

MIDTERM 2

① a)

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

$$F = m \cdot a$$

$$m = 5 \times 10^5 \text{ kg}$$

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

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

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

$$F_T = 8 \times 10^6 \text{ N}$$

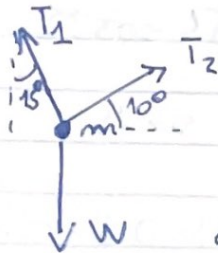
$$a = \frac{8 \times 10^6}{5 \times 10^5} = 16 \text{ m/s}^2$$

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

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

According to Newton's 3rd Law, the force exerted by the second player will be the same. So, 700 N

③



$$a) F_{\text{net } x} = T_2 \cos 10 - T_1 \sin 15$$

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

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

$$0 = T_2 \sin 10 - 76 \cdot 9,8 + T_1 \cos 15$$

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

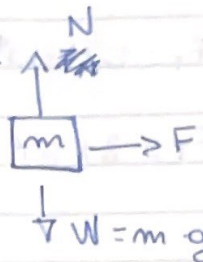
$$0 = 0,045637 T_1 - 744,8 + 0,9659 T_1$$

$$1,011537 T_1 = 744,8$$

$$T_1 = \frac{744,8}{1,011537} = 736,3 \text{ N}$$

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

3.1



$$\mu_s = 0,5$$

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

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

$$b) \quad 1176 \cdot 0,3 = \boxed{352,8 \text{ N}} \quad F_{\text{net}x} = 588 - 352,8 = 235,2 \text{ N}$$

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

3.2

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

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

$$N \cdot 0,1 = \text{friction}$$

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

$$a = \frac{F_{\text{net}}}{m}$$

$$F = m \cdot g \cdot \sin 25 = W \cdot \sin 25$$

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

$$F_{\text{net}} = 0,3342 W$$

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

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

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

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

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

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

$$4.1 \quad \omega \cdot r = v \quad \omega = \frac{v}{r} = \frac{144 \text{ Km}}{h} \cdot \frac{1000 \text{ m}}{1 \text{ Km}} \cdot \frac{1 \text{ h}}{3600 \text{ s}} = 40 \text{ m/s}$$

$$\omega = \frac{40}{0,5} = 80 \text{ rad/s}$$

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

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

$$mg = N \cos \theta$$

$$F_c = N \sin \theta$$

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

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

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

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

$$0,1814 = \tan \theta$$

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

4.3 $s = r\theta$

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

b)

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

$$F_c = m \cdot r \cdot \omega^2 \quad F_f = N \cdot \mu$$

~~0,1 m \cdot g~~ $0,1 \text{ m} \cdot g = m \cdot r \cdot \omega^2 \quad \omega^2 = \frac{0,1 \text{ m} \cdot g}{m \cdot r}$

$$\omega = \sqrt{\frac{0,1 \cdot g}{r}} \quad v_t = \omega \cdot r$$

$$v_t = \sqrt{\frac{0,1 \cdot g}{r}} \cdot r \quad v_{t1} = \sqrt{\frac{0,1 \cdot 9,8}{400}} \cdot 400 = \boxed{19 \text{ m/s}}$$

$$v_{t2} = \sqrt{\frac{0,1 \cdot 9,8}{800}} \cdot 800 = \boxed{28 \text{ m/s}}$$

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~~EX~~

BONUS POINTS

a)

$$\Delta x = 4,5 \times 10^{12} \text{ m} \quad m_P = 1,4 \times 10^{22}$$

~~$a_c = \frac{v^2}{r}$~~

$$F_c = m \cdot a_c$$

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

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

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

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

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

b) $a_c = \frac{G \cdot M}{r^2}$

$$a_c = \frac{6,67 \times 10^{-11} \cdot 3,62 \cdot 10^{25}}{(2,5 \cdot 10^{12})^2}$$

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

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

the acceleration is 20000
bigger