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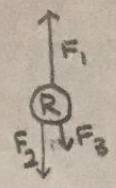
Midterm 2

1)

a) Rocket = R •
Thrusters Force = F_1 ↑
Air Resistance = F_2 ↓
Weight force = F_3 ↓



$F_1 = 1.25\times10^7\ N \quad F_2 = 4.5\times10^6\ N$

$F_3 = mg = 5\times10^5 \times 9.8 = 4.9\times10^6\ N$

b) $F = ma \rightarrow F_1 - (F_2 + F_3) = ma$

$1.25\times10^7 - (4.5\times10^6 + 4.9\times10^6) = 5\times10^5 (a)$

$a = \frac{3.1\times10^6}{5\times10^5} = \boxed{6.2\ \frac{m}{s^2}}$

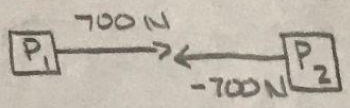
2)

a) Newton's 3rd Law: For every action, there is an equal and opposite reaction.

Player 1 = 700 N $\quad F_{12} = -F_{21} \rightarrow 700\,N = -700\,N$

Therefore, Player 2 is exerting −700N on Player 1.

$\boxed{-700\,N}$

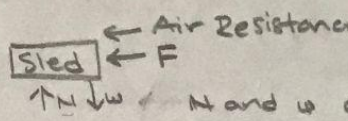


3)

$a = -200\ m/s^2$

$m = 2000\ kg$

Air Resistance = −1000 N $\quad F = ma \rightarrow F - 1000N = ma$



N and w cancel out cause Newton's 3rd Law

$F - 1000N = 2000(-200)$

$F = -400000 + 1000 = -399000\,N$

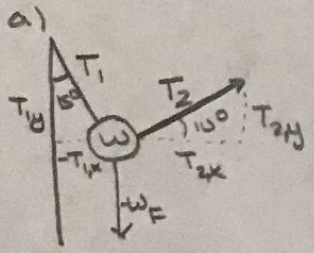
$= \boxed{-3.99\times10^5\ N}$

4)

$m = 76\ kg$

* No acceleration given

a)



T_1 = Tension
T_2 = Tension
w_F = weight force
$= mg$
$= 76\ kg(9.8\ m/s^2)$
$= 744.8\ N$

b) $F_{net,x} = ma_x = 76\,kg(a_x)$

c) $F_{net,y} = ma_y = 76\,kg(a_y)$

d) $F_{net} = 0$

x-position: $T_2\cos10 - T_1\sin15 = 0$

$T_2 = \frac{T_1 \sin 15}{\cos 10}$

y-position: $T_2\sin10 + T_1\cos15 - 744.8\,N = 0$

$T_1 = \frac{744.8\,N - T_2\sin10}{\cos 15}$

$\longrightarrow T_1 = \frac{744.8\,N - \frac{T_1\sin15}{\cos10}(\sin10)}{\cos 15}$

$T_1\cos15 + T_1\frac{\sin15}{\cos10}(\sin10) = 744.8\,N$

$0.965T_1 + 0.045T_1 = 744.8\,N$

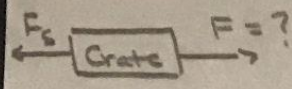
$1.01\,T_1 = 744.8\,N$

$\boxed{T_1 \cong 737.425\,N}$

$T_2 = \frac{737.425\,N \sin15}{\cos10} = \boxed{193.803\,N}$

1)

a) weight force = 120(9.8) = 1176 N



The maximum horizontal force on the crate without moving it is ≈ 588 N.

$F_s = 0.5(1176\text{N})$
$= 588$ N

b) $F_k = 0.3(1176\text{ N})$
$= 352.8$ N

$F = ma$
$F_s - F_k = ma$
$588 - 352 = 120(a)$

$a = \frac{236}{120} = \boxed{1.966 \frac{m}{s^2}}$

2) $F = ma$ $\quad w_x = w\sin 25$ $\quad f_k = 0.1(w\cos 25)$

$\rightarrow w_x - f_k = ma$ $\quad w = mg$

$\rightarrow w\sin 25 - (0.1(w\cos 25)) = ma$

$\rightarrow w(\sin 25 - (0.1)(\cos 25)) = ma$

$\rightarrow mg(\sin 25 - (0.1)(\cos 25)) = ma$

$a = 9.8(\sin 25 - 0.1\cos 25)$
$= \boxed{3.25 \frac{m}{s^2}}$

3) Top speed = 40 m/s
Area = 0.75 m^2
Density of air = $1.225 \frac{kg}{m^3}$
$C = 0.75$

$F_D = \frac{1}{2} C_p A v^2$

$= \frac{1}{2}(0.75)\left(1.225 \frac{kg}{m^3}\right)(0.75\text{ m}^2)\left(40 \frac{m}{s}\right)^2$

$= 551.25 \frac{kg \cdot m}{s^2} = \boxed{551.25\text{ N}}$

4) Young modulus $= \frac{\text{tensile stress}}{\text{tensile strain}}$

$m = 2300$ kg $\quad g = 9.8 \frac{m}{s^2}$ $\quad L_0 = 10$ m $\quad r = 4\text{ cm} = 0.04$ m $\quad \Delta l = 3\text{ mm} = 0.003$ m

$\frac{F}{A} = Y\left(\frac{\Delta L}{L_0}\right)$

$Y = \frac{F L_0}{A \Delta L}$

$\frac{(2300\text{ kg})(9.8\text{ m/s}^2)(10\text{ m})}{\pi(0.04\text{m})^2(0.003\text{ m})}$

$= \boxed{1.494 \times 10^{10} \frac{N}{m^2}}$

1) $v = r\omega \rightarrow \omega = \frac{v}{r}$

$v = 144 \text{ km/hour} = 40 \text{ m/s}$

$r = 0.5 \text{ m}$

$\rightarrow \omega = \frac{40 \text{ m/s}}{0.5 \text{ m}} = \boxed{80 \frac{\text{radians}}{\text{sec}}}$

2) $\tan\theta = \frac{v^2}{rg} \rightarrow \tan\theta = \frac{(33.33)^2}{900(9.8)}$

$v = 120 \text{ km/hr} = 33.33 \text{ m/s}$

$r = 0.9 \text{ km} = 900 \text{ m}$

$g = 9.8 \text{ m/s}^2$

$\theta = \tan^{-1}\left(\frac{(33.33)^2}{900(9.8)}\right)$

$= \boxed{7.178^\circ}$

3)

a) I think Path 2 may be taken at a higher speed compared to Path 1 since it looks like it has a more gradual curve with a larger radius. Based on what I know from racing, Path 2 is considered a "racing line," which allows a car to make a turn at max speed without sliding.

b) Path 1: $r = 400 \text{ m}$
Path 2: $r = 800 \text{ m}$
Coefficient of friction = 1.0

$f = \mu N = \mu mg$

$F_c = \frac{mv^2}{r}$

$\rightarrow \mu mg = \frac{mv^2}{r} \rightarrow \mu g = \frac{v^2}{r}$

$\rightarrow v^2 = \mu g r \rightarrow v = \sqrt{\mu g r}$

Path 1 $\rightarrow v = \sqrt{(1.0)(9.8 \text{ m/s}^2)(400 \text{ m})}$

$= \underline{62.61 \text{ m/s}}$

Path 2 $\rightarrow v = \sqrt{(1.0)(9.8 \text{ m/s}^2)(800 \text{ m})}$

$= \underline{88.54 \text{ m/s}}$

4)

a) $a_c = \frac{Gm}{r^2}$ $\quad m = 1.4 \times 10^{22}\ kg$ $\quad r = 4.5 \times 10^{12}\ m$ $\quad G = 6.674 \times 10^{-11}\ N$

$$a_c = \frac{(6.674 \times 10^{-11})(1.4 \times 10^{22})}{(4.5 \times 10^{12})^2} = \underline{4.614 \times 10^{-14}\ m/s^2}$$

b) $a_c = \frac{Gm}{r^2}$ $\quad m = 8.62 \times 10^{25}\ kg$ $\quad r = 2.5 \times 10^{12}\ m$

$$a_c = \frac{(6.674 \times 10^{-11})(8.62 \times 10^{25})}{(2.5 \times 10^{12})^2} = \underline{9.204 \times 10^{-10}\ m/s^2}$$

$$\frac{9.204 \times 10^{-10}}{4.614 \times 10^{-14}} = 19947.9844$$

Uranus centripetal acceleration is 19947.9844 times greater than Pluto centripetal acceleration.