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JEE (Main)

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

2022

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 29 June, 2022 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

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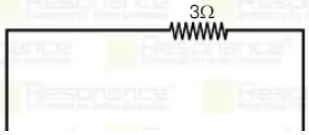
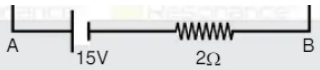
PART : PHYSICS

1. Find $V_A - V_B$





(1) 3 V (2) 7 V (3) 9 V (4) 11 V

Ans. **(3)**

Sol. $\ell = \frac{15}{3+2} = 3A$

$V_A - V_B = 3 \times 3 = 9V$

2. If $|\vec{A}+\vec{B}| = 2|\vec{A}-\vec{B}|$ & $|\vec{A}| = |\vec{B}|$. Find angle between $\vec{A}$ and $\vec{B}$

(1) $\cos^{-1}(3/5)$ (2) $\sin^{-1}(3/5)$ (3) $\sec^{-1}(3/5)$ (4) $\tan^{-1}(3/5)$

Ans. (1)

Sol. $|\vec{A}+\vec{B}| = 2|\vec{A}-\vec{B}|$

$\sqrt{A^2+B^2+2AB\cos\theta} = 2\sqrt{A^2+B^2-2AB\cos\theta}$

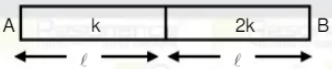
$A^2 + B^2 + 2AB\cos\theta = 4(A^2 + B^2 - 2AB\cos\theta)$

$10AB\cos\theta = 3A^2 + 3B^2$

$\cos\theta = \frac{3(A^2+B^2)}{10A.B} = \frac{3+2A^2}{10\times A^2} = \frac{6}{10} = \frac{3}{5}$

$\theta = \cos^{-1}(3/5)$

3. Find equivalent thermal conducting between A & B.



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

Ans. **(2)**

Sol. $\frac{\ell+\ell}{k_1} = \frac{\ell}{k} + \frac{\ell}{2k}$

$\frac{2\ell}{k_1} = \frac{3\ell}{2k}$

$k_1 = \frac{4k}{3}$

4. In cyclotron K.E. changes by 4 times of initial value. Find the ratio of initial and final radius.

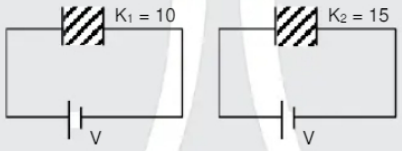
(1) 1 : 2 (2) 2 : 1 (3) 1 : 4 (4) 4 : 1

Ans. **(1)**

Sol. $r = \frac{\sqrt{2mK}}{qB}$

$\frac{r_1}{r_2} = \sqrt{\frac{K_1}{K_2}} = \frac{1}{\sqrt{4}} = \frac{1}{2}$

5. When dielectric K_1 is replaced by K_2 then find percentage change in energy stored inside capacitor :



(1) 50% (2) 70% (3) 90% (4) 100%

Ans. **(1)**

Sol. $U_i = \frac{1}{2}(K_1C)V^2$

$U_f = \frac{1}{2}(K_2C)V^2$

$\Delta U = U_f - U_i = \frac{1}{2}(K_2 - K_1)CV^2$

$\frac{\Delta U}{U_i} = \frac{\frac{1}{2}\times 5\times CV^2}{\frac{1}{2}\times 10\times CV^2} = \frac{1}{2}$

$\frac{\Delta U}{U_i} \times 100 = 50\%$

6. Under the force of 1 N, length of spring is L_1 and under a force of 2 N length is L_2. Find the natural length of spring.

(1) $3L_1 - L_2$ (2) $2L_1 + L_2$ (3) $L_2 - L_1$ (4) $2L_1 - L_2$

Ans. **(4)**

Sol. $1 = k(L_1 - L)$

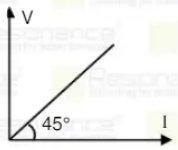
$2 = k(L_2 - L)$

$2 = \frac{L_2 - L}{L_1 - L}$

$2L_1 - 2L = L_2 - L$

$L = 2L_1 - L_2$

7. V–I graph of a wire is shown its diameter is 2.4 cm and length 3.14 cm. Find its resistivity



(1) 1.24×10^{-2} (2) 1.44×10^{-2} (3) 1.44×10^{-4} (4) 1.22×10^{-2}

Ans. **(2)**

Sol. $R = V/I = \tan 45° = 1$

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

$\rho = \frac{RA}{\ell} = 1\times\frac{3.14\times(1.2\times10^{-2})^2}{3.14\times10^{-2}}$

$\rho = 1.44 \times 10^{-2}$

8. For 1 mole of gas, Vander waal's equation is $\left(P + \frac{a}{V^2}\right)(V - b) = RT$. Find the dimensions of a/b, where P is gas pressure, V = volume of gas T = temperature of gas

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

Ans. **(3)**

Sol.

$\left(P - \frac{a}{V^2}\right)$ should be a kind of pressure

$(V - b) = nRT$ b should be a kind of volume

So $\frac{[a]}{[V^2]} = M^1L^{-1}T^{-2}$ So $[b] = L^3$

$\frac{[a]}{[L^3]^2} = M^{-1}L^{-1}T^{-2} \Rightarrow [a] = M^1L^5T^{-2}$

$\left[\frac{a}{b}\right] = \frac{M^1L^5T^{-2}}{L^3} = M^1L^2T^{-2}$

9. With a wavelength of 5000 Å, fringe width is 0.5 mm. If separation between the slits is doubled and wavelength used in 6000 Å. Find new fringe width :

(1) 0.3 mm (2) 0.5 mm (3) 0.7 mm (4) 0.9 mm

Ans. **(1)**

Sol. $\beta = \frac{\lambda D}{d}$ $\beta' = \frac{\lambda D}{2d}$

$\frac{\beta'}{\beta} = \frac{\lambda'}{\lambda \times 2} = \frac{6}{5 \times 2}$

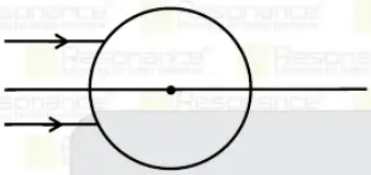
$\beta' = 0.5 \times \frac{6}{10} = 0.3$ mm

10. A parallel beam strikes a sphere of R.I. 1.5 and diameter 30 cm, the distance of image from centre of sphere will be :

(1) 25.5 cm (2) 20.5 cm (3) 22.5 cm (4) 32.5 cm

Ans. (3)

Sol.



$\frac{1.5}{V_1} - \frac{1}{\infty} = \frac{1.5-1}{+15}$

$V_1 = 45$

$\frac{1}{V_2} - \frac{1.5}{15} = \frac{1-1.5}{-15}$

$V_2 = 7.5$ cm

From centre 15 + 7.5 = 22.5 cm

11. A particle having mass = 100 g charge q = 40 μC is projected with velocity 20 m/s in the opposite direction of electric field. Find total distance covered by particle till velocity become zero :

(1) 5 m (2) 10 m (3) 15 m (4) 20

Ans. (1)

Sol. $a = \frac{qE}{m} = \frac{40 \times 10^{-6} \times 10^5}{100 \times 10^{-3}} = \frac{4}{0.1} = 40$

$v^2 = u^2 + 2as$

$0 = 400 - 2 \times 40 \times s$

$s = \frac{400}{80} = 5$m

12. Velocity of a particle varies as $V = bx^{5/2}$ where b = 0.25 find work done by the force from x = 0 to x = 4. Mass of particles is 500 gm.

(1) 16 J (2) 32 J (3) 8 J (4) 12 J

Ans. **(1)**

Sol. $w = \frac{1}{2}mV_f^2 - \frac{1}{2}mV_i^2$

$= \frac{1}{2} \times 0.5 \times \left[0.25 \times 4^5 - 0.25 \times 0^5\right]$

= 16 Joule

13. $x = 10\sin\left(2\pi\left(ft - \frac{x}{\lambda}\right)\right)$. If maximum particle velocity is four times wave velocity then find wavelength

(1) 2 π (2) 3 π (3) 4 π (4) 5 π

Ans. **(4)**

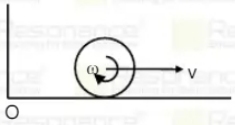
Sol. $V_{Pmax} = 4$ V wave

$10 \times \omega = 4 \times 6\lambda$

$10 \times 2\pi f = 4 \times f\lambda$

$\lambda = 5\pi$

14. A hollow sphere is under pure rolling find its angular momentum about O.



(1) $\frac{2}{3}mR^2\omega$ (2) $\frac{5}{3}mR^2\omega$ (3) $mR^2\omega$ (4) $\frac{1}{3}mR^2\omega$

Ans. **(2)**

Sol. $L = mvR + I_{cm}\omega$

$= mR^2\omega + 2/3\ mR^2\omega$

$L = \frac{5}{3}mR^2\omega$

15. In S.H.M. amplitude is 10 cm. At a distance 5 cm from mean position, velocity becomes 3 times. New amplitude will be :

(1) $\sqrt{700}$ (2) $\sqrt{500}$ (3) $\sqrt{400}$ (4) $\sqrt{300}$

Ans. **(1)**

Sol. $v = \omega\sqrt{10^2 - 5^2}$

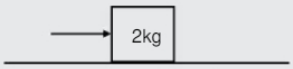
$v' = \omega\sqrt{(A')^2 - 5^2}$

$\frac{v'}{v} = \sqrt{\frac{(A')^2 - 25}{\sqrt{75}}} = 3$

$(A')^2 - 25 = 9 \times 75$

$A' = \sqrt{700}$

16. Water jet strikes a block of mass 2kg with velocity 10 m/s at 1 kg/sec rate. The acceleration of body will be :



(1) 3 m/s^2 (2) 4 m/s^2 (3) 5 m/s^2 (4) 7 m/s^2

Ans. **(3)**

Sol. $F = dp/dt = vdm/dt = 10 \times 1$

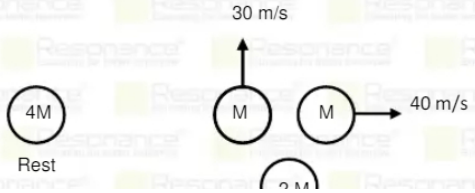
Acc. $= F/M = 10/2 = 5$ m/s^2

17. A body at rest explodes into 3 parts in the ratio 1 : 1 : 2. Two equal parts move perpendicular to each other at 30 m/s and 40 m/s in a plane. The speed of third part will be :

(1) 18 m/s (2) 20 m/s (3) 25 m/s (4) 35 m/s

Ans. **(3)**

Sol.

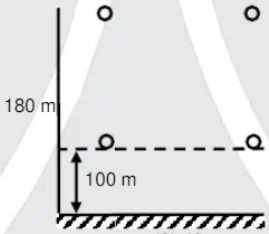


$(M \times 30)^2 + (M \times 40)^2 = (2M \times V)^2$

$M \times 50 = 2M \times V$

$V = 25$ m/s

18. A ball is dropped from a height 180 m. Two second later another ball is thrown down with speed u. The two balls cross each other at a height of 100 m, then the value of u will be :



(1) 20 (2) 30 (3) 40 (4) 60

Ans. (2)

Sol. $80 = \frac{1}{2} \times 10 \times t^2 \Rightarrow t = u$ sec.

$80 = u \times 2 + \frac{1}{2} \times 10 \times 2^2$

$u = 30$ m/s

19. Half-life of a substance is 5 days. Initial activity is 2.56×10^{-3}. After some time activity is 2×10^{-5} then the value of that time will be :

(1) 35 days (2) 15 days (3) 20 days (4) 27 days

Ans. **(1)**

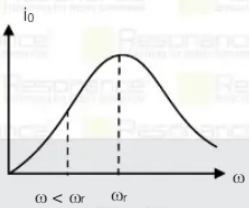
Sol. $R = R_0 e^{-\lambda t} = \frac{R_0}{2^{t/t_{\frac{1}{2}}}}$

$2 \times 10^{-5} = \frac{2.56 \times 10^{-3}}{2^{t/t_{\frac{1}{2}}}}$

$\frac{t}{t_{\frac{1}{2}}} = 7$

$t = 7 \times 5 = 35$ days

20. In an LCR alternating circuit, the amplitude of current varies with the angular frequency ω as shown in the figure. At the point P ($\omega < \omega_r$)



(a) To the left of resonance, circuit will be capacitive

(b) To the left of resonance, circuit will be inductive

(c) at resonance, circuit is purely resistive

(d) at resonance, net impedance will be zero.

(1) a & b are correct (2) a & c are correct (3) b & c are correct (4) b & d are correct

Ans. **(2)**

Sol. $w < w_r$, $X_L < X_C$

Circuit will be capacitive

21. **Statement–1 :** If energy of photon is less than the work function then no emission of photo electron takes

place.

Statement–2 : If energy of photon is same as work function then kinetic energy of all emitted photoelectron is 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)**

22. Gravitation escape speed at the surface of a uniform solid spherical plane is 12 km/sec. Find the escape speed of an another solid spherical planet whose density is 4 times and radius is $\frac{1}{2}$ that of the first plane.

(1) 12 km/hr (2) 6 km/hr (3) 24 km/hr (4) $12\sqrt{2}$ km/hr

Ans. **(1)**

Sol. $V_e = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2G(\rho)\left(\frac{4}{3}\pi R^2\right)}{R}}$

$V_e \propto R\sqrt{\rho} \propto \frac{1}{2}\sqrt{4}$ = same

23. Communication wavelength of the carrier wave is 6000 nm and 2% of the carrier frequency is used in transmission. If each channel occupies a band width of 1 kHz, then maximum how many channels can be transmitted :

(1) 10^6 (2) 10^7 (3) 10^9 (4) 10^8

Ans. **(3)**

Sol. $f = \frac{C}{\lambda} = \frac{3\times10^8}{6000\times10^{-9}} = 5\times10^{13}$Hz

Total band width used for transmission
= 2 % of $5 \times 10^{13} = 10^{12}$ Hz

Number of channels = $\frac{10^{12}}{1\times10^3} = 10^9$ channels

24. A coil heat certain amount of water in 20 min. Another coil heat the same water for temperature rise in 60 min. If the two coils are connected in parallel, find time taken to heat same water for same temperature rise

(1) 10 min. (2) 15 min. (3) 80 min. (4) 60 min.

Ans. **(2)**

Sol. $t = \frac{t_1 t_2}{t_1 + t_2}$

$= \frac{20\times60}{80} = \frac{120}{8}$ = 15 min

25. In a Carnot engine heat taken from source at 227°C is 300 Cal and heat given to sink is 225 cal. The temperature of sink will be :

(1) 100°C (2) 102°C (3) 105°C (4) 108°C

Ans. (2)

Sol. $\frac{Q_1}{Q_2} = \frac{T_1}{T_2}$

$\frac{300}{225} = \frac{500}{T_2}$

T_2 = 375 k = 102°C