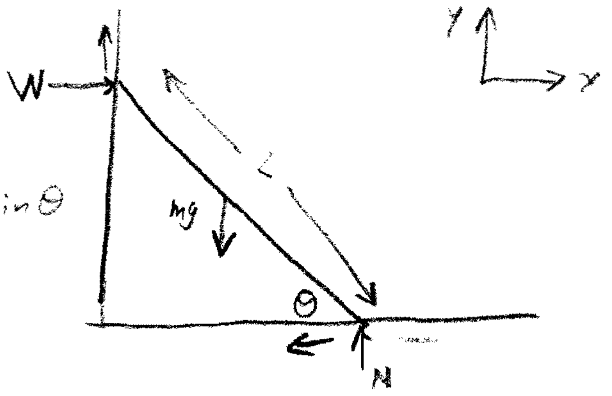
1)



$$\Sigma F_y = mg - N - f_W$$
$$= mg - N - \mu_s W = 0$$

$$\Sigma F_x = W - \mu_f N = 0$$
$$W = \mu_f N$$

$$\Sigma \tau = \tfrac{1}{2} mgL\cos\theta - \mu_s W L\cos\theta - WL\sin\theta = 0$$
About Bottom:

$$mg - N - \mu_s W = 0 \longrightarrow N = mg - \mu_s W$$
$$W - \mu_f N = 0 \longrightarrow N = \frac{W}{\mu_f}$$
$$\tfrac{1}{2} mg\cancel{L}\cos\theta - \mu_s W\cancel{L}\cos\theta - W\cancel{L}\sin\theta = 0$$

$$\left(\frac{mg}{2} - \mu_s W\right)\cos\theta = W\sin\theta$$

$$\tan\theta = \frac{\sin\theta}{\cos\theta} = \left(\frac{mg}{2W} - \mu_s\right)$$

$$mg - \mu_s W = \frac{W}{\mu_f}$$
$$mg = \frac{W}{\mu_f} + \mu_s W = W\left(\mu_s + \frac{1}{\mu_f}\right)$$
$$W = \frac{mg}{\left(\mu_s + \frac{1}{\mu_f}\right)}$$

So $$\frac{mg}{2W} = \frac{mg}{2mg}\left(\mu_s + \frac{1}{\mu_f}\right) = \frac{1}{2}\left(\mu_s + \frac{1}{\mu_f}\right)$$

$$\tan\theta = \frac{1}{2}\left(\mu_s + \frac{1}{\mu_f}\right) - \mu_s = \frac{1}{2\mu_f} - \frac{\mu_s}{2}$$
$$= \frac{1}{2}\left(\frac{1}{\mu_f} - \mu_s\right)$$

A) $$\tan\theta = \frac{1}{2}\left(\frac{1}{0.35} - 0.28\right) = 1.29$$
$$\theta = 52.2^\circ$$

B) $\mu_f \to 0$ $$\tan\theta = \frac{1}{2}\left(\frac{1}{\mu_f} - \mu_s\right) \to \infty$$
$$\theta \to 90^\circ$$ only

If $\mu_f \to 0$ $W \to 0$

Can Not lean on wall.

2) $F = G\frac{M_1 M_2}{r^2}$ $\quad a_g = \frac{GM}{r^2}$ $\quad G = 6.67\times10^{-11}\frac{Nm^2}{kg^2}$

$a_{Truck} = G\cdot\frac{4\times10^3}{(75)^2} = 4.74\times10^{-11}N$

$a_{Near} = G\cdot\frac{1.90\times10^{27}}{(7.8\times10^{11}-1.5\times10^{11})^2} = 3.19\times10^{-7}N$

$a_{Far} = G\frac{1.90\times10^{27}}{(7.8\times10^{11}+1.5\times10^{11})^2} = 1.47\times10^{-7}N$

$a_{Near} - a_{Far} = 1.72\times10^{-7}N$

3) $x = 0.35\sin(\omega t+\delta)$
$v = 0.35\omega\cos(\omega t+\delta)$
$a = -0.35\omega^2\sin(\omega t+\delta)$

$-0.080m = 0.35\sin(\delta)$
$-2.1m/s = 0.35\omega\cos(\delta)$
$E = 6J = \frac{1}{2}kX_{max}^2$

A) $\sin(\delta) = \frac{-0.080}{0.35} = -0.229$
$\delta = -13.2° = -0.231\ rad$

B) $\omega = \frac{-2.1m/s}{0.35\cos(\delta)} = -6.16\ r/s$
$f = \frac{\omega}{2\pi} = 0.98\ Hz$

C) $a = -0.35\omega^2\sin(\delta)$
$= -0.35\cdot(-6.16)^2(-0.229) = 3.04\ m/s^2$

D) $6J = \frac{1}{2}k(0.35)^2$ $\quad k = \frac{2\cdot6}{(0.35)^2}$

$k = 97.8\ N/m$

E) $\omega = \sqrt{\frac{k}{m}}$ $\quad \omega^2 = \frac{k}{m}$
$m = k/\omega^2 = \frac{97.8}{(6.16)^2}$

$m = 2.58kg$

4) $\nu = 120\ Hz$

$f_n = n\frac{v}{2L} = n\frac{\lambda f_n}{2L}$

$n\frac{\lambda}{2} = L$

$\lambda = \frac{2L}{n}$ $\qquad n = 3$ $\qquad \lambda\nu = v$, $\quad v = \sqrt{\frac{\tau}{\mu}}$

$\nu = \frac{v}{\lambda} = \frac{n\sqrt{\frac{\tau}{\mu}}}{2L}$ $\qquad \nu, \mu, L$ fixed

$3\sqrt{\tau_3} = 2\sqrt{\tau_2} = 5\sqrt{\tau_5}$

$\tau_3 = 0.215 \cdot g$ $\qquad \tau = mg$

$\tau_2 = \left(\frac{3}{2}\right)^2 \tau_3$ $\qquad \tau_5 = \left(\frac{3}{5}\right)^2 \tau_3$

$m_2 = \left(\frac{3}{2}\right)^2 m_3 = 484\ gm$ $\qquad m_5 = \left(\frac{3}{5}\right)^2 m_3 = 77.4\ gm$

OR

$f_n = \frac{nv}{2L} = \frac{n}{2L}\sqrt{\frac{F_T}{\mu}}$ $\qquad F_T = mg$

$\sqrt{\frac{F_T}{\mu}} = \frac{2Lf_n}{n}$

$F_T = \frac{\mu\,(2Lf_n)^2}{n^2} = mg$

μ, g, L, f Constant

$m = \frac{1}{n^2}\left(\frac{\mu}{g}(2Lf)^2\right) = \frac{1}{n^2}C$

$n = 3 \qquad m_3 = \frac{1}{9}C = 215\ g \quad \Rightarrow \quad C = 1935\ g$

$n = 2 \qquad m_2 = \frac{1}{4}C = 484\ g$

$n = 5 \qquad m_5 = \frac{1}{25}C = 77.4\ g$

5) $P + \rho g h + \frac{1}{2}\rho v^2$ constant

Top $P = 0$, $h = 0$, $v = 0$

$P = \rho g h = \frac{1}{2}\rho v^2$ $\quad v = \sqrt{2gh} = \sqrt{2gx}$

A) $V = v\sigma\Delta t = \sqrt{2gx}\,\sigma\Delta t$

B) $V = A\Delta x$

c) $A\Delta x = v\sigma\Delta t = \sqrt{2gx}\,\sigma\Delta t$

$\frac{\Delta x}{\Delta t} = \frac{v\sigma}{A} \qquad \frac{dx}{dt} = -\frac{v\sigma}{A} = -\sqrt{2gx}\left(\frac{\sigma}{A}\right)$

D) $\frac{dx}{dt} = 2\left[\sqrt{x_0} - \frac{1}{2}\left(\frac{\sigma}{A}\right)t\sqrt{2g}\right]\left(-\frac{1}{2}\left(\frac{\sigma}{A}\right)\sqrt{2g}\right)$

$= -\left[\sqrt{x_0} - \frac{1}{2}\left(\frac{\sigma}{A}\right)t\sqrt{2g}\right]\frac{\sigma}{A}\sqrt{2g}$

$-\sqrt{2gx}\left(\frac{\sigma}{A}\right) = -\sqrt{2g}\left[x_0 - \frac{1}{2}\left(\frac{\sigma}{A}\right)t\sqrt{2g}\right]\left(\frac{\sigma}{A}\right)$ $\updownarrow$ Match

E) $x(t) = \left[\sqrt{x_0} - \frac{1}{2}\left(\frac{\sigma}{A}\right)t\sqrt{2g}\right]^2 = 0$

$\sqrt{x_0} = \frac{1}{2}\left(\frac{\sigma}{A}\right)t\sqrt{2g}$

$t = 2\sqrt{\frac{x_0}{2g}}\left(\frac{A}{\sigma}\right)$

6) $mg\frac{W}{2} = \frac{1}{2}I\omega^2$ Energy Cons

$I = \frac{1}{3}mW^2$ $W = 30\,cm = 0.3\,m$

$mg\frac{W}{2} = \frac{1}{2}\frac{1}{3}mW^2\omega^2$

$\frac{1}{3}W\omega^2 = g$

$\omega^2 = \frac{3g}{W}$

$\omega = \sqrt{\frac{3g}{W}} = \sqrt{\frac{3\cdot 9.8}{0.3}}$

$\omega = 9.9$ rad/s

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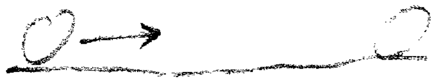
7) 

$M = 30 + 65 + 65 = 160\,kg$

$M_m = 3\,kg$

A) In Ice frame

$m_3 \rightarrow$ $6 - V_s$

$\leftarrow M$ V_s

$P = P_m + P_s = 0 \Rightarrow$ $P_m = -P_s$ $V_m = 6 - V_s$

$3(6 - V_s) = 160\,V_s$

$18 - 3V_s = 160\,V_s$

$18 = 163\,V_s$

$V_s = \frac{18}{163} = 0.11$ m/s

B) $V_s = 0$

C) $M\Delta x = 3(4 - \Delta x)$

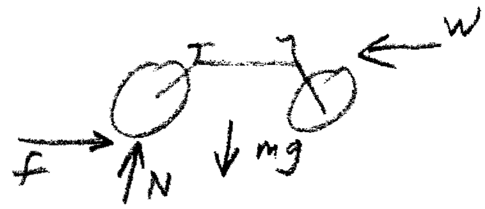
$160\Delta x = 12 - 3\Delta x$

$163\Delta x = 12$ kg m

$\Delta x = \frac{12}{163}$ m $= 0.074$ m $= 7.4$ cm

D) $\Delta X_{cm} = 0$ No External Force

8)

A) 

V, V_w Ground frame

B) V constant $a = \frac{dV}{dt} = 0$ $F = ma = 0$

$\Sigma \vec{F} = 0$

C) $V = 0$ in cyclist frame

$(V_w)_{c\ frame} = V + V_w$

$V = 0$ constant $\Sigma \vec{F} = 0$

D) $(V)_{wind} = V + V_w$

$(V_w)_{wind} = 0$

$V + V_w$ constant $\Sigma \vec{F} = 0$