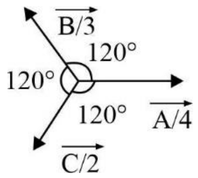
Solutions to JEE Main - 2 | JEE - 2024

PHYSICS

SECTION-1

1.(C) $v = u + at \quad \Rightarrow \quad 0 = 20 - 5t \quad \Rightarrow \quad t = 4s$

2.(B) $\dfrac{3\vec{A}}{4} + \dfrac{\vec{B}}{3} + \dfrac{\vec{C}}{2} = \dfrac{\vec{A}}{2} + \left(\dfrac{\vec{A}}{4} + \dfrac{\vec{B}}{3} + \dfrac{\vec{C}}{2}\right) = \dfrac{\vec{A}}{2} + \vec{0}$



$\Rightarrow \dfrac{\vec{A}}{2}$

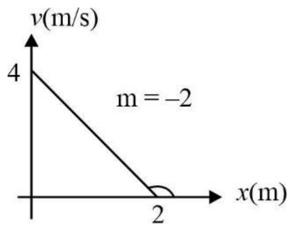
3.(C) $y = mx + C$

$v = 4 + (-2)x$

$\Rightarrow a = \dfrac{vdv}{dx}$

$\Rightarrow \dfrac{dv}{dx} = (-2) \qquad \Rightarrow a = \dfrac{vdv}{dx}$

$\Rightarrow a = (4 - 2x)(-2) \quad \Rightarrow a = -8 + 4x$



4.(B) Time of fall for 1^{st} drop = Time of fall for each drop

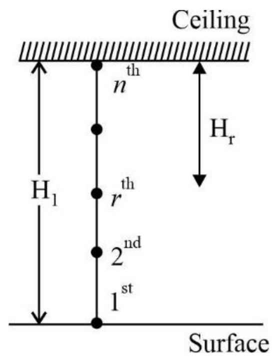
Time interval between any two drops, $\Delta t = \dfrac{T}{(n-1)} = \dfrac{1}{(n-1)}\sqrt{\dfrac{2H_1}{g}}$

r^{th} drop has fallen through $(n - r)$ time intervals at any instant.

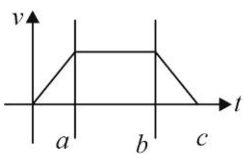
$S = ut + \dfrac{1}{2}at^2$

$H_r = 0 + \dfrac{1}{2} \times g \times \left[(n-r)\Delta t\right]^2 = \dfrac{g}{2}\left[\dfrac{(n-r)^2}{(n-1)^2} \times \dfrac{2H_1}{g}\right]$

$$\boxed{H_r = \frac{(n-r)^2 . H_1}{(n-1)^2}}$$



5.(C)



$a \rightarrow$ constant acceleration $\rightarrow$ s-t-graph will be increasing part of upward parabola.

$b \rightarrow$ positive uniform velocity -s-t- graph will be an increasing straight line.

$c \rightarrow$ constant retardation -s-t-graph will be increasing part of downward parabola.

$\therefore$ Correct option is (C).

6.(D) As seen from ground bolt will have some initial velocity at the time of leaving the ceiling. So first it will go up and will retard at the rate of g. After some time its velocity will become zero and then it will fall down.

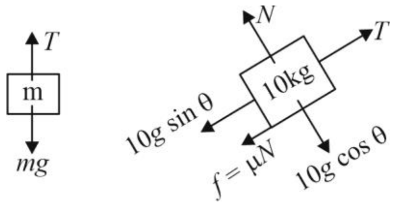
7.(C) Distance = displacement when particle travels in a straight line without turning back.

8.(B) Velocity is a vector quantity, so it must have direction (It is also known as speed with direction)

$$\Rightarrow \quad \vec{v} = |\vec{v}| A \quad \Rightarrow \quad \vec{v} = 6\left(\frac{2\hat{i} + 2j - k}{\sqrt{4+4+1}}\right)$$

$$\vec{v} = \left(4\hat{i} + 4j - 2k\right) \text{ units}$$

9.(A)



$T = mg$

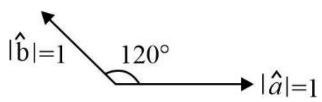
$10g\sin\theta + \mu N = mg$

$10g\sin 37° + \mu 10g\cos 37° = mg$

$10 \times \frac{3}{5} + \frac{1}{2} \times 10 \times \frac{4}{5} = m$; $\qquad 6 + 4 = m = 10kg$

10.(B) Sum of two unit vectors is a unit vector only if angle between them is 120°.

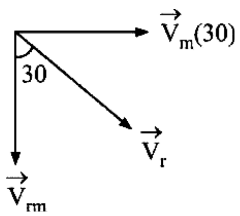
$$\left|a - \hat{b}\right| = 2 \times 1\sin\left(\frac{120}{2}\right)$$



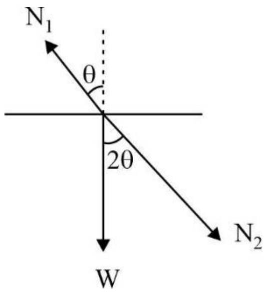
$$\left|a - \hat{b}\right| = 2 \times \frac{\sqrt{3}}{2}$$

$$\left|a - \hat{b}\right| = \sqrt{3}$$

11.(B) $V_r \sin 30 = 30 \quad \Rightarrow \quad V_r = 60$ km/hr



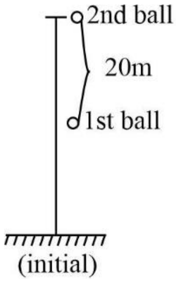
12.(C) $N_1 \sin\theta = N_2 \sin 2\theta$

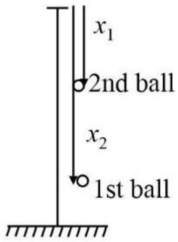


$N_1 = N_2\left(2\cos\theta\right)$; $\qquad \frac{N_1}{N_2} = 2\cos\theta$

13.(D) $(\vec{A}+\vec{B})\cdot(\vec{A}-\vec{B})=0 \quad \Rightarrow \quad A^2-B^2=0 \;\Rightarrow\; A=B$

14.(A) Initial separation between two balls = 20m.
If 1st ball travels t sec. then 2nd ball will travel $(t-2)$ sec.





$$x_2-x_1=40m$$

$$\Rightarrow \quad \frac{1}{2}gt^2-\frac{1}{2}g(t-2)^2=40$$

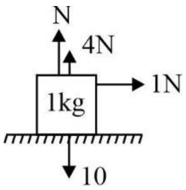
$$\Rightarrow \quad t^2-(t-2)^2=8$$

$$\Rightarrow \quad \boxed{t=3\text{sec}}$$

15.(D) $h=\frac{1}{2}gt_1^2;\; 2h=\frac{1}{2g}(t_1+t_2)^2$ and $3h=\frac{1}{2}g(t_1+t_2+t_3)^2$

$$t_1:t_2:t_3=\sqrt{\frac{2h}{g}}:\sqrt{\frac{4h}{g}}-\sqrt{\frac{2h}{g}}:\sqrt{\frac{6h}{g}}-\sqrt{\frac{4h}{g}}=1:\sqrt{2}-1:\sqrt{3}-\sqrt{2}$$

16.(A) $N=(10-4)$



$\boxed{N=6N}$

$f_L=\mu N\Rightarrow 0.3\times 6$

$\boxed{f_1=1.8N}$

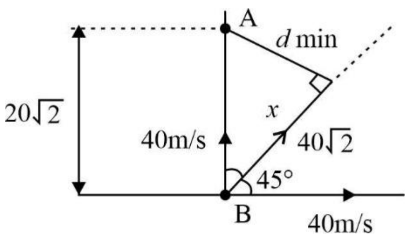
(F_{ext}) parallel to plane is 1N : So required friction will be $-1\hat{i}$

17.(B) Let total distance is d

$$V_m=\frac{d}{\frac{d/2}{v_0}+t},\left(V_1\frac{t}{2}+V_2\frac{t}{2}=\frac{d}{2}\;\Rightarrow\; t=\frac{d}{V_1+V_2}\right)$$

$$=\frac{d}{\frac{d}{2V_0}+\frac{d}{V_1+V_2}} \qquad \Rightarrow \qquad V_m=\frac{2V_0(V_1+V_2)}{V_1+V_2+2V_0}$$

18.(B) $x=20\sqrt{2}\sin 45^\circ$



$\boxed{x=20m}$

$$t=\frac{x}{40\sqrt{2}}$$

$$t=\frac{20}{40\sqrt{2}}$$

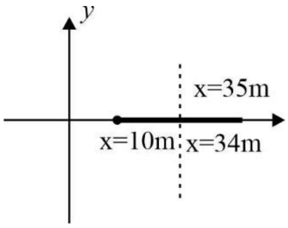
$$t=\frac{1}{2\sqrt{2}}\text{sec}.$$

19.(D) Since Block is in equilibrium so Net force must be zero. Best representation of triangle law of addition is 4.

20.(C) $x = 10 + 10t - t^2$

at t = 0 particle is at x = 10m.

Velocity of particle becomes zero at $t = 5\sec$



$\frac{dx}{dt} = 0 = 10 - 2t$

$t = 5\sec$

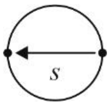
$\Rightarrow$ position of particle at $t = 5\sec$.

$x(5) = 35m$; so distance moved in 5sec. will be 25m, because it was initially $x = 10m$ at t = 0.

$\Rightarrow$ In the last sec. it will move in back-ward.

So total distance in 6sec = 26m

SECTION – 2

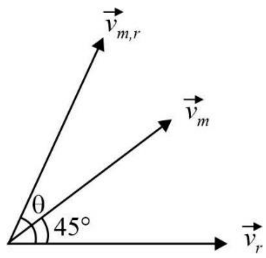
1.(2) $v_{avg} = \frac{s}{t}$ 

$s = 2R,\ t = \frac{\pi R}{v}$

$= \frac{2Rv}{\pi R} = \frac{2v}{\pi} = \frac{2\pi}{\pi} = 2$ m/s

2.(53) Resultant path of the swimmer is at 45° with bank, therefore, x-and y-components of swimmer's resultant velocity must be equal.

Let velocity of swimmer $|\vec{v}_m| = v$



$\vec{v}_m = \vec{v}_{m,r} + \vec{v}_r$; $\quad v_x = v_r + v_{m.r}\cos\theta$

$v_y = v_{m,r}\sin\theta$

Condition for reaching the point C,

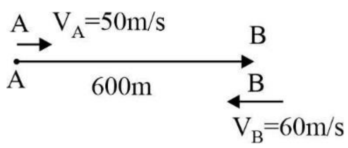
$\tan 45° = \frac{v_y}{v_x}, v_y = v_x$; $(v_r + v_{m,r}\cos\theta) = v_{m,r}\sin\theta$; $1 + 5\cos\theta = 5\sin\theta$

On squaring, $1 + 25\cos^2\theta + 10\cos\theta = 25 - 25\cos^2\theta$

$50\cos^2\theta + 10\cos\theta - 24 = 0$

On solving, we get $\theta = 53°$.

3.(7) Distance moved by train A = $\frac{1}{2} \times 8 \times 50$



$x_A = 200m$

Distance moved by train B in 8 sec.

$x_B = 60 \times 8 - \frac{1}{2} \times 6 \times 64$

$x_B = 480 - 192$

$x_B = 288m$

Separation between train A and B

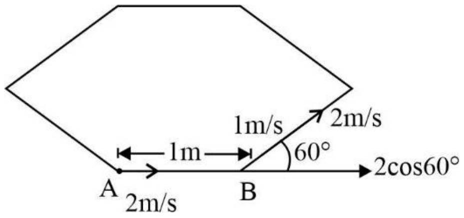
$$x = 600 - (x_A + x_B)$$
$$x = 600 - 488$$
$$x = 112m$$
$$\frac{x}{16} = 7$$

4.(20) (Take downward direction as particle)

$u = 0 \quad \Rightarrow v = \sqrt{2gH} = \sqrt{2 \times 10 \times 20} = 20$ m/s

5.(1) V_{AB} along the line AB = 2 – 2 cos (60°) = 1 m/s

$$t = \frac{\text{dist}}{V_{AB}}$$



$$t = \frac{1}{1} \Rightarrow 1\,\text{sec}.$$

CHEMISTRY

SECTION-1

1.(C) Variation of ψ^2 with r depends upon principal quantum number.

2.(A) Value of ℓ is from 0 to (n – 1).

3.(C) Bohr orbits have no real meaning and their existence can never be demonstrated experimentally.

4.(D) Explanation of intensity of black body radiation with wavelength & temperature and photoelectric effect are direct manifestation of the quantum nature of atoms.

5.(D) a = 0, b = 5, a + b = 5

6.(C) $m_\alpha = 4m_p; q_\alpha = 2q_p; \ \lambda = \frac{h}{\sqrt{2.m.q.V}}$

$$\lambda_\alpha = \frac{h}{\sqrt{2\times m_\alpha \times q_\alpha \times V}} = \frac{h}{\sqrt{2\times 4m_p \times 2q_p \times V}}$$

$$\lambda_p = \frac{h}{\sqrt{2\times m_p \times q_p \times V}} \Rightarrow \frac{\lambda_\alpha}{\lambda_p} = \sqrt{\frac{1}{4}\times\frac{1}{2}} = \frac{1}{2\sqrt{2}}$$

7.(C) Let mass of compound to be 100 gm.

	Re	Cl
	63.6gm	36.4gm
moles =	$\frac{63.6}{186}$	$\frac{36.4}{35.5}$
	= 0.342	= 1.025
	$\simeq$ 1 :	3

Empirical formula of compound will be: $ReCl_3$

8.(D) $SnO_2 + 2H_2 \rightarrow Sn + 2H_2O$

2gm $\Downarrow$

$\frac{2}{151}$mol $\quad \frac{4}{151}$mol

$\Downarrow$

$\frac{4}{151}\times 22.4\text{lit.}$ = 0.593 lit.

9.(C) Volume of 350 drops= 20mL

$\therefore$ Volume of 1 drops = $\frac{20}{350}mL$

Mass of 1 drop = volume × density = $\frac{20}{350}\times 1.2\text{g} = \frac{2.4}{35}\text{g}$

Number of moles in 1 drop = $\frac{2.4}{35}\times\frac{1}{70} = \frac{1.2}{(35)^2}$

Number of molecules = $\frac{1.2}{(35)^2}N_A$

10.(C) $\underset{1\,\text{mol}}{4A} + \underset{0.6\,\text{mol}}{2B} + \underset{0.72\,\text{mol}}{3C} \longrightarrow A_4B_2C_3$

1 mol A requires 0.5 mol B and 0.75 mol C so C is the limiting reagent. 3 mol C gives 1 mol product.

0.72 mol C will give $\frac{1}{3}\times 0.72$ mol product = 0.24 mol product

11.(B) Total meq of HCl added = 0.5 × 10 = 5

meq of excess HCl = meq of NaOH = 0.2 × 10 = 2

meq of HCl used by Ba $(OH)_2$ = 3 = meq of Ba $(OH)_2$

$$\text{meq} = \frac{g}{E}\times 1000$$

$$3 = \frac{g}{171/2}\times 1000 \Rightarrow g = \frac{3\times 171}{2}\times\frac{1}{1000} = \frac{256.5}{1000}$$

% of $Ba(OH)_2$ in the sample = $\frac{256.5}{1000\times 20}\times 100 = 1.28\%$

12.(B) Meq of $H^+ = (20\times 1)+(30\times 2\times 2) = 20+120 = 140$

meq of $OH^- = 30$

$\therefore$ meq of H^+ in final solution = 110

Normality of $H^+ = \frac{110}{60} = 1.83N$

13.(B) $MgCO_3 \xrightarrow{\Delta} \underset{8g}{MgO} + CO_2$

Mole of $MgO = \frac{8}{40}\text{mol} = \frac{1}{5}\text{mol}$

$\frac{1}{5}$ mol $MgCO_3$ will give $\frac{1}{5}$ mol MgO

$\therefore$ Mass of $MgCO_3 = \frac{1}{5}\times 84g$ $\Rightarrow$ % purity = $\frac{84}{5}\times\frac{1}{20}\times 100 = 84\%$

14.(C) For ionization potential Transition is from $n=1$ to $n=\infty$

$$\Delta E = 13.6Z^2\left(\frac{1}{1^2}-\frac{1}{\infty^2}\right) = 13.6\,Z^2\text{eV},\ \text{for } Li^{2+}\ \text{I.E.} = 13.6\times 9 = 122.4\,\text{eV}$$

15.(A) $Hg + e^- \longrightarrow Hg^- + \text{Light}$

$\therefore$ Energy of photon = energy of $e^- = 4.5\,\text{eV}$

$\therefore$ $E = \frac{hc}{\lambda} = 4.5\text{eV} = 4.5\times 1.6\times 10^{-19}\,\text{J}$

$$\therefore\ \frac{1}{\lambda} = \frac{4.5\times 1.6\times 10^{-19}}{6.6\times 10^{-34}\times 3\times 10^8}\,m^{-1} \approx 3.63\times 10^6\,m^{-1}$$

16.(A) $\frac{1240}{310} = \phi + E$

$\Rightarrow$ $4 = \phi + E$ ...... (1)

$$\frac{1240}{\frac{3}{4}[310]} = \phi + 2E \qquad \left\{\because 232.5 = \frac{3}{4}(310)\right\}$$

$$\Rightarrow \quad \frac{16}{3} = \phi + 2E \qquad \ldots\ldots (2)$$

$$\frac{16}{3} = \phi + 2[4-\phi] = \phi + 8 - 2\phi = 8 - \phi$$

$$\Rightarrow \quad \phi = 8 - \frac{16}{3} = \frac{24-16}{3} \quad \Rightarrow \quad \phi = \frac{8}{3} = 2.67\,\text{eV}$$

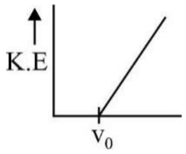
17.(A) $E = N_A \times \frac{hc}{\lambda}$

$$240 \times 10^3 = \frac{6 \times 10^{23} \times 6.6 \times 10^{-34} \times 3 \times 10^8}{\lambda}$$

$$\lambda = 4.95 \times 10^{-7}\,\text{m}$$

18.(B) Energy : 3p < 4s < 3d < 4p

19.(C)



v_0 is the threshold frequency.

20.(B) $\frac{X_{solute}}{X_{solvent}} = \frac{0.1}{0.9} = \frac{1}{9}$

$$\frac{W_{solute}}{W_{solvent}} \times \frac{M_{solvent}}{M_{solute}} = \frac{1}{9} \qquad \ldots(i)$$

$$W_{solute} + W_{solvent} = W_{solution} = \text{density} \times \text{volume}$$

$$W_{solute} + W_{solvent} = 2 \times V \qquad \ldots(ii)$$

Molarity = molality

$$\frac{n_{solute}}{V_{solution}} = \frac{n_{solute}}{W_{solvent}}$$

$$W_{solvent} = V_{solution} = \frac{W_{solute} + W_{solvent}}{2}$$

$$2W_{solvent} = W_{solute} + W_{solvent}$$

$$W_{solute} = W_{solvent} \qquad \ldots(iii)$$

Using equation (i) and (iii), we get $\frac{M_{solute}}{M_{solvent}} = 9$

$$M_{solute} = 9 \times 18 = 162\,\text{g}/\text{mole}$$

SECTION - 2

1.(2) (b) and (c) are correct.

(a) The shapes of the four d-orbitals $(d_{xy}, d_{xz}, d_{yz}, d_{x^2-y^2})$ are similar to each other, where as that of the fifth one, d_{z^2}, is different from others.

(d) The extra stability of d^5(half filled) and d^{10}(completely filled) subshell is due to smaller coulombic repulsion energy and larger exchange energy.

2.(75) Eq. of $CaCO_3$ = Eq. of H_3PO_4

$$\frac{x\times10^{-2}}{100}\times2=\frac{25}{1000}\times0.2\times3 \quad\Rightarrow\quad x=75$$

3.(2) Angular momentum of orbital = $\sqrt{\ell(\ell+1)}\,\dfrac{h}{2\pi}=\sqrt{\ell(\ell+1)}\,\dfrac{h}{2\pi}=\sqrt{2}\,\dfrac{h}{2\pi}$

4.(6)

$$\left.\begin{array}{l}10\rightarrow4\\9\rightarrow4\\8\rightarrow4\\7\rightarrow4\\6\rightarrow4\\5\rightarrow4\end{array}\right\}\text{Total 6 spectral lines in bracket series}$$

5.(6) $Fe_2O_3(s)+3C(s)\rightarrow2Fe(s)+3CO(g)$

1 mol of Fe_2O_3 requires 3 mole of C

So 6 mole of Fe_2O_3 will require 18 mol of C

But only 9 mole of C is present.

So the limiting reagent is carbon

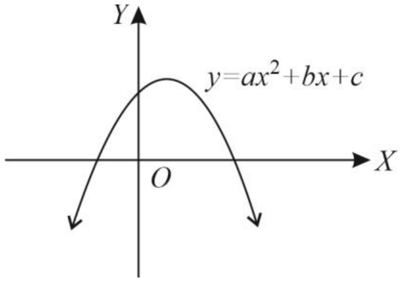
3 mole of C gives 2 mole of Fe

So 9 mol of C will give 6 mole of Fe

$\therefore$ theoretical yield of Fe = 6 mol

MATHEMATICS

SECTION-1



1.(C) $f(0) = c > 0$ .... **(i)**,

$a < 0$ .... **(ii)**

and $\frac{-b}{2a} > 0 \Rightarrow b > 0$ .... **(iii)**

From (i), (ii) and (iii)

We get : $ac < 0$; $ab < 0$; $bc > 0$ and $abc < 0$

2.(B) $\sin\frac{\pi}{n} + \sin\frac{3\pi}{n} + \sin\frac{5\pi}{n} + ...$ upto n terms

Angle are in A.P. with common difference $= \frac{2\pi}{n}$

$$\alpha = \frac{\pi}{n}, \beta = \frac{2\pi}{n} \quad \Rightarrow \quad \text{Sum} = \sin\left(\alpha + (n-1)\frac{\beta}{2}\right)\frac{\sin\frac{n\beta}{2}}{\sin\frac{\beta}{2}} = \frac{\sin(\pi)\sin\pi}{\sin\frac{\pi}{n}} = 0$$

3.(A) $x^2(\lambda+1) - x\left[b(\lambda+1) + a(\lambda-1)\right] + c(\lambda-1) = 0$

$\alpha + \beta = 0 \quad \Rightarrow \quad b(\lambda+1) + a(\lambda-1) = 0$

$$\Rightarrow \quad \frac{\lambda+1}{\lambda-1} = \frac{-a}{b} \quad \Rightarrow \quad \lambda = \frac{b-a}{-(a+b)} = \frac{a-b}{a+b}$$

4.(A) $$\left(\cos\frac{\pi}{12} - \sin\frac{\pi}{12}\right)\left(\frac{\sin\frac{\pi}{12}}{\cos\frac{\pi}{12}} + \frac{\cos\frac{\pi}{12}}{\sin\frac{\pi}{12}}\right) = \frac{\cos\frac{\pi}{12} - \sin\frac{\pi}{12}}{\sin\frac{\pi}{12}\cdot\cos\frac{\pi}{12}} = \frac{2\sqrt{1-\sin\pi/6}}{\sin\pi/6} = 2\sqrt{2}$$

5.(C) Let the roots be $\alpha, 2\alpha \Rightarrow 3\alpha = \frac{-a}{a-b}$ and $2\alpha^2 = \frac{1}{a-b}$

Eliminating α, we get : $\frac{9}{2} = \frac{a^2}{a-b} \Rightarrow 2a^2 - 9a + 9b = 0$

Since a is real, $D \ge 0 \Rightarrow 81 - 72b \ge 0 \quad \Rightarrow \quad b \le \frac{81}{72} = \frac{9}{8}$

6.(A) $f(-2) + f(3) = 0$

$f(x) = (x+1)(ax+b)$

$f(-2) + f(3) = -1(-2a+b) + 4(3a+b) = 0$

$2a - b + 12a + 4b = 0$

$14a + 3b = 0$

$\frac{-b}{a} = \frac{14}{3}$

7.(D) Squaring and adding

$$9 + 16 + 24\sin(P+Q) = 37$$

$$\Rightarrow \quad \sin(P+Q) = \frac{1}{2} \quad \Rightarrow \quad P+Q = \frac{\pi}{6} \quad \text{or} \quad P+Q = \frac{5\pi}{6}$$

$$\therefore \quad R = \frac{\pi}{6} \quad \text{or} \quad \frac{5\pi}{6}$$

$R = \frac{5\pi}{6}$ is not possible because then $P < \frac{\pi}{6}$

However, $3\sin P + 4\cos Q = 6$ and $\cos Q < 1$

This requires $\sin P > \frac{2}{3}$

8.(B) $16\sin 20°\sin 40°\sin 80° = 16\sin 40°\sin 20°\sin 80°$

$= 4(4\sin(60-20)\sin(20)\sin(60+20)) = 4\times\sin(3\times 20°)$

$[\because \sin 3\theta = 4\sin(60-\theta)\times\sin\theta\times\sin(60+\theta)]$

$= 4\times\sin 60° = 4\times\frac{\sqrt{3}}{2} = 2\sqrt{3}$

9.(A) $f(\theta) = \sin^4\theta + \cos^4\theta + 1$

$= \left(\sin^2\theta + \cos^2\theta\right)^2 + 1 - 2\sin^2\theta\cos^2\theta = 2 - \frac{1}{2}\sin^2 2\theta$

As $0 \le \frac{1}{2}\sin^2 2\theta \le \frac{1}{2}$ $\Rightarrow$ $\frac{3}{2} \le 2 - \frac{1}{2}\sin^2 2\theta \le 2$ or $f(\theta) \in \left[\frac{3}{2}, 2\right]$

10.(B) $ax^2 + bx + c = 0$ has roots α and β such that $\alpha + \beta = \frac{-b}{a}, \alpha\beta = \frac{c}{a}$

$2x^2 + 8x + 2 = 0$ has roots $\alpha - 1$ and $\beta - 1$ such that $(\alpha - 1) + (\beta - 1) = -4$;

$(\alpha - 1)(\beta - 1) = 1$

$\frac{-b}{a} = -2 \Rightarrow b = 2a$; $\frac{c}{a} + \frac{b}{a} = 0 \Rightarrow b + c = 0$

11.(C) $x^2 - 2ax + a^2 - 1 = 0$

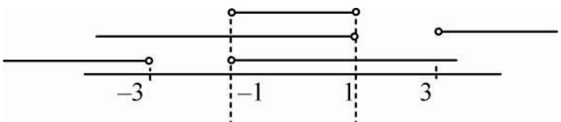
Booth roots lie between $(-2, 2)$ then $f(-2) > 0$, $f(2) > 0$, $-2 < x_v < 2$ and $D \ge 0$

$f(-2) > 0 \Rightarrow 4 + 4a + a^2 - 1 > 0 \Rightarrow (a+1)(a+3) > 0$

$f(2) > 0 \Rightarrow 4 - 4a + a^2 - 1 > 0 \Rightarrow (a-1)(a-3) > 0$

$-2 < x_v < 2 \Rightarrow -2 < 2a < 2 \Rightarrow -1 < a < 1$

$D \ge 0 \Rightarrow 4a^2 - 4\left(a^2 - 1\right) \ge 0 \Rightarrow 4 \ge 0$



12.(A) $\frac{\cos\theta}{p} = \frac{\sin\theta}{q} \Rightarrow \tan\theta = \frac{q}{p}$ ....(i)

$\frac{p}{\sec 2\theta} + \frac{q}{\operatorname{cosec} 2\theta} = p\cos 2\theta + q\sin 2\theta = p\frac{\left(1-\tan^2\theta\right)}{1+\tan^2\theta} + q\frac{2\tan\theta}{1+\tan^2\theta}$

$= p\frac{\left(p^2 - q^2\right)}{p^2 + q^2} + \frac{2pq^2}{p^2 + q^2} = p\frac{\left(p^2 + q^2\right)}{p^2 + q^2} = p$ Using (i)

13.(A) For $\theta \in \left[0, \frac{\pi}{2}\right], \sin\theta + \cos\theta \ge 1$

14.(A) If $x \in (-\infty, -2] \cup [3, \infty)$

$x^2 - 2x - 8 = 0 \quad \Rightarrow \quad x = -2, 4$

If $x \in (-2, 3)$

$x^2 = 4 \quad \Rightarrow \quad x = \pm 2$

15.(B) Let $\sec\theta + \tan\theta = x \quad \Rightarrow \quad \sec\theta - \tan\theta = \frac{1}{x}$ (since $\sec^2 - \tan^2 = 1$)

$\Rightarrow \quad 2\sec\theta = x + \frac{1}{x} \quad \Rightarrow \quad 2\left(a + \frac{1}{4a}\right) = x + \frac{1}{x} \quad \Rightarrow \quad 2a + \frac{1}{2a} = x + \frac{1}{x}$

$\Rightarrow \quad x = 2a$

16.(C) $\cos\left(\frac{13\pi}{24}\right) = \cos\left(\frac{\pi}{2} + \frac{\pi}{24}\right)$

$\cos^4\frac{\pi}{24} - \sin^4\frac{\pi}{24} = \cos^2\frac{\pi}{24} - \sin^2\frac{\pi}{24} = \cos\frac{\pi}{12} = \frac{\sqrt{3}+1}{2\sqrt{2}}$

17.(B) $3x^2 - 2x + p = 0$

and $\quad 6x^2 - 17x + 12 = 0 \quad \Rightarrow \quad 6x^2 - 9x - 8x + 12 = 0 \quad \Rightarrow \quad 3x(2x-3) - 4(2x-3) = 0$

$\Rightarrow \quad (3x-4)(2x-3) = 0 \quad \Rightarrow \quad x = \frac{4}{3}, \frac{3}{2}$

$3\left(\frac{4}{3}\right)^2 - 2\left(\frac{4}{3}\right) + p = 0 \quad \Rightarrow \quad p = -\frac{16}{3} + \frac{8}{3} = -\frac{8}{3}$

$\frac{27}{4} - 3 + p = 0 \quad \Rightarrow \quad p = 3 - \frac{27}{4} = -\frac{15}{4}$

$p_1 + p_2 = -\frac{8}{3} - \frac{15}{4} = \frac{-32-45}{12} = \frac{-77}{12}$

18.(C) $(\tan A - \tan B)^2 = \frac{D}{a^2} = 36 - 16 = 20$

$\tan^2(A-B) = \left(\frac{\tan A - \tan B}{1 + \tan A \tan B}\right)^2 = \frac{20}{(1+4)^2} = \frac{20}{25} = \frac{4}{5}$

19.(D) $\tan(1925°) = \tan(1800° + 125°) = \tan 125°$

$\tan(3700°) = \tan(3600° + 100°) = \tan 100°$

$\tan(225°) = \tan(100° + 125°) = \frac{\tan 100° + \tan 125°}{1 - \tan 100° . \tan 125°}$

20.(D) 1 radian $\approx 57.3°$

$\sin 4 < 0 < \sin 4°$

SECTION – 2

1.(2) Sum of roots $= -\frac{K-3}{2}$

Product of roots $= \frac{3K-5}{2}$

$\Rightarrow \quad -\frac{K-3}{2} = \frac{3K-5}{2}$

$\Rightarrow \quad -K+3=3K-5$

$\Rightarrow \quad K=2$

2.(6) $3\sin^2 x-6\sin x-\sin x+2=0$

$(3\sin x-1)(\sin x-2)=0$

$\sin x\neq 2$, then $\sin x=\dfrac{1}{3}$

$\sin x=\dfrac{1}{3}$ has 6 solutions for $x\in[0, 5\pi]$

3.(1) $1+\tan 135°=0$

$\therefore n-1=0$

4.(2) $\sin x+\sin^2 x=1 \quad \Rightarrow \quad \sin x=1-\sin^2 x=\cos^2 x$

Now, $\cos^{12} x+3\cos^{10} x+3\cos^8 x+\cos^6 x+1=\cos^6 x\left(\cos^6 x+3\cos^4 x+3\cos^2 x+1\right)+1$

$$=\cos^6 x\left(\cos^2 x+1\right)^3+1=\sin^3 x\left(\sin x+1\right)^3+1=\left(\sin^2 x+\sin x\right)^3+1=(1)^3+1=2$$

5.(4) $\cos 12°+\cos 84°+\cos 156°+\cos 132°$

$$=\cos 156°+\cos 84°+\cos 132°+\cos 12°$$

$$=2\cos\left(\frac{156°+84°}{2}\right)\cos\left(\frac{156°-84°}{2}\right)+2\cos\left(\frac{132°+12°}{2}\right)\cos\left(\frac{132°-12°}{2}\right)$$

$$=2\cos 120°\cos 36°+2\cos 72°\cos 60°=2\left(-\frac{1}{2}\right)\cos 36°+2\cos 72°\times\frac{1}{2}$$

$$=-\cos 36°+\cos 72°=-\frac{\sqrt{5}+1}{4}+\frac{\sqrt{5}-1}{4}=-\frac{1}{2}$$