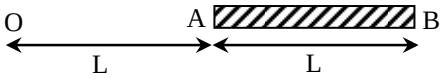
Part A - PHYSICS

Q.1 A charge Q is uniformly distributed over a long rod AB of length L as shown in the figure. The electric potential at the point O lying at a distance L from the end A is -

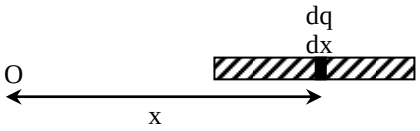


(1) $\frac{Q}{4\pi\in_0 L\ln 2}$ (2) $\frac{Q\ln 2}{4\pi\in_0 L}$

(3) $\frac{Q}{8\pi\in_0 L}$ (4) $\frac{3Q}{4\pi\in_0 L}$

Ans. **[2]**

Sol. **Electrostatics**



$\int_0^V dv = \int_L^{2L} \frac{kdq}{x}$ $\left[\lambda = \frac{Q}{L}\right]$

$V = \int \frac{k\lambda dx}{x}$

$V = \int \frac{kQ}{L}\ell n\left(\frac{2L}{L}\right)$

$V = \frac{kQ}{L}\ell n(2)$

Q.2 A sonometer wire of length 1.5 m is made of steel. The tension in it produces an elastic strain of 1%. What is the fundamental frequency of steel if density and elasticity of steel are 7.7×10^3 kg/m^3 and 2.2×10^{11} N/m^2 respectively ?

(1) 200.5 Hz (2) 770 Hz

(3) 188.5 Hz (4) 178.2 Hz

Ans. **[4]**

Sol. **Methanical wave and string**

$n_1 = \frac{1}{2L}\sqrt{\frac{T}{A\times\rho}}$ $\left[\because Y = \frac{T/A}{\Delta L/L} \Rightarrow \frac{T}{A} = Y\times\frac{\Delta L}{L}\right]$

$= \frac{1}{2L}\sqrt{\frac{2.2\times10^{11}\times0.01}{7.7\times10^3}} = \frac{1}{2L}\sqrt{\frac{10^8}{10^2}\times\frac{2}{7}}$

$= \frac{10^4}{10\times2\times1.5}\times\sqrt{\frac{2}{7}}$

$= \frac{10^4}{3\times10}\times\sqrt{\frac{2}{7}} = 178.2$ Hz

Q.3 A projectile is given an initial velocity of $(\hat{i}+2\hat{j})$ m/s, where $\hat{i}$ is along the ground and $\hat{j}$ is along the vertical. If g = 10 m/s^2, the equation of its trajectory is -

(1) $4y = 2x - 5x^2$ (2) $4y = 2x - 25x^2$

(3) $y = x - 5x^2$ (4) $y = 2x - 5x^2$

Ans. **[4]**

Sol. **Students may find this question in CP Sheet at : Projectile motion (same as theory given on article 1.3 Page 80)**

Velocity at time t

$v = \hat{i} + (2-10t)\hat{j}$

So, $v_x = \frac{dx}{dt} = 1$

$x = t$ ….(1)

and $v_y = \frac{dy}{dt} = 2-10t$

$y = 2t - 5t^2$ …(2)

so by equation (1) and (2)

$y = 2x - 5x^2$

Q.4 A uniform cylinder of length L and mass M having cross-sectional area A is suspended, with its length vertical, from a fixed point by a massless spring, such that it is half submerged in a liquid of density σ at equilibrium position. The extension x_0 of the spring when it is in equilibrium is -

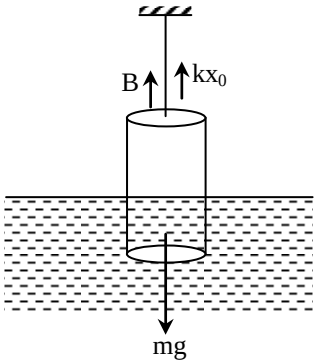
(Here k is spring constant)

(1) $\frac{Mg}{k}\left(1-\frac{LA\sigma}{2M}\right)$ (2) $\frac{Mg}{k}\left(1+\frac{LA\sigma}{M}\right)$

(3) $\frac{Mg}{k}$ (4) $\frac{Mg}{k}\left(1-\frac{LA\sigma}{M}\right)$

Ans. **[1]**

Sol. **Fluid Mechanics**



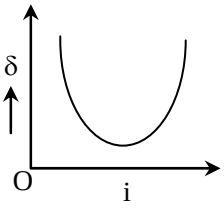
At equilibrium

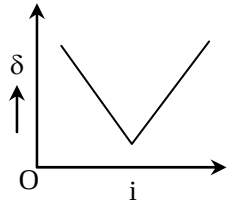
$kx_0 + B = Mg$

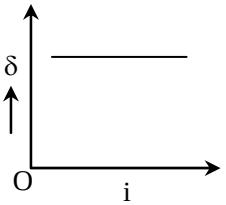
$$kx_0 = Mg - \left(\frac{L}{2}A\right)6g$$

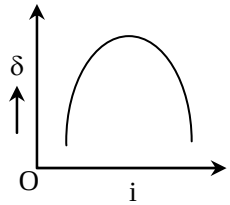
$$x_0 = \frac{Mg}{k}\left[1 - \frac{LA\rho}{2M}\right]$$

Q.5 The graph between angle of deviation (δ) and angle of incidence (i) for a triangular prism is represented by -

(1) 

(2) 

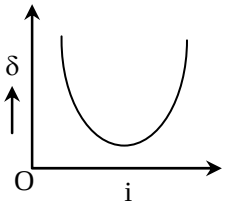
(3) 

(4) 

Ans. **[1]**

Sol. **Students may find this question in CP Sheet at : Prism, Level-1, Ques. 41/Page no.48**

By theory and experiment.



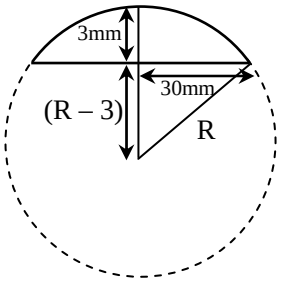
Q.6 Diameter of a plano-convex lens is 6 cm and thickness at the centre is 3 mm. If speed of light in material of lens is 2×10^8 m/s, the focal length of the lens is -

(1) 30 cm (2) 10 cm

(3) 15 cm (4) 20 cm

Ans. **[1]**

Sol.



$\therefore$ $\mu = 3/2$

$(R-3)^2 + (30)^2 = R^2$

$R^2 + 9 - 6R + 900 = R^2$

$6R = 909$

$R = 151.5$ mm

$$\frac{1}{f} = \left(\frac{3}{2} - 1\right)\left(\frac{1}{151.5} - \frac{1}{\infty}\right)$$

$$\frac{1}{f} = \frac{1}{303}$$

$f = 303$ mm

$f = 30.3$ cm

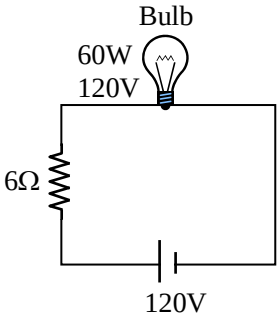
Q.7 The supply voltage to a room is 120 V. The resistance of the lead wires is 6Ω. A 60 W bulb is already switched on. What is the decrease of voltage across the bulb, when a 240 W heater is switched on in parallel to the bulb ?

(1) 13.3 V (2) 10.04 V

(3) zero V (4) 2.9 V

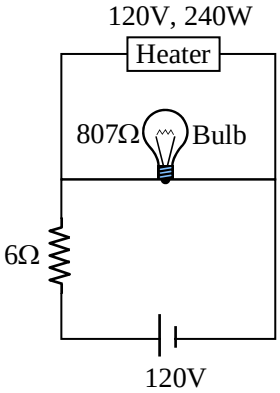
Ans. **[2]**

Sol. **Current Electricity**



$$R_{bulb} = \frac{(120 \times 120)}{60} = 240\ \Omega$$

$$V_{bulb} = \left(\frac{120}{6 + 240}\right) \times 240 = 117.0\,V$$



$R_{heater} = \frac{(120)^2}{240} = 60\,\Omega$

$V_{heater} = \left(\frac{120}{6+48}\right) 48 = 106.7$

$\Delta V = 117 - 106.7 \approx 10$ V

Q.8 A beam of unpolarised light of intensity I_0 is passed through a polaroid A and then through another polariod B which is oriented so that its principal plane makes an angle of 45º relative to that of A. The intensity of the emergent light is -

(1) $\frac{I_0}{4}$ (2) $\frac{I_0}{8}$

(3) I_0 (4) $\frac{I_0}{2}$

Ans. **[1]**

Sol. **Students may find this question Same as Level-2 Q.10/Page no.128**

Intensity of light emerge out from A = $\frac{I_0}{2}$

Again from Malus, law

Intensity of light emerge out from B

$= \frac{I_0}{2}\cos^2 45^o$

$= \frac{I_0}{4}$

Q.9 The amplitude of a damped oscillator decreases to 0.9 times its original magnitude in 5s. In another 10s it will decrease to α times its original magnitude, where α equals -

(1) 0.729 (2) 0.6

(3) 0.7 (4) 0.81

Ans. **[1]**

Sol. **SHM**

$A = A_0 e^{-\lambda t}$

For first 5s

$0.9\,A_0 = A_0 e^{-5\lambda}$ ...(1)

In another 10s

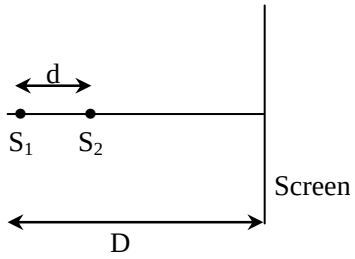
$\alpha A_0 = A_0 e^{-15\lambda}$ ...(2)

$= A_0 (e^{-5\lambda})^3$

$= (0.9)^3 A_0$

So, $\alpha = 0.729$

Q.10 Two coherent point sources S_1 and S_2 are separated by a small distance 'd' as shown. The fringes obtained on the screen will be -

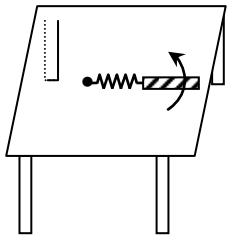


(1) semi-circles
(2) concentric circles
(3) points
(4) straight lines

Ans. **[2]**

Sol. **Level-4 (Sec-B) Q.1/Page no.115**

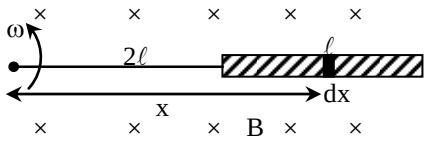
Q.11 A metallic rod of length 'ℓ ' is tied to a string of length 2ℓ and made to rotate with angular speed ω on a horizontal table with one end of the string fixed. If there is a vertical magnetic field 'B' in the region, the e.m.f. induced across the ends of the rod is -



(1) $\frac{4B\omega\ell^2}{2}$
(2) $\frac{5B\omega\ell^2}{2}$
(3) $\frac{2B\omega\ell^2}{2}$
(4) $\frac{3B\omega\ell^2}{2}$

Ans. **[2]**

Sol. **Electro Magnetic Induction**



emf across length dx

$dE = vBdx$

$= (x\omega)Bdx$

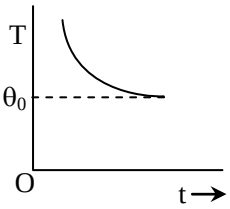
$E = B\omega \int_{x=2\ell}^{x=3\ell} xdx$

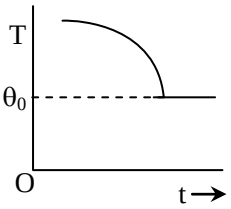
$$E = B\omega\left[\frac{x^2}{2}\right]_{2\ell}^{3\ell}$$

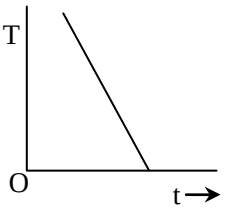
$$= \frac{B\omega}{2}[(3\ell)^2 - (2\ell)^2]$$

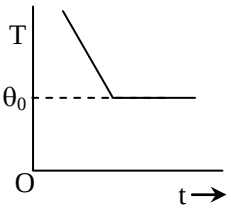
$$= \frac{5}{2}B\omega\ell^2$$

Q.12 If a piece of metal is heated to temperature θ and then allowed to cool in a room which is at temperature θ_0, the graph between the temperature T of the metal and time t will be closest to -

(1) 

(2) 

(3) 

(4) 

Ans. **[1]**

Sol. **Practical physics sheet, Page no.68, Q.5**

By Newton's law of cooling

$$\frac{dT}{dt} = -K(T - T_0)$$

$$\int_{T_{initial}}^{T} \frac{dT}{T - T_0} = -\int_0^t k\,dt$$

$$T = T_0 + (T_i - T_0)e^{-kt}$$

Q.13 This question has Statement-I and Statement-II. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement-I : Higher the range, greater is the resistance of ammeter.

Statement-II : To increase the range of ammeter, additional shunt needs to be used across it.

(1) If statement-I is true but statement-II is false.
(2) If statement-I is false but statement-II is true.
(3) If both statement-I and statement-II are true, and statement-II is the **correct** explanation of statement-I.
(4) If both statement-I and statement-II are true but statement-II is **not** the correct explanation of statement-I

Ans. **[2]**

Sol. **Electric Instruments**

Statement-I → false

Statement-II → True

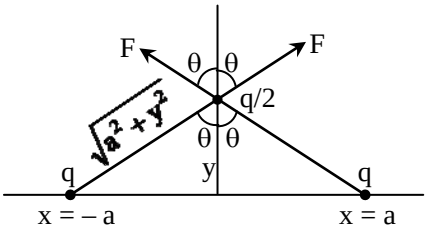
Q.14 Two charges, each equal to q, are kept at x = – a and x = a on the x-axis. A particle of mass m and charge $q_0 = \frac{q}{2}$ is placed at the origin. If charge q_0 is given a small displacement (y << a) along the y-axis, the net force acting on the particle is proportional to -

(1) $\frac{1}{y}$ (2) $-\frac{1}{y}$

(3) y (4) – y

Ans. **[3]**

Sol. **Electrostatics**



$F_{net} = 2F\cos\theta$

$= \frac{2kq\frac{q}{2}}{(a^2+y^2)}\frac{y}{\sqrt{a^2+y^2}}$

$= \frac{kq^2y}{(a^2+y^2)^{3/2}}$

if $y << a$, $(a^2+y^2)^{3/2} \approx a^3$

$F_{net} = \frac{kq^2y}{a^3}$

$\therefore F_{net} \propto y$

Q.15 This question has Statement-I and Statement-II. Of the four choices given after the statements, choose the one that best describes the two statements.

Statement-I : A point particle of mass m moving with speed v collides with stationary point particle of mass M. If the maximum energy loss possible is given as $f\left(\frac{1}{2}mv^2\right)$ then $f = \left(\frac{m}{M+m}\right)$.

Statement-II : Maximum energy loss occurs when the particles get stuck together as a result of the collision.

(1) If statement-I is true but statement-II is false.
(2) If statement-I is false but statement-II is true.
(3) If both statement-I and statement-II are true, and statement-II is the **correct** explanation of statement-I.
(4) If both statement-I and statement-II are true but statement-II is **not** the correct explanation of statement-I

Ans. **[2]**

Sol. **Students may find this question in CP Sheet at : Given on page no.150, Article 6.2**

Inelastic collision

Loss in KE

$$\Delta E = \frac{1}{2}\left\{\frac{mM}{m+M}\right\}(v-0)^2(1-e^2)$$

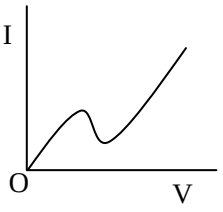
$$= \frac{1}{2}mv^2\left\{\frac{M}{m+M}\right\}(1-e^2)$$

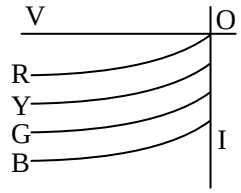
So, it will maximum when e = 0

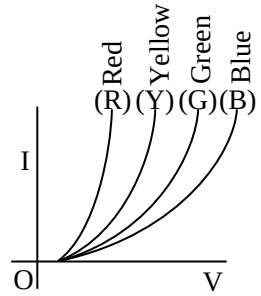
for perfectly inelastic

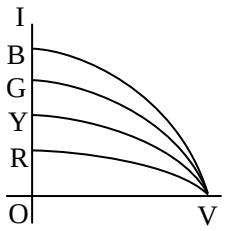
so 1st is wrong and 2 is correct.

Q.16 The I-V characteristic of an LED is -

(1) 

(2) 

(3) 

(4) 

Ans. **[3]**

Sol. **Semi Conductor**

By theory

Q.17 Assume that a drop of liquid evaporates by decrease in its surface energy, so that its temperature remains unchanged. What should be the minimum radius of the drop for this to be possible ? he surface tension is T, density of liquid is ρ and L is its latent heat of vaporization -

(1) $\frac{T}{\rho L}$ (2) $\frac{2T}{\rho L}$

(3) $\frac{\rho L}{T}$ (4) $\sqrt{\frac{T}{\rho L}}$

Ans. **[2]**

Sol. **Properties of matter**

Surface energy = T × ΔA

$\Delta A = 4\pi r^2 - 4\pi (r - dr)^2 = 8\pi\, rdr$

$m = (4\pi r^2 dr)\rho$

according to question

$T \times \Delta A = mL$

$T \times 8\pi r\, dr = (4\pi r^2 dr\, L)\rho$

$r = \dfrac{2T}{\rho L}$

Q.18 Two capacitors C_1 and C_2 are charged to 120 V and 200 V respectively. It is found that by connecting them together the potential on each one can be made zero -

(1) $3C_1 + 5C_2 = 0$ (2) $9C_1 = 4C_2$

(3) $5C_1 = 3C_2$ (4) $3C_1 = 5C_2$

Ans. **[4]**

Sol. **Capacitance**

C_1 C_2

120V 200V

Common potential

$V = \dfrac{C_1V_1 - C_2V_2}{C_1 + C_2} = 0$

$120C_1 - 200C_2 = 0$

$3C_1 = 5C_2$

Q.19 What is the minimum energy required to launch a satellite of mass m from the surface of a planet of mass M and radius R in a circular orbit at an altitude of 2R ?

(1) $\dfrac{GmM}{2R}$ (2) $\dfrac{GmM}{3R}$

(3) $\dfrac{5GmM}{6R}$ (4) $\dfrac{2GmM}{3R}$

Ans. **[3]**

Sol. **Students may find this similar question in CP Sheet : Q.No.37, Page no.30, Level-2 (Gravitation)**

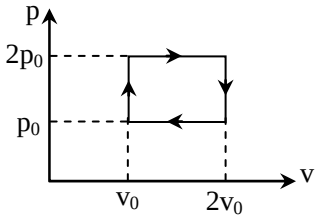
$E_K - \dfrac{GMm}{R} = -\dfrac{GMm}{3R} + \dfrac{1}{2}m\,\dfrac{GM}{3R}$

$E_K = \dfrac{GMm}{R} - \dfrac{GMm}{3R} + \dfrac{GMm}{6R}$

$= \dfrac{2}{3}\dfrac{GMm}{R} + \dfrac{GMm}{6R}$

$E_K = \dfrac{5GMm}{6R}$

Q.20 Given p-v diagram represents the thermodynamic cycle of an engine, operating with an ideal monoatomic gas. The amount of heat, extracted from the source in a single cycle is -



(1) $\left(\frac{11}{2}\right)p_0v_0$ (2) $4p_0v_0$

(3) p_0v_0 (4) $\left(\frac{13}{2}\right)p_0v_0$

Ans. **[4]**

Sol. **Thermodynamics**

$Q = nC_v\Delta T + nC_p\Delta T$

$= \frac{3}{2}nRT_0 + \frac{5}{2}nR(2T_0)$

$= \frac{3}{2}nRT_0 + 5nRT_0$

$= \frac{13}{2}nRT_0$

$= \frac{13}{2}P_0V_0$

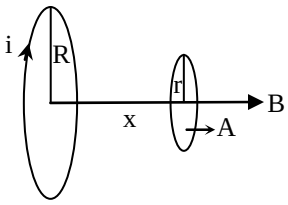
Q.21 A circular loop of radius 0.3 cm lies parallel to a much bigger circular loop of radius 20 cm. The centre of the small loop is on the axis of the bigger loop. The distance between their centres is 15 cm. If a current of 2.0 A flow through the smaller loop, then the flux linked with bigger loop is -

(1) 3.3×10^{-11} weber (2) 6.6×10^{-9} weber

(3) 9.1×10^{-11} weber (4) 6×10^{-11} weber

Ans. **[3]**

Sol. **Electro Magnetic Induction**



We know that mutual inductance remain same whether we pass current in any coil

$\therefore$ we pass same current in bigger coil then

$\phi_{Smaller}$ = BA cos 0°

$$= \frac{\mu_0 i R^2}{2(R^2+x^2)^{3/2}}.\pi r^2$$

$$= \frac{\mu_0 \pi i R^2 r^2}{2(R^2+x^2)^{3/2}}$$

$$= \frac{4\pi\times10^{-7}\times\pi\times2\times(0.2)^2(3\times10^{-3})^2}{2(0.2^2+0.15^2)^{3/2}}$$

$\approx 9.1 \times 10^{-11}$ wb

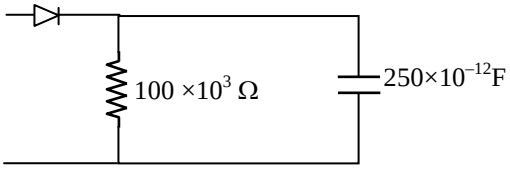
Q.22 A diode detector is used to detect an amplitude modulated wave of 60% modulation by using a condenser of capacity 250 pico farad in parallel with a load resistance 100 kilo ohm. Find the maximum modulated frequency which could be detected by it -

(1) 5.31 MHz (2) 5.31 kHz

(3) 10.62 MHz (4) 10.62 kHz

Ans. [4]

Sol. Communication



Given : $\frac{f_C}{f_m} = 0.6$

the modulated frequency is given by

$$f_C = \frac{1}{2\pi RC} = \frac{1}{2\times\pi\times100\times10^3\times250\times10^{-12}}$$

$$= \frac{1}{\pi\times5\times10^{-5}}$$

$$= \frac{100}{5\pi}\times10^3$$

$$= \frac{20}{\pi}\times10^3$$

= 6.36 kHz

This is 60% of maximum frequency.

$$\therefore f_{max} = 6.36 \times \frac{100}{60}$$

= 10.6 kHz

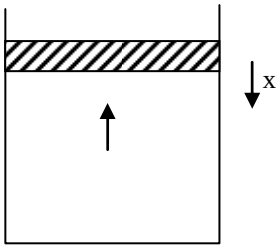
Q.23 An ideal gas enclosed in a vertical cylindrical container supports a freely moving piston of mass M. The piston and the cylinder have equal cross sectional area A. When the piston is in equilibrium, the volume of the gas is V_0 and its pressure is P_0. The piston is slightly displaced from the equilibrium position and released. Assuming that the system is completely isolated from its surrounding, the piston executes a simple harmonic motion with frequency -

(1) $\frac{1}{2\pi}\sqrt{\frac{A^2\gamma P_0}{MV_0}}$ (2) $\frac{1}{2\pi}\sqrt{\frac{MV_0}{A\gamma P_0}}$

(3) $\frac{1}{2\pi}\frac{A\gamma P_0}{V_0 M}$ (4) $\frac{1}{2\pi}\frac{V_0 M P_0}{A^2\gamma}$

Ans. **[1]**

Sol. **SHM Given in sheet thoery page 50 Article-12**



In Adiabatic process

$P_0V_0^{\gamma} = (P_0 + \Delta P)(V_0 - \Delta V)^{\gamma}$

By solving $\Delta P = \frac{\gamma P_0 \Delta V}{V_0}$ {neglect $\Delta P \Delta V$}

so Restoring force $F = -\Delta PA$

or acceleration = $\frac{F}{M} = -\left(\frac{\gamma P_0}{MV_0}A^2\right)\gamma$

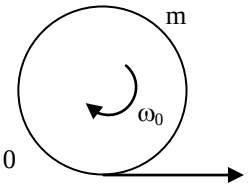
So $\omega = \sqrt{\frac{\gamma P_0 A^2}{MV_0}}$ or $f = \frac{1}{2\pi}\sqrt{\frac{\gamma P_0 A^2}{MV_0}}$

Q.24 A hoop of radius r and mass m rotating with an angular velocity ω_0 is placed on a rough horizontal surface. The initial velocity of the centre of the hoop is zero. What will bet he velocity of the centre of the hoop when it ceases to slip ?

(1) $\frac{r\omega_0}{2}$ (2) $r\omega_0$ (3) $\frac{r\omega_0}{4}$ (4) $\frac{r\omega_0}{3}$

Ans. **[1]**

Sol. **Rotational dynamics**



at t = 0 Friction force = f

Linear acceleration = f/m

$\alpha = \frac{f.r}{I} = \frac{f}{mr}$

after time t

$v = 0 + \frac{f}{m}t$

$\omega = \omega_0 - \frac{f}{mr}t$

when body start pure rolling

$v = r\omega$

$\frac{f}{m}t = r\left(\omega_0 - \frac{f}{mr}t\right)$ so $t = \frac{mr\omega_0}{2f}$

So $v = \frac{f}{m} \times \frac{mr\omega_0}{2f} = \frac{r\omega_0}{2}$

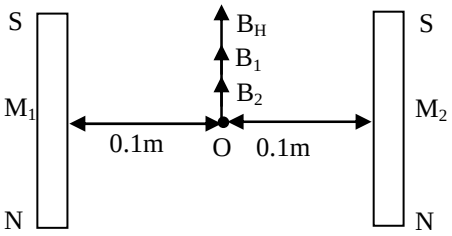
Q.25 Two short bar magnets of length 1 cm each have magnetic moments 1.20 Am^2 and 1.00 Am^2 respectively. They are placed on a horizontal table parallel to each other with their N poles pointing towards the South. They have a common magnetic equator and are separated by a distance of 20.0 cm. The value of the resultant horizontal magnetic induction at the mid-point O of the line joining their centres is close to
(Horizontal component of earth's magnetic induction is 3.6×10^{-5} Wb/m^2)

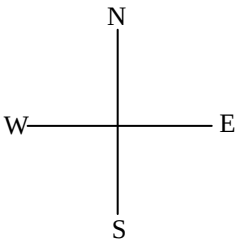
(1) 3.50×10^{-4} Wb/m^2 (2) 5.80×10^{-4} Wb/m^2

(3) 3.6×10^{-5} Wb/m^2 (4) 2.56×10^{-4} Wb/m^2

Ans. **[4]**

Sol. **Magnetism**





$B_0 = B_1 + B_2 + B_H$

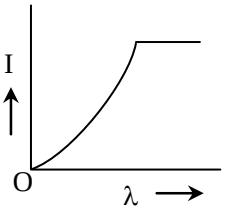
$= \frac{\mu_0}{4\pi}\frac{M_1}{r_1^3} + \frac{\mu_0}{4\pi}\frac{M_2}{r_2^3} + B_H$

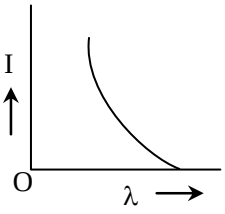
$= 10^{-7} \times \frac{1.2}{(0.1)^3} + \frac{10^{-7} \times 1}{(0.1)^3} + 3.6 \times 10^{-5}$

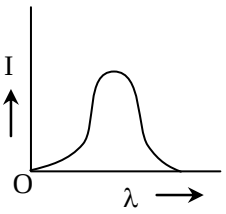
$= 1.2 \times 10^{-4} + 1 \times 10^{-4} + 3.6 \times 10^{-5}$

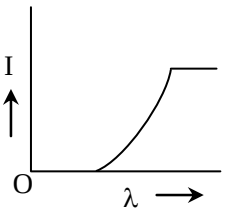
$= 2.2 \times 10^{-4} + 0.36 \times 10^{-4} = 2.56 \times 10^{-4}$ wb/m^2

Q.26 The anode voltage of a photocell is kept fixed. The wavelength λ of the light falling on the cathode is gradually changed. The plate current I of the photocell varies as follows

(1) 

(2) 

(3) 

(4) 

Ans. **[2]**

Sol. **Students may find this question in CP Sheet at : level (4) Q. 9 (Photoelectric Effect)**

Q.27 Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of vacuum. If M = mass, L = length, T = time and A = electric current, then -

(1) $[\varepsilon_0] = [M^{-1} L^2 T^{-1} A^{-2}]$ (2) $[\varepsilon_0] = [M^{-1} L^2 T^{-1} A]$

(3) $[\varepsilon_0] = [M^{-1} L^{-3} T^2 A]$ (4) $[\varepsilon_0] = [M^{-1} L^{-3} T^4 A^2]$

Ans. **[4]**

Sol. **Unit & dimension, Error theory given on page no.11, Article 3.4.3**

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

$$\varepsilon_0 = \frac{q_1 q_2}{Fr^2}$$

$$\varepsilon_0 = \frac{C^2}{MLT^{-2}L^2} \times \frac{T^2}{T^2}$$

$$\Rightarrow A^2 T^4 L^{-3} M^{-1}$$

Q.28 In a hydrogen like atom electron makes transition from an energy level with quantum number n to another with quantum number (n – 1). If n >> 1, the frequency of radiation emitted is proportional to -

(1) $\frac{1}{n^{3/2}}$ (2) $\frac{1}{n^3}$ (3) $\frac{1}{n}$ (4) $\frac{1}{n^2}$

Ans. **[2]**

Sol. **Atomic Structure**

Students may find this question in CP Sheet at : Level 2 Page No. 33

n to (n – 1)

$$\frac{c}{\lambda} = cRZ^2\left[\frac{1}{(n-1)^2} - \frac{1}{n^2}\right]$$

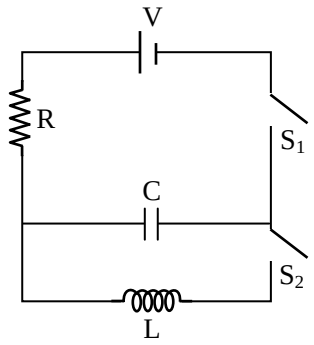
$$\nu = RcZ^2\left[\frac{n^2 - (n-1)^2}{n^2(n-1)^2}\right]$$

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

$$\nu = RcZ^2\left[\frac{2n}{n^4}\right]$$

$$\nu \propto \frac{1}{n^3}$$

Q.29 In an LCR circuit as shown below both switches are open initially. Now switch S_1 is closed S_2 kept open. (q is charge on the capacitor and τ = RC is Capacitive time constant). Which of the following statement is correct ?



(1) At $t = 2\tau$, $q = CV(1 - e^{-2})$

(2) At $t = \frac{\tau}{2}$, $q = CV(1 - e^{-1})$

(3) Work done by the battery is half of the energy dissipated in the resistor

(4) At $t = \tau$, $q = CV/2$

Ans. **[1]**

Sol. **Students may find this question in CP Sheet at : From Sheet (Capacitance)**

During charging of capacitor

$q = q_0[1 - e^{-t/RC}]$

$q = CV[1 - e^{2t/t}]$

$q = CV[1 - e^{2}]$

Q.30 The magnetic field in a traveling electromagnetic wave has a peak value of 20 nT. The peak value of electric field strength is -

(1) 9 V/m (2) 12 V/m (3) 3 V/m (4) 6 V/m

Ans. **[4]**

Sol. **Students may find this question in CP Sheet at : From EMW Sheet**

$$\frac{E_0}{B_0} = C$$

$E_0 = 3 \times 10^8 \times 20 \times 10^{-9}$

$E_0 = 6$ V/m

Part B - MATHEMATICS

Q.31 The real number k for which the equation, $2x^3 + 3x + k = 0$ has two distinct real roots in [0, 1]

(1) lies between –1 and 0 (2) does not exist

(3) lies between 1 and 2 (4) lies between 2 and 3

Ans. **[2]**

Sol. **Students may find this Question in CP Sheet at Q.21; Level-2; Page no. 144**

$f(x) = 2x^3 + 3x + k$

As $f'(x) = 6x^2 + 3$ (always +ve)

so it is strictly ↑

so equation has only one root.

Therefore no value of k.

Q.32 The number of values of k, for which the system of equation : $(k + 1)x + 8y = 4k$, $kx + (k + 3)y = 3k - 1$, has no solution, is -

(1) 2 (2) 3 (3) infinite (4) 1

Ans. **[4]**

Sol. **Students may find this Question in CP Sheet at Q.11, Level-4; Sec- B; Page no. 140**

$$\Delta = \begin{vmatrix} k+1 & 8 \\ k & k+3 \end{vmatrix} = 0$$

$(k + 1)(k + 3) - 8k = 0$

$k^2 + 4k + 3 - 8k = 0$

$k^2 - 4k + 3 = 0$

$(k - 1)(k - 3) = 0$

$k = 1, 3$

Then $\Delta_x = \begin{vmatrix} 4k & 8 \\ 3k-1 & k+3 \end{vmatrix} = 0$

$\Delta_x \Rightarrow (k^2 - 3k + 2) = 0$

$\Delta_x \Rightarrow (k - 1)(k - 2) = 0$

$k = 1, 2$

$\Delta_x \neq 0$ at $k = 3$

No. of values of k is only one.

Q.33 If $P = \begin{bmatrix} 1 & \alpha & 3 \\ 1 & 3 & 3 \\ 2 & 4 & 4 \end{bmatrix}$ is the adjoint of a 3×3 matrix A and $|A| = 4$, then α is equal to -

(1) 5 (2) 0 (3) 4 (4) 11

Ans. **[4]**

Sol. $|P| = 1(12 - 12) - \alpha(4 - 6) + 3(4 - 6)$

$|P| = 0 + 2\alpha - 6$

$|P| = 2(\alpha - 3)$

$P = \text{adj. } A$

$|P| = |\text{adj.}A| = |A|^2$

$2(\alpha - 3) = 16$

$\alpha - 3 = 8$

$\alpha = 11$

Q.34 Let T_n be the number of all possible triangles formed by joining vertices of an n-sided regular polygon. If $T_{n+1} - T_n = 10$ then the value of n is -

(1) 10 (2) 8 (3) 7 (4) 5

Ans. **[4]**

Sol. $^{n+1}C_3 - {}^nC_3 = 10$

$$\Rightarrow \quad \frac{(n+1)!}{(n-2)!\,3!} - \frac{n!}{3!(n-3)!} = 10$$

$$\Rightarrow \quad \frac{n!}{3!(n-3)!}\left[\frac{(n+1)}{(n-2)} - 1\right] = 10$$

$$\Rightarrow \quad \frac{n(n-1)(n-2)}{6}\left[\frac{n+1-n+2}{(n-2)}\right] = 10$$

$n(n-1) = 20$

$n^2 - n - 20 = 0$

$(n-5)(n+4) = 0$

$n = 5$

Q.35 At present, a firm is manufacturing 2000 items. It is estimated that the rate of change of production P w.r.t. additional number of workers x is given by $\frac{dP}{dx} = 100 - 12\sqrt{x}$. If the firm employs 25 more workers, then the new level of production of items is -

(1) 3500 (2) 4500 (3) 2500 (4) 3000

Ans. **[1]**

Sol. $dP = (100 - 12\sqrt{x})\,dx$

$P = 100x - 12 \cdot \frac{2}{3} \cdot x^{3/2} + c$

$P = 100x - 8x^{3/2} + c$

At $x = 0 \Rightarrow c = P = 2000$

$P = 100x - 8\,x^{3/2} + 2000$

$P = 100 \times 25 - 8.125 + 2000$

$= 2500 - 1000 + 2000$

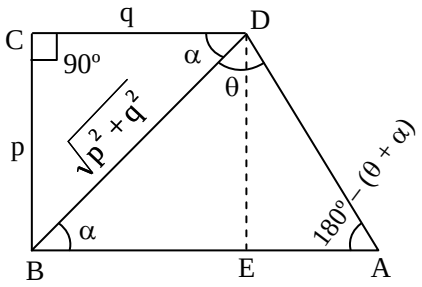
$= 3500$

Q.36 ABCD is a trapezium such that AB and CD are parallel and BC ⊥ CD. If ∠ADB = θ, BC = p and CD = q, then AB is equal to -

(1) $\frac{p^2+q^2}{p^2\cos\theta+q^2\sin\theta}$ (2) $\frac{(p^2+q^2)\sin\theta}{(p\cos\theta+q\sin\theta)^2}$ (3) $\frac{(p^2+q^2)\sin\theta}{p\cos\theta+q\sin\theta}$ (4) $\frac{p^2+q^2\cos\theta}{p\cos\theta+q\sin\theta}$

Ans. **[3]**

Sol.



By Sine rule

$$\frac{\sin\theta}{AB} = \frac{\sin(\pi-(\theta+\alpha))}{\sqrt{p^2+q^2}}$$

$$AB = \frac{\sqrt{p^2+q^2}\sin\theta}{\sin(\theta+\alpha)}$$

$$AB = \frac{\sqrt{p^2+q^2}\sin\theta}{\sin\theta\cos\alpha+\cos\theta\sin\alpha}$$

$$\text{Then AB} = \frac{\sqrt{p^2+q^2}\sin\theta}{\sin\theta\left(\frac{q}{\sqrt{p^2+q^2}}\right)+\cos\theta\left(\frac{p}{\sqrt{p^2+q^2}}\right)}$$

$$\text{So, AB} = \frac{(p^2+q^2)\sin\theta}{q\sin\theta+p\cos\theta}$$

Q.37 All the students of a class performed poorly in Mathematics. The teacher decided to give grace marks of 10 to each of the students. Which of the following statistical measures will not change even after the grace marks were given ?

(1) mode (2) variance (3) mean (4) median

Ans. **[2]**

Sol. **Students may find this Question in CP Sheet at Q.41; Level-1; Page no. 142**

If variance of

$x_1, x_2, x_3, ... x_n$ is σ^2

then variance of

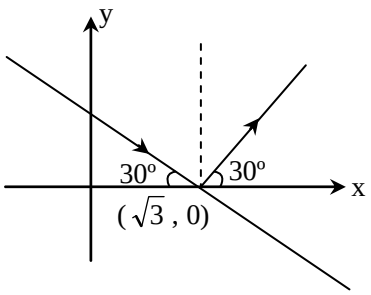
$x_1 + k, x_2 + k, ... x_n + k$ is also σ^2

Q.38 A ray of light along $x + \sqrt{3}\, y = \sqrt{3}$ gets reflected upon reaching x-axis, the equation of the reflected ray is -

(1) $y = \sqrt{3}\, x - \sqrt{3}$ (2) $\sqrt{3}\, y = x - 1$ (3) $y = x + \sqrt{3}$ (4) $\sqrt{3}\, y = x - \sqrt{3}$

Ans. **[4]**

Sol.



$y - 0 = \tan 30^\circ (x - \sqrt{3})$

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

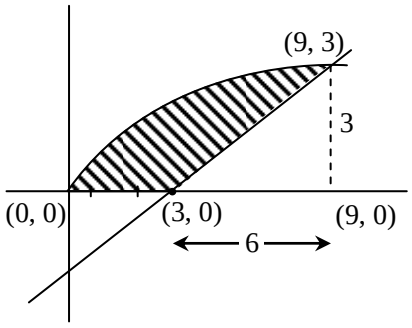
$\sqrt{3}\, y = x - \sqrt{3}$.

Q.39 The area (in square units) bounded by the curves $y = \sqrt{x}$, $2y - x + 3 = 0$, x-axis, and lying in the first quadrant is -

(1) 18 (2) $\frac{27}{4}$ (3) 9 (4) 36

Ans. **[3]**

Sol. **Students may find this Question in CP Sheet at Q.4; Level-4; Sec. B; Page no. 97**



$y = \sqrt{x}$ ....(1)

$2y - x + 3 = 0$ ....(2)

solving (1) & (2)

$2y - y^2 + 3 = 0$

$y^2 - 2y - 3 = 0$

$(y - 3)(y + 1) = 0$

$y = 3, y = -1$

Point of intersection (9, 3).

$$\text{Area} = \int_0^9 \sqrt{x}\,dx - \frac{1}{2}.6.3$$

$$= \frac{2}{3}\,(x^{3/2})_0^9 - 9$$

$$= \frac{2}{3}\,(27) - 9$$

$$= 18 - 9$$

$$= 9$$

Q.40 If z is a complex number of unit modulus and argument θ, then arg $\left(\frac{1+z}{1+\bar{z}}\right)$ equals -

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

Ans. **[1]**

Sol. $\text{Arg}\left(\frac{1+z}{1+\bar{z}}\right)$

$$= \text{Arg}\left(\frac{1+z}{1+\frac{1}{z}}\right)$$

$$= \text{Arg}\left(\left(\frac{1+z}{1+z}\right)z\right)$$

$$= \text{Arg}\, z$$

$$= \theta$$

Q.41 If $\int f(x)dx = \psi(x)$, then $\int x^5 f(x^3)dx$ is equal to -

(1) $\frac{1}{3}\,x^3\psi(x^3) - \int x^2\psi(x^3)dx + C$ (2) $\frac{1}{3}\left[x^3\psi(x^3) - \int x^3\psi(x^3)dx\right] + C$

(3) $\frac{1}{3}\left[x^3\psi(x^3) - \int x^2\psi(x^3)dx\right] + C$ (4) $\frac{1}{3}x^3\psi(x^3) - 3\int x^3\psi(x^3)dx + C$

Ans. **[1]**

Sol. **Students may find this Question in CP Sheet at Q.13; Level-2; Page no. 34**

$$\int x^3.x^2.f(x^3)dx \qquad x^3 = t$$

$$= \frac{1}{3}\int \underset{I}{t}\,.\,\underset{II}{f(t)}\,dt$$

$$= \frac{1}{3}\,[t.\psi(t) - \int \psi(t)dt] + C$$

$= \frac{1}{3}[x^3 . \psi(x^3) - \int \psi(x^3).dx^3] + C$

$= \frac{1}{3}[x^3 . \psi(x)^3] - \frac{1}{3}\int \psi(x^3).3x^2.dx + C$

$= \frac{1}{3}[x^3 \psi(x^3)] - \int \psi(x^3)\, x^2\, dx + C$

Q.42 Let A and B be two sets containing 2 elements and 4 elements respectively. The number of subsets of A × B having 3 or more elements is -

(1) 219 (2) 211 (3) 256 (4) 220

Ans. **[1]**

Sol. n (A) = 2,

n (B) = 4

n (A × B) = 8

No. of subsets of (A × B) containing atleast '3' elements is

$= {}^8C_3 + {}^8C_4 + {}^8C_5 + {}^8C_6 + {}^8C_7 + {}^8C_8$

$= 2^8 - {}^8C_0 - {}^8C_1 - {}^8C_2$

$= 256 - 1 - 8 - 28$

$= 219$

Q.43 If the lines $\frac{x-2}{1} = \frac{y-3}{1} = \frac{z-4}{-k}$ and $\frac{x-1}{k} = \frac{y-4}{2} = \frac{z-5}{1}$ are coplanar, then k can have -

(1) exactly two values (2) exactly three values

(3) any value (4) exactly one value

Ans. **[1]**

Sol. **Students may find this Question in CP Sheet at Q.4; Level-4; Sec. A (Topic-3D)**

$L_1 \rightarrow \frac{x-2}{1} = \frac{y-3}{1} = \frac{z-4}{-k}$

$L_2 \rightarrow \frac{x-1}{k} = \frac{y-4}{2} = \frac{z-5}{1}$

L_1 & L_2 are coplanar.

$$\therefore \quad \begin{vmatrix} x_2-x_1 & y_2-y_1 & z_2-z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} = 0$$

$$\Rightarrow \quad \begin{vmatrix} 1-2 & 4-3 & 5-4 \\ 1 & 1 & -k \\ k & 2 & 1 \end{vmatrix} = 0$$

$$\Rightarrow \quad \begin{vmatrix} -1 & 1 & 1 \\ 1 & 1 & -k \\ k & 2 & 1 \end{vmatrix} = 0$$

$-1(1+2k)-1(1+k^2)+1(2-k)=0$

$-1-2k-1-k^2+2-k=0$

$-k^2-3k=0$

$k^2+3k=0$

$k(k+3)=0$

$k=0, \quad k=-3$

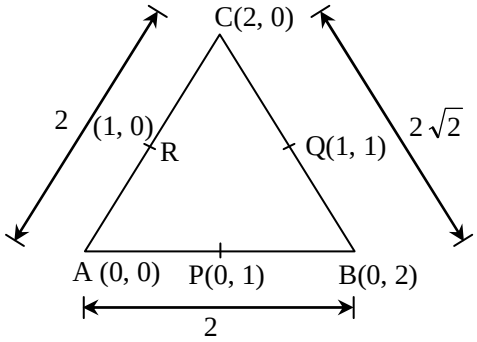
Exact two values.

Q.44 The x-coordinate of the incentre of the triangle that has the coordinates of mid points of its sides as (0,1) (1, 1) and (1, 0) is -

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

Ans. **[4]**

Sol. **Students may find this Question in CP Sheet at Q.1; Level-3 (Topic-Point)**



$$I \equiv \left(\frac{0(2\sqrt{2})+0(2)+2(2)}{2+2+2\sqrt{2}}, \frac{0(2\sqrt{2})+2(2)+0(2)}{2+2+2\sqrt{2}} \right)$$

$$I \equiv \left(\frac{4}{4+2\sqrt{2}}, \frac{4}{4+2\sqrt{2}} \right)$$

$$I \equiv \left(\frac{2}{2+\sqrt{2}}, \frac{2}{2+\sqrt{2}} \right)$$

$$\text{x-coordinate} = \frac{2}{2+\sqrt{2}} \times \frac{2-\sqrt{2}}{2-\sqrt{2}} = 2-\sqrt{2}\,.$$

Q.45 Consider :

Statement-I : $(p \wedge \sim q) \wedge (\sim p \wedge q)$ is a fallacy.

Statement-II: $(p \to q) \leftrightarrow (\sim q \to \sim p)$ is a tautology.

(1) Statement-I is true; Statement-II is false.

(2) Statement-I is false, Statement-II is true.

(3) Statement-I is true; Statement-II is true; Statement-II is a correct explanation for Statement-I.

(4) Statement-I is true; Statement-II is true; Statement-II is not a correct explanation for Statement-I.

Ans. **[4]**

Sol. **Students may find this Question in CP Sheet at Q.35; Level-1; Page no. 207**

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

Statement-I is correct.

p	q	~p	~q	$(p \to q)$	$(\sim q \to \sim p)$	$(p \to q) \leftrightarrow (\sim q \to \sim p)$
T	T	F	F	T	T	T
T	F	F	T	F	F	T
F	T	T	F	T	T	T
F	F	T	T	T	T	T

Statement-II is correct but not correct explanation.

Q.46 If the equations $x^2 + 2x + 3 = 0$ and $ax^2 + bx + c = 0$, a, b, c $\in$ R, have a common root, then a : b : c is -

(1) 1 : 3 : 2 (2) 3 : 1 : 2 (3) 1 : 2 : 3 (4) 3 : 2 : 1

Ans. **[3]**

Sol. **Students may find this Question in CP Sheet at Q.11, Page no.23**

$x^2 + 2x + 3 = 0$ ….(1)

$D = 4 - 4 \times 3 = -8 < 0$

roots are imaginary

$ax^2 + bx + c = 0$, a, b, c $\in$ R ….(2)

Eq. (1) & (2) have one root common and roots of (1) are imaginary so both roots will be common

$$\frac{a}{1} = \frac{b}{2} = \frac{c}{3}$$

a : b : c = 1 : 2 : 3

Q.47 The sum of first 20 terms of the sequence 0.7, 0.77, 0.777, ..., is -

(1) $\frac{7}{81}(179 + 10^{-20})$ (2) $\frac{7}{9}(99 + 10^{-20})$ (3) $\frac{7}{81}(179 - 10^{-20})$ (4) $\frac{7}{9}(99 - 10^{-20})$

Ans. **[1]**

Sol. **Students may find this Question in CP Sheet at Q.24, Level-2, Page no.55**

0.7 + 0.77 + 0.777 + …… 20 terms

7 [0.1 + 0.11 + 0.111 + …… 20 terms]

$\frac{7}{9}$[0.9 + 0.99 + 0.999 + …… 20 terms]

$$\frac{7}{9}\left[\left(1-\frac{1}{10}\right)+\left(1-\frac{1}{100}\right)+.....20 \text{ terms}\right]$$

$$\frac{7}{9}\left[20-\left(\frac{1}{10}+\frac{1}{10^2}+\text{..... 20 terms}\right)\right]$$

$$\frac{7}{9}\left[20-\frac{\frac{1}{10}\left(1-\frac{1}{10^{20}}\right)}{\left(1-\frac{1}{10}\right)}\right]$$

$$\frac{7}{81}\left[180-1+\frac{1}{10^{20}}\right] = \frac{7}{81}(179 + 10^{-20})$$

Q.48 The term independent of x in expansion of $\left(\frac{x+1}{x^{2/3}-x^{1/3}+1}-\frac{x-1}{x-x^{1/2}}\right)^{10}$ is -

(1) 210 (2) 310 (3) 4 (4) 120

Ans. **[1]**

Sol. **Students may find this Question in CP Sheet at Q.35, Level-2, Page no.80**

$$\left(\frac{(x^{1/3})^3+1}{x^{2/3}-x^{1/3}+1}-\frac{(x^{1/2}-1)(x^{1/2}+1)}{x^{1/2}(x^{1/2}-1)}\right)^{10}$$

$$\left(x^{1/3}+1-1-\frac{1}{x^{1/2}}\right)^{10} = \left(x^{1/3}-\frac{1}{x^{1/2}}\right)^{10}$$

$$T_{r+1} = {}^{10}C_r\,(x^{1/3})^{10-r}\left(-\frac{1}{x^{1/2}}\right)^r$$

$$= {}^{10}C_r\; x^{\frac{10-r}{3}-\frac{r}{2}}(-1)^r$$

Term independent of x so $\frac{10-r}{3}-\frac{r}{2}=0$

$20 - 5r = 0$

$r = 4$

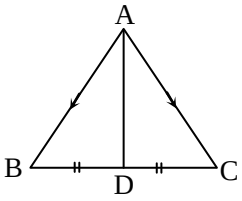
$T_5 = {}^{10}C_4(-1)^4 = 210$

Q.49 If the vectors $\overrightarrow{AB} = 3\hat{i} + 4\hat{k}$ and $\overrightarrow{AC} = 5\hat{i} - 2\hat{j} + 4\hat{k}$ are the sides of a triangle ABC, then the length of the median through A is -

(1) $\sqrt{33}$ (2) $\sqrt{45}$ (3) $\sqrt{18}$ (4) $\sqrt{72}$

Ans. **[1]**

Sol. **Students may find this Question in CP Sheet at Q.8, Level-4(Sec-A) ; (Topic-Vector)**



$\overrightarrow{AB} = 3\hat{i} + 4\hat{k}$

$\overrightarrow{AC} = 5\hat{i} - 2\hat{j} + 4\hat{k}$

$$\overrightarrow{AD} = \frac{\overrightarrow{AB}+\overrightarrow{AC}}{2}$$

$$\overrightarrow{AD} = \frac{8\hat{i}-2\hat{j}+8\hat{k}}{2}$$

$$\overrightarrow{AD} = 4\hat{i}-\hat{j}+4\hat{k}$$

$$AD = |\overrightarrow{AD}| = \sqrt{4^2+1^2+4^2}$$

$$AD = \sqrt{33}$$

Q.50 If x, y, z are in A.P. and $\tan^{-1}x$, $\tan^{-1}y$ and $\tan^{-1}z$ are also in A.P., then -

(1) $6x = 3y = 2z$ (2) $6x = 4y = 3z$ (3) $x = y = z$ (4) $2x = 3y = 6z$

Ans. **[3]**

Sol. $\tan^{-1}y - \tan^{-1}x = \tan^{-1}z - \tan^{-1}y$

$$\tan^{-1}\left(\frac{y-x}{1+yx}\right) = \tan^{-1}\left(\frac{z-y}{1+zy}\right)$$

$$\frac{y-x}{1+yx} = \frac{z-y}{1+zy}$$

$y - x + zy^2 - xyz = z - y + xyz - y^2x$

$y^2(x + z) + 2y - 2xyz - x - z = 0$

$y^2(2y) = 2xyz$

$y^2 = xz$

then x, y, z are in G.P.

So, $x = y = z$

Q.51 The intercepts on x-axis made by tangents to the curve, $y = \int_0^x |t|\,dt, x \in R$, which are parallel to the line $y = 2x$, are equal to -

(1) ± 3 (2) ± 4 (3) ± 1 (4) ± 2

Ans. **[3]**

Sol. $y = \int_0^x |t|\,dt$, $x \in R$; parallel to $y = 2x$, $m = 2$

$$\frac{dy}{dx} = |x| = 2 \Rightarrow x = \pm 2$$

at $x = 2$

$$y = \int_0^2 |t|\,dt = \int_0^2 t\,dt = \left(\frac{t^2}{2}\right)_0^2 = 2$$

Equation of tangent at (2, 2) is

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

At y = 0
–1 = x – 2
x = 1
at x = –2

$$y = \int_{0}^{-2} |t|\,dt$$

$$y = -\int_{-2}^{0} -t\,dt$$

$$y = \frac{1}{2}\left(t^2\right)_{-2}^{0}$$

$$\therefore\ y = \frac{1}{2}(0-(4)) = -2$$

Equation of tangent at (–2, –2) is
y + 2 = 2(x + 2)
At y = 0
1 = x + 2
x = –1

Q.52 Distance between two parallel planes 2x + y + 2z = 8 and 4x + 2y + 4z + 5 = 0 is -

(1) $\frac{7}{2}$ (2) $\frac{9}{2}$ (3) $\frac{3}{2}$ (4) $\frac{5}{2}$

Ans. **[1]**

Sol. **Students may find this Question in CP Sheet at Q.8, Level-4 (Sec-A) (Topic : 3D)**

4x + 2y + 4z + 5 = 0
4x + 2y + 4z – 16 = 0

$$\text{distance} = \frac{|5+16|}{\sqrt{16+4+16}}$$

$$= \frac{21}{6}$$

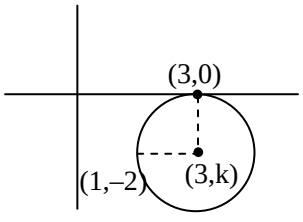
$$= \frac{7}{2}$$

Q.53 The circle passing through (1, –2) and touching the axis of x at (3,0) also passes through the point -

(1) (5, –2) (2) (–2, 5) (3) (–5, 2) (4) (2, –5)

Ans. **[1]**

Sol. **Students may find this Question in CP Sheet at Q.18, Level-4 (Sec-B) (Topic : Circle)**



$(x-3)^2 + (y-k)^2 = k^2$

passes through (1, –2)

$(1-3)^2 + (-2-k)^2 = k^2$

$4 + 4 + 4k + k^2 = k^2$

$4k = -8$

$k = -2$

Eq. $(x-3)^2 + (y+2)^2 = 4$

Now check the option.

Q.54 The equation of the circle passing through the foci of the ellipse $\frac{x^2}{16} + \frac{y^2}{9} = 1$, and having centre at (0, 3) is -

(1) $x^2 + y^2 - 6y - 5 = 0$ (2) $x^2 + y^2 - 6y + 5 = 0$

(3) $x^2 + y^2 - 6y - 7 = 0$ (4) $x^2 + y^2 - 6y + 7 = 0$

Ans. **[3]**

Sol. $\frac{x^2}{16} + \frac{y^2}{9} = 1$

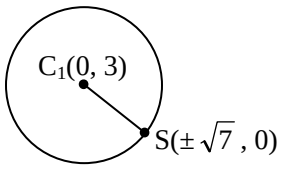
$e = \sqrt{1 - \frac{b^2}{a^2}}$

$= \sqrt{1 - \frac{9}{16}} = \frac{\sqrt{7}}{4}$

Focus $\Rightarrow$ S and S′ $(\pm ae, 0)$

$= \left(\pm 4.\frac{\sqrt{7}}{4}, 0\right) = \left(\pm\sqrt{7}, 0\right)$

radius, $r = C_1S = \sqrt{7+9} = 4$



Eq. of circle is $\Rightarrow$

$\Rightarrow$ $(x-0)^2 + (y-3)^2 = (4)^2$

$x^2 + y^2 - 6y + 9 = 16$

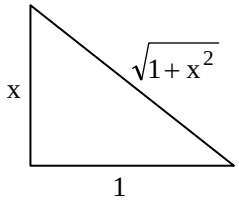
$x^2 + y^2 - 6y - 7 = 0$

Q.55 If $y = \sec(\tan^{-1} x)$, then $\frac{dy}{dx}$ at $x = 1$ is equal to -

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

Ans. **[3]**

Sol. **Students may find this Question in CP Sheet at Q.26, Level-1, Page no.107, (Topic : Differentiation)**



$\sec\theta = \sqrt{1+x^2}$

$y = \sec(\tan^{-1}x)$

$\tan^{-1}x = \theta$

$y = \sqrt{1+x^2}$

$\frac{dy}{dx} = \frac{2x}{2\sqrt{1+x^2}}$

$\left(\frac{dy}{dx}\right)_{x=1} = \frac{1}{\sqrt{2}}$

Q.56 The expression $\frac{\tan A}{1-\cot A} + \frac{\cot A}{1-\tan A}$ can be written as -

(1) tan A + cot A (2) sec A + cosec A (3) sin A cos A + 1 (4) sec A cosec A + 1

Ans. **[4]**

Sol. $\frac{\tan A}{1-\cot A} + \frac{\cot A}{1-\tan A}$

$\frac{\frac{\sin A}{\cos A}}{\frac{\sin A - \cos A}{\sin A}} + \frac{\frac{\cos A}{\sin A}}{1-\frac{\sin A}{\cos A}}$

$\frac{\sin^2 A}{\cos A(\sin A - \cos A)} + \frac{\cos^2 A}{(\cos A - \sin A)\sin A}$

$\frac{-\sin^3 A + \cos^3 A}{(\cos A - \sin A)\sin A\cos A}$

$= \frac{(\cos A - \sin A)(1+\sin A\cos A)}{(\cos A - \sin A).\sin A\cos A}$

$= \frac{1+\sin A\cos A}{\cos A\sin A} = (\sec A\,\mathrm{cosec}A + 1)$

Q.57 Given : A circle, $2x^2 + 2y^2 = 5$ and a parabola, $y^2 = 4\sqrt{5}\,x$.

Statement-I : An equation of a common tangent to these curves is $y = x + \sqrt{5}$.

Statement-II : If the line, $y = mx + \frac{\sqrt{5}}{m}$ $(m \neq 0)$ is their common tangent, then m satisfies $m^4 - 3m^2 + 2 = 0$,

(1) Statement-I is true; Statement-II is false.
(2) Statement-I is false; Statement-II is true.
(3) Statement-I is true; Statement-II is true; Statement-II is a correct explanation for Statement-I.
(4) Statement-I is true; Statement-II is true; Statement-II is not a correct explanation for Statement-I.

Ans. **[4]**

Sol. $x^2 + y^2 = \frac{5}{2}$ .....(1)

$y^2 = 4\sqrt{5}\,x$ .....(2)

$\Rightarrow 4a = 4\sqrt{5}$

Let, $y = mx + c$ .....(3)

By (1) & (3) $\Rightarrow c = \pm \sqrt{\frac{5}{2}}\sqrt{(1+m^2)}$

By (2) & (3) $\Rightarrow c = \frac{a}{m} = \frac{\sqrt{5}}{m}$

$\Rightarrow c^2 = \frac{5}{m^2} = \frac{5}{2}(1 + m^2)$

$\Rightarrow m^4 + m^2 - 2 = 0$

$m^2 = t$

$\Rightarrow t^2 + t - 2 = 0$

$\Rightarrow t^2 + 2t - t - 2 = 0$

$\Rightarrow t = -2, 1 = m^2$

$\Rightarrow m^2 = t = 1 \Rightarrow m = \pm 1 \Rightarrow c = \pm \sqrt{5}$

By (3) $\Rightarrow y = \pm (x + \sqrt{5}) \Rightarrow$ Eq. of common tangent.

Now, $m^2 = 1$ satisfy the given equation in statement-II.

Q.58 A multiple choice examination has 5 questions. Each question has three alternative answers of which exactly one is correct. The probability that a student will get 4 or more correct answers just by guessing is -

(1) $\frac{11}{3^5}$ (2) $\frac{10}{3^5}$ (3) $\frac{17}{3^5}$ (4) $\frac{13}{3^5}$

Ans. **[1]**

Sol. $p = \frac{1}{3}$ and $q = \frac{2}{3}$; $n = 5$

$P(r \geq 4) = P(r = 4) + P(r = 5)$

$= {}^5C_4\, p^4.q + {}^5C_5\, p^5$

$= 5 \times \left(\frac{1}{3}\right)^4 \times \frac{2}{3} + 1 \times \left(\frac{1}{3}\right)^5$

$= \frac{10+1}{3^5} = \frac{11}{3^5}$

Q.59 **Statement-I :** The value of the integral $\int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\tan x}}$ is equal to $\frac{\pi}{6}$.

Statement-II : $\int_a^b f(x)dx = \int_a^b f(a+b-x)dx$.

(1) Statement-I is true; Statement-II is false.

(2) Statement-I is false; Statement-II is true.

(3) Statement-I is true; Statement-II is true; Statement-II is a correct explanation for Statement-I.

(4) Statement-I is true; Statement-II is true; Statement-II is not a correct explanation for Statement-I.

Ans. **[2]**

Sol. **From Class notes result**

$$I = \int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\tan x}}$$

$$I = \int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{\cot x}} = \int_{\pi/6}^{\pi/3} \frac{\sqrt{\tan x}}{1+\sqrt{\tan x}} dx$$

$$2I = \int_{\pi/6}^{\pi/3} dx = \frac{\pi}{3} - \frac{\pi}{6} = \frac{\pi}{6}$$

$$I = \frac{\pi}{12}$$

Q.60 $\lim\limits_{x\to 0} \frac{(1-\cos 2x)(3+\cos x)}{x \tan 4x}$ is equal to -

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

Ans. **[2]**

Sol. $\lim\limits_{x\to 0} \frac{1-\cos 2x}{4x^2} \times \lim\limits_{x\to 0} 3 + \cos x \times \lim\limits_{x\to 0} \frac{4x}{\tan 4x}$

$= \frac{1}{2} \times 4 \times 1 = 2$

Part C - CHEMISTRY

Q.61 Which of the following represents the correct order of increasing first ionization enthalpy for Ca, Ba, S, Se and Ar ?

(1) Ba < Ca < Se < S < Ar (2) Ca < Ba < S < Se < Ar

(3) Ca < S < Ba < Se < Ar (4) S < Se < Ca < Ba < Ar

Ans. **[1]**

Sol. Ba < Ca < Se < S < Ar.

s-block metals have low value of IE. In a period, from left to right IE increases. Noble gases have highest IE.

Q.62 A gaseous hydrocarbon gives upon combustion 0.72 g. of water and 3.08 g. of CO_2. The empirical formula of the hydrocarbon is -

(1) C_6H_5 (2) C_7H_8 (3) C_2H_4 (4) C_3H_4

Ans. **[2]**

Sol. **Students may find this question in CP Sheet (Class copy)**

$C_xH_y + (x + y/4)O_2 \longrightarrow xCO_2 + \frac{y}{2} H_2O$

$H_2O = \frac{0.72}{18}$ = 0.04 mol = 0.08 mol ''H''.

$CO_2 = \frac{3.08}{44}$ = 0.07 mol = 0.07 mol ''C''

$x : \frac{y}{2} = 7 : 4$

$x : y = 7 : 8 \Rightarrow C_7H_8$

Q.63 The rate of a reaction doubles when its temperature changes from 300 K to 310 K. Activation energy of such a reaction will be : ($R = 8.314\ JK^{-1}\ mol^{-1}$ and log 2 = 0.301)

(1) 58.5 kJ mol^{-1} (2) 60.5 kJ mol^{-1} (3) 53.6 kJ mol^{-1} (4) 48.5 kJ mol^{-1}

Ans. **[3]**

Sol. **Students may find this question in CP Sheet chapter-Chemical Kinetics (Similar to) Q.4 Level-3.**

$$\log_{10}\left(\frac{k_2}{k_1} = 2\right) = \frac{E_a}{2.303 \times 8.314 \times 10^{-3}} \times \left\{\frac{10}{300 \times 310}\right\}$$

$$0.3 = \frac{10 E_a}{2.303 \times 8.314 \times 93}$$

E_a = 53.6 kJ

Q.64 The gas leaked from a storage tank of the Union Carbide plant in Bhopal gas tragedy was -

(1) Ammonia (2) Phosgene (3) Methylisocyanate (4) Methylamine

Ans. **[3]**

Sol. **Students may find this question in CP Sheet chapter - N-Containing substance (Class copy)**

Methyl isocyanate (MIC)

Q.65 An organic compound A upon reacting with NH_3 gives B. On heating, B gives C. C in presence of KOH reacts with Br_2 to give $CH_3CH_2CH_2$. A is -

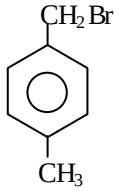
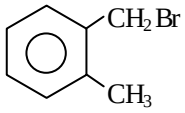
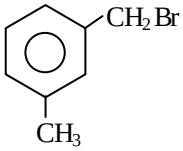
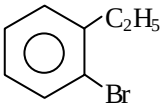
(1) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-COOH$ (2) CH_3CH_2COOH (3) CH_3COOH (4) $CH_3CH_2CH_2COOH$

Ans. **[2]**

Sol. **Students may find this question in CP Sheet chapter - Carboxylic acid (Example 28 Page No. 104)**

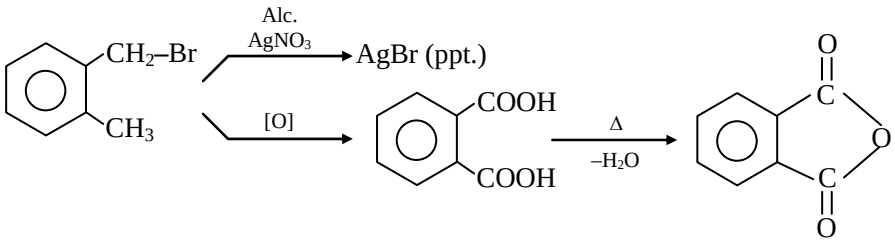
$$\underset{(A)}{CH_3-CH_2-\overset{O}{\overset{\|}{C}}-OH} \xrightarrow{NH_3} \underset{(B)}{CH_3-CH_2-\overset{\ominus}{C}OO\overset{\oplus}{N}H_4} \xrightarrow{\Delta} \underset{(C)}{CH_3-CH_2-\overset{O}{\overset{\|}{C}}-NH_2} \xrightarrow{Br_2+KOH} CH_3-CH_2-NH_2$$

Q.66 Compound (A), C_8H_9Br, gives a white precipitate when warmed with alcoholic $AgNO_3$. Oxidation of (A) gives an acid (B), $C_8H_6O_4$. (B) easily forms anhydride on heating. Identify the compound (A).

(1)  (2)  (3)  (4) 

Ans. **[2]**

Sol. **Students may find this question in CP Sheet chapter - Halogen containing substance.**



Q.67 A compound with molecular mass 180 is acylated with CH_3COCl to get a compound with molecular mass 390. The number of amino groups present per molecule of the former compound is -

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

Ans. **[4]**

Sol. **Students may find this question in CP Sheet chapter - Acid and its derivatives.**

$$R-\ddot{N}H_2 + CH_3-\overset{O}{\overset{\|}{C}}-Cl \longrightarrow R-NH-\overset{O}{\overset{\|}{C}}-CH_3$$

Due to reaction of one $-NH_2$ gp with $CH_3-\overset{O}{\overset{\|}{C}}-Cl$ difference in mass in 42. (increase)

Mass of the compound having x-NH_2 gp is given = 180

After reaction mass of the product = 390

Total increase in mass = 390 – 180 = 210

Total no. of $-NH_2$ gp present = $\frac{210}{42} = 5$

Q.68 Which one of the following molecules is expected to exhibit diamagnetic behaviour ?

(1) O_2 (2) S_2 (3) C_2 (4) N_2

Ans. **[3, 4]**

Sol. C_2 $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2$

N_2 $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 = \pi 2p_y^2 \sigma 2p_z^2$

Both have zero unpaired electrons. Thus, they are diamagnetic.

Q.69 In which of the following pairs of molecules/ions, both the species are not likely to exist ?

(1) H_2^{2+}, He_2 (2) H_2^-, He_2^{2+} (3) H_2^+, He_2^{2-} (4) H_2^-, He_2^{2-}

Ans. **[1]**

Sol. H_2^{2+}, He_2

Both have zero bond order. Thus, they do not exist.

Q.70 Which of the following complex species is not expected to exhibit optical isomerism ?

(1) $[Co(NH_3)_3Cl_3]$ (2) $[Co(en)(NH_3)_2Cl_2]^+$ (3) $[Co(en)_3]^{3+}$ (4) $[Co(en)_2Cl_2]^+$

Ans. **[1]**

Sol. $[Co(NH_3)_3Cl_3]$

Ma_3b_3 do not show optical isomerism because its both geometries have plane of symmetry.

Q.71 The coagulating power of electrolytes having ions Na^+, Al^{3+} and Ba^{2+} for arsenic sulphide sol increases in the order -

(1) $Ba^{2+} < Na^+ < Al^{3+}$ (2) $Al^{3+} < Na^+ < Ba^{2+}$ (3) $Al^{3+} < Ba^{2+} < Na^+$ (4) $Na^+ < Ba^{2+} < Al^{3+}$

Ans. **[4]**

Sol. **Students may find this question in CP Sheet chapter - Surface chemistry similar to Q.14, Level-2.**

$As_2S_3 \Rightarrow$ –ve sol

Coagulation power $\propto$ Magnitude of opp. charge

$\Rightarrow$ $Na^+ < Ba^{+2} < Al^{+3}$

Q.72 Consider the following reaction :

$$xMnO_4^- + yC_2O_4^{2-} + zH^+ \rightarrow xMn^{2+} + 2yCO_2 + \frac{z}{2}H_2O$$

The values of x, y and z in the reaction are, respectively -

(1) 2, 5 and 16 (2) 5, 2 and 8 (3) 5, 2 and 16 (4) 2, 5 and 8

Ans. **[1]**

Sol. **Students may find this question in CP Sheet chapter - Oxidation-Reduction same as Q.53, Level-1.**

$MnO_4^- \longrightarrow Mn^{+2}$; e^- gain = 5 .....(1)

$C_2O_4^{-2} \longrightarrow CO_2$; e^- loss = 2 .....(2)

(1) × 2 (To balance e^-)

(2) × 5

$$2MnO_4^- + 5C_2O_4^{-2} + zH^+ \longrightarrow 2Mn^{+2} + 10CO_2 + \frac{z}{2}H_2O$$

On balancing charge,

z = 16

x = 2, y = 5, z = 16

Q.73 Which of the following exists as covalent crystals in the solid state ?

(1) Sulphur (2) Phosphorus (3) Iodine (4) Silicon

Ans. **[4]**

Sol. **Students may find this question in CP Sheet chapter - Solid State (Class copy).**

Si has a regular covalent network structure.

$\Rightarrow$ S_8, P_4 and I_2 all are molecular solids.

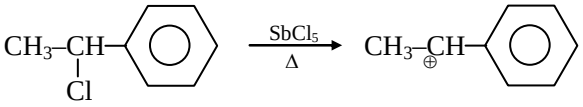
Q.74 A solution of (–) – 1 – chloro – 1 – phenylethane in toluene racemises slowly in the presence of a small amount of $SbCl_5$, due to the formation of -

(1) carbocation (2) free radical (3) carbanion (4) carbene

Ans. **[1]**

Sol. **Students may find this question in CP Sheet chapter-Halogen derivative (Q.7 Level-4B, Page No. 166).**

$SbCl_5$ is a Lewis acid which forms carbocation on reaction with alkyl halide.



Q.75 An unknown alcohol is treated with the "Lucas reagent" to determine whether the alcohol is primary, secondary or tertiary. Which alcohol reacts fastest and by what mechanism -

(1) secondary alcohol by S_{N^2} (2) tertiary alcohol by S_{N^2}

(3) secondary alcohol by S_{N^1} (4) tertiary alcohol by S_{N^1}

Ans. **[4]**

Sol. **Students may find this question in CP Sheet chapter-Alcohol (Q.33 Level-2, Page No.37.)**

Lucas reagent is conc. HCl + anhy.$ZnCl_2$ 3° alcohols are most reactive because

Reactivity $\propto$ Stability of carbocation formed

$$3°R–OH \xrightarrow[anhy.ZnCl_2]{HCl} 3°R^{\oplus} \xrightarrow{Cl^{\ominus}} \underset{\text{White turbidity}}{R-Cl}$$

Q.76 How many litres of water must be added to 1 litre of an aqueous solution of HCl with a pH of 1 to create an aqueous solution with pH of 2 ?

(1) 2.0 L (2) 9.0 L (3) 0.1 L (4) 0.9 L

Ans. **[2]**

Sol. **Students may find this question in CP Sheet chapter -Ionic Equilibrium (Class copy).**

HCl ; pH = 1 ; $[H^+] = 10^{-1}$

Final pH = 2 ; $[H^+] = 10^{-2}$

$M_1 \times V_1 = M_2 \times V_2$

$10^{-1} \times (1 \text{ lit.}) = 10^{-2} \times V_2$

$V_2 = 10$ lit.

$V_{water} = V_2 - V_1 = 9$ lit.

Q.77 The molarity of a solution obtained by mixing 750 mL of 0.5(M)HCl with 250 ml of 2(M)HCl will be -

(1) 1.75 M (2) 0.975 M (3) 0.875 M (4) 1.00 M

Ans. **[3]**

Sol. **Students may find this question in CP Sheet chapter-Solution & Colligative properties similar to Q.22, Level-1**

$$M_{res.} = \frac{M_1V_1 + M_2V_2}{V_1 + V_2}$$

$$= \frac{(0.5 \times 750) + (2 \times 250)}{250 + 750}$$

$$= \frac{375 + 500}{1000} = 0.875 \text{ M}$$

Q.78 A piston filled with 0.04 mol of an ideal gas expands reversibly from 50.0 mL to 375 mL at a constant temperature of 37.0ºC. As it does so, it absorbs 208 J of heat. The values of q and w for the process will be -

(R = 8.314 J/mol K) (ℓn 7.5 = 2.01)

(1) q = – 208 J, w = + 208 J (2) q = + 208 J, w = + 208 J

(3) q = + 208 J, w = – 208 J (4) q = – 208 J, w = – 208 J

Ans. **[3]**

Sol. **Students may find this question in CP Sheet chapter- Chemical Energetics similar to Q.36, Level-1**

By I^{st} law of thermodynamics, $q = \Delta E - W$

At constt T, $\Delta E = 0$

$q = -W$

Heat absorbed = 208 J

$\therefore$ $q = +208$ J

$W = -208$ J

Q.79 Experimentally it was found that a metal oxide has formula $M_{0.98}O$. Metal M, is present as M^{2+} and M^{3+} in its oxide. Fraction of the metal which exists as M^{3+} would be -

(1) 6.05% (2) 5.08% (3) 7.01% (4) 4.08%

Ans. **[4]**

Sol. **Students may find this question in CP Sheet chapter-Solid State similar to solved example 38.**

$M_{0.98}O \rightarrow M_x(+2)M_y(+3)O$

Atoms : $x + y = 0.98$ .....(1)

Charge : $2x + 3y - 2 = 0$

$2x + 3y = 2$ .....(2)

On solving,

$x = 0.94, y = 0.04$

$$\% M^{+3} = \frac{y}{x+y} \times 100$$

$$= \frac{0.04}{0.98} \times 100 = 4.08\%$$

Q.80 For gaseous state, if most probable speed is denoted by C*, average speed by $\overline{C}$ and mean square speed by C, then for a large number of molecules the ratios of these speeds are -

(1) $C^* : \overline{C} : C = 1 : 1.128 : 1.225$ (2) $C^* : \overline{C} : C = 1 : 1.225 : 1.128$

(3) $C^* : \overline{C} : C = 1.225 : 1.128 : 1$ (4) $C^* : \overline{C} : C = 1.128 : 1.225 : 1$

Ans. **[1]**

Sol. **Students may find this question in CP Sheet chapter-Gaseous State same as Q.37 Level-1.**

$$U_{mp} = \sqrt{\frac{2RT}{M}} = C^*$$

$$U_{av.} = \sqrt{\frac{8RT}{\pi M}} = \overline{C}$$

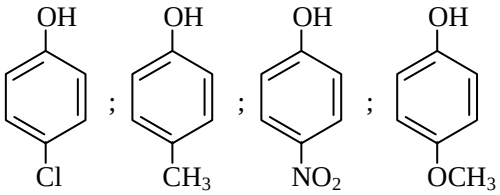
$$U_{rms} = \sqrt{\frac{3RT}{M}} = C$$

$$C^* : \overline{C} : C \quad \Rightarrow \quad \sqrt{2} : \sqrt{\frac{8}{\pi}} : \sqrt{3}$$

$= 1.41 : 1.61 : 1.73$

$= 1 : 1.12 : 1.22$

Q.81 Arrange the following compounds in order of decreasing acidity :

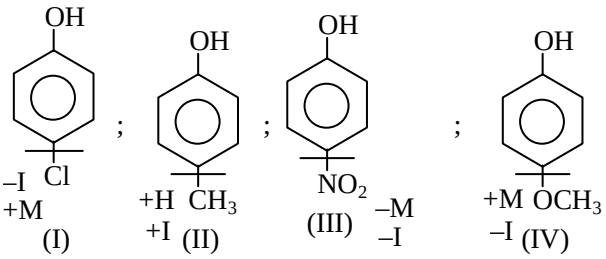


(I) (II) (III) (IV)

(1) III > I > II > IV (2) IV > III > I > II (3) II > IV > I > III (4) I > II > III > IV

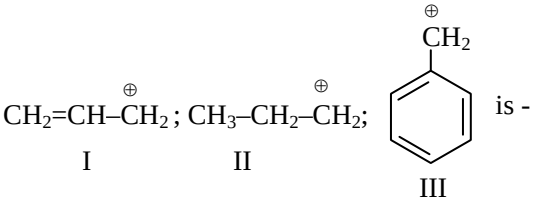
Ans. **[1]**

Sol. **Students may find this question in CP Sheet chapter-GOC (Example 15, Page No. 35)**



III > I > II > IV

Q.82 The order of stability of the following carbocations :



is -

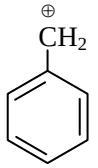
(1) I > II > III (2) III > I > II (3) III > II > I (4) II > III > I

Ans. **[3]**

Sol. **Students may find this question in CP Sheet chapter-GOC (Class copy).**

$CH_2=CH-\overset{\oplus}{C}H_2$; (I) Less conjugation less stable

$CH_3-CH_2-\overset{\oplus}{C}H_2$; (II) Non conjugated least stable



(III) More conjugation more stable

III > I > II

Q.83 The first ionisation potential of Na is 5.1 eV. The value of electron gain enthalpy of Na^+ will be -

(1) – 10.2 eV (2) + 2.55 eV (3) – 2.55 eV (4) – 5.1 eV

Ans. **[4]**

Sol. $Na \rightarrow Na^+ + e^-$; $(\Delta H)_{IE} = +5.1$ eV

On reversing, (By Lavoiser – Laplace law)

$Na^+ + e^- \rightarrow Na$; $(\Delta H)_{eg} = -5.1$ eV

Q.84 Four successive members of the first row transition elements are listed below with atomic numbers. Which one of them is expected to have the highest $E^0_{M^{3+}/M^{2+}}$ value ?

(1) Fe(Z = 26) (2) Co(Z = 27) (3) Cr(Z = 24) (4) Mn(Z = 25)

Ans. **[2]**

Sol. The value of $E^0_{M^{3+}/M^{2+}}$ for Co is + 1.97V which is highest among these elements.

Q.85 Stability of the species Li_2, Li_2^- and Li_2^+ increases in the order of -

(1) $Li_2 < Li_2^- < Li_2^+$ (2) $Li_2^- < Li_2 < Li_2^+$ (3) $Li_2 < Li_2^+ < Li_2^-$ (4) $Li_2^- < Li_2^+ < Li_2$

Ans. **[4]**

Sol. $Li_2^- < Li_2^+ < Li_2$

$Li_2 = \sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2$; B.O. = 1

$Li_2^+ = \sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^1$; B.O. = 0.5

$Li_2^- = \sigma_{1s}^2\sigma_{1s}^{*2}\sigma_{2s}^2\sigma_{2s}^{*1}$; B.O. = 0.5

Bond order $\propto$ stability of molecules

Because, Li_2^- has greater no. of anti-bonding e^- hence, Li_2^- is less stable than Li_2^+.

Q.86 Energy of an electron is given by $E = -2.178 \times 10^{-18}\ J\left(\frac{Z^2}{n^2}\right)$. Wavelength of light required to excite an electron in an hydrogen atom from level n = 1 to n = 2 will be : ($h = 6.62 \times 10^{-34}$ Js and $c = 3.0 \times 10^8\ ms^{-1}$)

(1) 6.500×10^{-7} m (2) 8.500×10^{-7} m (3) 1.214×10^{-7} m (4) 2.816×10^{-7} m

Ans. **[3]**

Sol. **Students may find this question in CP Sheet chapter- Atomic Structure (Class copy).**

$E_1 = -2.178 \times 10^{-18}$

$E_2 = -2.178 \times 10^{-18} \times \left(\frac{1}{4}\right)$

$\Delta E = |E_2 - E_1| = 2.178 \times 10^{-18} \times \frac{3}{4}$

$\Delta E = \frac{hc}{\lambda}$

$2.178 \times 10^{-18} \times \frac{3}{4} = \frac{6.6\times10^{-34}\times3\times10^8}{\lambda}$

$\lambda = \frac{19.8\times10^{-26}\times4}{2.178\times3\times10^{-18}} = 12.12 \times 10^{-8}\ m = 1.21 \times 10^{-7}\ m$

Q.87 Synthesis of each molecule of glucose in photosynthesis involves -

(1) 8 molecules of ATP (2) 6 molecules of ATP

(3) 18 molecules of ATP (4) 10 molecules of ATP

Ans. **[3]**

Sol. **Students may find this question in CP Sheet chapter-Biomolecules.**

One CO_2 requires 3 ATP molecules, one glucose molecule gives 6 CO_2 molecules. Each glucose molecule involves 18 ATP molecules in photosynthesis.

Q.88 Which of the following is the wrong statement ?

(1) Ozone is violet-black in solid state (2) Ozone is diamagnetic gas

(3) ONCl and ONO^- are not isoelectronic (4) O_3 molecule is bent

Ans. **[No option correct]**

Sol. All statement are correct and we have to chose wrong statement.

Q.89 Which of the following arrangements does **not** represent the correct order of the property stated against it ?

(1) $Co^{3+} < Fe^{3+} < Cr^{3+} < Sc^{3+}$: stability in aqueous solution

(2) Sc < Ti < Cr < Mn : number of oxidation states

(3) $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$: paramagnetic behaviour

(4) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$: ionic size

Ans. **[3]**

Sol. $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$

$V^{2+} = [Ar]\ 4s^0\ 3d^3$; unpaired $e^- = 3$

$Cr^{2+} = [Ar]\ 4s^0\ 3d^4$; unpaired $e^- = 4$

$Mn^{2+} = [Ar]\ 4s^0\ 3d^5$; unpaired $e^- = 5$

$Fe^{2+} = [Ar]\ 4s^0\ 3d^6$; unpaired $e^- = 4$

Q.90 Given $E^0_{Cr^{3+}/Cr} = -0.74$ V; $E^0_{MnO_4^-/Mn^{2+}} = 1.51$ V

$E^0_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33$ V; $E^0_{Cl/Cl^-} = 1.36$ V

Based on the data given above, strongest oxidizing agent will be -

(1) Mn^{2+} (2) MnO_4^- (3) Cl^- (4) Cr^{3+}

Ans. **[2]**

Sol. **Students may find this question in CP Sheet chapter-Electrochemistry similar to Q.34, Level-1.**

Highest SRP $\rightarrow$ Bottom of E.C.S $\Rightarrow$ Strongest oxidising agent = MnO_4^-