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JEE (Main)

PAPER-1 (B.E./B. TECH.)

2021

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COMPUTER BASED TEST (CBT) Memory Based Questions & Solutions

Date: 26 August, 2021 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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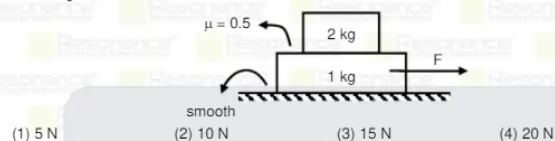
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PART : PHYSICS

1. Two blocks of mass 2 kg & 1 kg are rest on a smooth surface as shown in figure. There is friction between 2 kg & 1 kg block with $\mu = 0.5$. Find maximum force to be applied on 1 kg for the two blocks to move together.



Ans. (3)

Sol. For $F_{\max}$ with relative rest, f_s between 2 kg & 1 kg must be maximum.

$$\begin{aligned} \text{For } 2 \text{ kg block: } f_s &= \mu N \\ &= 0.5 \times 20 \\ &= 10 \text{ N} \end{aligned}$$

$$a_{\text{common}} \leq a_{\text{max}}$$

$$\frac{F}{3} \leq \frac{10}{2}$$

$$F \leq 15$$

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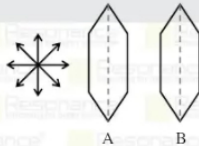
- (1) hyperbola (2) straight line (3) parabola (4) None of these

Ans. (2)

Sol. Horizontal component of velocity of bomb & fighter jet are same

So, bomb will remain just below the jet, path is straight line w.r.t. pilot.

3. Unpolarized light passes through polarizer A and B, intensity of unpolarized light is I , then find out angle of rotation of polarizer B, so final intensity becomes $3I/8$.



- (1) 30° (2) 40° (3) 50° (4) 60°
- Ans. (1)

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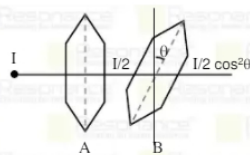
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Sol.

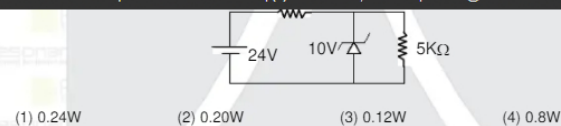


$$I' = \frac{I}{2} \cos^2 \theta$$

$$\frac{3I}{8} = \frac{I}{2} \cos^2 \theta$$

$$\theta = 30^\circ$$

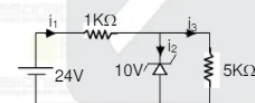
4. Find power developed in zener diode :



- (1) 0.24W (2) 0.20W (3) 0.12W (4) 0.8W

Ans. (3)

Sol.



$$i_1 = \frac{24}{1} = 24 \text{ mA}$$

$$i_3 = \frac{10}{5} = 2 \text{ mA}$$

$$i_2 = i_1 - i_3 = 22 \text{ mA}$$

Power consume in zener diode

$$= V \times i = 0.12 \text{ W}$$

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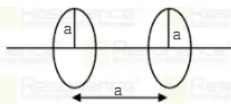
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5. Find potential difference between centres of rings :

+Q -Q



- (1) $\frac{KQ}{a}(2-\sqrt{2})$ (2) $\frac{KQ}{a}(2+\sqrt{2})$ (3) $\frac{KQ}{a}(2\sqrt{2})$ (4) $\frac{KQ}{a}(\sqrt{2})$

Ans. (1)

Sol. $V_1 = \frac{KQ}{a} + \frac{-KQ}{\sqrt{2}a}$

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$V_1 - V_2 = \frac{KQ}{a}(2-\sqrt{2})$

6. Error in length of pendulum is 0.1% then the error of seconds in a day is?
(1) 20.12 sec (2) 25.13 sec (3) 30.21 sec (4) 43.2 sec

Ans. (4)

Sol. $T = 2\pi\sqrt{\frac{\ell}{g}}$

$T \propto \ell^{1/2}$

$\frac{\Delta t}{t} = \frac{1}{2} \frac{\Delta \ell}{\ell}$

$\frac{\Delta t}{24 \times 3600} = \frac{1}{2} \times \frac{0.1}{100}$

$\Delta t = \frac{1}{2} \times \frac{0.1}{100} \times 24 \times 3600$

$\Delta t = 43.2 \text{ sec}$

7. Equation of two travelling waves are given as :
 $Y_1 = A_1 \sin(kx - vt)$
 $Y_2 = A_2 \sin(kx - vt + x_0)$
Find resultant amplitude on their superposition. Given $A_1 = 12$, $A_2 = 7$, $K = 6.28$, $x_0 = 3.5$
(1) 19 (2) 15 (3) 10 (4) 5

Ans. (4)

Sol. $\Delta \phi = kx_0 = \frac{2\pi}{\lambda} x_0 = 2\pi \times 3.5$ $\left(\lambda = \frac{2\pi}{k} = 1 \right)$

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$A_R = \sqrt{12^2 + 7^2 + 2 \times 12 \times 7 \times \cos(7\pi)} = \sqrt{(12-7)^2} = 5$

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8. Object, converging lens and convex mirror are arranged as shown in figure. The R.O.C. of mirror is 15 cm. Focal length of lens is unknown. It is given that image and object coincide. Find distance between image and object when mirror is removed.



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Ans. (2)

Sol. Image object coincide

Image by lens must be on centre of curvature of mirror. Hence, distance between object and image after removing mirror = $12 + 8 + 15 = 35$

9. Three liquids A, B and C have initial temperature 10°C , 20°C and 30°C respectively. If A & B are mixed then temperature of mixture is 16°C . If B & C are mixed then temperature of mixture is 26°C , if A & C are mixed then find final temperature.

- (1) $\frac{150}{11}$ (2) $\frac{160}{11}$ (3) $\frac{170}{11}$ (4) $\frac{120}{11}$

Ans. (3)

Sol. When A & B are mixed

$m_1 S_1 (16 - 10) = m_2 S_2 (20 - 16)$

$6m_1 S_1 = 4m_2 S_2$ (1)

When B & C are mixed

$m_2 S_2 (26 - 20) = m_3 S_3 (30 - 26)$

$6m_2 S_2 = 4m_3 S_3$ (2)

From equation (1) and (2)

$8m_3 S_3 = 3m_1 S_1$

When A & C are mixed

$m_1 S_1 (T - 10) = m_3 S_3 (30 - T)$

$T = \frac{30m_3 S_3 + 10m_1 S_1}{m_1 S_1 + m_3 S_3}$

$$T = \frac{10(3m_3S_3 + \frac{8}{3}m_1S_1)}{m_3S_3 + \frac{8}{3}m_1S_1}$$

$$T = \frac{170}{11}$$

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10. Match List I with List II and select the correct answer using the codes given below the lists :

- | | |
|--------------------------|-----------------------|
| List-I | List-II |
| P. Magnetic permeability | 1. $[M^L^{-1}T^0I^1]$ |
| Q. Magnetic flux | 2. $[M^1T^2I^{-1}]$ |

Codes :

	P	Q	R	S
(1)	3	4	1	2
(2)	3	2	1	4
(3)	4	2	1	3
(4)	4	1	2	3

Ans. (1)

11. If λ is the wavelength for which energy is E. If λ decreases to 75% of initial value, then find the energy gain.

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

Ans. (1)

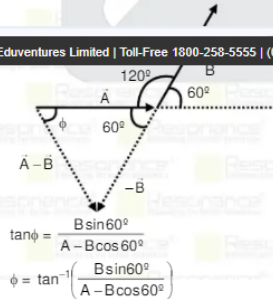
Sol. $E_1 = \frac{hc}{\lambda}$
 $E_2 = \frac{4hc}{3\lambda}$
 $\Delta E = E_2 - E_1 = \frac{hc}{3\lambda} = \frac{E}{3}$

12. Angle between two vector $\vec{A}$ and $\vec{B}$ is 60° , then find angle between $\vec{A} - \vec{B}$ & $\vec{A}$

- (1) $\tan^{-1}\left(\frac{A \sin 60^\circ}{B - A \cos 60^\circ}\right)$ (2) $\tan^{-1}\left(\frac{B \sin 60^\circ}{A + B \cos 60^\circ}\right)$
 (3) $\tan^{-1}\left(\frac{B \cos 60^\circ}{A - B \sin 60^\circ}\right)$ (4) $\tan^{-1}\left(\frac{B \sin 60^\circ}{A - B \cos 60^\circ}\right)$

Ans. (4)

Sol.



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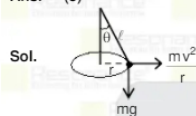
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13. A conical pendulum of length l moving in a circle of radius $\frac{l}{\sqrt{2}}$. Find the velocity of Pendulum :

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

Ans. (3)



Sol.

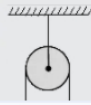
$$\sin \theta = \frac{1}{\sqrt{2}}$$

$$\theta = 45^\circ$$

$$\tan \theta = \frac{mv^2}{r \cdot mg} = \frac{v^2}{Rg} = 1$$

$$v^2 = rg \Rightarrow v = \sqrt{\frac{r}{\sqrt{2}}} g$$

14. In an atwood machine the maximum stress that a string can tolerate without break is $\frac{24}{\pi} \times 10^{-2}$ find the radius of string :



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- Ans. (1) 12.5 (2) 16.5 (3) 20.5 (4) 24.5

Sol. Tension in the string = $\frac{2m_1 m_2}{(m_1 + m_2)} g$

$$= \frac{2 \times 3 \times 5 \times 10}{8} = \frac{75}{2}$$

$$\text{Stress} = \frac{T}{A}$$

$$\frac{24}{\pi} \times 10^{-2} = \frac{75}{2(\pi r^2)}$$

$$r^2 = \frac{75}{48} \times 100$$

$$r^2 = \left(\frac{25}{2}\right)^2$$

$$R = 12.5$$

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15. Electric field of an electromagnetic wave is $E = 200 \sin \left(\omega \left(t - \frac{x}{c} \right) \right) \frac{V}{m}$. An electron is moving with speed 3×10^7 m/s. Find magnitude of magnetic force on electron.

- (1) 2.2×10^{-18} Newton (2) 3.2×10^{-18} Newton
(3) 1.2×10^{-18} Newton (4) 4.2×10^{-18} Newton

Ans. (2)

Sol. $E_0 = 200$

$$B_0 = \frac{E_0}{c} = \frac{200 \frac{V}{m}}{3 \times 10^8}$$

$$F_m = qvB_0 = \frac{1.6 \times 10^{-19} \times 3 \times 10^7 \times 200}{3 \times 10^8}$$

$$= 3.2 \times 10^{-18} \text{ Newton}$$

16. Equation of SHM for two particles is $x_1 = 5 \sin \left(\omega t + \frac{\pi}{4} \right)$ and $x_2 = 5\sqrt{2} [\sin 2\pi t + \cos 2\pi t]$. Then how many times amplitude of second particle greater than first.

Ans. (2)

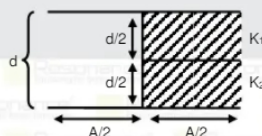
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$$x_2 = 10 \left[\sin \left(2\pi t + \frac{\pi}{4} \right) \right]$$

$$A_2 = 10$$

$$A_2 = 2A_1$$

17. Find equivalent capacitance



$$(1) \frac{A\epsilon_0}{d} \left(\frac{1}{3} + \frac{K_1 K_2}{K_1 + K_2} \right)$$

$$(2) \frac{A\epsilon_0}{d} \left(\frac{1}{2} + \frac{K_1 K_2}{K_1 + K_2} \right)$$

$$(3) \frac{A\epsilon_0}{d} \left(\frac{1}{2} + \frac{K_1 K_2}{K_1 + K_2} \right)$$

$$(4) \frac{A\epsilon_0}{d} \left(\frac{1}{2} + \frac{2K_1 K_2}{K_1 + K_2} \right)$$

Ans. (3)

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Sol.

$$C_1 = \frac{(A/2)\epsilon_0}{d}$$

$$C_2 = \frac{K_1(A/2)\epsilon_0}{d/2} = \frac{K_1 A \epsilon_0}{d}$$

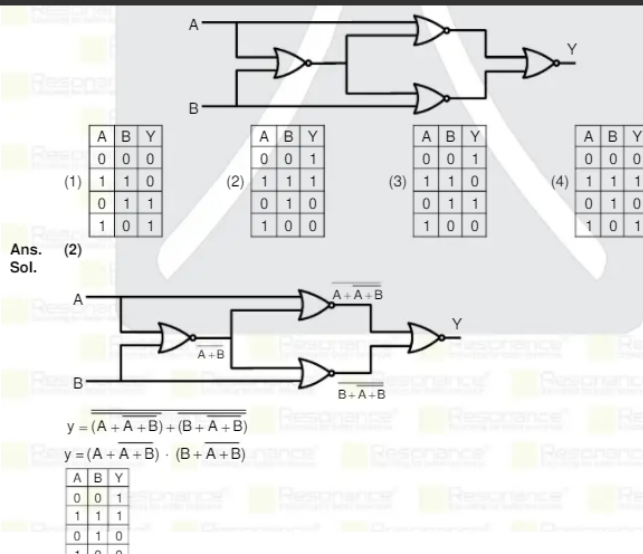
$$C_3 = \frac{K_2(A/2)\epsilon_0}{d/2} = \frac{K_2 A \epsilon_0}{d}$$

$$C_{eq} = C_1 + \frac{C_2 C_3}{C_2 + C_3}$$

$$C_{eq} = \frac{A \epsilon_0}{2d} + \frac{\frac{K_1 A \epsilon_0}{d} \times \frac{K_2 A \epsilon_0}{d}}{\frac{K_1 A \epsilon_0}{d} + \frac{K_2 A \epsilon_0}{d}}$$

$$C_{eq} = \frac{A \epsilon_0}{2d} + \frac{A \epsilon_0}{d} \left(\frac{K_1 K_2}{K_1 + K_2} \right) = \frac{A \epsilon_0}{d} \left(\frac{1}{2} + \frac{K_1 K_2}{K_1 + K_2} \right)$$

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19. A container has 1 mole of gas 'A' and 2 mole of gas 'B' confined in a space of volume 1 m^3 at 127°C temperature. Find the pressure exerted on the wall of container in kPa.

Ans. 10

Sol. for gas A

$$P_A V = n_A R T$$

$$P_A = \frac{(1)RT}{V}$$

for gas B

$$P_B V = n_B R T$$

$$P_B = \frac{(2)RT}{V}$$

$$P = P_A + P_B$$

$$= 9.976 \text{ kPa}$$

$$\approx 10 \text{ kPa}$$

20. Height of transmission tower and receiver tower are 80m and 50m respectively. If radius of earth is 6400km then find range of LOS communication.

(1) 50.2 km

(2) 99.2 km

(3) 150 km

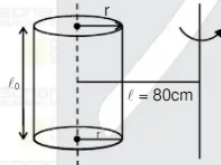
(4) 200 km

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Ans. (2)

Sol. Range = $\sqrt{2Rh_1} + \sqrt{2Rh_2}$
Putting values range = 99.2 km

21. Find density of a solid cylinder. If its movement of inertia about axis shown in figure is 2.7 kgm^2 . Length of cylinder is 80 cm and radius of cylinder is 20 cm.



- (1) 40.67 Kg/m^3 (2) 30.67 Kg/m^3
(3) 20.67 Kg/m^3 (4) 50.67 Kg/m^3

Ans. (1)

Sol. $I = \frac{Mr^2}{2} + Mr^2 = \frac{\rho(\pi r^2)l r^2}{2} + (\rho\pi r^2 l) r^2$
 $= \rho\pi r^2 l \left(\frac{r^2}{2} + r^2 \right)$

$$\Rightarrow \rho = \frac{I}{\pi r^2 l \left(\frac{r^2}{2} + r^2 \right)}$$

On putting the values $\rho = 40.67 \text{ Kg/m}^3$

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22. Initially $N_A^0 = 2N_B^0$ they decay with same rate $A \xrightarrow{\lambda} B \xrightarrow{\lambda} C$ then choose correct graph.



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Ans. (1)

Sol. Rate at which nuclei of B is forming

$$\frac{dN_B}{dt} = \lambda N_A - \lambda N_B$$

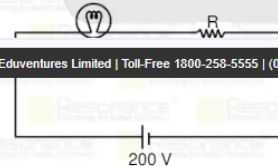
$$\frac{dN_B}{dt} = \lambda N_A^0 e^{-\lambda t} - \lambda N_B$$

$$\frac{dN_B}{dt} + \lambda N_B = \lambda N_A^0 e^{-\lambda t}$$

$$\frac{dN_B}{dt} = \lambda N_A^0 e^{-\lambda t} - \lambda N_B$$

$$N_A = N_A^0 e^{-\lambda t}$$

23. In given circuit, find the value for resistance 'R' So that bulb operate at the rated power of 500 Watt.



- (1) 20Ω (2) 30Ω (3) 40Ω (4) 50Ω

Ans. (1)

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Sol. Resistance of bulb

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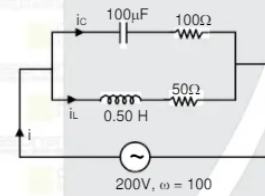
$$r = \frac{(100)^2}{500} = \frac{100 \times 100}{500} = 20$$

$$i = \frac{P}{V} = \frac{500}{100} = 5A$$

ΔV in resistance $R = 100V$

$$R = \frac{100}{5} = 20\Omega$$

24.



Find $i = ?$

- (1) $\sqrt{10}A$ (2) $2\sqrt{10}A$ (3) $\sqrt{20}A$ (4) $\sqrt{5}A$

Ans. (1)

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$$Z = \sqrt{\left(\frac{1}{100 \times 100 \times 10^{-6}}\right)^2 + 100^2}$$

$$= \sqrt{100^2 + 100^2}$$

$$= 100\sqrt{2}$$

$$Z_L = \sqrt{(\omega L)^2 + R^2} = \sqrt{(100 \times 0.5)^2 + 50^2} = 50\sqrt{2}$$

$$i_L = \frac{200}{Z_L} = \frac{200}{50\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2}$$

$$i_c = \frac{200}{Z_C} = \frac{200}{100\sqrt{2}} = \sqrt{2}$$

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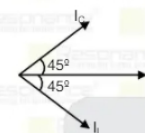
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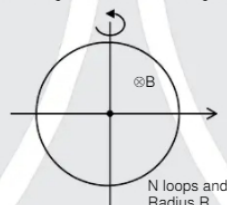
$$\cos \phi_1 = \frac{100}{100\sqrt{2}} = \frac{1}{\sqrt{2}}, \phi_1 = 45^\circ$$

$$\cos \phi_2 = \frac{50}{50\sqrt{2}} = \frac{1}{\sqrt{2}}, \phi_2 = 45^\circ$$



$$I = \sqrt{I_c^2 + I_L^2} ; I = \sqrt{8 + 2} ; I = \sqrt{10}A$$

25. A circular coil is rotating in uniform magnetic field shown in figure. Find the maximum induced emf ?



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Ans. (3)

Sol. $\text{Emf} = B\omega N A \sin \omega t$

$$\text{Emf}_{\max} = B\omega N A = B\omega N (\pi R^2)$$

26. A Carnot engine working between -10°C and 25°C temperature limit if produce a power of 35 W then what is the heat input rate in the engine.

- (1) 190 J (2) 290 J (3) 298 J (4) 250 J

Ans. (3)

Sol. $T_L = 273 + (-10) = 263 \text{ K}$

$$T_H = 273 + 25 = 298 \text{ K}$$

$$\eta = 1 - \frac{T_L}{T_H}; \eta = 1 - \frac{263}{298} = \frac{35}{298}; \eta = \frac{W}{Q_{\text{in}}} = \frac{35}{298}$$

$$Q_{\text{in}} = \frac{298}{35} \times 35 = 298 \text{ J}$$

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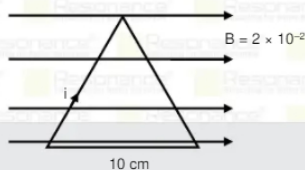
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27. A equilateral triangular coil placed in a uniform magnetic field $B = 2 \times 10^{-2} \text{ T}$ exist in horizontal direction. A current of 0.2 A is flowing in the coil if torque acting on coil is equal to $y \times 10^{-5} \text{ N.m}$ then find $y = ?$



Ans. 1.732

Sol. $\tau = \vec{M} \times \vec{B}$

$$= IAB$$

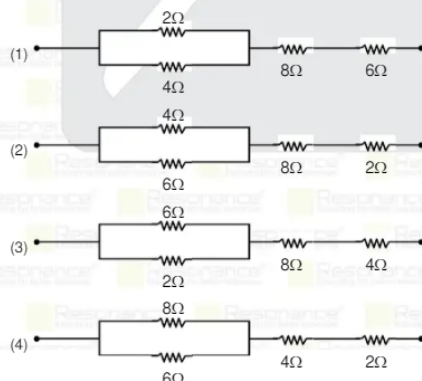
$$= 0.2 \times \left(\frac{\sqrt{3}a^2}{4} \right) \times 2 \times 10^{-2} = \frac{0.2 \times \sqrt{3} \times 10^{-2} \times 2 \times 10^{-2}}{4}$$

$$= \sqrt{3} \times 10^{-5}$$

$$\tau = 1.732 \times 10^{-5}$$

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28. Four resistance 2Ω , 6Ω , 4Ω , 8Ω , are arrange to find equivalent resistance $\frac{46}{3} \Omega$. Then which arrangement is correct.



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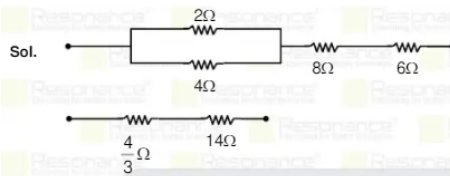
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Ans. (1)



$$R_{eq} = \frac{4}{3} \Omega + 14 \Omega = \frac{46}{3} \Omega$$

29. For a simple pendulum if percentage error in gravitational acceleration is 1% and percentage error in time period T is 1% then find maximum percentage error in energy.

Sol. $T = 2\pi \sqrt{\frac{l}{g}}$

$$l = \frac{gT^2}{4\pi^2}$$

$$\frac{\Delta g}{g} + \frac{2\Delta T}{T} = \frac{\Delta l}{l}$$

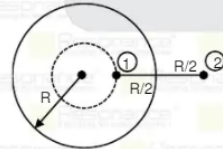
$$1 + 2 \times 1 = 3\%$$

$$E = \frac{1}{2} m \omega^2 A^2 = \frac{1}{2} m \frac{g}{l} A^2 = \frac{\Delta g}{g} + \frac{\Delta l}{l} = 1 + 3 = 4$$

30. A Solid sphere of radius R and charge Q, what is the ratio of electric potential at a point inside and outside the sphere with distance R/2 from surface :
 (1) 33/16 (2) 35/16 (3) 37/16 (4) 40/16

Ans. (1)

Sol.



$$\frac{V_1}{V_2} = \frac{\frac{KQ}{2R^3} \left[3R^2 - \left(\frac{R}{2} \right)^2 \right]}{\frac{KQ}{R}} = \frac{\frac{KQ}{2R} \left[\frac{11}{4} \right]}{\frac{KQ}{R}} = \frac{33}{4}$$

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AIR-2 (GEN-EWS)	Zonal Topper IIT-Kharagpur	2nd Rank in IIT-Kharagpur Zone	AIR-30	AIR-41
AIR-15	AIR-25	AIR-29		
DHANANJAY KEJRIWAL With us Since Class 9 th	SAMARTH AGARWAL With us Since Class 11 th	SANKALP PARASHAR With us Since Class 11 th	AARYAN K. GUPTA With us Since Class 9 th	UTKARSH P. SINGH With us Since Class 10 th

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Classroom: 11047 | Distance: 3708

NEET 2020

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