# MET 2017 Answer Key PDF

## Physics

**1.** *(b)* Using red light ($\lambda = 6600$ Å)60 fringes are seen.

Hence, range of field of view is

$$60 \times w = 60 \times \frac{D\lambda}{d}$$

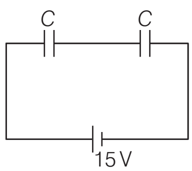
Using light of wavelength $\lambda', n$ fringes are seen, then

$$\Rightarrow \quad 60 \times \frac{D\lambda}{d} = n \times \frac{D\lambda'}{d}$$

$$60 \times \lambda = n \times \lambda'$$

$$\Rightarrow \quad n = 60 \times \frac{\lambda}{\lambda'} = 60 \times \frac{6600}{4400} = 90$$

**2.** *(c)* Let capacitance of each capacitor is $C$. Then equivalent capacitance in series is




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

$$\Rightarrow \quad C' = \frac{C}{2}$$

Charge $\quad Q = C'V = \frac{C}{2} \times 15 \quad \ldots(i)$

When filled with dielectric

$$C_1 = 4C, C_2 = C$$

$$\frac{1}{C'} = \frac{1}{4C} + \frac{1}{C} = \frac{5}{4C}$$

$$\Rightarrow \quad C' = \frac{4C}{5}$$

Since, charge is conserved

$$Q = C'V' = \frac{4C}{5} V' \quad \ldots(ii)$$

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

$$\frac{C}{2} \times 15 = \frac{4C}{5} V'$$

$$\Rightarrow \quad V' = \frac{15 \times 5}{4 \times 2} = 9.4 \text{ V} \approx 10 \text{ V}$$

**3.** *(a)* The speed of transverse wave

$$v = \sqrt{\frac{T}{m}}$$

Given, $T = 20$ N, $\frac{M}{l} = \frac{d \times Al}{l} = d \times A$

$$\therefore \quad v = \sqrt{\frac{20 \times 10^{-3}}{7.5 \times 0.2 \times (10^{-3})^2}}$$

$$v \approx 116 \text{ ms}^{-1}$$

**4.** *(d)* Common acceleration

$$a = \frac{F}{m_1 + m_2 + m_3}$$

$$a = \frac{40}{10 + 6 + 4} = 2 \text{ m/s}^2$$

Equation of motion of $m_3$ is

$$T_3 - T_2 = m_3 a$$

$$40 - T_2 = 4 \times 2 \Rightarrow T_2 = 32 \text{ N}$$

**5.** *(d)* Let $n$ cells be in series and $m$ in parallel, then

$$\frac{nE}{R + nr} = \frac{E}{R + \frac{r}{m}}$$

$$\Rightarrow \quad n\left[R + \frac{r}{m}\right] = R + nr$$

$$\Rightarrow \quad nRm + nr = Rm + mnr$$

$$\Rightarrow \quad 6 + 2r = 3 + 4r$$

$$\Rightarrow \quad 2r = 3$$

$$\Rightarrow \quad R = 1.5\ \Omega$$

**6.** *(d)* From Coulomb's law the force ($F$) between two charges is

$$F = \frac{1}{4\pi\varepsilon_0 k} \frac{q^2}{r^2}$$

First case : $\quad k = 1$

$$F = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q^2}{r^2} \quad \ldots(i)$$

Second case : $\quad k = 4$

$$F' = \frac{1}{4\pi\varepsilon_0 \times 4} \cdot \frac{q^2}{r^2} \quad \ldots(ii)$$

Dividing Eq. (i) by Eq. (ii), we have

$$\frac{F}{F'} = 4 \Rightarrow \quad F' = \frac{F}{4}$$

**7.** *(d)* The height ($h$) to which water rises in a capillary tube is given by

$h = \frac{2T\cos\theta}{r\rho g}$ where $\theta$ is angle of contact, $r$ the radius, $\rho$ the density and $g$ acceleration due to gravity.

When lift moves down with constant acceleration, height is less than $h$,because effective value of acceleration due to gravity increases hence $h$ decreases.

**8.** *(a)* From Stefan's law

$$E = \sigma T^4 A$$

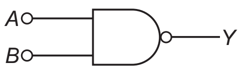
Given,

$$T = 727°C = 727 + 273 = 1000\text{ K},$$
$$A = 5 \times 10^{-4}\text{ m}^2$$

$\therefore$ $$\text{Energy} = 5.67 \times 10^{-8}\ (1000)^4\ (5 \times 10^{-4})\ 60$$

$\therefore$ $$E = 1.7 \times 10^3\text{ J}$$

**9.** *(a)* NAND gate is obtained when the output of AND gate is made as the input of NOT gate Boolean expression for NAND gate is




$$Y = \overline{A\,.\,B}$$

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 0 |

**10.** *(d)* Torque on dipole is

$$\tau = pE\sin\theta$$
$$\tau = q \times 2l\,E\sin\theta$$

$\Rightarrow$ $$q = \frac{\tau}{2El\sin\theta}$$

Given, $\tau = 4$ Nm, $E = 2 \times 10^5\text{ NC}^{-1}$,

$$l = 2 \times 10^{-2}\text{ m}, \theta = 30°$$

$\therefore$ $$q = \frac{4}{2 \times 2 \times 10^5 \times 2 \times 10^{-2} \times \sin 30°}$$

or $q = 2$ mC

**11.** *(b)* The velocity ($v$) is given by

$$v = f\lambda$$

$\Rightarrow$ $$f = \frac{v}{\lambda}$$

Number of beats = difference in frequencies

$\therefore$ $$f_1 - f_2 = v\left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)$$

$$\frac{10}{3} = v\left(\frac{1}{1} - \frac{1}{1.01}\right)$$

$$\frac{10}{3} = v\left(\frac{0.01}{1.01}\right)$$

$\Rightarrow$ $$v = \frac{10 \times 1.01}{3 \times 0.01} = 336.7\text{ m/s}$$

**12.** *(b)* The relation between $\alpha$ and $\beta$ is

$$\beta = \frac{\alpha}{1 - \alpha}$$

Putting this value in the given equation, we have

$$\frac{\beta - \alpha}{\alpha\beta} = \frac{\frac{\alpha}{1-\alpha} - \alpha}{\alpha \cdot \frac{\alpha}{1-\alpha}} = \frac{\alpha^2}{\alpha^2} = 1$$

**13.** *(a)* From Doppler's effect, perceived frequency

$$f' = f\left(\frac{v - v_o}{v - v_s}\right)$$

$$\frac{9}{8} = \frac{340}{340 - v_s}$$

$\Rightarrow$ $$9\,(340 - v_s) = 8 \times 340$$

$\therefore$ $$v_s = 37.7\text{ ms}^{-1} \approx 40\text{ ms}^{-1}$$

**14.** *(b)* The angular distance ($\theta$) is given by

$$\theta = \frac{\lambda}{d}$$

Given, $\theta = 2° = \frac{\pi}{180} \times 2$, $\lambda = 6980$ Å

$$= 6980 \times 10^{-10}\text{ m}$$

$\therefore$ $$d = \frac{\lambda}{\theta} = \frac{6980 \times 10^{-10} \times 180}{3.14 \times 2}$$

$\Rightarrow$ $$d \approx 2 \times 10^{-5}\text{ mm}$$

**15.** *(d)* The resistance at temperature $t$ is

$$R_t = R_0\,(1 + \alpha t)$$
$$R_t' = R_0\,(1 + \alpha t')$$

$\Rightarrow$ $$4 = 1 + 15\alpha \qquad \ldots\text{(i)}$$

$$5 = 1 + 37.5\alpha \qquad \ldots\text{(ii)}$$

$\therefore$ $$\frac{4}{5} = \frac{1 + 15\alpha}{1 + 37.5\alpha}$$

$\Rightarrow$ $$4\,(1 + 37.5\alpha) = 5\,(1 + 15\alpha)$$

$\Rightarrow$ $$75\alpha = 1 \Rightarrow \alpha = \frac{1}{75}\,°\text{C}^{-1}$$

**16.** *(c)* The relation between $K$ and $p$ is

$$p = \sqrt{2Km}$$

when increased by 25%, we have

$$p' = p + \frac{25}{100}\,p = \frac{5p}{4}$$

$\Rightarrow \qquad \frac{4p}{5p} = \sqrt{\frac{K_1}{K_2}}$

$\Rightarrow \qquad \frac{K_1}{K_2} = \frac{16}{25}$

Hence, percentage increase is

$$= \frac{25-16}{16} \times 100 = \frac{9}{16} \times 100 = 56.25\%$$

**17.** (*a*) The focal length of the combination is

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

Given, $f_1 = 50$ cm, $f_2 = 50$ cm

$\therefore \qquad \frac{1}{F} = \frac{1}{50} + \frac{1}{50} = \frac{2}{50}$

$\Rightarrow \qquad F = \frac{50}{2} = 25$ cm

Object when placed at centre of curvature forms a real, inverted image of same size as object $= (2 \times 25 = 50$ cm).

**18.** (*a*) $\quad M_{21} = \frac{\mu_0 N_1 N_2 A_2}{l_1}$

$$\therefore \qquad M_{21} = \frac{(4 \times 3.14 \times 10^{-7}) \times 1500 \times 100 \times \{3.14\,(2 \times 10^{-2})^2\}}{80 \times 10^{-4}}$$

$M_{21} = 2.96 \times 10^{-4}$ H

$\Rightarrow \qquad M_{12} = M_{21} = 2.96 \times 10^{-4}$ H

**19.** (*b*) Refractive index, $\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

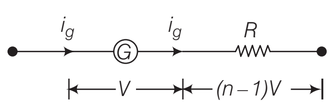
$\Rightarrow \qquad \sqrt{2} = \frac{\sin\left(\frac{60° + \delta_m}{2}\right)}{\sin\left(\frac{60°}{2}\right)}$

$\Rightarrow \qquad \sqrt{2} \times \sin 30° = \sin\left(\frac{60° + \delta_m}{2}\right)$

$\Rightarrow \qquad \sin 45° = \sin\left(\frac{60° + \delta_m}{2}\right)$

$\Rightarrow \qquad \delta_m = 30°$

**20.** (*b*) Suppose resistance $R$ is connected in series with voltmeter as shown. By Ohm's law




$$i_g R = (n-1)\,V$$

$\Rightarrow \qquad R = (n-1)\,G$

where $\qquad i_g = \frac{V}{G}$

**21.** (*d*) Fraction $= \frac{N}{N_0}$

$$= \left(\frac{1}{2}\right)^{\frac{6400}{1600}} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$$

**22.** (*d*) As we know $Q \propto T^4$

$\Rightarrow \qquad \frac{H_A}{H_B} = \left[\frac{273 + 727}{273 + 327}\right]^4 = \frac{625}{81}$

**23.** (*c*) Heat emitted by copper = Heat gained by ice

$$mc\Delta\theta = m'L$$

$\Rightarrow \qquad m' = \frac{mc\Delta\theta}{L}$

Given, $m = 2$ kg, $c = 400$ J-kg$^{-1}$ C$^{-1}$,

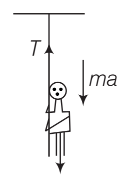
$\Delta\theta = 500$, $L = 3.5 \times 10^5$ J-kg$^{-1}$

$\therefore \qquad m' = \frac{2 \times 400 \times 500}{3.5 \times 10^5} = \frac{8}{7}$ kg

**24.** (*c*) The resultant of tension and weight given acceleration to the man, hence

$$mg - T = ma$$

$\Rightarrow \qquad T = mg - ma = m\,(g - a)$




Given, $\quad m = 100$ kg,

$g = 9.8$ m/s$^2$, $a = 1.8$ ms$^{-2}$.

$\therefore \qquad T = 100\,(9.8 - 1.8) = 800$ N

**25.** (*a*) $\qquad F = \frac{dp}{dt} \Rightarrow p = F\,dt$

where $p$ = momentum $= mv$

$\therefore \qquad mv = Fdt$

$\Rightarrow \qquad v = \frac{Fdt}{m}$

Given, $F = 20$ N, $dt = 2$ s, $m = 2$ kg

$\therefore \qquad v = \frac{20 \times 2}{2} = 20$ m/s$^2$

Work done = KE $= \frac{1}{2} \times 2 \times (20)^2 = 400$ J

**26.** (*d*) Force on a particle with charge $q$ in electric field $E$ is

$$F = qE = ma$$

$\therefore \qquad a = \frac{qE}{m}$

here $\qquad a = \frac{v}{t}$

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$$\therefore \qquad \frac{v}{t} = \frac{qE}{m} \Rightarrow v = \frac{qEt}{m}$$

Also, kinetic energy is due to velocity ($v$) is

$$K = \frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{qEt}{m}\right)^2 = \frac{q^2E^2t^2}{2m}$$

**27.** *(a)* $$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$$

Given, $\frac{1}{4\pi\varepsilon_0} = 9\times10^9$, $V = +100$ volt,

$$r = 10 \text{ cm} = 0.10 \text{ m.}$$

$$\therefore \qquad 100 = (9\times10^9)\times\frac{q}{0.10}$$

$$\Rightarrow \qquad q = \frac{100\times0.10}{9\times10^9} = 1.1\times10^{-9}\text{ C}$$

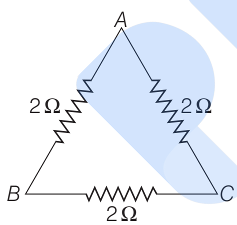
**28.** *(a)* Internal resistance ($r$) is given by

$$r = \frac{E-V}{i}$$

Also, $i = \frac{V}{R}$, we have

$$r = \frac{E-V}{V/R} \Rightarrow r = R\left(\frac{E}{V}-1\right)$$

**29.** *(a)* In triangle formation, two resistors are in series and their sum is connected in parallel. Therefore,

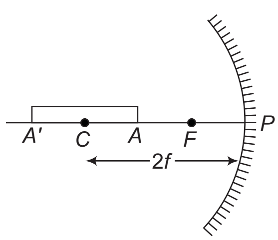



$$R' = 2\Omega + 2\Omega = 4\,\Omega$$

$$\frac{1}{R''} = \frac{1}{4}+\frac{1}{2} = \frac{1+2}{4} = \frac{3}{4}\,\Omega$$

$$R'' = \frac{4}{3}\,\Omega$$

**30.** *(a)* $u = PA = PC - AC = 2f - \frac{f}{3} = \frac{5f}{3}$




From mirror formula

$$\frac{1}{f} = \frac{1}{v}+\frac{1}{u}$$

$$\Rightarrow \qquad \frac{1}{v} = \frac{1}{f}-\frac{1}{u} = \frac{1}{f}-\frac{3}{5f} = \frac{2}{5f}$$

Length of image

$$CA' = PA' - PC = \frac{5f}{2} - 2f = \frac{f}{2}$$

$$\therefore \text{ Magnification } (m) = \frac{CA'}{CA} = \frac{f/2}{f/3} = 1.5$$

**31.** *(d)* Intensity ($I = ka^2$), where $a$ is amplitude and $k$ is a constant.

$$\therefore \qquad I_1 = ka_1^2$$

$$\Rightarrow \qquad \frac{I_1}{I_2} = \frac{a_1^2}{a_2^2} = \frac{9}{4}$$

$$\Rightarrow \qquad \frac{a_1}{a_2} = \frac{3}{2}$$

Maximum intensity

$$I_{max} = (a_1 + a_2) = (3+2) = 5$$

Minimum intensity

$$I_{min} = (a_1 - a_2) = (3-2) = 1$$

$$\therefore \qquad \frac{I_{max}}{I_{min}} = \frac{5}{1}$$

**32.** *(d)* Refractive index is given by

$$n = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}}$$

Given, $\delta_m = 180° - 2A$

$$\therefore \qquad n = \frac{\sin\left(\frac{A+180°-2A}{2}\right)}{\sin\frac{A}{2}}$$

$$n = \frac{\sin\left(\frac{180°}{2}-\frac{A}{2}\right)}{\sin\frac{A}{2}}$$

$$\Rightarrow \qquad n = \frac{\cos\frac{A}{2}}{\sin\frac{A}{2}} = \cot\frac{A}{2}.$$

**33.** *(a)* $\frac{1}{2}mv^2 = eV$

$$\Rightarrow \qquad \frac{e}{m} = \frac{v^2}{2V}$$

Given, $V = 200$ volt, $v = 8.4 \times 10^8$ cm/s
$= 8.4 \times 10^6$ m/s.

$$\therefore \quad \frac{e}{m} = \frac{(8.4 \times 10^6)^2}{2 \times 200} = 1.76 \times 10^{11} \text{ C/kg}$$

**34.** *(a)* $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For Lyman series $n = 1$
For Balmer series $n = 2$

$$\therefore \quad \frac{1}{\lambda_L} = R\left(\frac{1}{1^2}\right), \frac{1}{\lambda_B} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) \Rightarrow \frac{\lambda_B}{\lambda_L} = \frac{3}{1}$$

**35.** *(b)* When emf of cell is $E$, the potential drop is

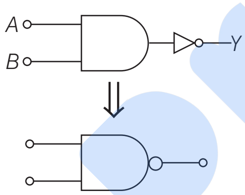
$$V = E - ir$$

where $i$ is current and $r$ the internal resistance.
Given, $i = 10$ mA $= 10 \times 10^{-3}$ A, $R = 200\ \Omega$,

$$V = 0.5 \text{ volt.}$$

$$\Rightarrow \quad E = V + ir$$
$$E = 0.5 + 10 \times 10^{-3} \times 200$$
$$E = 1.5 \text{ V}$$

**36.** *(d)* In the following figure, output of AND gate is made as input of NOT gate, we get NAND gate




NAND gate

$$Y = \overline{A \cdot B}$$

**37.** *(d)* Distance of the satellite from the centre are $7R$ and $3.5\,R$ respectively.

$$\frac{T_2}{T_1} = \left(\frac{R_2}{R_1}\right)^{3/2}$$

$$\Rightarrow \quad T_2 = 24\left[\frac{3.5\,R}{7R}\right]^{3/2} = 6\sqrt{2} \text{ h}$$

**38.** *(b)* We know that $\quad v \propto \lambda$

$$\Rightarrow \quad \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$$

$$\therefore \quad v_2 = \frac{v_1}{\lambda_1} \times \lambda_2$$

$$= 3 \times 10^8 \times \frac{4500}{6000} = 2.25 \times 10^8 \text{ m/s}$$

**39.** *(b)* The angle of minimum deviation is given by

$$\delta_m = (n - 1)\ A$$
$$\delta_m = (\sqrt{2} - 1)\ 60$$

Angle of incidence, $i = \frac{A + \delta_m}{2}$

$$i = \frac{60 + (\sqrt{2} - 1)\ 60}{2}$$

$$i = \frac{60\sqrt{2}}{2} = 30\sqrt{2} = 42°$$

**40.** *(c)* From Coulomb's law

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q \times \frac{q}{2}}{(a + x)^2} - \frac{1}{4\pi\varepsilon_0}\cdot\frac{q \times \frac{q}{2}}{(a - x)^2}$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q^2}{2}\left[\frac{1}{(a + x)^2} - \frac{1}{(a - x)^2}\right]$$

$$= \frac{1}{4\pi\varepsilon_0}\cdot\frac{q^2}{2}\left[-\frac{4\,ax}{(a^2 - x^2)^2}\right]$$

When $x << a$, then

$$F = -\frac{2q^2}{4\pi\varepsilon_0 a^3}\,x$$

$$\Rightarrow \quad F \propto -x$$

Hence, SHM along $x$-axis.

**41.** *(b)* From Coulomb's law

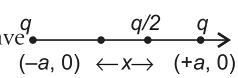
$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q^2}{2a^2}$$

$F_1$ and $F_2$ will be directed as shown, for this both $q$ should be negative

$$F_1 = F_2 = \frac{1}{4\pi\varepsilon_0}\cdot\frac{Qq}{a^2}$$

$$F_{12} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{\sqrt{2}\,Qq}{a^2}$$

For equilibrium of $Q$, we have




$$F = -F_{12}$$

$$\frac{Q^2}{2a^2} = -\frac{\sqrt{2}\,Qq}{a^2}$$

$$\Rightarrow \quad q = \frac{Q}{2\sqrt{2}}$$

Given $Q = +\sqrt{2}\,\mu$C

$$\therefore \quad q = -\frac{\sqrt{2}\,\mu\text{C}}{2\sqrt{2}} = -0.5\,\mu\text{C}$$

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**42.** *(c)* Let $p_1 = p$, $p_2 = p_1 + 50\%$ of $p_1$

$$= p_1 + \frac{p_1}{2} = \frac{3p_1}{2}$$

$$E \propto p^2$$

$$\Rightarrow \quad \frac{E_2}{E_1} = \left(\frac{p_2}{p_1}\right)^2 = \left(\frac{3p_1/2}{p_1}\right)^2 = \frac{9}{4}$$

$$\Rightarrow \quad E_2 = 2.25E_1 = E_1 + 1.25\, E_1$$

$$\therefore \quad E_2 = E_1 + 125\% \text{of } E_1$$

*ie*, kinetic energy will increase by 125%

**43.** *(c)* The energy stored in capacitor is given by

$$E = \frac{1}{2}CV^2$$

Resultant capacitance

$$C' = C_1 + C_2 = 4 + 6 = 10\,\text{pF}$$

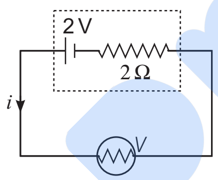
$$E = \frac{1}{2} \times 10 \times 10^{-12} \times (100)^2$$

$$(1\text{ pF} = 10^{-12}\text{ F})$$

$$= 5 \times 10^{-8}\text{J}$$

**44.** *(a)* From Ohm's law

$$i = \frac{E}{R + r} = \frac{2}{998 + 2} = 2 \times 10^{-3}\text{ A}$$




$R = 988$ W

Potential difference across the voltmeter is

$$V = iR = (2 \times 10^{-3}) \times 998 = 1.996\text{ V}$$

**45.** *(d)* When no current passes through the galvanometer, the bridge is balanced hence,

$$\frac{P}{Q} = \frac{R}{S}$$

$$\Rightarrow \quad \frac{24 + X}{10} = \frac{84 + Y}{30}$$

Also, applying Kirchhoff's law

$$\Sigma\, iR = \Sigma i'R' \qquad \text{(parallel)}$$

$$(X + 24) + (84) + Y = 3\,(10 + 30)$$

$$\Rightarrow \quad X + Y = 12 \qquad \ldots\text{(i)}$$

and $\quad 3X - Y = 12 \qquad \ldots$(ii)

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

$X = 6$, $Y = 6$ (neglecting negative value)

**46.** *(b)* The impedance of the circuit is

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$X_L = \omega L = 400 \times 20 \times 10^{-3} = 8\text{H}$$

$$X_C = \frac{1}{\omega C} = \frac{1}{400 \times 625 \times 10^{-6}} = 4\text{ C}$$

$$Z = \sqrt{(3)^2 + (8 - 4)^2} = 5$$

$$i = \frac{E}{Z} = \frac{300}{5} = 60\text{ A}$$

**47.** *(a)* If stopping potential is $V_0$, then maximum kinetic energy of photoelectrons is given by

$$E_k = eV$$

Given, $\quad V = 1.5\,\text{volt}$

$$E_k = 1.5\text{ eV}$$

**48.** *(b)* $a \sin\theta = 1 \times \lambda$

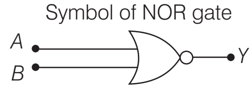
$$\Rightarrow \quad \lambda = a \sin\theta = 10^{-4} \times \frac{1}{2} = \frac{10 \times 10^{-5}}{2}$$

$$= 5 \times 10^{-5}\text{ cm} = 5000\text{ Å}$$

**49.** *(c)* NOR gate is obtained when the ouput of OR gate is made as the input of NOT gate, Boolean expression for NOR gate is

$$Y = \overline{A + B}$$

Symbol of NOR gate




**Truth Table**

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 0 |

**50.** *(c)* From Doppler's effect the perceived frequency $f'$ is given by

$$f' = f\left(\frac{v + v_o}{v}\right)$$

Given, $f = 990$ Hz, $v = 300$ m/s, $v_o = 33$ m/s

$$\therefore \quad f' = 990\left(\frac{330 + 33}{330}\right)$$

$$= 990 \times \frac{363}{330} = 1089\text{ Hz}$$

## Chemistry

**1.** *(b)* For $f$ orbital, $l = 3$

Hence, $m = -3, -2, -1, 0, +1, +2, +3$

**2.** *(b)* $3C + \frac{3}{2}O_2 \longrightarrow 3CO$

$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

1 mole of $Fe_2O_3 \equiv 3$ mole of $CO \equiv \frac{3}{2}$ mole of $O_2$

$\because$ 160 g of $Fe_2O_3$ require $O_2 = \frac{3}{2} \times 32 = 48$ g

$\therefore$ 1.60 kg of $Fe_2O_3$ will require $O_2 = 480$ g

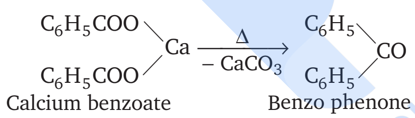
**3.** *(c)* The phenoxide ion left from *o*-hydroxybenzaldehyde and *p*-hydroxybenzaldehyde are stabilized by $-I$ and $-R$ effect of the —CHO group. But in *o*-isomer due to chelation it is difficult to remove the H-atom. Hence, *p*-hydroxybenzaldehyde is the strongest acid.

**4.** *(a)* Purification of NaCl by passage of hydrogen chloride through brine is based on common ion effect.

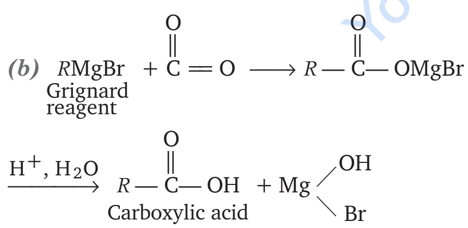
**5.** *(d)* Wurtz reaction involves the reduction of alkyl halide with Na in ether.

$$RX + 2Na + XR \xrightarrow{\text{Dry ether}} R—R + 2NaX$$

**6.** *(d)* Dry distillation of calcium benzoate gives benzophenone.




**7.** *(b)*




**8.** *(a)* The dilute aqueous solution (7 to 8%) of ethanoic acid (acetic acid) is called vinegar.

**9.** *(a)*

$$2(r^+ + r^-) = \sqrt{3}a$$
$$2(1.69 + 1.81) = \sqrt{3}a$$
$$2(3.5) = \sqrt{3}a$$
$$7.0 = \sqrt{3}a$$
$$a = \frac{7.0}{\sqrt{3}} = 4.04\text{ Å}$$

**10.** *(a)* $\underset{111\,g}{CaCl_2} + 2AgNO_3 \longrightarrow Ca(NO_3)_2 + \underset{2\times 43.5\,g}{2AgCl}$

$CaCl_2$ required to produce $2 \times 143.5$ g of AgCl $= 111$ g

$CaCl_2$ required to produce 14.35 g of AgCl

$$= \frac{111 \times 14.35}{2 \times 143.5} = 5.55\text{ g}$$

**11.** *(b)* In the hydrogen spectrum the Lyman series of lines appears in ultra violet region of electromagnetic spectrum.

**12.** *(b)* The first ionisation potential ($IE_1$) decreases from top to bottom in a group.

Hence, the order of ionisation potential is as :

$$Be > Mg > Ca$$

**13.** *(c)* Fog is a liquid in gas colloidal solution.

**14.** *(b)* $NOClO_4 \equiv (NO^+)\ (ClO_4^-)$

Let the O.N. of N in $NO^+$ is $x$.

$$x + (-2) = +1$$
$$x = 3$$

Let O.N. of Cl in $ClO_4^-$ is $y$.

$$y + 4(-2) = -1$$
$$y - 8 = -1$$
$$y = +7$$

**15.** *(a)* Slag formed during the extraction of iron is always lighter than the molten metal. Its melting point should also be less than the molten metal.

**16.** *(d)*

| Complex ion | Hybridisation on central atom |
|---|---|
| $[Fe(CN)_6]^{4-}$ | $d^2sp^3$ (Inner) |
| $[Mn(CN)_6]^{4-}$ | $d^2sp^3$ (Inner) |
| $[Co(NH_3)_6]^{3+}$ | $d^2sp^3$ (Inner) |
| $[Ni(NH_3)_6]^{2+}$ | $sp^3d^2$ (Outer) |

**17.** *(b)*

| Sugar : | Lactose | Glucose | Sucrose | Fructose |
|---|---|---|---|---|
| Relative sweetness | 16 | 74 | 100 | 173 |

**18.** *(c)* $\Rightarrow KE = \frac{3}{2}RT$ (for 1 mole)

Given, $T = 47 + 273 = 320$ K

$$KE = \frac{3}{2} \times 8.314 \times 320 = 3990.7\text{ J mol}^{-1}$$

Molar mass of $O_2 = 32\text{g mol}^{-1}$

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$$\text{KE (per gram of } O_2) = \frac{3990.7}{32}\ \text{J g}^{-1}$$
$$= 124.7\ \text{J g}^{-1}$$
$$= 1.24 \times 10^2\ \text{J g}^{-1}$$

**19.** *(a)* $\pi = \frac{n}{V}RT = \frac{0.2 \times 0.082 \times 300}{1.0} = 4.92$ atm

**20.** *(a)* Reduction of glucose with $NaBH_4$ gives sorbitol.

$$\underset{\text{Glucose}}{\begin{array}{c} CHO \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}} + 2[H] \xrightarrow{NaBH_4} \underset{\text{Sorbitol}}{\begin{array}{c} CH_2OH \\ | \\ (CHOH)_4 \\ | \\ CH_2OH \end{array}}$$

**21.** *(d)* Decarboxylation of sodium propionate leads to the formation of ethane.

$$CH_3CH_2COONa + NaOH \xrightarrow{\text{CaO, 360 K}} \underset{\text{Ethane}}{CH_3{-}CH_3} + Na_2CO_3$$

**22.** *(d)* Formic acid reacts with $PCl_5$ to give carbon monoxide and hydrogen chloride.

$$HCOOH + PCl_5 \rightarrow \underset{\text{unstable}}{[HCOCl]} \rightarrow CO + HCl$$

**23.** *(c)* $\Delta H < 0$ and $\Delta S > 0$ are always favourable conditions for spontaneity at all temperatures.

**24.** *(b)* $\Delta G° = -RT \ln K$

$$\Delta G° = -2.303\, RT \log K$$
$$= -2.303 \times 8 \times 300 \times \log 10$$
$$= -2.303 \times 8 \times 300 \times 1$$
$$= -5527\text{J mol}^{-1} = -5.527\ \text{kJ mol}^{-1}$$

**25.** *(a)* Due to $-R$ effect of the C=O group the electron density on the N-atom decreases, hence amides are weaker base than $NH_3$ and aliphatic amines. Further due to $-I$ effect of $NH_2$ group, the electron density on the other N-atom decreases. As a result, $NH_2NH_2$ is a much weaker base than $NH_3$ and aliphatic amines. Therefore, ethylamine is most basic among these.

**26.** *(a)* $CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

25 mL of 0.75 M HCl $= \frac{25}{1000} \times 0.75 = 0.01875$ mol

Moles of $CaCO_3$ required $= \frac{\text{moles of HCl}}{2}$

$$= \frac{0.01875}{2} = 9.375 \times 10^{-3}\ \text{mol}$$

Mass of $CaCO_3$ required

$$= 9.375 \times 10^{-3}\ \text{mol} \times 100\ \text{g mol}^{-1}$$
$$= 0.9375\ \text{g} = 0.94\ \text{g}$$

**27.** *(d)* There are $(2l + 1)$ values of $m$ for the each value of $l$.

$\because \quad l = 3$

$\therefore$ Total values of $m = (2 \times 3 + 1) = 7$

**28.** *(c)* The ionisation energy of nitrogen is larger than that of oxygen because half-filled $p$-orbitals of nitrogen have extra stability while oxygen has $2p^4$ electronic configuration of the outermost shell, hence its electrons can be easily removed.

**29.** *(a)* For two third of a reaction

$$[A]_0 = a, [A] = a - \frac{2}{3}a = \frac{a}{3}$$
$$t_{2/3} = \frac{2.303}{k} \log \frac{[A]_0}{[A]}$$
$$= \frac{2.303}{5.48 \times 10^{-14}} \log \frac{a}{a/3}$$
$$= \frac{2.303}{5.48 \times 10^{-14}} \log 3$$

**30.** *(a)* Nitric oxide (NO) has one unpaired electron and it is paramagnetic in nature. It has 15 electrons.

$$\text{NO} : KK\ \sigma(2s)^2\ \overset{*}{\sigma}(2s)^2\ \sigma(2p_z)^2$$
$$\pi(2p_x)^2\, \pi(2p_y)^2\ \overset{*}{\pi}(2p_x)^1$$

**31.** *(c)* Oxygen has an oxidation state of +2 in $OF_2$ because oxidation number of fluorine is always $-1$.

**32.** *(b)* Total volume after mixing = 50 + 30 = 80 cc

Moles of HCl after mixing $= \frac{50}{80}$ M

Moles of NaOH after mixing $= \frac{30}{80}$ M

Remaining number of moles of HCl after mixing

$$= \frac{50}{80} - \frac{30}{80} = 0.25\ \text{M}$$
$$[H^+] = 0.25 = 2.5 \times 10^{-1}$$
$$\text{pH} = -\log [2.5 \times 10^{-1}]$$
$$= 1 - 0.3979 = 0.6021$$

**33.** *(a)* Noble gases are monoatomic. The value of $C_P / C_V$ for noble gases is 1.66.

**34.** *(b)* Carbylamine test is performed in alcoholic KOH by heating a mixture of trihalogenated methane and a primary amine.

$$\underset{\text{Primary amine}}{RNH_2} + \underset{\text{Chloroform}}{CHCl_3} + 3KOH(\text{alc.}) \xrightarrow{\Delta} \underset{\text{Alkyl isocyanide}}{RNC} + 3KCl + 3H_2O$$

**35.** *(a)* The order of acidity is as :

$$RCOOH > H_2CO_3 > C_6H_5OH > H_2O > ROH$$

$\xrightarrow{\hspace{4cm}}$ Decreasing acid strength (Decreasing $K_a$)

**36.** *(d)* The order of reactivity of alcohols towards Lucas reagent is as

Tertiary > Secondary > Primary

Since 2-methyl propan-2-ol is a tertiary alcohol, hence it reacts fastest with Lucas reagent at room temperature.

**37.** *(a)* $\underset{\text{Methanal}}{HCHO} \xrightarrow{\text{Reduction}} \underset{\text{Methanol}}{CH_3OH} \xrightarrow{P + I_2} \underset{\text{Methyl iodide}}{CH_3I}$

$\xrightarrow{KCN} \underset{\text{Methyl cyanide}}{CH_3CN} \xrightarrow{\text{Hydrolysis}} \underset{\text{Acetic acid}}{CH_3COOH}$

**38.** *(a)* The conjugate base of the acid $H_2S$ is $HS^-$.

$$\underset{\text{Acid}}{H_2S} \rightleftharpoons \underset{\text{Conjugate base}}{HS^-} + H^+$$

**39.** *(b)* Transition metal ion having electronic configuration $(n-1)\ d^{1-9}$ forms coloured ion.

$Cu^{2+}$ $(Z = 29)$ : [Ar] $3d^9$

$Cu^+$ $(Z = 29)$ : [Ar] $3d^{10}$

$Ni^{2+}$ $(Z = 28)$ : [Ar] $3d^8$

$Fe^{3+}$ $(Z = 26)$ : [Ar] $3d^5$

Hence, $Cu^+$ ion is not coloured.

**40.** *(a)* Glycine can be obtained from formaldehyde by Streker synthesis.

$$\underset{\text{Formaldehyde}}{H-\overset{\overset{\displaystyle O}{\|}}{C}-H} + HCN \longrightarrow \underset{\text{Formaldehyde cyanohydrin}}{H-\overset{\overset{\displaystyle OH}{|}}{C}-CN}$$

$$\xrightarrow[-H_2O]{NH_3} H-\overset{\overset{\displaystyle NH_2}{|}}{CH}-CN \xrightarrow{H_2O/H^+} \underset{\text{Glycine}}{NH_2-CH_2-COOH}$$

**41.** *(c)* Polar aprotic solvents such as DMSO increase the rate of $S_N2$ reactions.

**42.** *(c)* EAN of Cu in $[Cu(NH_3)_4]\ SO_4$ is as :

EAN = $Z$ − (O.N.) + 2 (C.N.)

EAN = 29 − 2 + 4 × 2 = 35

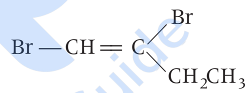
**43.** *(a)* For a reaction to be spontaneous $\Delta G$ should be negative.

$$\Delta G = -nFE^\circ_{\text{cell}}$$

From this reaction, $\Delta G$ will be negative when $E^\circ_{\text{cell}}$ is positive.

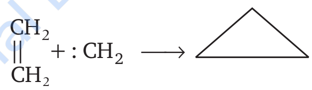
**44.** *(c)* In a face centred cubic lattice, a unit cell is shared equally by six unit cells.

**45.** *(b)* 1, 2-dibromobutene has different substituents on each C-atom of the double bond, hence it shows geometrical isomerism.



**46.** *(a)* α-amino acids are essential building units of proteins.

**47.** *(d)* $CH_2N_2 \xrightarrow[-N_2]{} \underset{\text{Carbene}}{:CH_2}$



**48.** *(b)* The first ever compound of noble gas $Xe^+\ [PtF_6]^-$ was prepared by Neil Bartlett in 1962.

**49.** *(a)* $K_2Cr_2O_7$ on heating with aqueous alkalies gives chromates

$$K_2Cr_2O_7 + 2NaOH \longrightarrow K_2CrO_4 + Na_2CrO_4 + H_2O$$

**50.** *(d)* Energy of electron in $n$th orbit of hydrogen,

$$E_n = -\frac{E}{n^2}$$

where, $E$ is a constant.

$$\Rightarrow \qquad \frac{E_2}{E_4} = \frac{(n_4)^2}{(n_2)^2}$$

$$\frac{-328}{E_4} = \frac{(4)^2}{(2)^2}$$

$$\therefore \qquad E_4 = \frac{-328 \times 4}{16} = -82 \text{ kJ mol}^{-1}$$

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## Mathematics

**1.** *(c)* Since, roots are complex.

$\therefore \quad a^2 - 36 < 0 \quad (\because \text{discriminant} < 0)$

$\Rightarrow \quad a^2 < 36$

$\Rightarrow \quad |a| < 6$

**2.** *(c)* Since, projection of $\mathbf{PQ}$ on $OX$, $OY$, $OZ$ are 12, 3 and 4 respectively, then $\mathbf{PQ} = 12\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 4\hat{\mathbf{k}}$

$$\therefore \quad |\mathbf{PQ}| = \sqrt{12^2 + 3^2 + 4^2} = \sqrt{169}$$
$$= 13$$

**3.** *(a)* Let $e$ be the identity.

$\therefore \quad a * e = a$

$\Rightarrow \quad \dfrac{ab}{6} = a$

$\Rightarrow \quad e = 6$

$\because \quad a * a^{-1} = e$

$\therefore \quad a * a^{-1} = 6$

$\Rightarrow \quad \dfrac{a\, a^{-1}}{6} = 6 \Rightarrow a^{-1} = \dfrac{6 \times 6}{a}$

$\therefore \quad 9^{-1} = \dfrac{6 \times 6}{9} = 4$

**4.** *(c)* Let $I = \displaystyle\int_0^1 \frac{d}{dx}\left[\sin^{-1}\left(\frac{2x}{1+x^2}\right)\right] dx$

$$\therefore \quad I = \int_0^1 \frac{d}{dx}\,[\sin^{-1}(\sin 2\theta)]\, dx \qquad (\text{put } x = \tan\theta)$$
$$= 2\int_0^1 \frac{d}{dx}\,[\tan^{-1} x]\, dx$$
$$= 2\,[\tan^{-1}(1) - \tan^{-1}(0)]$$
$$= 2 \cdot \frac{\pi}{4} = \frac{\pi}{2}$$

**5.** *(a)* Given, $4\sin^{-1} x + \cos^{-1} x = \pi$

$\Rightarrow \quad 4\sin^{-1} x + \dfrac{\pi}{2} - \sin^{-1} x = \pi$

$\Rightarrow \quad 3\sin^{-1} x = \dfrac{\pi}{2}$

$\Rightarrow \quad x = \sin\left(\dfrac{\pi}{6}\right) = \dfrac{1}{2}$

**6.** *(b)* $\displaystyle\sum_{n=1}^{\infty} \frac{(-1)^n}{n+1}$

$$= -\frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \ldots \infty$$
$$= 1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} + \ldots \infty - 1 = \log 2 - 1$$

**7.** *(b)* Given, $\tan^{-1} x + \tan^{-1} y + \tan^{-1} z = \pi$

$\Rightarrow \quad \tan^{-1}\left(\dfrac{x + y + z - xyz}{1 - xy - yz - zx}\right) = \pi$

$\Rightarrow \quad x + y + z - xyz = 0$

**8.** *(a)*

| $p$ | $q$ | $\sim p$ | $\sim q$ | $p \wedge \sim q$ | $\sim p \vee q$ | $(p \wedge \sim q) \wedge (\sim p \vee q)$ |
|---|---|---|---|---|---|---|
| T | T | F | F | F | T | F |
| T | F | F | T | T | F | F |
| F | T | T | F | F | T | F |
| F | F | T | T | F | T | F |

Clearly, $(p \wedge \sim q) \wedge (\sim p \vee q)$ is a contradiction.

**9.** *(d)* $(1 + x + x^2 + x^3)^{-3} = \left[\dfrac{(x^4 - 1)}{x - 1}\right]^{-3}$

$$= (x^4 - 1)^{-3}\,(x - 1)^3$$
$$= (-1)^{-3}\,(1 - x^4)^{-3}\,(x - 1)^3$$
$$= (-1)\,(1 + 3x^4 + \ldots)\,(x^3 - 3x^2 + 3x - 1)$$

$\therefore$ Coefficient of $x$ in $(1 + x + x^2 + x^3)^{-3}$ is $-3$.

**10.** *(a)* $f'(3) = \displaystyle\lim_{h \to 0} \frac{f(3 + h) - f(3)}{h}$

$$= \lim_{h \to 0} \frac{f(3)\, f(h) - f(3)}{h} \qquad [\because f(x + y) = f(x)\, f(y)]$$

Now, $\quad f(x + 0) = f(x)\, f(0)$

$\Rightarrow \quad f(x)\,[f(0) - 1] = 0$

Either $f(x) = 0$ or $f(0) = 1$

$\therefore \quad f'(3) = f(3) \displaystyle\lim_{h \to 0} \frac{f(h) - f(0)}{h}$

$$= f(3)\, f'(0) = f(3) \cdot 11$$
$$= 3 \times 11 = 33$$

**11.** *(c)* The equation of given line is

$$\frac{x}{a} - \frac{y}{b} = 1$$

$\Rightarrow \quad bx - ay = ab$

A line perpendicular to given line is

$$ax + by = \lambda$$

$\therefore$ In the given options, option (c) is correct.

**12.** *(c)* Given, $\cos^{-1} x + \cos^{-1} y = 2\pi$

$\Rightarrow \quad \dfrac{\pi}{2} - \sin^{-1} x + \dfrac{\pi}{2} - \sin^{-1} y = 2\pi$

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$\Rightarrow \quad \pi - 2\pi = \sin^{-1} x + \sin^{-1} y$

$\Rightarrow \quad \sin^{-1} x + \sin^{-1} y = -\pi$

**13.** *(b)* $\log_3 2, \log_3 (2^x - 5), \log_3 \left(2^x - \frac{7}{2}\right)$ are in AP.

$$\Rightarrow \log_3 (2^x - 5) = \frac{\log_3 \left(2^x - \frac{7}{2}\right) + \log_3 2}{2}$$

$$\Rightarrow (2^x - 5)^2 = 2 \cdot \left(2^x - \frac{7}{2}\right)$$

$$\Rightarrow (2^x)^2 + 25 - 10 \cdot 2^x = 2 \cdot 2^x - 7$$

$$\Rightarrow (2^x)^2 - 12 \cdot 2^x + 25 + 7 = 0$$

$$\Rightarrow (2^x)^2 - 12 \cdot 2^x + 32 = 0$$

$$\Rightarrow 2^x = 8 \text{ or } 2^x = 4$$

$$\Rightarrow x = 3 \text{ or } 2$$

$\Rightarrow x = 3$ ($\because x = 2$ does not satisfy the given series)

**14.** *(c)* $\int_0^1 x(1-x)^{12}\, dx$

$$= \left[\frac{x(1-x)^{13}}{-13} + \int_0^1 \frac{(1-x)^{13}}{13}\, dx\right]_0^1$$

$$= \left[\frac{x(1-x)^{13}}{-13}\right]_0^1 + \left[\frac{(1-x)^{14}}{-14 \times 13}\right]_0^1$$

$$= [0 - 0] + \left[0 - \frac{1}{-14 \times 13}\right] = \frac{1}{182}$$

**15.** *(a)* Middle term is $\left(\frac{n}{2} + 1\right)$th term for $n$ even.

$\therefore$ Middle term $= \left(\frac{6}{2} + 1\right) = 4$ th term

$$\therefore \quad T_4 = {}^6C_3 (\sqrt{x})^3 \left(-\frac{1}{\sqrt{x}}\right)^{6-3}$$

$$= \frac{6!}{3!\,3!} (\sqrt{x})^3 \frac{(-1)^3}{(\sqrt{x})^3}$$

$$= \frac{-6 \times 5 \times 4}{6}$$

$$= -20$$

**16.** *(d)* Let $a$ and $b$ be any element of group $G$.

$\therefore \quad a = a^{-1}, b = b^{-1} \ \forall\ a, b \in G$

Now, $(ab)^{-1} = ab$ [$\because a, b \in G \Rightarrow ab \in G$]

$\Rightarrow \quad b^{-1}a^{-1} = ab \Rightarrow ba = ab \ \forall\ a, b \in G$

Hence, commutative law holds in group $G$.

Therefore, $G$ is abelian group.

**17.** *(b)* Since, $P(3)$ is true.

Assume $P(k)$ is true $\Rightarrow P(k+1)$ is true means, if $P(3)$ is true $\Rightarrow P(4)$ is true $\Rightarrow P(5)$ is true and so on. So, statement is true for all $n \geq 3$.

**18.** *(b)* $\Delta = \begin{vmatrix} 1 & a & a^2 \\ 1 & b & b^2 \\ 1 & c & c^2 \end{vmatrix} = \begin{vmatrix} 1 & a & a^2 \\ 0 & b-a & b^2-a^2 \\ 0 & c-a & c^2-a^2 \end{vmatrix}$

(using $R_2 \to R_2 - R_1$ and $R_3 \to R_3 - R_1$)

$$= (b-a)(c-a) \begin{vmatrix} 1 & a & a^2 \\ 0 & 1 & b+a \\ 0 & 1 & c+a \end{vmatrix}$$

$$= (b-a)(c-a)(c+a-b-a)$$

$\Rightarrow (b-a)(c-a)(c-b)$

$= k(a-b)(b-c)(c-a)$ (given)

$\Rightarrow \quad k = 1$

**19.** *(c)* Number of required ways $= {}^{22-4-2}C_{11-2}$

$= {}^{16}C_9$

**20.** *(b)* Given, $\Delta_1 = \begin{vmatrix} x & a & b \\ b & x & a \\ a & b & x \end{vmatrix}, \Delta_2 = \begin{vmatrix} x & b \\ a & x \end{vmatrix}$

$$\therefore \frac{d}{dx}(\Delta_1) = \begin{vmatrix} 1 & 0 & 0 \\ b & x & a \\ a & b & x \end{vmatrix} + \begin{vmatrix} x & a & b \\ 0 & 1 & 0 \\ a & b & x \end{vmatrix} + \begin{vmatrix} x & a & b \\ b & x & a \\ 0 & 0 & 1 \end{vmatrix}$$

$$= \begin{vmatrix} x & a \\ b & x \end{vmatrix} + \begin{vmatrix} x & b \\ a & x \end{vmatrix} + \begin{vmatrix} x & a \\ b & x \end{vmatrix} = 3\Delta_2$$

$$\therefore \frac{d}{dx}(\Delta_1) = 3\Delta_2$$

**21.** *(a)* Let $I = \int_{-1/2}^{1/2} \frac{dx}{(1-x^2)^{1/2}}$

Again, let $f(x) = \frac{1}{(1-x^2)^{1/2}}$

$$f(-x) = \frac{1}{(1-x^2)^{1/2}} = f(x)$$

$$\therefore \quad I = 2\int_0^{1/2} \frac{dx}{(1-x^2)^{1/2}} = \left[2\sin^{-1}\frac{x}{1}\right]_0^{1/2}$$

$$= 2\sin^{-1}\frac{1}{2} = 2 \times \frac{\pi}{6} = \frac{\pi}{3}$$

**22.** *(c)* $\lim_{n \to \infty} \left[\frac{1}{n+1} + \frac{1}{n+2} + \ldots + \frac{1}{n+5n}\right]$

$$= \lim_{n \to \infty} \sum_{r=0}^{5n} \frac{1}{n+r} = \lim_{n \to \infty} \left[\frac{1}{n} \sum_{r=0}^{5n} \frac{n}{n+r}\right]$$

$$= \lim_{n \to \infty} \left[\frac{1}{n} \sum_{r=0}^{5n} \frac{1}{1+(r/n)}\right]$$

$$= \int_0^5 \frac{1}{1+x}\, dx = [\log(1+x)]_0^5$$

$$= \log 6 - \log 1 = \log 6$$

**23.** *(b)* $\left[5+\left(\frac{dy}{dx}\right)^2\right]^{5/3} = x^5\left[\frac{d^2y}{dx^2}\right]$

$\Rightarrow \quad \left[5+\left(\frac{dy}{dx}\right)^2\right]^5 = x^{15}\left[\frac{d^2y}{dx^2}\right]^3$

$\therefore$ Degree = 3

**24.** *(c)* The difference of the focal distance at any point on the hyperbola is same as length of transverse axis.

**25.** *(b)* Since, a ray makes angles $\alpha, \beta, \gamma$ with the positive direction of the axes.

$\therefore \quad \cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$

$\Rightarrow \quad 1-\sin^2\alpha + 1 - \sin^2\beta + 1 - \sin^2\gamma = 1$

$\Rightarrow \quad \sin^2\alpha + \sin^2\beta + \sin^2\gamma = 2$

**26.** *(b)* Given, $f(x) = \begin{cases} 3x^2 + 12x - 1, & -1 \le x \le 2 \\ 37 - x, & 2 \le x \le 3 \end{cases}$

On differentiating, we get

$$f'(x) = \begin{cases} 6x + 12, & -1 \le x \le 2 \\ -1 , & 2 \le x \le 3 \end{cases}$$

$\Rightarrow \quad f'(x) > 0$ for $-1 \le x \le 2$

$\therefore$ $f(x)$ is increasing in $[-1, 2]$

$\lim\limits_{x \to 2^+} f'(x) = -1$ and $\lim\limits_{x \to 2^-} f'(x) = 24$

$\therefore$ $f'(2)$ does not exist.

**27.** *(c)* Given,

$$\mathbf{a} = \frac{1}{7}(2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 6\hat{\mathbf{k}}), \mathbf{b} = \frac{1}{7}(3\hat{\mathbf{i}} - \lambda\hat{\mathbf{j}} + 2\hat{\mathbf{k}})$$

Since, the vectors **a** and **b** are perpendicular.

$\therefore \quad \mathbf{a} \cdot \mathbf{b} = 0$

$\Rightarrow \frac{1}{7}(2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 6\hat{\mathbf{k}}) \cdot \frac{1}{7}(3\hat{\mathbf{i}} - \lambda\hat{\mathbf{j}} + 2\hat{\mathbf{k}}) = 0$

$\Rightarrow \quad \frac{1}{49}(6 - 3\lambda + 12) = 0$

$\Rightarrow \quad 3\lambda = 18$

$\Rightarrow \quad \lambda = 6$

**28.** *(c)* The locus of the point of intersection of two perpendicular tangents to a circle is called director circle.

**29.** *(b)* The equation of given curve is

$$y = x^4 - 2x^3 + x^2 + 3$$

On differentiating w.r.t. $x$, we get

$$\frac{dy}{dx} = 4x^3 - 6x^2 + 2x$$

Again, differentiating, we get

$$\frac{d^2y}{dx^2} = 12x^2 - 12x + 2$$

Put, $\frac{dy}{dx} = 0$ for maxima or minima.

$\Rightarrow \quad 2x(2x^2 - 3x + 1) = 0$

$\Rightarrow \quad x = 0, 1, \frac{1}{2}$

$\therefore \quad \left(\frac{d^2y}{dx^2}\right)_{(x=0)} = 2$

$\therefore$ Function is minimum at $x = 0$

and $\quad \left(\frac{d^2y}{dx^2}\right)_{x=1} = 12 - 12 + 2 = 2$

$\therefore$ Function is minimum at $x = 1$

Also, $\quad \left(\frac{d^2y}{dx^2}\right)_{\left(x=\frac{1}{2}\right)} = -1 < 0$

$\therefore$ Function is maximum at $x = \frac{1}{2}$

$\therefore$ Required area $= \int_0^1 (x^4 - 2x^3 + x^2 + 3)\, dx$

$$= \left[\frac{x^5}{5} - \frac{2x^4}{4} + \frac{x^3}{3} + 3x\right]_0^1$$

$$= \frac{1}{5} - \frac{1}{2} + \frac{1}{3} + 3$$

$$= \frac{91}{30} \text{ sq unit}$$

**30.** *(b)* $\int (e^{a\log x} + e^{x\log a})\, dx = \int (e^{\log x^a} + e^{\log a^x})\, dx$

$= \int (x^a + a^x)\, dx = \frac{x^{a+1}}{a+1} + \frac{a^x}{\log_e a} + c$

**31.** *(d)* $\lim\limits_{n \to \infty}\left(\frac{1}{\sqrt{4n^2 - 1}} + \frac{1}{\sqrt{4n^2 - 2^2}} + \ldots + \frac{1}{\sqrt{3n^2}}\right)$

$$= \lim_{n \to \infty} \frac{1}{n}\left[\frac{1}{\sqrt{4 - \left(\frac{1}{n}\right)^2}} + \frac{1}{\sqrt{4 - \left(\frac{2}{n}\right)^2}} + \ldots + \frac{1}{\sqrt{4 - \left(\frac{n}{n}\right)^2}}\right]$$

$$= \lim_{h \to 0} h\left[\frac{1}{\sqrt{4 - h^2}} + \frac{1}{\sqrt{4 - (2h)^2}} + \ldots + \frac{1}{\sqrt{4 - (nh)^2}}\right]$$

$$= \int_0^1 \frac{dx}{\sqrt{4 - x^2}} = \left[\sin^{-1}\frac{x}{2}\right]_0^1$$

$$= \sin^{-1}\left(\frac{1}{2}\right) - \sin^{-1}(0) = \frac{\pi}{6}$$

Your Personal Exams Guide

**32.** *(b)* Let $I = \int \frac{dx}{x^2 + 4x + 13}$

$$= \int \frac{dx}{x^2 + 4x + 4 + 3^2} = \int \frac{dx}{(x + 2)^2 + 3^2}$$

$$= \frac{1}{3} \tan^{-1} \left(\frac{x + 2}{3}\right) + c$$

**33.** *(b)* Equation of tangent at $(a, 0)$ is $x = a$ and the point of intersection of $x = a$ and the asymptotes will be obtained by solving $x = a$ and the equation of asymptotes $bx \pm ay = 0$

$\therefore \quad ab \pm ay = 0$

$\Rightarrow \quad y = \pm b$

Now, point of intersections are $(a, b)$ and $(a, -b)$.

$\therefore$ Area of triangle $= \frac{1}{2}(ab \times 2) = ab$ sq unit

**34.** *(c)* The equation of line passing through the origin is given by

$$y = mx \quad \ldots\text{(i)}$$

On differentiating w.r.t. $x$, we get

$$\frac{dy}{dx} = m \Rightarrow \frac{dy}{dx} = \frac{y}{x} \quad \text{[from Eq. (i)]}$$

$$\Rightarrow \quad x\frac{dy}{dx} - y = 0$$

**35.** *(b)* $\therefore PQ = \begin{bmatrix} i & 0 & -i \\ 0 & -i & i \\ -i & i & 0 \end{bmatrix} \begin{bmatrix} -i & i \\ 0 & 0 \\ i & -i \end{bmatrix}$

$$= \begin{bmatrix} -i^2 - i^2 & i^2 + i^2 \\ 0 + 0 + i^2 & -i^2 \\ i^2 & -i^2 \end{bmatrix} = \begin{bmatrix} 2 & -2 \\ -1 & 1 \\ -1 & 1 \end{bmatrix}$$

**36.** *(a)* $x = \sin^{-1}(3t - 4t^3)$

and $\quad y = \cos^{-1}(\sqrt{1 - t^2})$

Let $\quad t = \sin\theta$

$\therefore \quad x = \sin^{-1}(3\sin\theta - 4\sin^3\theta)$

$= \sin^{-1}(\sin 3\theta) = 3\sin^{-1} t$

$\therefore \quad \frac{dx}{dt} = \frac{3}{\sqrt{1 - t^2}}$

and $\quad y = \cos^{-1}(\sqrt{1 - \sin^2\theta})$

$= \cos^{-1}(\sqrt{\cos^2\theta}) = \sin^{-1} t$

$\therefore \quad \frac{dy}{dt} = \frac{1}{\sqrt{1 - t^2}}$

$\therefore \quad \frac{dy}{dx} = \frac{dy/dt}{dx/dt} = \frac{1/\sqrt{1 - t^2}}{3/\sqrt{1 - t^2}} = \frac{1}{3}$

**37.** *(d)* Since, $a$ and $b$ are the roots of equation

$$x^2 - 3x + 1 = 0$$

$\therefore \quad a + b = 3$ and $ab = 1$

Now, the given roots are $a - 2$ and $b - 2$

$\therefore$ Sum of roots $= a - 2 + b - 2$

$= 3 - 4 = -1$

and products of roots $= (a - 2)(b - 2)$

$= ab - 2(a + b) + 4$

$= 1 - 6 + 4 = -1$

$\therefore$ Required equation is $x^2 + x - 1 = 0$

Which is equivalent to $x^2 + px + q = 0$

$\therefore \quad p = 1$ and $q = -1$

**38.** *(a)* Since, $\mathbf{AB} = \hat{\mathbf{i}} + 5\hat{\mathbf{j}} - \hat{\mathbf{k}}$

and $\quad \mathbf{BC} = -3\hat{\mathbf{j}} - \hat{\mathbf{k}}$

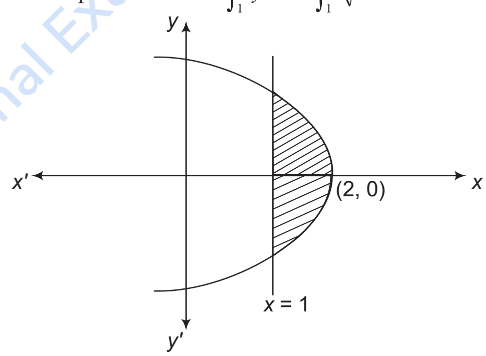
$\therefore$ Projection of $\mathbf{AB}$ on $\mathbf{BC} = \frac{\mathbf{AB} \cdot \mathbf{BC}}{|\mathbf{BC}|}$

$$= \frac{(\hat{\mathbf{i}} + 5\hat{\mathbf{j}} - \hat{\mathbf{k}}) \cdot (-3\hat{\mathbf{j}} - \hat{\mathbf{k}})}{\sqrt{(-3)^2 + (-1)^2}} = \frac{-15 + 1}{\sqrt{10}} = -\frac{14}{\sqrt{10}}$$

**39.** *(a)* Given equation can be rewritten as

$$y^2 = -4(x - 2)$$

$\therefore$ Required area $= 2\int_1^2 y\,dx = \int_1^2 \sqrt{8 - 4x}\,dx$




$$= \left[\frac{(8 - 4x)^{3/2}}{\frac{3}{2}(-4)}\right]_1^2 = -\frac{1}{6}[0 - 8]$$

$$= \frac{4}{3} \text{ sq unit}$$

**40.** *(b)* The given equation is

$$(2y - 1)\,dx - (2x + 3)\,dy = 0$$

or it can be rewritten as

$$\frac{dx}{(2x + 3)} - \frac{dy}{(2y - 1)} = 0$$

On integrating both sides, we get

$$\int \frac{1}{(2x+3)}\,dx - \int \frac{1}{(2y-1)}\,dy = 0$$

$$\Rightarrow \quad \frac{1}{2}\log(2x+3) - \frac{1}{2}\log(2y-1) = \frac{1}{2}\log c$$

$$\Rightarrow \quad \log\left(\frac{2x+3}{2y-1}\right) = \log c \Rightarrow \frac{2x+3}{2y-1} = c$$

**41.** (a) According to the question,

$$5\left(-\frac{1}{2}\right)^{n-1} = \frac{5}{1024}$$

$$\Rightarrow \quad \left(-\frac{1}{2}\right)^{n-1} = \left(-\frac{1}{2}\right)^{10}$$

$$\Rightarrow \quad n-1 = 10$$

$$\Rightarrow \quad n = 11$$

**42.** (a) Give that, $77x \equiv 88 \pmod 5$

$\Rightarrow 77x - 88$ is divisible by 5.

$\therefore \quad x = 4$

[$\because 77 \times 4 - 88 = 308 - 88 = 220$ is divisible by 5]

**43.** (b) Let $p$ : Paris is in France.

$q$ : London is in England.

$\therefore$ We have, $p \wedge q$

Its negation is $\sim(p \wedge q) = \sim p \vee \sim q$

*ie,* Paris is not in France or London is not in England.

**44.** (a) Given, $^{2n}C_3 : {}^nC_2 = \frac{44}{3}$

$$\Rightarrow \quad \frac{2n!}{(2n-3)!\,3!} \times \frac{2!(n-2)!}{n!} = \frac{44}{3}$$

$$\Rightarrow \frac{2n(2n-1)(2n-2)}{3} \times \frac{1}{n(n-1)} = \frac{44}{3}$$

$$\Rightarrow \quad \frac{2}{3} \times 2(2n-1) = \frac{44}{3}$$

$$\Rightarrow \quad 2n-1 = 11 \Rightarrow 2n = 12 \Rightarrow n = 6$$

**45.** (a) Now, $\lim_{x \to 0} f(x) = \lim_{x \to 0} \frac{3x + \tan^2 x}{x}$

$$= \lim_{x \to 0} \frac{3 + 2\tan x \sec^2 x}{1}$$

$$= 3$$

Since, $f(x)$ is continuous at $x = 0$

$\therefore \quad f(0) = 3$

**46.** (c) $0.2 + 0.22 + 0.222 + \ldots n$ terms

$= 2(0.1 + 0.11 + 0.111 + \ldots n \text{ terms})$

$$= 2\left(\frac{1}{10} + \frac{11}{100} + \frac{111}{1000} + \ldots n \text{ terms}\right)$$

$$= \frac{2}{9}\left(\frac{9}{10} + \frac{99}{100} + \frac{999}{1000} + \ldots n \text{ terms}\right)$$

$$= \frac{2}{9}\left(1 - \frac{1}{10} + 1 - \frac{1}{100} + 1 - \frac{1}{1000} + \ldots \; n \text{ terms}\right)$$

$$= \frac{2}{9}\left[n - \left(\frac{1}{10} + \frac{1}{100} + \frac{1}{1000} + \ldots n\right)\right]$$

$$= \frac{2}{9}\left[n - \frac{1}{10}\,\frac{\left\{1 - \left(\frac{1}{10}\right)^n\right\}}{\left(1 - \frac{1}{10}\right)}\right]$$

$$= \frac{2}{9}\left[n - \frac{1}{10} \times \frac{10}{9} \cdot \left(\frac{10^n - 1}{10^n}\right)\right]$$

$$= \frac{2}{9}\left[n - \frac{1}{9}(1 - 10^{-n})\right]$$

**47.** (d) $(1 + \omega - \omega^2)^5 + (1 - \omega + \omega^2)^5$

$= (-\omega^2 - \omega^2)^5 + (-\omega - \omega)^5$

$= -32(\omega^2)^5 + (-32)\omega^5$

$= -32(\omega + \omega^2) = 32$

**48.** (d) Lines, $x + y = 6$, $2x + y = 4$ and $x + 2y = 5$ intersect at points $(-2, 8)$, $(7, -1)$ and $(1, 2)$.

Now, all these points lie on

$$x^2 + y^2 - 17x - 19y + 50 = 0$$

**49.** (b) $\lim_{x \to 0} \frac{\sin 3x - \sin x}{\sin x}$

$$= \lim_{x \to 0} \frac{2\cos 2x \sin x}{\sin x} = 2$$

**50.** (c) Product of roots of equation is

$$\frac{2m-1}{m} = (-1) \text{ given}$$

$$\Rightarrow \quad 2m - 1 = -m$$

$$\Rightarrow \quad 3m = 1 \Rightarrow m = \frac{1}{3}$$

**51.** (a) Let $I = \int_0^{2a} \frac{f(x)}{f(x) + f(2a-x)}\,dx \quad \ldots\text{(i)}$

$$I = \int_0^{2a} \frac{f(2a-x)}{f(2a-x) + f(x)}\,dx \quad \ldots\text{(ii)}$$

On adding Eqs. (i) and (ii), we get

$$2I = \int_0^{2a} \frac{f(2a-x) + f(x)}{f(2a-x) + f(x)}\,dx = \int_0^{2a} dx = 2a$$

$\Rightarrow I = a$

**52.** *(c)* Let $I = \int \frac{\sqrt{\tan x}}{\sin x \cos x} dx = \int \frac{\sqrt{\tan x}}{\tan x} \sec^2 x \, dx$

$= \int \frac{1}{\sqrt{\tan x}} \cdot \sec^2 x \, dx = \frac{\sqrt{\tan x}}{1/2} = 2\sqrt{\tan x} + c$

**53.** *(a)* The given equation of curve is $(1 + x^2) y = 2 - x$, it meets $x$-axis at $(2, 0)$

or it can be rewritten as $y = \frac{2 - x}{1 + x^2}$

On differentiating w.r.t. $x$, we get

$$\frac{dy}{dx} = \frac{(1 + x^2)(-1) - (2 - x)(2x)}{(1 + x^2)^2}$$

$$= \frac{-1 - x^2 - 4x + 2x^2}{(1 + x^2)^2}$$

$$\Rightarrow \left(\frac{dy}{dx}\right)_{(2,0)} = \frac{-1 - 4 - 8 + 8}{25} = -\frac{1}{5}$$

$\therefore$ Required equation of tangent is

$$(y - 0) = -\frac{1}{5}(x - 2) \Rightarrow x + 5y = 2$$

**54.** *(b)* $\lim_{x \to 0} \left(\frac{1 - \cos mx}{1 - \cos nx}\right)$

$$= \lim_{x \to 0} \frac{2\sin^2 (mx/2)}{(mx/2)^2} \cdot \frac{(nx/2)^2}{2\sin^2 (nx/2)} \cdot \frac{m^2}{n^2} = \frac{m^2}{n^2}$$

**55.** *(c)* $|\mathbf{a} + \mathbf{b} + \mathbf{c}|^2 = |\mathbf{a}|^2 + |\mathbf{b}|^2 + |\mathbf{c}|^2 + 2(\mathbf{a} \cdot \mathbf{b} + \mathbf{b} \cdot \mathbf{c} + \mathbf{c} \cdot \mathbf{a})$

$= a^2 + a^2 + a^2$

($\because$ **a**, **b** and **c** are mutually perpendicular)

$\Rightarrow \quad |\mathbf{a} + \mathbf{b} + \mathbf{c}| = \sqrt{3}a$

**56.** *(a)* We know that $K_n$, the complete graph of $n$ vertices is a connected graph in which degree of each vertex is $n - 1$. Since, a graph is Eulerian if and only if it is connected and degree of each vertex is even, we conclude that $K_n$ is an Euler graph if and only if $n$ is odd.

**57.** *(a)* Now, $5^2 \equiv 4 \pmod 7$

$5^4 \equiv 16 \pmod 7 = 2 \pmod 7$

$(5^4)^5 \equiv 2^5 \pmod 7$

i.e. $\quad 5^{20} \equiv 32 \pmod 7 = 4 \pmod 7$

$\therefore$ Remainder is 4.

**58.** *(c)* Since, $a \cdot b = (a * b) + 3$

$\therefore \quad 4 \cdot 7 = (4 * 7) + 3 = 7 + 3 = 10$

**59.** *(b)* Total degree $= 2(n - 1) = 2n - 2$

Let $p$ be the number of pendant vertices. Then $(n - p - 1)$ are vertices with degree 3, one vertex of degree 2. Total degree $= 2 + p + 3(n - p - 1)$

$\Rightarrow \quad 2n - 2 = -1 - 2p + 3n$

$\Rightarrow \quad p = \frac{n+1}{2} = \frac{9+1}{2} \qquad (\because n = 9 \text{ given})$

$= 5$

**60.** *(d)* $\frac{1}{\log_{25} 10} + \frac{1}{\log_4 10} + \frac{1}{\log_{\sqrt{2}} 10} + \frac{1}{\log_{\sqrt{5}} 10}$

$$= \frac{\log 25}{\log 10} + \frac{\log 4}{\log 10} + \frac{\log \sqrt{2}}{\log 10} + \frac{\log \sqrt{5}}{\log 10}$$

$$= \frac{2\log 5 + \frac{1}{2}\log 5}{\log 10} + \frac{2\log 2 + \frac{1}{2}\log 2}{\log 10}$$

$$= \frac{5}{2}\left(\frac{\log 5 + \log 2}{\log 10}\right) = \frac{5}{2}\frac{\log 10}{\log 10} = \frac{5}{2}$$

**61.** *(a)* Here, $a = 2$, $b = 3$, $h = \frac{5}{2}$

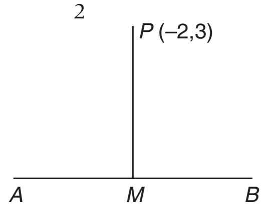
$$\therefore \quad \tan\theta = \frac{2\sqrt{\left(\frac{5}{2}\right)^2 - 6}}{2 + 3}$$

$$\Rightarrow \quad m = \frac{1}{5}$$

**62.** *(b)* Let $AB$ be the line $2x - y - 3 = 0$ ...(i)

Its slope $= 2$

Slope of $PM = -\frac{1}{2}$




Equation of $PM$ is

$$y - 3 = -\frac{1}{2}(x + 2)$$

$\Rightarrow \quad x + 2y - 4 = 0$ ...(ii)

On solving Eqs. (i) and (ii), we get

$x = 2, y = 1$

$\therefore$ Foot of perpendicular is $(2, 1)$.

**63.** *(a)* $\int_{-\pi/2}^{\pi/2} |\sin x| \, dx = 2\int_0^{\pi/2} \sin x \, dx$

$= 2[-\cos x]_0^{\pi/2} = 2$

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**64.** *(b)* $\because \begin{bmatrix} 2+x & 3 & 4 \\ 1 & -1 & 2 \\ x & 1 & -5 \end{bmatrix}$ is a singular matrix.

$$\therefore \quad \begin{vmatrix} 2+x & 3 & 4 \\ 1 & -1 & 2 \\ x & 1 & -5 \end{vmatrix} = 0$$

$$\Rightarrow (2+x)(5-2) - 3(-5-2x) + 4(1+x) = 0$$
$$\Rightarrow \quad 6 + 3x + 15 + 6x + 4 + 4x = 0$$
$$\Rightarrow \quad 13x + 25 = 0$$
$$\Rightarrow \quad x = -\frac{25}{13}$$

**65.** *(c)* $(b^2 + c^2)\, a \cos A + (c^2 + a^2)\, b \cos B + (a^2 + b^2)\, c \cos C$

$= ab\,(b \cos A + a \cos B) + bc\,(b \cos C + c \cos B) + ca\,(a \cos C + c \cos A)$

$= abc + abc + abc = 3\,abc$

**66.** *(a)* Given, $y = a\,(1 - \cos x)$

On differentiating w.r.t. $x$, we get

$$\frac{dy}{dx} = a \sin x$$

Again differentiating w.r.t. $x$, we get

$$\frac{d^2y}{dx^2} = a \cos x$$

Put $\frac{dy}{dx} = 0$ for maxima or minima

$$\Rightarrow \quad a \sin x = 0 \quad \Rightarrow \quad x = \pi$$

$$\therefore \quad \left(\frac{d^2y}{dx^2}\right)_{x=\pi} = a \cos \pi = -a$$

$\therefore$ Function is maximum at $x = \pi$.

**67.** *(b)* Volume of parallelopiped $= \begin{vmatrix} 2 & -3 & 0 \\ 1 & 1 & -1 \\ 3 & 0 & -1 \end{vmatrix}$

$= 2(-1) + 3(-1+3) = -2 + 6 = 4$ cu unit.

**68.** *(a)* It is not possible for wheel $W_n$ $(n \geq 3)$ to be bipartite.

**69.** *(c)*

$$\begin{array}{l} 364)\overline{462}(1 \\ \underline{364} \\ \quad 98)364(3 \\ \quad\quad \underline{294} \\ \quad\quad 70)98(1 \\ \quad\quad\quad \underline{70} \\ \quad\quad\quad 28)70(2 \\ \quad\quad\quad\quad \underline{56} \\ \quad\quad\quad\quad 14)28(2 \\ \quad\quad\quad\quad\quad \underline{28} \\ \quad\quad\quad\quad\quad \times \end{array}$$

$\therefore$ GCD of 364 and 462 is 14.

**70.** *(d)* Given system of equations are

$$x + 4y - 2z = 3$$
$$3x + y + 5z = 7$$
and $$2x + 3y + z = 5$$

$$\therefore \quad \Delta = \begin{vmatrix} 1 & 4 & -2 \\ 3 & 1 & 5 \\ 2 & 3 & 1 \end{vmatrix}$$

$$= 1(1 - 15) - 4(3 - 10) - 2(9 - 2)$$
$$= -14 + 28 - 14 = 0$$

and $$\Delta_2 = \begin{vmatrix} 1 & 3 & -2 \\ 3 & 7 & 5 \\ 2 & 5 & 1 \end{vmatrix}$$

$$= 1 \neq 0$$

$\therefore$ No solution will exist.

## English & General Aptitude

**16.** (*a*) All are the names of rivers.

**17.** (*c*) 'Leap' is the movement of rabbit; 'Frisk' is the movement of 'Lamb' and 'Trot' is the movement of 'Donkey'.

**18.** (*b*) All are stationery goods.

**19.** (*c*) All are week days.

**20.** (*a*) They have two vowels 'a' and 'e'.

**21.** (*d*) None of the options is correct as they are the names of currencies.

**22.** (*d*) 'Jaipur' is the capital of 'Rajasthan'; 'Bengaluru' is the capital of 'Karnataka' and 'Mumbai' is the capital of 'Maharashtra'.

**23.** (*c*) 'Colombo' is the capital of Sri Lanka; 'Kathmandu' is the capital of 'Nepal' and 'Havana' is the capital of 'Cuba'.

**24.** (*d*) 'Squeak' is the sound produced by Mice; Hiss is the sound produced by Snake and Howl is the sound produced by Jackal.

**25.** (*b*) 'Kathak' is the classical dance of North India; 'Bharatnatyam' is the classical dance of Tamilnadu while 'Odissi' is the classical dance of Orissa.