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Unleashing Potential

JEE MAIN 2023

JAN ATTEMPT

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

QUESTIONS & SOLUTIONS

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24 JANUARY, 2023

9:00 AM to 12:00 Noon

Duration : 3 Hours | Maximum Marks : 300

SUBJECT - PHYSICS

Reliable Institute : A-10, Road No.1, IPIA, Kota-324005 (Rajasthan), India
Tel. : 0744-3535544, 2665544 I Website : www.reliablekota.com I E-mail : info@reliablekota.com

PHYSICS

1. The kinetic energy of a particle is 1000 joule with the mass 2 kg. Find the momentum for the particle?

(1) 200 kg m/s (2) 400 kg m/s (3) 800 kg m/s (4) 600 kg m/s

Ans. **(1)**

Sol. $P = \sqrt{2m(K\ E)}$

$P = \sqrt{2\times2\times1000} = 200$ kg m/s

2. A Particle is projected vertically upward reaches 136 m height. What will be the maximum range for the particle projected with same speed ?

(1) 272 m (2) 280 m (3) 290 m (4) 300 m

Ans. **(1)**

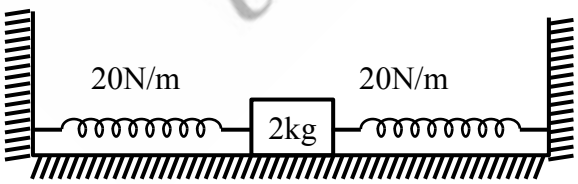
Sol. $\frac{U^2}{2g} = H_{max} = 136$ m

for maximum ranges $R = \frac{U^2}{g}$

$R_{max} = 2 \times H_{max}$

$R_{max} = 272$ m

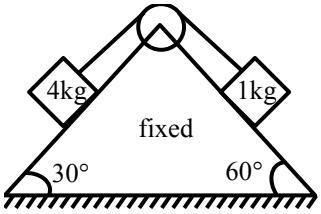
3. Given system is performing SHM with time period $T = \frac{\pi}{\sqrt{x}}$. Find x (all surfaces are smooth)?



Ans. **(5)**

Sol. $T = 2\pi\sqrt{\frac{2}{40}} = \frac{\pi}{\sqrt{5}} \therefore x = 5$

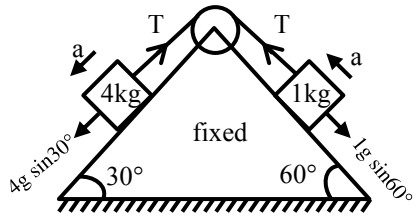
4. Find tension in string if all surfaces are smooth and string is massless.



(1) $4(\sqrt{3}+1)$N (2) $4(\sqrt{3}-1)$N (3) $(4\sqrt{3}+1)$N (4) $(4\sqrt{3}-1)$N

Ans. (1)

Sol.



$$a = \frac{4g\sin 30° - 1g\sin 60°}{5}$$

$$= \frac{20 - 5\sqrt{3}}{5}$$

$$= (4 - \sqrt{3})\text{m/s}^2$$

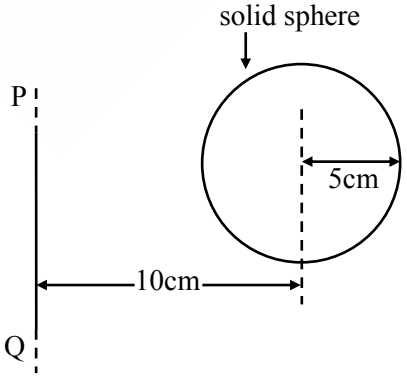
$4g\sin30° - T = 4a$

$T = 20 - 4(4 - \sqrt{3})$

$= 20 - 16 + 4\sqrt{3}$

$= 4 + 4\sqrt{3} = 4(\sqrt{3}+1)$N

5. Radius of gyration of solid sphere about axis PQ is $\sqrt{x}\frac{R}{5}$ where R is radius of sphere. Find the value of x ?



Ans. 110

Sol. $I_{com} = \frac{2}{5}MR^2$

||axis theorem

$I_{PQ} = Icom + m(2R)^2 = \frac{2}{5}MR^2 + 4MR^2 = \frac{22}{5}MR^2$

$I_{PQ} = MK^2$

$\frac{25}{5}MR^2 = MK^2 \Rightarrow K = \sqrt{\frac{25}{5}} \times R = \sqrt{110}\frac{R}{5}$

6. If equation of wave is given by y = 0.05 sin (2x – 4t). Find velocity of wave?

(1) 1 (2) 2 (3) 4 (4) 05

Ans. **(2)**

Sol. $V = \frac{\text{coefficient of t}}{\text{coefficient of x}}$

$= \frac{4}{2}$

= 2 m/sec

7. In a hydrogen atom first line wavelength of paschen series is λ = 720 nm. Find out second line wavelength of same series?

(1) 70.31 nm (2) 90 nm (3) 150 nm (4) 200 nm

Ans. **(1)**

Sol. $\frac{1}{\lambda} \propto \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

1^{st} wavelenth $\frac{1}{\lambda_1} \propto \left(\frac{1}{3^2} - \frac{1}{4^2}\right)$

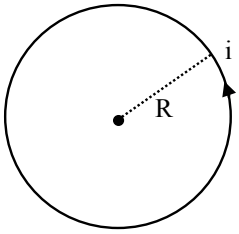
2^{nd} wavelenth $\frac{1}{\lambda_1} \propto \left(\frac{1}{3^2} - \frac{1}{5^2}\right)$

Taking ratio

$\frac{\lambda_2}{\lambda_1} = \frac{25}{256}$

$\lambda_2 = \frac{720 \times 25}{256} \approx 70.31$ nm

8. Figure shows current carrying coil of radius R. Find $\frac{B_{centre}}{B_{axis} \text{ at } r = R}$.



(1) $4\sqrt{2}$ (2) $2\sqrt{2}$ (3) $3\sqrt{2}$ (4) $\sqrt{2}$

Ans. (2)

Sol. $B_C = \frac{\mu_0 i}{2R}$ … (1)

$B_{r=R} = \frac{\mu_0 iR^2}{2(R^2+R^2)^{3/2}} = \frac{\mu_0 i}{4\sqrt{2}R}$ … (2)

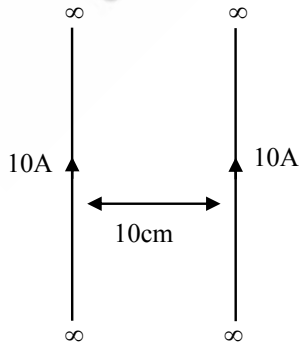
$\frac{B_C}{B_{r=R}} = \frac{\mu_0 i 4\sqrt{2}R}{2R\mu_0 i} = 2\sqrt{2}$

9. Two charges q_1 & q_2 are placed in a di-electric medium 'K' at a separation d and resultant force on any charge is F_0. If both are placed in air, then what should be the separation between them so that they experience same force?

(1) r = Kd (2) r = d (3) r = $d\sqrt{K}$ (4) r = $K^{3/2}d$

Ans. (3)

10. If a magnetic force on 10 cm portion of one wire is F_1. Now distance is halved and current gets doubled, then force on same portion is xF_1. Find x.



Ans. 8

Sol. $F_1 = \frac{\mu_0 i^2}{2\pi r} \times \ell$

$F_1 \propto \frac{i^2}{r}$

$\frac{F_1}{F_2} = \frac{i_1^2 / r_1}{i_2^2 / r_2} = \frac{1}{8}$

$F_2 = 8F_1$

$\therefore \quad x = 8$

11. A circular loop of radius $\frac{10}{\sqrt{\pi}}$cm is placed in a uniform time varying magnetic field with field being perpendicular to the plane of the loop. If the field decreases from 0.5 T to zero in 0.5 sec, then induced emf in the loop at 0.25 sec. is :

(1) 1 mV (2) 10 mV (3) 5 mV (4) 100 mV

Ans. **(2)**

Sol. $|\varepsilon| = A.\frac{dB}{dt} = \pi \times \left(\frac{100}{\pi} \times 10^{-4}\right) \times \frac{0.5}{0.5} = 0.01 \text{ Volt}$

12. **Statement-1 :** When light is incident from air to water then Brewster's angle is θ_B then if light is incident from water to air then Brewster's angle is $\frac{\pi}{2} - \theta_B$.

Statement-2 : When light goes from air to any medium of refractive index is then Brewster's angle (θ_B) is given by $\theta_B = \tan^{-1}(\mu)$.

(1) both statement-1 and Statement-2 is true

(2) statement-1 is true and statement-2 is false

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

(4) both statement-1 and statement-2 are false

Ans. **(1)**

Sol. $r + r' = 90°$

$r' = 90° - r$

but $r = i$

$r' = 90° - i$

Now if light is incident from water to air then angle of incidence is $\frac{\pi}{2} - i$.

13. A cylinder has inner radius 2 mm and outer radius 4 mm. The resistivity of its material is $2.4 \times 10^{-5}\ \Omega$ m and its length is 3.14 m given. Find out its resistance between two ends?

Ans. **2**

Sol. $R = \rho\frac{\ell}{A}$

$$R = \frac{2.4\times10^{-5}\times3.14}{\pi[16-4]\times10^{-6}}$$

$$R = 2\ \Omega$$

14. Weight of an object on Earth is 18 N. Find out its weight (in N) at height 3200 km from the earth surface?

Ans. **8**

Sol. $R_e = 6400\text{Km}$

$$\text{height} = 3200\ \text{Km} = \left(\frac{R_e}{2}\right)$$

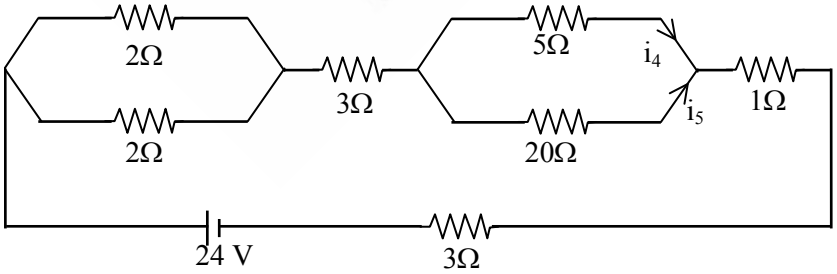
$$W_{earth} = 18\ \text{N} = m\ \frac{GM_e}{R_e^{\ 2}}$$

$$W' = m\ \frac{GM_e}{\left(R_e + \frac{R_e}{2}\right)^2}$$

$$W' = m\frac{GM}{R_e^2}\left(\frac{4}{9}\right) = 18 \times \frac{4}{9} = 8\text{N}$$

$$\boxed{W' = 8\text{N}}$$

15. Find the value of currents i_4 and i_5



(1) $\frac{2}{5}, \frac{8}{5}$ (2) $\frac{8}{5}, \frac{2}{5}$ (3) $\frac{3}{5}, \frac{6}{5}$ (4) $\frac{1}{5}, \frac{4}{5}$

Ans. **(2)**

Sol. $R_{eq} = \frac{2\times2}{2+2} + 3 + \frac{5\times20}{5+20} + 1 + 3$

$R_{eq} = 1 + 3 + 4 + 1 + 3 = 12\Omega$

$i_{circuit} = \frac{24}{R_{eq}} = \frac{24}{12} = 2A$

$i_4 = i_{circuit}\frac{(20)}{20+5} = 2\times\frac{20}{25} = \frac{8}{5}A$

$i_5 = i_{circuit}\frac{(5)}{20+5} = \frac{2\times5}{25} = \frac{2}{5}A$

Ans. $\left(\frac{8}{5}, \frac{2}{5}\right)$

16. **Statement-1 :** In photodiode, the intensity of light is measured while reverse biasing the photodiode.

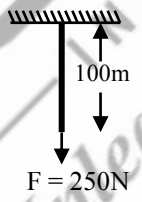
Statement-2 : Forward bias current is more than reverse bias current in PN junction.

(1) TF (2) TT (3) FF (4) FT

Ans. **(2)**

17. A force of 250 N is applied on a wire as shown

[Young Modulus = 10^{10} N/m^2, Area = 6.25×10^{-4} m^2]. Find extension (in cm) is spring ?



Ans. **0.4**

Sol. F = Kx

$250 = \frac{\gamma A}{\ell}x$

$250 = \frac{10^{10}\times6.25\times10^{-4}x}{100}$

$x = 4 \times 10^{-3}m$

$x = 0.4$ cm

18. Match the column.

	Column-I		**Column-II**
(a)	h (Planck's constant)	(P)	$[M^1L^1T^{-1}]$
(b)	P (momentum)	(Q)	$[M^1L^2T^{-3}]$
(c)	V (stopping potential)	(R)	$[M^1L^2T^{-2}]$
(d)	ϕ (work function)	(S)	$[M^1L^2T^{-3}A^{-1}]$

Choose the correct option

(1) (a) $\rightarrow$ Q, (b) $\rightarrow$ P, (c) $\rightarrow$ S, (d) $\rightarrow$R

(2) (a) $\rightarrow$ P, (b) $\rightarrow$ Q, (c) $\rightarrow$ R, (d) $\rightarrow$ S

(3) (a) $\rightarrow$ R, (b) $\rightarrow$ P, (c) $\rightarrow$ S, (d) $\rightarrow$ Q

(4) (a) $\rightarrow$ S, (b) $\rightarrow$ P, (c) $\rightarrow$ Q, (d) $\rightarrow$ R

Ans. (1)

Sol. h(Planck's constant)

(a) $E = h\nu$

$$\frac{[ML^2T^{-2}]}{[T^{-1}]} = h = [M^1L^2T^{-1}] = h$$

(b) P(momentum)

$P = mv = [m][LT^{-1}] = [MLT^{-1}]$

(c) V_s (stopping potential)

$$V_s = Ed = \frac{Fd}{q} = \frac{[M^1L^1T^{-2}][L]}{[AT]} = [M^1L^2T^{-3}A^{-1}]$$

(d) Work function (ϕ)

ϕ = Energy

$\phi = [M^1L^2T^{-2}]$

19. An Electromagnetic wave propagation vector $\vec{K}$ and electric field $\vec{E}$. If ω is the angular frequency then the value of the magnetic field is?

(1) $\omega\left(\vec{K}\times\vec{E}\right)$

(2) $\frac{I}{\omega}\left(\vec{K}\times\vec{E}\right)$

(3) $\vec{K}\times\vec{E}$

(4) $\vec{E}\times\vec{K}$

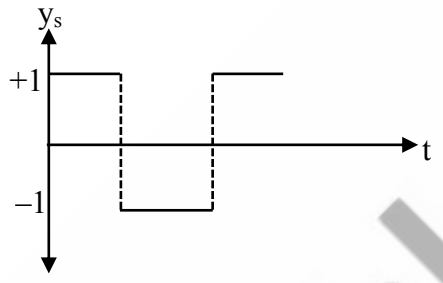
Ans. (3)

Sol. $C = \frac{E}{B}$ and $C = \frac{\omega}{K}$

$\frac{\omega}{K} = \frac{E}{B} \Rightarrow B = \frac{EK}{\omega}$

and $\left(\vec{K} \times \vec{E}\right)$ is direction of propagation of $\vec{B}$.

20. A signal of square shape is superimposed with a carrier wave $y_c = 2 \sin(\omega_c t - kx)$, then modulation index of amplitude modulated wave is



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

Ans. **(1)**

Sol. $\mu = \frac{A_m}{A_c} = \frac{1}{2}$

21. **Statement 1 :** If temperature of a gas is increased from – 73ºC to 527°C then its rms velocity becomes double.

Statement 2 : Product of pressure and volume is equal to translational kinetic energy of an ideal gas.

(1) Statement 1 is true, statement-II is true

(2) Statement 1 is false, statement-II is true

(3) Statement 1 is true, statement-II is false

(4) Statement 1 is false, statement-II is false

Ans. **(3)**

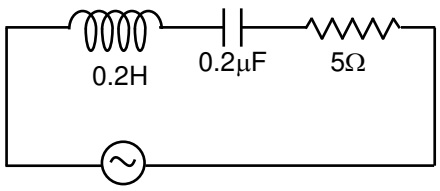
Sol. Statement-1 $V_{rms} = \sqrt{\frac{3RT}{M_0}}$

$\frac{V_{rms_1}}{V_{rms_2}} = \sqrt{\frac{T_1}{T_2}} = \sqrt{\frac{200}{800}} = \frac{1}{2}$

$2V_{rms_1} = V_{rms_2}$

Statement-2 $K.\varepsilon_T = \frac{3}{2}PV$

22. Calculate the ratio of quality factor and band width for the following circuit.



Ans. **8**

Sol. For an RLC circuit

band with = $\frac{R}{L} = \frac{5}{0.2}$ Hz

for an RLC circuit factor $\frac{\sqrt{L}}{R\sqrt{C}} = \frac{\sqrt{0.2}}{5\times\sqrt{0.2}\times10^{-6}} = 200$

$\frac{Q}{B \text{ width}} = \frac{200}{25} = \frac{8}{1}$

23. A radioactive substance $^{218}_{84}X$ undergoes following decay:

$$^{218}_{84}X \xrightarrow{\alpha-\text{Decay}} A \xrightarrow{\beta^- -\text{Decay}} B \xrightarrow{\alpha-\text{Decay}} C \xrightarrow{\beta^+ -\text{Decay}} D \xrightarrow{\gamma-\text{Decay}} Y$$

Then product y is :

(1) $^{210}_{84}Y$ (2) $^{210}_{80}Y$ (3) $^{208}_{84}Y$ (4) $^{210}_{82}Y$

Ans. **(2)**

Sol. By mass conservation : $218 - 4 \times 2 = 210$

By Charge conservation : $84 - 2 \times 2 + (-1) + 1 \times 1 = 80$

24. 1 gm liquid is converted into vapour under 3×10^5 Pa. 10% of heat is used to expand volume by 1600 cm^3. What is the increase in internal energy:-

(1) 4800 (2) 4320 (3) 4300 (4) 400

Ans. **(2)**

Sol. 10% of heat is used in expansion

Rest 90% will increase internal energy

$Q \times \frac{10}{100} = P.\Delta V = 3 \times 10^5 \times 1600 \times 10^{-6}$

$0.1Q = 48 \times 10 = 480$

$Q = 4800$ J

$\Delta U = 0.9\ Q = 0.9 \times 4800 =$ $\boxed{4320J}$

25. Choose the correct option based on the following statements

(a) Photoelectric effect is explained by wave theory

(b) Stopping potential may depend on work function

(c) If intensity of light increases then photoelectric current also increases

(d) If intensity of light increases then maximum kinetic energy of photoelectrons increases.

(1) (a, d) (2) (a, c) (3) c (2) (b, c, d)

Ans (3)

Basic Theory

26. If $\vec{A} = 3\hat{i} - 2\hat{j} + b\hat{k}$ and $\vec{B} = a\hat{i} + \frac{7}{2}\hat{j} + 2\hat{k}$ and $\vec{A}$ & $\vec{B}$ are perpendicular to each other, also $2a - 3b = -4$. If $\frac{a}{b} = \frac{x}{2}$. The value of x is ?

Ans. (1)

Sol. $\vec{A}.\vec{B} = 0$

$3a - 7 + 2b = 0$

$3a + 2b = 7$

$\Rightarrow a = 1$ & $b = 2$

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