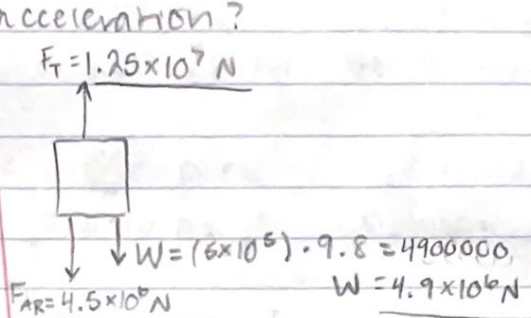


Kamariwa Hewitt Midterm #2

Score: 19/20, well done!

Chapter 4

- 1) A 5×10^5 kg rocket is accelerating straight up. The Thrusters produce an upwards force of 1.25×10^7 N, and air resistance is 4.5×10^6 N downwards. a) draw a FBD including weight of the rocket, the thrust, and air resistance. b) what is the rocket's acceleration?



$$F = m \cdot a \rightarrow \frac{F}{m} = a$$

$$a = \frac{1.25 \times 10^7 - (4.5 \times 10^6 + 4.9 \times 10^6)}{5 \times 10^5}$$

$$a = \frac{3.1 \times 10^6}{5 \times 10^5}$$

$$a = 6.2 \text{ m/s}^2$$

- 2) A football player with mass 70 kg pushes on a player with mass 90 kg. According to Newton's 3rd law, if the first player exerts a force of 700 N on the second player, what is the force the second player exerts on the first player?

a) -700 N

- 3) A rocket sled is decelerated at a rate of 200 m/s^2 , and it has a mass of 2000 kg. There is a constant air resistance force of 1000 N. What additional force is required to give the rocket the deceleration

$$F = m \cdot a$$

$$F_1 + F_2 = m \cdot a$$

$$1000 \text{ N} + F_2 = 2000 \cdot 200$$

$$F_2 = 400000 - 1000$$

$$F_2 = 399000 \text{ N}$$

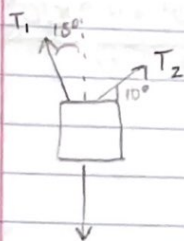
$F_2 = 399000 \text{ N}$
 in the same direction
 as air resistance

4) a 76 kg person is being pulled away from a burning building
 a) draw a FBD including the two tension vectors and the woman's weight

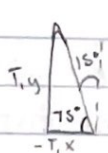
b) write down an expression for $F_{net,x}$

c) write down an expression for $F_{net,y}$

d) assuming $F_{net} = 0$, calculate the tension in the two ropes



$$W = 76 \times 9.8 = 744.8 \text{ N}$$



$$\cos(\theta) = \frac{A}{H}$$

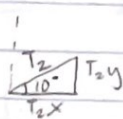
$$\cos(75^\circ) = \frac{T_{1y}}{T_1}$$

$$T_{1y} = T_1 \cdot \cos(75^\circ)$$

$$\sin(\theta) = \frac{O}{H}$$

$$\sin(75^\circ) = \frac{T_{1x}}{T_1}$$

$$T_{1x} = T_1 \cdot \sin(75^\circ)$$



$$\cos(10^\circ) = \frac{T_{2y}}{T_2}$$

$$T_{2y} = \cos(10^\circ) \cdot T_2$$

$$\sin(10^\circ) = \frac{T_{2x}}{T_2}$$

$$T_{2x} = \sin(10^\circ) \cdot T_2$$

$$c) F_{net,y} = T_1 \cdot \sin(75^\circ) + T_2 \cdot \sin(10^\circ) - 744.8$$

$$T_1 \cdot \sin(75^\circ) + T_2 \cdot \sin(10^\circ) - 744.8 = 0$$

$$\frac{T_2 \cos(10^\circ)}{\cos(75^\circ)} (\sin(75^\circ)) + T_2 \sin(10^\circ) - 744.8 = 0$$

$$b) F_{net,x} = -T_1 \cdot \cos(75^\circ) + T_2 \cdot \cos(10^\circ) = 0 \quad T_2 \cdot 3.675 + T_2 \sin(10^\circ) = 744.8$$

$$T_2 (3.675 + \sin(10^\circ)) = 744.8$$

$$T_2 \cdot \cos(10^\circ) = T_1 \cdot \cos(75^\circ)$$

$$T_2 \cdot 3.8486 = 744.8$$

$$d) T_2 = 193.5 \text{ N}$$

$$\frac{T_2 \cos(10^\circ)}{\cos(75^\circ)} = T_1$$

$$\frac{193.5 \cdot \cos(10^\circ)}{\cos(75^\circ)} = T_1$$

$$d) T_1 = 736.3 \text{ N}$$

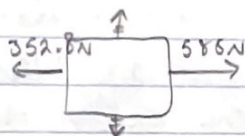
chapter 5

- 1) Suppose you have a 120 kg wooden crate resting on a wooden floor. $\mu_s = 0.5$ $\mu_k = 0.3$
- a) What max force can you exert horizontally on the crate without moving it
- b) If you continue to exert this force once the crate starts to slip, what will the magnitude of its acceleration then be?

$$F_N = 120 \cdot 9.8 = 1176 \text{ N}$$

$$f_s \leq \mu_s \cdot N \leq 0.5 \times 1176 = 588 \text{ N}$$

$$f_k = \mu_k \cdot N = 352.8 \text{ N}$$



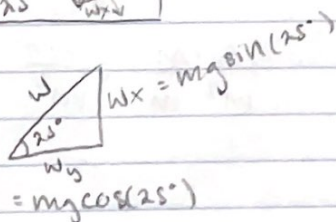
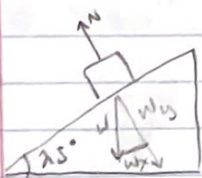
a) The max force you can exert is 588 N

$$F = ma \quad b) \text{ Mag. of acceleration} = 1.96 \text{ m/s}^2$$

$$588 - 352.8 = 120a$$

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

- 2) Suppose a skier is sliding down a slope w/ incline 25° . If the coefficient of kinetic friction is 0.1, what is the skier's acceleration?



$$mg \sin(25^\circ) - \mu mg = ma$$

$$g \sin(25^\circ) - \mu g = a$$

$$9.8(\sin(25^\circ) - 0.1) = a$$

$$9.8(0.42 - 0.1) = a$$

$$a = 3.16 \text{ m/s}^2$$

- 3) Suppose the skier reaches a top speed of 40 m/s. If his area is 0.75 m^2 , density of air is 1.225 kg/m^3 , and $C=0.75$, what is the magnitude of the drag force in Newtons?

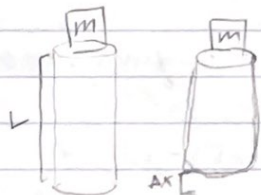
$$F_D = \frac{1}{2} C \rho A v^2$$

$$F_D = \frac{1}{2} (0.75) (1.225 \frac{\text{kg}}{\text{m}^3}) (0.75 \text{ m}^2) (40 \frac{\text{m}}{\text{s}})^2 = \text{kg m/s}^2 = \text{N}$$

$$F_D = 551.25 \text{ N}$$

- 4) A mass of 2300 kg is placed on top of a 10m long wooden beam w/ radius 4cm. If the length of the beam decreases by 3mm, what is the young's modulus of the wood?

$$\text{Stress} = Y \times \text{Strain} \text{ or } \frac{F}{A} = Y \left(\frac{\Delta x}{L} \right)$$



$$F = 2300 \cdot 9.8 = 22540 \text{ N}$$

$$A = \pi r^2 = \pi (0.04)^2 = 0.0016\pi \text{ m}^2$$

$$\Delta x = 0.003 \text{ m}$$

$$L = 10 \text{ m}$$

$$Y = \frac{FL}{A\Delta x} = \frac{22540(10)}{0.0016\pi \cdot 0.003}$$

$$\frac{\text{N} \cdot \text{m}}{\text{m}^2 \cdot \text{m}} = \frac{\text{N} \cdot \text{m}}{\text{m}^3} = \frac{\text{N}}{\text{m}^2}$$

$$Y = 14947301738.7 \text{ N/m}^2$$

chapter 6

$$\frac{144 \text{ km}}{1 \text{ hr}} \left(\frac{1 \text{ hr}}{3600 \text{ s}} \right) \left(\frac{1000 \text{ m}}{1 \text{ km}} \right) = 40 \text{ m/s}$$

- 1) a pitcher in baseball pitches a ball at 144 km/hr and the ball rotates around his arm at a radius of 0.5 m. what is the angular velocity of the ball as he throws it, in radians per second?

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

- 2) what is the ideal banking angle for a gentle turn of 0.9 km radius on a highway w/ a 120 km/hr speed limit?

$$mg \frac{\sin(\theta)}{\cos(\theta)} = \frac{mv^2}{r}$$

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

$$v = 33.33 \text{ m/s}$$

$$mg \tan(\theta) = \frac{mv^2}{r}$$

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

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

$$\theta = \tan^{-1} \left(\frac{v^2}{rg} \right)$$

$$\theta = \tan^{-1} \left(\frac{(33.33)^2 \text{ m}^2/\text{s}^2}{9.8 \text{ m/s}^2 \cdot 900 \text{ m}} \right)$$

$$\theta = \tan^{-1} (0.125976)$$

$$\boxed{\theta = 7.18^\circ}$$

- 3) a) which path may be taken at a higher speed, if both paths correspond to the same force of friction and cent. force?
 b) Suppose path 1 has a radius of curvature of 400m and path 2 has a radius of curvature of 800m. $\mu = 1$ if $F_f = F_c$ what are the tangential velocities of each race car?

$$\mu N = \frac{mv^2}{r}$$

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

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

$$g = \frac{v^2}{r}$$

$$v = \sqrt{g \cdot r}$$

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

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

$$\mu g = \frac{v^2 \cdot r}{v^2}$$

$$v_t = \frac{v^2 \cdot r}{\mu g}$$

$$v_{t1} = \frac{v^2(400)}{9.8}$$

$$v_{t2} = \frac{v^2(800)}{9.8}$$

a) path 2 can be taken at a higher speed

b) the tangential velocity of path 2 will be twice that of path 1?

(-1)

"v" in centripetal force is the tangential velocity, so all you have to do is solve for v.