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JEE MAIN 2023

APRIL ATTEMPT

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

QUESTIONS & SOLUTIONS

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12 APRIL, 2023

9:00 AM to 12:00 Noon

Duration : 3 Hours | Maximum Marks : 300

SUBJECT - PHYSICS

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PHYSICS

1. If a Planet has mass equal to 16 times the mass of earth and radius equal to 4 times that of Earth. The ratio of escape speed of Planet is to that of Earth is:

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

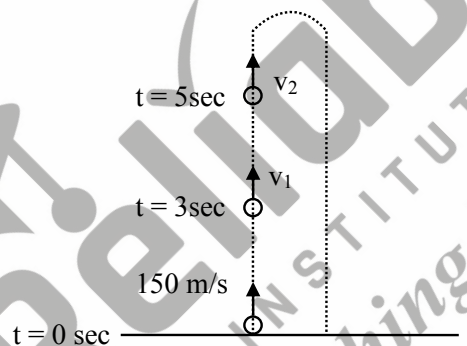
Ans. **(1)**

Sol. $V_{planet} = \sqrt{\frac{2\,G\,16m_e}{4R_e}}$

$V_{planet} = 2\sqrt{\frac{2\,Gm_e}{R_e}}$

$V_{planet} = 2V_{earth}$

2. A body is projected vertically upwards with a velocity 150 m/sec. Find the ratio of speeds at t = 3 sec. and t = 5 sec.?



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

Ans. **(3)**

Sol. $\frac{V_1}{V_2} = \frac{150-10(3)}{150-10(5)} = \frac{120}{100}$

$\frac{V_1}{V_2} = \frac{6}{5}$

3. If proton and α particle are moving with accelerating potential difference 2 V and 4 V respectively. Find out ratio of their de-Broglie wave length :

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

Ans. **(3)**

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

$\lambda_p = \frac{h}{\sqrt{2mq(2v)}}$

$\lambda_\alpha = \frac{h}{\sqrt{2\times 4m\times 2q\times (4v)}}$

$\frac{\lambda_p}{\lambda_\alpha} = 4$

4. A particle under SHM having amplitude A. Find ratio of potential energy and KE of $x = \frac{A}{2}$ from mean position.

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

Ans. **(1)**

Sol. $KE = \frac{1}{2}m\omega^2\left[A^2 - \frac{A^2}{4}\right]$

$= = \frac{1}{2}m\omega^2 \times 3\frac{A^2}{4}$

$PE = = \frac{1}{2}m\omega^2 \frac{A^2}{4}$

$\frac{PE}{KE} = \frac{1}{3}$

5. A body of mass 5 kg is in equilibrium due to forces F_1, F_2 and F_3. F_2 and F_3 are perpendicular to each other. If F_1 is removed then what would be the acceleration of body.

Given $F_2 = 6N$ and $F_3 = 8$ N

(1) 2 m/s^2 (2) 1 m/s^2 (3) 4 m/s^2 (4) 8 m/s^2

Ans. **(1)**

Sol. $\vec{a} = \frac{\vec{F} + \vec{F}_3}{m}$

$\vec{a} = \frac{6\hat{i} + 8\hat{j}}{5}$

$|\vec{a}| = \frac{10}{5} = 2 \text{ m/s}^2$

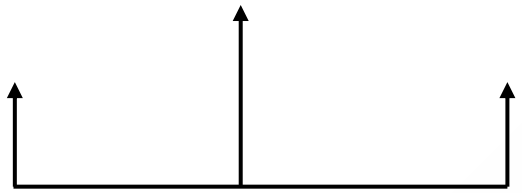
6. Given, the message signal is $y_m = A_m \sin(4\pi t)$ and carrier signal is $y_c = A_c \sin(1000\ \pi t)$. Choose the frequencies given below which lies in the bandwidth of amplitude modulated signal as given below:

(A) 428 Hz (B) 425 Hz (C) 498 Hz (D) 502 Hz (E) 500 Hz

(1) A, B, C (2) C, D, E (3) B, D (4) B, D, E

Ans. **(2)**

Sol.

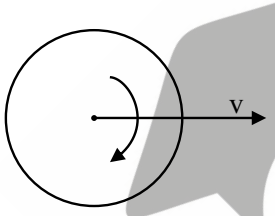


$F_c - F_m$ = 498 H_z F_c = 500 H_z $F_c + F_m$ = 502 H_z

7. A spherical shell is performing pure rolling motion. If the ratio of rotational kinetic energy and total kinetic energy is $\frac{x}{5}$? Find the value of x.

Ans. **2**

Sol.



$$K_{Tr} = \frac{1}{2}mv^2, \quad K_R = \frac{1}{2}\left(\frac{2}{3}mR^2\right)\omega^2$$

$$K_T = K_{Tr} + K_R$$

$$= \frac{mv^2}{2} + \frac{mv^2}{3}$$

$$K_T = \frac{5mv^2}{6}$$

$$\frac{K_R}{K_T} = \frac{1/3mv^2}{5/6mv^2} = \frac{2}{5}$$

8. A car of mass 500 kg is moving with constant velocity 80 km/hr. If friction coefficient between tyre of car and road is 0.04. Find work done (KJ) by engine of car in moving 4 km :

Ans. **800**

Sol. $F = umg = 0.04 \times 5000 = 200$ N

$w = 200 \times 4000$

$w = 8000$ kJ

9. Two satellites of masses m and 2 m are revolving in same orbit about earth. Which quantities will be same for both satellites

(1) Kinetic energy (2) Potential energy

(3) Total energy (4) Speed

Ans. **(4)**

Sol. Orbital speed

$$v = \sqrt{\frac{GM_e}{r}}$$

M_e = mass of earth

r = radius of orbit

these will depend on mass of satellite

$$KE = \frac{GM_em}{2r}$$

$$PE = -\frac{GM_em}{r}$$

$$TE = -\frac{GM_em}{2r}$$

10. 64 identical drops each charged to 10 volts coalesce to form a bigger drop. Find potential of bigger bubble (in volt) :

Ans. **160**

Sol. By volume conservation

$$64 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$$

$R = 4r$

Now, $V = \frac{kQ}{r} = 10$ volt

$$V' = \frac{k(64Q)}{4r}$$

$$= \frac{16kQ}{r} = 160 \text{ volt}$$

11. Temperature of body down from 80º C to 60º C in 5 minute. Then in what time temperature down from 60º C to 40º C? Given $T_{surrounding}$ = 20º C :

(1) $\frac{20}{3}$min. (2) $\frac{25}{3}$min. (3) 10 min. (4) 5 min.

Ans. **(2)**

Sol. $\frac{\Delta T}{\Delta t} = K\left(T - T_s\right)$

$\frac{80-60}{5} = K(70-20)$

$4 = K\,(50)$ …. (i)

$\frac{60-40}{t} = K(50-20)$

$t = \frac{2}{3K} = \frac{2\times 50}{3\times 4}$

$t = \frac{25}{3}$ min.

12. In an NPN transistor for common emitter mode the value of current gain will be _____ .

(Given ΔI_C = 11 mA, ΔI_B = 100 μA)

(1) 50 (2) 100 (3) 110 (4) 220

Ans. **(3)**

Sol. CE mode current given

$\beta = \frac{\Delta I_C}{\Delta I_B} = 110$

13. R.M.S. speed of chlorine molecule is 490 m/sec. Find R.M.S. speed of Argon molecule at same temperature.

(Molar mass of chlorine = 70.9 μ; Molar mass of argon = 39.9 μ)

(1) 451.9 (2) 551.9 (3) 651.9 (4) 751.9

Ans. **(3)**

Sol. $V_{rms} \propto \sqrt{\frac{1}{M}}$

$$\frac{v_{rms}}{490} = \sqrt{\frac{70.9}{39.9}}$$

$$V_{rms} = 490 \times 1.3 = 651.9$$

14. Find efficiency of Carnot engine working between boiling point and melting point of water :

(1) 100 % (2) 26.81 % (3) 36.63 % (4) 73.19 %

Ans. **(2)**

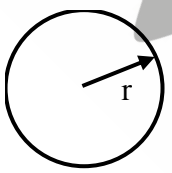
Sol. $\eta = 1 - \frac{T_L}{T_H} = i - \frac{273}{373}$

$$\eta = 26.81\ \%$$

15. The rate of change of radius of a coil is 0.1 mm/s. The magnetic field is 0.4 Tesla. The induced emf is $x\mu_0$ volt. Find value of x?

Ans. **4**

Sol.



$$A = \pi r^2$$

$$\phi = B\pi r^2$$

$$\frac{d\phi}{dt} = e = B\pi 2r\frac{dr}{dt}$$

$$e = 0.4 \times 2 \times \pi \times r \times 0.1 \times 10^{-2}$$

$$e = 8\pi \times 10^{-4} \times 2 \times 10^{-3}$$

$$e = 16\pi \times 10^{-7} \text{ volt}$$

$$e = 4\mu_0 \text{ volt}$$

16. If length of conducting wire of resistance 'R' is made double by elongating it ; its new resistance will be

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

Ans. **(2)**

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

After elongation $R' = \frac{\rho \times 2\ell}{\frac{A}{2}}$

$= 4\ R$

17. Current at 0°C is 2A. Current at 100°C is 1.2 A. Then what would be the current at 50°C.

(1) 1.2 A (2) 1.4 A (3) 1.6 A (4) 1.8 A

Ans. **(3)**

Sol. $i = \ell_0 (1 - \propto \Delta T)$

$1.2 = 2(1 - \propto (100 - 0))$

$\propto = 4 \times 10^{-3}$

$i = 2 (1 - 4 \times 10^{-3} \times 50)$

$i = 1.6$ A

18. If light of photon energy 12.75 eV is incident on H-sample. Find out number of spectral lines emitted.

Ans. **6**

Sol. $12.75 = 13.6 \left(\frac{1}{1^2} - \frac{1}{n^2}\right)$

$n = 4$

number of spectral lines $= \frac{n(n-1)}{2} = 6$

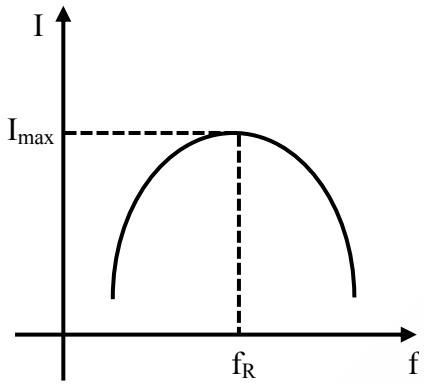
19. **Statement-I:-** In a series LCR circuit if frequency increases then current flowing through circuit first increases then attains maximum value and then decreases.

Statement-II:- At resonant frequency power factor of LCR circuit is one.

(1) T T (2) T F (3) F T (4) F F

Ans. **(1)**

Sol.



Also at $\omega = \omega_R$; $z = R \Rightarrow \cos\phi = \frac{R}{z} = 1$

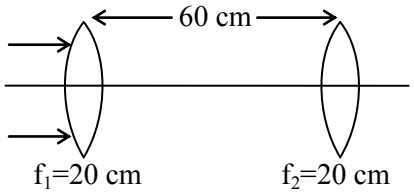
20. **Statement-1 :** Diamagnetism do not depend on temperature.

Statement-2 : In diamagnetic materials, induced B is opposite to applied magnetic field.

(1) True, False (2) False, True (3) True, True (4) False, False

Ans. **(3)**

21. Two identical convex lenses are arranged as shown in figure. What will be the distance of final image from first lens.



(1) 40 cm (2) 60 cm (3) 80 cm (4) 100 cm

Ans. **(3)**

Sol. for Ist lens

$$\frac{1}{V_1}-\frac{1}{\infty}=\frac{1}{20}$$

$V_1 = 20$ cm

For IInd lens

$$\frac{1}{V_2}-\frac{1}{-40}=\frac{1}{20}$$

$V_2 = +20$ cm

Hence distance = 80 cm

22. Match the quantities in **column-I** with their dimension in **column-II**.

Column-I		**Column-II**
(P) Angular speed	(a)	$[ML^2T^{-1}]$
(Q) Angular momentum	(b)	$[T^{-1}]$
(R) Spring constant	(c)	$[MT^{-2}]$
(S) Moment of inertia	(d)	$[ML^2]$

(1) (P)-(b), (Q)-(a), (R) – (c), (S) – (d)

(2) (P)-(b), (Q)-(c), (R) – (a), (S) – (d)

(3) (P)-(a), (Q)-(b), (R) – (d), (S) – (c)

(4) (P)-(a), (Q)-(c), (R) – (b), (S) – (d)

Ans. **(1)**

Sol. $[T^{-1}] = \omega$

$L = mvr = [ML^2T^{-1}]$

$k = \frac{F}{x} = [MT^{-2}]$

$I = MR^2 = [ML^2]$

23. **Statement-I :** If car and truck are having same speed and are provided same deceleration then they will cover same distance.

Statement-I : Car is moving towards east then turns north, speed remains constant and acceleration is zero.

(1) Statement-I and Statement-II are true.

(2) Statement-I and Statement-II are false.

(3) Statement-I is true and Statement-II is false.

(4) Statement-I is false and Statement-II is true.

Ans. **(3)**

Sol. Basic theory

24. **Assertion :** If dipole is kept in an isolated box. The total flux through the box is zero.

Reason : Dipole has equal and opposite charge.

(1) Statement-I and Statement-II are true.

(2) Statement-I and Statement-II are false.

(3) Statement-I is true and Statement-II is false.

(4) Statement-I is false and Statement-II is true.

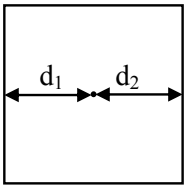
Ans. **(1)**

Sol. Basic theory

25. **A small bubble is** trapped inside a cube of edge length 24 cm. If apparent distance of bubble 12 cm and 4 cm from one and other side. Find out refractive index of ice.

Ans. **1.5**

Sol. $12 = \frac{d_1 \times \ell}{\mu}$ … (i) $4 = \frac{d_2 \times \ell}{\mu}$



$d_1 + d_2 = 24 \text{ cm} = 12\ \mu + 4\ \mu = 16\ \mu \text{ cm}$

$\mu = \frac{24}{16} = \frac{3}{2} = 1.5$

26. A dipole having dipole moment $\vec{M}$ is placed in two magnetic field of strength B_1 and B_2 respectively. If dipole oscillates 60 time in 20 seconds in B_1 magnetic field and 60 oscillations in 30 sec. in B_2 magnetic field. Then find $\frac{B_1}{B_2}$

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

Ans. **(1)**

Sol. $T = 2\pi\sqrt{\frac{I}{MB}}$

$\frac{T_1}{T_2} = \sqrt{\frac{B_2}{B_1}}$

$\frac{B_1}{B_2} = \left(\frac{T_2}{T_1}\right)^2$

$\frac{B_1}{B_2} = \left(\frac{30}{60}\right)^2 \times \left(\frac{60}{20}\right)^2$

$\frac{B_1}{B_2} = \frac{9}{4}$

27. Calculate energy released in MeV in following nuclear reaction :

$${}^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He + Q$$

[^{238}U =238.05079 u, ^{234}Th = 234.04363 u, ${}^{4}_{2}\alpha$ = 4.00260 u] (Take 1 u = 931.5 MeV/c^2)

Ans. 4.25

Sol. $Q = (M_U - M_{Th} - M_{He})\, C^2$

$= 0.00456 \times 931.5 = 4.25$ MeV

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SATYAM CHAKRAVORTY

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