

**Date:** 18<sup>th</sup> March 2021 (Shift-1)

**Subject:** Physics

## Section - A

**1. In a series LCR resonance circuit, if we change the resistance only, from a lower to higher value :**

- |                                                                                                                                 |                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| <p>a. The resonance frequency will increase.</p> <p>c. The quality factor and the resonance frequency will remain constant.</p> | <p>b. The quality factor will increase.</p> <p>d. The bandwidth of resonance circuit will increase.</p> |
|---------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|

**Answer (d)**

**Sol.**  $\omega_f = \frac{1}{\sqrt{LC}}$  frequency will not change

$$\omega = \frac{\omega L}{R} \quad R \uparrow \quad Q \downarrow$$

$$\omega = \frac{\omega L}{R} = \frac{\omega}{\Delta B}$$

$$\Delta B = \frac{R}{L} \quad R \uparrow \quad \Delta B \uparrow$$

So, bandwidth of resonance circuit will increase.

**2. A radioactive sample disintegrates via two independent decay processes having half lives  $T_{\frac{1}{2}}^{(1)}$  and  $T_{\frac{1}{2}}^{(2)}$  respectively. The effective half – life,  $T_{\frac{1}{2}}$  of the nuclei is:**

a. None of the above

b.  $T_{\frac{1}{2}} = T_{\frac{1}{2}}^{(1)} + T_{\frac{1}{2}}^{(2)}$

c.  $T_{\frac{1}{2}} = \frac{T_{\frac{1}{2}}^{(1)} + T_{\frac{1}{2}}^{(2)}}{T_{\frac{1}{2}}^{(1)} - T_{\frac{1}{2}}^{(2)}}$

d.  $T_{\frac{1}{2}} = \frac{T_{\frac{1}{2}}^{(1)} T_{\frac{1}{2}}^{(2)}}{T_{\frac{1}{2}}^{(1)} + T_{\frac{1}{2}}^{(2)}}$

**Answer (d)**

**Sol.**  $\left(-\frac{dN}{dt}\right) = N\lambda_1, \left(-\frac{dN}{dt}\right) = N\lambda_2$

$$\frac{dN}{dt} = \left(\frac{dN}{dt}\right)_1 + \left(\frac{dN}{dt}\right)_2$$

$$N\lambda_{\text{eff}} = N\lambda_1 + N\lambda_2$$

$$\frac{1}{T_{\frac{1}{2}}} = \frac{1}{T_{\frac{1}{2}}^{(1)}} + \frac{1}{T_{\frac{1}{2}}^{(2)}}$$

$$T_{\frac{1}{2}} = \frac{T_{\frac{1}{2}}^{(1)} T_{\frac{1}{2}}^{(2)}}{T_{\frac{1}{2}}^{(1)} + T_{\frac{1}{2}}^{(2)}}$$

3. In the experiment of Ohm's law, a potential difference of 5.0 V is applied across the end of a conductor of length 10.0 cm and diameter of 5.00 mm. The measured current in the conductor is 2.00 A. The maximum permissible percentage error in the resistivity of the conductor is:
- a. 7.5 b. 3.9  
 c. 8.4 d. 3.0

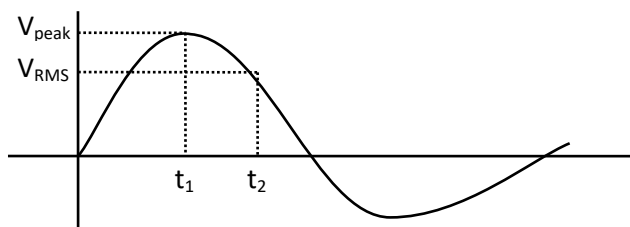
**Answer (b)**

**Sol.**  $V = IR$   
 $R = \rho \frac{\ell}{A}$   
 $V = I \left( \frac{\rho \ell}{A} \right)$   
 $\rho = \frac{VA}{I\ell}$   
 $A = \frac{\pi d^2}{4}$   
 $\frac{\Delta \rho}{\rho} = \frac{\Delta V}{V} + \frac{\Delta I}{I} + \frac{\Delta \ell}{\ell} + 2 \frac{\Delta d}{d}$   
 $= \frac{0.1}{5} + \frac{0.01}{2} + \frac{0.1}{10} + 2 \times \frac{0.01}{5}$   
 $\frac{\Delta \rho}{\rho} = 0.02 + 0.005 + 0.01 + 0.004$   
 $\frac{\Delta \rho}{\rho} = 0.039$   
 $\frac{\Delta \rho}{\rho} \times 100 = 0.039 \times 100 = 3.9\%$

4. An AC source rated 220V, 50 Hz is connected to a resistor. The time taken by the current to change from its maximum to the rms value is:
- a. 0.25 ms b. 25 ms  
 c. 2.5 ms d. 2.5 s

**Answer. (C)**

**Sol.**



$$V = V_0 \sin \omega t = 220\sqrt{2} \sin(100\pi t_1)$$

$$\omega = 2\pi f$$

$$220\sqrt{2} = 220\sqrt{2} \sin(100\pi t_1)$$

$$1 = \sin(100\pi t_1)$$

$$\frac{\pi}{2} = 100\pi t_1$$

$$t_1 = \frac{1}{200}$$

$$\frac{200}{200\sqrt{2}} = \sin(100\pi t_2)$$

$$\frac{\pi}{4} = 100\pi t_2$$

$$t_2 = \frac{1}{400}$$

$$\Delta t = t_1 - t_2 = \frac{1}{200} - \frac{1}{400}$$

$$\Delta t = \frac{1}{400} \text{ sec} = 2.5 \text{ ms}$$

### II<sup>nd</sup> Method

Phase different b/w

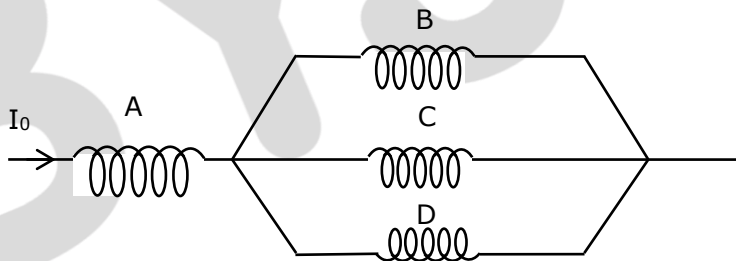
$$\text{Max \& RMS} = \frac{\pi}{4}$$

So,  $\Delta t = T/8$

$$\Delta t = \frac{1}{8 \times 50} = \frac{1}{400} \text{ sec}$$

$$\Delta t = 2.5 \text{ ms}$$

5. Four identical long solenoids A, B, C and D are connected to each other as shown in the figure. If the magnetic field at the center of A is 3 T, the field at the center of C would be: (Assume that the magnetic field is confined within the volume of respective solenoid.)



a. 6T

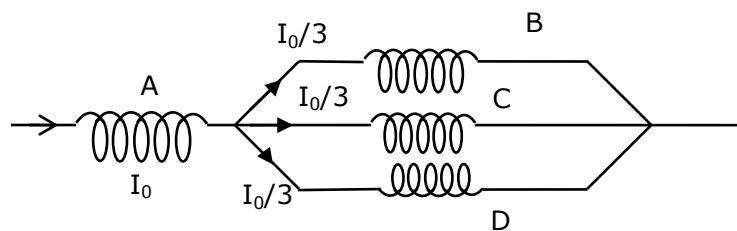
b. 12T

c. 1T

d. 9T

**Answer. (c)**

**Sol.**



$$B \propto i$$

$$\text{So, field at centre of C} = \frac{3}{3} = 1 \text{ T}$$

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B

6. A plane electromagnetic wave of frequency 100 MHz is travelling in vacuum along the x- direction. At a particular point in space and time,  $\vec{B} = 2.0 \times 10^{-8} \hat{k} \text{ T}$  (where,  $\hat{k}$  is unit vector along z – direction). What is  $\vec{E}$  at this point ? (speed of light  $c = 3 \times 10^8 \text{ m/s}$ )

a.  $0.6 \hat{j} \frac{\text{V}}{\text{m}}$

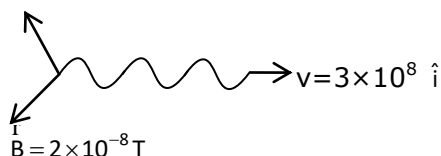
b.  $6.0 \hat{k} \text{ V/m}$

c.  $6.0 \hat{j} \text{ V/m}$

d.  $0.6 \hat{k} \text{ V/m}$

Answer. (c)

Sol.  $f = 100 \text{ MHz}$



$$\begin{aligned} \vec{E} &= \vec{B} \times \vec{V} \\ &= (2 \times 10^{-8} \hat{k}) \times (3 \times 10^8 \hat{i}) \\ &= 6 (\hat{k} \times \hat{i}) = 6 \hat{j} \text{ V/m} \\ \vec{E} &= 6 \hat{j} \text{ V/m} \end{aligned}$$

7. A particle is travelling, 4 times as fast as an electron. Assuming the ratio of de-Broglie wavelength of a particle to that of electron is 2:1, the mass of the particle is :

a.  $\frac{1}{16}$  times of mass of  $e^-$

b. 16 times the mass of  $e^-$

c.  $\frac{1}{8}$  times the mass of  $e^-$

d. 8 times the mass of  $e^-$

Answer. (c)

Sol.  $\lambda = \frac{h}{p} = \frac{h}{mv}$

$$\frac{\lambda_p}{\lambda_e} = \frac{\frac{h}{m_p v_p}}{\frac{h}{m_e v_e}} = \frac{m_e v_e}{m_p v_p}$$

$$\frac{2}{1} = \frac{m_e}{m_p} \times \frac{v_e}{4v_e}$$

$$m_p = \frac{m_e}{8}$$

$\frac{1}{8}$  times the mass of electron

8. What will be the average value of energy along one degree of freedom for an ideal gas in thermal equilibrium at a temperature  $T$ ? ( $k_B$  is Boltzmann constant)

- a.  $k_B T$  b.  $\frac{2}{3} k_B T$   
 c.  $\frac{3}{2} k_B T$  d.  $\frac{1}{2} k_B T$

**Answer.(d)**

**Sol.** Energy associated with each digress of freedom is  $\frac{1}{2} k_B T$ .

9. Your friend is having eye sight problem. She is not able to see clearly a distant uniform window mesh and it appears to her as non-uniform and distorted. The doctor diagnosed the problem as:

- a. Myopia and hypermetropia b. Astigmatism  
 c. Myopia with astigmatism d. Presbyopia with astigmatism

**Answer. (c)**

**Sol.** If distant objects are blurry then problem is Myopia.  
 If objects are distorted then problem is Astigmatism.

10. The time period of a simple pendulum is given by  $T = 2\pi \sqrt{\frac{l}{g}}$ . The measured value of the length of pendulum is 10 cm known to a 1 mm accuracy. The time for 200 oscillations of the pendulum is found to be 100 second using a clock of 1 s resolution. The percentage accuracy in the determination of 'g' using this pendulum is 'x'. The value of 'x' to the nearest integer is .

- a. 5% b. 4%  
 c. 3% d. 2%

**Answer (c)**

**Sol.**  $T = 2\pi \sqrt{\frac{l}{g}} \Rightarrow T^2 = 2\pi \left(\frac{l}{g}\right)$   
 $g = 2\pi \frac{l}{T^2}$   
 $\frac{\Delta g}{g} = \frac{\Delta l}{l} + \frac{2\Delta T}{T}$   
 $\frac{\Delta g}{g} = \frac{1 \times 10^{-3}}{10 \times 10^{-2}} + \frac{2 \times 1}{100}$   
 $\frac{\Delta g}{g} = 0.01 + 0.02 = 0.03$   
 $100 \times \frac{\Delta g}{g} = 0.03 \times 100 = 3\%$   
 $\frac{\Delta g}{g} \times 100 = 3\%$

11. An oil drop of radius 2 mm with a density  $3 \text{ g cm}^{-3}$  is held stationary under a constant electric field  $3.55 \times 10^5 \text{ V m}^{-1}$  in the Millikan's oil drop experiment. What is the number of excess electrons that the oil drop will possess? Consider  $g = 9.81 \text{ m/s}^2$

a.  $1.73 \times 10^{10}$

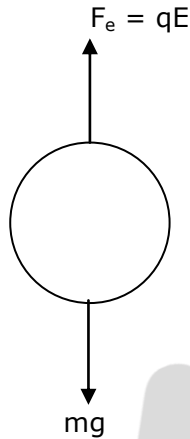
b.  $48.8 \times 10^{11}$

c.  $1.73 \times 10^{12}$

d.  $17.3 \times 10^{10}$

**Answer (a)**

**Sol.**



$$F_e = qE = (ne)E$$

$$F_e = mg$$

$$(ne)E = mg$$

$$n = \frac{mg}{eE} = \frac{\rho \frac{4}{3} \pi R^3 \times g}{eE}$$

$$n = \frac{3000 \times \frac{4}{3} \times 3.14 \times 8 \times 10^{-9} \times 9.8}{1.6 \times 10^{-19} \times 3.55 \times 10^5}$$

$$n = \frac{984704 \times 10^5}{5.68} = 1.73 \times 10^{10}$$

$$n = 1.73 \times 10^{10}$$

12. The time period of a satellite in a circular orbit of radius  $R$  is  $T$ . The period of another satellite in a circular orbit of radius  $9R$  is :

a.  $3T$

b.  $9T$

c.  $27T$

d.  $12T$

**Answer (c)**

**Sol.**  $T^2 \propto R^3$

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

$$\frac{T_1}{T_2} = \left(\frac{R}{9R}\right)^{\frac{3}{2}}$$

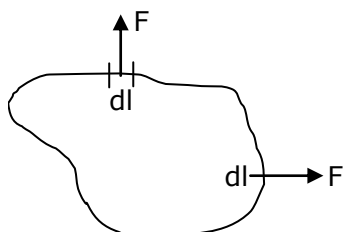
$$\frac{T}{T_2} = \frac{1}{27}$$

$$T_2 = 27T$$

- 13. A loop of flexible wire of irregular shape carrying current is placed in an external magnetic field. Identify the effect of the field on the wire**
- |                                                                                                                   |                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| a. Loop assumes circular shape with its plane parallel to the field<br>c. wire gets stretched to become straight. | b. shape of the loop remains unchanged<br>d. loop assumes circular shape with its plane normal to the field |
|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|

**Answer (d)**

**Sol.** Force on each small wire segment be along radially outward and equal so, it will take the shape of circle and parallel to the field.



- 14. In Young's double slit arrangement, slits are separated by a gap of 0.5 mm, and the screen is placed at a distance of 0.5 m from them. The distance between the first and the third bright fringe formed when the slits are illuminated by a monochromatic light of 5890 Å is:**
- |                                                          |                                                           |
|----------------------------------------------------------|-----------------------------------------------------------|
| a. $1178 \times 10^{-6}$ m<br>c. $5890 \times 10^{-7}$ m | b. $1178 \times 10^{-9}$ m<br>d. $1178 \times 10^{-12}$ m |
|----------------------------------------------------------|-----------------------------------------------------------|

**Answer (a)**

**Sol.**  $D = 0.5$  m  
 $d = 0.5$  mm  
 $\lambda = 5890 \text{ \AA}$

$$\begin{aligned} \text{Distance between first and third bright fringe} &= 2\beta = \frac{2\lambda D}{d} \\ &= 2 \times 5890 \times 10^{-10} \times \frac{0.5}{0.5 \times 10^{-3}} \\ &= 1178 \times 10^{-6} \text{ m} \end{aligned}$$

- 15. Match List - I with List - II**

List - I	List - II
(a) 10 km height over earth's surface	(i) Thermosphere
(b) 70 km height over earth's surface	(ii) Mesosphere
(c) 180 km height over earth's surface	(iii) stratosphere
(d) 270 km height over earth's surface	(iv) Troposphere

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- a. (a) – (ii), (b) – (i), (c) – (iv), (d) – (iii)  
c. (a) – (iii), (b) – (ii), (c) – (i), (d) – (iv)

- b. (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)  
d. (a) – (i), (b) – (iv), (c) – (iii), (d) – (ii)

**Answer (b)**

**Sol. Troposphere**

The troposphere starts at the Earth's surface and extends 8 to 14.5 kilometers high (6 to 9 miles).

**Stratosphere**

The stratosphere starts just above the troposphere and extends to 50 kilometers (31 miles) high.

**Mesosphere**

The mesosphere starts just above the stratosphere and extends to 85 kilometers (53 miles) high.

**Thermosphere**

The Thermosphere starts just above the mesosphere and extends to 600 kilometers (372 miles) high.

**Ionosphere**

The ionosphere is an abundant layer of electrons and ionized atoms and molecules that stretches from about 48 kilometres (30 miles) above the surface to the edge of space at about 965 km (600 mi).

**Exosphere**

This is the upper limit of our atmosphere. It extends from the top of the thermosphere up to 10000 km (6200mi).

- 16. A constant power delivering machine has towed a box, which was initially at rest, along a horizontal straight line. The distance moved by the box in time 't' is proportional to:**

- a. t  
c.  $t^{1/2}$   
b.  $t^{3/2}$   
d.  $t^{2/3}$

**Answer (b)**

**Sol.**  $\vec{P} = \vec{F} \cdot \vec{V} = |\vec{F}||\vec{V}|\cos\theta$

As force and velocity has same direction the angle between  $\vec{F}$  and  $\vec{V}$  is  $0^\circ$

$$P = \frac{mVdV}{dt}$$

$$\int_0^t P dt = m \int_0^V V dV$$

$$Pt = \frac{mV^2}{2}$$

$$V = \sqrt{\frac{2Pt}{m}}$$



$$\frac{dx}{dt} = \sqrt{\frac{2Pt}{m}}$$

$$\int dx = \int \sqrt{\frac{2Pt}{m}} dt$$

$$x \propto t^{3/2}$$

17. A thin circular ring of mass  $M$  and radius  $r$  is rotating about its axis with an angular speed  $\omega$ . Two particles having mass  $m$  each are now attached at diametrically opposite points. The angular speed of the ring will become:

a.  $\omega \frac{M}{M+2m}$

b.  $\omega \frac{M}{M+m}$

c.  $\omega \frac{M+2m}{M}$

d.  $\omega \frac{M-2m}{M+2m}$

**Answer (a)**

**Sol.**  $\tau_{\text{net}} = 0$ , so angular momentum is conserved

By angular momentum conservation

$$L_i \omega_i = L_f \omega_f$$

$$(MR^2)\omega = (MR^2 + 2mR^2)\omega_f$$

$$\omega_f = \frac{(MR^2)\omega}{MR^2 + 2mR^2} = \frac{M\omega}{M+2m}$$

$$\omega_f = \frac{M\omega}{M+2m}$$

18. Imagine that the electron in a hydrogen atom is replaced by a muon ( $\mu$ ). The mass of muon particle is 207 times that of an electron and charge is equal to the charge of an electron. The ionization potential of this hydrogen atom will be:

a. 27.2 eV

b. 331.2 eV

c. 13.6 eV

d. 2815.2 eV

**Answer. (d)**

**Sol.**  $E \propto \frac{1}{r}$

$$r \propto \frac{1}{m}$$

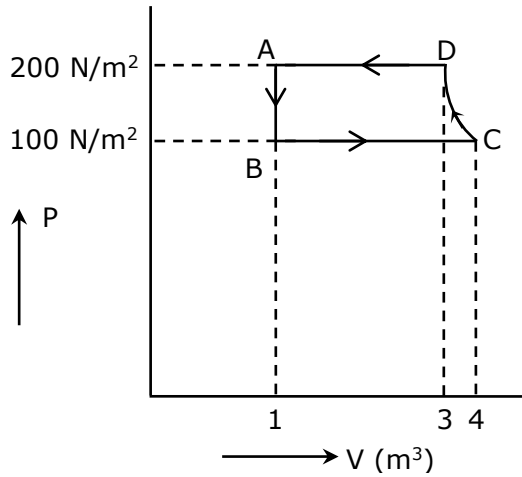
$$E \propto m$$

$$\text{Ionization potential} = 13.6 \times \frac{(\text{mass}_\mu)}{(\text{mass}_e)} \text{ eV}$$

$$= 13.6 \times 207 \text{ eV} = 2815.2 \text{ eV}$$

19. The P-V diagram of a diatomic ideal gas system going under cyclic process as shown in figure. The work done during an adiabatic process CD is (use  $\gamma = 1.4$ ):

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- a. 200 J  
c. - 400 J

- b. -500 J  
d. 400 J

**Answer (b)**

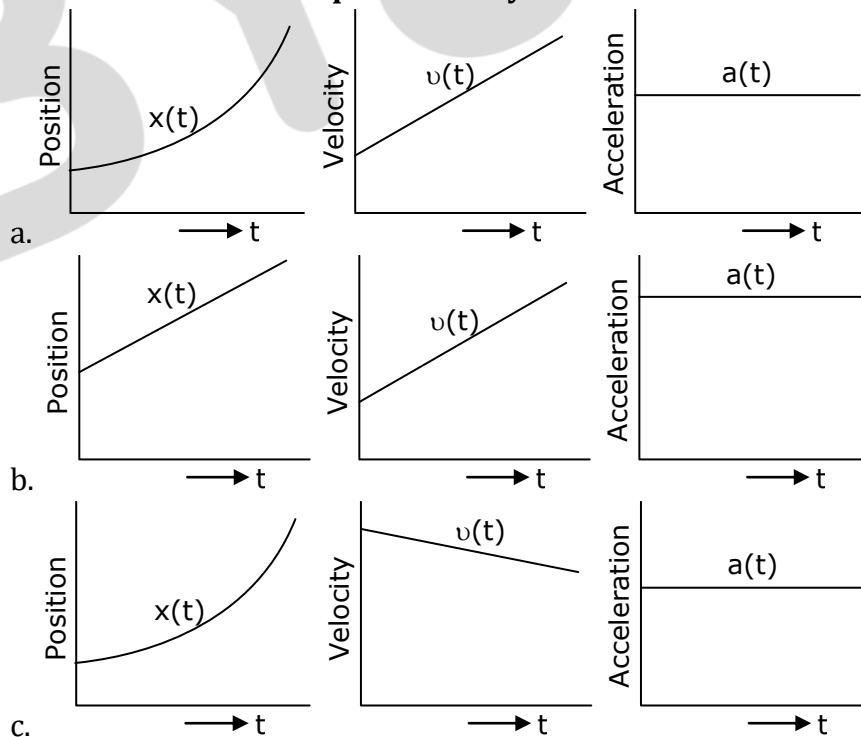
**Sol.** work done for adiabatic process is

$$W_{CD} = \frac{nR\Delta T}{1-\gamma} = \frac{p_f v_f - p_i v_i}{1-\gamma} = \frac{200 \times 3 - 4 \times 100}{1-1.4}$$

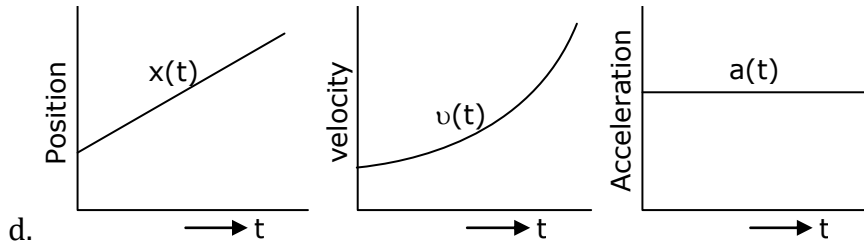
$$W_{CD} = \frac{600-400}{-0.4} = -\frac{200}{0.4} = -500 \text{ J}$$

$$W_{CD} = -500 \text{ J}$$

**20. The position, velocity and acceleration of a particle moving with a constant acceleration can be represented by:**



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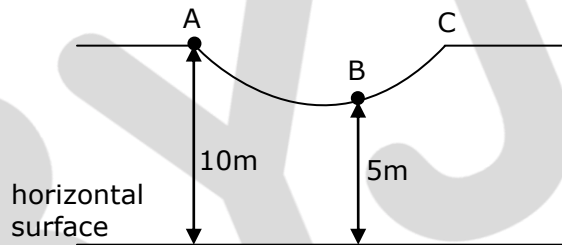


**Answer (a)**

**Sol.** Acceleration is constant  
 $a = \text{constant}$   
 $v \propto t$  (straight line graph)  
 $x \propto t^2$  (parabolic graph)

## SECTION-B

1. As shown in the figure, a particle of mass 10 kg is placed at a point A. When the particle is slightly displaced to its right, it starts moving and reaches the point B. The speed of the particle at B is  $x$  m/s. (Take  $g = 10 \text{ m/s}^2$ ) The value of 'x' to the nearest integer is \_\_\_\_\_.



**Answer (10)**

**Sol.** Take horizontal surface as reference level for gravitational potential energy  
 By energy conservation

$$K_i + U_i = K_f + U_f$$

$$0 + 10 \times 10 \times 10 = \frac{1}{2} \times 10 \times v_B^2 + 10 \times 10 \times 5$$

$$1000 = 5v_B^2 + 500$$

$$v_B^2 = \frac{500}{5} = 100$$

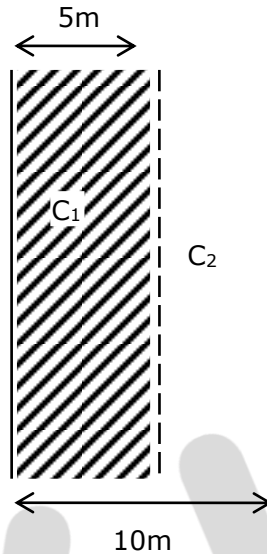
$$v_B = 10 \text{ m/s}$$

$$x = 10$$

2. A parallel plate capacitor has plate area  $100 \text{ m}^2$  and plate separation of  $10 \text{ m}$ . The space between the plates is filled up to a thickness  $5 \text{ m}$  with a material of dielectric constant of  $10$ . The resultant capacitance of the system is 'x' pF. The value of  $\epsilon_0 = 8.85 \times 10^{-12} \text{ F.m}^{-1}$ . The value of 'x' to the nearest integer is \_\_\_\_\_.

**Answer. (161)**

**Sol.** Area = 100 m<sup>2</sup>  
 Separation (d) = 10 m  
 Thickness = 5 m  
 Dielectric constant (K) = 10



$$C_1 = \frac{KA\epsilon_0}{d}, C_2 = \frac{A\epsilon_0}{d}$$

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2} = \frac{\frac{KA\epsilon_0}{d} \times \frac{A\epsilon_0}{d}}{\frac{KA\epsilon_0}{d} + \frac{A\epsilon_0}{d}}$$

$$C_{eq} = \frac{KA^2\epsilon_0^2}{d^2} \times \frac{d}{A\epsilon_0(1+K)}$$

$$C_{eq} = \frac{KA\epsilon_0}{d(1+K)} = \frac{10 \times 100 \times 8.85 \times 10^{-12}}{5(1+10)}$$

$$C_{eq} = \frac{8.85 \times 10^{-9}}{55} = 0.1609090 \times 10^{-9} \text{ F}$$

$$C_{eq} = 160.90 \times 10^{-12} \text{ F}$$

$$C_{eq} = 161 \text{ pF}$$

**3. An npn transistor operates as a common emitter amplifier with a power gain of 10<sup>6</sup>. The input circuit resistance is 100 Ω and the output load resistance is 10 kΩ. The common emitter current gain 'β' will be \_\_\_\_\_. (Round off to the nearest integer)**

**Answer. (100)**

**Sol.** Power gain = 10<sup>6</sup>  
 Input resistance = 100 Ω  
 Output load resistance = 10 kΩ  
 Power gain = β<sup>2</sup> ×  $\frac{r_{out}}{r_{in}}$

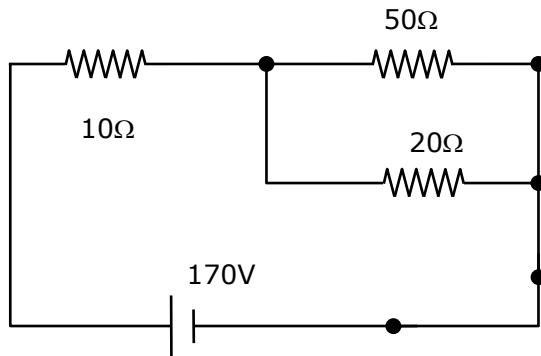
$$10^6 = \beta^2 \times \frac{10 \times 10^3}{100}$$

$$\beta^2 = 10^4 \Rightarrow \beta = 100$$

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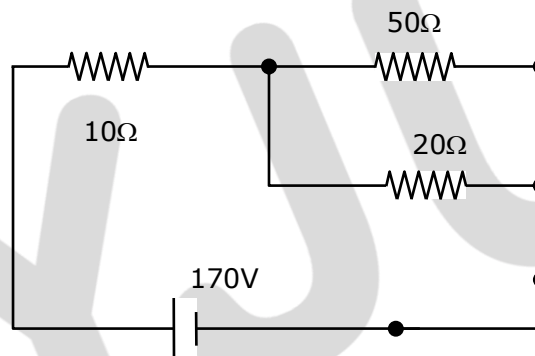
4. The voltage across the  $10\ \Omega$  resistor in the given circuit is  $x$  volt.



The value of 'x' to the nearest integer is \_\_\_\_\_.

**Answer. (70)**

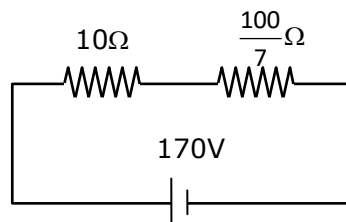
**Sol.**



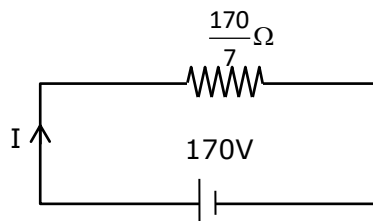
Equivalent resistance of  $50\ \Omega$  and  $20\ \Omega$

$$R_{eq} = \frac{50 \times 20}{50 + 20}$$

$$R_{eq} = \frac{1000}{70} = \frac{100}{7}\ \Omega$$



$$R_{eq} = 10 + \frac{100}{7} = \frac{170}{7}\ \Omega$$



$$I = \frac{V}{R} = \frac{170}{170/7}$$

$$I = 7 \text{ A}$$

Potential Across  $10 \Omega$  resistor

$$V_{10} = IR = 7 \times 10 = 70 \text{ V}$$

$$V_{10} = 70 \text{ V}$$

5. Two separate wires A and B are stretched by 2 mm and 4 mm respectively, when they are subjected to a force of 2 N . Assume that both the wires are made up of same material and the radius of wire B is 4 times that of the radius of wire A. The length of the wires A and B are in the ratio of a:b, Then  $\frac{a}{b}$  can be expressed as  $\frac{1}{x}$  where x is .

**Answer. (32)**

**Sol.**  $F_A = F_B$

$$r_B = 4r_A$$

$$\Delta l_a = 2 \text{ mm}$$

$$\Delta l_B = 4 \text{ mm}$$

$$Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{\Delta l/l}$$

$$\frac{\Delta l}{l} = \frac{F}{AY}$$

$$l = \frac{AY\Delta l}{F}$$

$$\frac{l_a}{l_b} = \frac{\pi r_a^2 \times Y \times \Delta l_a \times F}{\pi r_b^2 \times Y \times \Delta l_b \times F}$$

$$\frac{l_a}{l_b} = \frac{r_a^2 \times \Delta l_a}{r_b^2 \times \Delta l_b} = \frac{r_a^2 \times 2}{(4r_a)^2 \times 4} = \frac{r_a^2}{16r_a^2 \times 2}$$

$$\frac{l_a}{l_b} = \frac{1}{32}$$

$$x = 32$$

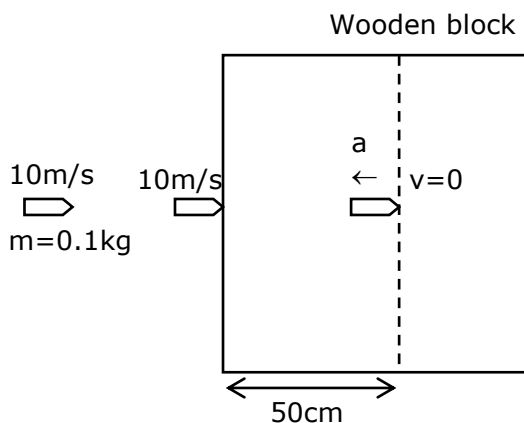
6. A bullet of mass 0.1 kg is fired on a wooden block to pierce through it, but it stops after moving a distance of 50 cm into it. If the velocity of bullet before hitting the wood is 10 m/s and it slows down with uniform deceleration, then the magnitude of effective retarding force on the bullet is 'x' N. The value of 'x' to the nearest integer is

**Answer. (10)**

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Sol.  $M_{\text{bullet}} = 0.1\text{kg}$



$$v^2 = 10^2 + 2(-a) \times 0.5$$

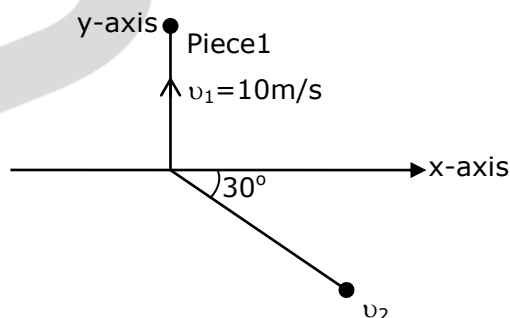
$$0 = (10)^2 - 2a \times (0.5)$$

$$\text{Retardation (a)} = \frac{100}{2 \times 0.5} = 100\text{m/s}^2$$

$$\text{Retarding force (F)} = ma = 0.1 \times 100$$

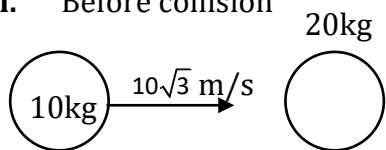
$$F = 10\text{N}$$

7. A ball of mass 10 kg moving with a velocity  $10\sqrt{3}$  m/s along the x-axis, hits another ball of mass 20 kg which is at rest. After the collision, first ball comes to rest while the second ball disintegrates into two equal pieces. One piece starts moving along y-axis with a speed of 10 m/s. The second piece starts moving at an angle of  $30^\circ$  with respect to the x - axis. The velocity of the ball moving at  $30^\circ$  with x-axis is x m/s. The configuration of pieces after collision is shown in the figure below. The value of x to the nearest integer is



**Answer. (20)**

Sol. Before collision



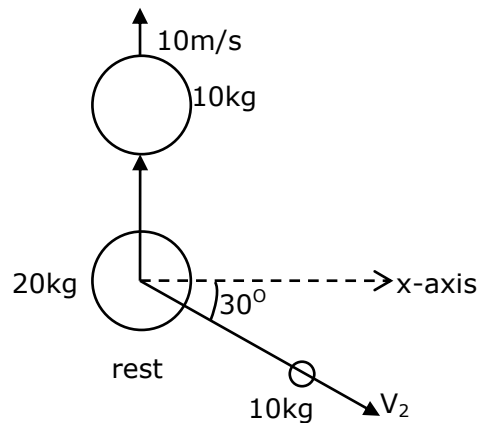
In x - direction

$$P_i = 10 \times 10\sqrt{3} + 20 \times 0$$

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$P_i = 100\sqrt{3} \text{ kg m/s}$   
After collision



In x - direction

$$P_f = 10 \times v_2 \cos 30^\circ$$

In y direction

$$P_f = 10 \times 10 - 10 v_2 \sin 30^\circ$$

$$P_f = 100 - 5v_2$$

Apply momentum conservation in x-direction

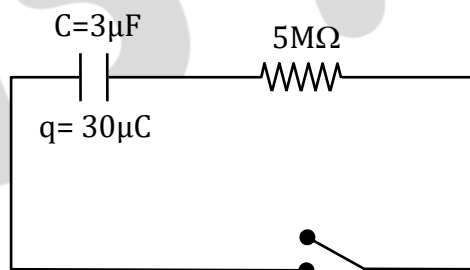
$$P_i = p_f$$

$$100\sqrt{3} = \frac{10\sqrt{3}}{2} v_2$$

$$v_2 = 20 \text{ m/s}$$

So, answer is  $v_2 = 20 \text{ m/s}$

8.

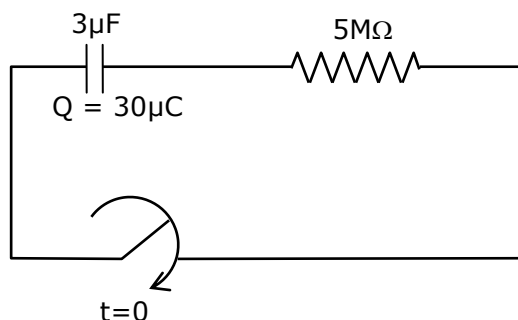


The circuit shown in the figure consists of a charged capacitor of capacity  $3 \mu\text{F}$  and a charge of  $30 \mu\text{C}$ . At time  $t = 0$ , when the key is closed, the value of current flowing through the  $5\text{M}\Omega$  resistor is 'x'  $\mu\text{A}$ . The value of 'x' to the nearest integer is \_\_\_\_\_.

Answer (b)

Sol.





$$Q = Q_0 e^{-t/RC}$$

$$I = \frac{Q_0}{RC} e^{-t/RC}$$

$$Q_0 = 30 \times 10^{-6} \text{ C}$$

$$C = 3 \times 10^{-6} \text{ F}$$

$$\text{at } t = 0, I = \frac{Q_0}{RC} e^{-0/RC}$$

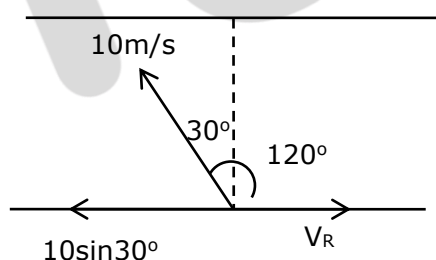
$$I = \frac{Q}{RC} = \frac{30}{5 \times 10^6 \times 3} = 2 \times 10^{-6} \text{ A}$$

$$I = 2 \mu\text{A}$$

9. A person is swimming with a speed of 10 m/s at an angle of  $120^\circ$  with the flow and reaches to a point directly opposite on the other side of the river. Then speed of the flow is 'x' m/s. The value of 'x' to the nearest integer is \_\_\_\_.

Answer. (5)

Sol.



Velocity along the river

$$V_R = 10 \sin 30^\circ$$

$$V_R = \frac{10}{2} = 5 \text{ m/s}$$

$$V_R = 5 \text{ m/s}$$

10. A particle performs simple harmonic motion with a period of 2 second. The time taken by the particle to cover a displacement equal to half of its amplitude from the mean position is  $\frac{1}{a}$  s. The value of 'a' to the nearest integer is \_\_\_\_.

Answer. (6)

Sol. Time period (T) = 2 sec.

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$$x = A \sin (\omega t + \phi) \quad (\phi = 0 \text{ at M.P.})$$

$$\frac{A}{2} = A \sin\left(\frac{2\pi}{T}t\right)$$

$$\frac{2\pi}{T}t = \frac{\pi}{6}$$

$$t = \frac{1}{6} \text{ s}$$

$$a = 6$$

BYJU'S