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

2022

COMPUTER BASED TEST (CBT) Memory Based Questions & Solutions

Date: 28 June, 2022 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)
Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

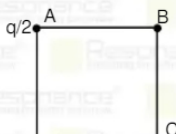
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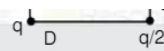
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PART : PHYSICS

1. Three point charges are placed at corners of a square as shown in figure. Find electric field at point B.

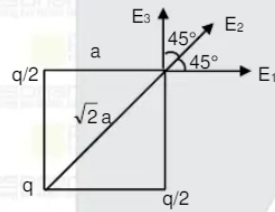




- (1) $\frac{2kq}{a^2} \left(\frac{1}{\sqrt{2}} + \frac{1}{2} \right)$ (2) $\frac{kq}{a^2} \left(\frac{1}{\sqrt{2}} + 2 \right)$ (3) $\frac{kq}{a^2} \left(\frac{1}{\sqrt{2}} + 1 \right)$ (4) $\frac{kq}{a^2} \left(\frac{1}{\sqrt{2}} + \frac{1}{2} \right)$

Ans. (4)

Sol.



$$E = E_1 \cos 45^\circ + E_2 \cos 45^\circ + E_2$$

$$= \frac{kq/2}{a^2} \times \frac{1}{\sqrt{2}} + \frac{kq/2}{a^2} \times \frac{1}{\sqrt{2}} + \frac{kq}{2a^2}$$

$$E = \frac{kq}{a^2} \left(\frac{1}{\sqrt{2}} + \frac{1}{2} \right)$$

2. Rigid Body

Moment of inertia

- (A) MOI of solid sphere about its tangent (p) $\frac{1}{2} MR^2$
 (B) MOI of hollow sphere about its diameter (q) $\frac{1}{4} MR^2$
 (C) MOI of disc about its diameter (r) $\frac{2}{3} MR^2$
 (D) MOI of ring about its diameter (s) $\frac{7}{5} MR^2$
 (1) A-s, B-r, C-q, D-p (2) A-r, B-s, C-q, D-p (3) A-s, B-r, C-p, D-q (4) A-p, B-r, C-s, D-q

Ans. (1)

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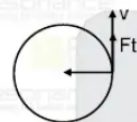
3. A particle having mass m is moving along a circle with radius r . centripetal acceleration varies as.

$$a_c = k^2 \cdot r \cdot t^2. \text{ Find power delivered :}$$

- (1) $m \cdot k^2 \cdot r^2 t$ (2) $m \cdot k^2 \cdot r^2$ (3) $m \cdot k \cdot r^2 t$ (4) $m \cdot k^2 \cdot r t$

Ans. (1)

Sol. $\frac{v^2}{r} = k^2 \cdot r \cdot t^2$



$$v^2 = k^2 \cdot r^2 \cdot t^2$$

$$v = k \cdot r \cdot t$$

$$a_t = \frac{dv}{dt} = k \cdot r$$

$$\text{power} = \vec{F} \cdot \vec{v}$$

$$= Ft \cdot v$$

$$= m \cdot a_t \cdot v$$

4. Relation between time period of two satellites is $T_A = 2T_B$. Find ratio between radii of orbits

- (1) $4^{1/3}$ (2) $2^{1/3}$ (3) $3^{1/3}$ (4) $4^{2/3}$

Ans. (1)

Sol. $T \propto r^{3/2}$

$$\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{3/2}$$

$$2 = \left(\frac{r_A}{r_B}\right)^{3/2} \Rightarrow \frac{r_A}{r_B} = 4^{1/3}$$

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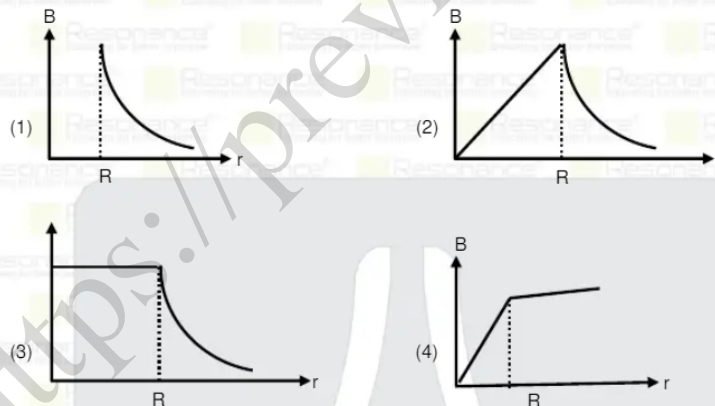
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5. Current i is flowing in a long thin hollow cylinder. Choose correct graph between magnetic field verses distance r from axis :



Ans. (1)

Sol. $B = 0, r < R$

$$\frac{\mu_0 i}{2\pi r}, r \geq R$$

6. Equation of two SHMs are

$$x = 4 \sin\left(\frac{\pi}{2} - \omega t\right) \text{ \& } y = 4 \sin \omega t$$

Then path of resultant motion will be :

- (1) straight line (2) Circle (3) Parabola (4) Hyperbola

Ans. (2)

Sol. $x = 4 \sin\left(\frac{\pi}{2} - \omega t\right)$

$$X = 4 \cos \omega t$$

$$y = 4 \sin \omega t$$

$$x^2 + y^2 = 4^2$$

7. Aperture of a telescope is 24.4 cm wavelength of light 2440Å, then its resolving power will be :

- (1) 8.2×10^4 (2) 8.2×10^5 (3) 7.2×10^5 (4) 8.2×10^3

Ans. (2)

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Sol. $R.P = \frac{a}{1.22\lambda} = \frac{24.4 \times 10^{-2}}{1.22 \times 2440 \times 10^{-10}} = \frac{10^{-2}}{1.22 \times 100 \times 10^{-10}}$
 $= \frac{10^6}{1.22} = 8.2 \times 10^5$

8. Kinetic energy of electron and photon is same then relation between wavelength of photon and wavelength electron will be :

- (1) $\lambda_p \propto \lambda_e$ (2) $\lambda_p \propto \frac{1}{\lambda_e^2}$ (3) $\lambda_p \propto \lambda_e^2$ (4) $\lambda_p \propto \frac{1}{\lambda_e}$

Ans. (3)

Sol. $E_p = \frac{hc}{\lambda}$
 $E_p = \frac{1}{2}mv^2$
 $= \frac{1}{2}m^2v^2$
 $E_e = \frac{1}{2}\frac{h^2}{\lambda_e^2 m}$
 $\frac{hc}{\lambda_p} = \frac{h^2}{m\lambda_e^2} = \lambda_p \propto \lambda_e^2$

9. Two sound waves of wavelength $\lambda_1 = 4.08$ m and $\lambda_2 = 4.16$ m gives 40 beats in 12 sec. Find speed of sound in medium.

- (1) 500 m/s (2) 710 m/s (3) 640 m/s (4) 800 m/s

Ans. (2)

Sol. $f_1 - f_2 = f$

$$V \left[\frac{1}{\lambda_1} - \frac{1}{\lambda_2} \right] = \frac{40}{12}$$
$$V = \frac{\lambda_1 \lambda_2}{\lambda_2 - \lambda_1} \times \frac{40}{12}$$
$$= \frac{4.16 \times 4.08 \times 1}{(0.08)} \times \frac{40}{12}$$
$$= 4.16 \times \frac{408}{8} \times \frac{10}{3} \times 1 = 707.2 \text{ m/s}$$

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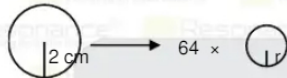
PAGE # 4

10. A liquid drop of radius 2 cm is broken into 64 drops. If surface tension of liquid is $T = 0.075 \text{ N/m}$, find surface energy of one small drop :

- (1) $0.2355 \times 10^{-3} \text{ J}$ (2) $0.2355 \times 10^{-5} \text{ J}$ (3) $0.2355 \times 10^{-4} \text{ J}$ (4) $0.2355 \times 10^{-6} \text{ J}$

Ans. (3)

Sol.

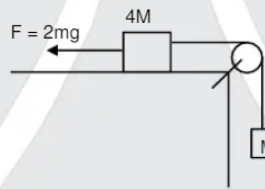


$$\frac{4}{3} \pi \times 2^3 = 64 \times \frac{4}{3} \pi r^3 \Rightarrow r = \frac{1}{2} \text{ cm}$$

surface energy of small drop is $T \times 4\pi r^2$

$$= 0.075 \times \frac{4 \times 3.14 \times 10^{-4}}{4} = 0.2355 \times 10^{-4} \text{ J}$$

11. System shown is pulled with a force $F = 2Mg$. Find the tension in the string



- (1) $\frac{6}{5} Mg$ (2) $\frac{7}{5} Mg$ (3) $\frac{5}{6} Mg$ (4) $\frac{5}{7} Mg$

Ans. (1)

Sol. $2Mg - T = 4Ma$

$$T - Mg = Ma$$

$$Mg = 5Ma$$

$$a = \frac{g}{5}$$

$$T = M \times \frac{g}{5} + Mg = \frac{6}{5} Mg$$

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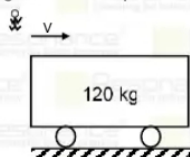
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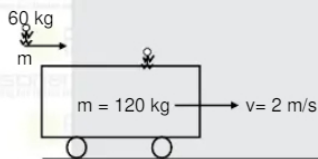
PAGE # 5

12. A boy 60 kg running with speed v jump on trolley of 120 kg as shown in figure, just after jump system start moving with speed 2 m/s w.r.t ground. Find speed v .



Ans. (3)

Sol.



$$60 v = (180) (2)$$

$$v = 6 \text{ m/s}$$

13. Internal energy of 2 moles of mole atomic gas at 300 K will be :

- (1) 1500 J (2) 2500 J (3) 3500 J (4) 7500 J

Ans. (4)

Sol. $U = \frac{3}{2} nRT$

$$= \frac{3}{2} \times 2 \times \frac{25}{3} \times 300 = 7500 \text{ J}$$

14. **Statement-1** : In an adiabatic process work done by gas $w = \frac{nR\Delta T}{1-\gamma}$

Statement-2 : If work is done on gas, temperature will increase

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

Ans. (1)

Sol. As $w = \frac{nR\Delta T}{1-\gamma}$

If w is negative so, $\Delta T = +ve$ so temperature will rise.

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15. **Statement-1** : Pressure x time has same dimension as coefficient of viscosity.

Statement-2 : coefficient of viscosity = $\frac{\text{force}}{\text{velocity gradient}}$

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

Ans. (3)

Sol. $F = \eta A \frac{\Delta v}{\Delta y}$

$$\frac{F}{A} = \eta \frac{\Delta v}{\Delta y}$$

Pressure = $\eta \frac{\Delta v}{\Delta y} \Rightarrow$ Pressure x time has same dimension as coefficient of viscosity

16. Maths the following

- (A) Human speech (i) 1 kHz
 (B) High music (ii) 30 MHz
 (C) Radio (iii) 20 KHz
 (D) Television (iv) 6 KHz

- (1) A -iii, B-iv, C-iii, D-ii (2) A -i, B-ii, C-iii, D-ii (3) A -i, B-iv, C-iii, D-ii (4) A -ii, B-i, C-iii, D-iv

17. What is the relation between Q value and kinetic energy of particle to initiate the endothermic nuclear reaction?

Particle $(K) + X \rightarrow Y + Q$

- (1) $K + Q > 0$ (2) $K + Q < 0$ (3) $K = Q$ (4) $K = 0$

Ans. (1)

Sol. $K = \left(1 + \frac{m_1}{m_2}\right) |Q|$

Q is negative and $K > |Q|$ there $K + Q > 0$

18. For a prism $\mu = \cot A/2$ find the angle of minimum deviation

- (1) $\pi - 2A$ (2) $\pi - A$ (3) $2\pi - A$ (4) $\pi - 3A$

Ans. (1)

Sol. $\frac{\sin\left(\frac{A + \delta_{\min}}{2}\right)}{\sin\frac{A}{2}} = \mu$

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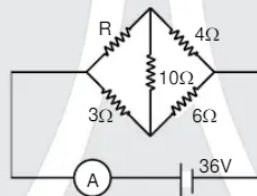
$$\frac{\sin\left(\frac{A + \delta_{\min}}{2}\right)}{\sin\frac{A}{2}} = \cot\frac{A}{2}$$

$$\frac{\sin\left(\frac{A + \delta_{\min}}{2}\right)}{\sin\frac{A}{2}} = \frac{\cos\frac{A}{2}}{\sin\frac{A}{2}}$$

$$\frac{A + \delta_{\min}}{2} = \frac{\pi}{2} - \frac{A}{2}$$

$$\delta_{\min} = \pi - 2A$$

19. In the circuit shown, there is no current in $10\ \Omega$ resistance. Find the reading of ideal ammeter.



(1) $8\ \text{A}$

(2) $10\ \text{A}$

(3) $4\ \text{A}$

(4) $2\ \text{A}$

Ans. (2)

Sol. $\frac{R}{4} = \frac{3}{6} \Rightarrow R = 2\ \Omega$

$$R_{\text{eq}} = \frac{6 \times 9}{6 + 9} = \frac{54}{15} = \frac{18}{5}$$

$$i = \frac{36}{18} \times 5 = 10\ \text{A}$$

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