

TEST PAPER OF JEE(MAIN) EXAMINATION – 2019

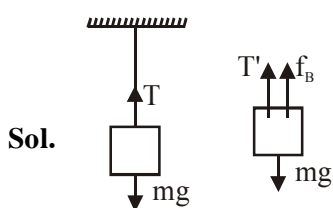
(Held On Saturday 12th JANUARY, 2019) TIME : 02 : 30 PM To 05 : 30 PM

**PHYSICS**

1. A load of mass  $M$  kg is suspended from a steel wire of length 2 m and radius 1.0 mm in Searle's apparatus experiment. The increase in length produced in the wire is 4.0 mm. Now the load is fully immersed in a liquid of relative density 2. The relative density of the material of load is 8. The new value of increase in length of the steel wire is :

- (1) 4.0mm (2) 3.0mm (3) 5.0mm (4) zero

Ans (2)



$$\frac{F}{A} = y \cdot \frac{\Delta l}{l}$$

$$\Delta l \propto F \quad \dots(i)$$

$$T = mg$$

$$T = mg - f_B = mg - \frac{m}{\rho_b} \cdot \rho_l \cdot g$$

$$= \left(1 - \frac{\rho_l}{\rho_b}\right) mg$$

$$= \left(1 - \frac{2}{8}\right) mg$$

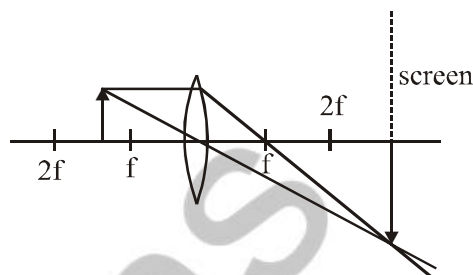
$$T' = \frac{3}{4} mg$$

From (i)

$$\frac{\Delta l'}{\Delta l} = \frac{T'}{T} = \frac{3}{4}$$

$$\Delta l' = \frac{3}{4} \cdot \Delta l = 3 \text{ mm}$$

2. Formation of real image using a biconvex lens is shown below :



If the whole set up is immersed in water without disturbing the object and the screen position, what will one observe on the screen ?

- (1) Image disappears  
(2) No change  
(3) Erect real image  
(4) Magnified image

Ans (1)

Sol. From  $\frac{1}{f} = (\mu_{\text{rel}} - 1) \left( \frac{1}{R_1} - \frac{1}{R_2} \right)$

Focal length of lens will change hence image disappears from the screen.

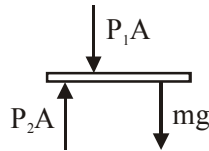
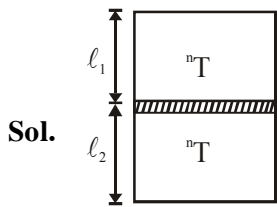
3. A vertical closed cylinder is separated into two parts by a frictionless piston of mass  $m$  and of negligible thickness. The piston is free to move along the length of the cylinder. The length of the cylinder above the piston is  $l_1$ , and that below the piston is  $l_2$ , such that  $l_1 > l_2$ . Each part of the cylinder contains  $n$  moles of an ideal gas at equal temperature  $T$ . If the piston is stationary, its mass,  $m$ , will be given by :

( $R$  is universal gas constant and  $g$  is the acceleration due to gravity)

(1)  $\frac{nRT}{g} \left[ \frac{1}{l_2} + \frac{1}{l_1} \right]$  (2)  $\frac{nRT}{g} \left[ \frac{l_1 - l_2}{l_1 l_2} \right]$

(3)  $\frac{RT}{g} \left[ \frac{2l_1 + l_2}{l_1 l_2} \right]$  (4)  $\frac{RT}{ng} \left[ \frac{l_1 - 3l_2}{l_1 l_2} \right]$

Ans (2)



$$P_2A = P_1A + mg$$

$$\frac{nRT.A}{Al_2} = \frac{nRT.A}{Al_1} + mg$$

$$nRT \left( \frac{1}{l_2} - \frac{1}{l_1} \right) = mg$$

$$m = \frac{nRT}{g} \left( \frac{l_1 - l_2}{l_1 \cdot l_2} \right)$$

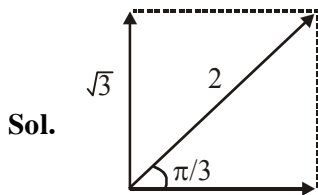
4. A simple harmonic motion is represented by:

$$y = 5(\sin 3\pi t + \sqrt{3} \cos 3\pi t) \text{ cm}$$

The amplitude and time period of the motion are:

- (1) 5cm,  $\frac{3}{2}$ s                      (2) 5cm,  $\frac{2}{3}$ s  
 (3) 10cm,  $\frac{3}{2}$ s                      (4) 10cm,  $\frac{2}{3}$ s

**Ans. (4)**



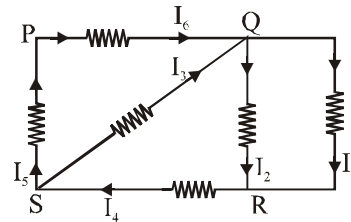
$$y = 5 \left[ \sin(3\pi t) + \sqrt{3} \cos(3\pi t) \right]$$

$$= 10 \sin \left( 3\pi t + \frac{\pi}{3} \right)$$

Amplitude = 10 cm

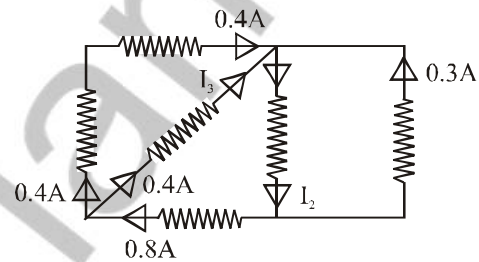
$$T = \frac{2\pi}{\omega} = \frac{2\pi}{3\pi} = \frac{2}{3} \text{ sec}$$

5. In the given circuit diagram, the currents,  $I_1 = -0.3\text{A}$ ,  $I_4 = 0.8\text{A}$  and  $I_5 = 0.4\text{A}$ , are flowing as shown. The currents  $I_2, I_3$  and  $I_6$ , respectively, are :



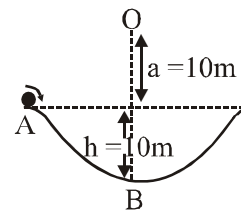
- (1) 1.1 A, 0.4 A, 0.4 A  
 (2) -0.4 A, 0.4 A, 1.1 A  
 (3) 0.4 A, 1.1 A, 0.4 A  
 (4) 1.1 A, -0.4 A, 0.4 A

**Ans. (1)**



From KCL,  $I_3 = 0.8 - 0.4 = 0.4\text{A}$   
 $I_2 = 0.4 + 0.4 + 0.3 = 1.1\text{A}$   
 $I_6 = 0.4\text{A}$

6. A particle of mass 20 g is released with an initial velocity 5 m/s along the curve from the point A, as shown in the figure. The point A is at height h from point B. The particle slides along the frictionless surface. When the particle reaches point B, its angular momentum about O will be : (Take  $g = 10 \text{ m/s}^2$ )



- (1)  $8\text{kg}\cdot\text{m}^2/\text{s}$                       (2)  $6\text{kg}\cdot\text{m}^2/\text{s}$   
 (3)  $3\text{kg}\cdot\text{m}^2/\text{s}$                       (4)  $2\text{kg}\cdot\text{m}^2/\text{s}$

**Ans. (2)**

**Sol.** Work Energy Theorem from A to B

$$mgh = \frac{1}{2}mv_B^2 - \frac{1}{2}mv_A^2$$

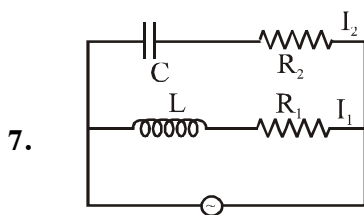
$$2gh = v_B^2 - v_A^2$$

$$2 \times 10 \times 10 = v_B^2 - 5^2$$

$$v_B = 15 \text{ m/s}$$

Angular momentum about O

$$\begin{aligned} L_0 &= mvr \\ &= 20 \times 10^{-3} \times 20 \\ L_0 &= 6 \text{ kg.m}^2/\text{s} \end{aligned}$$



In the above circuit,  $C = \frac{\sqrt{3}}{2} \mu\text{F}$ ,  $R_2 = 20 \Omega$ ,

$L = \frac{\sqrt{3}}{10} \text{ H}$  and  $R_1 = 10 \Omega$ . Current in L- $R_1$  path

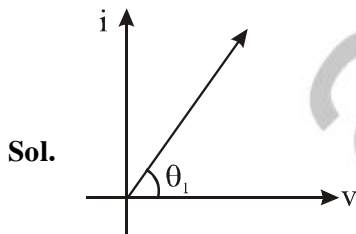
is  $I_1$  and in C- $R_2$  path it is  $I_2$ . The voltage of A.C source is given by

$V = 200\sqrt{2} \sin(100t)$  volts. The phase difference

between  $I_1$  and  $I_2$  is :

- (1)  $30^\circ$     (2)  $0^\circ$     (3)  $90^\circ$     (4)  $60^\circ$

**Ans. (Bonus)**



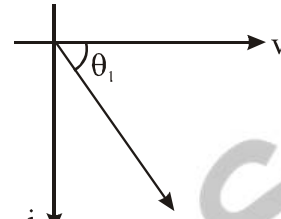
$$x_e = \frac{1}{\omega_c} = \frac{4}{10^{-6} \times \sqrt{3} \times 100} = \frac{2 \times 10^4}{\sqrt{3}}$$

$$\tan \theta/2 \frac{x_e}{R_e} = \frac{10^3}{\sqrt{3}}$$

$\theta_1$  is close to  $90$

For L-R circuit

$$x_L = w_L = 100 \times \frac{\sqrt{3}}{10} = \sqrt{3}$$



$$R_1 = 10$$

$$\tan \theta_2 = \frac{x_e}{R}$$

$$\tan \theta_2 = \sqrt{3}$$

$$\theta_2 = 60$$

So phase difference comes out  $90 + 60 = 150$ .

Therefore Ans. is Bonus

If  $R_2$  is  $20 \text{ K}\Omega$

then phase difference comes out to be  $60+30 = 90^\circ$

8. A paramagnetic material has  $10^{28}$  atoms/ $\text{m}^3$ . Its magnetic susceptibility at temperature  $350 \text{ K}$  is  $2.8 \times 10^{-4}$ . Its susceptibility at  $300 \text{ K}$  is :

- (1)  $3.672 \times 10^{-4}$                       (2)  $3.726 \times 10^{-4}$   
(3)  $3.267 \times 10^{-4}$                       (4)  $2.672 \times 10^{-4}$

**Ans (3)**

**Sol.**  $x \propto \frac{1}{T_c}$

curie law for paramagnetic substance

$$\frac{x_1}{x_2} = \frac{T_{c2}}{T_{c1}}$$

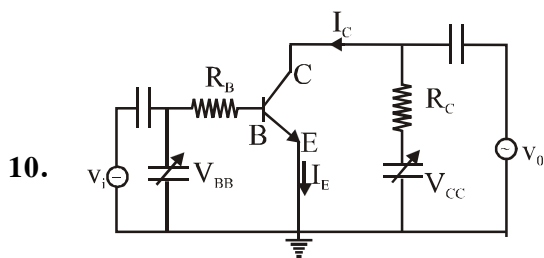
$$\frac{2.8 \times 10^{-4}}{x_2} = \frac{300}{350}$$

$$\begin{aligned} x_2 &= \frac{2.8 \times 350 \times 10^{-4}}{300} \\ &= 3.266 \times 10^{-4} \end{aligned}$$

9. A 10 m long horizontal wire extends from North East to South West. It is falling with a speed of  $5.0\text{ms}^{-1}$ , at right angles to the horizontal component of the earth's magnetic field, of  $0.3 \times 10^{-4}\text{Wb/m}^2$ . The value of the induced emf in wire is :
- (1)  $2.5 \times 10^{-3}\text{V}$       (2)  $1.1 \times 10^{-3}\text{V}$   
(3)  $0.3 \times 10^{-3}\text{V}$       (4)  $1.5 \times 10^{-3}\text{V}$

**Ans (4)**

**Sol.** Induced emf =  $Bv\ell$   
 $= 0.3 \times 10^{-4} \times 5 \times 10$   
 $= 1.5 \times 10^{-3}\text{ V}$



10.

In the figure, given that  $V_{BB}$  supply can vary from 0 to 5.0 V,  $V_{CC} = 5\text{V}$ ,  $\beta_{dc} = 200$ ,  $R_B = 100\text{ k}\Omega$ ,  $R_C = 1\text{ k}\Omega$  and  $V_{BE} = 1.0\text{ V}$ , The minimum base current and the input voltage at which the transistor will go to saturation, will be, respectively :

- (1)  $20\mu\text{A}$  and  $3.5\text{V}$       (2)  $25\mu\text{A}$  and  $3.5\text{V}$   
(3)  $25\mu\text{A}$  and  $2.5\text{V}$       (4)  $20\mu\text{A}$  and  $2.8\text{V}$

**Ans (2)**

**Sol.** At saturation,  $V_{CE} = 0$   
 $V_{CE} = V_{CC} - I_C R_C$

$$\Rightarrow I_C = \frac{V_{CC}}{R_C} = 5 \times 10^{-3}\text{ A}$$

Given

$$\beta_{dc} = \frac{I_C}{I_B}$$

$$I_B = \frac{5 \times 10^{-3}}{200}$$

$$I_B = 25\ \mu\text{A}$$

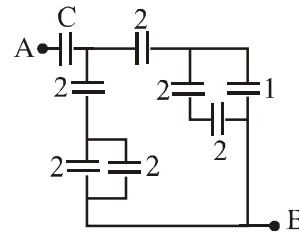
At input side

$$V_{BB} = I_B R_B + V_{BE}$$

$$= (25\text{mA}) (100\text{k}\Omega) + 1\text{V}$$

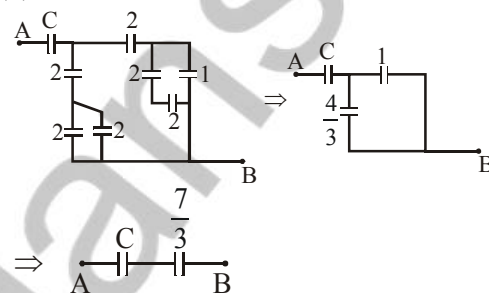
$$V_{BB} = 3.5\text{ V}$$

11. In the circuit shown, find C if the effective capacitance of the whole circuit is to be  $0.5\ \mu\text{F}$ . All values in the circuit are in  $\mu\text{F}$ .



- (1)  $\frac{7}{10}\ \mu\text{F}$     (2)  $\frac{7}{11}\ \mu\text{F}$     (3)  $\frac{6}{5}\ \mu\text{F}$     (4)  $4\ \mu\text{F}$

**Ans (2)**



**Sol.**

From equs.

$$\frac{\frac{7C}{3}}{\frac{7}{3} + C} = \frac{1}{2}$$

$$\Rightarrow 14C = 7 + 3C$$

$$\Rightarrow C = \frac{7}{11}$$

12. Two satellites, A and B, have masses  $m$  and  $2m$  respectively. A is in a circular orbit of radius  $R$ , and B is in a circular orbit of radius  $2R$  around the earth. The ratio of their kinetic energies,  $T_A/T_B$ , is:

- (1) 2      (2)  $\sqrt{\frac{1}{2}}$       (3) 1      (4)  $\frac{1}{2}$

**Ans (3)**

**Sol.** Orbital velocity  $V = \sqrt{\frac{GM_e}{r}}$

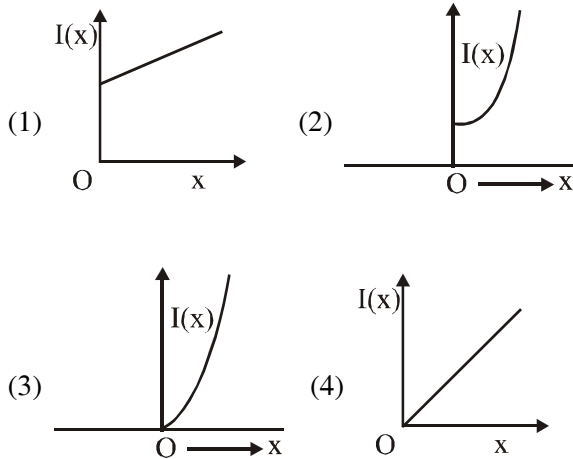
$$T_A = \frac{1}{2} m_A V_A^2$$

$$T_B = \frac{1}{2} m_B V_B^2$$

$$\Rightarrow \frac{T_A}{T_B} = \frac{m \times \frac{GM}{R}}{2m \times \frac{GM}{2R}}$$

$$\Rightarrow \frac{T_A}{T_B} = 1$$

13. The moment of inertia of a solid sphere, about an axis parallel to its diameter and at a distance of  $x$  from it, is  $I(x)$ . Which one of the graphs represents the variation of  $I(x)$  with  $x$  correctly?



Ans. (2)

Sol.  $I = \frac{2}{5}mR^2 + mx^2$

14. When a certain photosensitive surface is illuminated with monochromatic light of frequency  $\nu$ , the stopping potential for the photo current is  $-V_0/2$ . When the surface is illuminated by monochromatic light of frequency  $\nu/2$ , the stopping potential is  $-V_0$ . The threshold frequency for photoelectric emission is:

- (1)  $\frac{3\nu}{2}$       (2)  $2\nu$       (3)  $\frac{4}{3}\nu$       (4)  $\frac{5\nu}{3}$

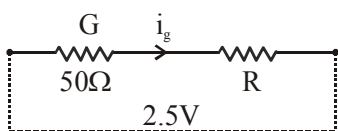
Ans. (BONUS)

15. A galvanometer, whose resistance is 50 ohm, has 25 divisions in it. When a current of  $4 \times 10^{-4}$  A passes through it, its needle (pointer) deflects by one division. To use this galvanometer as a voltmeter of range 2.5 V, it should be connected to a resistance of:

- (1) 6250 ohm      (2) 250 ohm  
(3) 200 ohm      (4) 6200 ohm

Ans. (3)

Sol.  $I_g = 4 \times 10^{-4} \times 25 = 10^{-2}$  A

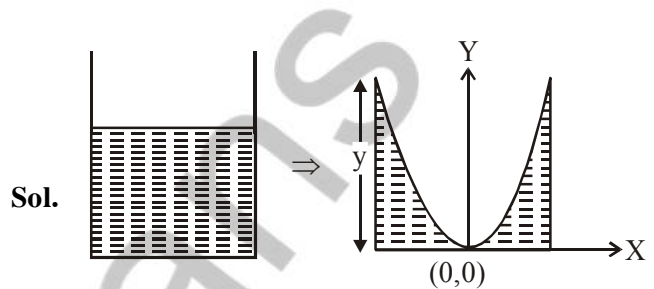


$2.5 = (50 + R) 10^{-2} \therefore R = 200 \Omega$

16. A long cylindrical vessel is half filled with a liquid. When the vessel is rotated about its own vertical axis, the liquid rises up near the wall. If the radius of vessel is 5 cm and its rotational speed is 2 rotations per second, then the difference in the heights between the centre and the sides, in cm, will be:

- (1) 1.2      (2) 0.1      (3) 2.0      (4) 0.4

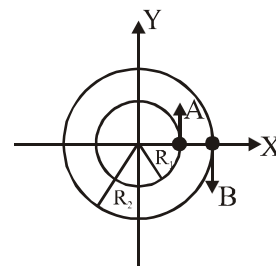
Ans. (3)



Sol.

$$y = \frac{\omega^2 x^2}{2g} = \frac{(2 \times 2\pi)^2 \times (0.05)^2}{20} \approx 2 \text{ cm}$$

17. Two particles A, B are moving on two concentric circles of radii  $R_1$  and  $R_2$  with equal angular speed  $\omega$ . At  $t = 0$ , their positions and direction of motion are shown in the figure :

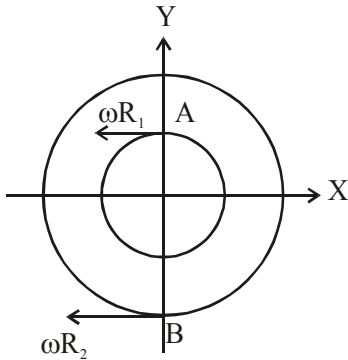


The relative velocity  $\vec{v}_A - \vec{v}_B$  at  $t = \frac{\pi}{2\omega}$  is given by :

- (1)  $-\omega(R_1 + R_2)\hat{i}$       (2)  $\omega(R_1 + R_2)\hat{i}$   
(3)  $\omega(R_1 - R_2)\hat{i}$       (4)  $\omega(R_2 - R_1)\hat{i}$

Ans. (4)

**Sol.**  $\theta = \omega t = \omega \frac{\pi}{2\omega} = \frac{\pi}{2}$

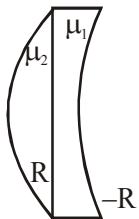


$\vec{V}_A - \vec{V}_B = \omega R_1(-\hat{i}) - \omega R_2(-\hat{j})$

**18.** A plano-convex lens (focal length  $f_2$ , refractive index  $\mu_2$ , radius of curvature  $R$ ) fits exactly into a plano-concave lens (focal length  $f_1$ , refractive index  $\mu_1$ , radius of curvature  $R$ ). Their plane surfaces are parallel to each other. Then, the focal length of the combination will be :

- (1)  $f_1 - f_2$                       (2)  $f_1 + f_2$   
 (3)  $\frac{R}{\mu_2 - \mu_1}$                       (4)  $\frac{2f_1 f_2}{f_1 + f_2}$

**Ans. (3)**



**Sol.**

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1 - \mu_1}{R} + \frac{\mu_2 - 1}{R}$$

**19.** Let  $\ell$ ,  $r$ ,  $c$  and  $v$  represent inductance, resistance, capacitance and voltage, respectively. The

dimension of  $\frac{\ell}{rcv}$  in SI units will be:

- (1) [LTA]    (2) [LA<sup>-2</sup>]    (3) [A<sup>-1</sup>]    (4) [LT<sup>2</sup>]

**Ans. (3)**

**Sol.**  $\left[\frac{\ell}{r}\right] = T$

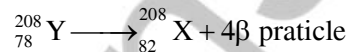
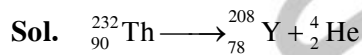
[CV] = AT

So,  $\left[\frac{\ell}{rcv}\right] = \frac{T}{AT} = A^{-1}$

**20.** In a radioactive decay chain, the initial nucleus is  ${}_{90}^{232}\text{Th}$ . At the end there are 6  $\alpha$ -particles and 4  $\beta$ -particles which are emitted. If the end nucleus,  ${}^A_Z\text{X}$ , A and Z are given by :

- (1) A = 208; Z = 80  
 (2) A = 202; Z = 80  
 (3) A = 200; Z = 81  
 (4) A = 208; Z = 82

**Ans. (4)**



**21.** The mean intensity of radiation on the surface of the Sun is about  $10^8 \text{ W/m}^2$ . The rms value of the corresponding magnetic field is closest to :

- (1)  $10^2 \text{ T}$                               (2)  $10^{-4} \text{ T}$   
 (3)  $1 \text{ T}$                                 (4)  $10^{-2} \text{ T}$

**Ans. (2)**

**Sol.**  $I = \epsilon_0 C E_{\text{rms}}^2$

$\& E_{\text{rms}} = c B_{\text{rms}}$

$I = \epsilon_0 C^3 B_{\text{rms}}^2$

$B_{\text{rms}} = \sqrt{\frac{I}{\epsilon_0 C^3}}$

$B_{\text{rms}} \approx 10^{-4}$

**22.** A resonance tube is old and has jagged end. It is still used in the laboratory to determine velocity of sound in air. A tuning fork of frequency 512 Hz produces first resonance when the tube is filled with water to a mark 11 cm below a reference mark, near the open end of the tube. The experiment is repeated with another fork of frequency 256 Hz which produces first resonance when water reaches a mark 27 cm below the reference mark. The velocity of sound in air, obtained in the experiment, is close to:

- (1)  $328 \text{ ms}^{-1}$                               (2)  $322 \text{ ms}^{-1}$   
 (3)  $341 \text{ ms}^{-1}$                               (4)  $335 \text{ ms}^{-1}$

**Ans. (1)**

- 23.** An ideal gas is enclosed in a cylinder at pressure of 2 atm and temperature, 300 K. The mean time between two successive collisions is  $6 \times 10^{-8}$  s. If the pressure is doubled and temperature is increased to 500 K, the mean time between two successive collisions will be close to:
- (1)  $4 \times 10^{-8}$ s                      (2)  $3 \times 10^{-6}$ s  
(3)  $2 \times 10^{-7}$ s                      (4)  $0.5 \times 10^{-8}$ s

**Ans. (1)**

**Sol.**  $t \propto \frac{\text{Volume}}{\text{velocity}}$

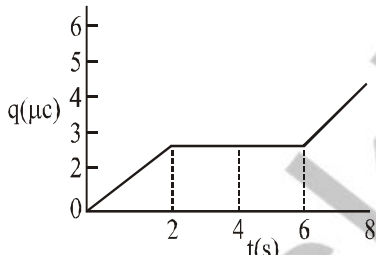
volume  $\propto \frac{T}{P}$

$\therefore t \propto \frac{\sqrt{T}}{P}$

$\frac{t_1}{6 \times 10^{-8}} = \frac{\sqrt{500}}{2P} \times \frac{P}{\sqrt{300}}$

$t_1 = 3.8 \times 10^{-8}$   
 $\approx 4 \times 10^{-8}$

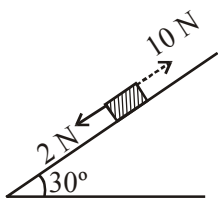
- 24.** The charge on a capacitor plate in a circuit, as a function of time, is shown in the figure: What is the value of current at  $t = 4$  s ?



- (1)  $3\mu\text{A}$     (2)  $2\mu\text{A}$     (3) zero    (4)  $1.5\mu\text{A}$

**Ans. (3)**

- 25.** A block kept on a rough inclined plane, as shown in the figure, remains at rest upto a maximum force 2 N down the inclined plane. The maximum external force up the inclined plane that does not move the block is 10 N. The coefficient of static friction between the block and the plane is : [Take  $g = 10 \text{ m/s}^2$ ]



- (1)  $\frac{2}{3}$     (2)  $\frac{\sqrt{3}}{2}$     (3)  $\frac{\sqrt{3}}{4}$     (4)  $\frac{1}{2}$

**Ans. (2)**

**Sol.**  $2 + mg \sin 30 = \mu mg \cos 30^\circ$   
 $10 = mg \sin 30 + \mu mg \cos 30^\circ$   
 $= 2\mu mg \cos 30 - 2$

$6 = \mu mg \cos 30$

$4 = mg \sin 30$

$\frac{3}{2} = \mu \times \sqrt{3}$

$\mu = \frac{\sqrt{3}}{2}$

- 26.** An alpha-particle of mass  $m$  suffers 1-dimensional elastic collision with a nucleus at rest of unknown mass. It is scattered directly backwards losing, 64% of its initial kinetic energy. The mass of the nucleus is :-

- (1) 4 m    (2) 3.5 m    (3) 2 m    (4) 1.5 m

**Ans. (1)**



**Sol.**

$mv_0 = mv_2 - mv_1$

$\frac{1}{2}mV_1^2 = 0.36 \times \frac{1}{2}mV_0^2$

$v_1 = 0.6v_0$

$\frac{1}{2}M V_2^2 = 0.64 \times \frac{1}{2}mV_0^2$

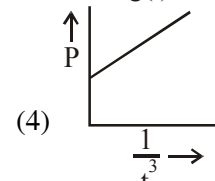
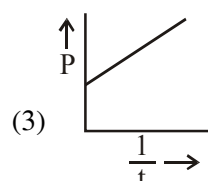
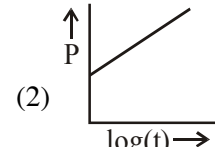
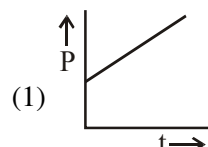
$V_2 = \sqrt{\frac{m}{M}} \times 0.8V_0$

$mV_0 = \sqrt{mM} \times 0.8V_0 - m \times 0.6V_0$

$\Rightarrow 1.6m = 0.8\sqrt{mM}$

$4m^2 = mM$

- 27.** A soap bubble, blown by a mechanical pump at the mouth of a tube, increases in volume, with time, at a constant rate. The graph that correctly depicts the time dependence of pressure inside the bubble is given by :-



**Ans. (4)**

**28.** To double the covering range of a TV transmission tower, its height should be multiplied by :-

- (1)  $\frac{1}{\sqrt{2}}$       (2) 4      (3)  $\sqrt{2}$       (4) 2

**Ans. (2)**

**29.** A parallel plate capacitor with plates of area  $1\text{m}^2$  each, area t a separation of  $0.1\text{ m}$ . If the electric field between the plates is  $100\text{ N/C}$ , the magnitude of charge each plate is :-

(Take  $\epsilon_0 = 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{N-m}^2}$ )

- (1)  $7.85 \times 10^{-10}\text{ C}$       (2)  $6.85 \times 10^{-10}\text{ C}$   
(3)  $9.85 \times 10^{-10}\text{ C}$       (4)  $8.85 \times 10^{-10}\text{ C}$

**Ans. (4)**

**Sol.**  $E = \frac{\sigma}{\epsilon_0} = \frac{Q}{A \epsilon_0}$

$Q = AE\epsilon_0$

$Q = (1)(100)(8.85 \times 10^{-12})$

$Q = 8.85 \times 10^{-10}\text{C}$

**30.** In a Frank-Hertz experiment, an electron of energy  $5.6\text{ eV}$  passes through mercury vapour and emerges with an energy  $0.7\text{ eV}$ . The minimum wavelength of photons emitted by mercury atoms is close to :-

- (1)  $2020\text{ nm}$  Y:\node05\JEE-Main 2019-(On line)\12-01-2019\Evening\PDF      (2)  $220\text{ nm}$   
(3)  $250\text{ nm}$       (4)  $1700\text{ nm}$

**Ans. (3)**

**Sol.**  $\lambda = \frac{1240}{5.6 - 0.7}\text{ nm}$

askITians



## CHEMISTRY

1. 8g of NaOH is dissolved in 18g of H<sub>2</sub>O. Mole fraction of NaOH in solution and molality (in mol kg<sup>-1</sup>) of the solutions respectively are :

- (1) 0.167, 11.11                      (2) 0.2, 22.20  
(3) 0.2, 11.11                        (4) 0.167, 22.20

Ans. (1)

Sol. 8g NaOH, mol of NaOH =  $\frac{8}{40} = 0.2 \text{ mol}$

18g H<sub>2</sub>O, mol of H<sub>2</sub>O =  $\frac{18}{18} = 1 \text{ mol}$

$$\therefore X_{\text{NaOH}} = \frac{0.2}{1.2} = 0.167$$

$$\text{Molality} = \frac{0.2 \times 1000}{18} = 11.11 \text{ m}$$

2. The correct statement(s) among I to III with respect to potassium ions that are abundant within the cell fluids is/are :

- I. They activate many enzymes  
II. They participate in the oxidation of glucose to produce ATP  
III. Along with sodium ions, they are responsible for the transmission of nerve signals

- (1) I, II and III                      (2) I and III only  
(3) III only                            (4) I and II only

Ans. (1)

Sol. All the three statements are correct a/c to NCERT (s-block)

3. The magnetic moment of an octahedral homoleptic Mn(II) complex is 5.9 BM. The suitable ligand for this complex is :

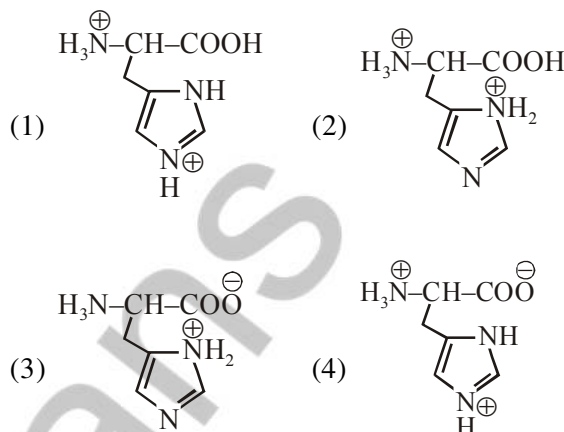
- (1) CN<sup>-</sup>                                  (2) NCS<sup>-</sup>  
(3) CO                                    (4) ethylenediamine

Ans. (2)

Sol.  $\mu = 5.9 \text{ BM} \therefore n$  (no of unpaired.e<sup>-</sup>) = 5  
Cation Mn<sup>II</sup> - 3d<sup>5</sup> confn only possible for relatively weak ligand.

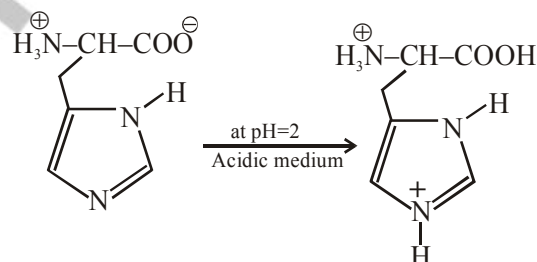
$$\therefore \text{NCS}^-$$

4. The correct structure of histidine in a strongly acidic solution (pH=2) is



Ans. (1)

Sol. Histidine is



Zwitter ionic form

$$pI_n = 7.59$$

5. The compound that is NOT a common component of photochemical smog is :

- (1) O<sub>3</sub>                                      (2) CH<sub>2</sub>=CHCHO  
(3) CF<sub>2</sub>Cl<sub>2</sub>                              (4) H<sub>3</sub>C-C(=O)-OONO<sub>2</sub>

Ans. (3)

Sol. Freons (CFC's) are not common components of photo chemical smog.

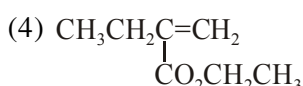
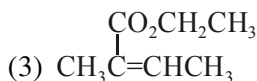
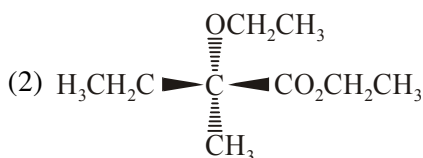
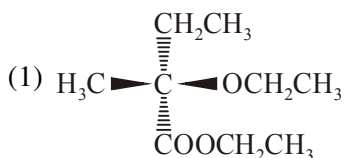
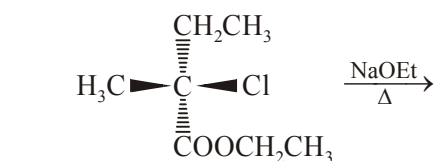
6. The upper stratosphere consisting of the ozone layer protects us from the sun's radiation that falls in the wavelength region of :

- (1) 600-750 nm
- (2) 0.8-1.5 nm
- (3) 400-550 nm
- (4) 200-315 nm

**Ans. (4)**

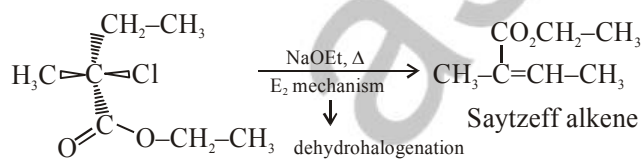
**Sol.** Ozone protects most of the medium frequencies ultraviolet light from 200 - 315 nm wave length.

7. The major product of the following reaction is:

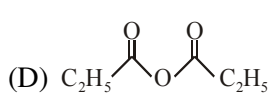
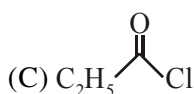
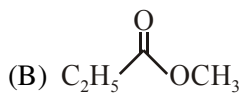
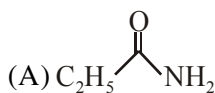


**Ans. (3)**

**Sol.**



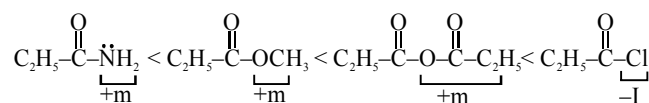
8. The increasing order of the reactivity of the following with  $\text{LiAlH}_4$  is :



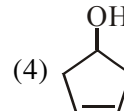
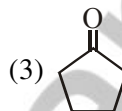
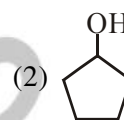
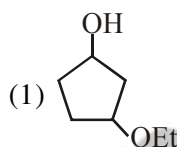
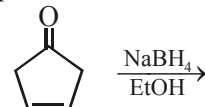
- (1) (A) < (B) < (D) < (C)
- (2) (A) < (B) < (C) < (D)
- (3) (B) < (A) < (D) < (C)
- (4) (B) < (A) < (C) < (D)

**Ans. (1)**

**Sol.** Rate of nucleophilic attack on carbonyl  $\propto$  Electrophilicity of carbonyl group



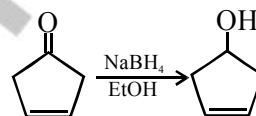
9. The major product of the following reaction is:



**Ans. (4)**

**Sol.**  $\text{NaBH}_4$  can not reduce  $\text{C}=\text{C}$

but can reduce  $-\overset{\text{O}}{\parallel}{\text{C}}-$  into  $\text{OH}$ .



10. Molecules of benzoic acid ( $\text{C}_6\text{H}_5\text{COOH}$ ) dimerise in benzene. 'w' g of the acid dissolved in 30 g of benzene shows a depression in freezing point equal to 2K. If the percentage association of the acid to form dimer in the solution is 80, then w is :

(Given that  $K_f = 5 \text{ K kg mol}^{-1}$ , Molar mass of benzoic acid =  $122 \text{ g mol}^{-1}$ )

- (1) 1.8 g
- (2) 2.4 g
- (3) 1.0 g
- (4) 1.5 g

**Ans. (2)**

**Sol.**  $2(\text{C}_6\text{H}_5\text{COOH}) \xrightarrow[\text{dimer}]{\text{C}_6\text{H}_6, (30\text{g})} (\text{C}_6\text{H}_5\text{COOH})_2$

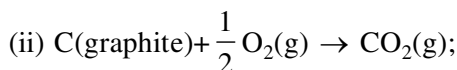
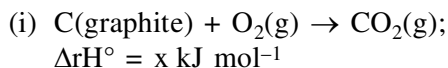
$$\Delta_f T = i k_f m$$

$$2 = 0.6 \times 5 \times \frac{w \times 1000}{122 \times 30}$$

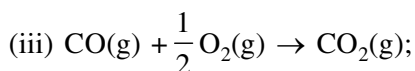
$$(i = 1 - 0.8 + 0.4 = 0.6)$$

$$w = 2.44 \text{ g}$$

11. Given :



$$\Delta_r H^\circ = y \text{ kJ mol}^{-1}$$



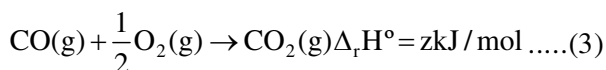
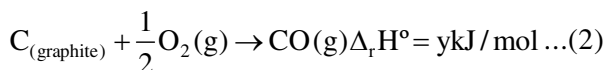
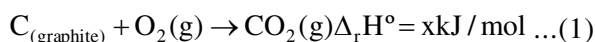
$$\Delta_r H^\circ = z \text{ kJ mol}^{-1}$$

Based on the above thermochemical equations, find out which one of the following algebraic relationships is correct ?

- (1)  $z = x + y$                       (2)  $x = y - z$   
(3)  $x = y + z$                       (4)  $y = 2z - x$

**Ans. (3)**

**Sol.**



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

$$x = y + z$$

**12.** An open vessel at 27°C is heated until two fifth of the air (assumed as an ideal gas) in it has escaped from the vessel. Assuming that the volume of the vessel remains constant, the temperature at which the vessel has been heated is :

- (1) 750°C                              (2) 500°C  
(3) 750 K                              (4) 500 K

**Ans. (4)**

**Sol.**  $\frac{2}{5}$  air escaped from vessel,  $\therefore \frac{3}{5}$  air remain

is vessel. P, V constant

$$n_1 T_1 = n_2 T_2$$

$$n_1(300) = \left(\frac{3}{5} n_1\right) T_2 \Rightarrow T_2 = 500 \text{ K}$$

**13.**  $\Lambda_m^\circ$  for NaCl, HCl and NaA are 126.4, 425.9 and 100.5 S cm<sup>2</sup>mol<sup>-1</sup>, respectively. If the conductivity of 0.001 M HA is 5 × 10<sup>-5</sup> S cm<sup>-1</sup>, degree of dissociation of HA is :

- (1) 0.75    (2) 0.125    (3) 0.25    (4) 0.50

**Ans. (2)**

**Sol.**

$$\Lambda_m^\circ(\text{HA}) = \Lambda_m^\circ(\text{HCl}) + \Lambda_m^\circ(\text{NaA}) - \Lambda_m^\circ(\text{NaCl})$$

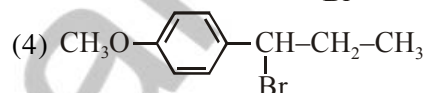
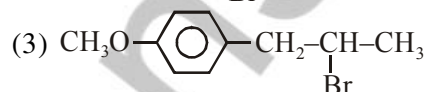
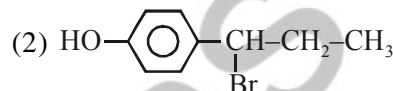
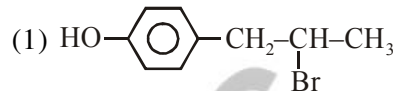
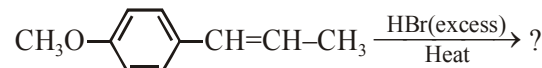
$$= 425.9 + 100.5 - 126.4$$

$$= 400 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\Lambda_m = \frac{1000K}{M} = \frac{1000 \times 5 \times 10^{-5}}{10^{-3}} = 50 \text{ S cm}^2 \text{ mol}^{-1}$$

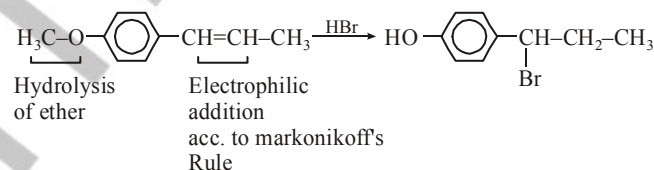
$$\alpha = \frac{\Lambda_m}{\Lambda_m^\circ} = \frac{50}{400} = 0.125$$

**14.** The major product in the following conversion is :



**Ans. (2)**

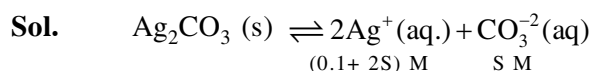
**Sol.**



**15.** If  $K_{sp}$  of  $\text{Ag}_2\text{CO}_3$  is  $8 \times 10^{-12}$ , the molar solubility of  $\text{Ag}_2\text{CO}_3$  in 0.1M  $\text{AgNO}_3$  is :

- (1)  $8 \times 10^{-12} \text{ M}$                       (2)  $8 \times 10^{-10} \text{ M}$   
(3)  $8 \times 10^{-11} \text{ M}$                       (4)  $8 \times 10^{-13} \text{ M}$

**Ans. (2)**



$$K_{sp} = [\text{Ag}^+]^2[\text{CO}_3^{2-}]$$

$$8 \times 10^{-12} = (0.1 + 2S)^2 (S)$$

$$S = 8 \times 10^{-10} \text{ M}$$

16. Among the following, the false statement is :

- (1) Latex is a colloidal solution of rubber particles which are positively charged
- (2) Tyndall effect can be used to distinguish between a colloidal solution and a true solution.
- (3) It is possible to cause artificial rain by throwing electrified sand carrying charge opposite to the one on clouds from an aeroplane.
- (4) Lyophilic sol can be coagulated by adding an electrolyte.

**Ans. (1)**

**Sol.** Colloidal solution of rubber are negatively charged.

17. The pair that does NOT require calcination is:

- (1) ZnO and MgO
- (2)  $\text{Fe}_2\text{O}_3$  and  $\text{CaCO}_3 \cdot \text{MgCO}_3$
- (3) ZnO and  $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
- (4)  $\text{ZnCO}_3$  and CaO

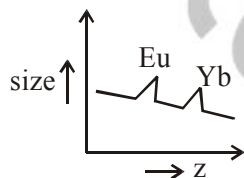
**Ans. (1)**

**Sol.** ZnO & MgO both are in oxide form therefore no change on calcination.

18. The correct order of atomic radii is :

- (1)  $\text{Ce} > \text{Eu} > \text{Ho} > \text{N}$
- (2)  $\text{N} > \text{Ce} > \text{Eu} > \text{Ho}$
- (3)  $\text{Eu} > \text{Ce} > \text{Ho} > \text{N}$
- (4)  $\text{Ho} > \text{N} > \text{Eu} > \text{Ce}$

**Ans. (3)**



**Sol.**

$\text{Eu} > \text{Ce} > \text{Ho} > \text{N}$ .

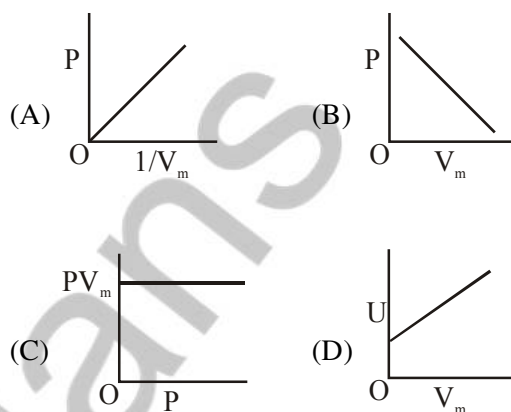
19. The element that does NOT show catenation is:

- (1) Sn
- (2) Ge
- (3) Si
- (4) Pb

**Ans. (4)**

**Sol.** Catenation is not shown by lead.

20. The combination of plots which does not represent isothermal expansion of an ideal gas is:

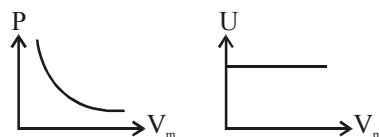


- (1) (A) and (C)
- (2) (A) and (D)
- (3) (B) and (D)
- (4) (B) and (C)

**Ans. (3)**

**Sol.** Isothermal expansion  $PV_m = K$  (Graph-C)

$$P = \frac{K}{V_m} \text{ (Graph-A)}$$



21. The volume strength of 1M  $\text{H}_2\text{O}_2$  is:

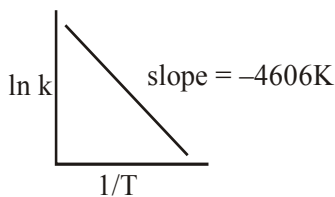
(Molar mass of  $\text{H}_2\text{O}_2 = 34 \text{ g mol}^{-1}$ )

- (1) 16.8
- (2) 11.35
- (3) 22.4
- (4) 5.6

**Ans. (2)**

**Sol.** 1L – 1M  $\text{H}_2\text{O}_2$  solution will produce 11.35 L  $\text{O}_2$  gas at STP.

22. For a reaction consider the plot of  $\ln k$  versus  $1/T$  given in the figure. If the rate constant of this reaction at 400 K is  $10^{-5} \text{ s}^{-1}$ , then the rate constant at 500 K is :



- (1)  $2 \times 10^{-4} \text{ s}^{-1}$       (2)  $10^{-4} \text{ s}^{-1}$   
(3)  $10^{-6} \text{ s}^{-1}$       (4)  $4 \times 10^{-4} \text{ s}^{-1}$

Ans. (2)

Sol. 
$$\ln \frac{K_2}{K_1} = \frac{E_a}{R} \left[ \frac{1}{T_1} - \frac{1}{T_2} \right]$$

$$2.303 \log \frac{K_2}{10^{-5}} = 4606 \left[ \frac{1}{400} - \frac{1}{500} \right]$$

$$\Rightarrow K_2 = 10^{-4} \text{ s}^{-1}$$

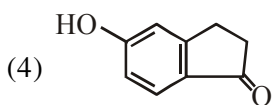
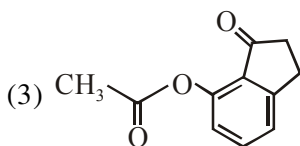
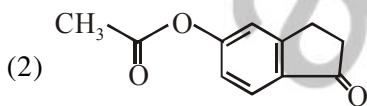
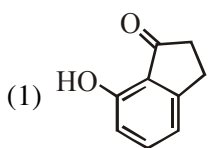
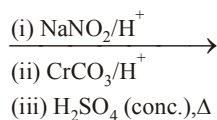
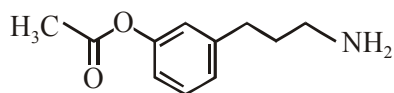
23. The element that shows greater ability to form  $p\pi-p\pi$  multiple bonds, is :

- (1) Si      (2) Ge      (3) Sn      (4) C

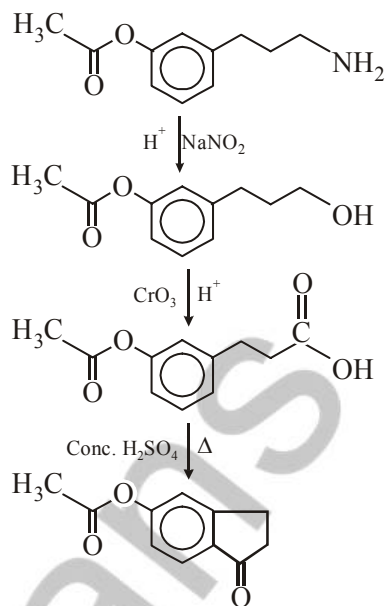
Ans. (4)

Sol. carbon atom have 2p orbitals able to form strongest  $p\pi - p\pi$  bonds

24. The major product of the following reaction is:

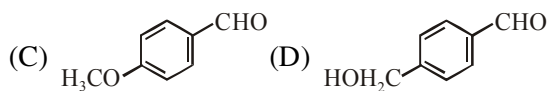
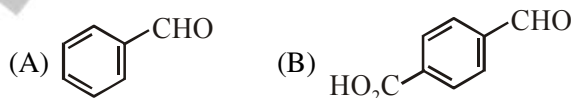


Ans. (2)



Sol.

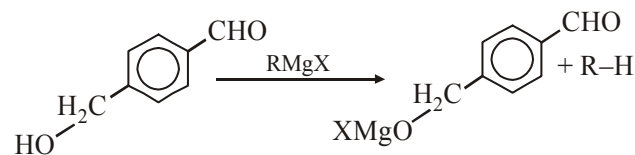
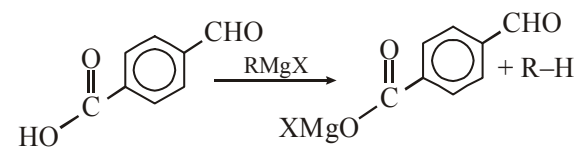
25. The aldehydes which will not form Grignard product with one equivalent Grignard reagents are :



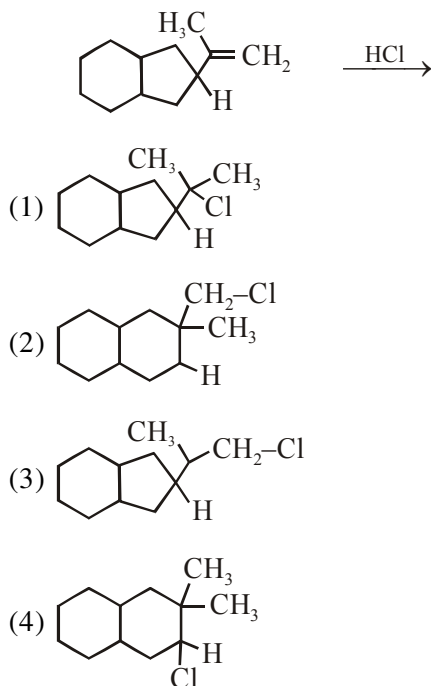
- (1) (B), (C), (D)      (2) (B), (D)  
(3) (B), (C)      (4) (C), (D)

Ans. (2)

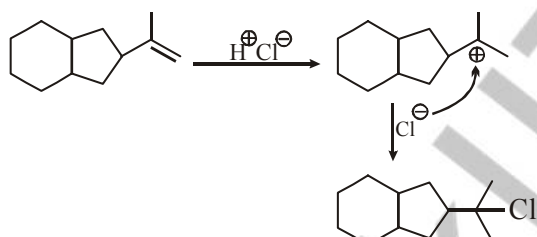
Sol. Acid-base reaction of G.R are fast.



26. The major product of the following reaction is:



Ans. (1)

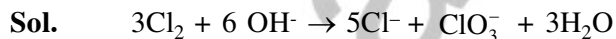


Sol.

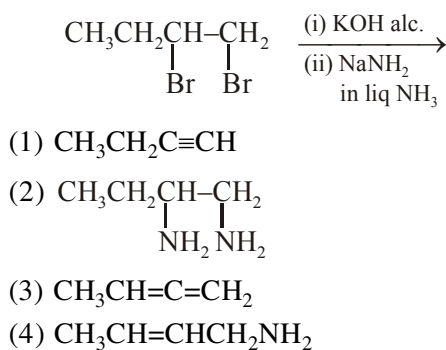
27. Chlorine on reaction with hot and concentrated sodium hydroxide gives :

- (1)  $\text{Cl}^-$  and  $\text{ClO}_2^-$       (2)  $\text{Cl}^-$  and  $\text{ClO}_3^-$   
 (3)  $\text{Cl}^-$  and  $\text{ClO}^-$       (4)  $\text{ClO}_3^-$  and  $\text{ClO}_2^-$

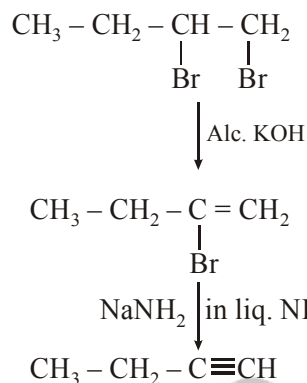
Ans. (2)



28. The major product of the following reaction is:



Ans. (1)



Sol.

29. If the de Broglie wavelength of the electron in  $n^{\text{th}}$  Bohr orbit in a hydrogenic atom is equal to  $1.5\pi a_0$  ( $a_0$  is Bohr radius), then the value of  $n/z$  is :

- (1) 1.0      (2) 0.75      (3) 0.40      (4) 1.50

Ans. (2)

Sol. According to de-broglie's hypothesis

$$2\pi r_n = n\lambda \Rightarrow 2\pi \cdot a_0 = \frac{n^2}{z} = n \times 1.5\pi a_0$$

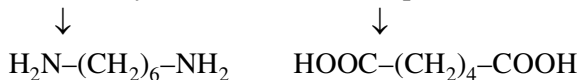
$$\frac{n}{z} = 0.75$$

30. The two monomers for the synthesis of Nylon 6, 6 are :

- (1)  $\text{HOOC}(\text{CH}_2)_6\text{COOH}$ ,  $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$   
 (2)  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ ,  $\text{H}_2\text{N}(\text{CH}_2)_4\text{NH}_2$   
 (3)  $\text{HOOC}(\text{CH}_2)_6\text{COOH}$ ,  $\text{H}_2\text{N}(\text{CH}_2)_4\text{NH}_2$   
 (4)  $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ ,  $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$

Ans. (4)

Sol. Nylon-6,6 is polymer of Hexamethylene diamine & Adipic acid



**MATHEMATICS**

1. Let  $Z$  be the set of integers. If  
 $A = \{x \in Z : 2(x+2)(x^2 - 5x + 6)\} = 1$  and  
 $B = \{x \in Z : -3 < 2x - 1 < 9\}$ , then the number of  
subsets of the set  $A \times B$ , is :  
(1)  $2^{18}$  (2)  $2^{10}$  (3)  $2^{15}$  (4)  $2^{12}$

**Ans (3)**

**Sol.**  $A = \{x \in Z : 2^{(x+2)(x^2-5x+6)} = 1\}$   
 $2^{(x+2)(x^2-5x+6)} = 2^0 \Rightarrow x = -2, 2, 3$   
 $A = \{-2, 2, 3\}$   
 $B = \{x \in Z : -3 < 2x - 1 < 9\}$   
 $B = \{0, 1, 2, 3, 4\}$   
 $A \times B$  has 15 elements so number of subsets  
of  $A \times B$  is  $2^{15}$ .

2. If  $\sin^4 \alpha + 4 \cos^4 \beta + 2 = 4\sqrt{2} \sin \alpha \cos \beta$  ;  
 $\alpha, \beta \in [0, \pi]$ , then  $\cos(\alpha + \beta) - \cos(\alpha - \beta)$  is  
equal to :  
(1) 0 (2)  $-\sqrt{2}$  (3) -1 (4)  $\sqrt{2}$

**Ans (2)**

**Sol.** A.M.  $\geq$  G.M.  
 $\frac{\sin^4 \alpha + 4 \cos^4 \beta + 1 + 1}{4} \geq (\sin^4 \alpha \cdot 4 \cos^4 \beta \cdot 1 \cdot 1)^{\frac{1}{4}}$   
 $\sin^4 \alpha + 4 \cos^4 \beta + 2 \geq 4\sqrt{2} \sin \alpha \cos \beta$   
given that  $\sin^4 \alpha + 4 \cos^4 \beta + 2 = 4\sqrt{2} \sin \alpha \cos \beta$   
 $\Rightarrow$  A.M. = G.M.  $\Rightarrow \sin^4 \alpha = 1 = 4 \cos^4 \beta$   
 $\sin \alpha = 1, \cos \beta = \pm \frac{1}{\sqrt{2}}$   
 $\Rightarrow \sin \beta = \frac{1}{\sqrt{2}}$  as  $\beta \in [0, \pi]$   
 $\cos(\alpha + \beta) - \cos(\alpha - \beta) = -2 \sin \alpha \sin \beta$   
 $= -\sqrt{2}$

3. If an angle between the line,  $\frac{x+1}{2} = \frac{y-2}{1} = \frac{z-3}{-2}$   
and the plane,  $x - 2y - kz = 3$  is  $\cos^{-1}\left(\frac{2\sqrt{2}}{3}\right)$ ,  
then a value of  $k$  is:

(1)  $-\frac{5}{3}$  (2)  $\sqrt{\frac{3}{5}}$  (3)  $\sqrt{\frac{5}{3}}$  (4)  $-\frac{3}{5}$

**Ans (3)**

**Sol.** DR's of line are 2, 1, -2  
normal vector of plane is  $\hat{i} - 2\hat{j} - k\hat{k}$   
 $\sin \alpha = \frac{(2\hat{i} + \hat{j} - 2\hat{k}) \cdot (\hat{i} - 2\hat{j} - k\hat{k})}{3\sqrt{1+4+k^2}}$

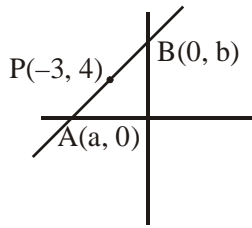
$\sin \alpha = \frac{2k}{3\sqrt{k^2+5}}$  .....(1)

$\cos \alpha = \frac{2\sqrt{2}}{3}$  .....(2)

$(1)^2 + (2)^2 = 1 \Rightarrow k^2 = \frac{5}{3}$

4. If a straight line passing through the point  
 $P(-3, 4)$  is such that its intercepted portion between  
the coordinate axes is bisected at  $P$ , then its  
equation is :  
(1)  $x - y + 7 = 0$   
(2)  $3x - 4y + 25 = 0$   
(3)  $4x + 3y = 0$   
(4)  $4x - 3y + 24 = 0$

**Ans (4)**



**Sol.**

Let the line be  $\frac{x}{a} + \frac{y}{b} = 1$

$$(-3, 4) = \left(\frac{a}{2}, \frac{b}{2}\right)$$

$$a = -6, b = 8$$

equation of line is  $4x - 3y + 24 = 0$

5. The integral  $\int \frac{3x^{13} + 2x^{11}}{(2x^4 + 3x^2 + 1)^4} dx$  is equal to :

(where C is a constant of integration)

(1)  $\frac{x^4}{(2x^4 + 3x^2 + 1)^3} + C$

(2)  $\frac{x^{12}}{6(2x^4 + 3x^2 + 1)^3} + C$

(3)  $\frac{x^4}{6(2x^4 + 3x^2 + 1)^3} + C$

(4)  $\frac{x^{12}}{(2x^4 + 3x^2 + 1)^3} + C$

**Ans (2)**

**Sol.**  $\int \frac{3x^{13} + 2x^{11}}{(2x^4 + 3x^2 + 1)^4} dx$

$$\int \frac{\left(\frac{3}{x^3} + \frac{2}{x^5}\right) dx}{\left(2 + \frac{3}{x^2} + \frac{1}{x^4}\right)^4}$$

Let  $\left(2 + \frac{3}{x^2} + \frac{1}{x^4}\right) = t$

$$-\frac{1}{2} \int \frac{dt}{t^4} = \frac{1}{6t^3} + C \Rightarrow \frac{x^{12}}{6(2x^4 + 3x^2 + 1)^3} + C$$

6. There are m men and two women participating in a chess tournament. Each participant plays two games with every other participant. If the number of games played by the men between themselves exceeds the number of games played between the men and the women by 84, then the value of m is :

- (1) 9      (2) 11      (3) 12      (4) 7

**Ans (3)**

**Sol.** Let m-men, 2-women

$${}^mC_2 \times 2 = {}^mC_1 \cdot {}^2C_1 \cdot 2 + 84$$

$$m^2 - 5m - 84 = 0 \Rightarrow (m - 12)(m + 7) = 0$$

$$m = 12$$

7. If the function f given by  $f(x) = x^3 - 3(a - 2)x^2 + 3ax + 7$ , for some  $a \in \mathbb{R}$  is increasing in  $(0, 1]$  and decreasing in  $[1, 5)$ , then a root of the equation,

$$\frac{f(x) - 14}{(x - 1)^2} = 0 (x \neq 1) \text{ is :}$$

- (1) 6      (2) 5      (3) 7      (4) -7

**Ans (3)**

**Sol.**  $f(x) = 3x^2 - 6(a - 2)x + 3a$

$$f'(x) \geq 0 \forall x \in (0, 1]$$

$$f'(x) \leq 0 \forall x \in [1, 5)$$

$$\Rightarrow f'(x) = 0 \text{ at } x = 1 \Rightarrow a = 5$$

$$f(x) - 14 = (x - 1)^2 (x - 7)$$

$$\frac{f(x) - 14}{(x - 1)^2} = x - 7$$

8. Let f be a differentiable function such that  $f(1) = 2$  and  $f'(x) = f(x)$  for all  $x \in \mathbb{R}$ . If  $h(x) = f(f(x))$ , then  $h'(1)$  is equal to :

- (1) 4e      (2) 4e<sup>2</sup>      (3) 2e      (4) 2e<sup>2</sup>

**Ans (1)**

**Sol.**  $\frac{f'(x)}{f(x)} = 1 \forall x \in \mathbb{R}$

Integrate & use  $f(1) = 2$

$$f(x) = 2e^{x-1} \Rightarrow f'(x) = 2e^{x-1}$$

$$h(x) = f(f(x)) \Rightarrow h'(x) = f'(f(x)) f'(x)$$

$$h'(1) = f'(f(1)) f'(1)$$

$$= f'(2) f'(1)$$

$$= 2e \cdot 2 = 4e$$



9. The tangent to the curve  $y = x^2 - 5x + 5$ , parallel to the line  $2y = 4x + 1$ , also passes through the point.

(1)  $\left(\frac{1}{4}, \frac{7}{2}\right)$                       (2)  $\left(\frac{7}{2}, \frac{1}{4}\right)$

(3)  $\left(-\frac{1}{8}, 7\right)$                       (4)  $\left(\frac{1}{8}, -7\right)$

**Ans (4)**

**Sol.**  $y = x^2 - 5x + 5$

$$\frac{dy}{dx} = 2x - 5 = 2 \Rightarrow x = \frac{7}{2}$$

at  $x = \frac{7}{2}, y = \frac{-1}{4}$

Equation of tangent at  $\left(\frac{7}{2}, \frac{-1}{4}\right)$  is  $2x - y - \frac{29}{4} = 0$

Now check options

$x = \frac{1}{8}, y = -7$

10. Let S be the set of all real values of  $\lambda$  such that a plane passing through the points  $(-\lambda^2, 1, 1)$ ,  $(1, -\lambda^2, 1)$  and  $(1, 1, -\lambda^2)$  also passes through the point  $(-1, -1, 1)$ . Then S is equal to :

(1)  $\{\sqrt{3}\}$                       (2)  $\{\sqrt{3} - \sqrt{3}\}$

(3)  $\{1, -1\}$                       (4)  $\{3, -3\}$

**Ans (2)**

**Sol.** All four points are coplaner so

$$\begin{vmatrix} 1-\lambda^2 & 2 & 0 \\ 2 & -\lambda^2+1 & 0 \\ 2 & 2 & -\lambda^2-1 \end{vmatrix} = 0$$

$(\lambda^2 + 1)^2 (3 - \lambda^2) = 0$

$\lambda = \pm\sqrt{3}$

11. If a circle of radius R passes through the origin O and intersects the coordinate axes at A and B, then the locus of the foot of perpendicular from O on AB is :

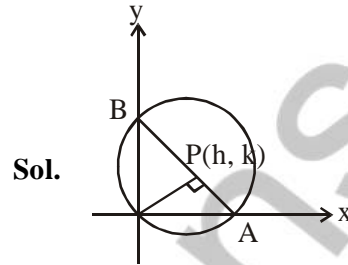
(1)  $(x^2 + y^2)^2 = 4R^2x^2y^2$

(2)  $(x^2 + y^2)(x + y) = R^2xy$

(3)  $(x^2 + y^2)^3 = 4R^2x^2y^2$

(4)  $(x^2 + y^2)^2 = 4R^2x^2y^2$

**Ans (3)**



Slope of AB =  $-\frac{h}{k}$

Equation of AB is  $hx + ky = h^2 + k^2$

$A\left(\frac{h^2 + k^2}{h}, 0\right), B\left(0, \frac{h^2 + k^2}{k}\right)$

$AB = 2R$

$\Rightarrow (h^2 + k^2)^3 = 4R^2h^2k^2$

$\Rightarrow (x^2 + y^2)^3 = 4R^2x^2y^2$

12. The equation of a tangent to the parabola,  $x^2 = 8y$ , which makes an angle  $\theta$  with the positive direction of x-axis, is :

(1)  $x = y \cot \theta + 2 \tan \theta$       (2)  $x = y \cot \theta - 2 \tan \theta$

(3)  $y = x \tan \theta - 2 \cot \theta$       (4)  $y = x \tan \theta + 2 \cot \theta$

**Ans (1)**

**Sol.**  $x^2 = 8y$

$\Rightarrow \frac{dy}{dx} = \frac{x}{4} = \tan \theta$

$\therefore x_1 = 4 \tan \theta$

$y_1 = 2 \tan^2 \theta$

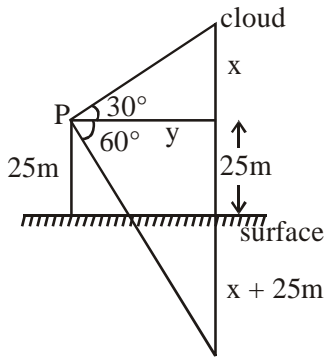
Equation of tangent :-

$y - 2 \tan^2 \theta = \tan \theta (x - 4 \tan \theta)$

$\Rightarrow x = y \cot \theta + 2 \tan \theta$

- 13.** If the angle of elevation of a cloud from a point P which is 25 m above a lake be  $30^\circ$  and the angle of depression of reflection of the cloud in the lake from P be  $60^\circ$ , then the height of the cloud (in meters) from the surface of the lake is :
- (1) 42      (2) 50      (3) 45      (4) 60

**Ans (2)**



**Sol.**

$$\tan 30^\circ = \frac{x}{y} \Rightarrow y = \sqrt{3}x \quad \dots(i)$$

$$\tan 60^\circ = \frac{25+x+25}{y}$$

$$\Rightarrow \sqrt{3}y = 50 + x$$

$$\Rightarrow 3x = 50 + x$$

$$\Rightarrow x = 25 \text{ m}$$

$\therefore$  Height of cloud from surface =  $25 + 25 = 50\text{m}$

- 14.** The integral  $\int_1^e \left\{ \left(\frac{x}{e}\right)^{2x} - \left(\frac{e}{x}\right)^x \right\} \log_e x dx$  is equal to :

(1)  $\frac{1}{2} - e - \frac{1}{e^2}$       (2)  $\frac{3}{2} - \frac{1}{e} - \frac{1}{2e^2}$

(3)  $-\frac{1}{2} + \frac{1}{e} - \frac{1}{2e^2}$       (4)  $\frac{3}{2} - e - \frac{1}{2e^2}$

**Ans. (4)**

$$\int_1^e \left(\frac{x}{e}\right)^{2x} \log_e x dx - \int_1^e \left(\frac{e}{x}\right)^x \log_e x dx$$

Let  $\left(\frac{x}{e}\right)^{2x} = t$ ,  $\left(\frac{e}{x}\right)^x = v$

$$= \frac{1}{2} \int_{\left(\frac{1}{e}\right)^2}^1 dt + \int_e^1 dv$$

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

- 15.**  $\lim_{n \rightarrow \infty} \left( \frac{n}{n^2+1^2} + \frac{n}{n^2+2^2} + \frac{n}{n^2+3^2} + \dots + \frac{1}{5n} \right)$

is equal to :

(1)  $\frac{\pi}{4}$       (2)  $\tan^{-1}(2)$

(3)  $\tan^{-1}(3)$       (4)  $\frac{\pi}{2}$

**Ans. (2)**

$$\lim_{x \rightarrow \infty} \sum_{r=1}^{2n} \frac{n}{n^2+r^2}$$

$$\lim_{x \rightarrow \infty} \sum_{r=1}^{2n} \frac{1}{n \left(1 + \frac{r^2}{n^2}\right)} = \int_0^2 \frac{dx}{1+x^2} = \tan^{-1} 2$$

- 16.** The set of all values of  $\lambda$  for which the system of linear equations.

$$x - 2y - 2z = \lambda x$$

$$x + 2y + z = \lambda y$$

$$-x - y = \lambda z$$

has a non-trivial solution.

(1) contains more than two elements

(2) is a singleton

(3) is an empty set

(4) contains exactly two elements

**Ans. (2)**

$$\begin{vmatrix} \lambda-1 & 2 & 2 \\ 1 & 2-\lambda & 1 \\ 1 & 1 & 1 \end{vmatrix} = 0 \Rightarrow (\lambda-1)^3 = 0 \Rightarrow \lambda = 1$$

- 17.** If  ${}^nC_4$ ,  ${}^nC_5$  and  ${}^nC_6$  are in A.P., then n can be :

(1) 14      (2) 11      (3) 9      (4) 12

**Ans. (1)**

$$2 \cdot {}^nC_5 = {}^nC_4 + {}^nC_6$$

$$2 \cdot \frac{|n|}{|5|n-5} = \frac{|n|}{|4|n-4} + \frac{|n|}{|6|n-6}$$

$$\frac{2}{5} \cdot \frac{1}{n-5} = \frac{1}{(n-4)(n-5)} + \frac{1}{30}$$

n = 14 satisfying equation.

18. Let  $\vec{a}, \vec{b}$  and  $\vec{c}$  be three unit vectors, out of which vectors  $\vec{b}$  and  $\vec{c}$  are non-parallel. If  $\alpha$  and  $\beta$  are the angles which vector  $\vec{a}$  makes with vectors  $\vec{b}$  and  $\vec{c}$  respectively and  $\vec{a} \times (\vec{b} \times \vec{c}) = \frac{1}{2} \vec{b}$ , then

$|\alpha - \beta|$  is equal to :

- (1)  $60^\circ$       (2)  $30^\circ$       (3)  $90^\circ$       (4)  $45^\circ$

Ans. (2)

$$(\vec{a} \cdot \vec{c})\vec{b} - (\vec{a} \cdot \vec{b})\vec{c} = \frac{1}{2}\vec{b}$$

$\therefore \vec{b}$  &  $\vec{c}$  are linearly independent

$$\therefore \vec{a} \cdot \vec{c} = \frac{1}{2} \quad \& \quad \vec{a} \cdot \vec{b} = 0$$

(All given vectors are unit vectors)

$$\therefore \alpha \wedge \gamma = 60^\circ \quad \& \quad \alpha \wedge \beta = 90^\circ$$

$$\therefore |\alpha - \beta| = 30^\circ$$

19. If  $A = \begin{bmatrix} 1 & \sin \theta & 1 \\ -\sin \theta & 1 & \sin \theta \\ -1 & -\sin \theta & 1 \end{bmatrix}$ ; then for all

$\theta \in \left(\frac{3\pi}{4}, \frac{5\pi}{4}\right)$ ,  $\det(A)$  lies in the interval :

(1)  $\left[\frac{5}{2}, 4\right)$                       (2)  $\left(\frac{3}{2}, 3\right]$

(3)  $\left(0, \frac{3}{2}\right]$                       (4)  $\left(1, \frac{5}{2}\right]$

Ans (2)

$$|A| = \begin{vmatrix} 1 & \sin \theta & 1 \\ -\sin \theta & 1 & \sin \theta \\ -1 & -\sin \theta & 1 \end{vmatrix}$$

$$= 2(1 + \sin^2 \theta)$$

$$\theta \in \left(\frac{3\pi}{4}, \frac{5\pi}{4}\right) \Rightarrow \frac{1}{\sqrt{2}} < \sin \theta < \frac{1}{\sqrt{2}}$$

$$\Rightarrow 0 \leq \sin^2 \theta < \frac{1}{2}$$

$$\therefore |A| \in [2, 3)$$

20.  $\lim_{x \rightarrow 1^-} \frac{\sqrt{\pi} - \sqrt{2\sin^{-1}x}}{\sqrt{1-x}}$  is equal to :

- (1)  $\frac{1}{\sqrt{2\pi}}$       (2)  $\sqrt{\frac{\pi}{2}}$       (3)  $\sqrt{\frac{2}{\pi}}$       (4)  $\sqrt{\pi}$

Ans. (3)

$$\lim_{x \rightarrow 1^-} \frac{\sqrt{\pi} - \sqrt{2\sin^{-1}x}}{\sqrt{1-x}} \times \frac{\sqrt{\pi} + \sqrt{2\sin^{-1}x}}{\sqrt{\pi} + \sqrt{2\sin^{-1}x}}$$

$$\lim_{x \rightarrow 1^-} \frac{2\left(\frac{\pi}{2} - \sin^{-1}x\right)}{\sqrt{1-x} \cdot (\sqrt{\pi} + \sqrt{2\sin^{-1}x})}$$

$$\lim_{x \rightarrow 1^-} \frac{2\cos^{-1}x}{\sqrt{1-x}} \cdot \frac{1}{2\sqrt{\pi}}$$

Put  $x = \cos \theta$

$$\lim_{\theta \rightarrow 0^+} \frac{2\theta}{\sqrt{2} \sin\left(\frac{\theta}{2}\right)} \cdot \frac{1}{2\sqrt{\pi}} = \sqrt{\frac{2}{\pi}}$$

21. The expression  $\sim(\sim p \rightarrow q)$  is logically equivalent to :

- (1)  $\sim p \wedge \sim q$                       (2)  $p \wedge q$   
(3)  $\sim p \wedge q$                       (4)  $p \wedge \sim q$

Ans. (1)

p	q	$\sim p$	$\sim p \rightarrow q$	$\sim(\sim p \rightarrow q)$	$(\sim p \wedge \sim q)$
T	T	F	T	F	F
F	T	T	T	F	F
T	F	F	T	F	F
F	F	T	F	T	T

22. The total number of irrational terms in the binomial

expansion of  $(7^{1/5} - 3^{1/10})^{60}$  is :

- (1) 55      (2) 49      (3) 48      (4) 54

Ans. (4)

$$\text{General term } T_{r+1} = {}^{60}C_r \cdot 7^{\frac{60-r}{5}} \cdot 3^{\frac{r}{10}}$$

$\therefore$  for rational term,  $r = 0, 10, 20, 30, 40, 50, 60$

$\Rightarrow$  no of rational terms = 7

$\therefore$  number of irrational terms = 54

23. The mean and the variance of five observations are 4 and 5.20, respectively. If three of the observations are 3, 4 and 4; then the absolute value of the difference of the other two observations, is :

- (1) 1      (2) 3      (3) 7      (4) 5

**Ans. (3)**

mean  $\bar{x} = 4, \sigma^2 = 5.2, n = 5, x_1 = 3, x_2 = 4 = x_3,$

$$\sum x_i = 20$$

$$x_4 + x_5 = 9 \dots\dots(i)$$

$$\frac{\sum x_i^2}{n} - (\bar{x})^2 = \sigma^2 \Rightarrow \sum x_i^2 = 106$$

$$x_4^2 + x_5^2 = 65 \dots\dots(ii)$$

Using (i) and (ii)  $(x_4 - x_5)^2 = 49$

$$|x_4 - x_5| = 7$$

24. If the sum of the first 15 terms of the

series  $\left(\frac{3}{4}\right)^3 + \left(1\frac{1}{2}\right)^3 + \left(2\frac{1}{4}\right)^3 + 3^3 + \left(3\frac{3}{4}\right)^3 + \dots$  is

equal to 225 k, then k is equal to :

- (1) 9      (2) 27      (3) 108      (4) 54

**Ans. (2)**

$$S = \left(\frac{3}{4}\right)^3 + \left(\frac{6}{4}\right)^3 + \left(\frac{9}{4}\right)^3 + \left(\frac{12}{4}\right)^3 + \dots\dots\dots 15 \text{ term}$$

$$= \frac{27}{64} \sum_{r=1}^{15} r^3$$

$$= \frac{27}{64} \cdot \left[ \frac{15(15+1)}{2} \right]^2$$

$$= 225 K \text{ (Given in question)}$$

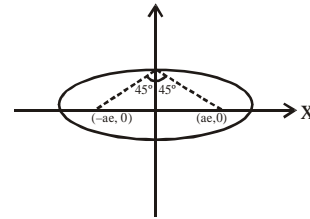
$$K = 27$$

25. Let S and S' be the foci of the ellipse and B be any one of the extremities of its minor axis. If  $\Delta S'BS$  is a right angled triangle with right angle at B and area  $(\Delta S'BS) = 8$  sq. units, then the length of a latus rectum of the ellipse is :

- (1)  $2\sqrt{2}$       (2) 2      (3) 4      (4)  $4\sqrt{2}$

**Ans. (3)**

$$m_{SB} \cdot m_{S'B} = -1$$



$$b^2 = a^2 e^2 \dots (i)$$

$$\frac{1}{2} S'B \cdot SB = 8$$

$$S'B \cdot SB = 16$$

$$a^2 e^2 + b^2 = 16 \dots (ii)$$

$$b^2 = a^2 (1 - e^2) \dots (iii)$$

using (i), (ii), (iii)  $a = 4$

$$b = 2\sqrt{2}$$

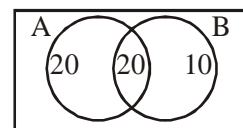
$$e = \frac{1}{\sqrt{2}}$$

$$\therefore \ell \text{ (L.R)} = \frac{2b^2}{a} = 4 \quad \boxed{\text{Ans.3}}$$

26. In a class of 60 students, 40 opted for NCC, 30 opted for NSS and 20 opted for both NCC and NSS. If one of these students is selected at random, then the probability that the student selected has opted neither for NCC nor for NSS is :

- (1)  $\frac{2}{3}$       (2)  $\frac{1}{6}$       (3)  $\frac{1}{3}$       (4)  $\frac{5}{6}$

**Ans. (2)**



A  $\rightarrow$  opted NCC

B  $\rightarrow$  opted NSS

$$\therefore P \text{ (nither A nor B)} = \frac{10}{60} = \frac{1}{6}$$

27. The number of integral values of m for which the quadratic expression.

$(1 + 2m)x^2 - 2(1 + 3m)x + 4(1 + m)$ ,  $x \in \mathbb{R}$ , is always positive, is :

- (1) 8            (2) 7            (3) 6            (4) 3

**Ans. (2)**

Expression is always positive if

$$2m + 1 > 0 \Rightarrow m > -\frac{1}{2}$$

&

$$D < 0 \Rightarrow m^2 - 6m - 3 < 0$$

$$3 - \sqrt{12} < m < 3 + \sqrt{12} \quad \dots \text{(iii)}$$

$\therefore$  Common interval is

$$3 - \sqrt{12} < m < 3 + \sqrt{12}$$

$\therefore$  Integral value of m {0,1,2,3,4,5,6}

28. In a game, a man wins Rs. 100 if he gets 5 or 6 on a throw of a fair die and loses Rs. 50 for getting any other number on the die. If he decides to throw the die either till he gets a five or a six or to a maximum of three throws, then his expected gain/loss (in rupees) is :

- (1)  $\frac{400}{3}$  gain                      (2)  $\frac{400}{3}$  loss  
(3) 0                                  (4)  $\frac{400}{9}$  loss

**Ans. (3)**

$$\begin{aligned} \text{Expected Gain/ Loss} &= \\ &= w \times 100 + Lw(-50 + 100) + L^2w(-50 - 50 + 100) + L^3(-150) \end{aligned}$$

$$= \frac{1}{3} \times 100 + \frac{2}{3} \cdot \frac{1}{3} (50) + \left(\frac{2}{3}\right)^2 \left(\frac{1}{3}\right) (0) +$$

$$\left(\frac{2}{3}\right)^3 (-150) = 0$$

here w denotes probability that outcome 5 or 6 (

$$w = \frac{2}{6} = \frac{1}{3})$$

here L denotes probability that outcome

$$1,2,3,4 \left( L = \frac{4}{6} = \frac{2}{3} \right)$$

29. If a curve passes through the point (1, -2) and has slope of the tangent at any point (x, y) on it as

$$\frac{x^2 - 2y}{x}, \text{ then the curve also passes through the}$$

point :

(1)  $(-\sqrt{2}, 1)$                       (2)  $(\sqrt{3}, 0)$

(3)  $(-1, 2)$                       (4)  $(3, 0)$

**Ans. (2)**

$$\frac{dy}{dx} = \frac{x^2 - 2y}{x} \quad \text{(Given)}$$

$$\frac{dy}{dx} + 2\frac{y}{x} = x$$

$$\text{I.F} = e^{\int \frac{2}{x} dx} = x^2$$

$$\therefore y \cdot x^2 = \int x \cdot x^2 dx + C$$

$$= \frac{x^4}{4} + C$$

hence bpasses through (1, -2)  $\Rightarrow C = -\frac{9}{4}$

$$\therefore yx^2 = \frac{x^4}{4} - \frac{9}{4}$$

Now check option(s) , Which is satisfy by option (ii)

30. Let  $Z_1$  and  $Z_2$  be two complex numbers satisfying  $|Z_1| = 9$  and  $|Z_2 - 3 - 4i| = 4$ . Then the minimum value of  $|Z_1 - Z_2|$  is :

- (1) 0            (2) 1            (3)  $\sqrt{2}$             (4) 2

**Ans. (1)**

$$|z_1| = 9, \quad |z_2 - (3 + 4i)| = 4$$

$$C_1 (0, 0) \text{ radius } r_1 = 9$$

$$C_2 (3, 4), \text{ radius } r_2 = 4$$

$$C_1 C_2 = |r_1 - r_2| = 5$$

$\therefore$  Circle touches internally

$$\therefore |z_1 - z_2|_{\min} = 0$$