JEE MAIN - 2015

PHYSICS

ANSWER KEY AND EXPLANATIONS

Q1. Sol. (3)

For $t = 0$ to $t = 8s$,

$V_{rul} = \text{constant} = (40 - 10)\,\text{m/s} = 30\,\text{m/s}$.

So, $(Y_2 - Y_1) = 30 \times t; = 0$ to $t = 8s$

Then particle 1 comes to rest as it reaches the ground and then the distance changes by simple kinematics equation for a particle,

$(Y_{2-}Y_1) = S = ut - \frac{1}{2}gt^2$, which is a parabola with speed increasing. In the remaining two figures, speed is increasing in 3^{rd} graph (As evident from increasing slope).

Q2. Sol. (4)

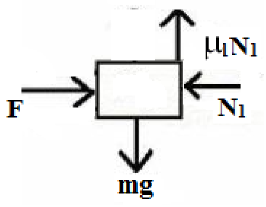
$$\left(\frac{\Delta g}{g}\right) = \left(2\frac{\Delta T}{T} + \frac{\Delta l}{l}\right)$$

$$\left(\frac{\Delta g}{g} \times 100\right) = \left(2 \times \frac{1}{90} + \frac{0.1}{20}\right) \times 100$$

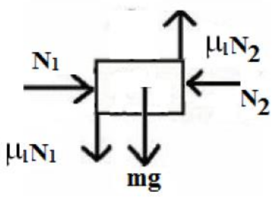
$= 2.72\%$

$= 3\%$

Q3. Sol. (3)



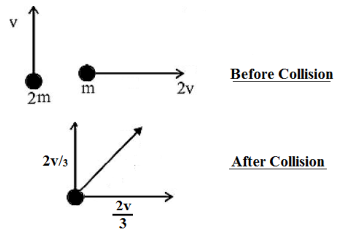
Here $M_1N_1 = mg = 20N$



$M_1N_1 + mg = M_2N_2$

$\Rightarrow M_2N_2 = 20 + 100 = 120N$

Q4. Sol. (3)



Applying momentum conservation

Along $x =$ axis

$2mV = (3m)\upsilon_x^1$

$\Rightarrow \upsilon_x^1 = \dfrac{2\upsilon}{3}$

Along $y -$ axis

$2\text{mv} = (3m)V_j^1$

$$\Rightarrow V_j^1 = \frac{2\upsilon}{3}$$

So, $V_{net} = \sqrt{\left(\frac{2\upsilon}{3}\right)^2 + \left(\frac{2\upsilon}{3}\right)^2} = \frac{\sqrt[2]{2_\upsilon}}{3}$

$$K.E = \frac{1}{2} \times 3m \times \frac{8}{9} V2$$

$$\text{Initial } K.E = \frac{1}{2} \times 2m \times v^2 + \frac{1}{2} \times m \times (2v)^2$$

$$= 3mV^2$$

So, $\Delta K.E. = \frac{3mV^2 - \left(4m\upsilon^2/3\right)}{3mV^2}$

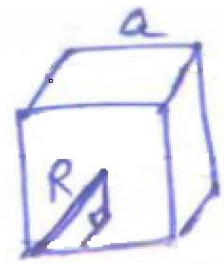
$$= \frac{5}{9} \times 100 = 56\%$$

Q5. Sol. (2)

Centre of mean of solid cone $= \frac{h}{4}$ from the base

So, $Z_o = h - \frac{h}{4} = \frac{3h}{4}$

Q6. Sol. (3)



$$R^2 = \left(\frac{a}{2}\right)^2 + \left(\frac{a}{\sqrt{2}}\right)^2$$

‘ a ’ is the side of cube

So, $R^2 = \frac{3a}{4} \Rightarrow a = \frac{2R}{\sqrt{3}}$

Now, Mean of cube $= \frac{\mu}{\frac{4}{3}\pi R^3} \times a^3$

$$= \frac{\mu}{\frac{4}{3}\pi R^3} \times R^3 \times \frac{8}{\sqrt[3]{3}}$$

$$= \frac{3M}{4\pi} \times 2\sqrt{2} = \frac{2M}{\pi\sqrt{3}}$$

$$= \frac{3\sqrt{2}M}{2\pi}$$

Moments of inertia of cube $= \frac{ma^2}{6}$

$$= \frac{3\sqrt{2}M}{2\pi \times 6} \times R^2 \times 2 = \frac{2m}{\pi\sqrt{3}} \times \frac{4R^2}{3} \times \frac{1}{6}$$

$$\Rightarrow = \frac{4mR^2}{a\sqrt{3}\pi}$$

Q7. Sol. (2)

Potential at the centre of cavity $= V_0 =$

Potential at the centre due to whole sphere $-$ Potential due to the removed portion

$$V = \frac{-Gm}{2R^3}\left(2R^2 - r^2\right)$$

Due to the removed sphere,

$$V_1 = \frac{-3Gm}{2R} = -\frac{3G\left(\frac{m}{8}\right)}{2\times\left(\frac{R}{2}\right)}$$

$$\text{Mean} = \frac{M}{\frac{4}{3}\pi k^3}\times\frac{4}{3}\left(\frac{R}{2}\right)^3$$

$$= \frac{M}{8}$$

So,

$$V_o = V - V_1$$

$$= \frac{-GM}{R}$$

Q8. Sol. (1)

$$T = 2\pi\sqrt{\frac{l}{g}}$$

When 'M' is attached,

$$T_m = 2\pi\sqrt{\frac{l_1}{g}}$$

Now,

$$\frac{\left(\frac{F}{A}\right)}{\left(\frac{\Delta l}{l}\right)} = Y \; So, \frac{\frac{mg}{A}}{\frac{\Delta l}{l}} = Y$$

$$\Rightarrow \frac{\Delta l}{l} = \frac{mg}{AY}$$

$$\text{So}, \frac{\Delta l + l}{l} = \left(\frac{Mg}{AY} + 1\right)$$

$$\Rightarrow \frac{l_1}{l} = \left(1 + \frac{mg}{AY}\right)$$

So,

$$\frac{Tm^2}{T^2} = \frac{l_1}{l} = 1 + \frac{mg}{AY}$$

$$\Rightarrow \frac{1}{Y} = \left(\frac{Tm^2}{T^2} - 1\right)\frac{A}{Mg}$$

Q9. Sol. (3)

$$P = \frac{1}{3}\left(\frac{U}{\upsilon}\right)$$

$$\frac{nRT}{V} \alpha T^4 \Rightarrow VT^3 = K; K = \text{constant}$$

$$\Rightarrow \frac{4}{3}\pi R^3 \times T^3 = K$$

$$\Rightarrow TR = \text{Adifferent constant } L$$

$$\Rightarrow T \alpha \frac{1}{R}$$

Q10. Sol. (2)

$$ds = \int \frac{c \cdot dT}{T} = C \cdot \ln\left(\frac{T_f}{T_2}\right)$$

$$= \ln 2$$

This is for one or many reservoir in contact as entropy is a state function.

Q11. Sol. (3)

$$\text{As}\, \tau \frac{l}{V_{rms}} = \frac{1}{\sqrt{2n\pi}\upsilon_{rms} d^2}$$

$$\text{As}\, n = \frac{N}{V}$$

$$\text{So}, \tau \times \frac{V}{\sqrt{T}}$$

$$\text{Since}, V_{rms} = \sqrt{\frac{3RT}{m}} \times \sqrt{T}$$

$$\text{So}, \quad \tau \alpha V \frac{y+1}{2}$$

Q12. Sol. (2)

P.E. is min at the mean position and K.E. is maximumhere. Reverse happens at extreme position.

Q13. Sol. (2)

$$f_1 = \left(\frac{v}{v - v_5}\right) f_0 = 1000 \times \frac{320}{300}$$

$$f_2 = \left(\frac{v}{v + v_5}\right) = 1000 \times \frac{320}{340}$$

$$\text{So}, \Delta f \simeq 12\%$$

Q14. Sol. (1)

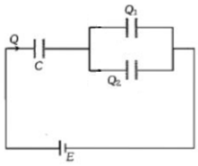
Field lines originate from positive charge & end on negative charge and are perpendicular at the surfer of a conductor.

Q15. Sol. (3)

$$V_{r<R} = \frac{KQ}{2R^3}\left(3R^2 - r_2\right)$$

$$Vr > R = \frac{KQ}{r}$$

Q16. Sol. (3)



$$Q_2 = \frac{2}{2+1} \cdot Q = \frac{2Q}{3}$$

$$Q = F \times \frac{3\mu}{\mu+3}$$

$$\Rightarrow Q_2 = \frac{2\mu F}{\mu+3}$$

Q17. Sol. (4)

$$V_d = jne = \frac{I}{A}ne$$

$$\Rightarrow I = neAV_d$$

Now,

$$S = \frac{v}{nev_d l} = 1.6 \times 10^{-5} - 2m$$

Q18. Sol. (3)

Applying KVL,

If we take potential at P to be 0 and at Q to be V

$$\frac{v-6}{3}+\frac{v-0}{1}+\frac{v+9}{5}=0$$

$$\Rightarrow V=\frac{2}{23}$$

So,

$$I=\frac{v-0}{1}=\frac{3}{23}=0.13A$$

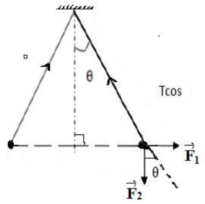
The direction is from Q to P, as 'I' is positive.

Q19. Sol. (1)

As magnetic field due to the inner solenoid is zero outside of it, so $\vec{F_2}=0$. But, magnetic field due to outer solenoid is actually perpendicular to all current elements of the inner Solenoid. So, force acts radially outward. Net force over each loop is zero as they act radially outward along all direction. So,

$\vec{F_1}=0$ (net force).

Q20. Sol. (2)



$$\vec{F_1}=\left[\frac{\mu_0 I^2}{2\pi(2L\sin\theta)}\right]\times 1$$

$$\vec{F_2}=\lambda eg$$

From the equilibrium condition,

$$\lambda eg\sin\theta = \frac{\mu o I^2}{2\pi(2L\sin\theta)} \times l\cos\theta$$

$$\Rightarrow I = \sqrt{\frac{jgzl}{\mu_0\cos\theta}} \times 2\sin$$

Q21. Sol. (3)

At $\theta = 0$, equilibrium is stable

$\theta = 180$, equilibrium is unstable

Q22. Sol. (4)

For decay of current in LR circuit

$$I = I_o \cdot e^{-tR/L}$$

$$\text{So, } I = \frac{E_o}{R} \cdot e^{-tR/L}$$

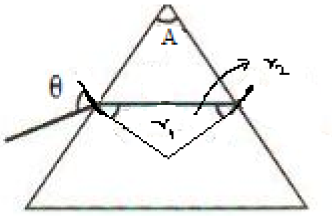
Q23. Sol. (2)

$$\text{Intensity } = \frac{1}{2} \in_0 E^2 \cdot c = \frac{\text{Power emitted}}{\text{Surface area}}$$

$$\Rightarrow \frac{P}{4\pi R^2} = \frac{1}{2} \in_0 E_0^2 C$$

$$\Rightarrow E_0 = 2 \cdot 45V/w.$$

Q24. Sol. (1)



For emergence to other side

$$r_2 < i_c$$
$$\Rightarrow (A - r_1) < i_c$$
$$\Rightarrow \sin(A - r_1) < \sin i_c$$
$$\Rightarrow (A - r_1) < \sin^{-1}\left[\frac{1}{\mu}\right]\left[\because \sin ic = \frac{1}{\mu}\right]$$
$$\Rightarrow r_1 > A - \sin^{-1}\left(\frac{1}{\mu}\right)$$

So,

$$\sin r_1 > \left[A - \sin^{-1}\left(\frac{1}{4}\right)\right]$$

Also,

$$\frac{\sin r_1}{\sin\theta} = \frac{1}{\mu}$$

which implies,

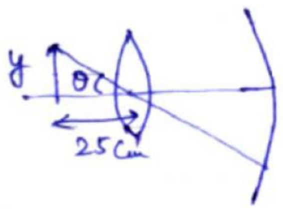
$$\Rightarrow \frac{\sin\theta}{\varpi} > \sin\left[A - \sin^{-1}\left(\frac{1}{\mu}\right)\right]$$
$$\Rightarrow \theta > \sin^{-1}\left[\mu \sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]$$

Q25. Sol. (4)

Ray 'B' travels faster have wave front bends as shown

Q26. Sol. (2)

Resolving power $= \frac{1.22\lambda}{D}$



So, $\theta = \frac{y}{d} = \frac{1.22\lambda}{D}$

$\Rightarrow y = 30\mu m.$

Q27. Sol. (1)

Kinetic energy
$= -$Total energy

And Total energy $\propto \frac{z^2}{r^2}$

So as 'n' decreases, $K.E$ increases and potential and total energy decreases

Q28. Sol. (3)

Franck-Hertz experiment is associated with discrete energy levels of atom.

Photo electric effect $\rightarrow$ Particle nature of light

Davison Germer $\rightarrow$ Wave nature of electron

Q29. Sol. (3)

Resultant frequencies are,

$f_0 + f_m, f_0, f_0 - f_m$

Q30. Sol. (1)

Applying KVL,

$$\frac{d^2q}{dt^2} + \frac{R}{L}\frac{dq}{dt} + \frac{q}{LC} = 0.$$

Damping constant $= R/L$.

Now,

$$\theta_{\max} = Q_o \cdot e^{-\frac{Rt}{LL.}}$$

So, lesser the self-inductance, faster is the damping.