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Unleashing Potential

JEE MAIN 2023

APRIL ATTEMPT

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

QUESTIONS & SOLUTIONS

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15 APRIL, 2023

9:00 AM to 12:00 Noon

Duration : 3 Hours | Maximum Marks : 300

SUBJECT - PHYSICS

LEAGUE OF TOPPERS (Since 2020)

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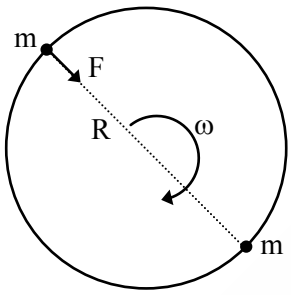
PHYSICS

1. Two point objects of mass 'm' performing circular motion due to each other's gravitational pull. Find the angular velocity of each object.

(1) $\frac{1}{R}\sqrt{\frac{Gm}{4R}}$ (2) $\frac{1}{R}\sqrt{\frac{Gm}{R}}$ (3) $\frac{1}{R}\sqrt{\frac{Gm}{2R}}$ (4) $\frac{1}{R}\sqrt{\frac{Gm}{6R}}$

Ans. **(1)** **Sol.**



$$m\omega^2 R = \frac{Gm^2}{(2R)^2}$$

$$\omega^2 = \frac{Gm}{4R^3}$$

$$\omega = \frac{1}{R}\sqrt{\frac{Gm}{4R}}$$

2. A string is vibrating in fundamental mode whose both end is fixed.

Given :

$f = 50$ Hz ; $f_0 \rightarrow$ fundamental frequency

$\mu = \frac{1}{50}$ Kg/m

$m = \frac{18}{1000}$ Kg

$\mu \rightarrow$ mass per unit length of string

$m \rightarrow$ mass of string

Find speed of wave.

(1) 90 m/s (2) 60 m/s (3) 40 m/s (4) 100 m/s

Ans. **(1)**

Sol. $\mu = \frac{m}{\ell}$

$$\ell = \frac{m}{\mu}$$

$f_0 = \frac{v}{2\ell}$

$v = (2\ell)f_0$

$v = \frac{2m}{\mu} f_0$

$v = 2 \times \frac{18}{1000} \times \frac{50 \times 50}{1}$

$v = 90$ m/s

3. For a particle performing SHM, mark correct options :

(i) Minimum acceleration is at extreme position.

(ii) Maximum velocity at mean position.

(iii) Restoring force is proportional to displacement.

(iv) Direction of acceleration and displacement are opposite.

(1) (ii), (iii), (iv) (2) (i), (ii), (iii) (3) (ii), (iii) (4) (iii), (iv)

Ans. **(1)**

Sol. Basic theory.

4. A particle experience a force F = 5x N, find work done when particle moves from x = 2 m to x = 4 m.

Ans. 30

Sol. $w = \int_2^4 5x dx$

$w = \frac{5}{2}[x^2]_2^4$

$w = \frac{5}{2}[16-4] = \frac{5 \times 12}{2} = 30J$

5. The position vector of a particle is $\vec{r} = (10t\hat{i} + 15t^2\hat{j} + 7\hat{k})$ m. Direction of force.

(1) +x (2) +y (3) –y (4) +z

Ans. **(2)**

Sol. $\frac{d\vec{r}}{dt} = v(t) = 10\hat{i} + 30t\hat{j}$

$\frac{d^2\vec{r}}{dt^2} = \frac{dv}{dt} = 30\hat{j}$ m/s^2

6. The half life of a substance is 5yr. Find the amount of substance left after 15 yr :

(1) $\frac{1}{8}^{th}$ (2) $\frac{1}{10}^{th}$ (3) $\frac{1}{4}^{th}$ (4) $\frac{1}{20}^{th}$

Ans. **(1)**

Sol. $N_t = \frac{N_0}{2^3}$

$N_t = \frac{N_0}{8}$

7. $x(t) = t^2 - 2t$, find speed of the particle at t = 2 sec.?

(1) 1 m/s (2) 2m/s (3) 4m/s (4) 6 m/s

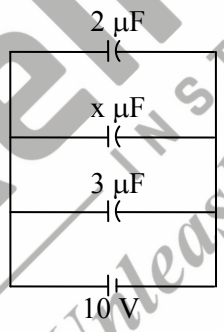
Ans. **(2)**

Sol. $x(t) = t^2 - 2t$

$v(t) = 2t - 2$

$v(t = 2) = 4 - 2 = 2$ m/s

8. Total charged stored in capacitor is 100 μC. Find x ?



(1) 2 μF (2) 3 μF (3) 4 μF (4) 5 μF

Ans. **(4)**

Sol. $Q_1 + Q_2 + Q_3 = 100$ μC

$20 + 30 + 10x = 100$ μC ....(1)

$x = 5$ μF

9. The de-broglie wavelength 'λ' when kinetic energy E, the de-broglie wavelength when kinetic energy $\frac{E}{4}$.

(1) 2 λ (2) 3 λ (3) 4 λ (4) 6 λ

Ans. **(1)**

Sol. $\lambda = \frac{h}{\sqrt{2mK}}$

$\lambda = \frac{1}{\sqrt{k}}$

$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{K_2}{K_1}}$

$\frac{\lambda}{\lambda_2} = \sqrt{\frac{E/4}{E}} = \frac{1}{2}$

$\lambda_2 = 2\lambda$

10. Find the ratio of radius of gyration of solid sphere to solid cylinder, if mass and radius of both objects are same. Axis is passing through centre of mass:

(1) $\sqrt{\frac{4}{5}}$ (2) $\sqrt{\frac{6}{5}}$ (3) $\sqrt{\frac{7}{5}}$ (4) $\sqrt{\frac{5}{6}}$

Ans. **(1)**

Sol. $\frac{K_S}{K_C} = \sqrt{\frac{I_S}{I_C}} = \sqrt{\frac{4}{5}\frac{mR^2}{mR^2}}$

$\frac{K_S}{K_C} = \sqrt{\frac{4}{5}}$

11. Height of receiving and transmitting antenna in communication of a signal are 245 m and 180 m. Find the maximum distance between the two antenna for proper communication:

(1) 104 km (2) 106 km (3) 110 km (4) 112 km

Ans. **(1)**

Sol. $d = \sqrt{2Rh_t} + \sqrt{2Rh_R}$

$d = \sqrt{2R}\left[\sqrt{R_t} + \sqrt{h_R}\right]$

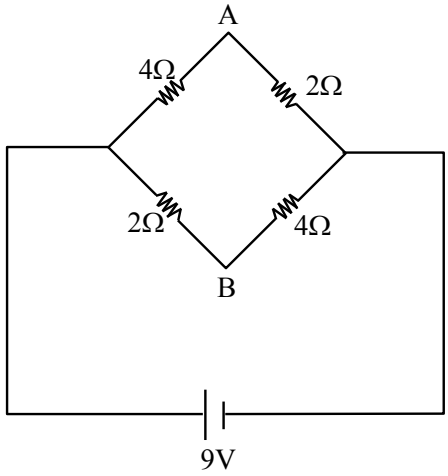
$d = \sqrt{2\times 6400\times 10^3}\left[\sqrt{180} + \sqrt{245}\right]$

$d = 800\ [60 + 70]$

$d = 104000$ meter

$d = 104$ km

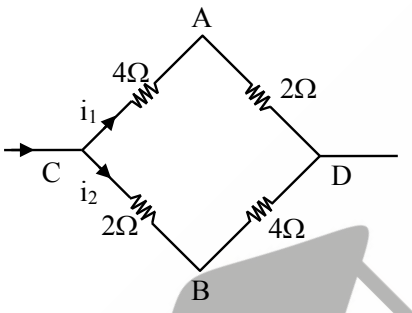
12. Find the potential difference between A and B?



(1) 3 V (2) 5 V (3) 7 V (4) 9 V

Ans. **(1)**

Sol.



$i_1 = i_2 = \frac{9}{6} = 1.5$

$V_{CA} = i_1 4 = 6$ volt

$V_{CB} = i_2 2 = 3$ volt

$V_A - V_B = 6 - 3 = 3$ volt

13. Electric field due to small dipole at large distance is proportional to :

(1) r^{-2} (2) r^{-3} (3) r^{-4} (4) r^3

Ans. **(2)**

Sol. $E_r = \frac{kP}{r^3}\sqrt{1+3\cos^2\theta}$

14. A soap bubble of radius R with surface tension T is placed in water at depth 'h'. Find $P_2 - P_1$.

Given :

P_1 = Atmospheric pressure

P_2 = Pressure inside the bubble

(1) $\rho gh + \frac{4T}{R}$ (2) $\rho gh - \frac{4T}{R}$ (3) ρgh (4) $\frac{4T}{R}$

Ans. **(1)**

Sol. $P_1 + \rho gh + \frac{4T}{R} = P_2$

$$P_2 - P_1 = \rho gh + \frac{4T}{R}$$

15. Find out the ratio of average translational kinetic energy of H_2 and Argon at temp 30ºC.

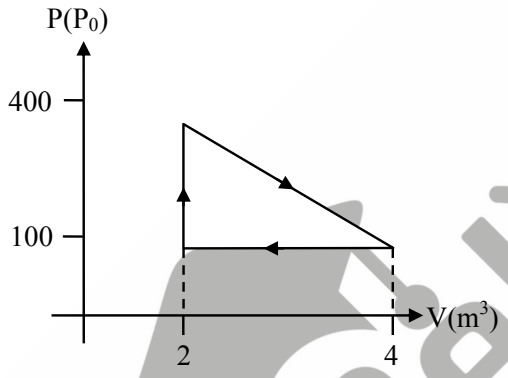
(1) 1 : 4 (2) 1 : 1 (3) 3 : 5 (4) 5 : 3

Ans. **(2)**

Sol. $\frac{\text{K.E.}}{\text{molecule}} = \frac{3}{2}KT$

So ratio is 1 : 1

16.



Work done by gas?

(1) 100 J (2) 200 J (3) 300 J (4) 350 J

Ans. **(3)**

Sol. Work done by gas = area under curve of P – V

$$= \frac{1}{2} \times 300 \times 2 = 300 \text{ J}$$

17. A body of mass m is released from height R from surface of earth. Find velocity of body when it reaches the surface of earth ?

(1) $\sqrt{\frac{GM}{4R}}$ (2) $\sqrt{\frac{2GM}{R}}$ (3) $\sqrt{\frac{GM}{R}}$ (4) $\sqrt{\frac{GM}{2R}}$

Ans. **(3)**

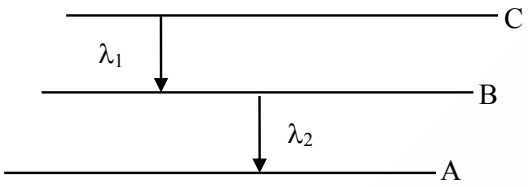
Sol. **M.E. conservation**

$$-\frac{GMm}{2R}=-\frac{GMm}{R}+\frac{1}{2}mv^2$$

$$\frac{1}{2}mv^2=\frac{GMm}{2R}$$

$$v=\sqrt{\frac{GM}{R}}$$

18. In hydrogen spectrum ratio of wavelength $\lambda_2 : \lambda_1$ is $\frac{7}{4n}$ then the value of n is :



A : 1st excited state

B : 3nd excited state

C : 3rd excited state

Ans. **5**

Sol. For A, x = 2

B, x = 3

C, x = 4

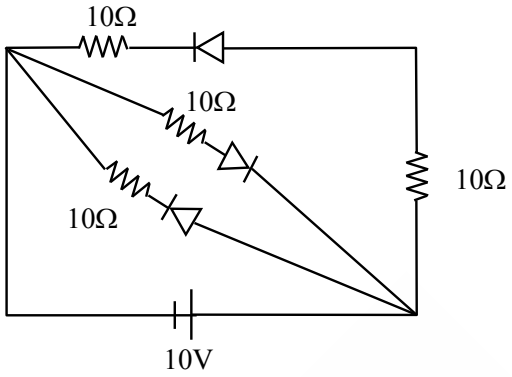
$$\frac{1}{\lambda_1}=Rz^2\left[\frac{1}{9}-\frac{1}{16}\right]$$

$$\frac{1}{\lambda_1}=Rz^2\frac{7}{16\times 9}$$

$$\frac{1}{\lambda_2}=Rz^2\left[\frac{1}{4}-\frac{1}{9}\right]=Rz^2\frac{5}{9\times 4}$$

$$\frac{\lambda_2}{\lambda_1}=\frac{7}{5\times 4}\quad\Rightarrow\quad n=5$$

19. Find current given by battery?



(1) 1.5 A (2) 2.5 A (3) 1 A (4) 0A

Ans. **(1)**

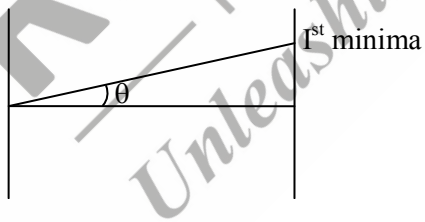
Sol. $R_{eq} = \frac{20\times10}{20+10} = \frac{20}{3}$

$I = \frac{10}{\left(\frac{20}{3}\right)} = \frac{3}{2} = 1.5A$

20. Light of λ = 600 nm is diffracted using a single slit of width d. Find d (in μm) if I^{st} minima is formed at 30° ?

Ans. **1.2**

Sol.



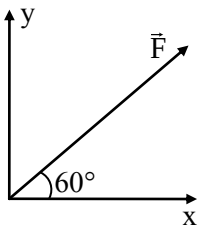
I^{st} minima is at $\sin\theta = \frac{\lambda}{d}$

$\therefore \quad \sin30° = \frac{600\times10^{-9}}{d}$

$\therefore \quad d = 1200 \times 10^{-9}$ m

$= 1.2\ \mu m$

21. y-component of force $\vec{F}$ is $2\sqrt{3}$ newton. What will be the x-component of $\vec{F}$.



(1) 1 N (2) 4N (3) 5 N (4) 2N

Ans. **(4)**

Sol. $\tan 60° = \frac{F_y}{F_x}$

$F_x = \frac{F_y}{\tan 60°}$

$F_x = \frac{2\sqrt{3}}{\sqrt{3}} = 2$ Newton

22. **Statement-1 :** In Bohr's orbit, angular momentum of an electron is quantized.

Statement-2 : Bohr's model does not obey Heisenberg uncertainty principle.

(1) Statement 1 & statement 2 are true

(2) Statement 1 & statement 2 are false

(3) Statement 1 is true and statement 2 is false

(4) Statement 1 is false and statement 2 is true

Ans. **(1)**

Sol. Basic theory

23. Velocity is represented in terms of wavelength λ, gravitational acceleration g, density ρ as $v = \lambda^a g^b \rho^c$, then value of a, b, c is

(1) $1, \frac{1}{2}, \frac{1}{2}$ (2) $\frac{1}{2}, \frac{1}{2}, 0$ (3) $\frac{1}{2}, 0, \frac{1}{2}$ (4) 1, 1, 0

Ans. **(2)**

Sol. $[v] = [\lambda]^a [g]^b [\rho]^c$

$[M^0L^1T^{-1}] = [L^{\alpha}][L^bT^{-2b}][M^cL^{-3c}]$

$= M^cL^{a+b-3c}T^{-2b}$

$c = 0 ; -2b = -1$

$\therefore \quad b = \frac{1}{2}$

& $a + b - 3c = 1$

and $a + \frac{1}{2} = 1$

$\therefore \quad a = \frac{1}{2}$

$\therefore \quad [v] = [\lambda]^{1/2}\,[g]^{1/2}[\rho]^{0}$

24. S_1 : In series combination the value of equivalent resistance is less then the smallest resistance

S_2 : Resistivity of material depends on temperature

(1) S_1 and S_2 True

(2) S_1 is true and S_2 is false

(3) S_1 is False and S_2 is true

(4) S_1 and S_2 is false.

Ans. **(3)**

Sol. $R_{eq.} = R_1 + R_2$

$\mathbf{R_{eq.}} >$ Max. (R_1 and R_2)

25. A wire of length ℓ, radius r is stretched by force F then elongation in wire is x if another wire of same material but length 2ℓ, radius 2r is stretched by 2F force, then elongation in wire.

(1) 2x (2) x (3) $\frac{x}{2}$ (4) 4x

Ans. **(2)**

Sol. $\mathbf{y} = \frac{F\ell}{x \times \pi r^2}$ **x'** = new elongation

$\mathbf{y} = \frac{2Fx2\ell}{x' \times 4\pi r^2}$ **x** = old elongation

26. Match the following :

Column-I		Column-II	
(A)	Visible	(p)	400 nm – 700 nm
(B)	γ-ray	(q)	10^{-3} nm – 10^{-2} nm
(C)	Ultra-violet	(r)	1 nm – 400 nm
(D)	X-ray	(s)	0.1 nm – 10 nm

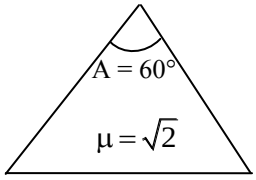
(1) A- p, B-q, C-r, D-s (2) A-q, B-p, C-r, D-s

(3) A-q, B-p, C-s, D-r (4) D-q, B-p, C-s, A-r

Ans. **(1)**

Sol. Basic Theory

27.



Find the minimum deviation ?

Ans. $\delta_{min} = 30°$

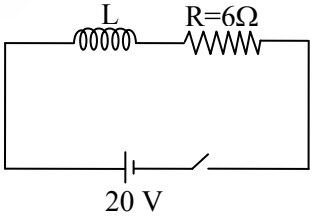
Sol. $$\mu = \frac{\sin\left[\frac{\delta_{min}+A}{2}\right]}{\sin\left(\frac{A}{2}\right)}$$

$$\frac{1}{\sqrt{2}} = \sin\left(\frac{\delta_{min}}{2}+30\right)$$

$$\frac{\delta_{min}}{2}+30° = 45°$$

$$\delta_{min} = 30°$$

28. at t = 0 switch is closed. At t = 1 ms voltage across inductor is 10 V. Find L.



(1) 8.6 mH (2) 12 mH (3) 4 mH (4) 3 mH

Ans. **(1)**

Sol. $i = \frac{\varepsilon}{R}[1 - e^{\frac{-tR}{L}}]$

$$L\frac{di}{dt} = \varepsilon e^{\frac{-t}{L}R}$$

$$10 = 20\, e^{\frac{-1\times10^{-3}\times6}{L}}$$

$$L = \frac{6\times10^{-3}}{\ell n\, 2}$$

$$L = 8.6 \times 10^{-3}\ H$$

$$L = 8.6\ mH$$

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SATYAM CHAKRAVORTY

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