1. Two plane mirrors are inclined to each other such that a ray of light incident on the first mirror (M₁) and parallel to the second mirror (M₂) is finally reflected from the second mirror (M₂) parallel to the first mirror (M₁). The angle between the two mirrors will be:
(1) 90°  (2) 45°  (3) 75°  (4) 60°
Ans. (4)
Sol. Assuming angles between two mirrors be θ as per geometry,
sum of angles of Δ = 180°
θ = 60°

2. In a Young’s double slit experiment, the slits are placed 0.320 mm apart. Light of wavelength λ = 500 nm is incident on the slits. The total number of bright fringes that are observed in the angular range −30° ≤ θ ≤ 30° is:
(1) 320  (2) 641  (3) 321  (4) 640
Ans. (2)
Sol. Pam difference
dsinθ = nλ
where d = separation of slits
λ = wave length
n = no. of maxima
0.32 × 10⁻³ sin 30° = n × 500 × 10⁻⁹
n = 320

3. At a given instant, say t = 0, two radioactive substances A and B have equal activities. The ratio \( \frac{R_B}{R_A} \) of their activities after time t itself decays with time t as e⁻ⁿᵗ. If the half-life of A is \( m_2 \), the half-life of B is:
(1) \( \frac{n}{2m} \)  (2) \( 2\frac{n}{m} \)  (3) \( \frac{n}{4m} \)  (4) \( 4\frac{n}{m} \)
Ans. (3)
Sol. Half life of A = \( \frac{n}{m} \)
\( t_{1/2} = \frac{\ell n2}{\lambda} \)
\( \lambda_A = 1 \)
at t = 0  \( R_B = R_A = N_Ae^{-\lambda_A t} \)
\( N_Ae^{-\lambda_A t} = N_Be^{-\lambda_B t} \)
\( N_B = N_A \) at \( t = 0 \)
at \( t = t \)  \( \frac{R_B}{R_A} = \frac{N_Be^{-\lambda_B t}}{N_Ae^{-\lambda_A t}} \)
e⁻ⁿᵗ = \( e^{-\frac{\lambda_B t}{\lambda_A} - \frac{\lambda_A t}{\lambda_B}} \)
\( \frac{\lambda_A}{\lambda_B} = 3 \)
\( \frac{\lambda_B}{\lambda_A} = \frac{3 + \lambda_A}{\lambda_B} = \frac{4}{3} \)
\( t_{1/2} = \frac{\ell n2}{\lambda} = \frac{\ell n2}{\lambda_B} = \frac{\ell n2}{\lambda_A} \)

4. Ge and Si diodes start conducting at 0.3 V and 0.7 V respectively. In the following figure if Ge diode connection are reversed, the value of \( V_o \) changes by:
(assume that the Ge diode has large breakdown voltage)
(1) 0.6 V  (2) 0.8 V  (3) 0.4 V  (4) 0.2 V
Ans. (3)
Sol. Initially Ge & Si are both forward biased so current will effectively pass through Ge diode with a drop of 0.3 V if "Ge" is reversed then current will flow through "Si" diode hence an effective drop of $(0.7 - 0.3) = 0.4$ V is observed.

5. A rod of mass 'M' and length '2L' is suspended at its middle by a wire. It exhibits torsional oscillations; If two masses each of 'm' are attached at distance 'L/2' from its centre on both sides, it reduces the oscillation frequency by 20%. The value of ratio $m/M$ is close to :

- (1) 0.17
- (2) 0.37
- (3) 0.57
- (4) 0.77

Ans. (2)

Sol. Frequency of torsional oscillations is given by

$$f = \frac{k}{\sqrt{I}}$$

$$f_1 = \frac{k}{\sqrt{\frac{M(2L)^2}{12}}}$$

$$f_2 = \frac{k}{\sqrt{\frac{M(2L)^2}{12} + 2m(\frac{1}{2})^2}}$$

$$f_2 = 0.8 \times f_1$$

$$\frac{m}{M} = 0.375$$

6. A 15 g mass of nitrogen gas is enclosed in a vessel at a temperature 27°C. Amount of heat transferred to the gas, so that rms velocity of molecules is doubled, is about :

[Take $R = 8.3$ J/ K mole]

- (1) 10 kJ
- (2) 0.9 kJ
- (3) 6 kJ
- (4) 14 kJ

Ans. (1)

Sol. $Q = nC_A \Delta T$ as gas in closed vessel

$$Q = \frac{15}{28} \times 5 \times \frac{R}{2} \times (4T - T)$$

$$Q = 10000 \text{ J} = 10 \text{ kJ}$$

7. A particle is executing simple harmonic motion (SHM) of amplitude A, along the x-axis, about $x = 0$. When its potential Energy (PE) equals kinetic energy (KE), the position of the particle will be :

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

Ans. (3)

Sol. Potential energy (U) = $\frac{1}{2}kx^2$

Kinetic energy (K) = $\frac{1}{2}kA^2 - \frac{1}{2}kx^2$

According to the question, $U = K$

$$\therefore \frac{1}{2}kx^2 = \frac{1}{2}kA^2 - \frac{1}{2}kx^2$$

$$x = \pm \frac{A}{\sqrt{2}}$$

$$\therefore$$ Correct answer is (3)

8. A musician using an open flute of length 50 cm produces second harmonic sound waves. A person runs towards the musician from another end of a hall at a speed of 10 km/h. If the wave speed is 330 m/s, the frequency heard by the running person shall be close to :

- (1) 753 Hz
- (2) 500 Hz
- (3) 333 Hz
- (4) 666 Hz

Ans. (4)

Sol. Frequency of the sound produced by flute,

$$f = 2\left(\frac{v}{2\ell}\right) = \frac{2 \times 330}{2 \times 0.5} = 660 \text{ Hz}$$

Velocity of observer, $v_0 = 10 \times \frac{5}{18} = \frac{25}{9} \text{ m/s}$

$$\therefore$$ frequency detected by observer, $f' = \left[\frac{v + v_0}{v}\right]f$

$$\therefore f' = \left[\frac{\frac{25}{9} + 330}{330}\right] 660 = 335.56 \times 2 = 671.12$$

$$\therefore$$ closest answer is (4)

9. In a communication system operating at wavelength 800 nm, only one percent of source frequency is available as signal bandwidth. The number of channels accommodated for transmitting TV signals of band width 6 MHz are (Take velocity of light $c = 3 \times 10^8 \text{ m/s}, h = 6.6 \times 10^{-34} \text{ J-s}$)

- (1) $3.75 \times 10^6$
- (2) $4.87 \times 10^5$
- (3) $3.86 \times 10^6$
- (4) $6.25 \times 10^5$

Ans. (4)
Sol. 

\[ f = \frac{3 \times 10^8}{8 \times 10^{-7}} = 3 \times 10^{14} \text{ Hz} \]

\[ = 3.75 \times 10^{14} \text{ Hz} \]

1% of \( f \) = \( 0.0375 \times 10^{14} \text{ Hz} \)

\[ = 3.75 \times 10^{12} \text{ Hz} = 3.75 \times 10^6 \text{ MHz} \]

number of channels = \( \frac{3.75 \times 10^6}{6} = 6.25 \times 10^5 \)

\[ \therefore \text{ correct answer is (4)} \]

10. Two point charges \( q_1 (\sqrt{10} \mu \text{C}) \) and \( q_2 (-25 \mu \text{C}) \) are placed on the x-axis at \( x = 1 \text{ m} \) and \( x = 4 \text{ m} \) respectively. The electric field (in V/m) at a point \( y = 3 \text{ m} \) on y-axis is,

\[ E_1 = \frac{1}{4\pi \varepsilon_0} \frac{q_1}{r} \]

\[ = \frac{9 \times 10^9 \times 25}{4^2 + 3^2} \times 10^{-6} \text{ V/m} \]

\[ E_2 = 9 \times 10^3 \text{ V/m} \]

Let \( \vec{E}_1 \) & \( \vec{E}_2 \) are the values of electric field due to \( q_1 \) & \( q_2 \) respectively magnitude of

\[ \vec{E} = \vec{E}_1 + \vec{E}_2 \]

Ans. (3)

11. A parallel plate capacitor with square plates is filled with four dielectrics of dielectric constants \( K_1, K_2, K_3, K_4 \) arranged as shown in the figure. The effective dielectric constant \( K \) will be:

\[ K = \frac{K_1 + K_2}{2(K_1 + K_2 + K_3 + K_4)} \]

\[ = \frac{K_1 + K_2 + K_3 + K_4}{2(K_1 + K_2 + K_3 + K_4)} \]

\[ = K \]

Ans. (Bonus)
### JEE (Main) Examination–2019/Evening Session/09-01-2019

**Sol.**

\[
\begin{align*}
C_{12} &= \frac{C_1 C_2}{C_1 + C_2} = \frac{k_1 k_2}{k_1 + k_2} \frac{\varepsilon_0}{d/2} \frac{L}{2} \\
C_{12} &= \frac{k_1 k_2 \varepsilon_0 L^2}{k_1 + k_2} d \\
\therefore C_{eq} &= C_{12} + C_{34} = \frac{(k_1 k_2 + k_1 k_4) \varepsilon_0 L^2}{(k_1 + k_2)(k_1 + k_4) d} \quad \text{...(i)}
\end{align*}
\]

Now if \( k_{eq} = k \), \( C_{eq} = \frac{k \varepsilon_0 L^2}{d} \) \quad \text{....(ii)}

On comparing equation (i) to equation (ii), we get

\[
k_{eq} = \frac{k_1 k_2 (k_1 + k_4) + k_1 k_4 (k_1 + k_2)}{(k_1 + k_2)(k_1 + k_4)}
\]

This does not match with any of the options so probably they have assumed the wrong combination

\[
C_{13} = \frac{k_1 \varepsilon_0 L}{d/2} + \frac{k_3 \varepsilon_0 L}{d/2} = (k_1 + k_3) \frac{\varepsilon_0 L^2}{d}
\]

\[
C_{24} = (k_2 + k_4) \frac{\varepsilon_0 L^2}{d}
\]

**12.** A rod of length 50cm is pivoted at one end. It is raised such that if makes an angle of 30° from the horizontal as shown and released from rest. Its angular speed when it passes through the horizontal (in rad s\(^{-1}\)) will be (g = 10ms\(^{-2}\))

\[
(1) \sqrt{30} \quad (2) \frac{\sqrt{30}}{2} \quad (3) \frac{\sqrt{30}}{2} \quad (4) \frac{\sqrt{20}}{3}
\]

**Ans.** (2)

**Sol.**

Work done by gravity from initial to final position is,

\[
W = mg \frac{\ell}{2} \sin 30°
\]

\[
= \frac{mg\ell}{4}
\]

According to work energy theorem

\[
W = \frac{1}{2} \mathcal{I} \omega^2
\]
13. One of the two identical conducting wires of length \( L \) is bent in the form of a circular loop and the other one into a circular coil of \( N \) identical turns. If the same current is passed in both, the ratio of the magnetic field at the central of the loop (\( B_L \)) to that at the centre of the coil (\( B_C \)), i.e. \( R_L \) will be:

(1) \( \frac{1}{N} \)  
(2) \( N^2 \)  
(3) \( \frac{1}{N^2} \)  
(4) \( N \)

Ans. (3)

Sol.

\[
R_L = \frac{B_L}{B_C} = \frac{\mu_0 i}{2R} \quad \text{Coil}
\]

\[
R = \frac{\mu_0 i}{2r}
\]

14. The energy required to take a satellite to a height \( h \) above Earth surface (radius of Earth = \( 6.4 \times 10^3 \) km) is \( E_1 \) and kinetic energy required for the satellite to be in a circular orbit at this height is \( E_2 \). The value of \( h \) for which \( E_1 \) and \( E_2 \) are equal, is:

(1) \( 1.28 \times 10^4 \) km  
(2) \( 6.4 \times 10^3 \) km  
(3) \( 3.2 \times 10^3 \) km  
(4) \( 1.6 \times 10^3 \) km

Ans. (3)

Sol.

\[
U_{\text{surface}} + E_1 = U_h
\]

KE of satellite is zero at earth surface & at height \( h \)

15. The energy associated with electric field is \( U_E \) and with magnetic field is \( U_B \) for an electromagnetic wave in free space. Then:

(1) \( U_E = U_B \)  
(2) \( U_E < U_B \)  
(3) \( U_E = U_B \)  
(4) \( U_E > U_B \)

Ans. (3)

Sol.

\[
U_E = \frac{\varepsilon_0 \varepsilon_0}{2} \quad \text{Average energy density of electric field,}
\]

\[
U_B = \frac{B_0^2}{2\mu_0} \quad \text{Average energy density of magnetic field,}
\]

\[
u_0 = C B_0 \quad \text{now, } \varepsilon_0 = C B_0 \quad \mu_0 = \varepsilon_0
\]

\[
u_E = \frac{\varepsilon_0 \varepsilon_0}{2} \times C^2 B_0^2
\]
15. A series AC circuit containing an inductor (20 mH), a capacitor (120 \( \mu \)F) and a resistor (60 \( \Omega \)) is driven by an AC source of 24 V/50 Hz. The energy dissipated in the circuit in 60 s is :

- (1) \( 2.26 \times 10^3 \) J
- (2) \( 3.39 \times 10^3 \) J
- (3) \( 5.65 \times 10^2 \) J
- (4) \( 5.17 \times 10^2 \) J

Ans. (4)

Sol. \( R = 60 \ \Omega \), \( f = 50 \text{Hz}, \omega = 2\pi f = 100 \pi \)

\[ x_C = \frac{1}{\omega C} = \frac{1}{100\pi \times 120 \times 10^{-6}} = \frac{1}{12000000} \]

\[ x_C = 26.52 \ \Omega \]

\[ x_L = \omega L = 100\pi \times 20 \times 10^{-3} = 2\pi \Omega \]

\[ x_C - x_L = 20.24 \approx 20 \]

\[ z = \sqrt{R^2 + (x_C - x_L)^2} \]

\[ z = 20\sqrt{10} \Omega \]

\[ \cos \phi = \frac{R}{z} = \frac{3}{\sqrt{10}} \]

\[ P_{\text{avg}} = V \cos \phi, I = \frac{V}{z} \]

\[ I = \frac{V^2}{z \cos \phi} \]

\[ I = 8.64 \ \text{watt} \]

\[ Q = P \cdot t = 8.64 \times 60 = 5.18 \times 10^2 \]

17. Expression for time in terms of G (universal gravitational constant), h (Planck constant) and c (speed of light) is proportional to :

- (1) \( \sqrt{\frac{Gh}{c^5}} \)
- (2) \( \sqrt{\frac{hc^3}{G}} \)
- (3) \( \sqrt{\frac{c^7}{G}} \)
- (4) \( \sqrt{\frac{Gh}{c^5}} \)

Ans. (4)

18. The magnetic field associated with a light wave is given, at the origin, by

\[ B = B_0 [\sin(3.14 \times 10^7)ct + \sin(6.28 \times 10^7)ct] \]

If this light falls on a silver plate having a work function of 4.7 eV, what will be the maximum kinetic energy of the photo electrons ?

- (1) 7.72 eV
- (2) 8.52 eV
- (3) 12.5 eV
- (4) 6.82 eV

Ans. (1)

Sol. \( B = B_0 \sin(\pi \times 10^7)ct + B_0 \sin(2\pi \times 10^7)ct \)

Since there are two EM waves with different frequency, to get maximum kinetic energy we take the photon with higher frequency

\[ B_1 = B_0 \sin(\pi \times 10^7)ct \]

\[ B_2 = B_0 \sin(2\pi \times 10^7)ct \]

where \( C \) is speed of light \( C = 3 \times 10^8 \text{m/s} \)

\( v_2 > v_1 \)

So KE of photoelectron will be maximum for photon of higher energy.

\( v_2 = 10^7 \text{Hz} \)

\( h\nu = \phi + \text{KE}_{\text{max}} \)

Energy of photon

\[ E_{\text{ph}} = \frac{h\nu}{c} = 6.6 \times 10^{-19} \text{J} \]

\[ 6.6 \times 3 \times 10^{-19} \text{eV} = 12.375 \text{eV} \]

\[ \text{KE}_{\text{max}} = E_{\text{ph}} - \phi = 12.375 - 4.7 = 7.675 \text{ eV} \approx 7.7 \text{ eV} \]
19. Charge is distributed within a sphere of radius R with a volume charge density \( \rho(r) = \frac{A}{r^2}e^{-2r/a} \), where A and a are constants. If Q is the total charge of this charge distribution, the radius R is:

(1) \( \frac{a}{2} \log \left( 1 - \frac{Q}{2\pi aA} \right) \)

(2) \( a \log \left( 1 - \frac{Q}{2\pi aA} \right) \)

(3) \( \log \left( \frac{1}{1 - \frac{Q}{2\pi aA}} \right) \)

(4) \( \frac{a}{2} \log \left( \frac{1}{1 - \frac{Q}{2\pi aA}} \right) \)

Ans. (4)

\[ \text{Sol.} \]

\[ Q = \int \rho \, dv = \int_0^R \frac{A}{r^2}e^{-2r/a} \left( 4\pi r^2 \, dr \right) \]

\[ = 4\pi A \int_0^R e^{-2r/a} \, dr \]

\[ = 4\pi A \left( \frac{e^{-2r/a}}{-\frac{2}{a}} \right)_0^R \]

\[ = 4\pi A \left( \frac{1}{2} \left( e^{-2R/a} - 1 \right) \right) \]

\[ Q = 2\pi aA \left( 1 - e^{-2R/a} \right) \]

\[ R = \frac{a}{2} \log \left( \frac{1}{1 - \frac{Q}{2\pi aA}} \right) \]

20. Two Carnot engines A and B are operated in series. The first one, A, receives heat at \( T_1 (= 600 \text{ K}) \) and rejects to a reservoir at temperature \( T_2 \). The second engine B receives heat rejected by the first engine and, in turn, rejects to a heat reservoir at \( T_3 (= 400 \text{ K}) \). Calculate the temperature \( T_2 \) if the work outputs of the two engines are equal:

(1) 400 K  (2) 600 K  (3) 500 K  (4) 300 K

Ans. (3)

\[ \text{Sol.} \]

\[ w_1 = w_2 \]

\[ \Delta u_1 = \Delta u_2 \]

\[ T_1 - T_2 = T_2 - T_1 \]

\[ 2T_2 = T_1 + T_3 \]

\[ T_2 = 500 \text{ K} \]

21. A carbon resistance has a following colour code. What is the value of the resistance?

(1) 1.64 MΩ ± 5%  (2) 530 kΩ ± 5%
(3) 64 kΩ ± 10%  (4) 5.3 MΩ ± 5%

Ans. (2)

\[ \text{Sol.} \]

\[ G \quad O \quad Y \quad \text{Golden} \]

\[ 5 \quad 3 \quad 10 \quad +5\% \]

\[ R = 53 \times 10^4 \pm 5\% = 530 \text{ kΩ} \pm 5\% \]

22. A force acts on a 2 kg object so that its position is given as a function of time as \( x = 3t^2 + 5 \). What is the work done by this force in first 5 seconds?

(1) 850 J  (2) 900 J  (3) 950 J  (4) 875 J

Ans. (2)

\[ \text{Sol.} \]

\[ x = 3t^2 + 5 \]

\[ v = \frac{dx}{dt} \]

\[ v = 6t + 0 \]

at \( t = 0 \quad v = 0 \)

\[ t = 5 \text{ sec} \quad v = 30 \text{ m/s} \]

\[ W.D. = \Delta KE \]

\[ W.D. = \frac{1}{2}mv^2 - 0 = \frac{1}{2}(2)(30)^2 = 900 \text{ J} \]
23. The position co-ordinates of a particle moving in a 3-D coordinate system is given by
   \[ x = a \cos \omega t \]
   \[ y = a \sin \omega t \]
   \[ z = at \]
   The speed of the particle is :
   (1) \( a \omega \)
   (2) \( 3a \omega \)
   (3) \( 2a \omega \)
   (4) \( 2a \omega \)
   Ans. (3)
   Sol.
   \[ v_x = -a \omega \sin \omega t \]
   \[ v_y = a \omega \cos \omega t \]
   \[ v_z = \omega \]
   \[ v^2 = v_x^2 + v_y^2 + v_z^2 \]
   \[ v = 2a \omega \]

24. In the given circuit the internal resistance of the 18 V cell is negligible. If \( R_1 = 400 \, \Omega \), \( R_3 = 100 \, \Omega \)
   and \( R_4 = 500 \, \Omega \), and the reading of an ideal voltmeter across \( R_4 \) is 5V, then the value \( R_2 \) will be :
   (1) 300 \, \Omega 
   (2) 230 \, \Omega 
   (3) 450 \, \Omega 
   (4) 550 \, \Omega 
   Ans. (1)
   Sol.
   \[ V_4 = 5V \]
   \[ i_4 = \frac{V_4}{R_4} = 0.01 \, A \]
   \[ V_3 + V_4 = 6V = V_2 \]
   \[ V_1 = 12 \, V \]
   \[ V_2 = 6V \]
   \[ i = \frac{V_2}{R_4} = 0.03 \, \text{Amp} \]
   \[ i_2 = 0.02 \, \text{Amp} \]
   \[ R_2 = \frac{V_2}{i_2} = 300 \, \Omega \]

25. A mass of 10 kg is suspended vertically by a rope from the roof. When a horizontal force is applied on the rope at some point, the rope deviated at an angle of 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is \( (g = 10 \, \text{ms}^{-2}) \)
   (1) 200 N (2) 100 N (3) 140 N (4) 70 N
   Ans. (2)
   Sol.
   \[ F = 100 \, N \]
   at equation
   \[ \tan 45° = \frac{100}{F} \]

26. In a car race on straight road, car A takes a time \( t \) less than car B at the finish and passes finishing point with a speed \( v \) more than that of car B. Both the cars start from rest and travel with constant acceleration \( a_1 \) and \( a_2 \) respectively. Then \( v \) is equal to
   (1) \( \frac{a_1 + a_2}{2} t \)
   (2) \( \sqrt{2a_1a_2} t \)
   (3) \( \frac{2a_1a_2}{a_1 + a_2 - t} \)
   (4) \( \sqrt{a_1a_2} t \)
   Ans. (4)
   Sol. For A & B let time taken by A is \( t_0 \)
   \[ u = 0 \]
   \[ v_A = a_1 t_0, \quad v_B = a_2 (t_0 + t) \]
   from ques.
   \[ v_A - v_B = v = (a_1 - a_2) t_0 - a_2 t \quad ....(i) \]
   \[ x_B = x_A = \frac{1}{2} a_1 t_0^2 = \frac{1}{2} a_2 (t_0 + t)^2 \]
   \[ \Rightarrow \sqrt{a_1} t_0 = \sqrt{a_2} (t_0 + t) \]
   \[ \Rightarrow \left( \sqrt{a_2} - \sqrt{a_1} \right) t_0 = \sqrt{a_2} t \quad ....(ii) \]
27. A power transmission line feeds input power at 2300 V to a step down transformer with its primary windings having 4000 turns. The output power is delivered at 230 V by the transformer. If the current in the primary of the transformer is 5A and its efficiency is 90%, the output current would be:

(1) 25 A (2) 50 A (3) 35 A (4) 45 A

Ans. (4)

Sol. \[ P_{\text{out}} = \frac{V_{\text{out}}I_{\text{out}}}{V_{\text{in}}I_{\text{in}}} \]
\[ 0.9 = \frac{230 \times 5}{23 \times I_{\text{out}}} \]
\[ I_{\text{out}} = 45A \]

28. The top of a water tank is open to air and its water level is maintained. It is giving out 0.74 m³ water per minute through a circular opening of 2 cm radius in its wall. The depth of the centre of the opening from the level of water in the tank is close to:

(1) 9.6 m (2) 4.8 m (3) 2.9 m (4) 6.0 m

Ans. (2)

Sol. In flow volume = outflow volume
\[ 0.74 = (\pi \times 4 \times 10^{-4}) \times \sqrt{2gh} \]
\[ \sqrt{2gh} = \frac{7400}{240\pi} \]
\[ h = \frac{7400}{2 \times 24} \times 10 \left( \pi^2 = 10 \right) \]
\[ h = 4.8m \]

29. The pitch and the number of divisions, on the circular scale, for a given screw gauge are 0.5 mm and 100 respectively. When the screw gauge is fully tightened without any object, the zero of its circular scale lies 3 divisions below the mean line.
The readings of the main scale and the circular scale, for a thin sheet, are 5.5 mm and 48 respectively, the thickness of this sheet is:

(1) 5.755 m (2) 5.725 mm (3) 5.740 m (4) 5.950 mm

Ans. (2)

Sol. \[ LC = \frac{\text{Pitch}}{\text{No. of division}} \]
\[ LC = 0.5 \times 10^{-2} \text{ mm} \]
\[ +ve \text{ error} = 3 \times 0.5 \times 10^{-2} \text{ mm} \]
\[ = 1.5 \times 10^{-2} \text{ mm} = 0.015 \text{ mm} \]

Reading = MSR + CSR – (+ve error)

\[ = 5.5 \text{ mm} + (48 \times 0.5 \times 10^{-2}) – 0.015 \]
\[ = 5.5 + 0.24 - 0.015 = 5.725 \text{ mm} \]

30. A particle having the same charge as of electron moves in a circular path of radius 0.5 cm under the influence of a magnetic field of 0.5 T. If an electric field of 100 V/m makes it to move in a straight path, then the mass of the particle is

(Given charge of electron = 1.6 \times 10^{-19} C)

(1) 2.0 \times 10^{-24} kg (2) 1.6 \times 10^{-19} kg (3) 1.6 \times 10^{-27} kg (4) 9.1 \times 10^{-31} kg

Ans. (1)

Sol. \[ \frac{mv^2}{R} = qvB \]
\[ mv = qBR \quad \ldots (i) \]
Path is straight line
\[ \text{it} \ qE = qvB \]
\[ E = vB \quad \ldots (ii) \]
From equation (i) & (ii)
\[ m = \frac{qB^2R}{E} \]
\[ m = 2.0 \times 10^{-24} \text{ kg} \]