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

JEE (Main) 2020

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 04 September, 2020 (SHIFT-2)  |  TIME : (03.00 p.m. to 06.00 p.m)
Duration: 3 Hours  |  Max. Marks: 300
SUBJECT : PHYSICS

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1. Two disc made of same material and same thickness having radius R and \( \alpha R \). Their moment of inertia about their own axis are in ratio 1 : 16. Calculate the value of \( \alpha \).

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

   Ans. (1)

   Sol. Moment of inertia of disc is given by 
   \[ I = \frac{MR^2}{2} = \frac{I_0 (\alpha R)^2}{2} \]
   \[ I = R^4 \]
   \[ \frac{I_2}{I_1} = \left( \frac{R_2}{R_1} \right)^4 \]
   \[ \frac{16}{1} = \alpha^4 \]
   \[ \alpha = 2 \]

2. Bus moving with speed \( v \) towards a stationary wall. It produces sound of frequency \( f = 420 \text{ Hz} \). The heard frequency of reflected sound from wall by driver is \( 490 \text{ Hz} \). Calculate the speed \( v \) of bus. The velocity of sound in air is 330 m/s
3. The given circuit behaves like a following single gate

\[ y = A + B + C \]

\[ y = A \cdot B \cdot C \]

whole arrangement behaves like a \textit{AND} gate

4. In the given circuit calculate the potential difference between points A and B.

\[ (1) \ 12 \ V \qquad (2) \ 24 \ V \qquad (3) \ 36 \ V \qquad (4) \ 48 \ V \]

\[ \text{Ans.} \ (3) \]
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**Sol.**

From ohm's law $V_{AB} = 90 \times 0.4 = 36$ V

5. Find current through $4\Omega$ resistance

Ans. 1 Amp

**Sol.**

$$I_B = \frac{8}{4 + 4} = 1 \text{ Amp}$$
6. Force on a particle varies with position (x) of particle as shown, calculate work done by force from x = 0 to x = 30 m

\[ F = 200 \text{ N} \]

\[ W = 100 \times 15 + \frac{1}{2} (100 + 200) \times 15 \]

\[ = 3000 + 2250 \]

\[ W = 5250 \text{ J} \]

Answer (1)

Sol. \[
\begin{align*}
(1) & \quad 5250 \text{ J} \\
(2) & \quad 4250 \text{ J} \\
(3) & \quad 7500 \text{ J} \\
(4) & \quad 3750 \text{ J}
\end{align*}
\]

7. A capacitor of capacitance \( C_0 \) is charged to potential \( V_0 \). Now it is connected to another uncharged capacitor of capacitance \( \frac{C_0}{2} \). Calculate the heat loss in this process.

\[ \text{(1)} \quad \frac{1}{2} C_0 V_0^2 \]

\[ \text{(2)} \quad \frac{1}{3} C_0 V_0^2 \]

\[ \text{(3)} \quad \frac{1}{6} C_0 V_0^2 \]

\[ \text{(4)} \quad \frac{1}{8} C_0 V_0^2 \]

Answer (3)

Sol.

\[ C_0 \]

\[ \Rightarrow \]

\[ \frac{C_0}{2} \]

Heat loss

\[ H = \frac{C_0 C_2}{2(C_1 + C_2)} (V_1 - V_2)^2 \]

\[ = \frac{C_0 C_2}{2(C_1 + C_2)} (V_0 - 0)^2 = \frac{C_0 V_0^2}{6} \]

\[ H = \frac{1}{6} C_0 V_0^2 \]

8. Find the ratio of moment of inertia about axis perpendicular to rectangular plate passing through O’ & O

\[ \begin{align*}
(1) & \quad \frac{1}{2} \\
(2) & \quad \frac{1}{3} \\
(3) & \quad \frac{1}{4} \\
(4) & \quad \frac{1}{8}
\end{align*} \]
9. Find the loss in gravitational potential energy of cylinder when valve is opened and level of liquid in both cylinder become same.

\[
\begin{align*}
(1) & \quad \frac{\rho Ag(x_1 - x_2)^2}{4} \\
(2) & \quad \frac{\rho Ag(x_1 + x_2)^2}{4} \\
(3) & \quad \frac{\rho Ag(x_1^2 - x_2^2)}{4} \\
(4) & \quad \frac{\rho Ag(x_1^2 + x_2^2)}{4}
\end{align*}
\]

Ans. (1)

10. A coil has moment of inertia 0.8 kg/m² released in uniform magnetic field 4T when there is 60° angle between magnetic field and magnetic moment of coil. Magnetic moment of coil is 20 A·m². Find the angular speed of coil when it passes through stable equilibrium.

\[
\begin{align*}
(1) & \quad 20 \text{ rad/s}^{-1} \\
(2) & \quad 20 \text{ rad/s}^{-1} \\
(3) & \quad 10 \text{ rad/s}^{-1} \\
(4) & \quad 10 \text{ rad/s}^{-1}
\end{align*}
\]

Ans. (4)

Sol. From energy conservation

\[
\frac{1}{2} I_0^2 = U_i - U_f
\]

\[
= -MB \cos 60° - (-MB)
\]

\[
\frac{MB}{2} = \frac{1}{2} I_0^2
\]

\[
20 \times 4 = \frac{1}{2} (0.8) \omega^2
\]
11. A charged particle of charge $q$ released in electric field $E = E_0(1-ax^2)$ from origin. Find position when its kinetic energy again becomes zero.

\[
\begin{align*}
(1) \quad & \frac{r}{\sqrt{a}} \\
(2) \quad & \frac{\sqrt{2}}{\sqrt{a}} \\
(3) \quad & \frac{\sqrt{3}}{\sqrt{a}} \\
(4) \quad & \frac{2\sqrt{r}}{\sqrt{a}}
\end{align*}
\]

Ans. (3)

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Sol. $W_{Kx} = \Delta K$  
$K_f - K_i = 0$

\[
\int_0^x qE_0(1-ax^2)dx = 0
\]

\[
qE_0 \left[ x - \frac{ax^3}{3} \right]_0^x = 0
\]

\[
x - \frac{ax^3}{3} = 0
\]

\[
1 - \frac{ax^2}{3} = 0
\]

\[
\frac{ax^2}{3} = 1
\]

\[
x^2 = \frac{3}{a}
\]

\[
x = \pm \frac{\sqrt{3}}{\sqrt{a}}
\]

12. A light is incident on a metallic surface. Graph between stopping potential $V_s$ and $1/\lambda$ is as shown in figure. When intensity of light is increase at given frequency then :

(1) Graph does not change  
(2) Graph steeper  
(3) $V_s$ intercept change  
(4) Graph gets narrower

Ans. (1)

Sol. $eV_s = h\nu - w$

$V_s = \frac{h\nu - w}{e}$

Frequency and work function are constant therefore graph does not change.
13. A ball is thrown with velocity $v_0$ from ground in vertical upward direction. If particle experiences resistance force $mkv^2$. Where $v$ is the speed of particle, $m$ mass of the particle and $k$ is a positive constant. Find maximum height reached.

\[
\begin{align*}
(1) & \quad \frac{1}{2K} \left( \frac{g + kv^2}{g} \right) \\
(2) & \quad \frac{1}{3K} \left( \frac{g + kv^2}{g} \right) \\
(3) & \quad \frac{2}{3K} \left( \frac{g + kv^2}{g} \right) \\
(4) & \quad \frac{1}{K} \left( \frac{g + kv^2}{g} \right)
\end{align*}
\]

Ans. (1)

Sol. $F_{\text{net}} = ma$

\[
-mg - mkv^2 = mv \frac{dv}{ds}
\]

\[
\frac{dv}{ds} = \frac{g - kv^2}{v} = \frac{h_{\text{max}}}{ds} = \frac{h_{\text{max}}}{0} = \frac{1}{2K} \left( \frac{g + kv^2}{g} \right)
\]

14. $\lambda = 6000 \times 10^{-10} \text{ m}$ and width $: 0.6 \times 10^{-4} \text{ m}$. Find highest order of minima on both side of central maxima

\[
\begin{align*}
(1) & \quad 10 \\
(2) & \quad 20 \\
(3) & \quad 100 \\
(4) & \quad 200
\end{align*}
\]

Ans. (3)

Sol. Light of wavelength $8000 \times 10^{-10} \text{ m}$ passes through a single slit of width $0.6 \times 10^{-4} \text{ m}$. Find height of highest order of minima on both side central maxima

for minima

\[
ds \sin \theta = n\lambda
\]

\[
sin \theta = \frac{n\lambda}{d} < 1
\]

\[
n \leq \frac{d}{\lambda}
\]

\[
n < \frac{0.6 \times 10^{-4}}{8000 \times 10^{-10}}
\]

\[
n < 100
\]
15. Maximum move length of Lyman series photon for H is then minimum wavelength of Balmer series photon for He* atm

\[ \frac{\lambda}{4} \quad \frac{3\lambda}{4} \quad \frac{\lambda}{4} \quad \frac{2\lambda}{3} \]

**Ans.** (2)

**Sol.**

\[ \frac{1}{\lambda_{\text{He}}} = R \left( \frac{1}{4} - \frac{1}{\infty} \right) = R \]

\[ \frac{1}{\lambda_{\text{He}}} = \frac{1}{R} \]

\[ \lambda_{\text{He}} = R \left( \frac{1}{4} - \frac{1}{\infty} \right) \]

\[ \lambda_{\text{He}} = \frac{3R}{4} \]

\[ R = \frac{4}{3\lambda_{\text{He}}} \]

\[ \therefore \quad \lambda_{\text{He}} = \frac{3\lambda}{4} \]

16. Electric field in EM waves is \( E = E_0 \hat{i} + \hat{j} \sin(kz - \omega t) \), then equation of magnetic field is:

\[ (1) \quad B = B_0 \hat{i} - \hat{j} \sin(kz - \omega t) \quad (2) \quad B = B_0 \hat{i} + \hat{j} \sin(kz - \omega t) \]

\[ (3) \quad B = B_0 (\hat{i} + \hat{k}) \sin(kz - \omega t) \quad (4) \quad B = B_0 (\hat{i} + \hat{j}) \sin(kz - \omega t) \]

**Ans.** (1)

**Sol.**

\[ E = B \| \hat{C} \]

17. The circuit is switched on at \( t = 0 \), find the time when energy stored in inductor becomes \( \frac{1}{n} \) times of maximum energy stored in it:

\[ L = \frac{1}{R} \sqrt{\frac{n}{R}} \sqrt{n + 1} \quad (2) \quad L = \frac{1}{R} \ln \sqrt{n + 1} \]

\[ (3) \quad L = \frac{1}{R} \ln \sqrt{n - 1} \quad (4) \quad L = \frac{1}{R} \ln \sqrt{n} \]

**Ans.** (2)

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18. Intensity of magnetization is 4 (unit) at temperature 6K and B = 0.4 T. What is the intensity of magnetization at temperature 24 K in B = 0.3 T

- (1) 0.75
- (2) 0.25
- (3) 0.5
- (4) 1

Ans. (1)

Sol. Magnetization = 4

\[ T = 6k, B = 0.4T \]

Paramagnetic substance

\[ T = 24k, B = 0.3T \]

\[ M = \frac{CB}{T} \]

\[ \frac{4}{M} = \frac{0.4/6}{0.3/24} = 0.75 \]

19. Match the following

I  Adiabatic  (A) \[ \Delta U = 0 \]
II  Isothermal  (B) \[ \Delta W = 0 \]
III  Isobaric  (C) \[ \Delta Q = 0 \]
IV  Isochoric  (D) \[ \Delta U = 0 \]

\[ \Delta Q = 0 \]

\[ \Delta W = 0 \]

- (1) I → A  II → C  III → D  IV → B
- (2) I → D  II → B  III → C  IV → A
- (3) I → C  II → A  III → D  IV → B
- (4) I → B  II → D  III → C  IV → A

Ans. (3)

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20. A Satellite is revolving around the earth. Ratio of its orbital speed and escape speed will be.

- (1) \[ \frac{1}{\sqrt{2}} \]
- (2) \[ \sqrt{2} \]
- (3) \[ \frac{1}{3} \]
- (4) \[ 2\sqrt{2} \]

Ans. (1)

Sol. \[ v_o = \sqrt{\frac{GM}{r}} \]

\[ v_e = \frac{1}{\sqrt{2}} \]

21. If I is moment of inertia, F is force, v is velocity, E is energy and L is length then, dimension of \[ \frac{IFv^2}{EL^2} \] will be:

- (1) Energy density
- (2) Viscosity
- (3) Young modulus
- (4) Torque

Ans. (1)

Sol. \[ \frac{IFv^2}{EL^2} = \frac{(ML^2)(ML^2T^{-2})(L^2T^{-2})}{(ML^2T^{-2})(L^2)} = \frac{L^4T^{-4}}{L^4} = MX^2T^{-2} = \text{Energy density} \]

22. Speed time graph of a particle is shown in figure. Find distance travelled by particle in 5 second.
Ans. 20.00

Sol. Distance = Area of |v| - t graph
= \frac{1}{2} \times 8 \times 5 = 20 \text{ m}

23. In displacement method distance of lens and screen is 100 cm. Initial image is obtained on screen. Now lens is displaced 40 cm, image formed on screen again \( \phi \). If power of the lens is \( (100/N) \) dioptries, then find the value of \( N \):

Ans. 21.00

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\[
\text{Sol. } f = \frac{D^2 - d'^2}{4D} = \frac{100^2 - 40^2}{4(100)} = \frac{(100 + 40)(100 - 40)}{4(100)}
\]

\[
= \frac{140 \times 60}{4 \times 100} = \frac{14 \times 6}{2 \times 2} = 7 \times 3 = 21 \text{ cm}
\]

\[
p = \frac{100}{21} = \frac{100}{21} \text{ D}
\]

24. Binding energy per nucleon of \(^{92}\text{Sn}\) is approximately \(\text{MeV} \). [Atomic mass of \(^{129}\text{Sn}\) is \(129.500 \text{ u} \) and that of \(^{1}H\) is \(1.007 \text{ u} \). Mass of neutron = \(1.008 \text{ u} \), \(1u = 931 \text{ MeV} \)]

Ans. 3.18 MeV

\[
\text{Sol. } \text{The number of protons in } ^{92}\text{Sn} = 50 \text{ and the number of neutrons } = 120 - 50 = 70.
\]

\[
\text{The binding energy of } ^{92}\text{Sn} = [50 \times 1.007 \text{ u} + 70 \times 1.008 \text{ u} - 129.500 \text{ u}] \times c^2 = (0.41 \text{ u})c^2
\]

\[
= (0.41 \text{ u})(931 \text{ MeV}u) = 381.71 \text{ MeV}.
\]

\[
\text{ Binding energy per nucleon } = \frac{381.71}{120} = 3.18 \text{ MeV}
\]
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