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Physics Midterm 2 11-21-22

1.) a. 

b. $F=ma$

$F = T - f - mg \rightarrow ma = T - f - mg \rightarrow a = \frac{T - F - mg}{m}$

$a = \frac{1.25\times10^7\,N - 4.5\times10^6\,N - (5\times10^5\,kg)(9.8\,m/s^2)}{5\times10^5\,kg}$

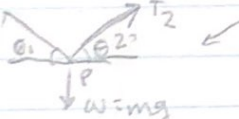
$\boxed{a = 6.20\,m/s^2}$

2.) $\boxed{a = -700\,N}$ It's a trick question, right? Because newton's 3rd law is equal + opposite.

3.) $F=ma \rightarrow a = 200\,m/s^2,\ m = 2000\,kg$

$F = 2000\,kg \cdot 200\,m/s^2 + 1000\,N$

$F = \boxed{401000\,N}$

4) a. 

$\theta_1 = 75°, \theta_2 = 10°$

$w = 76.0\,kg \cdot 9.8\,m/s^2$

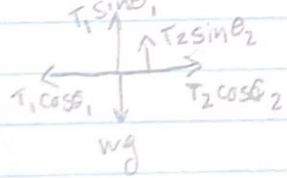
$= 744.8\,N$

b. $F_{net,x} = T_2\cos\theta_2 - T_1\cos\theta_1$

$\boxed{ma_x = T_2\cos\theta_2 - T_1\cos\theta_1}$

c. $F_{net,y} = T_1\sin\theta_1 + T_2\sin\theta_2 - mg$

$\boxed{ma_y = T_1\sin\theta_1 + T_2\sin\theta_2 - mg}$



d. horiz.

$T_1\cos\theta_1 = T_2\cos\theta_2$

$T_1\cos(75°) = T_2\cos(10)$

$\frac{T_1 \cdot 0.259}{0.259} = \frac{T_2 \cdot 0.985}{0.259}$

$T_1\sin(75) + T_2\sin(10) = mg$

$\frac{T_2 \cdot 0.985}{0.259}(0.966) + T_2 \cdot 0.174 = 76.0\,kg \cdot 9.8\,m/s^2$

$T_2(3.67) + T_2(0.174) = 744.8$

$T_2(3.67 + 0.174) = 744.8$

$T_2 = \frac{744.8}{3.844} = \boxed{193.76\,N}$

$T_1 = 193.76 \cdot \frac{0.985}{0.259} = \boxed{736.87\,N}$

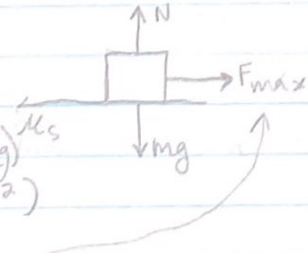
So $\boxed{T_1 = 736.87\,N \text{ \& } T_2 = 193.76\,N}$

3.1.) a. $F_{max} = \mu_s N$

$= \mu_s mg$

$= (0.5)(120\,kg)(9.8\,m/s^2)$

$= \boxed{588\,N}$



b.) $\frac{ma}{m} = \frac{600 - \mu_k mg}{m} \rightarrow a = \frac{600N - (0.3_{\mu_k})(120kg)(9.8\,m/s^2)}{120\,kg} = \boxed{2.06\,m/s^2}$

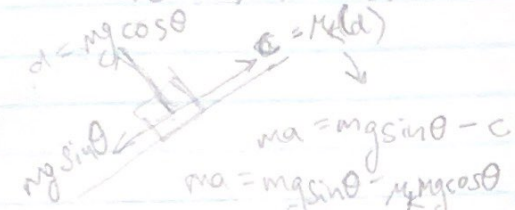
2.) $mg\sin\theta - \mu_k mg\cos\theta = ma$

$g(\sin\theta - \mu_k\cos\theta) = a$

$a = 9.8\,m/s^2(\sin(25) - 0.1\cos(25))$

$\boxed{a = 3.25\ m/s^2}$

$\theta = 25 \quad \mu_k = 0.1$



3.) $F_D = \frac{1}{2} C\rho A v^2$

$= \frac{1}{2}(0.75)(1.225\,kg\,m^{-3})(0.75\,m^2)(40\,m/s)^2$

$= \boxed{551.25\ N}$

$v = 40\,m/s \quad A = 0.75\,m^2 \quad \rho = 1.225\,kg\,m^{-3} \quad C = 0.75$

4.) 2300 kg → 0.74 cm

10.0 m − 3 mm

$\frac{F}{A} = Y(\Delta x/L) \rightarrow Y = \frac{F/A}{\Delta x/L}$

$L = 10\ m$

$\Delta x = 3\,mm$

$F = 2300\,kg \cdot 9.8\,m/s^2$

$A = 2\pi rh + 2\pi r^2$ ← area of a cylinder

$= 2.5\,m^2$

$\frac{F}{A} = \frac{(2300\,kg)(9.81\,m/s^2)}{(0.003m)/(10m)} = \frac{((2300\,kg)(9.8\,m/s^2))/(2.5\,m^2)}{(0.003m)/(10m)} = \boxed{3.01 \times 10^7\ N}$

4.1.) linear vel. $= 144\ km/hr \cdot \frac{1000\,m}{1\,km} \cdot \frac{1\,hr}{3600\,s} = 40\,m/s \quad r = 0.5m$

$v = r\omega$

$\omega = \frac{v}{r} \rightarrow \frac{40\,m/s}{0.5m} = \boxed{80\ rad/sec}$

2.) $v = \sqrt{rg\tan\theta}^2$ $\quad g = 9.8$

$\tan\theta = \frac{v^2}{rg}$

$\frac{120\,km}{1\,hr} \cdot \frac{1000\,m}{1\,km} \cdot \frac{1\,hr}{3600\,s} = 33.33\,m/s$

$0.9\,km \cdot \frac{1000\,m}{1\,km} = 900\,m$

$\tan\theta = \frac{(33.33\,m/s)^2}{(900\,m \cdot 9.8\,m/s^2)}$

$= \frac{1110.89}{8820}\,m$

$\tan\theta = 0.12595\,m$

$\tan^{-1}(0.12595) = \boxed{7.18°}$

3.) a. path 2 because path 1 will have a greater angular velocity.

b. $F_s = \mu_s mg$

$\mu mg = mv^2/r$

$\mu = \frac{v^2}{gr}$

$0.1 = \frac{v^2}{(9.8\,m/s^2)(400m)}$

$\sqrt{v^2} = \sqrt{(0.1)(5920\,m^2/s^2)}$

$\sqrt{v^2} = \sqrt{392}$

$v_1 = 20\,m/s$

$\sqrt{v^2} = \sqrt{(0.1)(9.8\,m/s^2)(800m)}$

$\rightarrow v_2 = 28\,m/s$

4.) a. $\vec{F}_g = \frac{GM}{r^2}$ $\quad G = 6.67430 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$

$M = 1.4 \times 10^{22}\ kg$

$r = 4.5 \times 10^{12}$

$$\vec{F}_g = \frac{(6.67430 \times 10^{-11}\ N \cdot m^2/kg^2)(1.4 \times 10^{22}\ kg)}{(4.5 \times 10^{12}\ kg)^2}$$

$$\vec{F}_g = \boxed{4.61 \times 10^{-14}\ m/s^2}$$

b. $\vec{F}_g = \frac{GM}{r^2}$ $\quad G = 6.67430 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$

$M = 8.62 \times 10^{25}\ kg$

$r = 2.5 \times 10^{12}\ m$

$$= \frac{(6.67430 \times 10^{-11} \frac{N \cdot m^2}{kg^2})(8.62 \times 10^{25}\ kg)}{(2.5 \times 10^{12}\ kg)^2}$$

$$= \boxed{9.21 \times 10^{-10}\ m/s^2}$$

Compare:

$$\frac{g}{g} = \frac{9.21 \times 10^{-10}\ m/s^2}{4.61 \times 10^{-14}\ m/s^2} = \boxed{2.0 \times 10^4}$$