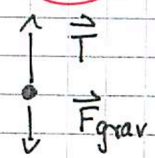
Phys 1410 : class test # 2

(1) tension is greatest at lowest point, (0.5)

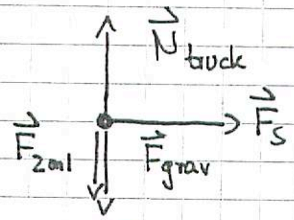
because it has to compensate gravity ($T = m\left(g + \frac{v^2}{R}\right)$ in this case) (0.5)

(optional : FBD for lowest point

require $ma_c = T - mg$)

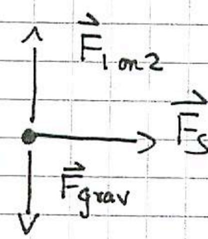


(2) a) m_1



(1)

m_2



(1)

b) Consider Newton-2 for horizontal + vertical components;

start with m_2 :

$\hat{i}: \quad m_2 a = F_s^{(2)} = (16 \times 1.5)\ kg \cdot \frac{m}{s^2}$ (0.5)

$= 24\ N$ (0.5)

$\hat{j}: \quad 0 = F_{1 on 2} - m_2 g$ (0.5)

$\Leftrightarrow \quad F_{1 on 2} = m_2 g = 160\ N$ (0.5)

m_1 : $\hat{i}: \quad m_1 a = F_s^{(1)} = (32 \times 1.5)\ kg \cdot m/s^2$ (0.5)

$= 48\ N$ (0.5)

$\hat{j}: \quad 0 = -m_1 g + N_{truck} + \overbrace{F_{2 on 1}}^{<0}$ (0.5)

$\Leftrightarrow \quad N_{truck} = m_1 g + F_{1 on 2}$ (use Newton-3) (0.5)

$= 470\ N$ (0.5) ; $m_1 g = 310\ N$ (0.5)

3

a) $\vec{r}(t) = R\cos\omega t\,\hat{i} + R\sin\omega t\,\hat{j}$

$$\vec{v}(t) = \frac{d\vec{r}}{dt} = -R\omega\sin\omega t\,\hat{i} + R\omega\cos\omega t\,\hat{j} \qquad (0.5)$$

$$\vec{a}(t) = \frac{d\vec{v}}{dt} = -R\omega^2\cos\omega t\,\hat{i} - R\omega^2\sin\omega t\,\hat{j} \qquad (0.5)$$

$$= -\omega^2\left(R\cos\omega t\,\hat{i} + R\sin\omega t\,\hat{j}\right) \qquad (0.5)$$

$$= -\omega^2\,\vec{r}(t) \qquad (0.5)$$

$$a_c = |\vec{a}(t)| = \omega^2\,|\vec{r}(t)| = \omega^2 R \qquad (0.5)$$

$$= \left(\frac{v}{R}\right)^2 R = \frac{v^2}{R} \qquad (0.5)$$

use $v = |\vec{v}| = \omega R$

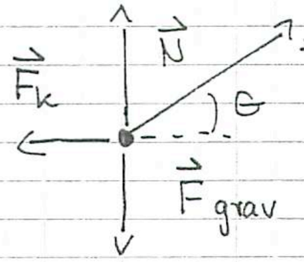
b) $$F_{grav} = \frac{G M_E M_\odot}{d_{SE}^2} = M_E a_c = M_E \frac{v^2}{d_{SE}} \qquad (1)$$

$$\Leftrightarrow \quad v^2 = \frac{G M_\odot}{d_{SE}} = \left(8.9\times10^8\left(\frac{m}{s}\right)^2\right) \qquad (0.5)$$

$$v = \sqrt{\frac{G M_\odot}{d_{SE}}} = 3.0\times10^4\ m/s \qquad (0.5)$$

(4)

(a) FBD



(1)

(b) $\hat{i}$: $ma_x = F_{net,x} = -|F_k| + T\cos\theta$ (0.5)

$\hat{j}$: $0 = ma_y = F_{net,y} = N + T\sin\theta - mg$ (0.5)

$\Leftrightarrow \quad N = mg - T\sin\theta$ (0.5)

use it to determine $|F_k| = \mu_k N$

$= \mu_k (mg - T\sin\theta)$ (0.5)

summary : $F_{net,x} = -\mu_k (mg - T\sin\theta) + T\cos\theta$

$= -\mu_k mg + T(\mu_k \sin\theta + \cos\theta)$

$= -35.8 + 35 \times 1.08$

$= 2.0\ N$ (0.5)

$F_{net,y} = 0$ (0.5)

(c) $W_{rope} = \vec{T} \cdot \Delta\vec{r} = T\Delta x \cos\theta = 220\ J$ (1)

(d) $W_{fric} = \vec{F}_k \cdot \Delta\vec{r} = -F_k \Delta x = -280\ J$ (1)

(e) $W_{net} = \vec{F}_{net} \cdot \Delta\vec{r} = F_{net,x} \cdot \Delta x = 14\ J$ (1)

(f) Work-energy theorem : $\Delta KE = W_{net}$

$\Leftrightarrow \quad KE_f = KE_i + W_{net}$

$= \frac{m}{2} v_i^2 + W_{net} = 18\ J$ (1)