

## TEST PAPER OF JEE(MAIN) EXAMINATION – 2019

**(Held On Thursday 10<sup>th</sup> JANUARY, 2019) TIME : 02 : 30 PM To 05 : 30 PM**

### PHYSICS

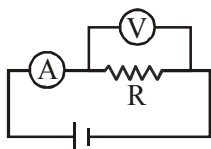
1. Two forces P and Q of magnitude 2F and 3F, respectively, are at an angle  $\theta$  with each other. If the force Q is doubled, then their resultant also gets doubled. Then, the angle is :
- (1)  $30^\circ$     (2)  $60^\circ$     (3)  $90^\circ$     (4)  $120^\circ$

**Ans. (4)**

**Sol.**  $4F^2 + 9F^2 + 12F^2 \cos \theta = R^2$   
 $4F^2 + 36 F^2 + 24 F^2 \cos \theta = 4R^2$   
 $4F^2 + 36 F^2 + 24 F^2 \cos \theta$   
 $= 4(13F^2 + 12F^2 \cos \theta) = 52 F^2 + 48F^2 \cos \theta$

$$\cos \theta = -\frac{12F^2}{24F^2} = -\frac{1}{2}$$

2. The actual value of resistance R, shown in the figure is  $30\Omega$ . This is measured in an experiment as shown using the standard formula  $R = \frac{V}{I}$ , where V and I are the readings of the voltmeter and ammeter, respectively. If the measured value of R is 5% less, then the internal resistance of the voltmeter is :



- (1)  $350\Omega$     (2)  $570\Omega$     (3)  $35\Omega$     (4)  $600\Omega$

**Ans. (2)**

**Sol.**  $0.95 R = \frac{R R_v}{R + R_v}$

$$0.95 \times 30 = 0.05 R_v$$

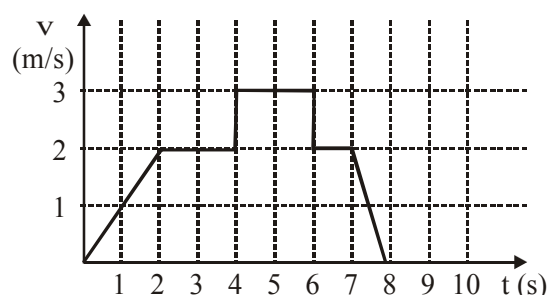
$$R_v = 19 \times 30 = 570 \Omega$$

3. An unknown metal of mass 192 g heated to a temperature of  $100^\circ\text{C}$  was immersed into a brass calorimeter of mass 128 g containing 240 g of water a temperature of  $8.4^\circ\text{C}$ . Calculate the specific heat of the unknown metal if water temperature stabilizes at  $21.5^\circ\text{C}$  (Specific heat of brass is  $394 \text{ J kg}^{-1} \text{ K}^{-1}$ )
- (1)  $1232 \text{ J kg}^{-1} \text{ K}^{-1}$     (2)  $458 \text{ J kg}^{-1} \text{ K}^{-1}$   
 (3)  $654 \text{ J kg}^{-1} \text{ K}^{-1}$     (4)  $916 \text{ J kg}^{-1} \text{ K}^{-1}$

**Ans. (4)**

**Sol.**  $192 \times S \times (100 - 21.5)$   
 $= 128 \times 394 \times (21.5 - 8.4)$   
 $+ 240 \times 4200 \times (21.5 - 8.4)$   
 $\Rightarrow S = 916$

4. A particle starts from the origin at time  $t = 0$  and moves along the positive x-axis. The graph of velocity with respect to time is shown in figure. What is the position of the particle at time  $t = 5\text{s}$  ?



- (1) 6 m    (2) 9 m    (3) 3 m    (4) 10 m

**Ans. (2)**

$S = \text{Area under graph}$

$$\frac{1}{2} \times 2 \times 2 + 2 \times 2 + 3 \times 1 = 9 \text{ m}$$

5. The self induced emf of a coil is 25 volts. When the current in it is changed at uniform rate from 10 A to 25 A in 1s, the change in the energy of the inductance is :

- (1) 437.5 J    (2) 637.5 J  
 (3) 740 J    (4) 540 J

**Ans. (1)**

$$L \frac{di}{dt} = 25$$

$$L \times \frac{15}{1} = 25$$

$$L = \frac{5}{3} \text{ H}$$

$$\Delta E = \frac{1}{2} \times \frac{5}{3} \times (25^2 - 10^2) = \frac{5}{6} \times 525 = 437.5 \text{ J}$$

6. A current of 2 mA was passed through an unknown resistor which dissipated a power of 4.4 W. Dissipated power when an ideal power supply of 11V is connected across it is :

- (1)  $11 \times 10^{-5} \text{ W}$     (2)  $11 \times 10^{-4} \text{ W}$   
 (3)  $11 \times 10^5 \text{ W}$     (4)  $11 \times 10^{-3} \text{ W}$

Ans. (1)

$$P = I^2 R$$

$$4.4 = 4 \times 10^{-6} R$$

$$R = 1.1 \times 10^6 \Omega$$

$$P' = \frac{11^2}{R} = \frac{11^2}{1.1} \times 10^{-6} = 11 \times 10^{-5} W$$

7. The diameter and height of a cylinder are measured by a meter scale to be  $12.6 \pm 0.1$  cm and  $34.2 \pm 0.1$  cm, respectively. What will be the value of its volume in appropriate significant figures ?

(1)  $4260 \pm 80$  cm<sup>3</sup>      (2)  $4300 \pm 80$  cm<sup>3</sup>

(3)  $4264.4 \pm 81.0$  cm<sup>3</sup>      (4)  $4264 \pm 81$  cm<sup>3</sup>

Ans. (1)

$$\frac{\Delta V}{V} = 2 \frac{\Delta d}{d} + \frac{\Delta h}{h} = 2 \left( \frac{0.1}{12.6} \right) + \frac{0.1}{34.2}$$

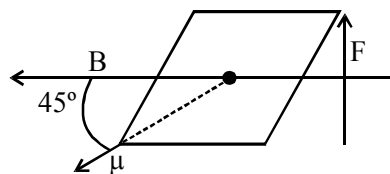
$$V = 12.6 \times \frac{\pi}{4} \times 314.2$$

8. At some location on earth the horizontal component of earth's magnetic field is  $18 \times 10^{-6}$  T. At this location, magnetic needle of length 0.12 m and pole strength 1.8 Am is suspended from its mid-point using a thread, it makes  $45^\circ$  angle with horizontal in equilibrium. To keep this needle horizontal, the vertical force that should be applied at one of its ends is :

(1)  $3.6 \times 10^{-5}$  N      (2)  $6.5 \times 10^{-5}$  N

(3)  $1.3 \times 10^{-5}$  N      (4)  $1.8 \times 10^{-5}$  N

Ans. (2)



$$\mu B \sin 45^\circ = F \frac{l}{2} \sin 45^\circ$$

$$F = 2\mu B$$

9. The modulation frequency of an AM radio station is 250 kHz, which is 10% of the carrier wave. If another AM station approaches you for license what broadcast frequency will you allot ?

(1) 2750 kHz      (2) 2000 kHz

(3) 2250 kHz      (4) 2900 kHz

Ans. (2)

$$f_{\text{carrier}} = \frac{250}{0.1} = 2500 \text{ KHZ}$$

$\therefore$  Range of signal = 2250 Hz to 2750 Hz

Now check all options : for 2000 KHZ

$$f_{\text{mod}} = 200 \text{ Hz}$$

$\therefore$  Range = 1800 KHZ to 2200 KHZ

10. A hoop and a solid cylinder of same mass and radius are made of a permanent magnetic material with their magnetic moment parallel to their respective axes. But the magnetic moment of hoop is twice of solid cylinder. They are placed in a uniform magnetic field in such a manner that their magnetic moments make a small angle with the field. If the oscillation periods of hoop and cylinder are  $T_h$  and  $T_c$  respectively, then :

(1)  $T_h = 0.5 T_c$       (2)  $T_h = 2 T_c$

(3)  $T_h = 1.5 T_c$       (4)  $T_h = T_c$

Ans. (4)

$$T = 2\pi \sqrt{\frac{I}{\mu B}}$$

$$T_h = 2\pi \sqrt{\frac{mR^2}{(2\mu)B}}$$

$$T_c = 2\pi \sqrt{\frac{1/2 mR^2}{\mu B}}$$

11. The electric field of a plane polarized electromagnetic wave in free space at time  $t=0$  is given by an expression

$$\vec{E}(x,y) = 10\hat{j} \cos [(6x + 8z)]$$

The magnetic field  $\vec{B}(x, z, t)$  is given by : ( $c$  is the velocity of light)

(1)  $\frac{1}{c}(6\hat{k} + 8\hat{i})\cos[(6x - 8z + 10ct)]$

(2)  $\frac{1}{c}(6\hat{k} - 8\hat{i})\cos[(6x + 8z - 10ct)]$

(3)  $\frac{1}{c}(6\hat{k} + 8\hat{i})\cos[(6x + 8z - 10ct)]$

(4)  $\frac{1}{c}(6\hat{k} - 8\hat{i})\cos[(6x + 8z + 10ct)]$

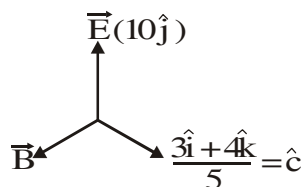
**Ans. (2)**

$$\vec{E} = 10\hat{j} \cos \left[ (6\hat{i} + 8\hat{k}) \cdot (x\hat{i} + z\hat{k}) \right]$$

$$= 10\hat{j} \cos[\vec{K} \cdot \vec{r}]$$

$\therefore \vec{K} = 6\hat{i} + 8\hat{k}$ ; direction of waves travel.

i.e. direction of 'c'.



$\therefore$  Direction of  $\hat{B}$  will be along

$$\hat{C} \times \hat{E} = \frac{-4\hat{i} + 3\hat{k}}{5}$$

Mag. of  $\vec{B}$  will be along  $\hat{C} \times \hat{E} = \frac{-4\hat{i} + 3\hat{k}}{5}$

$$\text{Mag. of } \vec{B} = \frac{E}{C} = \frac{10}{C}$$

$$\therefore \vec{B} = \frac{10}{C} \left( \frac{-4\hat{i} + 3\hat{k}}{5} \right) = \frac{(-8\hat{i} + 6\hat{k})}{C}$$

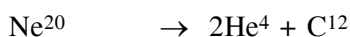
**12.** Consider the nuclear fission



Given that the binding energy/nucleon of  $\text{Ne}^{20}$ ,  $\text{He}^4$  and  $\text{C}^{12}$  are, respectively, 8.03 MeV, 7.07 MeV and 7.86 MeV, identify the correct statement :

- (1) 8.3 MeV energy will be released
- (2) energy of 12.4 MeV will be supplied
- (3) energy of 11.9 MeV has to be supplied
- (4) energy of 3.6 MeV will be released

**Ans. (3)**



$$8.03 \times 20 \quad 2 \times 7.07 \times 4 + 7.86 \times 12$$

$$\therefore E_B = (\text{BE})_{\text{react}} - (\text{BE})_{\text{product}} = 9.72 \text{ MeV}$$

**13.** Two vectors  $\vec{A}$  and  $\vec{B}$  have equal magnitudes.

The magnitude of  $(\vec{A} + \vec{B})$  is 'n' times the magnitude of  $(\vec{A} - \vec{B})$ . The angle between  $\vec{A}$  and  $\vec{B}$  is :

$$(1) \sin^{-1} \left[ \frac{n^2 - 1}{n^2 + 1} \right] \quad (2) \cos^{-1} \left[ \frac{n - 1}{n + 1} \right]$$

$$(3) \cos^{-1} \left[ \frac{n^2 - 1}{n^2 + 1} \right] \quad (4) \sin^{-1} \left[ \frac{n - 1}{n + 1} \right]$$

**Ans. (3)**

$$|\vec{A} + \vec{B}| = 2a \cos \theta / 2 \quad \text{---(1)}$$

$$|\vec{A} - \vec{B}| = 2a \cos \frac{(\pi - \theta)}{2} = 2a \sin \theta / 2 \quad \text{---(2)}$$

$$\Rightarrow n \left( 2a \cos \frac{\theta}{2} \right) = 2a \frac{\sin \theta}{2}$$

$$\Rightarrow \tan \frac{\theta}{2} = n$$

**14.** A particle executes simple harmonic motion with an amplitude of 5 cm. When the particle is at 4 cm from the mean position, the magnitude of its velocity in SI units is equal to that of its acceleration. Then, its periodic time in seconds is :

$$(1) \frac{7}{3}\pi \quad (2) \frac{3}{8}\pi$$

$$(3) \frac{4\pi}{3} \quad (4) \frac{8\pi}{3}$$

**Ans. (4)**

$$v = \omega \sqrt{A^2 - x^2} \quad \text{---(1)}$$

$$a = -\omega^2 x \quad \text{---(2)}$$

$$|v| = |a| \quad \text{---(3)}$$

$$\omega \sqrt{A^2 - x^2} = \omega^2 x$$

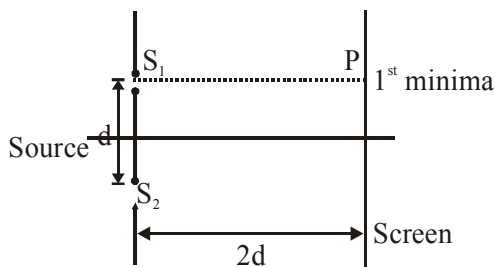
$$A^2 - x^2 = \omega^2 x^2$$

$$5^2 - 4^2 = \omega^2 (4^2)$$

$$\Rightarrow 3 = \omega \times 4$$

$$T = 2\pi/\omega$$

15. Consider a Young's double slit experiment as shown in figure. What should be the slit separation  $d$  in terms of wavelength  $\lambda$  such that the first minima occurs directly in front of the slit ( $S_1$ ) ?



- (1)  $\frac{\lambda}{2(5-\sqrt{2})}$       (2)  $\frac{\lambda}{(5-\sqrt{2})}$   
 (3)  $\frac{\lambda}{(\sqrt{5}-2)}$       (4)  $\frac{\lambda}{2(\sqrt{5}-2)}$

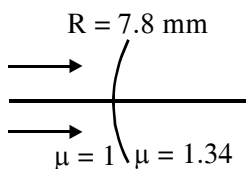
Ans. (4)

$$\sqrt{5}d - 2d = \frac{\lambda}{2}$$

16. The eye can be regarded as a single refracting surface. The radius of curvature of this surface is equal to that of cornea (7.8 mm). This surface separates two media of refractive indices 1 and 1.34. Calculate the distance from the refracting surface at which a parallel beam of light will come to focus.

- (1) 2 cm      (2) 1 cm  
 (3) 3.1 cm      (4) 4.0 cm

Ans. (3)



$$\frac{1.34}{V} - \frac{1}{\infty} = \frac{1.34 - 1}{7.8}$$

$$\therefore V = 30.7 \text{ mm}$$

17. Half mole of an ideal monoatomic gas is heated at constant pressure of 1atm from 20 °C to 90°C. Work done by gas is close to : ( Gas constant  $R = 8.31 \text{ J /mol.K}$ )  
 (1) 73 J      (2) 291 J      (3) 581 J      (4) 146 J

Ans. (2)

$$WD = P\Delta V = nR\Delta T = \frac{1}{2} \times 8.31 \times 70$$

18. A metal plate of area  $1 \times 10^{-4} \text{ m}^2$  is illuminated by a radiation of intensity  $16 \text{ mW/m}^2$ . The work function of the metal is 5eV. The energy of the incident photons is 10 eV and only 10% of it produces photo electrons. The number of emitted photo electrons per second and their maximum energy, respectively, will be : [1 eV =  $1.6 \times 10^{-19} \text{ J}$ ]

- (1)  $10^{10}$  and 5 eV      (2)  $10^{14}$  and 10 eV  
 (3)  $10^{12}$  and 5 eV      (4)  $10^{11}$  and 5 eV

Ans. (4)

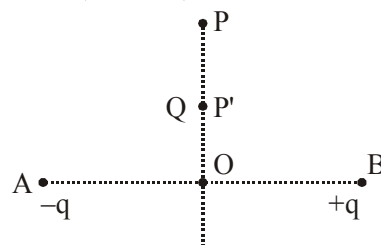
$$I = \frac{nE}{At}$$

$$16 \times 10^{-3} = \left(\frac{n}{t}\right)_{\text{Photon}} \frac{10 \times 1.6 \times 10^{-19}}{10^{-4}} = 10^{12}$$

19. Charges  $-q$  and  $+q$  located at A and B, respectively, constitute an electric dipole. Distance  $AB = 2a$ , O is the mid point of the dipole and OP is perpendicular to AB. A charge Q is placed at P where  $OP = y$  and  $y \gg 2a$ . The charge Q experiences an electrostatic force F. If Q is now moved along the equatorial line

to P' such that  $OP' = \left(\frac{y}{3}\right)$ , the force on Q will be

close to :  $\left(\frac{y}{3} \gg 2a\right)$



- (1)  $\frac{F}{3}$       (2) 3F      (3) 9F      (4) 27F

Ans. (4)

Sol. Electric field of equatorial plane of dipole

$$= -\frac{K\vec{P}}{r^3}$$

$$\therefore \text{At P, } F = -\frac{K\vec{P}}{r^3}Q.$$

$$\text{At P}^1, F^1 = -\frac{K\vec{P}Q}{(r/3)^3} = 27F.$$

20. Two stars of masses  $3 \times 10^{31}$  kg each, and at distance  $2 \times 10^{11}$  m rotate in a plane about their common centre of mass O. A meteorite passes through O moving perpendicular to the star's rotation plane. In order to escape from the gravitational field of this double star, the minimum speed that meteorite should have at O is : (Take Gravitational constant  $G = 6.67 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$ )

- (1)  $1.4 \times 10^5 \text{ m/s}$       (2)  $24 \times 10^4 \text{ m/s}$   
 (3)  $3.8 \times 10^4 \text{ m/s}$       (4)  $2.8 \times 10^5 \text{ m/s}$

Ans. (4)

By energy conservation between 0 &  $\infty$ .

$$-\frac{GMm}{r} + \frac{-GMm}{r} + \frac{1}{2}mV^2 = 0 + 0$$

[M is mass of star m is mass of meteorite)

$$\Rightarrow v = \sqrt{\frac{4GM}{r}} = 2.8 \times 10^5 \text{ m/s}$$

21. A closed organ pipe has a fundamental frequency of 1.5 kHz. The number of overtones that can be distinctly heard by a person with this organ pipe will be : (Assume that the highest frequency a person can hear is 20,000 Hz)

- (1) 7      (2) 5      (3) 6      (4) 4

Ans. (1)

Sol. For closed organ pipe, resonant frequency is odd multiple of fundamental frequency.

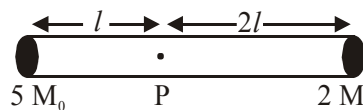
$$\therefore (2n + 1) f_0 \leq 20,000$$

$$(f_0 \text{ is fundamental frequency} = 1.5 \text{ KHz})$$

$$\therefore n = 6$$

$\therefore$  Total number of overtone that can be heard is 7. (0 to 6).

22. A rigid massless rod of length  $3l$  has two masses attached at each end as shown in the figure. The rod is pivoted at point P on the horizontal axis (see figure). When released from initial horizontal position, its instantaneous angular acceleration will be :



- (1)  $\frac{g}{2l}$       (2)  $\frac{7g}{3l}$       (3)  $\frac{g}{13l}$       (4)  $\frac{g}{3l}$

Ans. (3)



Applying torque equation about point P.

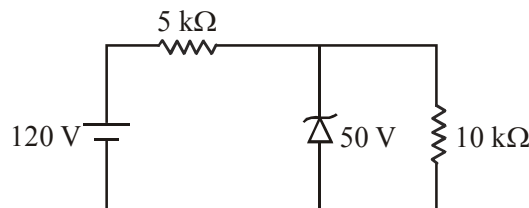
$$2M_0(2l) - 5M_0gl = I\alpha$$

$$I = 2M_0(2l)^2 + 5M_0l^2 = 13M_0l^2$$

$$\therefore \alpha = -\frac{M_0gl}{13M_0l^2} \Rightarrow \alpha = -\frac{g}{13l}$$

$$\therefore \alpha = \frac{g}{13l} \text{ anticlockwise}$$

23. For the circuit shown below, the current through the Zener diode is :



- (1) 5 mA      (2) Zero      (3) 14 mA      (4) 9 mA

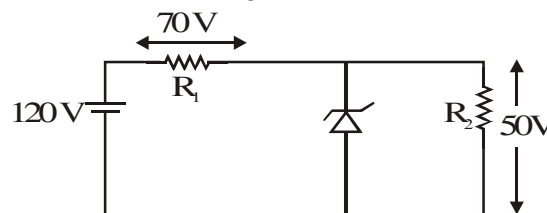
Ans. (4)

Assuming zener diode does not undergo

$$\text{breakdown, current in circuit} = \frac{120}{15000} = 8 \text{ mA}$$

$$\therefore \text{Voltage drop across diode} = 80 \text{ V} > 50 \text{ V.}$$

The diode undergoes breakdown.



$$\text{Current in } R_1 = \frac{70}{5000} = 14 \text{ mA}$$

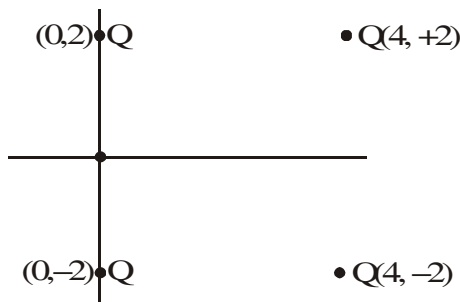
$$\text{Current in } R_2 = \frac{50}{10000} = 5 \text{ mA}$$

$$\therefore \text{Current through diode} = 9 \text{ mA}$$

24. Four equal point charges Q each are placed in the xy plane at (0, 2), (4, 2), (4, -2) and (0, -2). The work required to put a fifth charge Q at the origin of the coordinate system will be :

- (1)  $\frac{Q^2}{2\sqrt{2}\pi\epsilon_0}$                       (2)  $\frac{Q^2}{4\pi\epsilon_0}\left(1+\frac{1}{\sqrt{5}}\right)$   
 (3)  $\frac{Q^2}{4\pi\epsilon_0}\left(1+\frac{1}{\sqrt{3}}\right)$                       (4)  $\frac{Q^2}{4\pi\epsilon_0}$

Ans. (2)



$$\text{Potential at origin} = \frac{KQ}{2} + \frac{KQ}{2} + \frac{KQ}{\sqrt{20}} + \frac{KQ}{\sqrt{20}}$$

(Potential at  $\infty = 0$ )

$$= KQ\left(1+\frac{1}{\sqrt{5}}\right)$$

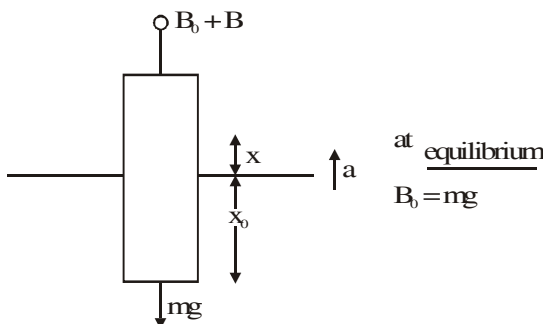
$\therefore$  Work required to put a fifth charge Q at origin

$$\text{is equal to } \frac{Q^2}{4\pi\epsilon_0}\left(1+\frac{1}{\sqrt{5}}\right)$$

25. A cylindrical plastic bottle of negligible mass is filled with 310 ml of water and left floating in a pond with still water. If pressed downward slightly and released, it starts performing simple harmonic motion at angular frequency  $\omega$ . If the radius of the bottle is 2.5 cm then  $\omega$  close to : (density of water =  $10^3 \text{ kg / m}^3$ )

- (1)  $5.00 \text{ rad s}^{-1}$                       (2)  $1.25 \text{ rad s}^{-1}$   
 (3)  $3.75 \text{ rad s}^{-1}$                       (4)  $2.50 \text{ rad s}^{-1}$

Ans. (Bonus)



$$\text{Extra Boyant force} = \delta A x g$$

$$B_0 + B \times mg = ma$$

$$B = ma$$

$$a = \left(\frac{\delta A g}{m}\right)^x$$

$$w^2 = \frac{\delta A g}{m}$$

$$w = \sqrt{\frac{10^3 \times \pi (2.5)^2 \times 10^{-4} \times 10}{310 \times 10^{-6} \times 10^3}}$$

$$= \sqrt{63.30} = 7.95$$

26. A parallel plate capacitor having capacitance 12 pF is charged by a battery to a potential difference of 10 V between its plates. The charging battery is now disconnected and a porcelain slab of dielectric constant 6.5 is slipped between the plates the work done by the capacitor on the slab is :

- (1) 692 pJ                                      (2) 60 pJ  
 (3) 508 pJ                                      (4) 560 pJ

Ans. (3)

Initial energy of capacitor

$$U_i = \frac{1}{2} \frac{v^2}{c}$$

$$= \frac{1}{2} \times \frac{120 \times 120}{12} = 600 \text{ J}$$

Since battery is disconnected so charge remain same.

Final energy of capacitor

$$U_f = \frac{1}{2} \frac{v^2}{c}$$

$$= \frac{1}{2} \times \frac{120 \times 120}{12 \times 6.5} = 92$$

$$W + U_f = U_i$$

$$W = 508 \text{ J}$$

27. Two kg of a monoatomic gas is at a pressure of  $4 \times 10^4 \text{ N/m}^2$ . The density of the gas is  $8 \text{ kg / m}^3$ . What is the order of energy of the gas due to its thermal motion ?

- (1)  $10^3 \text{ J}$                                       (2)  $10^5 \text{ J}$   
 (3)  $10^6 \text{ J}$                                       (4)  $10^4 \text{ J}$

Ans. (4)

Thermal energy of N molecule

$$= N \left(\frac{3}{2} kT\right)$$

$$= \frac{N}{N_A} \frac{3}{2} RT$$

$$= \frac{3}{2} (nRT)$$

$$= \frac{3}{2} PV$$

$$= \frac{3}{2} P \left( \frac{m}{8} \right)$$

$$= \frac{3}{2} \times 4 \times 10^4 \times \frac{2}{8}$$

$$= 1.5 \times 10^4$$

order will  $10^4$

28. A particle which is experiencing a force, given by  $\vec{F} = 3\vec{i} - 12\vec{j}$ , undergoes a displacement of  $\vec{d} = 4\vec{i}$ . If the particle had a kinetic energy of 3 J at the beginning of the displacement, what is its kinetic energy at the end of the displacement ?

- (1) 15 J    (2) 10 J    (3) 12 J    (4) 9 J

Ans. (1)

$$\begin{aligned} \text{Work done} &= \vec{F} \cdot \vec{d} \\ &= 12\text{J} \end{aligned}$$

work energy theorem

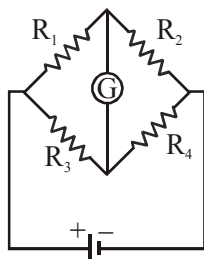
$$W_{\text{net}} = \Delta \text{K.E.}$$

$$12 = K_f - 3$$

$$K_f = 15\text{J}$$

29. The Wheatstone bridge shown in Fig. here, gets balanced when the carbon resistor used as  $R_1$  has the colour code ( Orange, Red, Brown). The resistors  $R_2$  and  $R_4$  are  $80\Omega$  and  $40\Omega$ , respectively.

Assuming that the colour code for the carbon resistors gives their accurate values, the colour code for the carbon resistor, used as  $R_3$ , would be :



- (1) Red, Green, Brown  
 (2) Brown, Blue, Brown  
 (3) Grey, Black, Brown  
 (4) Brown, Blue, Black

Ans. (2)

$$R_1 = 32 \times 10 = 320$$

for wheat stone bridge

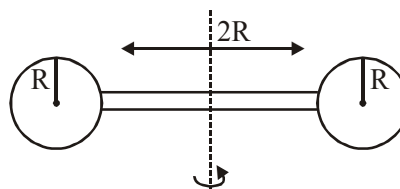
$$\Rightarrow \frac{R_1}{R_3} = \frac{R_2}{R_4}$$

$$\frac{320}{R_3} = \frac{80}{40}$$

$$R_3 = 160$$

Brown                      Blue                      Brown

30. Two identical spherical balls of mass  $M$  and radius  $R$  each are stuck on two ends of a rod of length  $2R$  and mass  $M$  (see figure). The moment of inertia of the system about the axis passing perpendicularly through the centre of the rod is :



- (1)  $\frac{152}{15} MR^2$                       (2)  $\frac{17}{15} MR^2$   
 (3)  $\frac{137}{15} MR^2$                       (4)  $\frac{209}{15} MR^2$

Ans. (3)

For Ball  
 using parallel axis theorem.

$$I_{\text{ball}} = \frac{2}{5} MR^2 + M(2R)^2$$

$$= \frac{22}{5} MR^2$$

$$2 \text{ Balls so } \frac{44}{5} MR^2$$

$$I_{\text{rod}} = \text{for rod } \frac{M(2R)^2}{12} = \frac{MR^2}{3}$$

$$I_{\text{system}} = I_{\text{Ball}} + I_{\text{rod}}$$

$$= \frac{44}{5} MR^2 + \frac{MR^2}{3}$$

$$= \frac{137}{15} MR^2$$