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JEE (Main)

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

2022

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 27 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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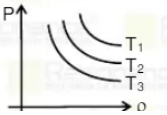
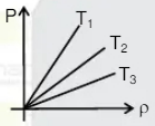
PART : PHYSICS

1. Which graph is correct for an ideal gas between pressure & density ($T_1 < T_2 < T_3$)

(1)

(2)



(3) 

(4) 

Ans. (4)

Sol. We know that

$$P = \frac{\rho RT}{M}$$

$$\Rightarrow P = \left(\frac{RT}{M}\right)\rho$$

$$\Rightarrow P \propto \rho$$

$$\frac{p}{\rho} = \frac{RT}{M_W} = \text{slope}$$

$T\uparrow$ $S\uparrow$

2. Dimensions of Pascal x sec will be :

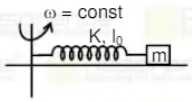
(1) $ML^{-1}T^{-1}$ (2) $M^2L^1T^2$ (3) $M^{-1}L^3T$ (4) ML^3T^2

Ans. (1)

Sol. $Pt = \frac{Ft}{A} = \frac{\text{Change in momentum}}{\text{Area}}$

$$\frac{MLT^{-1}}{L^2} = ML^{-1}T^{-1}$$

3. A block connected with spring is rotated with constant angular velocity ω. Spring constant of spring is K & its natural length is l_0 find extension in the spring.



(1) $\frac{m\omega^2 l_0}{k - m\omega^2}$ (2) $\frac{m\omega^2}{k - m\omega^2}$ (3) $\frac{m\omega^2 K}{l_0 - m\omega^2}$ (4) None

Ans. **(1)**

Sol. For circular motion

$Kx = m\omega^2(l_0 + x)$

$\Rightarrow (k - m\omega^2)x = m\omega^2 l_0$

$$\Rightarrow x = \frac{m\omega^2 l_0}{k - m\omega^2}$$

4. A particle executes SHM with amplitude A = 8 cm & time period T = 6 sec. Find time taken by the particle from $x = +A$ to $x = +\frac{A}{2}$

(1) 2 sec (2) 1 sec (3) 4 sec (4) 5 sec

Ans. **(2)**

Sol. Time taken by the particle from

$x = +A$ to $+\frac{A}{2}$ is $\frac{T}{6}$

So $\frac{T}{6} = \frac{6}{6} = 1$ sec.

5. Equation of SHM of particle is given by $x = \sin\pi\left(t + \frac{1}{3}\right)$, then velocity at t = 1 sec. is

(1) $-\frac{\pi}{2}$ (2) π (3) $-\frac{\pi}{3}$ (4) $-\frac{\pi}{4}$

Ans. **(1)**

Sol. $V = \frac{dx}{dt} = \pi\cos\pi\left(t+\frac{1}{3}\right)$

V at t = 1 = $\pi\cos\pi\left(1+\frac{1}{3}\right)$

$= \pi\cos\left(\pi+\frac{\pi}{3}\right)$

$= -\pi\cos\frac{\pi}{3}$

$= -\frac{\pi}{2}$

6. Work done by gas in isobaric expansion is 400 J. Find heat given to the system (γ = 1.4) :

(1) 1000 J (2) 1400 J (3) 1200 J (4) 2000 J

Ans. **(2)**

Sol. ω = 400 J = nRΔT (for isobaric process)

ΔQ = ?

For isobaric process

$\Delta Q = nC_P\Delta T$

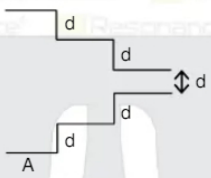
$\Rightarrow \Delta Q = n\left(\frac{\gamma R}{\gamma-1}\right)\Delta T$

$\Rightarrow \Delta Q = nR\Delta T\left(\frac{\gamma}{\gamma-1}\right)$

$\Rightarrow \Delta Q = 400 \times \frac{1.4}{1.4-1} = 400 \times \frac{1.4}{.4}$

$\Rightarrow \Delta Q = 100 \times 14 = 1400$ J

7. Find Equivalent Capacitance?



(1) $\frac{23}{15}\frac{\epsilon_0 A}{d}$ (2) $\frac{42}{15}\frac{\epsilon_0 A}{d}$ (3) $\frac{37}{15}\frac{\epsilon_0 A}{d}$ (4) $\frac{63}{15}\frac{\epsilon_0 A}{d}$

Ans. **(1)**

Sol. There will be three Capacitors in parallel combination in given system so Equivalent capacitance

$C = C_1 + C_2 + C_3$

$\Rightarrow c = \frac{\epsilon_0 A}{5d} + \frac{\epsilon_0 A}{3d} + \frac{\epsilon_0 A}{d} = \frac{\epsilon_0 A}{d}\left(\frac{1}{5}+\frac{1}{3}+1\right)$

$\Rightarrow \frac{23}{15}\frac{\epsilon_0 A}{d}$

8. A wire of length 20 cm is in N-S direction it is moving with 20/s in east. Horizontal component of earth's magnetic field is $B_H = 4 \times 10^{-4}$T and angle of dip is $\phi = 45°$. Find induced emf in wire

(1) 1.6×10^{-4} V (2) 16×10^{-4} V (3) 18×10^{-4}V (4) 1.8×10^{-4} V

Ans. **(2)**

Sol. vertical component of earths magnetic field is perpendicular to length of the wire so

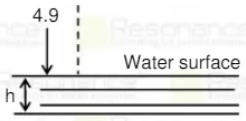
induced emf in wire $e = B_v\ell v$

angle of dip f = 45° so $B_v = B_H$

$e = B_v\ell v = 4 \times 10^{-4} \times 0.2 \times 20$

$= 16 \times 10^{-4}$ volt

9. A ball is dropped from rest from height of 4.9 m above water surface. Once it reached the water surface it continue to move in water with constant velocity. It reach 'h' depth in water total time of journey from the movement it is dropped is 4 sec. Determine depth 'h' (take g = 9.8 m/s^2)



(1) 24.3 m (2) 29.4 m (3) 34.3 m (4) 36.3 m

Ans. **(2)**

Sol. $S = ut + \frac{1}{2}at^2$

$-4.9 = 0 + \frac{1}{2}(-9.8)t^2$

$t = 1$ sec

In 1 sec it reach the surface of water

$V^2 = u^2 + 2as$

$V^2 = 0 + 2(-9.8)(4.9) \quad \therefore v = 9.8$

then in water journey = 4 – 1 = 3 sec

$h = vt = 9.8 \times 3 = 29.4$ metre

10. Proton and deutron are projected with same kinetic energy in uniform magnetic field in the direction perpendicular to the magnetic field. Then the ratio of radii deutron to proton in magnetic field is :

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

Ans. **(2)**

Sol. For circular path in magnetic field.

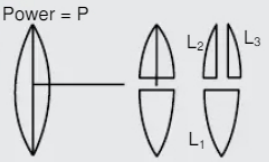
$$r = \frac{mV}{qB} = \frac{\sqrt{2mE_k}}{qB}$$

So,

	p	d
m	1	2
q	+e	e

$r_1 : r_2 = \sqrt{2}:1$

11. Equi-convex lens is cut into three pieces as shown in figure. Select the incorrect option :

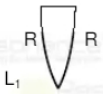


(1) Power of $L_1 = \frac{P}{2}$ (2) Power of $L_2 = \frac{P}{2}$ (3) Power of $L_3 = \frac{P}{2}$ (4) Power of $L_1 = P$

Ans. **(1)**

Sol.

$$P = \frac{1}{f} = (\mu - 1)\left(\frac{2}{R}\right)$$



L_1 $P_1 = \frac{1}{f} = (\mu-1)\left(\frac{2}{R}\right) = P$

L_2 $P_2 = \frac{1}{f} = (\mu-1)\left(\frac{1}{R}\right) = \frac{P}{2}$

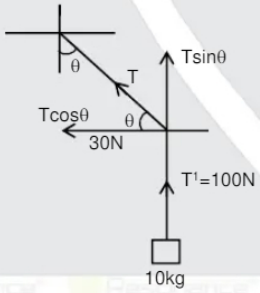
L_3 $P_3 = \frac{1}{f} = (\mu-1)\left(\frac{1}{R}\right) = \frac{P}{2}$

12. A Block of mass 10 kg is suspended with the help of sting of length 5 m. A force of 30 N is applied in horizontal direction at mid-point of sting then angle made by upper half part of string with horizontal direction in equilibrium condition will be :

(1) $\theta = \tan^{-1}\left(\frac{3}{10}\right)$ (2) $\theta = \tan^{-1}\left(\frac{10}{3}\right)$ (3) $q = \tan^{-1}(3)$ (4) $\theta = \tan^{-1}\left(\frac{1}{3}\right)$

Ans. **(2)**

Sol.



$T\cos\theta = 30$ ...(1)

$T\sin\theta = 100$ ...(2)

From equation (1) & (2)

$\tan\theta = \frac{10}{3}$

$\theta = \tan^{-1}\left(\frac{10}{3}\right)$

13. Which option does not represent dimension of time :

(1) $\sqrt{LC}$ (2) $\frac{L}{R}$ (3) $\frac{L}{C}$ (4) RC

Ans. **(3)**

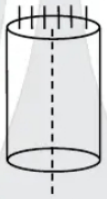
Sol. We Kn that time period is

$T = 2\pi\sqrt{LC}$

So $\sqrt{LC}$ represents dimensions of time const. of L–R series circuit is $\frac{L}{R}$ so $\frac{L}{R}$ represent dimensions of

time. Time const. of R–C circuit is RC so RC represents dimensions of time but $\frac{L}{C}$ does not represents dimensions of time

14. Current is flowing through conductor where current density J is uniform and it is equal to 10^6 A/m^2. Radius of conductor is R = 4 mm. Determine the current flow from r = R/2 to r = R



(1) 4π Amp (2) 6π Amp (3) 12π Amp (4) 24π Amp

Ans. **(3)**

Sol. Current = J × Area

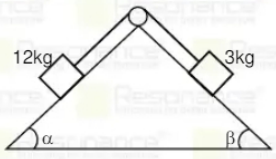
$= J \times \pi\left[R^2 - \left(\frac{R}{2}\right)\right]^2$

$= J\pi\frac{3R^2}{4}$

$= 10^6 \times \pi \times 3 \times \left(\frac{4\times10^{-3}}{4}\right)^2$

$\Rightarrow \pi \times 3 \times \frac{16}{4} = 12\pi$ Amp

15. Acceleration of 12 kg as shown in figure is

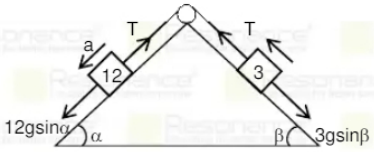


(1) $\frac{g}{2}(4\sin\alpha - \sin\beta)$ (2) $\frac{g}{5}(4\sin\alpha - \sin\beta)$

(3) $\frac{g}{2}(4\sin\alpha + \sin\beta)$ (4) $\frac{g}{5}(4\sin\alpha + \sin\beta)$

Ans. (2)

Sol.



$12\,g\sin\alpha - T = 12\,a$ ...(1)

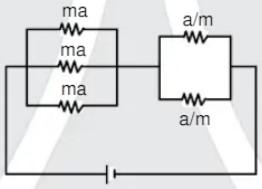
$T - 3g\sin\beta = 3a$ ...(2)

From equation (1) & (2)

$a = \frac{(4g\sin\alpha - g\sin\beta)3}{15}$

$a = \frac{g}{5}(4\sin\alpha - \sin\beta)$

16. For what value of m equivalent resistance of given circuit is minimum :



$\sqrt{3}$ $\sqrt{1}$ $\sqrt{3}$ $\sqrt{2}$

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

Ans. **(3)**

Sol. $\text{Req} = \frac{ma}{3} + \frac{a}{2m}$

Req is function of m

$\therefore$ for Minima of m

$\frac{d_{\text{Req}}}{dm} = 0$

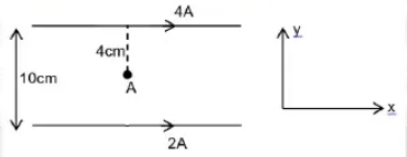
$\frac{a}{3} + \frac{a}{2}\left(\frac{-1}{m^2}\right) = 0$

$\frac{1}{3} = \frac{1}{2m^2}$

$m^2 = \frac{3}{2}$

$m = \sqrt{\frac{3}{2}}$

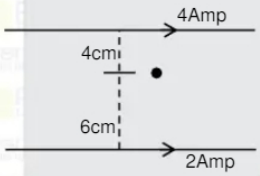
17. There are two parallel long conductor carrying current 4A & 2A as shown in figure. Both conductors are in xy plane and point A is also in xy plane. A change of q = 3πC is moving with velocity $\vec{V} = 2\hat{i} + 4\hat{j}$ at point A. Magnetic force on this charge is given by $\vec{F} = 4\pi(2\hat{j} - x\hat{i}) \times 10^{-5}$ N determine x.



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

Ans. (4)

Sol.



$B_{\text{Net}} = \frac{\mu_0 4}{2\pi \times \frac{4}{100}} - \frac{\mu_0 2}{2\pi \times \frac{6}{100}}$

$= \frac{\mu_0}{\pi} \times 100\left[\frac{1}{2} - \frac{1}{6}\right]$

$= \frac{\mu_0}{\pi} \times 100\left[\frac{4}{2 \times 6}\right]$

$= \frac{\mu_0 \times 100}{3\pi}(-\hat{k})$

$\vec{F} = 9(\vec{V} \times \vec{B}) = 3\pi\left[2\hat{i} + 4\hat{j}\right]\frac{\mu_0 \times 100}{3\pi}(-\hat{k})$

$= 4\pi \times 10^{-7}\left[2\hat{i} + 4\hat{j}\right] \times 100(-\hat{k})$

$= 4\pi \times 10^{-5}\left[2\hat{j} - 4\hat{i}\right]$

$\therefore$ x = 4

18. Transistor acts as a switch in :

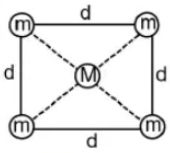
(1) Active region (2) Saturation & cut off region

(3) cut off region only (4) saturation region only

Ans. **(2)**

Sol. Informative & self explanatory

19. Gravitational potential energy of given system is :



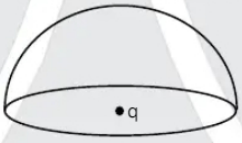
(1) $-\frac{Gm}{d}\left[4\sqrt{2}M+\left(4+\sqrt{2}\right)m\right]$ (2) $-\frac{GM}{d}\left[4\sqrt{2}m+\left(4+\sqrt{2}\right)M\right]$

(3) $-\frac{Gm}{d}\left[4\sqrt{2}M+\left(4+\sqrt{2}\right)m\right]$ (4) $-\frac{Gm}{d}\left[4\sqrt{2}m+\left(4+\sqrt{2}\right)m\right]$

Ans. **(1)**

Sol. $PE = -\left(\frac{4Gm^2}{d}+\frac{2Gm^2}{\sqrt{2}d}+\frac{4GmM}{d/\sqrt{2}}\right)=-\frac{Gm}{d}\left[4\sqrt{2}M+m\left(4+\sqrt{2}\right)\right]$

20. Electric flux passing through given hemisphere if charge is placed at centre of hemisphere is :



Hemisphere

(1) $\frac{q}{2\varepsilon_0}$ (2) $\frac{q}{\varepsilon_0}$ (3) $\frac{q}{4\varepsilon_0}$ (4) None

Ans. **(1)**

Sol. For complete sphere total flux passing through the sphere is $=\frac{q}{\varepsilon_0}$ (using gauss's law)

So flux passing through given hemisphere is $\phi=\frac{\frac{q}{\varepsilon_0}}{2}=\frac{q}{2\varepsilon_0}$

21. A bullet at temperature $t_1°C$ fired from gun with speed v enters in lead block. Due to resistance of lead block bullet melts at temperature $t_2°C$ ($t_2 > t_1$) due loss of 40% kinetic energy of bullet initial speed of bullet is____ (S = specific heat of bullet and L = Latent heat)

(1) $\sqrt{5S(t_2-t_1)+5L}$ (2) $\sqrt{5S(t_2+t_1)+5L}$

(3) $\sqrt{4S(t_2-t_1)+5L}$ (4) $\sqrt{7S(t_2-t_1)+5L}$

Ans. (1)

Sol. $0.4\times\frac{1}{2}mv^2 = mS(t_2-t_1)+mL$

22. Wave goes from rarer medium to Denser medium (f = freq. of wave, λ = wavelength of wave, v = speed of wave)

(1) V_1 f and λ all are increases (2) V_1 f and λ all are decreases

(3) f constant but v and λ decreases (4) f constant but v and λ increases

Ans. **(3)**

Sol. $v = f\lambda$

f = constant

So, $V \propto \lambda$

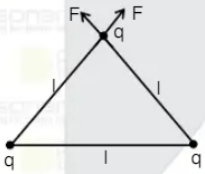
In denser medium v decrease.

23. Three identical changes 2C each are connected with three different identical vertical strings of length 2m each. All the three string are suspended at same point. Due to electrostatic repulsive force all the three charges are separated symmetrically. Find ratio of net force on any one charge to the force between any two charges.

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

Ans. **(4)**

Sol.



Net force on are charge

$F_q = \sqrt{F^2 + F^2 + 2FF\cos 60^\circ}$

$= \sqrt{3}\,F$

Where F is force b/w any two charges

So $\frac{F_q}{F} = \sqrt{3}$

24. Low frequency signal cannot be transmitted to large distance. Identify incorrect statement

(1) It can be transmitted by modulating high frequency signal with it.

(2) Antenna size required is very large to directly transmit it

(3) power of low-frequency signal gets attenuated part

(4) Low frequency signal can be used under space communicate

Ans. **(4)**

25. Mean free path of gas molecules

(1) increases with increase in temperature

(2) increases with increase in density

(3) increases with increase in temperature constant but pressure constant

(4) increases with increase in pressure but temperature constant

Which options are correct

(1) AB (2) AC (3) AD (4) All

Ans. **(2)**

Sol. Mean free path $\lambda = \frac{1}{\sqrt{2}\pi d^2 n}$ $\qquad n = \frac{N}{V}$

$\Rightarrow \lambda = \frac{1}{\sqrt{2}\pi d^2 N/V}$ $\qquad PV = NKT$

$\Rightarrow \lambda = \frac{KT}{\sqrt{2}\pi d^2 P}$ $\qquad P = \frac{\rho RT}{M}$