Vidyamandir Classes
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MOCK TEST PAPER # 4

SOLUTION

IITJEE (Main) PHYSICS

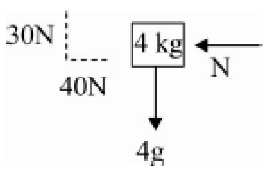
1.(B) Since horizontal velocity for both is same. So distance between them will vary as $y = ut - \frac{1}{2}gt^2$ [downward parabola]

2.(C) $R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$

$$\frac{\Delta R_{eq}}{R_{eq}} = \frac{\Delta R_1}{R_1} + \frac{\Delta R_2}{R_2} + \frac{\Delta R_1 + \Delta R_2}{R_1 + R_2} = \frac{0.1}{10} + \frac{0.05}{5} + \frac{0.1 + 0.05}{10 + 5} = 0.01 + 0.01 + 0.01 = 0.03$$

$$\frac{\Delta R_{eq}}{R_{eq}} \times 100 = 3\%$$

3.(B)

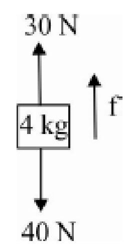


Limiting value of frictional force $\mu N = 0.5 \times 40 = 20\,N$

Net force in vertical direction

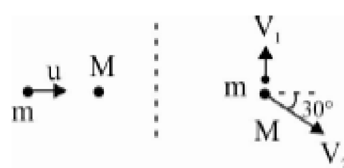
$30 + f = 40$

$f = 10N$



Net contact force $= \sqrt{10^2 + 40^2} = 10\sqrt{17}\,N$

4.(B) Conserving momentum along x axis $v_2 = \frac{2u}{5\sqrt{3}}$



Along y axis $v_1 = \frac{5}{2}v_2 = \frac{u}{\sqrt{3}}$.

Fraction lost = 2/5

5.(A) $m\left[h\cot\theta - x\right] = Mx \quad \Rightarrow \quad x = \frac{mh\cot\theta}{m + M}$

6.(A) $I_{AB} = I_{cm} + M\left(\frac{R}{2}\right)^2 = I_{CD} = \frac{2}{3}MR^2$

7.(C) $\frac{mv^2}{R} = \frac{GMm}{R^2} \quad \Rightarrow \quad v = \sqrt{\frac{Gm}{R}}$

Total energy of satellite = $\frac{1}{2}mv^2 - \frac{GMm}{R}$

Energy required to escape field

$$E + \frac{1}{2}mv^2 - \frac{GMm}{R} = 0 \quad \Rightarrow \quad E + \frac{1}{2}m\frac{GM}{R} - \frac{GMm}{R} = 0$$

$$E = \frac{GMm}{2R}$$

8.(A) $F = \frac{YA}{l}\Delta l \text{ or } F = k\Delta l \quad \Rightarrow \quad \omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{YA}{0.1l}} = 140$

9.(B) $R = c_p - c_v = \frac{2}{3}c_v \quad \Rightarrow \quad c_p = \frac{5}{3}c_v \quad \Rightarrow \quad \gamma = 5/3$

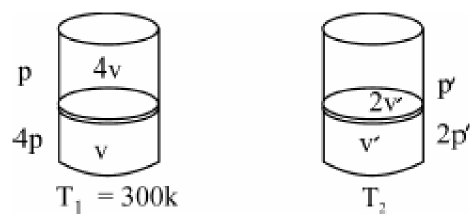
$pv^\gamma = \text{constant} \quad \Rightarrow \quad p\left(\frac{nRT}{p}\right)^\gamma = \text{constant}$

$p^{\frac{1}{\gamma}-1} T = \text{constant} \quad \Rightarrow \quad p \propto T^{5/2}$

10.(B) $4p - p = 2p' - p'$

$5V = 3V'$

$\frac{p_1v_1}{T_1} = \frac{p_2v_2}{T_2} \Rightarrow T_2 = 750k$



11.(B) $W = 2\Delta U = 2nC_V\Delta T$

$Q = \Delta U + w = 3nC_V\Delta T$

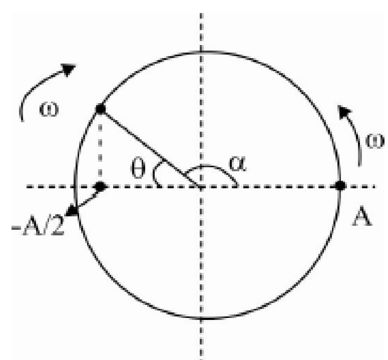
$nC\Delta T = 3nC_V\Delta T$

$C = 3C_V = \frac{3R}{\gamma - 1} = 6R$

12.(B) $A\cos\theta = \frac{A}{2} \Rightarrow \theta = \frac{\pi}{3}$

$\alpha = \frac{2\pi}{3}$

$t = \frac{2\pi/3}{2\omega} = \frac{\pi}{3 \times 2\pi/T} = T/6$



13.(C) $n_1 = n\frac{v}{v - v_s};\ n_2 = \frac{nv}{v + v_s}$

$\frac{n_1}{n_2} = \frac{4}{5} = \frac{330 - v_s}{330 + v_s} \Rightarrow v_s = 36.6\,m/s$

14.(A)

15.(A) Apply $V = \frac{KQ}{2R}\left(3 - \frac{r^2}{R^2}\right)$ for potential inside & $V = \frac{KQ}{r}$ for potential outside.

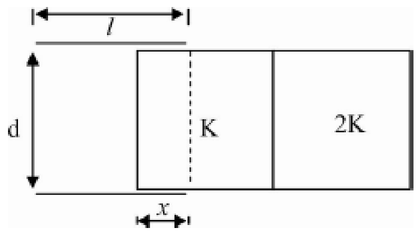
16.(B) Here x = vt

$$C_0 = \frac{\epsilon_0 l^2}{d} \text{ (plates are square shaped)}$$

$$C = \frac{k\epsilon_0 lx}{d} + \frac{k\epsilon_0 (l-x)}{d} = \frac{\epsilon_0 l}{d}[l+(k-1)x]$$

$$C = C_0 + \frac{\epsilon_0 l(k-1)x}{d} \text{ \& } x = vt$$

$$C = C_0 + \frac{\epsilon_0 l(k-1)vt}{d}$$



17.(B) Apply $i = nAv_d e \Rightarrow v_d = \frac{i}{nAe}$

18.(D)

19.(B) Direction of magnetic dipole moment M is given by screw law and this is perpendicular to plane of loop. In stable equilibrium position, angle between M and B is 0° and in unstable equilibrium angle is 180°.

20.(C) Magnetic force on the wire is given by $\vec{F}_m = i(\vec{l} \times \vec{B})$

21.(C) Ratio of magnetic moment and angular momentum is given by $\left(\frac{M}{L} = \frac{q}{2m}\right)$ which is a function of q and m only.

22.(C) Just before opening the switch, the current in the inductor is E/R. Energy stored in it = $\frac{1}{2}L\left(\frac{\varepsilon}{R}\right)^2$

Thus energy will dissipate in resistors R_1 and R_2 in the ratio $\frac{1}{R_1}$ and $\frac{1}{R_2}$

23.(A) $\frac{P}{4\pi R^2} = \frac{1}{2}\epsilon_0 E^2(c) \Rightarrow E = \sqrt{\frac{P}{2\pi R^2 \epsilon_0 C}}$ $(P = 3w) \Rightarrow E = 1.34 V/m$

24.(D) Avoid total internal reflection at the second surface.

25.(A) The vector along the ray is $3\hat{i} + \hat{j} + 2\hat{k}$ So $\cos\alpha = \frac{3}{\sqrt{3^2+1^2+2^2}} = \frac{3}{\sqrt{14}} \Rightarrow \alpha = \cos^{-1}\left(\frac{3}{\sqrt{14}}\right)$

26.(B) $L = v_0 + f_e$

$14 = v_0 + 5 \Rightarrow v_0 = 9\,cm$

Magnifying power of microscope for relaxed eye, $m = \frac{v_0}{u} \times \frac{D}{f_e} \Rightarrow 25 = \frac{9}{u_0} \times \frac{25}{5} \Rightarrow u_0 = 1.8\,cm$

27.(C) Centripetal acceleration = v^2/r

Further, as n increases, r increases and v decreases. So, centripetal acceleration for $n = 2$ is less than that for n = 1. So, statement (i) is wrong.

28.(B)

29.(B) $c.s. = 2(\Delta f)$

$\Delta f = \frac{200}{2} = 100\,KHz \Rightarrow m_f = \frac{\Delta f}{f_m} = \frac{100}{10} = 10$

30.(C) Here as steady state $Q_0 = C_{eq}v$

$Q_0 = 2\times10^{-6} \times 20 = 4\times10^{-5} C$

Now, $\frac{Q_0^2}{2C} = \frac{1}{2}Li_0^2 \Rightarrow \frac{16\times10^{-10}}{2\times4\times10^{-6}} = \frac{1}{2}\times2\times10^{-4}\times i_0^2 \Rightarrow i_0^2 = 2 \Rightarrow i_0 = \sqrt{2}\,amp$

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