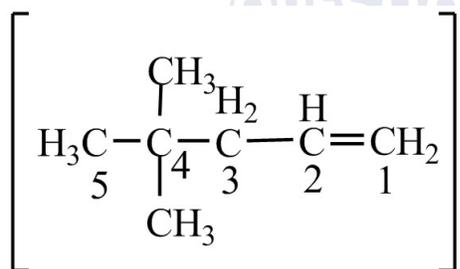50. Biochemical Oxygen demand is the full form of BOD.

51. The percentage of sulfur in the organic compound is 8% that is $8g$ of sulfur is present in $100\,g$ of the compound.

If $8\,g$ of sulfur is present in $100\,g$ of compound, then,

$32\,g$ of sulfur is present in $= \dfrac{100}{8} \times 32$

$= 400\,g$ of organic compound.

Thus, the molecular weight of the compound is $400\,g/mol$.

52. The compound that contains 7 carbon atoms possessing a neopentyl and a vinyl group is $4,4-$dimethylpentene as shown below.

$$
\begin{bmatrix}
\overset{\displaystyle CH_3}{\underset{\displaystyle CH_3}{H_3C - \underset{5}{C} \underset{4}{|} }} \overset{\displaystyle H_2}{\underset{3}{C}} - \overset{\displaystyle H}{\underset{2}{C}} = \underset{1}{CH_2}
\end{bmatrix}
$$

53. The common reaction for the combustion of an alkane is shown as follows.

$$C_nH_{2n+2} + \left(\dfrac{3n+1}{2}\right)O_2 \rightarrow nCO_2 + (n+1)H_2O$$

$\quad\;\; 5\,L \qquad\qquad 25\,L$
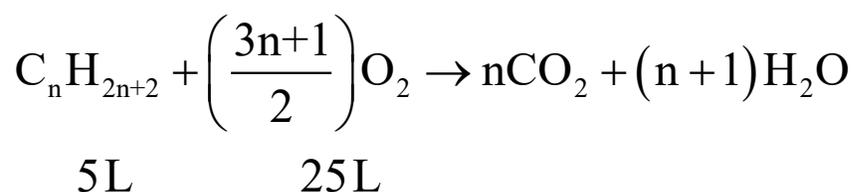
As, the volume is always calculated at constant temperature and pressure, thus

volume $\propto$ mole.

Calculate the number of moles.

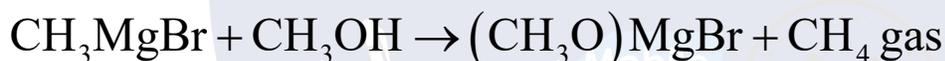$$n_{alkane} = \left(\frac{2}{3n + 1} \right) \times n_{O_2}$$

$$5 = \left(\frac{2}{3n + 1} \right) \times 25$$

$$n = 3$$

Hence, $n = 3$ that satisfies by propane with molecular formula C_3H_8.

54. Methane is evolved on heating CH_3MgBr which is shown by a reaction below.

$$CH_3MgBr + CH_3OH \rightarrow (CH_3O)MgBr + CH_4 \text{ gas}$$

55. The reduction of an ester by using sodium dissolved in ethyl alcohol is illustrated by the Bouveault-Blanc reduction reaction.

56. The compound which is used to distinguish between the primary, secondary and tertiary amines is benzene sulphonyl chloride, $C_6H_5SO_2Cl$. This reaction is known as Hinsberg reaction. In this reaction, primary amines forms water soluble

sulfonamide salt whereas tertiary amines form water soluble sulfonate salts on reaction with $C_6H_5SO_2Cl$.

57. rayon is prepared by the acetylation of cellulose. Therefore, both assertion and reason are correct, and reason is the correct explanation of the assertion.

58. For the give sequence for aspartic acid, the isoelectric point (PI) of aspartic acid is calculated as follows.

$$PI = \frac{pK_1 + pK_2}{2}$$
$$= \frac{1.88 + 3.65}{2}$$
$$= 2.77$$

59. . Alitame is approximately two thousand times sweeter than sucrose (artificial sweetner as well). It is a artificial sweetner that has the highest sweetness value in comparison to cane sugar.

60. The most appropriate method of making an egg-albumin sol is breaking an egg and transferring its transparent part to $100\,mL$

of 5%w/V saline solution. After that, stir well the solution. This method is only done with the transparent part of the egg because only its transparent part contains albumin.
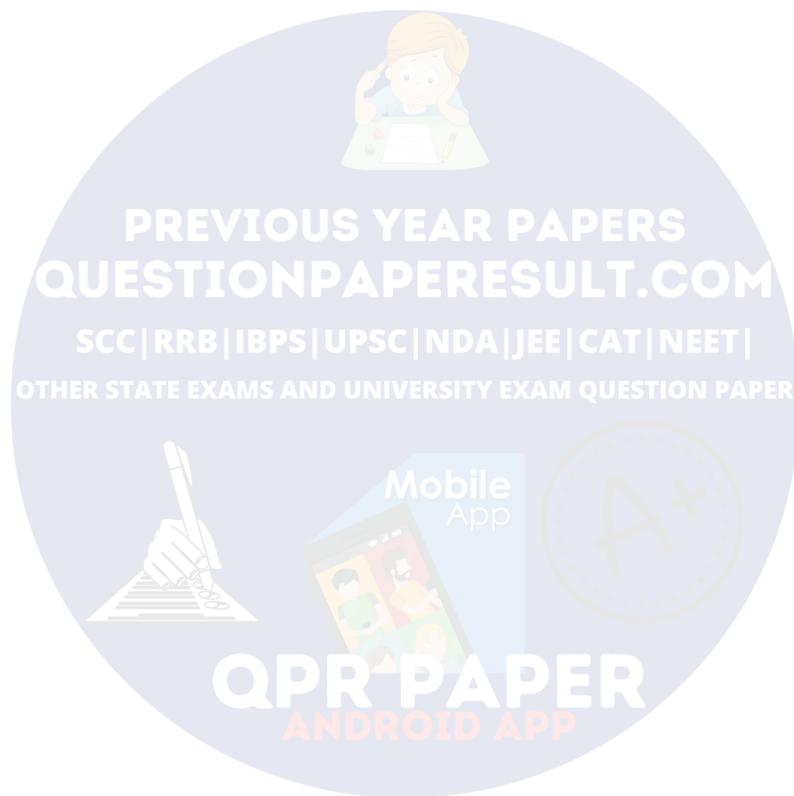
IIT JEE Mains 2016 9th April 2016
<u>Answer Key</u>

1	3	19	*	37	4	55	2	73	3
2	2	20	2	38	4	56	2	74	2
3	1	21	3	39	4	57	1	75	3
4	2	22	3	40	2	58	4	76	2
5	1	23	2	41	4	59	4	77	4
6	3	24	3	42	3	60	1	78	3
7	3	25	1	43	2	61	2	79	3
8	3	26	2	44	4	62	2	80	2
9	4	27	2	45	1	63	4	81	2
10	1	28	1	46	2	64	4	82	4
11	3	29	3	47	4	65	3	83	3
12	1	30	1	48	3	66	1	84	1
13	2	31	3	49	4	67	1	85	1
14	2	32	2	50	3	68	4	86	1
15	1	33	4	51	2	69	2	87	2
16	1	34	3	52	3	70	2	88	4
17	2	35	2	53	2	71	3	89	2
18	3	36	2	54	2	72	1	90	3