Arnau Llorens

Score: 19/20, well done

MIDTERM 2

1) a)

$F = 1{,}25 \times 10^7$ N (thrust)

$m = 5 \times 10^5$ kg

$A_R = 4{,}5 \times 10^6$ N (air resistance)

$F = m \cdot a$

$a = \dfrac{F}{m}$

$F_T = 1{,}25 \times 10^7 - 4{,}5 \times 10^6$

$F_T = 8 \times 10^6$ N

$$\boxed{a = \frac{8 \times 10^6}{5 \times 10^5} = 16\ m/s^2}$$

(-1) Missing the weight

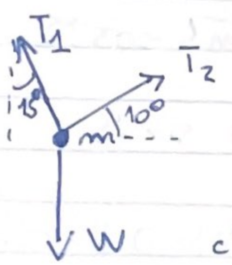
2) Newtons 3rd Law $\vec{F}_{AB} = -\vec{F}_{BA}$

(-1) Rocket sled problem is missing

$\boxed{70\ kg} \xrightarrow{700N} \boxed{90\ kg}$

According to newtons 3rd Law, the force exerted by the second player will be the same. So, $\boxed{700\ N}$

3)



a) $F_{Net\,x} = T_2 \cos 10 - T_1 \cdot \sin 15$

b) $F_{net\,y} = T_2 \cdot \sin 10 - 76 \cdot 9{,}8 + T_1 \cdot \cos 15$

c) $T_2 \cos 10 - T_1 \sin 15 = 0$ $\quad T_2 = \dfrac{T_1 \sin 15}{\cos 10}$

$0 = T_2 \cdot \sin 10 - 76{,}98 + T_1 \cdot \cos 15$

$0 = \left(\dfrac{T_1 \cdot \sin 15}{\cos 10} \right) \cdot \sin 10 - 744{,}8 + T_1 \cdot \cos 15$

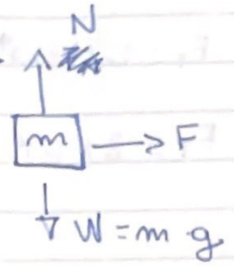
$0 = 0{,}045637\, T_1 - 744{,}8 + 0{,}9659\, T_1$

$1{,}011537\, T_1 = 744{,}8$ $\quad T_1 = \dfrac{744{,}8}{1{,}011537} = \boxed{736{,}3\ N}$

Correct! Both T1 and T2

$\cancel{T_2}$ $T_2 = \frac{T_1 \sin 15}{\cos 10} = 736,3 \cdot \frac{\sin 15}{\cos 10} = \boxed{193,43 \text{ N}}$

3.1



$\mu_s = 0,5$

$W = 120 \cdot 9,8 = 1176 \text{ N}$

$N = W$

a) $F = 0,5 \cdot 1176 = \boxed{588 \text{ N}}$

b) $1176 \cdot 0,3 = \boxed{352,8 \text{ N}}$

$F_{netx} = 588 - 352,8 = 235,2 \text{ N}$

$a = \frac{F}{m} = \frac{235,2}{120} = \boxed{1,96 \text{ m/s}^2}$

3.2 $W = m \cdot g$ $m \cdot g \cdot \cos 25 = N$

$0,1 \cdot \cos 25 \cdot W = f$

$N \cdot 0,1 = \text{friction}$ $\cancel{0,1 \cdot 9,8 \cdot m \cdot \cos 25 = 0,8882 m}$

$a = \frac{F_{net}}{m}$ $F = m \cdot g \cdot \sin 25 = W \cdot \sin 25$

$F_{net} = W \cdot \sin 25 - W \cdot 0,1 \cdot \cos 25$

$F_{net} = 0,332 \, W$

$a = \frac{0,332 \cdot \cancel{m} \cdot g}{\cancel{m}}$

$a = 0,332 \cdot 9,8 = \boxed{3,25 \text{ m/s}^2}$

Well done

$\boxed{3.3.}$ $F_D = \frac{1}{2} C_D A v^2$ $F_D = \frac{1}{2} \cdot 0{,}75 \cdot 1{,}225 \cdot 0{,}75 \cdot 40^2$

$\boxed{F_D = 551{,}25\ N}$

$\boxed{3.4}$ $Y = \frac{\text{stress}}{\text{strain}} = \frac{(F/A)}{(\Delta x/\ell)} = \frac{(2300 \cdot 9{,}8)/(0{,}04^2 \cdot \pi)}{0{,}003/10}$

$\boxed{Y = 1{,}4947 \cdot 10^{10}\ N/m^2}$

Yes!

$\boxed{4.1}$ $\omega \cdot r = v$ $\omega = \frac{v}{R} =$

$144\ \frac{Km}{h} \cdot \frac{1000\,m}{1\,Km} \cdot \frac{1\,h}{3600\,s} = 40\ m/s$ $\omega = \frac{40}{0{,}5} = \boxed{80\ rad/s}$

$\boxed{4.2}$ $v = 120\ Km/h$ $\frac{120}{3{,}6} = 33{,}33\ m/s = v$

$r = 900\ m$

$mg = N\cos\theta$ $F_c = N\sin\theta$

$\frac{mv^2}{r\,mg} = \frac{N\sin\theta}{N\cos\theta}$ $\frac{mv^2}{r} = N\sin\theta$

$\frac{v^2}{rg} = \tan\theta$ $\frac{40^2}{900 \cdot 9{,}8} = \tan\theta$ $0{,}1814 = \tan\theta$

$\tan^{-1}(0{,}1814) = \theta = \boxed{10{,}28^\circ}$

(-1) Math error (7 degrees)

4.3 $s = r\theta$

a) Path 2 may be taken at a higher speed as it has a larger radius. ~~Thee~~ Path 1 would have to slowdown the car in order to not get ejected.

b)

$F_c = \frac{m v^2}{r}$ $a_c = v^2/r$ $v_t = w \cdot r$

$F_c = m \cdot r \cdot w^2$ $F_f = N \cdot u$

$0{,}1\, m \cdot g = m \cdot r \cdot w^2$ $w^2 = \frac{0{,}1\, \cancel{m} \cdot g}{\cancel{m} \cdot r}$

$w = \sqrt{\left(\frac{0{,}1 \cdot g}{r}\right)}$ $vt = w \cdot r$

$vt = \sqrt{\left(\frac{0{,}1 \cdot g}{r}\right)} \cdot r$ $vt_1 = \sqrt{\frac{0{,}1 \cdot 9{,}8}{400}} \cdot 400 = \boxed{19\ m/s}$

$vt_2 = \sqrt{\frac{0{,}1 \cdot 9{,}8}{800}} \cdot 800 = \boxed{28\ m/s}$

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BONUS POINTS

a)

$\Delta x = 4{,}5 \times 10^{12}\ m \qquad mP = 1{,}4 \times 10^{22}$

$\cancel{a_c = \frac{v^2}{r}} \qquad F_c = m \cdot a_c \qquad F = G \cdot \frac{m\,M}{r^2}$

$\cancel{m} \cdot a_c = \frac{G \cdot \cancel{m} \cdot M}{r^2}$

$a_c = \frac{G \cdot M}{r^2} \qquad a_c = \frac{6{,}67 \times 10^{-11}\,(1{,}4 \cdot 10^{22})}{(4{,}5 \times 10^{12})^2}$

$\boxed{a_c = 4{,}611 \times 10^{-14}\ m/s^2}$

b) $a_c = \frac{G \cdot M}{r^2} \qquad a_c = \frac{6{,}67 \times 10^{-11} \cdot 8{,}62 \cdot 10^{25}}{(2{,}5 \cdot 10^{12})^2}$

$\boxed{a_c = 9{,}2 \cdot 10^{-10}\ m/s^2}$

$\frac{9{,}2 \cdot 10^{-10}}{4{,}611 \times 10^{-14}} = 19952 \simeq 20.000$

the acceleration is 20000 bigger

(+2) Nice work