

Jayden Del Mar

20643293

Midterm 2

Score: 22/20, well done!

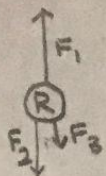
1)

a) Rocket = R.

Thrusters Force = $F_1 \uparrow$

Air Resistance = $F_2 \downarrow$

Weight force = $F_3 \downarrow$



$$F_1 = 1.25 \times 10^7 \text{ N} \quad F_2 = 4.5 \times 10^6 \text{ N}$$

$$F_3 = mg = 5 \times 10^5 \times 9.8 = 4.9 \times 10^6 \text{ N}$$

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

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

$$a = \frac{3.1 \times 10^6}{5 \times 10^5} = \boxed{6.2 \frac{\text{m}}{\text{s}^2}}$$

2)

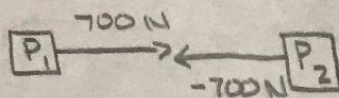
a) Newton's 3rd Law: For every action, there is an equal and opposite reaction.

Player 1 = 700 N

$$F_{12} = -F_{21} \rightarrow 700 \text{ N} = -700 \text{ N}$$

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

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



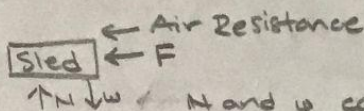
3)

$$a = -200 \text{ m/s}^2$$

$$m = 2000 \text{ kg}$$

$$F = ma$$

$$\text{Air Resistance} = -1000 \text{ N} \rightarrow F - 1000 \text{ N} = ma$$



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

$$F - 1000 \text{ N} = 2000 (-200)$$

$$F = -400000 + 1000 = -399000 \text{ N}$$

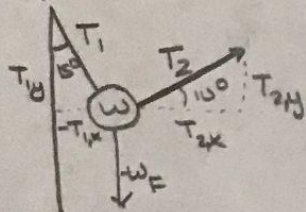
$$= \boxed{-3.99 \times 10^5 \text{ N}}$$

4)

$$m = 76 \text{ kg}$$

* No acceleration given

a)



T_1 = Tension

T_2 = Tension

W_F = weight force

$$= mg$$

$$= 76 \text{ kg} (9.8 \text{ m/s}^2)$$

$$= 744.8 \text{ N}$$

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

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

$$d) F_{\text{net}} = 0$$

$$x\text{-position: } T_2 \cos 10 - T_1 \sin 15 = 0$$

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

$$y\text{-position: } T_2 \sin 10 + T_1 \cos 15 - 744.8 \text{ N} = 0$$

$$T_1 = \frac{744.8 \text{ N} - T_2 \sin 10}{\cos 15}$$

$$\rightarrow T_1 = \frac{744.8 \text{ N} - \frac{T_1 \sin 15}{\cos 10} (\sin 10)}{\cos 15}$$

$$T_1 \cos 15 + T_1 \frac{\sin 15}{\cos 10} (\sin 10) = 744.8 \text{ N}$$

$$0.965 T_1 + 0.045 T_1 = 744.8 \text{ N}$$

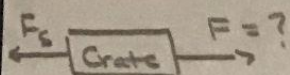
$$1.01 T_1 = 744.8 \text{ N}$$

$$\boxed{T_1 = 737.425 \text{ N}}$$

$$T_2 = \frac{737.425 \text{ N} \sin 15}{\cos 10} = \boxed{193.803 \text{ N}}$$

1)

a) weight force = $120(9.8) = 1176 \text{ N}$



The maximum horizontal force on the crate without moving it is $\approx 588 \text{ N}$.

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

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

$$F = ma$$

$$F_s - F_k = ma$$

$$588 - 352 = 120(a)$$

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

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

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

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

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

$$\rightarrow \cancel{m} g (\sin 25^\circ - (0.1)(\cos 25^\circ)) = \cancel{m} a$$

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

3) Top speed = 40 m/s

Area = 0.75 m^2

Density of air = $1.225 \frac{\text{kg}}{\text{m}^3}$

$C = 0.75$

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

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

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

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

$m = 2300 \text{ kg}$ $g = 9.8 \frac{\text{m}}{\text{s}^2}$

$L_0 = 10 \text{ m}$

$r = 4 \text{ cm} = 0.04 \text{ m}$

$\Delta l = 3 \text{ mm} = 0.003 \text{ m}$

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

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

$$= \frac{(2300 \text{ kg})(9.8 \text{ m/s}^2)(10 \text{ m})}{\pi (0.04 \text{ m})^2 (0.003 \text{ m})} = 1.494 \times 10^{10} \frac{\text{N}}{\text{m}^2}$$

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

$$v = 144 \text{ km/hr} \rightarrow \omega = \frac{40 \text{ m/s}}{0.5 \text{ m}} = \boxed{80 \frac{\text{radians}}{\text{sec}}}$$

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

$$\theta = \tan^{-1} \left(\frac{(33.33)^2}{900(9.8)} \right) = \boxed{7.178^\circ}$$

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

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

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

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

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

$$\rightarrow v^2 = \mu gr \rightarrow v = \sqrt{\mu gr}$$

$$\text{Path 1} \rightarrow v = \sqrt{(1.0)(9.8 \text{ m/s}^2)(400 \text{ m})} = \underline{62.61 \text{ m/s}}$$

$$\text{Path 2} \rightarrow v = \sqrt{(1.0)(9.8 \text{ m/s}^2)(800 \text{ m})} = \underline{88.54 \text{ m/s}}$$

4)

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

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

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

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

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

(+2) Bonus

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