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JEE (Main)

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

2022

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 24 June, 2022 (SHIFT-2) | TIME : (3.00 p.m. to 6.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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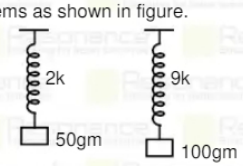
PART : PHYSICS

1. We have two spring block systems as shown in figure.



During oscillation maximum speed of both block is same. Find the ratio of Amplitude of oscillation of Blocks ?

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

Ans. **(2)**

Sol. $V_{man} = \omega_1 A_1 = \omega_2 A_2$

$$\frac{A_1}{A_2} = \frac{\omega_2}{\omega_1} = \frac{\sqrt{K_2/m_2}}{\sqrt{K_1/m_1}}$$

$$= \frac{\sqrt{K_2}}{\sqrt{K_1}} \times \frac{\sqrt{m_2}}{\sqrt{m_1}}$$

$$= \frac{\sqrt{9k}}{\sqrt{2K}} \times \frac{\sqrt{50}}{\sqrt{100}} = \frac{3}{2}$$

2. A particle of mass 5 kg is thrown upwards from ground. It experiences a constant air resistance 10 N opposite to the direction of velocity of particle. The ratio of time of ascent to the time of descent is. [g = 10 m/s^2]

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

Ans. **(2)**

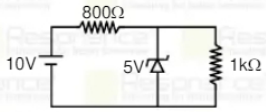
Sol. Let a be the retardation produced by air resistive force a = $\frac{F_{air}}{M} = \frac{10}{5} = 2$, t_a and t_d be the time of ascent and time of descent respectively.

If the particle rises upto a height h

then $h = \frac{1}{2}(g + a)\, t_a^2$ and $h = \frac{1}{2}(g - a)\, t_d^2$

$\therefore$ $\frac{t_a}{t_d} = \sqrt{\frac{g-a}{g+a}} = \sqrt{\frac{10-2}{10+2}} = \sqrt{\frac{2}{3}}$ **Ans.** $\sqrt{\frac{2}{3}}$

3. Determine current in

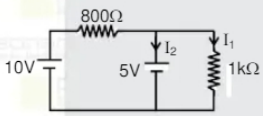


For the circuit above current through Zener diode.

(1) 1.125 mA (2) 2.25 mA (3) 4 mA (4) 4.5 mA

Ans. **(1)**

Sol.



$-10 + 800I + 5 = 0$

$$I = \frac{5}{800} \text{ Amp}$$

$$I_1 = \frac{5}{1000} \text{ Amp}$$

$I_2 = I - I_1$

$$= \frac{5}{800} - \frac{5}{1000} = 1.125 \text{ mA}$$

4. If the ratio of intensity of to light is 9 : 4. Find the ratio of maximum to minimum intensity due to interference of the lights.

(1) 5 : 1 (2) 25 : 1 (3) 7 : 5 (4) 25 : 16

Ans. **(2)**

Sol. Given

$$\frac{I_1}{I_2}=\frac{9}{4}$$

$$\frac{I_{max.}}{I_{min.}}=\frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2}=\frac{\left(\frac{\sqrt{I_1}}{\sqrt{I_2}}+1\right)^2}{\left(\frac{\sqrt{I_1}}{\sqrt{I_2}}-1\right)^2}=25:1$$

5. Proton, deuteron and α-particle are projected with same kinetic energy in uniform magnetic field in the direction perpendicular to the magnetic field. Then ratio radii in magnetic field is :

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

Ans. **(3)**

Sol. For circular path in magnetic field.

$r=\frac{\sqrt{2mE}}{qB}$ E = kinetic energy

So

	d	p	α
m	2	1	4
q	e	+e	2e

$$r_1:r_2:r_3=\frac{\sqrt{m_1}}{q_1}:\frac{\sqrt{m_2}}{q_2}:\frac{\sqrt{m_3}}{q_3}=\frac{\sqrt{1}}{e}:\frac{\sqrt{2}}{e}:\frac{\sqrt{4}}{2e}=1:\sqrt{2}:1$$

6. During circular motion with constant angular acceleration, in 1st second, starting from rest covers 5 rotation. Then find number of rotation in next second.

(1) 5 (2) 12 (3) 10 (4) 15

Ans. **(4)**

Sol. $\theta=\omega t+\frac{1}{2}\alpha t^2$

$\theta_1=\frac{1}{2}\alpha(1)^2$ ...(i)

$\theta_1+\theta_2=\frac{1}{2}\alpha(2)^2$ ...(ii)

so $\theta_2=3\theta_1=3\times5=15$

7. Hammer of mass 1.5 kg strikes to nail of mass 5 kg with velocity 20 m/s. $\frac{1}{4}$ th energy of hammer is transfer to nail, then find rise in temperature of nail, (s = 0.42)

(1) 35 K (2) 102 K (3) 90 K (4) 180 K

Ans. **(1)**

Sol. $\frac{1}{4}$ kinetic energy of hammer is converted into heat. Which is transfer to the nail.

$$\frac{1}{4}\left(\frac{1}{2}M_{hammer}\times v^2\right)=M_{nail}\,s\Delta\theta$$

$$\Delta\theta=\frac{1}{8}\frac{M_{hammer}}{M_{nail}}\frac{v^2}{s}=\frac{1\times1.5\times(20)^2}{8\times5\times0.42}=34.56\text{ K}$$

8. Which of the following option have physical quantity of same dimension.

(1) Angular velocity & Angular momentum (2) Wien's constant; Stefan's constant
(3) Velocity gradient, decay constant (4) Torque, Force

Ans. **(3)**

9. Earth is revolving around sun in orbit of radius r with time period T_1. If radius becomes 3r and time periods becomes T_2, find $\frac{T_2}{T_1}$:

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

Ans. **(3)**

Sol. $\frac{T_2}{T_1} = \left(\frac{r_2}{r_1}\right)^{3/2} = \left(\frac{3r}{r}\right)^{3/2}$

$\frac{T_2}{T_1} = 3\sqrt{3}$

10. A particle attached to a light rod moving with constant speed in vertical circular motion. Select the correct option :

(1) Tension is minimum at highest position (2) Tension is maximum at highest position
(3) Tension is maximum when string is Horizontal (4) Tension is minimum when string is horizontal.

Ans. **(1)**

11. A particle of mass 5 kg is projected is angle of 45º with horizontal at t = 0. Its velocity at t = 2 second is 20 m/s, than maximum height of particle from the earth surface.

(1) 20 m (2) 40 m (3) 30 m (4) 10 m

Ans. **(1)**

Sol. Assume initial speed is u

then $\vec{u} = \frac{u}{\sqrt{2}}\hat{i} + \frac{u}{\sqrt{2}}\hat{j}$

at 2 sec

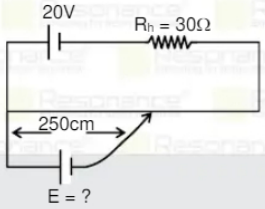
$\vec{v} = \frac{u}{\sqrt{2}}\hat{i} + \left(\frac{u}{\sqrt{2}} - g\times 2\right)\hat{j}$

given $\Rightarrow v = 20 = \sqrt{\left(\frac{u}{\sqrt{2}}\right)^2 + \left(\frac{u}{\sqrt{2}} - 2g\right)^2}$

$400 = \frac{u^2}{2} + \frac{u^2}{2} + 400 - \frac{40u}{\sqrt{2}}$; $u^2 - \frac{40}{\sqrt{2}}u = 0$; $u\left(u - \frac{40}{\sqrt{2}}\right) = 0$ $\Rightarrow u = 0$ or $u = \frac{40}{\sqrt{2}}$ m/s

Maximum height = $\frac{u^2(\sin^2\theta)}{2g} = \frac{\left(\frac{40}{\sqrt{2}}\frac{1}{\sqrt{2}}\right)^2}{2g} = \frac{(20)^2}{20} = 20$ m

12. In potentiometer circuit A cell of Emf E was balanced for balance length of 250 cm. Resistance of potentiometer wire = 20Ω. Length of potentiometer wire = 10 m. Determine Emf E.



(1) 8 (2) 6 (3) 4 (4) 2

Ans. **(2)**

Sol. $I = \frac{20}{R+R_n} = \frac{20}{20+30} = \frac{20}{50} = \frac{2}{5}$ Amp

Y = potential gradient = $\frac{iR}{L} = \frac{2}{5} \times \frac{20}{10} = \frac{4}{5}$ V/m

Balance length = 250 cm = 2.5 metre

E = y × Balance length = $\frac{4}{5} \times 2.5 = 2$ volt

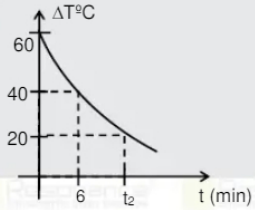
Ans. 2 volt

13. Hot water at temperature 80ºC start cooling in surrounding whose temperature remain constant.

ΔT = temperature difference between water and surrounding

t = time in minutes

Graph showing variation of ΔT with time (t) in given. Determine t_2 in minutes



(1) 16 min (2) 32 min (3) 45 min (4) 60 min

Ans. **(1)**

Sol. $\Delta T = T_{water} - T_{sourounding} = T - T_s$

At t = 0 $\Delta T = 60$ and $T = 80^ºC$

$80 - T_s = 60$ $\therefore T_s = 20^ºC$

Newton law of cooling

$$-\frac{(T_f - T_i)}{\Delta t} = k\left(\frac{T_i + T_{fi}}{2} - T_s\right)$$

between 0 to 6 minute

$$\frac{20}{6\,\text{min}} = k\left[\left(\frac{60+40}{2} + 20\right) - 20\right]$$

between 6 to t_2 minute

$$\frac{20}{t_2 - 6} = k\left[\left(\frac{40+20}{2} + 20\right) - 20\right]$$

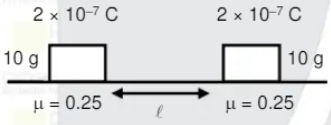
after dividing by t_2 = 16 min.

14. Two identical small block of same charge q = 2×10^{-7} C are placed on rough surface at distance ℓ from each other. Mass of each block is 10 gm and coefficient of friction for each block is $\mu = 0.25$. If both charges are in equilibrium then find ℓ.

(1) 10 cm (2) 12 cm (3) 4 cm (4) 6 cm

Ans. **(2)**

Sol.



$$\frac{kq^2}{\ell^2} = \mu mg$$

$$\ell = \sqrt{\frac{kq^2}{\mu mg}} = \sqrt{\frac{9\times10^9\times4\times10^{-14}}{0.25\times10\times10^{-3}\times10}}$$

$$= \sqrt{\frac{36\times10^{5\,|\,3}}{25}} = \frac{6}{5}\times10^{-1}\,m = \frac{60}{5}\ cm = 12\ cm$$

15. Material used for making electromagnet have different properties of the following, which property best matches for type of magnet required.

(1) High permeability & high retentively (2) low retentively and low coercively

(3) low retentively and high coercively (4) High permeability & high coercively

Ans. **(2)**

16. **Statement-1 :** Reactance may be zero if L and C are connected in AC circuit.

Statement-2 : Average power can never be zero.

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1

(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True.

Ans. **(3)**

17. In heat engine source temperature is T_1 = 727 ºC & sink temperature is T_2 = 127 ºC. If it take 3000 Kcal heat from source in each cycle find work done (in Joule) by it in each cycle.

(1) 900 J (2) 1800 J (3) 1800 × 4.2 J (4) 1800 × 10^3 × 4.2 J

And. **(4)**

Sol. Given

$T_1 = 727 + 273 = 1000$ K

$T_2 = 227 + 273 = 400$ K

$Q_1 = 3000$ K.cal

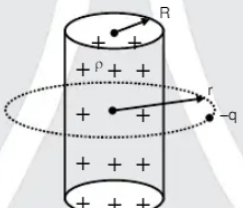
Efficiency

$$\eta = \frac{w}{Q_1} = 1 - \frac{T_2}{T_1}$$

$$w = Q_1\left(1 - \frac{T_2}{T_1}\right) = 3000\left(1 - \frac{400}{1000}\right)$$

W = 1800 K. cal

18. –q is moving along circular path around solid long cylinder under the interference of electric force. Determine kinetic energy of particle



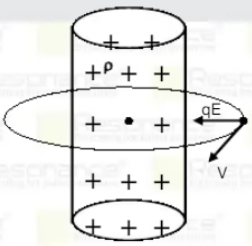
(1) $\frac{q\rho R^2}{3\varepsilon_0}$ (2) $\frac{q\rho R^2}{8\varepsilon_0}$ (3) $\frac{q\rho R^2}{4\varepsilon_0}$ (4) $\frac{q\rho R^2}{4\varepsilon_0 r}$

Ans. **(3)**

Sol. Charge (λ) per unit length of cylinder = $\frac{Q}{\ell}$

$= \frac{\rho \times \pi R^2 \ell}{\ell} = \rho\pi R^2$

$E = \frac{\lambda}{2\pi\varepsilon_0 r} = \frac{\rho\pi R^2}{2\pi\varepsilon_0 r} = \frac{\rho R^2}{2\varepsilon_0 r}$



$qE = \frac{mV^2}{r}$

$\frac{q \times \rho R^2}{2\varepsilon_0 r} = \frac{mV^2}{r}$

$mV^2 = \frac{q\rho R^2}{2\varepsilon_0}$

$KE = \frac{1}{2}mV^2 = \frac{q\rho R^2}{4\varepsilon_0}$

19. Lamp emit electromagnetic wave uniformly in all direction lamp is 3.5% efficient in converting electrical power to electromagnetic wave and consume 100 W of power.
Determine the amplitude of magnetic field associated with wave at a distance of 4 metre from lamp.
(1) 2.2×10^{-8} T (2) 3.5×10^{-8} T (3) 1.2×10^{-8} T (4) 6.4×10^{-8} T

Ans. **(3)**

Sol. Power of light = Power = $100 \times \frac{3.5}{100}$

$I = \text{Intensity} = \frac{\text{Power}}{4\pi r^2} = \frac{3.5 \times 100}{100 \times 4\pi (4)^2}\ w/m^2 = 0.0173\ w/m^2$

$I = \frac{B_0^2 C}{2\mu_0}$; $B_0 = \sqrt{\frac{I \times 2\mu_0}{C}}$; $B_0 = 1.2 \times 10^{-8}$ T

20. In a process diatomic gas is used, work done by gas is Q and change in internal energy is Q/4, find molar heat capacity of the gas in terms of R is :
(1) $\frac{25}{3}R$ (2) $\frac{25}{2}R$ (3) $\frac{25}{8}R$ (4) $\frac{25}{4}R$

Ans. **(2)**

Sol. given W = Q

$\Delta U = \frac{Q}{4}$

$\Delta Q = W + \Delta U = Q + \frac{Q}{4} = \frac{5}{4}Q$

We know $\Delta U = \frac{f}{2}nR(\Delta T)$ .....(1)

& $\Delta Q = nC\Delta T$ .....(2)

equation (2) & (1)

$\frac{C}{\frac{f}{2}R} = \frac{\Delta Q}{\Delta U}$; $\frac{C}{\frac{f}{2}R} = \frac{5Q}{4\frac{Q}{4}}$ $\therefore C = \frac{5fR}{2} = \frac{25R}{2}$

21. A capacitor have some charge say 'Q' coulomb. If 2 coulomb charge more is given to that capacitor then energy of capacitor is increased by 44%. Determine initial charge 'Q' in coulomb.
(1) 2C (2) 4C (3) 6C (4) 10C

Ans. **(4)**

Sol. $U = \frac{Q^2}{2C}$

New charge $\Rightarrow Q + 2$

U' = new energy = $\frac{(Q+2)^2}{2C}$

$U' = U + U \times \frac{44}{100} = U \times 1.44$

$$\frac{(Q+2)^2}{2C} = \frac{Q^2}{2C} \times 1.44$$

$Q + 2 = Q \times \sqrt{1.44}$

$Q + 2 = Q \times 1.2$

$2 = 0.2\,Q$

$Q = 10$ coulomb