

4: Dynamics, Force, Newtons (acc or motion)

1) acceleration?

$$a = \frac{F_T - F_a - mg}{m}$$

$$a = \frac{(1.25 \times 10^7 \text{ N}) - (4.5 \times 10^6 \text{ N}) - (70 \text{ kg})(9.8 \text{ m/s}^2)}{70 \text{ kg}}$$

114,275.91 ~~N/kg~~ or ~~m/s²~~

1.14 × 10⁷ m/s² or N/kg

(2) mass 70 kg, force 1,700 N

~~90 kg force 2?~~

$$F_{\text{net}} = p - F = ma$$

$$F_{AB} = -F_{BA}$$

$$700 = -700??$$

$$1700 \text{ N} = +700 \text{ N}?$$

NOT USE Hooke's Law w/o "acc."?



(3) decelerates 200 m/s²
mass = 2,000 kg

constant air resistance = 1000 N

what other force? = ~~F = ma~~

$$\sum F_x = ma$$

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

$$T_1 = 736,32 \text{ N}$$

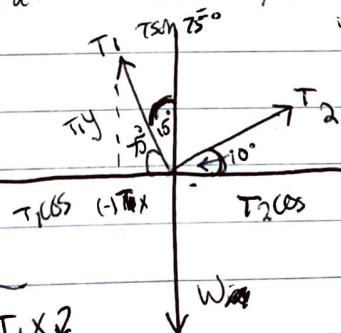
$$T_2 = 193$$

4) mass = 76 kg

$\sum F_x = 0$
 $\sum F_y = 0$

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

assume $F_{\text{net}} = 0$, calc. tensions in ropes =



$$-T_1 \cos 75^\circ + T_2 \cos 10^\circ = 0$$

$$-W + T_1 \sin 75^\circ + T_2 \sin 10^\circ = 0$$

$$T_1 \times 2 \cos 75^\circ = \frac{W}{2}$$

$$\cos(75^\circ) = \frac{-T_1 \times 2}{T_1}$$

$$W = mg$$

$$(76 \text{ kg})(9.8 \text{ m/s}^2) = 744.8 \text{ N}$$

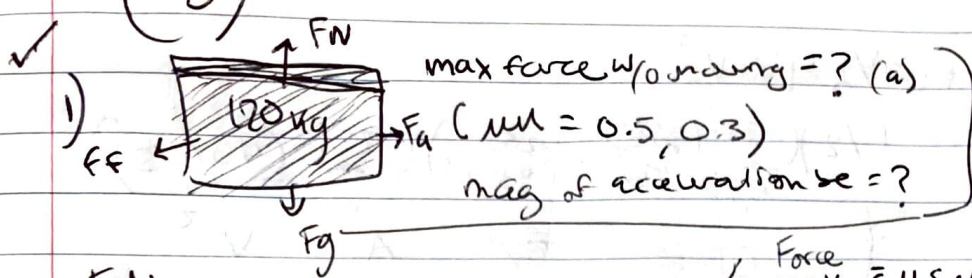
$$\frac{T_1}{T_2} = \frac{\cos 10^\circ}{\cos 75^\circ}$$

$$T_1 = 8.805 T_2$$

$$3.805 T_2 \sin 75^\circ + T_2 \sin 10^\circ = 744.8 \text{ N}$$

$$T_2 = 193.514 \text{ N}$$

$$T_1 = 3.805 \times 193.514 = 736.324 \text{ N}$$



$$F_N = mg$$

$$= (120 \text{ kg})(9.8 \text{ m/s}^2)$$

~~$G = 1176 \text{ N}$~~
 ~~$\mu_s \times N = (0.5)(1176)$~~
 ~~$\mu_k \times N = (0.3)(1176)$~~

$$\text{Force}_{\text{max}} = \mu_s \cdot M \cdot g$$

$$= (0.5)(120 \text{ kg})(9.8 \text{ m/s}^2)$$

$$588 \text{ N}$$

max force without moving

(b) $F_k = (\mu_k)(N) = (0.3)(1176)$
 $F = F_{s\text{max}} - F_k$

$$588 - (352.8)$$

$$F = ma$$

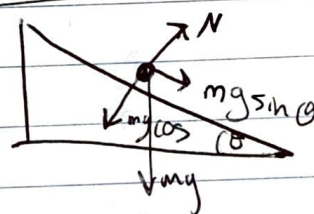
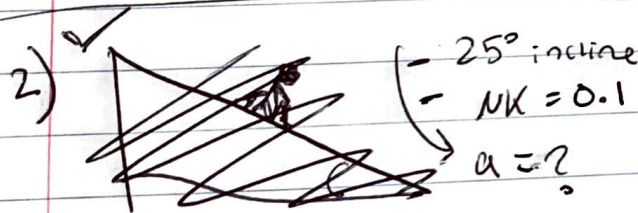
$$F/m = a$$

$$(235.2 \text{ N})$$

$$(120 \text{ kg})$$

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

$$\text{N/kg}$$



$$F_{\text{net}} = mg \sin \theta - \mu_k (mg \cos \theta)$$

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

$$a = (4.14165) - (0.8891)$$

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

4.6

✓ i) $V = r\omega$
 144 km/hour
 $0.5 = R$
 $(144) \text{ km/hour} = \frac{288,000 \text{ m}}{1 \text{ hour}} \cdot \frac{60 \text{ min}}{60 \text{ min}} = 4,800 \text{ RPM}$
 \downarrow in km (0.0005 km)
 \downarrow Radians/sec
 $\frac{4,800 \text{ RPM} \cdot \frac{1 \text{ min}}{60 \text{ sec}} \cdot \frac{2\pi}{1 \text{ rev}}}{1 \text{ min}} = 502.65 \text{ Radians per sec.}$

2# $\mu m = 0.9 \text{ km Rad.}$
 $(120 \text{ km per hour 1 unit})$

$\tan \theta = \frac{v^2}{r g}$
 \downarrow

$\frac{120 \text{ km}}{\text{hour}} \cdot \frac{1000 \text{ m}}{\text{km}} \cdot \frac{1 \text{ hour}}{3600 \text{ sec}} = 33.3 \text{ m/sec} = \text{velocity}$

$0.9 \text{ km} \times 1000 = 900 \text{ m}$

3

$\tan(\theta) = \frac{(33.3)^2}{(900)(9.8)}$ $\left\{ \begin{array}{l} \text{radius} \\ = \end{array} \right.$

$\theta = \tan^{-1} \left(\frac{(33.3)^2}{(900)(9.8)} \right)$

$\theta = \tan^{-1}(0.1257)$

$\theta = 7.16^\circ$

- a) Some friction, $\frac{1}{2}$ cent. F?
 safer at higher speed?
 \downarrow larger angles so path 2 can be taken at higher speeds.

b)

path 1	2
Radius of 400 m	R of 800 m

$\mu_k = 1.0$

$F_f = C_F$, what tangential velocities?

$F_c = m a_c$
 $= \frac{m v^2}{r}$
 $= m \omega^2 r$

$\frac{(1) x^2}{400} = 20$

$\frac{(1) x^2}{800} = v^2$

~~1.1.1~~

1/3

top speed = 40 m/s

area = 0.75 m²

air density = 1.255 kg m⁻³

C = 0.75

mag. in Newtons?
OF
drag force

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

$$\left(\frac{1}{2}\right) (0.75) \left(\frac{1.255}{\text{kg m}^{-3}}\right) (0.75 \text{ m}^2) (40 \text{ m/s})^2$$

C A v²

$$F_D = 564.78 \text{ N}$$

4) BOWS

acceleration

due to gravity

a) at Neptune dist to Pluto
 $4.5 \times 10^{12} \text{ m}$ apart

(mass $1.4 \times 10^{22} \text{ kg}$)

b) Uranus ($8.62 \times 10^{25} \text{ kg}$)
 $2.5 \times 10^{12} \text{ m}$ apart

AND compare

$$a = \frac{Gm}{r^2}$$

$$G = 6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2 / \text{kg}^2$$

$$a = \frac{6.67 \times 10^{-11} \times 1.4 \times 10^{22}}{(4.5 \times 10^{12})^2}$$

$$a = 4.6 \times 10^{-14} \text{ m/s}^2$$

Uranus

$$(b) \quad a = \frac{Gm}{r^2}$$

$$a = \frac{6.67 \times 10^{-11} \times 8.62 \times 10^{25}}{(2.5 \times 10^{12})^2}$$

$$a = 9.2 \times 10^{-10} \text{ m/s}^2$$

The acceleration
 due to gravity by presence
~~of Uranus~~ of Uranus
 is greater than that of
 Pluto.