

This Question Paper contains 8 Printed Pages]

054(E)
(MARCH, 2003)

Time : 3.00 Hours]

[Maximum Marks : 100

Q.1. (A) Answer in short.

5

- (1) Write dimensional formula of the ratio of damping co-efficient and mass of the Oscillator.
- (2) Why cricketer hits a ball by moving his bat?
- (3) How many beats will be generated if two tuning forks of 285 Hz and 300 Hz are sounded together?
- (4) Define Node in case of Stationary waves.
- (5) The masses of two bodies are in ratio 11 : 4 and their linear momentum are in ratio 1 : 2, then what is the ratio of their Kinetic energies?

(B) Attempt ANY THREE.

6

- (1) Write differential equation of forced oscillations in presence of damping. Write down its solution on the basis of the solution. Define Resonance.
- (2) Define centre of mass for system of particles. Using this definition, derive the expression $\vec{P} = M\vec{v}_{cm}$.
- (3) State law of Conservation of Linear Momentum. Explain it with a suitable example.
- (4) Obtain differential equation for Simple Harmonic Motion. Define S.H.M.

(C) Attempt **ANY THREE** of the following problems.

9

- (1) An Oscillator having a mass of 0.2 kg. is executing Simple Harmonic Oscillations. After 100 oscillations the amplitude becomes $\frac{1}{7}$ th of original value. Find damping co-efficient of this motion, if its periodic time is 2 seconds.
- (2) Two wires placed close to each other are vibrating in their first harmonic. The sound produced by the two wires produce 5 beats per second. If the longer wire is 25 cm long and the velocity of waves in wire is 50 m/s, then find length of the smaller wire.
- (3) A rectangular pipe having cross-sectional area A closed at one end, and at its other end a block having same cross-section is placed, so that the system is air-tight. In the equilibrium position, the pressure inside the tube is P and the volume enclosed is V . If the block is now given a small displacement x and then released, show that it would execute S.H.M. (Assume frictionless walls and isothermal compression.)
- (4) Equation of a propagating wave is $y = 20 \sin (\pi t - 2\pi x)$, with y in meter and t in second. What will be the phase difference of oscillations at two points located at a distance of 2 m at a given time? Also for a given point what will be the change in phase of oscillation after a time interval of 5.2 second?

Q.2. (A) Answer in short.

5

- (1) 1 MKS unit of Universal Gravitational Constant is equal to how many CGS units?
- (2) Out of hour-hand of clock and Earth rotating on its own axis, which body will have less angular speed?
- (3) In adiabatic process,
slope of graph of $\ln P \rightarrow \ln V$ is (Fill up the gap)

[3]

- (4) The total emissive power of a substance is W_1 at 127°C . If its emissive power is to be made 16 times, then what should be the temperature of the substance?
- (5) Write dimensional formula of Angular Momentum.

(B) Answer **ANY THREE** of the following questions.

6

- (1) Prove that rate of change of angular momentum of a rigid body is equal to torque.
- (2) Write a note on 'The general theory of Relativity.'
- (3) What is a Projectile Motion? Obtain expression for the maximum height attained by a projectile.
- (4) Assume the expression $a = \frac{2}{3}g \sin \theta$ for the acceleration of a cylinder rolling down a slope without sliding. Using it, obtain the condition for it to roll without sliding.

(C) Attempt **ANY THREE** of the following problems.

9

- (1) The Escape velocity for a body at Earth's surface is 11.2 km/s. If mass of Jupiter is 318 times that of Earth and its radius is 11.2 times that of Earth, then find the Escape velocity of same object on Jupiter.
- (2) In a Carnot engine, the temperature of sink is 27°C . Its efficiency is 25%. Find the temperature of the source. If one wants to have 60% efficient engine with the same sink temperature, how much temperature of source should be changed?
- (3) Prove that the point where a Projectile hits the horizontal plane, makes the same angle with the $(-)x$ direction as that made by it with the $(+)x$ direction at the point from where it was projected; x being the horizontal direction from the point of projection.

[4]

- (4) One mole of an ideal gas at 27.7°C is adiabatically compressed so that its pressure becomes 8.08 times the initial pressure. Find the final temperature of the gas. ($\gamma=1.4$)

Q.3. (A) Answer in short of the following.

5

- (1) The value of Carbon resistance is $26\text{ M}\Omega \pm 20\%$. Write its colour code.
- (2) A wire of 20Ω is stretched to increase its length by 2%, then find out the percentage change in its resistivity.
- (3) Define Henry.
- (4) If the current flowing through any one wire of infinite length, out of two very long conducting wires placed parallel to each other, is doubled then what is the effect on the force existing between them.
- (5) Give the unit of L/R .

(B) Answer **ANY THREE** of the following questions.

6

- (1) Write short note on Peltier effect.
- (2) Prove that $I = Avne$ in a conductor, where I is current flowing in the conductor.
- (3) Draw labelled diagram of a Galvanometer. Find its principle.
- (4) Write down the laws of Faraday, relating to Electrolysis. Discuss the First law.

(C) Attempt **ANY THREE** of the following problems.

9

- (1) Resistance of silver wire is 3Ω at 30°C and at 100°C , it is 3.5Ω . Find its temperature co-efficient of resistance.

[5]

- (2) How much current should be passed through an electro-chemical cell to deposit 0.5 gm of Gold on cathode in 1 hour.

Faraday constant = 96500 coulomb/mole;

Atomic Weight of Gold = 197 gm/mole, Valency of Gold = 3.

- (3) A conducting loop of radius r is placed concentric with another loop of a much larger radius R , so that both the loops are coplanar. Find mutual inductance of the system of the two loops. (Take $R \gg r$)
- (4) An electron in an atom is revolving round the nucleus in a circular orbit with a speed of 10^7 m/s. If the magnetic field at the centre is 32 webre/m², then find the radius of the orbit.

$$\left(e = 1.6 \times 10^{-19} \text{ Coulomb}, \mu_0 = 4\pi \times 10^{-7} \frac{\text{Tesla} \cdot \text{m}}{\text{Amp}} \right)$$

Q.4. (A) Answer in short.

5

- (1) In Hertz experiment, what are radiated components?
- (2) In A.C. circuit, 1 μF capacitance is connected, then what is the value of its impedance?
- (3) Out of red and violet coloured light which light gives interference fringes of more width.
- (4) When resonance occurs in an L-C-R series circuit, what is the value of power factor?
- (5) Give Rayleigh's criterion for resolution.

(B) Answer **ANY THREE** of the following questions.

6

- (1) What is an Electric Motor? Give its principle and write names of the different components of D.C. motor and also draw diagram.
- (2) Write 4 characteristics of Electro-magnetic Wave.

- (3) Give the geometry for Young's experiment. Using it, obtain the expression for path difference.
- (4) Write down the differential equation for charge Q for L-C-R series circuit and using the expression, derive the equation of complex current.

(C) Attempt **ANY THREE** of the following problems .

9

- (1) A capacitor of $10\mu\text{F}$ and a resistance of 40Ω are connected in series. This circuit is connected to A.C. supply of 60 Hz and *rms* voltage of 110 volts. Find

(i) Impedance of circuit

(ii) Phase difference between Voltage and Current.

- (2) Velocity of Light in vacuum is $3.3 \times 10^5 \text{ km/s}$.

If permittivity of vacuum is $8.854 \times 10^{-12} \frac{\text{C}^2}{\text{Nm}^2}$, then find permeability of vacuum.

- (3) In Young's experiment, distance between two slits is 0.5 mm and distance between slit and screen is 1.5 m. If the slit is illuminated with light of $6000 \text{ \AA}$ wave-length, then find the distance between 3rd bright and eighth dark fringe formed on same side of central bright fringe.
- (4) Prove that in Young's double slit interference experiment, if the separation of slits is twice the wave-length of light used, the maximum number of bright fringes obtained on screen will be 5.

Q.5. (A) Answer in short.

5

- (1) In a half wave rectifier, if the frequency of input voltage is 50 Hz, then find out the frequency of output voltage in Hertz?

- (2) ${}_{92}\text{U}^{235} + {}_0\text{n}^1 \longrightarrow \dots\dots\dots + \dots\dots\dots + 4 [{}_0\text{n}^1]$.

(Fill in the blanks.)

[7]

- (3) If the energy of electron for Hydrogen atom in ground state is $-x$, then what is the energy of the electron in fourth excited state?
- (4) Why no input A.C. signal is required in any transistor oscillator?
- (5) Stopping potential depends upon the intensity of light incident on the emitter. Do you agree with this statement?

(B) Answer **ANY THREE** of the following questions.

6

- (1) For Bohr model of atom, deduce the expression for energy of an orbit with the help of radius $r = \frac{n^2 h^2 \epsilon_0}{\pi Z e^2 m}$.
- (2) Describe the experimental arrangement of Millikan's experiment to determine the electron charge e , giving the necessary diagram.
- (3) What is a Transistor? Give its type and name of its different parts and its circuit notation.
- (4) Write down laws of Rutherford and Soddy for α and β decay. Give one illustration for each.

(C) Attempt **ANY THREE** of the following problems.

9

- (1) Show that in a Hydrogen atom, angular speed of an

electron is given by $\omega = \frac{m\pi e^4}{2\epsilon_0^2 n^3 h^3}$

- (2) The mass of α particle is 4.0028 amu . Find its Binding energy in eV and Joule.

$$M_P = 1.00758 \text{ amu.}$$

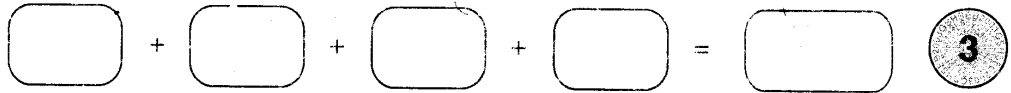
$$M_N = 1.00897 \text{ amu.}$$

[8]

- (3) For a transistor $\alpha = 0.95$; if emitter current is 10 mA, then find collector current and base current. Also find current gain β .
- (4) In Millikan oil drop experiment, charge on a drop is $5e$. The mass of the drop is 1.6×10^{-15} kg. When a potential of V volt is applied between two plates, the oil drop remains in equilibrium. If distance between two plates is 10 cm, then find the potential difference applied between the plates. (Neglect the buoyancy force)
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$$Q = 1$$

$$Q = 1 \text{ (C)}$$

(1) Dimensional formula of m = $M^0 L^0 T^{-1}$ $\frac{1 \text{ kg}}{\text{sec} \cdot \cancel{\text{kg}}}$

(2) To gain more momentum of the bat which can be imparted to the ball

(3) No. of Beats per second = 15

(4) In stationary waves, locations for which $\sin kx = 0$, have zero amplitudes and these points remain stationary. These points are called nodes.



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(5-)

$$\frac{m_1}{m_2} = \frac{11}{4}$$

$$\frac{p_1}{p_2} = \frac{1}{2}$$

$$\frac{K_1}{K_2} = \frac{p_1^2}{2m_1} \times \frac{2m_2}{p_2^2}$$

$$= \left(\frac{p_1}{p_2}\right)^2 \times \frac{m_2}{m_1}$$

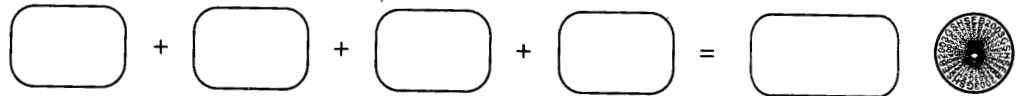
$$= \left(\frac{1}{2}\right)^2 \times \frac{4}{11}$$

$$= \frac{1}{4} \times \frac{4}{11}$$

$$\boxed{\frac{K_1}{K_2} = \frac{1}{11}}$$



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Q: 1 (B)

(1)

~~Differential~~

→ differential equation of forced oscillation in presence of damping.

$$\frac{d^2 y}{dt^2} + r \frac{dy}{dt} + \omega_0^2 y = a_0 \sin \omega t$$

$$r = \frac{b}{m}, \quad \omega_0^2 = \frac{k}{m}, \quad a_0 = \frac{F}{m}$$

Solution :-

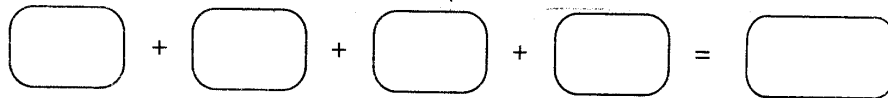
$$y = A \sin(\omega t + \alpha) \dots$$

A and α are constants

$$A = \frac{a_0}{[c\omega_0^2 - \omega^2]^2 + r^2\omega^2}^{1/2}$$

→ When $\omega_0 = \omega$, i.e. frequency of applied external periodic force is equal to natural oscillation frequency, then amplitude of oscillation attains its maximum value,

$$\frac{a_0}{r\omega}$$



Under this condition, system is said to be resonating, phenomenon is called resonance.

(2).

For system made of n particles, let position vectors of particles with respect to arbitrarily selected origin be $\vec{r}_1, \vec{r}_2, \dots, \vec{r}_n$. Let $m_1, m_2, m_3, \dots, m_n$ be masses of respective particles. Now, centre of mass of system is defined as point whose position vector $\vec{r}_{cm}$ is,

$$\vec{r}_{cm} = \frac{m_1 \vec{r}_1 + m_2 \vec{r}_2 + \dots + m_n \vec{r}_n}{m_1 + m_2 + \dots + m_n}$$

Writing $M = m_1 + m_2 + \dots + m_n$ for total mass of system.



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$$M \vec{v}_{cm} = m_1 \vec{v}_1 + m_2 \vec{v}_2 + \dots + m_n \vec{v}_n$$

→ Suppose masses in system do not change with time, differentiating w.r.t time,

$$M \frac{d\vec{r}_{cm}}{dt} = m_1 \frac{d\vec{r}_1}{dt} + m_2 \frac{d\vec{r}_2}{dt} + \dots + m_n \frac{d\vec{r}_n}{dt}$$

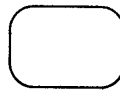
→ $m_1 \frac{d\vec{r}_1}{dt} = m_1 \vec{v}_1 = \vec{p}_1 =$ linear momentum of 1st particle.

→ $m_2 \frac{d\vec{r}_2}{dt} = m_2 \vec{v}_2 = \vec{p}_2 =$ linear momentum of 2nd particle.

$$M \vec{v}_{cm} = \vec{p}_1 + \vec{p}_2 + \dots + \vec{p}_n$$

$$\left(\frac{d\vec{r}_{cm}}{dt} = \vec{v}_{cm} \right)$$

$$\therefore \boxed{M \vec{v}_{cm} = \vec{P}}$$



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(u) - According to Newton's second law of motion,

Force = mass $\times$ acceleration

$$\therefore m \frac{d^2 y}{dt^2} = F \quad \text{--- (1)}$$

- For simple harmonic oscillator,

$$F = -ky \quad \text{--- (2)}$$

$$m \frac{d^2 y}{dt^2} = -ky$$

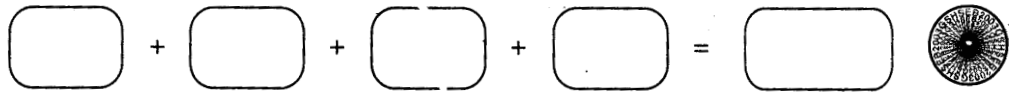
$$\frac{d^2 y}{dt^2} = \frac{-ky}{m} = -\frac{m\omega^2 y}{m}$$

$$\therefore \boxed{\frac{d^2 y}{dt^2} + \omega^2 y = 0}$$

This is required differential equation.



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SHM :-

→ Oscillatory motion along a linear path executed by body about a fixed point under the action of force that is proportional to its distance from that point and directed towards that point, is called Simple Harmonic Motion (SHM)



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Q-1 (c)

(1)

$$m = 0.2 \text{ kg}$$

Time for one oscillation = 2 sec

Time for 100 oscillations

$$= 200 \text{ sec}$$

$$t = 200 \text{ sec}$$

$$A(t) = Ae^{\frac{-bt}{2m}}$$

$$A(t) = \frac{A}{7}$$

$$\therefore \frac{A}{7} = Ae^{\frac{-bt}{2m}}$$

$$\therefore e^{\frac{bt}{2m}} = 7$$

$$\therefore \frac{bt}{2m} = \log_e 7$$

$$\therefore \frac{b(200)}{2(0.2)} = 2.303 \times 0.8451$$

$$b = \frac{0.4606 \times 0.8451}{100}$$

$$\therefore b = \frac{0.3894}{100}$$

$$\therefore b = 3.894 \times 10^{-3} \text{ kg}$$

$$\begin{array}{r} 1.6634 \\ 1.9270 \\ \hline 1.5904 \end{array}$$

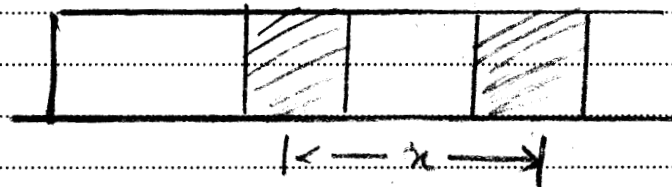


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$$\square + \square + \square + \square = \square$$



(3)



- Let the volume decrease by amount ΔV .

- let associated increase in pressure Δp .

Since compression is isothermal,

$$pV = (p + \Delta p)(V - \Delta V)$$

$$\therefore pV = pV - p\Delta V + V\Delta p - \Delta p\Delta V$$

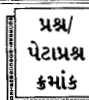
$\Delta p, \Delta V \rightarrow$ are small terms
So neglecting their product compared to other terms

$$\therefore p\Delta V = V\Delta p \quad (\Delta V = Ax)$$

$$\therefore \Delta p = \frac{pAx}{V}$$

$\rightarrow$ Now, force on the block due to increase in pressure Δp is,

$$F = A\Delta p.$$



$$\therefore F = A \left(\frac{\rho A x}{V} \right)$$

$$\therefore \boxed{F = \frac{\rho A^2 x}{V}} = kx$$

$$\left(k = \frac{\rho A^2}{V} = \text{constant} \right)$$

→ This force is proportional to displacement and directed opposite to displacement.

So, motion of block is S.H.M.

(4)

$$y = 20 \sin(\pi t - 2\pi x)$$

→ comparing with,

$$y = A \sin(\omega t - kx),$$

$$A = 20 \text{ m},$$

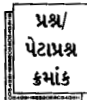
$$\omega = \pi \text{ rad/sec} \quad k = 2\pi \text{ rad/m}$$

→

$$k = 2\pi$$

$$\frac{2\pi}{\lambda} = 2\pi$$

$$\therefore \boxed{\lambda = 1 \text{ m}}$$



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Now, $x = 2\text{ m}$.

Phase difference,
$$S = \frac{2\pi x}{\lambda}$$

$$= \frac{2\pi (2)}{1}$$

$$\boxed{S = 4\pi \text{ radian.}} \quad \text{--- ①}$$

→ In one period (T), phase of oscillation of particle changes by 2π .

$$\omega = \frac{2\pi}{T} = \pi$$

$$t = 5.2 \text{ sec.}$$

$$\therefore \boxed{T = 2 \text{ sec}}$$

$$2\pi$$

So, for $t = 5.2 \text{ sec}$,
change in phase,

$$\Delta \theta = \frac{5.2 \times 2\pi}{2}$$

$$5.2 \times \pi$$

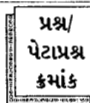
$$\boxed{\Delta \theta = 5.2 \pi \text{ radian.}}$$



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$$Q : 2.$$

$$Q : 2 (A).$$

$$(1) \quad \frac{1 \text{ N-m}^2}{\text{kg}^2} = \frac{10^3 \text{ dyn-}10^4 \text{ cm}^2}{10^3 \text{ gm}^2} \left| \frac{\text{N-m}^2}{\text{kg}^2} \right.$$

$$= \frac{10^9 \text{ dyn-cm}^2}{10^6 \text{ gm}^2}$$

$$\boxed{\frac{1 \text{ N-m}^2}{\text{kg}^2} = 10^3 \frac{\text{dyn-cm}^2}{\text{gm}^2}}$$

$$(2) \quad \text{For hour hand,}$$

$$\omega_1 = \frac{2\pi}{12} = \frac{\pi}{6} \frac{\text{rad}}{\text{hrs.}}$$

For earth, ?

$$\omega_2 = \frac{2\pi}{24} = \frac{\pi}{12} \frac{\text{rad}}{\text{hrs.}}$$

→ Earth has less angular speed.



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(3).

$$PV^\gamma = \text{constant}$$

$$\ln P + \gamma \ln V = \text{constant}$$

$$\ln P = -\gamma \ln V + \text{const}$$

$$\gamma = m + c$$

$$\text{slope} = -\gamma \left(-\frac{C_p}{C_v} \right)$$

(4).

$$T_1 = 127^\circ\text{C} = 400 \text{ K}$$

$$W_1 = W_1$$

$$W_2 = 16 W_1$$

$$T_2 = ?$$

$$W \propto T^\gamma$$

$$\frac{W_2}{W_1} = \left(\frac{T_2}{T_1} \right)^\gamma$$

$$16 = \left(\frac{T_2}{T_1} \right)^\gamma$$

$$\frac{T_2}{T_1} = 2$$

$$\frac{T_2}{T_1}$$

$$T_2 = 2T_1$$

$$\therefore T_2 = 800 \text{ K}$$

$$\boxed{T_2 = 527 \text{ K}}$$

$$\begin{array}{r} 79.16 \\ 800 \\ \hline 273 \\ \hline 527 \end{array}$$



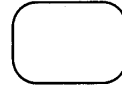
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(5)

Dimensional formula of angular momentum = $M L^2 T^{-1}$

$$\frac{m v r}{\text{kg} \cdot \frac{\text{m}}{\text{sec}} \times \text{m}}$$



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Q : 2 (B)

Q) General theory of relativity:-

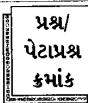
→ The curve on the surface giving the minimum distance between two points on the surface is called geodesic.

→ After his special theory of relativity, Einstein proposed general theory of relativity to include gravitation in it.

→ Let us consider four-dimensional space. Three space-coordinates (x, y, z) and fourth time co-ordinate constitute such space.

→ In absence of gravitation, motion of ~~particle~~ projectile will be along straight path.

→ In presence of gravitation, this motion will be along curved path.



→ This curved path, according to Einstein, will be geodesic.

→ He explained this curved path as "Four-dimensional space around a mass becomes curved" so gravitation can be understood in terms of curvature of this four-dimensional space.

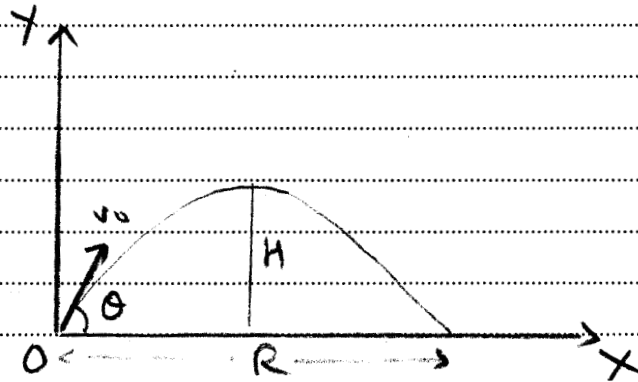
(2). Projectile motion:-

When an object is thrown at some angle to the horizontal direction in earth's gravitational field, it moves with constant horizontal velocity and constant acceleration in vertical direction. Such a motion is called projectile motion and object called projectile.



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→ At maximum height, y-component of velocity momentarily becomes zero and then reverses the direction.

→ Using equation of motion $v^2 - v_0^2 = 2ad$ and substituting for vertical motion,

$$\left. \begin{aligned} v &= 0 \\ v_0 &= v_0 \sin \theta \\ a &= -g \\ d &= H \end{aligned} \right\} \text{At maximum height.}$$

$$\therefore 0 - v_0^2 \sin^2 \theta = -2gH$$

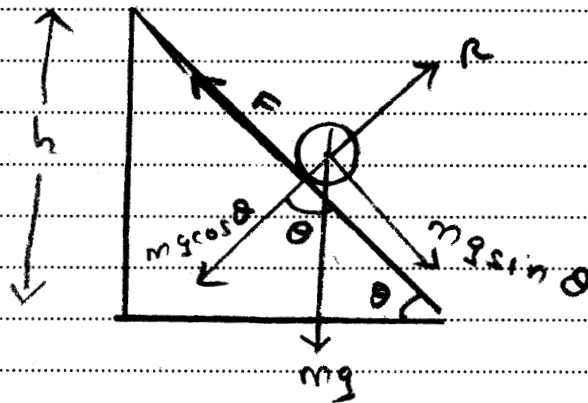
$$H = \frac{v_0^2 \sin^2 \theta}{2g}$$

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(4).



$$- a = \frac{2}{3} g \sin \theta. \text{ This is}$$

acceleration of cylinder parallel to slope.

- From the force diagram,

$$mg \sin \theta - F = ma$$

$F \rightarrow$ Friction force.

$$\therefore mg \sin \theta - F = \frac{2}{3} mg \sin \theta$$

$$\therefore \boxed{F = \frac{1}{3} mg \sin \theta} \quad - (1)$$

Now, Frictional force, $F = \mu_s R$
 $R = mg \cos \theta$

$$\therefore \boxed{F = \mu_s mg \cos \theta} \quad - (2)$$



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By ① and ②,

$$\frac{1}{2} mg \sin \theta = \mu_s mg \cos \theta$$

$$\mu_s = \frac{\tan \theta}{3}$$

It is due to this friction that body rolls without slipping.

Conclusion :-

If $\mu_s \geq \frac{\tan \theta}{3}$, then body will roll without slipping.



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Q: 2 (c)

(2)

$$T_2 = 27^\circ\text{C} = 300 \text{ K}$$

$$\eta = 25\% = \frac{1}{4}$$

$$\rightarrow \eta = 1 - \frac{T_2}{T_1}$$

$$\therefore \frac{1}{4} = 1 - \frac{T_2}{T_1}$$

$$\therefore \frac{T_2}{T_1} = \frac{3}{4}$$

$$T_1 = \frac{4}{3} \times 300$$

$$\boxed{T_1 = 400 \text{ K}} = \boxed{127^\circ\text{C}}$$

$$\rightarrow \eta' = 60\% = \frac{60}{100} = \frac{3}{5}$$

$T_2 \rightarrow \text{constant}$

$$T_1' - T_1 = ?$$

$$\text{Now, } \eta' = 1 - \frac{T_2}{T_1'}$$

$$\frac{3}{5} = 1 - \frac{300}{T_1'}$$



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$$\frac{300}{T_1} = 1 - \frac{3}{5} = \frac{2}{5}$$

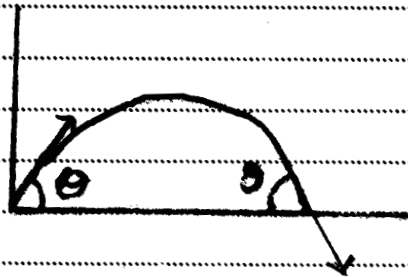
$$\therefore T_1 = \frac{300 \times 5}{2}$$

$$T_1 = 750$$

$$T_1 - T_2 = 750 - 400$$

$$T_1 - T_2 = \boxed{350 \text{ N}} = \boxed{77 \text{ C}}$$

(3)



$$y = (\tan \theta) x - \frac{1}{2} \frac{g x^2}{v_0^2 \cos^2 \theta}$$

$$\frac{dy}{dx} = (\tan \theta) - \frac{g x}{v_0^2 \cos^2 \theta}$$

$$\rightarrow \textcircled{1} \left(\frac{dy}{dx} \right)_{x=0} = \underline{\tan \theta}$$



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$$\rightarrow \textcircled{2} \cdot \left(\frac{dy}{dx} \right)_{x=R} = (\tan \theta) - \frac{gR}{v_0^2 \cos^2 \theta}$$

$$= \tan \theta - \frac{g v_0^2 \sin 2\theta}{v_0^2 \cos^2 \theta \cdot g}$$

$$= \tan \theta - \frac{2 \sin \theta \cos \theta}{\cos^2 \theta}$$

$$= \tan \theta - 2 \tan \theta$$

$$= -\tan \theta$$

$$= \underline{\underline{\tan(-\theta)}}$$

$\rightarrow$ Thus, angle at $x=0$ and $x=R$ is θ .

(4)

$$T_1 = 27.2^\circ \text{C}$$

$$\therefore T_1 = 300.7 \text{ K}$$

$$P_2 = 8.05 P_1$$

$$T_2 = ?$$

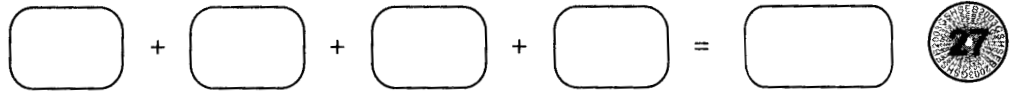
For an adiabatic process

$$P_1 V_1^\gamma = P_2 V_2^\gamma$$

$$PV = nRT$$



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$$P_1 V_1 = n R T_1 \Rightarrow V_1 = n \frac{R T_1}{P_1}$$

$$P_2 V_2 = n R T_2 \Rightarrow V_2 = n \frac{R T_2}{P_2}$$

$$\therefore P_1 \left(\frac{n R T_1}{P_1} \right)^Y = P_2 \left(\frac{n R T_2}{P_2} \right)^Y$$

$$\therefore P_1^{1-Y} T_1^Y = P_2^{1-Y} T_2^Y$$

$$\therefore \left(\frac{T_2}{T_1} \right)^Y = \left(\frac{P_1}{P_2} \right)^{1-Y}$$

$$= \left(\frac{1}{8.08} \right)^{1-1.4}$$

$$\left(\frac{T_2}{T_1} \right)^{1.4} = (8.08)^{0.4}$$

$$\frac{T_2}{T_1} = (8.08)^{2/7}$$

$$T_2 = (300.7) (8.08)^{2/7}$$

$$\log T_2 = \log 300.7 + \frac{2}{7} \log 8.08$$

$$= 2.7365$$

$$T_2 = 545.1 \text{ K}$$

$$T_2 = 272^\circ \text{C}$$

$$\begin{array}{r} 410 \\ 545.1 \\ \hline 273.0 \\ \hline 272.1 \end{array}$$

$$\begin{array}{r} 0.1296 \\ 0.9094 \\ \hline 1 \\ \hline 0.1292 \\ 2 \\ \hline 0.2584 \\ 2.4781 \\ \hline 2.7365 \end{array}$$



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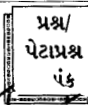


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Lined area for writing answers, consisting of multiple horizontal dotted lines.



$$Q = 3$$

$$Q = 3(A).$$

(1)

$$26 \times 10^6 \Omega \pm 20\%$$

Colour code :-

Red

Blue

Blue

None

0 B

1 B

2 B

3 B

4 B

5 B

6 B

7 B

8 B

9 B

10 B

11 B

12 B

(2)

$$R_1 = 20\%$$

$$R_2 = R_1 + 2\%$$

$$= R_1 + \frac{2}{100} R_1$$

$$=$$

Resistivity does not depend on dimension.

∴ Percentage change in resistivity is Zero



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$$\square + \square + \square + \square = \square$$



(3) Henry :-

In a system formed by two coils, if emf induced in one of the coils is 1 volt per unit time rate of change of current in other coil, then mutual inductance of system is 1 Henry.

$$M_{21} = \frac{\mathcal{E}_2}{\frac{dI_1}{dt}} = \frac{1}{1} = 1 \text{ Henry}$$

(4)
$$F = \frac{\mu_0}{2\pi} \frac{I_1 I_2 (l)}{y}$$

Force will also double

$$\text{Unit of } \frac{L}{R} = \frac{\text{Henry}}{\text{ohm}} = \frac{\text{Volt-sec}}{\text{Amp-Volt}} = \text{Amp}$$

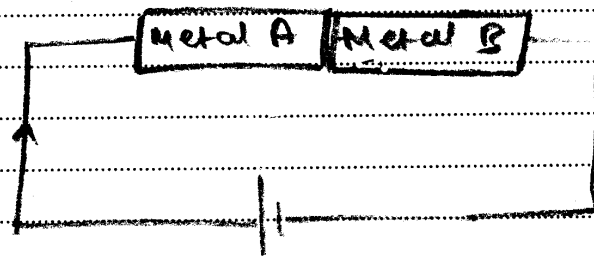
$$= \boxed{\text{second}}$$



$$Q = 3(B).$$

(1).

Peltier effect :-



- when current is passed through junction of two dissimilar metals, there is exchange of heat between junction and environment. This effect is called Peltier effect.
- The heat exchanged near the junction is proportional to amount of charge crossing junction.
- On reversing the ~~sign~~^{direction} of current, sign of heat exchange reverses. i.e. If junction were absorbing heat from environment, it would start releasing.



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$$\square + \square + \square + \square = \square$$



heat. and if junction were releasing heat it would start absorbing heat on reversing direction of current.

— If heat is absorbed at junction, heat-energy is converted to electrical energy. If heat is released, electrical energy is converted to heat-energy.

⇒ Amount of heat absorbed or released at junction per unit electric charge crossing it is called Peltier coefficient or Peltier emf π_{AB} .

→ Value of π_{AB} depends on type of metals and temperature of junction.



(2) - By ohm's law,

$$V = IR.$$

- If electric field is applied to conductor of length l and cross-section A , then field strength,

$$E = \frac{V}{l} \Rightarrow V = El.$$

- Also, $R = \frac{\rho l}{A}$.

$$El = IR \frac{l}{A}$$

$$\boxed{E = \frac{I \rho}{A}}$$

→ Current I is due to drift velocity of electrons.

→ Electrons moving with velocity v and passing through cross-section of conductor in one second will be



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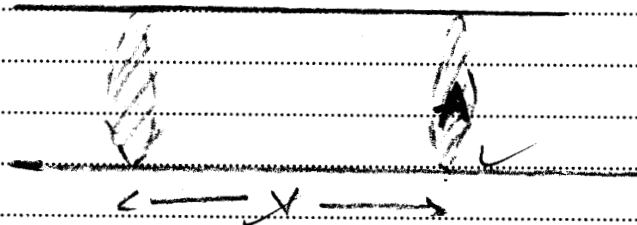
contained in length l
of conductor.

- If number density of
such electrons is n ,
total number of
electrons in length
 l is Avn .

- Charge carried by these
electrons = $Avne$

— So, this much charge
passes through cross-section
of conductor per second,

$\therefore$ Current $I = Avne$





(4)

Faraday's laws -

— 1st law :-

Mass 'm' of element separated from electrolyte on the cathode is directly proportional to the amount of charge ~~cross~~ passed through electrolyte.

$$m \propto Q$$

$$\boxed{m = ZQ} \quad \text{--- (1)}$$

$Z \rightarrow$ electrochemical equivalent of element

Now, $Q = It$, $I \rightarrow$ average current

$$\boxed{m = ZIt} \quad \text{--- (2)}$$

$\rightarrow$ In eqn (1), if $Q = 1$ coulomb

$$Z = m$$

So, mass 'm' of element separated from electrolyte on passing 1 coulomb charge through electrolyte is called its electrochemical equivalent.





⇒ In eqn ②, if $I = 1 \text{ amp}$ and $t = 1 \text{ sec}$
 $z = m$,

So, mass 'm' of element separated from electrolyte, on passing 1 ampere current for 1 second is called electrochemical equivalent of element.

- 2nd law :-

If same amount of current is passed for same time through two different electrolytes, masses of elements separated from electrolytes are in proportion to their respective chemical equivalents.



$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{}$$

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Q : 34C)

(1).

$$R_{30} = 3 \Omega, \quad R_{100} = 3.5 \Omega$$

$$\rightarrow R_t = R_{20} [1 + \alpha(t - 20)]$$

$$\therefore R_{30} = R_{20} [1 + \alpha(10)]$$

$$R_{100} = R_{20} [1 + \alpha(80)]$$

$$\therefore \frac{R_{100}}{R_{30}} = \frac{1 + 80\alpha}{1 + 10\alpha}$$

$$\therefore \frac{3.5}{3} = \frac{1 + 80\alpha}{1 + 10\alpha}$$

$$\therefore 3.5 + 35\alpha = 3 + 240\alpha$$

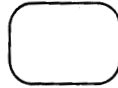
$$\therefore 0.5 = 205\alpha$$

$$\therefore \alpha = \frac{1}{2 \times 205} = \frac{1}{410}$$

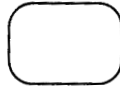
$$\therefore \alpha = \frac{1000}{410} \times 10^{-3}$$

$$\therefore \alpha = 2.439 \times 10^{-3} (^{\circ}\text{C})$$

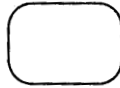
$$\begin{array}{r} 99.944 \\ 2.0000 \\ \hline 2.6128 \\ \hline 0.3872 \end{array}$$



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(2)

$$m = 0.5 \text{ gm.}$$

$$t = 3600 \text{ sec.}$$

$$\rightarrow e = \frac{\text{At. wt.}}{\text{Valency}} = \frac{197}{3} \frac{\text{gm}}{\text{mole}}$$

$$\rightarrow Z = \frac{e}{F} = \frac{197}{3 \times 96500} \frac{\text{gm}}{\text{coulomb}}$$

$$\text{Now, } m = ZIt.$$

$$0.5 = \frac{197}{3 \times 96500} \times I \times 3600$$

$$I = \frac{965 \times 0.5}{197 \times 12}$$

$$= \frac{965}{197 \times 24}$$

$$\underline{I = 0.2041 \text{ amp.}}$$

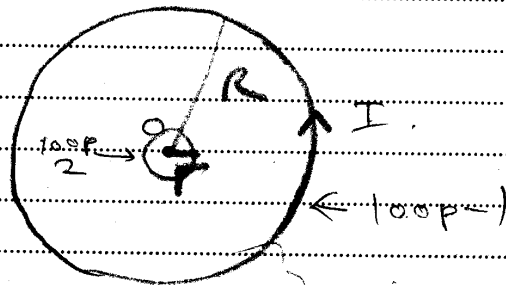
$$\begin{array}{r} 2.2945 \\ 1.3802 \\ \hline 3.6747 \\ 79.10 \\ 2.9845 \\ \hline 3.6747 \\ \hline 7.3098 \end{array}$$



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$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{}$$

(3).



→ Suppose current I is passed through the bigger loop.

→ Magnetic field at the centre, due to this current,

$$B = \frac{\mu_0 I}{2R}$$

→ Now, $R \gg r$, so this magnetic field can be taken constant over the region of smaller loop.

→ So, flux linked with small loop,

$$\phi = \pi r^2 B = \pi r^2 \frac{\mu_0 I}{2R}$$

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Mutual inductance,

$$M = \frac{\phi}{I}$$

$$= \frac{\mu_0 \pi r^2 I}{2R \cdot I}$$

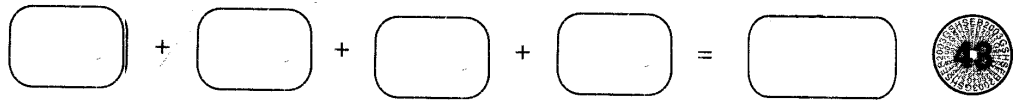
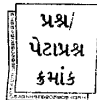
$$\therefore \boxed{M = \frac{\mu_0 \pi r^2}{2R}}$$



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$$Q = 4.$$

$$Q = 4(A)$$

(1) Radiated components:-

At regions far away from the oscillator, vectors $\vec{E}$ and $\vec{B}$ oscillate in same phase and their amplitude decrease as $\frac{1}{r}$, r being distance from the source. Such field components are called radiated components.

(2)

$$C = 10^{-6} \text{ F}$$

$$Z = \frac{1}{\omega C} = \frac{10^6}{\omega}$$

(3)

VIBRYOR. $\rightarrow$ wavelength (λ) increases.

$$\pi = \frac{\lambda D}{d}$$

$\rightarrow$ Red light gives interference fringes of more width.



$$\square + \square + \square + \square = \square$$



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(4)

$$\cos \delta = \frac{R}{|Z|}$$

In Resonance, $|Z| = R$.

Power factor, $\boxed{\cos \delta = 1}$

(5)

→ Images of two point objects can be identified as belonging to separate objects if central maximum in the diffraction pattern of one falls on the first minimum in diffraction pattern of other or is at greater separation.

This is Rayleigh Criterion.



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$$Q : 4(B).$$

(12) → Characteristics of Electromagnetic waves :-

→ At regions far away from source, $\vec{E}$ and $\vec{B}$ oscillate in same phase in plane perpendicular to direction of propagation.

→ They are non-mechanical and transverse waves.

→ Their velocity in vacuum is $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$

$\mu_0 =$ permeability of vacuum
 $= 4\pi \times 10^{-7} \text{ Wb}$

$\epsilon_0 =$ electric permittivity of vacuum
 $= 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{N-m}^2}$

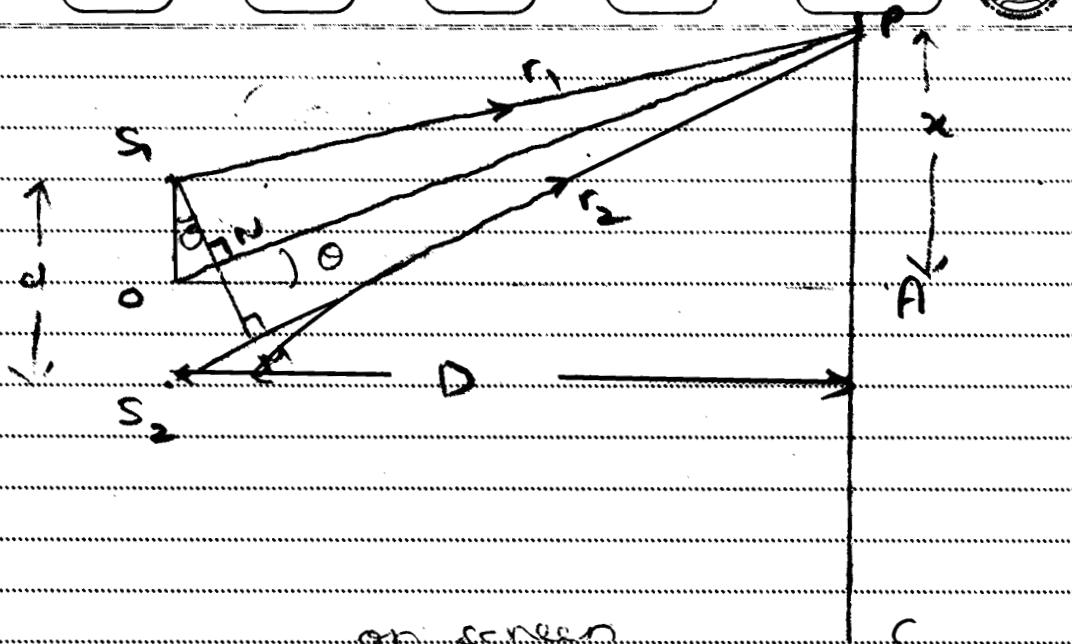
$$c = 3 \times 10^8 \text{ m s}^{-1}$$

→ Velocity of these waves depend on electromagnetic properties of medium through which



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(3)



→ Point A, is on perpendicular bisector of $S_1 S_2$ on screen C

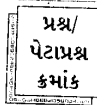
→ P is on screen at distance r_1 and r_2 respectively from S_1 and S_2 . So path difference at P is $r_2 - r_1$

→ $AP = x$ | $\rightarrow$ let M be
 $S_1 S_2 = d$ | foot of perpendicular
 $OA = D$ | from S_1 on
 $AP = x$ | $S_2 P$.
 $\angle AOP = \theta$

→ d is order of few mm and D is of order of a meter, so

$$r_2 - r_1 = S_2 P - S_1 P$$

$$[r_2 - r_1 = S_2 M]$$



$$\square + \square + \square + \square = \square$$

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→ Now, OP and S_2P are very long compared to OS_2

So taking $\vec{OP} \parallel \vec{S_2M}$

$$\therefore \angle S_1MO = 90^\circ$$

→ Now by geometry,

$$\angle S_2S_1M = \angle AOP = \theta$$

$$\therefore \sin(\angle S_2S_1M) = \sin\theta = \frac{S_2M}{S_1S_2}$$

$$\therefore \sin\theta = \frac{S_2M}{d}$$

$$\therefore S_2M = d \sin\theta$$

$$\therefore r_2 - r_1 = d \sin\theta$$

→ θ being v.v. small,
 $\sin\theta \approx \tan\theta$

$$\therefore \tan\theta = \frac{AP}{OA} = \frac{r_2}{D}$$

$$\therefore r_2 - r_1 = \frac{d r_2}{D}$$



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Rough

~~$$x = (v_0 \cos \theta) t$$~~

~~$$y = (v_0 \sin \theta) t - \frac{1}{2} g t^2$$~~
~~$$= (\tan \theta) x - \frac{1}{2} g \frac{x^2}{v_0^2 \cos^2 \theta}$$~~

~~$$r_2 - r_1 = n \lambda$$~~

~~$$r_2 - r_1 = \frac{d \lambda}{D}$$~~

~~$$d = 2 \lambda$$~~

~~$$r_2 - r_1 = d \sin \theta \quad n \lambda = \frac{2 \lambda x}{D}$$~~

~~$$r_2 - r_1 = n \lambda \quad n = \frac{2x}{D}$$~~

~~$$n \lambda = 2x \sin \theta$$~~

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(4)

$$\frac{d^2 q}{dt^2} + \frac{R}{L} \frac{dq}{dt} + \frac{q}{LC} = \frac{V_m \cos \omega t}{L} \quad \text{--- (1)}$$

Now, R.H.S $V_m \cos \omega t$ can be expressed as $\text{Re}[V_m e^{j\omega t}]$

So R.H.S of eqn (1)

becomes $\text{Re}\left[\frac{V_m e^{j\omega t}}{L}\right]$

Taking q as complex charge, i.e. $Q = \text{Re}\{z\}$, we get

$$\frac{d^2 z}{dt^2} + \frac{R}{L} \frac{dz}{dt} + \frac{z}{LC} = \frac{V_m e^{j\omega t}}{L}$$



$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{}$$



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- t, R, L, C are real.
- Voltage being alternating, charge Q will also vary periodically.

- Trying solution,

$$q = q_0 e^{j\omega t}$$

$$\frac{dq}{dt} = q_0 j\omega e^{j\omega t}$$

$$\frac{d^2q}{dt^2} = -\omega^2 q_0 e^{j\omega t}$$

$$- \omega^2 q_0 e^{j\omega t} + \frac{R q_0 j\omega e^{j\omega t}}{L} + \frac{q_0 e^{j\omega t}}{LC} = \frac{V_m e^{j\omega t}}{L}$$

$$\therefore q_0 \left(-\omega^2 + \frac{Rj\omega}{L} + \frac{1}{LC} \right) = \frac{V_m}{L}$$

$$\therefore q_0 = \frac{V_m}{-\omega^2 L + Rj\omega + \frac{1}{C}}$$



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$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{} \quad \textcircled{3}$$

$$\therefore q = \frac{V_m e^{j\omega t}}{-\omega^2 L + Rj\omega + \frac{1}{C}}$$

complex current,

$$\bar{i} = \frac{dq}{dt} = \frac{V_m j\omega e^{j\omega t}}{-\omega^2 L + Rj\omega + \frac{1}{C}}$$

$$\therefore \bar{i} = \frac{V_m e^{j\omega t}}{-\frac{\omega L}{j} + R + \frac{1}{j\omega C}}$$

$$\bar{i} = \frac{V_m e^{j\omega t}}{R + j\omega L - \frac{j}{\omega C}}$$

$$\boxed{\bar{i} = \frac{V_m e^{j\omega t}}{R + j(\omega L - \frac{1}{\omega C})}}$$

Supplimentary / પુરવણી - 1

★ અહીંથી જ લખવાનું શરૂ કરવું. ★



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c3)

$$d = 5 \times 10^{-4} \text{ m}$$

$$D = 1.5 \text{ m}$$

$$\lambda = 6 \times 10^{-7} \text{ m}$$

Distance between third
bright and eight dark
 $x = \frac{5\lambda - \lambda}{2}$

$$x = \frac{9\lambda}{2}$$

$$x = \frac{9}{2} \lambda D$$

$$= \frac{9}{2} \times \frac{6 \times 10^{-7} \times 1.5}{5 \times 10^{-4}}$$

$$= \frac{9}{2} \times \frac{0.9}{5} \times 10^{-3}$$

$$= 8.1 \times 10^{-3} \text{ m}$$

8D -

3B -

3D -



$$n = 8.1 \text{ mm}$$

3

(4)

$$d = 2\lambda$$

Path difference, $r_2 - r_1 = d \sin \theta$

For bright fringes,

$$r_2 - r_1 = n\lambda$$

$$\therefore n\lambda = d \sin \theta$$

$$\therefore n\lambda = 2\lambda \sin \theta$$

$$\therefore \underline{n = 2 \sin \theta}$$

Now, maximum value of $\sin \theta = 1$.

$\therefore$ maximum value of $n = 2$.

In that case, five bright fringes are obtained as

- (1) two bright fringes on upper side
- (2) two bright fringes on lower side
- (2) one central maximum (1)



$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{}$$



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પેટપ્રશ્ન
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Thus, maximum number of
bright fringes is five



$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{}$$

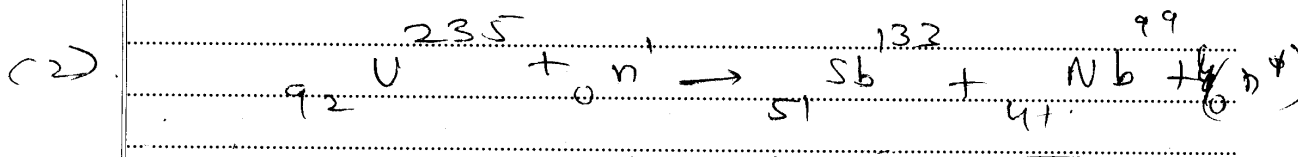


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પરિણામ
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$$Q = 5$$

$$Q = 5 (A)$$

(1) $\times$ 25 Hertz



(3).

$$E_n = -\frac{me^4}{8\epsilon_0^2 n^2 h^2}$$

$$E_n \propto \frac{1}{n^2}$$

$$\begin{array}{l} n_1 = \infty \\ n_2 = 1 \\ n_3 = 5 \end{array}$$

$$\frac{E_2}{E_1} = \left(\frac{n_1}{n_2}\right)^2 = \left(\frac{1}{5}\right)^2$$

$$\frac{E_2}{E_1} = \frac{1}{25}$$

$$E_1 = -\infty$$

$$\boxed{E_2 = -\frac{\infty}{25}}$$

Supplimentary / પુરવણી - 2

★ અહીંથી જ લખવાનું શરૂ કરવું. ★

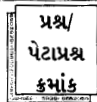


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ક્રમાંક

$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{} \quad \text{①}$$

(4) In transistor oscillator, part of output of amplifier is fed back to input through suitable L-C network. So there is no need of input A.C signal.

(5) No.



$$Q : 5(B).$$

(1)

$$r = \frac{n^2 h^2 \epsilon_0}{\pi Z e^2 m} \quad \text{--- (1)}$$

Total, $E_n =$ Kinetic energy + Potential energy

$$= \frac{1}{2} m v^2 - F r.$$

$$\text{Now, } F = \frac{1}{4\pi\epsilon_0} \frac{Z e^2}{r^2} = \frac{m v^2}{r}.$$

$$\therefore \boxed{m v^2 = \frac{1}{4\pi\epsilon_0} \frac{Z e^2}{r}}$$

$$\therefore E_n = \frac{1}{8\pi\epsilon_0} \frac{Z e^2}{r} - \frac{1}{4\pi\epsilon_0} \frac{Z e^2}{r}$$

$$E_n = -\frac{1}{8\pi\epsilon_0} \frac{Z e^2}{r}$$

Using equation (1),

$$E_n = -\frac{1}{8\pi\epsilon_0} \frac{Z e^2}{\frac{n^2 h^2 \epsilon_0}{\pi Z e^2 m}}$$



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અકાદમી

$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{} \quad \textcircled{3}$$

$$\therefore E_n = \frac{-me^4 Z^2}{8\epsilon_0^2 n^2 h^2}$$

(3) Transistor :-

It is device formed by two P-N junctions either as P-N-P or N-P-N

1) P-N-P transistor :-

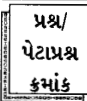
There is thin wafer of N-type semi-conductor between two P-type semi-conducting materials.

2) N-P-N transistor :-

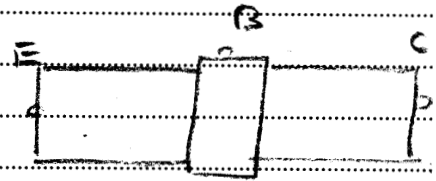
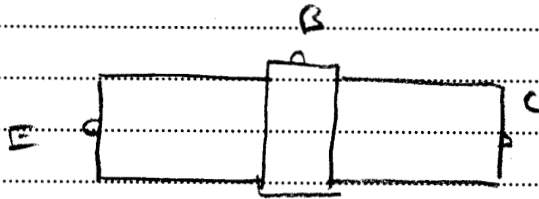
There is thin wafer of P-type semi-conductor between two N-type semi-conducting materials.

Parts of transistor :-

- 1) Emitter
- 2) Base
- 3) Collector.



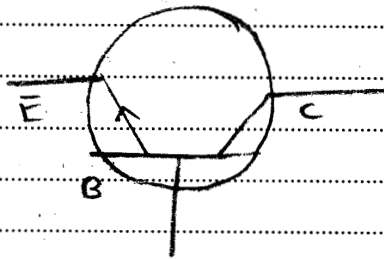
Circuit.



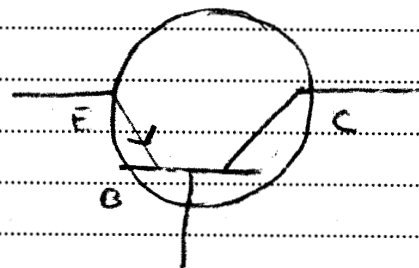
N - P - N

P - N - P

Circuit symbols :-



N - P - N



P - N - P

Supplimentary / પુરવણી - 3

★ અહીંથી જ લખવાનું શરૂ કરવું. ★



પ્રશ્ન/
પેટાપ્રશ્ન
ક્રમાંક

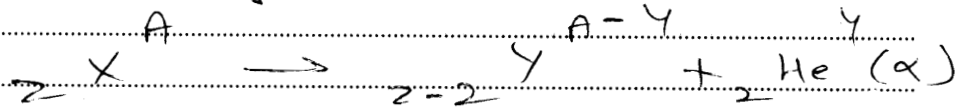
$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{} \quad \textcircled{1}$$

(4)

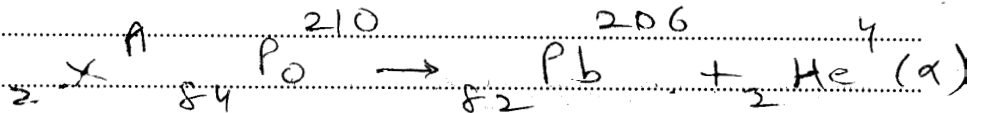
Law of α -decay :-

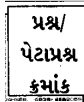
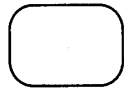
If an element decays by emission of α -Particle, atomic number of daughter element is less by 2 and atomic mass number is less by 4 compared to parent element.

Symbolically :-



Example :-

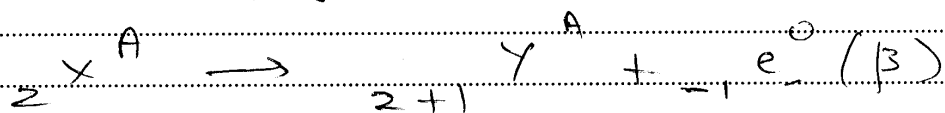




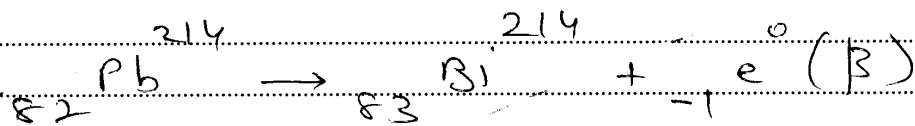
Law of β -decay :-

- If an element decays by emission of β -particle, atomic number of daughter element is more by one and atomic mass number is same compared to parent element.

- β -particle is electron. In decaying nucleus, neutron changes to proton giving an electron which cannot remain in nucleus, so expelled as β -particle. Thus, number of nucleons remain unchanged. Symbolically,



Example,





$$\square + \square + \square + \square = \square \quad \text{3}$$

3

પ્રશ્ન/
પેટાપ્રશ્ન
ક્રમાંક



$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{}$$



A series of horizontal dotted lines for writing answers.

Supplimentary / પુરવણી - 4

★ અહીંથી જ લખવાનું શરૂ કરવું. ★



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પેટાપ્રશ્ન
ક્રમાંક

+ + + =



(3)

$$\alpha = 0.95.$$

$$I_E = 10 \times 10^{-3} \text{ A.}$$

$$\text{Now, } \alpha = \frac{I_C}{I_E}$$

$$\therefore 0.95 = \frac{I_C}{10 \times 10^{-3}}$$

$$\therefore I_C = 9.5 \times 10^{-3} \text{ A}$$

$$\therefore \boxed{I_C = 9.5 \text{ mA}}$$



$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{}$$



48/42/48
5415

Now, $I_E = I_B + I_C$

$$\therefore I_B = I_E - I_C$$

$$= 10 \text{ mA} - 9.5 \text{ mA}$$

$$\therefore \boxed{I_B = 0.5 \text{ mA}}$$

$$\beta = \frac{I_C}{I_B} = \frac{9.5}{0.5} = \boxed{19}$$

(4)

$$q = 5e = 5 \times 1.6 \times 10^{-19} \text{ C}$$

$$m = 1.6 \times 10^{-15} \text{ kg}$$

Since the oil drop remains in equilibrium,

$$mg = qE \quad (\text{Neglecting buoyancy})$$

$$\therefore E = \frac{mg}{q}$$

$$E = \frac{1.6 \times 10^{-15} \times 9.8}{5 \times 1.6 \times 10^{-19}}$$

$$= \frac{10^4 \times 9.8}{5}$$

$$= \frac{10^4 \times 19.2}{10}$$

$$= 19.2 \times 10^3$$

$$E = 19,200 \text{ V/m}$$

$$d = 10 \times 10^{-2} \text{ m}$$



$$\boxed{} + \boxed{} + \boxed{} + \boxed{} = \boxed{} \quad \textcircled{3}$$

$$E = V$$

$$E = \frac{V}{d}$$

$$\therefore V = E d$$

$$= 19,200 \times 10 \times 10^{-2}$$

$$\underline{V = 1920 \text{ Volts.}}$$

α -particle = Helium nucleus

$$M = 4.0026 \text{ amu} = 2 \text{ He}^4$$

$$Z = 2$$

$$N = 2$$

$$M_p = 1.00758 \text{ amu}$$

$$M_n = 1.00897 \text{ amu}$$

$$\begin{aligned} 2M_p + 2M_n &= 2(1.00758) + 2(1.00897) \\ &= 2(2.01655) \end{aligned}$$

$$= 4.03310 \text{ amu}$$



Mass defect $\Delta m =$

$$(2M_p + M_n) - M$$

$$= 0.0303 \text{ amu}$$

Binding energy

$$= 0.0303 \times 931.48 \text{ MeV}$$

$$= \boxed{28.21 \text{ MeV}}$$

$$= 28.21 \times 10^6 \times 1.6 \times 10^{-19}$$

$$= 28.21 \times 1.6 \times 10^{-13}$$

$$= 45.14 \times 10^{-13} \text{ Joule}$$

$$\begin{array}{r} 1.0611 \\ 1.06704 \\ \hline 2 \end{array}$$

$$2.01516$$

$$\begin{array}{r} 1.11 \\ 1.00897 \\ \hline 1.002 \end{array}$$

2.0 in
2.01516

$$1.002$$

$$2.03310$$

$$4.03810$$

$$4.0028$$

$$0.0303$$

$$1.4505 \quad 2.4691$$

$$0.2041 \quad 2.4814$$

$$1.6546 \quad 1.4505$$