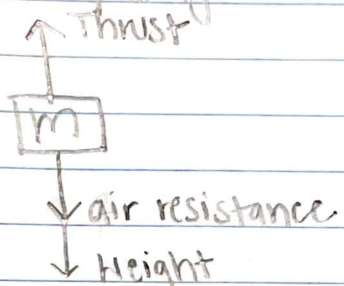
PHYS 135 A - Exam 2 11/21/22

2 Chapter 4: Dynamics, Force & Newton's...

1)

5.00×10^5 kg ↑ rocket
1.25×10^7 N ↑ thrusters
4.5×10^6 N ↓ air resis.

(a) Free body diagram



(b) rocket's acceleration?

$F_{net} = ma$
$F = T - f - mg$
$ma = T - f - mg$
↳ accel. ↳ 9.8 m/s

$(5 \times 10^5 \text{ kg})\, a = 1.25 \times 10^7 \text{N} - 4.5 \times 10^6 \text{N} - (5 \times 10^5 \text{kg})(9.8 \text{m/s})$

Solve for a: $a = \dfrac{(1.25 \times 10^7 \text{N}) - (4.5 \times 10^6 \text{N}) - (4.9 \times 10^6 \text{N})}{(5 \times 10^5 \text{kg})}$

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

2) 70 kg pushes → w/ mass 90 kg
exerts 700N on 2nd player. Force 2nd exerts on 1st?

$F_1 = F_2$
$m_1 a_1 = m_2 a_2$

$m_1 = 70$ kg
$m_2 = 90$ kg
$F_1 = 700$ N

So, if player 1 exerts a force on player 2, then player 2 must exert a force of = magnitude & opposite direction back on player 1.

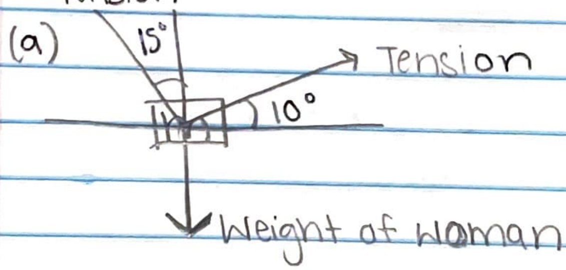
$\boxed{F_2 = -700 \text{N}}$

3) Sled decelerated $200 m/s^2$ air resistance = 1000N
mass = 2000kg What add. f required for dec?

$F = (\text{deacceleration})(\text{mass})$
$F = (200 m/s^2)(2000 kg)$
$F = 400{,}000 N$

An added force of
400,000 N
$\to 4.0 \times 10^5 N$

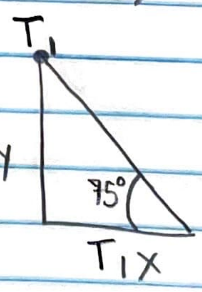
4) 76 kg person. Pulled

(a)


(b) $F_{Net,x}$
$F_{Net} = \cancel{m a_x}$
$F_{Net} = 0$
$\boxed{F_{Net,x} = T_2 \cos\theta_2 - T_1 \sin\theta_1}$

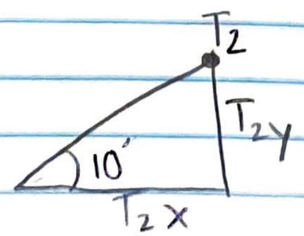
(c) $F_{Net,y}$
$F_{Net} = \cancel{m a_y}$
$F_{Net} = 0$
$\boxed{F_{Net,y} = T_2 \sin\theta_2 + T_1 \cos\theta_1 - \vec{W}}$

(d) $F_{Net} = 0$



$\cos 75° = \frac{a}{h}$

$\sin 75° = \frac{o}{h}$



$\cos 10° = \frac{a}{h}$

$\sin 10° = \frac{o}{h}$

$T_1 = \frac{(76kg)(9.8 m/s^2)}{\cos 15° + \left(\frac{\sin 15°}{\cos 10°}\right)\sin 10°}$

$\boxed{= 736.3N}$

$T_2 = (736.3N)\left(\frac{\sin 15°}{\sin 10°}\right)$

$\boxed{= 193.5N}$

3 Chapter 5: Friction, Drag, & Elasticity

1) 120 kg wooden crate
Static = 0.5
Kinetic = 0.3

(a) max force horizon. w/moving?
$f = \mu N \rightarrow f = \mu mg$

$f_{static} = (0.5)(120\,kg)(9.8\,m/s^2)$
$\boxed{f_{static} = 588\,N \,/\, f_s < 588\,N}$

(b) $f_{kinetic} = (0.3)(120\,kg)(9.8\,m/s^2)$
$f_{kinetic} = 352.8\,N$

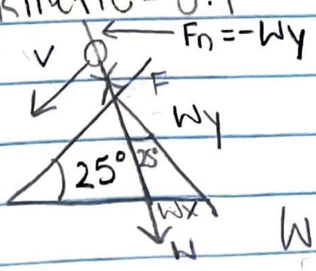
$F_{Net} = ma$

$\text{Acceleration} = \dfrac{f_{static} - f_{kinetic}}{m}$

$a = \dfrac{588\,N - 352.8\,N}{120\,kg}$

$\boxed{a = 1.96\,m/s^2}$

2) incline 25° a=?
Kinetic = 0.1



$\sin 25° = \dfrac{W_x}{W} \rightarrow W\sin 25°$

$\cos 25° = \dfrac{-W_y}{W} \rightarrow W_y = -W\cos 25°$

$W_x - F_K = ma_x$

$f_s \leq \mu_s F_N$

$f_K = U_K F_N$

$a = (9.81)(\sin(25°) - 0.1(\cos(25°)))$
$\boxed{a = 3.25\,m/s^2}$

3) 40m/s top speed magnitude = ?
0.75m^2 area
1.225kgm^{-3} den. of air
0.75 = C

$F_D = 1/2\, C\rho A v^2$
$= 1/2\,(0.75)(1.225\,kg\,m^{-3})(0.75m^2)(40m/s^2)$
$\boxed{F_D = 551.25N}$

4) 2300kg mass $\frac{F}{A} = Y(\Delta x/L)$
10m long wooden beam
radius = 4cm → 40mm → 0.04m 10 (7m/-3mm)
decreases by 3mm → 0.003m

$F = mg$
$\frac{F/A}{\Delta L/L} = Y \rightarrow Y = \frac{22563N/5\times10^{-3}m^2}{0.003m/10m}$ $F = (2300kg)(9.81m/s^2)$
$= 22563N$
$\boxed{Y = 1.5\times10^{10}\,N/m^2}$

4 Chapter 6: Uniform Circular Motion..

1) pitch 144 km/hr → 40 m/s

0.5 m radius

$V = r\omega$

$\downarrow$ m/sec, m, 1/sec

$$\frac{40\,m/s}{0.5} = \frac{0.5\,\omega}{0.5}$$

$$\boxed{80\text{ rad/sec} = \omega}$$

2) 0.9 km radius

120 km/hr

$$V = \frac{120\,km}{1\,hr}\left(\frac{1000\,m}{1\,km}\right)\left(\frac{1\,hr}{3600\,s}\right)$$

$V = 33.3$ m/s

0.9 km → 900 meters

$$\tan^{-1} = \left(\frac{(33.3\,m/s)^2}{900 \times 9.8}\right)$$

$$\boxed{\theta = 7.17^\circ}$$

3) 2 race cars

(a) which path... friction and centripetal force?
- Path 2 because the friction of path 2 allows for the vehicle to take the curve at significantly higher speeds.

(b) Path 1 = 400 m   Path 2 = 800 m
coe. friction = 1.0

Path 1 = $v = \sqrt{1(9.81 m/s^2)(400m)}$
$\boxed{v = 62.6 \text{ m/s}}$

$F_c = \frac{mv^2}{r} = m a g$

$\frac{v^2}{rg} \rightarrow v = \sqrt{rg}$ (meters)

Path 2 = $v = \sqrt{1(9.81 m/s^2)(800m)}$
$\boxed{v = 88.6 \text{ m/s}}$

4)

(a) 4.5×10^{12} m apart
1.4×10^{22} kg mass of Pluto

$F_G = \frac{G m_1 m_2}{r^2} \rightarrow G = \frac{6.673 \times 10^{-11} N \cdot m^2/kg^2 (1.4 \times 10^{22} kg)}{(4.5 \times 10^{12} m)^2}$

Acc. due to G. Neptune = $\boxed{4.6 \times 10^{-14} m/s^2}$

(b) $G = \frac{6.673 \times 10^{-11} N \cdot m^2/kg^2 (8.62 \times 10^{25} kg)}{(2.5 \times 10^{12} m)^2}$

$\boxed{G = 9.2 \times 10^{-10} m/s^2}$ (Neptune & Uranus)

$\frac{9.2 \times 10^{-10} m/s^2}{4.6 \times 10^{-14} m/s^2} = \boxed{2.0 \times 10^4}$ acceleration due to gravity at Neptune to Uranus compared with Pluto.