20th Apr. Solution (Discussion)

1) a) After cutting String $a_A\uparrow$ $\uparrow 5mg$ $\downarrow 3mg$ $\frac{5mg-3mg}{3m} = 2g/3 \uparrow$

$a_B\downarrow$ $2m$ $\downarrow 2mg$ $a_B = \frac{2mg}{2m} = g\downarrow$

b) $3m$ $3mg \downarrow\downarrow 2mg$ $\downarrow 5mg$ $a_A = \frac{5mg}{3m} = 5g/3 \downarrow$

$2mg\uparrow$ $2m$ $\downarrow 2mg$ $a_B = 0$

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2) a) acc. of C.O.M. $= \left(\frac{m_2 - m_1}{m_2 + m_1}\right)^2 \times g = \frac{4}{10 \times 10} \times 10 = 0.4\ m/s^2 \downarrow$

3) a) net Area covered $= 10^3 \left[\frac{1}{2} \times 2 \times 0.2 - \frac{1}{2} \times 1 \times 0.1 - \cancel{\frac{1}{2}} \times 1 \times 0.1\right]$

$= 10^3 \left[0.2 - 0.15\right]$

$= \underline{0.05 \times 10^3\ N \cdot s}$

4) a) $\tan\theta_1 = 1$; $\tan\theta_2 = 1$

$\therefore |\Delta \vec{P}| = m \times (1+1)$

$= 2m$ $\because$ m not given.

5) $\frac{h+y}{h'+2y} = \left(\frac{y}{2y}\right)^2 \Rightarrow 4h + 4y = h' + 2y$

$h' = \underline{(4h+2y)}$

5) a) $\omega = \sqrt{k/3m}$

$a_{Max} = k/3m\ A$

f_{Max} on $m = KA/3$

$\mu_{min} = \frac{KA}{3 \times 2mg}$ //

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6) $3 = \dfrac{\sin\theta + \mu\cos\theta}{\sin\theta - \mu\cos\theta}$ as $\theta = 45^\circ$, $\sin\theta = \cos\theta$

$= \dfrac{1+\mu}{1-\mu} \Rightarrow 3 - 3\mu = 1 + \mu$

$4\mu = 2$

$\Rightarrow \mu = 1/2$

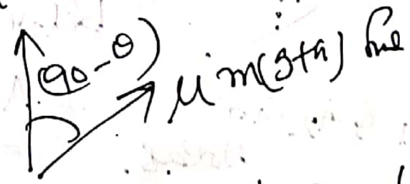
$10\mu = 5$

7) $x_1 = x$ $x_2 = x+y$

$W = \frac{1}{2} k \left[(x+y)^2 - x^2 \right]$

$= \frac{1}{2} k \left[2xy + y^2 \right]$

8) a) $\frac{1}{2}at^2$



$W = \frac{1}{2} \mu m(g+a) a t^2 \sin^2\theta$

b) Tension $= \dfrac{2m_1m_2}{(m_1+m_2)} g = 48N \uparrow$

S in 2 seconds $= \downarrow = \frac{1}{2} \times \cancel{4} \times 4$ m $\downarrow$

$\therefore$ work $= -48 \times 4$ J

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9) a) $U = \cos(x+y)$

$= \cos x \cos y - \sin x \sin y$

$\frac{dU}{dx} = -\sin x \cos y - \cos x \sin y$

$\frac{dU}{dy} = -\cos x \sin y - \sin x \cos y$

$\vec{F_x} = (\sin x \cos y + \cos x \sin y)\hat{i}$

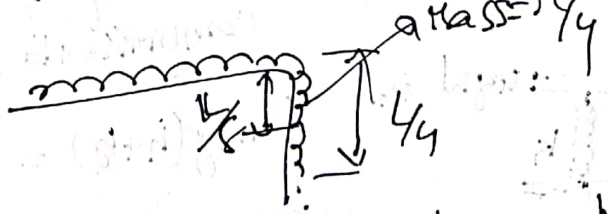
$= \frac{1}{\sqrt{2}}\hat{i}$

$\vec{F_y} = (\cos x \sin y - \sin x \cos y)\hat{j}$

$= \frac{1}{\sqrt{2}}$

$\therefore \vec{F} = \frac{(\hat{i}+\hat{j})}{\sqrt{2}}$

b)



$\therefore$ W are done in dragging hanging part

$= \frac{M}{4} \times g \times L/8$

$= \frac{MgL}{32}$

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21st Apr. Disc. solutions

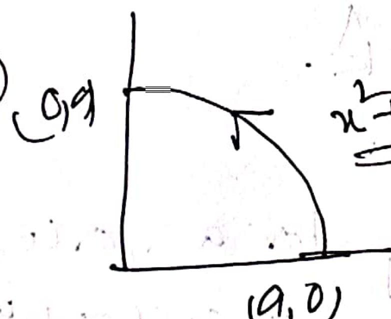
① $U = \frac{A}{r^2} - \frac{B}{r}$

$\Rightarrow F = -\frac{dU}{dr} = -\frac{2A}{r^3} + \frac{B}{r^2}$

for equilibrium $F = 0$

$\Rightarrow -\frac{2A}{r^3} + \frac{B}{r^2} = 0 \Rightarrow r = \frac{2A}{B}$

②



$x^2 + y^2 = a^2$

$\vec{F} = \frac{k}{a^3}\left[x\hat{i} + y\hat{j}\right]$

$W = \frac{k}{a^3}\left[\int_a^0 x\,dx + \int_0^a y\,dy\right]$

$=$ zero

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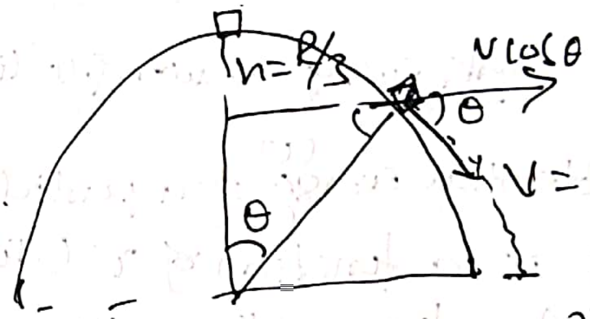
3) a)

$\cos\theta = 2/3$



$V = \sqrt{\frac{2gR}{3}} = \sqrt{\frac{2\times10\times15}{3}} = 10\,m/s$

once when A leaves hemisphere it is a projectile V_x unchanged

$\therefore V_x = v\cos\theta = 10\times\frac{2}{3} = \frac{20}{3}\,m/s$

4) $U = -\frac{k}{2r^2}$ $\quad F = -\frac{dU}{dr} = \frac{k}{r^3} = \frac{mv^2}{r}$

$\therefore KE = \frac{1}{2}mv^2 = \frac{k}{2r^2}$

$\therefore$ total Energy $= -\frac{k}{2r^2} + \frac{k}{2r^2} = 0$

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⑤ $\vec{F}_{(N)} = (2t\hat{i} + 3t^2\hat{j}) = m\vec{a}$ $m = 1\,kg$

$\therefore \vec{a}_{(m/s^2)} = \underline{(2t\hat{i} + 3t^2\hat{j})} = \frac{d\vec{v}}{dt}$

$\vec{dv} = (2t\hat{i} + 3t^2\hat{j})\,dt$

$\vec{v} = \int_0^{\vec{v}} (2t\hat{i} + 3t^2\hat{j})\,dt$

$= (t^2\hat{i} + t^3\hat{j})$

$\therefore$ Power $= \vec{F}\cdot\vec{v} = (2t^3 + 3t^5)$ Watt

⑥

$a_c = k^2 r t^2 = v^2/r$

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

$v = krt$

$a_t = \frac{dv}{dt} = \underline{kr}$

$\therefore F_t = mkr$

$\therefore$ Power $= F_t v = \underline{mk^2r^2t}$

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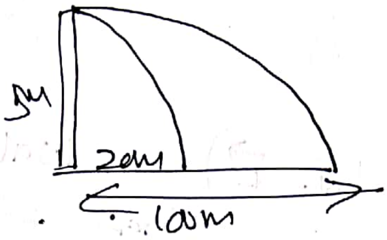
(7)

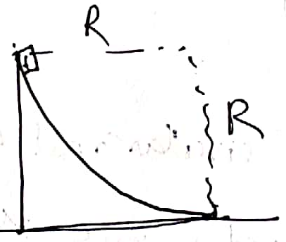


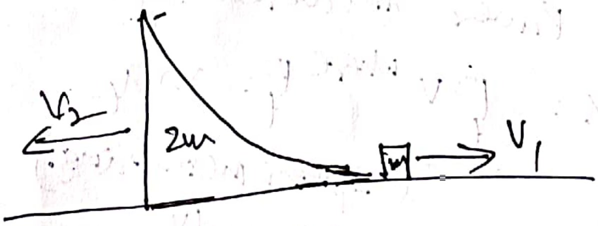
Velocity of 0.2kg $= 20\,m/s$ $(t = 1\,sec)$

velocity 0.01 kg $= 100\,m/s$ $(t = 1\,s)$

$$\therefore\ 0.01 \times U = 0.2 \times 20 + 0.01 \times 100$$
$$= 5$$
$$U = \frac{5}{0.01} = 500\,m/s = 100\,n$$
$$n = 5$$

(8)





$$m v_1 = 2m v_2$$
$$v_2 = v_1/2$$

$$\cancel{m} gR = \frac{1}{2} m v_1^2 + \frac{1}{2} 2m \cdot \frac{v_1^2}{4}$$
$$= \frac{3\cancel{m} v_1^2}{4} \Rightarrow v_1 = \sqrt{\frac{4gR}{3}}$$
$$v_2 = \sqrt{\frac{gR}{3}}$$

Dist moved by B $= -\frac{mR}{m+2m} = -R/3$

towards left by $R/3$

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