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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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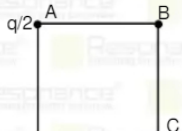
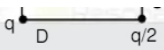
PART : PHYSICS

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

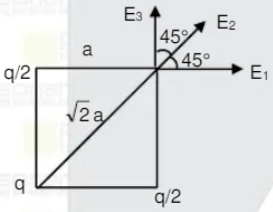




(1) $\frac{2kq}{a^2}\left(\frac{1}{\sqrt{2}}+\frac{1}{2}\right)$ (2) $\frac{kq}{a^2}\left(\frac{1}{\sqrt{2}}+2\right)$ (3) $\frac{kq}{a^2}\left(\frac{1}{\sqrt{2}}+1\right)$ (4) $\frac{kq}{a^2}\left(\frac{1}{\sqrt{2}}+\frac{1}{2}\right)$

Ans. (4)

Sol.



$E = E_1\cos45° + E_3\cos45° + E_2$

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

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

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

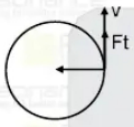
Ans. (1)

3. A particle having mass m is moving along a circle with radius r. centripetal acceleration varies as. $a_c = k^2.\ r.\ t^2$. Find power delivered :

(1) $m.\ k^2.\ r^2\ t$ (2) $m.\ k^2.\ r^2$ (3) $m.\ k.\ r^2\ t$ (4) $m.k^2.rt$

Ans. (1)

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



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

$v = k.r.t$

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

power $= \vec{F}.\vec{v}$

$= Ft.\ v$

$= m.\ a_t\ v$

$= m.k^2.r.t$

$F = m.k^2.r^2.t$

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

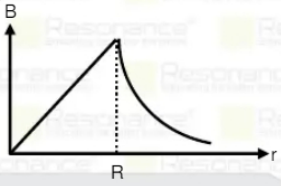
$$\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{3/2}$$

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

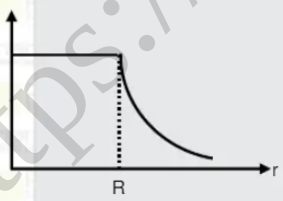
5. Current i is flowing in a long thin hollow cylinder. Choose correct graph between magnetic field verses distance r from axis :

(1)

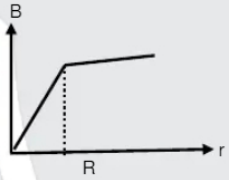
(2)



(3)



(4)



Ans. **(1)**

Sol. B = O, r < R

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

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

$X = 4 \cos wt$

$y = 4 \sin wt$

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

Required path is circle

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)

Sol. $R.P = \frac{a}{1.22\lambda} = \frac{24.4\times10^{-2}}{1.22\times2440\times10^{-10}} = \frac{10^{-2}}{1.22\times100\times10^{-10}}$

$= \frac{10^6}{1.22} = 8.2 \times 10^5$

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. $E_p = \frac{hc}{\lambda}$

$E_p = \frac{1}{2}mv^2$

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

$E_e = \frac{1}{2}\frac{h^2}{\lambda_e^2 m}$

$\frac{hc}{\lambda_p} = \frac{h_2}{m\lambda_e^2} = \lambda_p \propto \lambda e^2$

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. $f_1 - f_2 = f$

$V\left[\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right] = \frac{40}{12}$

$V = \frac{\lambda_1\lambda_2}{\lambda_2 - \lambda_1}\frac{40}{12}$

$= \frac{4.16\times4.08\times1}{(0.08)}\times\frac{40}{12}$

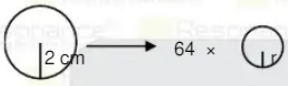
$= 4.16 \times \frac{408}{8}\times\frac{10}{3}\times1 = 707.2$ m/s

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

(1) 0.2355×10^{-3} J (2) 0.2355×10^{-5} J (3) 0.2355×10^{-4} J (4) 0.2355×10^{-6} J

Ans. **(3)**

Sol.

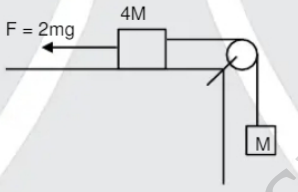


$\frac{4}{3}\pi \times 2^3 = 64 \times \frac{4}{3}\pi r^3 \Rightarrow r = \frac{1}{2}$ cm

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

$= 0.075 \times \frac{4 \times 3.14 \times 10^{-4}}{4} = 0.2355 \times 10^{-4}$ 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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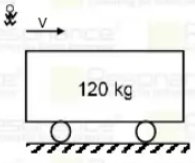
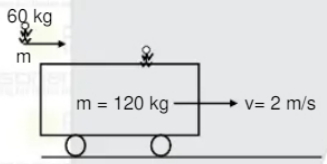
12. A boy 60 kg running with speed v jump on trolley of 120 kg as shown in figure, just after jump system start moving with speed 2 m/s w.r.t ground. Find speed v.



(1) 2 m/s (2) 4 m/s (3) 6 m/s (4) 8 m/s

Ans. **(3)**

Sol.



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

$v = 6$ 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. $U = \frac{3}{2}nRT$

$= \frac{3}{2} \times 2 \times \frac{25}{3} \times 300 = 7500$ 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, ΔT = +ve so temperature will rise.

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

Ans. (3)

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

Particle (K) + X → 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. $\frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin\frac{A}{2}} = \mu$

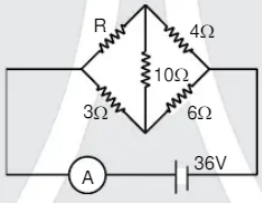
$$\frac{\sin\left(\frac{A+\delta_{min}}{2}\right)}{\sin\frac{A}{2}} = \cot\frac{A}{2}$$

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

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

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

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



(1) 8Å (2) 10 Å (3) 4Å (4) 2Å

Ans. **(2)**

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

$$R_{eq} = \frac{6\times9}{6+9} = \frac{54}{15} = \frac{18}{5}$$

$$i = \frac{36}{18}\times5 = 10Å$$