

**PHYSICS**

**SECTION - A**

**Multiple Choice Questions:** This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

**Choose the correct answer:**

- Every planet revolves around the sun in an elliptical orbit:
  - The force acting on a planet is inversely proportional to square of distance from sun.
  - Force acting on planet is inversely proportional to product of the masses of the planet and the sun.
  - The Centripetal force acting on the planet is directed away from the sun.
  - The square of time period of revolution of planet around sun is directly proportional to cube of semi-major axis of elliptical orbit.

Choose the correct answer from the options given below:

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

**Answer (4)**

**Sol.** A is correct because  $F = \frac{Gm_1m_2}{r^2}$

D is correct because  $T^2 \propto r^3$

$\therefore$  A and D are correct

2. Match List I with List II

	List I		List II
A.	Isothermal Process	I.	Work done by the gas decreases internal energy
B.	Adiabatic Process	II.	No change in internal energy
C.	Isochoric Process	III.	The heat absorbed goes partly to increase internal energy and partly to do work
D.	Isobaric Process	IV.	No work is done on or by the gas

Choose the correct answer from the options given below:

- (1) A-I, B-II, C-III, D-IV    (2) A-I, B-II, C-IV, D-III  
(3) A-II, B-I, C-IV, D-III    (4) A-II, B-I, C-III, D-IV

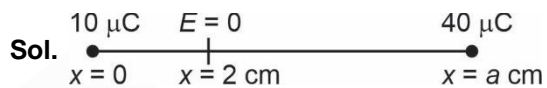
**Answer (3)**

- Sol.** A. Isothermal process  $\rightarrow$  II ( $\Delta U = 0$ )  
 B. Adiabatic process  $\rightarrow$  I ( $\Delta Q = 0$ )  
 C. Isochoric process  $\rightarrow$  IV ( $w = 0$ )  
 D. Isobaric process  $\rightarrow$  III ( $\Delta Q = \Delta U + w$ )

3. A point charge of  $10 \mu\text{C}$  is placed at the origin. At what location on the X-axis should a point charge of  $40 \mu\text{C}$  be placed so that the net electric field is zero at  $x = 2 \text{ cm}$  on the X-axis?

- (1)  $x = 8 \text{ cm}$                       (2)  $x = 6 \text{ cm}$   
(3)  $x = -4 \text{ cm}$                     (4)  $x = 4 \text{ cm}$

**Answer (2)**



$\therefore E_{x=2 \text{ cm}} = 0$

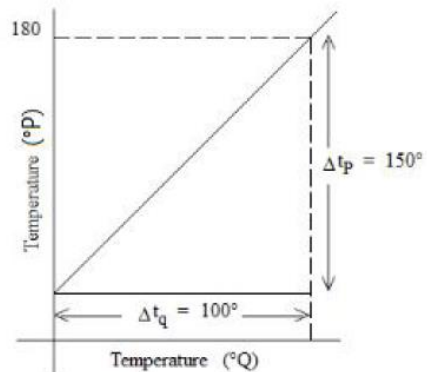
$$\frac{1}{4\pi\epsilon_0} \frac{(10 \mu\text{C})}{(2 \text{ cm})^2} = \frac{1}{4\pi\epsilon_0} \frac{(40 \mu\text{C})}{[(a-2) \text{ cm}]^2}$$

$$\Rightarrow \left(\frac{a-2}{2}\right)^2 = 4$$

$$\Rightarrow \frac{a-2}{2} = 2$$

$$\boxed{a = 6 \text{ cm}}$$

4. The graph between two temperature scales P and Q is shown in the figure. Between upper fixed point and lower fixed point there are 150 equal divisions of scale P and 100 divisions on scale Q. The relationship for conversion between the two scales is given by:



(1)  $\frac{t_P}{180} = \frac{t_Q - 40}{100}$                       (2)  $\frac{t_Q}{100} = \frac{t_P - 30}{150}$

(3)  $\frac{t_P}{100} = \frac{t_Q - 180}{150}$                       (4)  $\frac{t_P}{150} = \frac{t_P - 180}{150}$

**Answer (2)**

Sol. From graph, we can say that.

$$\frac{t_P - 30}{150} = \frac{t_Q - 0}{100}$$

5. Given below are two statements:

**Statement I:** Stopping potential in photoelectric effect does not depend on the power of the light source.

**Statement II:** For a given metal, the maximum kinetic energy of the photoelectron depends on the wavelength of the incident light.

In the light of above statements, choose the most appropriate answer from the options given below.

- (1) Both Statement I and statement II are correct
- (2) Statement I is correct but statement II is incorrect
- (3) Both Statement I and Statement II are incorrect
- (4) Statement I is incorrect but statement II is correct

**Answer (1)**

Sol. **Statement I** is correct as stopping potential is independent of power of light used.

**Statement II** is correct as maximum kinetic energy of photoelectron depends on wavelength of light.

6. The light rays from an object have been reflected towards an observer from a standard flat mirror, the image observed by the observer are: -

- A. Real
- B. Erect
- C. Smaller in size than object
- D. Laterally inverted

Choose the *most appropriate* answer from the options given below:

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

**Answer (1)**

Sol. The image will be **erect** and **laterally inverted**.

7. Two objects are projected with same velocity 'u' however at different angles  $\alpha$  and  $\beta$  with the horizontal. If  $\alpha + \beta = 90^\circ$ , the ratio of horizontal range of the first object to the 2nd object will be :

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

**Answer (4)**

Sol. Both the objects will have the same range because,  $\alpha + \beta = 90^\circ$ . i.e.,  $\alpha, \beta$  are complementary angles.

8. Match List I with List II

List I		List II	
A.	Troposphere	I.	Approximate 65-75 km over Earth's surface
B.	E-Part of Stratosphere	II.	Approximate 300 km over Earth's surface
C.	F <sub>2</sub> -Part of Thermosphere	III.	Approximate 10 km over Earth's surface
D.	D-Part of Stratosphere	IV.	Approximate 100 km over Earth's surface

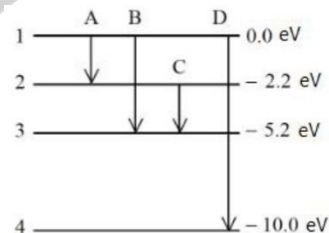
Choose the correct answer from the options given below:

- (1) A-III, B-II, C-I, D-IV
- (2) A-I, B-II, C-IV, D-III
- (3) A-I, B-IV, C-III, D-II
- (4) A-III, B-IV, C-II, D-I

**Answer (4)**

Sol. → 10 km over Earth's surface – Troposphere  
 → 100 km over Earth's surface – E-part of stratosphere  
 → 300 km over Earth's surface – F<sub>2</sub>-part of thermosphere  
 → 65-75 km over Earth's surface – D-part of stratosphere

9. The energy levels of an atom is shown in figure.



Which one of these transitions will result in the emission of a photon of wavelength 124.1 nm?

Given ( $h = 6.62 \times 10^{-34}$  Js)

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

**Answer (1)**

Sol.  $\therefore \lambda = \frac{hc}{\Delta E}$

$$\lambda = \frac{1240}{10} \text{ nm}$$

$$\approx 124 \text{ nm.}$$

$\therefore$  D is the transition required.

10. For a moving coil galvanometer, the deflection in the coil is 0.05 rad when a current of 10 mA is passed through it. If the torsional constant of suspension wire is  $4.0 \times 10^{-5} \text{ N m rad}^{-1}$ , the magnetic field is 0.01 T and the number of turns in the coil is 200, the area of each turn (in  $\text{cm}^2$ ) is :

- (1) 1.0 (2) 0.5  
(3) 2.0 (4) 1.5

**Answer (1)**

$$\text{Sol. } \therefore \theta = \left( \frac{NBA}{K} \right) I$$

$$A = \frac{\theta K}{NB I}$$

$$= \frac{0.05 \times 4 \times 10^{-5}}{(200) \times (0.01) \times (10 \times 10^{-3})}$$

$$= 1 \text{ cm}^2$$

11. A particle executes simple harmonic motion between  $x = -A$  and  $x = +A$ . If time taken by particle to go from  $x = 0$  to  $\frac{A}{2}$  is 2 s; then time taken by

particle in going from  $x = \frac{A}{2}$  to  $A$  is

- (1) 3 s (2) 2 s  
(3) 1.5 s (4) 4 s

**Answer (4)**

$$\text{Sol. } x = A \sin(\omega t)$$

$$x = \frac{A}{2} = A \sin(\omega t)$$

$$\frac{1}{2} = \sin(\omega t)$$

$$t = \left( \frac{\pi}{6\omega} \right) = 2$$

$$\boxed{\frac{\pi}{\omega} = 12 \text{ sec}}$$

$$x = A = A \sin(\omega t)$$

$$\omega t = \left( \frac{\pi}{2} \right)$$

$$t = \left( \frac{\pi}{2\omega} \right) = 6 \text{ second}$$

$$\text{time} = 6 - 2 = 4 \text{ seconds}$$

12. A wire of length 1 m moving with velocity 8 m/s at right angles to a magnetic field of 2 T. The magnitude of induced emf, between the ends of wire will be \_\_\_\_\_

- (1) 20 V (2) 16 V  
(3) 8 V (4) 12 V

**Answer (2)**

$$\text{Sol. } \varepsilon = Bv l$$

$$= 2 \times 8 \times 1$$

$$= 16 \text{ V}$$

13. The distance travelled by a particle is related to time  $t$  as  $x = 4t^2$ . The velocity of the particle at  $t = 5$  s is:

- (1)  $8 \text{ ms}^{-1}$  (2)  $20 \text{ ms}^{-1}$   
(3)  $40 \text{ ms}^{-1}$  (4)  $25 \text{ ms}^{-1}$

**Answer (3)**

$$\text{Sol. } x = 4t^2$$

$$\frac{dx}{dt} = 8t$$

$$v \text{ at } t = 5 \text{ s} = 40 \text{ m/s}$$

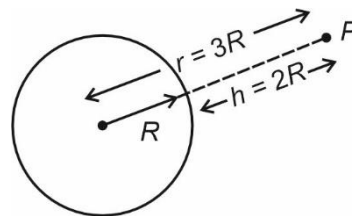
14. A body of mass is taken from earth surface to the height  $h$  equal to twice the radius of earth ( $R_e$ ), the increase in potential energy will be:

( $g$  = acceleration due to gravity on the surface of Earth)

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

**Answer (3)**

**Sol.**



$$V_{\text{surface}} = - \left( \frac{GMm}{R_e} \right)$$

$$V_p = - \frac{GMm}{3R_e}$$

$$\Delta V = \frac{GMm}{R_e} \left( 1 - \frac{1}{3} \right)$$

$$= \frac{2}{3} \frac{GMm}{R_e^2} \times R_e$$

$$\Delta V = \frac{2}{3} mgR_e$$

15. Match List I with List II

	List I		List II
A.	Young's Modulus ( $Y$ )	I.	$[ML^{-1}T^{-1}]$
B.	Co-efficient of Viscosity ( $\eta$ )	II.	$[ML^2T^{-1}]$
C.	Planck's Constant ( $h$ )	III.	$[ML^{-1}T^{-2}]$
D.	Work Function ( $\phi$ )	IV.	$[ML^2T^{-2}]$

Choose the correct answer from the options given below:

- (1) A-I, B-II, C-III, D-IV (2) A-III, B-I, C-II, D-IV  
(3) A-II, B-III, C-IV, D-I (4) A-I, B-III, C-IV, D-II

**Answer (2)**

**Sol.** (A)  $[Y] = \left[ \frac{MLT^{-2}}{L^2} \right] = [ML^{-1}T^{-2}] \dots(III)$

$$\frac{F}{A} = \eta \left( \frac{dV}{dY} \right)$$

(B)  $[\eta] = \left[ \frac{MLT^{-2} \times L}{L^2 \times LT^{-1}} \right] = [ML^{-1}T^{-1}] \dots(I)$

$$h\nu = E = [ML^2T^{-2}]$$

(C)  $[h] = [ML^2T^{-1}] \dots II$

(D)  $\phi = [ML^2T^{-2}] \dots IV$

16. Match List I with List II

	List I		List II
A.	Gauss's Law in Electrostatics	I.	$\oint \vec{E} \cdot d\vec{l} = -\frac{d\phi_B}{dt}$
B.	Faraday's Law	II.	$\oint \vec{B} \cdot d\vec{A} = 0$
C.	Gauss's Law in Magnetism	III.	$\oint \vec{B} \cdot d\vec{l} = \mu_0 i_c + \mu_0 \epsilon_0 \frac{d\phi_E}{dt}$
D.	Ampere-Maxwell Law	IV.	$\oint \vec{E} \cdot d\vec{s} = \frac{q}{\epsilon_0}$

Choose the correct answer from the options given below.

- (1) A-II, B-III, C-IV, D-I  
(2) A-III, B-IV, C-I, D-II  
(3) A-IV, B-I, C-II, D-III  
(4) A-I, B-II, C-III, D-IV

**Answer (3)**

**Sol.** Gauss's law  $\oint \vec{E} \cdot d\vec{s} = \frac{q}{\epsilon_0} \quad (A \rightarrow IV)$

Faraday's law  $\oint \vec{E} \cdot d\vec{l} = -\frac{d\phi_B}{dt} \quad (B \rightarrow I)$

Gauss's law in magnetism  $\oint \vec{B} \cdot d\vec{A} = 0 \quad (C \rightarrow II)$

Ampere's-Maxwell law  $\oint \vec{B} \cdot d\vec{l} = \mu_0 i_c + \mu_0 \epsilon_0 \frac{d\phi_E}{dt} \quad (D \rightarrow III)$

17. According to law of equipartition of energy the molar specific heat of a diatomic gas at constant volume where the molecule has one additional vibrational mode is

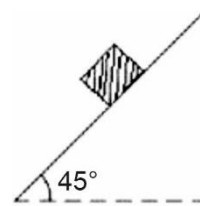
- (1)  $\frac{3}{2}R$  (2)  $\frac{7}{2}R$   
(3)  $\frac{9}{2}R$  (4)  $\frac{5}{2}R$

**Answer (2)**

**Sol.** According to the equipartition of energy degree of freedom of diatomic gas is  $f = 7$ , (2 degree of freedom is added for every vibrational mode) So,

$$C_v = \frac{f}{2}R = \frac{7R}{2}$$

18. Consider a block kept on an inclined plane (inclined at  $45^\circ$ ) as shown in the figure. If the force required to just push it up the incline is 2 times the force required to just prevent it from sliding down, the coefficient of friction between the block and inclined plane ( $\mu$ ) is equal to



- (1) 0.60 (2) 0.25  
(3) 0.50 (4) 0.33

**Answer (4)**

**Sol.** Force required to push

$$F_1 = mg \sin \theta + \mu mg \cos \theta = \frac{mg}{\sqrt{2}}(1 + \mu)$$

Force required to prevent from sliding

$$F_2 = (mg \sin \theta - \mu mg \cos \theta) = \frac{mg}{\sqrt{2}}(1 - \mu)$$

Given  $F_1 = 2F_2$

$$1 + \mu = 2(1 - \mu)$$

$$\mu = \frac{1}{3} = 0.33$$

19. **Statement I:** When a Si sample is doped with Boron, it becomes P type and when doped by Arsenic it becomes N-type semiconductor such that P-type has excess holes and N-type has excess electrons.

**Statement II:** When such P-type and N-type semiconductors, are fused to make a junction, a current will automatically flow which can be detected with an externally connected ammeter.

In the light of above statements, choose the **most appropriate** answer from the options given below.

- (1) Both statement I and statement II are correct
- (2) Statement I is correct but statement II is incorrect
- (3) Both statement I and statement II are incorrect
- (4) Statement I is incorrect but statement II is correct

**Answer (2)**

**Sol.** Statement I is correct but in statement II we cannot detect the current through ammeter thus the statement II is incorrect.

20. The resistance of a wire is  $5 \Omega$ . It's new resistance in ohm if stretched to 5 times of its's original length will be

- (1) 25
- (2) 5
- (3) 125
- (4) 625

**Answer (3)**

**Sol.**  $R' = n^2 R$   
 $= 5^2 \times 5 \Omega$   
 $= 125 \Omega$

**SECTION - B**

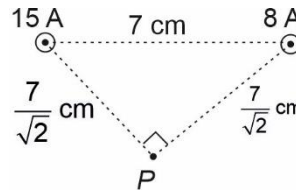
**Numerical Value Type Questions:** This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a **NUMERICAL VALUE**. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

21. Two long parallel wires carrying currents 8 A and 15 A in opposite directions are placed at a distance of 7 cm from each other. A point P is at equidistant from both the wires such that the lines joining the point P to the wires are perpendicular to each other. The magnitude of magnetic field at P is \_\_\_\_\_  $\times 10^{-6}$  T.

(Given :  $\sqrt{2} = 1.4$ )

**Answer (68)**

**Sol.** From question



$$\vec{B}_{15A} = \frac{\mu_0 \times 15}{2\pi \left(\frac{7}{\sqrt{2}} \text{ cm}\right)}, \quad \vec{B}_{8A} = \frac{\mu_0 \times 8}{2\pi \left(\frac{7}{\sqrt{2}} \text{ cm}\right)}$$

$\vec{B}_{15A}$  &  $\vec{B}_{8A}$  are perpendicular to each other.

Hence  $\vec{B}_P = \vec{B}_{15A} + \vec{B}_{8A}$

$$= \sqrt{(B_{15A})^2 + (B_{8A})^2}$$

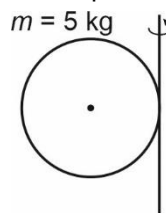
$$= \frac{\mu_0}{2\pi \left(\frac{7}{\sqrt{2}} \text{ cm}\right)} \sqrt{18^2 + 8^2} = \frac{\mu_0 17}{2\pi \times \left(\frac{7}{\sqrt{2}}\right) \times 10^{-2}}$$

$$= \frac{4\pi \times 17 \times 10^{-7}}{2\pi \times \frac{7}{\sqrt{2}} \times 10^{-2}} = 68 \times 10^{-6}$$

22. If a solid sphere of mass 5 kg and a disc of mass 4 kg have the same radius. Then the ratio of moment of inertia of the disc about a tangent in its plane to the moment of inertia of the sphere about its tangent will be  $\frac{x}{7}$ . Then the value of x is \_\_\_\_\_

**Answer (5)**

**Sol.** Solid sphere



$$I_{\text{tangent}} = I_{\text{cm}} + mR^2$$

$$= \frac{2}{5} mR^2 + mR^2 = \frac{7}{5} mR^2$$

$$= 7R^2 \quad (m = 5 \text{ kg})$$

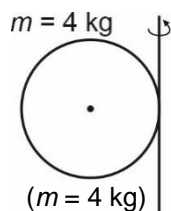
$$I_{disc} = I_{cm} + mR^2$$

$$= \frac{mR^2}{4} + mR^2$$

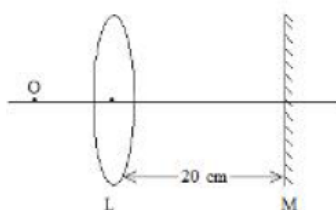
$$= \frac{5}{4}mR^2$$

$$= 5R^2$$

$$\frac{I_{disc}}{I_{tangent}} = \frac{5}{7}$$

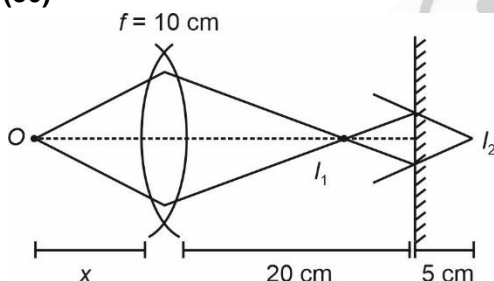


23. An object is placed on the principal axis of convex lens of focal length 10 cm as shown. A plane mirror is placed on the other side of lens at a distance of 20 cm. The image produced by the plane mirror is 5 cm inside the mirror. The distance of the object from the lens is \_\_\_\_\_ cm



**Answer (30)**

**Sol.**



From diagram

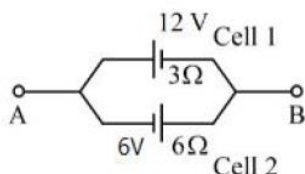
$I_1$  is image formed by lens and  $I_2$  is image formed by mirror.

Location of  $I_1$  and  $I_2$  from mirror will be equal = 5 cm  
Hence  $I_1 = 15$  cm from lens

$$\text{From } \frac{1}{v} - \frac{1}{u} = \frac{1}{10}; \quad u = -x, v = 15$$

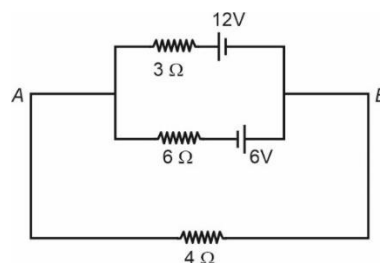
$$\frac{1}{x} = \frac{1}{10} - \frac{1}{15} \Rightarrow x = 30 \text{ cm}$$

24. Two cells are connected between points A and B as shown. Cell 1 has emf of 12 V and internal resistance of 3 Ω. Cell 2 has emf of 6 V and internal resistance of 6 Ω. An external resistor R of 4 Ω is connected across A and B. The current flowing through R will be \_\_\_\_\_ A.



**Answer (1)**

**Sol.**



KCL at A gives

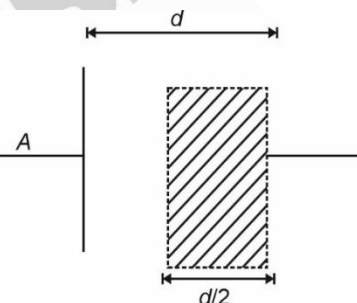
$$\frac{6 - V_A}{4} + \frac{0 - V_A}{6} + \frac{18 - V_A}{3} = 0$$

$$V_A = 10$$

$$\text{So current through } 4 \Omega = \frac{10 - 6}{4} = 1 \text{ A}$$

25. A capacitor has capacitance 5 μF when its parallel plates are separated by air medium of thickness d. A slab of material of dielectric constant 1.5 having area equal to that of plates but thickness  $\frac{d}{2}$  is inserted between the plates. Capacitance of the capacitor in the presence of slab will be \_\_\_\_\_ μF

**Answer (6)**



**Sol.**

$$C = \frac{\epsilon_0 A}{d} K$$

When completely air filled

$$C = 5 \mu\text{F} = \frac{\epsilon_0 A}{d} \quad \dots(1)$$

When half filled with  $K = 1.5$

$$\frac{1}{C_{eq}} = \frac{d}{2\epsilon_0 A} + \frac{d}{2\epsilon_0 AK}$$

$$C_{eq} = \left( \frac{2K}{K+1} \right) \frac{\epsilon_0 A}{d} \quad \dots(2)$$

From (1) & (2)

$$C_{eq} = \left( \frac{2 \times 1.5}{1.5 + 1} \right) 5 \mu\text{F} = 6 \mu\text{F}$$

26. A train blowing a whistle of frequency 320 Hz approaches an observer standing on the platform at a speed of 66 m/s. The frequency observed by the observer will be (given speed of sound = 330 ms<sup>-1</sup>) Hz.

**Answer (400)**

**Sol.**  $f = f_0 \left( \frac{v}{v - v_s} \right)$

$$f = 320 \left( \frac{330}{330 - 66} \right)$$

$$= 320 \times \frac{330}{264}$$

$$= 400 \text{ Hz.}$$

27. A nucleus disintegrates into two smaller parts, which have their velocities in the ratio 3:2. The ratio of their nuclear sizes will be  $\left( \frac{x}{3} \right)^{\frac{1}{3}}$ . The value of 'x' is

**Answer (02)**

**Sol.**  $m_1 v_1 = m_2 v_2$

$$\Rightarrow \left( \frac{m_1}{m_2} \right) = \frac{v_2}{v_1} = \left( \frac{2}{3} \right)$$

$m \propto A$

$$\frac{A_1}{A_2} = \left( \frac{2}{3} \right)$$

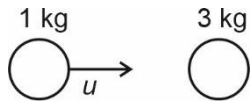
$$\frac{R_1}{R_2} = \left( \frac{A_1}{A_2} \right)^{\frac{1}{3}} = \left( \frac{2}{3} \right)^{\frac{1}{3}}$$

$x = 2$

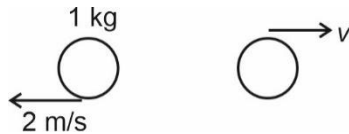
28. A body of mass 1 kg collides head on elastically with a stationary body of mass 3 kg. After collision, the smaller body reverses its direction of motion and moves with a speed of 2 m/s. The initial speed of the smaller body before collision is \_\_\_\_\_ ms<sup>-1</sup>.

**Answer (04)**

**Sol.** Before collision



After collision



Momentum conservation

$$u + 0 = 3v - 2$$

$$\boxed{3v - u = 2} \quad \dots(1)$$

also,

$$\frac{v+2}{u} = 1 \Rightarrow v+2 = u$$

$$\boxed{u - v = 2} \quad \dots(2)$$

Adding (1) and (2)

$$2v = 4$$

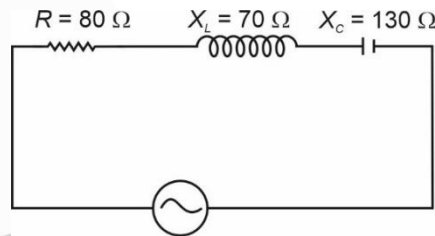
$$v = 2 \text{ m/s}$$

$$\boxed{u = 4 \text{ m/s}}$$

29. A series LCR circuit is connected to an AC source of 220 V, 50 Hz. The circuit contains a resistance  $R = 80 \Omega$ , an inductor of inductive reactance  $X_L = 70 \Omega$ , and a capacitor of capacitive reactance  $X_C = 130 \Omega$ . The power factor of circuit is  $\frac{x}{10}$ . The value of x is:

**Answer (08)**

**Sol.**



$$\text{Power factor} = \cos \phi = \frac{R}{Z} = \frac{80}{\sqrt{80^2 + 60^2}}$$

$$\frac{8}{10} = \frac{x}{10} \Rightarrow \boxed{x = 8}$$

30. A spherical drop of liquid splits into 1000 identical spherical drops. If  $u_i$  is the surface energy of the original drop and  $u_f$  is the total surface energy of the resulting drops, the (ignoring evaporation),  $\frac{u_f}{u_i} = \left( \frac{10}{x} \right)$ . Then value of x is \_\_\_\_\_ :

**Answer (01)**

**Sol.**  $\frac{u_f}{u_i} = \frac{\text{Area of final drop}}{\text{Area of Initial drop}}$

$$\frac{u_f}{u_i} = \frac{1000 \times 4\pi r_f^2}{4\pi r_i^2} = \frac{1000(r_f^2)}{(r_i^2)}$$

$$1000 \times \frac{4}{3} \pi r_f^3 = \frac{4}{3} \pi r_i^3$$

$$r_i = 10r_f$$

$$\frac{u_f}{u_i} = \frac{1000r_f^2}{100r_i^2} = 10$$

$$\frac{10}{x} = 10 \Rightarrow x = 1$$