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NATIONAL LEVEL SCIENCE TALENT SEARCH EXAMINATION

CLASS - 12 (PCM)
Question Paper Code : UN497

KEY

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11. A	12. C	13. C	14. B	15. A	16. A	17. A	18. D	19. D	20. D
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SOLUTIONS

MATHEMATICS

01. (B) $\Delta = xyz\,(a^3 + b^3 + c^3) - abc\,(x^3 + y^3 + z^3)$

but $a + b + c = 0 \Rightarrow a^3 + b^3 + c^3 = 3abc$

Similarly, $x^3 + y^3 + z^3 = 3xyz$

Thus, $\Delta = xyz\,(3abc) - abc\,(3xyz) = 0$

02. (D) The function f is clearly continuous at each point in its domain except possibly at $x = 0$, as x, $\sin^{-1}x$ and $\tan^{-1}x$ are continuous functions near "0". So f to be continuous at $x = 0$, we have

$$f(0) = \underset{x\to 0}{\text{Lt}}\ f(x)$$

$$= \underset{x\to 0}{\text{Lt}}\ \frac{2x - \sin^{-1}x}{2x + \tan^{-1}x} = \frac{1}{3}$$

03. (A) The given system has a unique solution if

$$\begin{vmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 2 & 5 & \lambda \end{vmatrix} \neq 0 \Rightarrow \lambda \neq 8$$

04. (C) $2ax + x^2 = (x + a)^2 - a^2$

Put $x + a = a\sec\theta$, so that $dx = a\sec\theta\tan\theta\,d\theta$

$$\therefore\quad I = \int \frac{a\sec\theta\tan\theta}{a^3\tan^3\theta}.d\theta$$

$$= \frac{1}{a^2}\int \frac{\cos\theta}{\sin^2\theta}.d\theta = \frac{-1}{a^2\sin\theta} + C$$

$$= \frac{-1}{a^2}\frac{\sec\theta}{\tan\theta} + C$$

$$= \frac{-1}{a^2}\frac{x + a}{\sqrt{2ax + x^2}} + C$$

05. (A) $\left(\frac{d^2y}{dx^2}\right)^{\frac{3}{2}} = \left(\frac{dy}{dx}\right)^{\frac{1}{2}} + 4$

Squaring on both sides,

$$\left(\frac{d^2y}{dx^2}\right)^3 = \frac{dy}{dx} + 16 + 8\left(\frac{dy}{dx}\right)^{\frac{1}{2}}$$

$$\Rightarrow \left[\left(\frac{d^2y}{dx^2}\right)^3 - \frac{dy}{dx} - 16\right] = 8\left(\frac{dy}{dx}\right)^{\frac{1}{2}}$$

Again squaring on both sides

$$\left[\left(\frac{d^2y}{dx^2}\right)^3 - \frac{dy}{dx} - 16\right]^2 = 64\frac{dy}{dx}$$

$\therefore$ Degree = 6

06. (B) $\sin nx - \sin(n-2)x = 2\cos(n-1)x.\sin x$

$\Rightarrow$ $\sin nx = \sin(n-2)x + 2\cos(n-1)x.\sin x$

$$\Rightarrow \frac{\sin nx}{\sin x} = \frac{\sin(n-2)x}{\sin x} + 2\cos(n-1)x$$

$$I_n = \int \frac{\sin nx}{\sin x}.dx = \int \frac{\sin(n-2)x}{\sin x}dx + 2\int \cos(n-1)x.dx$$

$$= I_{n-2} + \frac{2}{n-1}\sin(n-1)x$$

$$\Rightarrow I_n - I_{n-2} = \frac{2}{n-1}\sin(n-1)x$$

07. (A) $xA + B = \begin{vmatrix} x^3 + x & x + 1 & x - 2 \\ 2x^3 + 3x - 1 & 3x & 3x - 3 \\ x^3 + 2x + 3 & 2x - 1 & 2x - 1 \end{vmatrix}$

$$R_2 - R_1 - R_3 = \begin{vmatrix} x^3 + x & x + 1 & x - 2 \\ -4 & 0 & 0 \\ x^3 + 2x + 3 & 2x - 1 & 2x - 1 \end{vmatrix}$$

$$R_1 + \frac{1}{4}x^3R_2 \;\; R_3 + \frac{1}{4}x^3R_2 = \begin{vmatrix} x & x + 1 & x - 2 \\ -4 & 0 & 0 \\ 2x + 2x + 3 & 2x - 1 & 2x - 1 \end{vmatrix}$$

$$R_3 - 2R_1 = \begin{vmatrix} x & x + 1 & x - 2 \\ -4 & 0 & 0 \\ 3 & -3 & 3 \end{vmatrix}$$

$$= \begin{vmatrix} x & x & x \\ -4 & 0 & 0 \\ 3 & -3 & 3 \end{vmatrix} + \begin{vmatrix} 0 & 1 & -2 \\ -4 & 0 & 0 \\ 3 & -3 & 3 \end{vmatrix}$$

$$= x\begin{vmatrix} 1 & 1 & 1 \\ -4 & 0 & 0 \\ 3 & -3 & 3 \end{vmatrix} + \begin{vmatrix} 0 & 1 & -2 \\ -4 & 0 & 0 \\ 3 & -3 & 3 \end{vmatrix}$$

08. (A) $I = \int \frac{4e^x + 6e^{-x}}{9e^x - 4e^{-x}}dx = \int \frac{4e^{2x} + 6}{9e^{2x} - 4}dx$

Put

$e^{2x} = y \Rightarrow 2e^{2x}dx = dy \Rightarrow dx = dy/2y$

$$I = \int \frac{4y + 6}{9y - 4}\frac{dy}{2y} = \int \frac{2y + 3}{y(9y - 4)}dy \int\left[\frac{35}{4(9y - 4)} - \frac{3}{4y}\right]dy$$

$$= \frac{35}{36}\log|9y - 4| - \frac{3}{4}\log|y| + c$$

$$= \frac{35}{36}\log|9e^{2x} - 4| - \frac{3}{4}\log e^{2x} + c$$

$$= \frac{35}{36}\log\left(9e^{2x} - 4\right) - \frac{3}{2}x + c$$

$\therefore$ $A = -3/2$

09. (C) Let $\tan^{-1}\frac{1}{3} = \alpha$ and $\tan^{-1}2\sqrt{2} = \beta$

Then $\tan\alpha = \frac{1}{3}$ and $\tan\beta = 2\sqrt{2}$, so that

$\sin(2\tan^{-1}\frac{1}{3}) + \cos(\tan^{-1}2\sqrt{2})$

$= \sin 2\alpha + \cos\beta$

$$= \frac{2\tan\alpha}{1 + \tan^2\alpha} + \frac{1}{\sqrt{1 + \tan^2\beta}}$$

$$= \frac{2\left(\frac{1}{3}\right)}{1 + \frac{1}{9}} + \frac{1}{\sqrt{1 + 8}} = \frac{3}{5} + \frac{1}{3} = \frac{14}{15}$$

10. (A) $\int_{\sqrt{2}}^{x} \frac{dt}{t\sqrt{t^2-1}} = \frac{\pi}{2}$

$\Rightarrow \left[\sec^{-1}t\right]_{\sqrt{2}}^{x} = \frac{\pi}{2}$

$\Rightarrow \sec^{-1}x - \frac{\pi}{4} = \frac{\pi}{2}$

$\Rightarrow \sec^{-1}x = \frac{3\pi}{4}$

$\Rightarrow x = \sec\frac{3\pi}{4} = -\sqrt{2}$

11. (A) $(\vec{a}+\vec{b})\times(\vec{a}\times\vec{b}) = \left[(\vec{a}+\vec{b}).\vec{b}\right]\vec{a} - \left[(\vec{a}+\vec{b}).\vec{a}\right]\vec{b}$

$= (\vec{a}.\vec{b})\vec{a} + (\vec{b}.\vec{b})\vec{a} - (\vec{a}.\vec{a})\vec{b} - (\vec{b}.\vec{a})\vec{b}$

$= (\vec{a}.\vec{b})(\vec{a}-\vec{b}) + (\vec{a}-\vec{b})$

$= \left[(\vec{a}.\vec{b})+1\right](\vec{a}-\vec{b})$

$\therefore$ $(\vec{a}+\vec{b})\times(\vec{a}\times\vec{b})$ is parallel to $\vec{a}-\vec{b}$

12. (C) Given equation contains only one parameter, its order is 1.

$y^2 = 2c(x + \sqrt{c}\,)$

$\Rightarrow 2y.y_1 = 2c \Rightarrow c = yy_1$

$\therefore$ The given equation is

$y^2 = 2yy_1\,(x + \sqrt{yy_1}\,)$

$\Rightarrow y - 2xy_1 = 2y_1\sqrt{yy_1}$

$\Rightarrow (y - 2xy_1)^2 = 4y.y_1^{\,3}$

$\therefore$ Degree = 3

13. (C) $3\tan^{-1}\left(\frac{1}{2+\sqrt{3}}\right) = \tan^{-1}\frac{1}{x} + \tan^{-1}\frac{1}{3}$

Put $\frac{1}{2+\sqrt{3}} = t$

$\text{LHS} = \tan^{-1}\left(\frac{3t-t^3}{1-3t^2}\right) = \tan^{-1}1 = \frac{\pi}{4}$

$\text{RHS} = \tan^{-1}\frac{1}{x} + \tan^{-1}\frac{1}{3} = \tan^{-1}\left(\frac{3+x}{3x-1}\right)$

$\therefore$ $\frac{\pi}{4} = \tan^{-1}\left(\frac{3+x}{3x-1}\right) \Rightarrow 1 = \frac{3+x}{3x-1} \Rightarrow x = 2$

14. (B) The required determinant is obtained by the successive operations

$C_1 \to 2C_1$ and $C_1 \to C_1 + 3C_2 + 4C_3$

$\therefore$ The value of the determinant is multiplied by 2 (since of the first operation), second operation does not affect the value of the determinant.

15. (A) Since, f(x) is continuous at x = 0

$\therefore$ $\lim_{x\to 0} f(x) = f(0) = k$

$\Rightarrow \lim_{x\to 0} (\cos x)^{1/x} = k$

$\lim_{x\to 0} \frac{1}{x}\log\cos x = \log k$

$\Rightarrow \lim_{x\to 0} \frac{\frac{-\sin x}{\cos x}}{1} = \log k$

$\Rightarrow \log k = 0$

$\therefore$ $k = e^0 = 1$

16. (A) Let $y = \frac{x^2 + 34x - 71}{x^2 + 2x - 7}$

$\Rightarrow (y-1)x^2 + (2y-34)x - 7y + 71 = 0$

For x to be real,

$(2y-34)^2 \geq 4(y-1)(71-7y)$

[$\because$ Discriminent ≥ 0]

$\Rightarrow y^2 + 289 - 34y \geq -7y^2 - 71 + 78y$

$\Rightarrow 8y^2 - 112y + 360 \geq 0$

$\Rightarrow y^2 - 14y + 45 \geq 0$

$\Rightarrow (y-9)(y-5) \geq 0$

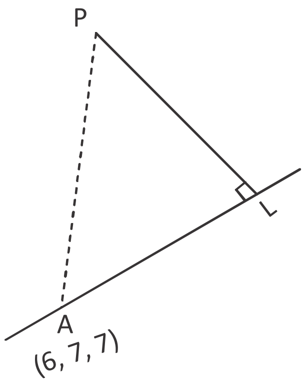
$\Rightarrow y \leq 5$ or $y \geq 9$

$\therefore$ cannot lie between 5 and 9

17. (A) The point A (6, 7, 7) is on the line. Let the perpendicular from P meet the line in L. Then

$AP^2 = (6-1)^2 + (7-2)^2 + (7-3)^2 = 66.$

Also AL = projection of AP on line



$\left(\text{actual d.c's } \frac{3}{\sqrt{17}}, \frac{2}{\sqrt{17}}, \frac{-2}{\sqrt{17}}\right)$

$= (6-1).\frac{3}{\sqrt{17}} + (7-2).\frac{2}{\sqrt{17}} + (7-3).\frac{-2}{\sqrt{17}} = \sqrt{17}$

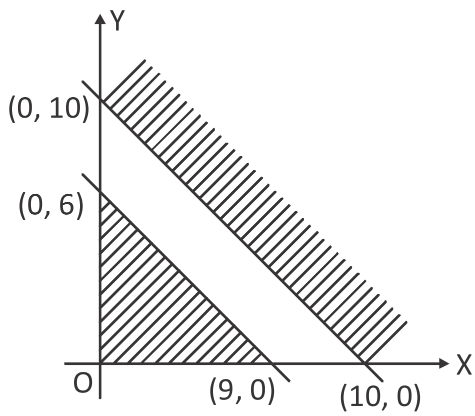
$\therefore$ $\perp$ distance d of p from the line is given by $d^2 = AP^2 - AL^2 = 66 - 17 = 49$, so that d = 7

18. (D) Total numbers which are divisible by 2 and 3 = 16

$\therefore$ Required probability

$$\frac{^{16}C_3}{^{100}C_3} = \frac{4}{1155}$$

19. (D) On drawing the graph of given inequations, it is clear from the graph that there is no common region.



20. (D) We have, $f(x) = e^{x^3-3x+2}$

Let $g(x) = x^3 - 3x + 2$

$g'(x) = 3x^2 - 3 = 3(x^2 - 1)$

$g'(x) = \geq 0$, for $x \in (-\infty, -1]$

$\therefore$ g(x) is increasing function

$\therefore$ f(x) is one-one

Now, Range of f(x) is $(0, e^4]$, but codomain is $(0, e^5]$

$\therefore$ f(x) is into function

21. (B) We have, $\begin{vmatrix} b^2-ab & b-c & bc-ac \\ ab-a^2 & a-b & b^2-ab \\ bc-ac & c-a & ab-a^2 \end{vmatrix}$

$= (b-a)^2 \begin{vmatrix} b & b-c & c \\ a & a-b & b \\ c & c-a & a \end{vmatrix}$

[Taking (b – a) common from C_1 and C_3]

$= (b-a)^2 \begin{vmatrix} b-c & b-c & c \\ a-b & a-b & b \\ c-a & c-a & a \end{vmatrix}$

$[\text{Applying } C_1 \to C_1 - C_3]$

= 0 [$\because$ C_1 and C_2 are identical]

22. (C) We have, $x^2 + xy + y^2 = 7$

On differentiating (1) w.r.t. 'x', we get

$$2x + x\frac{dy}{dx} + y + 2y\frac{dy}{dx} = 0 \Rightarrow \frac{dy}{dx} = -\frac{(2x+y)}{(x+2y)}$$

Length of subtangent

$$= \left|\frac{y}{\frac{dy}{dx}}\right| = \left|\frac{-y(x+2y)}{2x+y}\right|$$

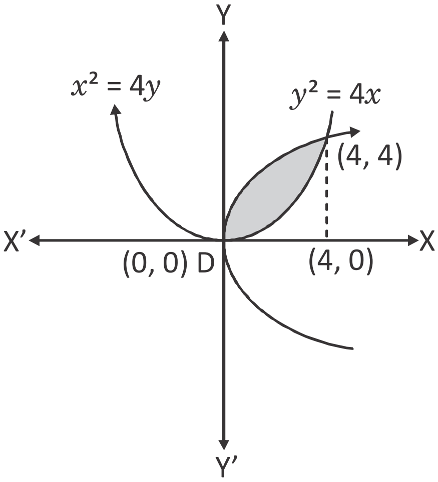
$\therefore$ Length of subtangent at (1, –3) = 15

23. (C) For the point of intersection,

solve $y^2 = 4x$ and $x^2 = 4y$

$$\Rightarrow \left(\frac{x^2}{4}\right)^2 = 4x$$

$$\Rightarrow x^4 = 43\ x \Rightarrow x = 0,\ 4$$



∴ Area bounded between curves

$$= \int_0^4 \left(\sqrt{4x} - \frac{x^2}{4}\right) dx$$

$$= \left[2.\frac{x^{\frac{3}{2}}}{\frac{3}{2}} - \frac{x^3}{12}\right]$$

$$= \frac{4}{3}.(4)^{\frac{3}{2}} - \frac{(4)^3}{12}$$

$$= \frac{32}{3} - \frac{16}{3} = \frac{16}{3}$$

24. (A) Let the directrix be $x = -2a$ and latus rectum be 4a. Then, the equation of the parabola is

(distance from focus = distance from directrix),

$x^2 + y^2 = (2a + x)^2$ or $y^2 = 4a\ (a + x)$

Differentiating w.r.t. x, we get

Putting this value of a in (1), the differential euqation is

$$y^2 = 2y\frac{dy}{dx}\left(\frac{y}{2}\frac{dy}{dx} + x\right)$$

or $$y\left(\frac{dy}{dx}\right)^2 + 2x\left(\frac{dy}{dx}\right) - y = 0$$

25. (A) Total ways of selecting 2 persons = ${}^{13}C_2$ ways. Favourable ways for selection of no woman i.e., both selected are men in ${}^{8}C_2$ ways.

∴ Probability of selecting two persons without a single woman is

$$= \frac{{}^{8}C_2}{{}^{13}C_2} = \frac{14}{39}$$

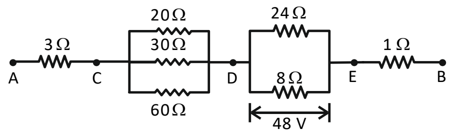
Hence required probability

= P (at least one woman is selected)

$$= 1 - \frac{14}{39} = \frac{25}{39}$$

PHYSICS

26. (D) The equivalent circuit is as shown below.



Resistance between C and D

$$\frac{1}{R_p} = \frac{1}{20} + \frac{1}{30} + \frac{1}{60} = \frac{3+2+1}{60} = \frac{1}{10}$$

or $R_p = 10\ \Omega$.

Resistance between D and E

$$= \frac{24 \times 8}{24 + 8} = 6\ \Omega$$

Total resistance between A and B

$= 3 + 10 + 6 + 1 = 20\ \Omega$

Current through D to E = $\frac{48}{6} = 8\text{A}$

∴ Potential difference between A and B

$= 20 \times 8 = 160$ V

27. (A) On rotating the magnet, no change in flux is linked with the coil. Therefore, induced e.m.f./current is zero.

28. (A) Magnetic field will be independent of the motion of the observer because the velocity with which the observer is moving is comparable to drift velocity of electron which is very small as compared to the speed of flow of current from one end of wire to other end. So it can be neglected and hence, magnetic field due to the wire w.r.t the observer will be $B = \frac{\mu_0 i}{2\pi r}$

29. (C) The magnitude of electric field is proportional to the density of electric field lines. Density of electric field lines at A and C are same. i.e., $E_A = E_C$. Electric field lines density at A and C is greater as compared to electric field line density at B. So, $E_A = E_C > E_B$.

30. (A) After absorption of energy, the hydrogen atom goes to the nth excited state.

Therefore, the energy absorbed can be written as,

$$10.2 = 13.6 \times \left(\frac{1}{1^2} - \frac{1}{n^2}\right)$$

$$\frac{10.2}{13.6} = 1 - \frac{1}{n^2}$$

$$\frac{1}{n^2} = \frac{13.6 - 10.2}{13.6}$$

$$\frac{1}{n^2} = \frac{3.4}{13.6}$$

$n^2 = 4$ $n = 2$

The orbital angular momentum of the electron in the n^{th} state is given by,

$$L_n = \frac{nh}{2\pi}$$

Change in the angular momentum,

$$\Delta L = \frac{2h}{2\pi} - \frac{h}{2\pi} = \frac{h}{2\pi}$$

$$= \frac{6.625 \times 10^{-34}}{2 \times 3.14}$$

$= 1.05 \times 10^{-34}$ J s

31. (C) Number of copper atoms = Charge delivered to cathode per second

(0.002×10^{25})

$$= \frac{0.002 \times 10^{25} \times 2 \times 1.6 \times 10^{-19}}{100 \times 60} = 1.06 \text{ C}$$

32. (B) Given energy flux $\phi = 20 \frac{W}{cm^2}$

Area, A = 30 cm^2

Time, t = 30min = 30 × 60 s

Now, total energy falling on the surface in time t is,

$$U = \phi A t = 20 \times 30 \times (30 \times 60) \text{ J}$$

Momentum of the incident light $= \frac{U}{c}$

$$= \frac{20 \times 30 \times (30 \times 60)}{3 \times 10^8} = 36 \times 10^{-4} \text{ kg m/s}$$

Momentum of the reflected light = 0

∴ Momentum delivered to the surface

$$= 36 \times 10^{-4} - 0 = 36 \times 10^{-4} \text{ kg m/s}$$

33. (A) Here $2l$ = 12 cm = 0.12 m

m = 20 Am, d = 10 cm = 0.1 m

On axial line, $B = \frac{\mu_0}{4\pi} \frac{2Md}{(d^2 - l^2)^2}$

$$B = 10^{-7} \times \frac{2(20)(0.12) \times 0.1}{\left[(0.1)^2 - (0.06)^2\right]^2}$$

$= 1.17 \times 10^{-3}$ T

34. (C) By using the equation $f = \frac{R}{\mu - 1}$

R = 20 cm, μ = 15

$$f = \frac{20}{1.5 - 1} = 40 \text{ cm}$$

As the focal length is greater than zero, i.e., f > O of converging nature.

Therefore, lens act as a convex lens irrespective of the side on which the object lies.

35. (D) The minimum capacitance can be obtained by connecting all capacitors in series. It can be calculated as follows:

$$\frac{1}{C}=\frac{1}{6}+\frac{1}{6}+\frac{1}{6}=\frac{1}{2}$$

$$C=2\mu F$$

The maximum capacitance can be obtained by connecting all capacitors in parallel. It can be calculated as follows:

$$C=6+6+6=18\mu F$$

36. (D) Here

$$X_L=\omega L=2\pi nL$$

$$=2\pi\times 50\times\frac{0.4}{\pi}=40\ \Omega$$

$$R=30\Omega$$

$$\therefore Z=\sqrt{R^2+X_L^2}=\sqrt{30^2+40^2}=50\ \Omega$$

$$I_v=\frac{E_v}{Z}=\frac{200}{50}=4\,A$$

37. (A) An electromagnetic wave bends round the corners of an obstacle if the size of the obstacle is comparable to the wavelength of the wave. An AM wave has less frequency than an FM wave, So, an AM wave has a higher wavelength than an FM wave and it bends round the corners of a 1m × 1m board.

38. (B) In series combination;

$$\frac{V^2}{nR}=4 \qquad \text{..... (i)}$$

In parallel combination;

$$\frac{V^2}{R/n}=64 \qquad \text{..... (ii)}$$

Dividing (ii) by (i), we get, n^2 = 16 or

n = 4

39. (B) In the coolidge tube, the electrons are produced by thermionic effect from a tungsten filament heated by an electric current. The filament is the cathode of the tube. The high voltage potential is between the cathode and anode. The electrons are thus accelerated and then hit the anode. The kinetic energy of the free electrons of the target is the source of energy of a photon of a characteristic X-ray from a Coolidge tube.

40. (A) As the two positive charges q_2 and q_3 exert a net electric force in +x direction on the charge q_1 fixed along the x-axis, the charge on q_1 is negative.

Due to the addition of positive charge Q at (x, 0), the force on –q shall increase along the positive x-axis.

CHEMISTRY

41. (D) $$\frac{\text{Wt. of } O_2}{\text{Wt. of Ag}}=\frac{\text{Eq. wt. of oxygen}}{\text{Eq. wt. of Ag}}$$

Or $$\frac{1.6}{\text{wt. of Ag}}=\frac{8}{108}$$

Or wt.. of Ag $\frac{1.6\times 108}{8}$ = 21.6 g

42. (A) $4KMnO_4 + 6H_2SO_4 \rightarrow 4MnSO_4 + 2K_2SO_4 + 5O_2 + 6H_2O$

$Mn^{7+} + 5e^- \rightarrow Mn^{2+}$

The number of eelctrons gained by $KMnO_4$ in acidic solution is 5.

$$\therefore \quad \text{Eq. wt.} = \frac{\text{Mol. wt}}{5}$$

43. (A) Ionic solids have high electrical conductivity in the molten state as they have free ions to move and carry electric charge. Rest of the characteristics of ionic solids is true.

44. (A) IUPAC name of m-cresol is 3-methylphenol

45. (C) $$t_{90\%} = \frac{2.303}{k}\log\frac{a}{a-0.9a}$$

$$= \frac{2.303}{k}\log 10 = \frac{2.303}{k}$$

$$t_{1/2} = \frac{2.303}{k}\log\frac{a}{a-a/2}$$

$$= \frac{2.303}{k}\log 2 = \frac{2.303}{k}\times 0.3010$$

$$\therefore \quad t_{90\%}/t_{1/2} = \frac{1}{0.3010} = 3.3$$

i.e., $t_{90\%} = 3.3 \text{ times } t_{1/2}$

46. (B) Zone refining method is based on the principle that impurities are more soluble in molten metal than in the solid state of the metal.

47. (A) In Clemmensen reduction, carbonyl compound is treated with Zinc amalgam and HCl act as reagent in this reaction as given below:

$$>C=O \xrightarrow{Zn(Hg)HCl} >CH_2$$

48. (B) Thiosulphate ion $(S_2O_3^{2-})$ contains two sulphur atoms in different oxidation states of + 6 and −2 and is highly unstable in the presence of acids.

$$Na_2S_2O_3 + 2HCl \longrightarrow 2NaCl + SO_2 + S + H_2O$$

49. (C) For equimolar solutions, $x_B = x_T = 0.5$

$P_B = x_B \times P°_B = 0.5 \times 160 = 80$ mm

$P_T = x_T \times P°_T = 0.5 \times 60 = 30$ mm

$P_{Total} = 80 + 30 = 110$ mm

Mole fraction of toluene in vapour phase

$$= \frac{30}{110} = 0.27$$

50. (A) In physisorption, absorbent does not show specificity for any particular gas, because involved Vander Waal's forces are universal. It means that extent of Vander Waal's interaction between adsorbate and adsorbent is constant for all gases.

51. (C) In strong field ligand, there is more energy separation than weak field ligand. It means that as the strength of the ligand increases, crystal field splitting energy increases.

$$\Delta E = \frac{hc}{\lambda} \text{ or } \Delta\frac{E\alpha 1}{\lambda}$$

As ΔE increases, wavelength of light absorbed decreases.

Further, the colour of coordination compounds depends on nature and the magnitude of crystal field splitting of the ligands bonded with central atom. A stronger ligand has higher splitting power than a weak ligand. Amongst the given ligands in Co-ordination complexes, the order of splitting power is:

$H_2O < NH_3 < CN$; As CN has higher splitting power it would absorb more. Hence, the correct order of absorption of wavelength of light in the visible region is

$$[Co(H_2O)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(CN)_6]^{3-}$$

52. (D) Amorphous solids are isotropic in nature because it has no long range order and any physical property will be the same on all directions. On the other hand, anisotropic nature is a characteristic feature of crystalline solids.

53. (B) $$2\,NaOH\,(\text{dilute}) + Br_2 \xrightarrow{\text{cold}} NaBrO + NaBr + H_2O$$

$$3NaBrO \xrightarrow{300K} 3NaBr + NaBrO_3$$

On acidification, the final mixture gives bromine

$5\,NaBrO + NaBrO_3 + 6\,HCl \longrightarrow 6\,NaCl + 3\,Br_2 + 3H_2O$

Thus, during the reaction, bromine is present in four different oxidation states i.e., zero in Br_2, +1 in NaBrO, – 1 in NaBr and + 5 in $NaBrO_3$. The greatest difference between various oxidation states of bromine is 6 and not 5. On acidification of the final mixture, Br_2 is formed and disproportionation of Br_2 occurs during the reaction giving

BrO^-, Br^- and BrO_3^- ions.

54. (A) The higher the surface area, the higher will be the intermolecular forces of attraction and thus boiling point too. Boiling point increases with increase in molecular mass of halogen atom for the similar type of alkyl halide. Butane has no halogen atom and rest of all three compounds are halo derivatives of butane.

Atomic mass of iodine is highest, so the boiling point of 1-iodobutane is maximum among all the given compounds.

Given below are the boiling points along with their molecular mass in the increasing order.

Name of the Compound	Boiling Point in °C	Molecular Mass in g/mol
Butane	–0.5	58.12
1-Chlorobutane	78	92.57
1-Bromobutane	102	137.02
1-Iodobutane	130	184.02

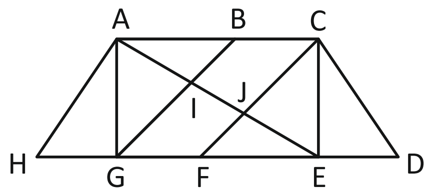
55. (B) $\underset{\text{Butan-2-ol}}{CH_3-\overset{\overset{OH}{|}}{CH}-CH_2CH_3} \xrightarrow[KMnO_4]{\text{Alkaline}} \underset{\text{Butanone}}{CH_3-\overset{\overset{O}{||}}{C}-CH_2CH_3}$

CRITICAL THINKING

56. (B) If Gmail is slower than Hot mail and faster than Yahoo. It logically follows that Yahoo is slower than Gmail, and Hot mail is slower than Gmail as well.

∴ Statement 3, Yahoo runs faster than Hot mail is false if statement 1 and 2 are true.

57. (D) There are 14 triangles in the given figure.



ΔAGE ; ΔAGI ; ΔAIB ; ΔAGE ; ΔACE ; ΔACJ; ΔGIE ; ΔAGB ; ΔCJE ; ΔCEF ; ΔCED ; ΔCFD ; ΔJFE ; ΔEAH

58. (C) Option (A) figure is ball-pen hammer for metal work.

Option (B) figure is claw hammer for carpentry.

Option (C) figure is sledge hammer for concrete.

59. (B) Smaller administrative units can often result in a more precise distribution of resources and better attention to specific needs. This is a direct benefit of having additional districts.

60. (B) The one who likes Renault car.