



(see note 2 below)

FORENAME(S): Simon

12 Pages

1. Please give the information requested in the boxes below.
2. Enter your name in the space provided to the right, fold over and seal down (using the label provided) to hide your name.
3. The answers must be legibly written. The Examiners can either ignore illegible script or have it typed and the expense of typing charged to the candidate.
4. Write your answers in ink.
5. Begin each answer on a fresh page. Do all rough work in the answer book and cross it through.
6. No part of this book is to be torn out; it must be handed in complete.
7. If more books than one are used, fasten them together using the tags available from the invigilator(s).
8. **Every book must be handed in. In no circumstances may answer books, used or unused, be taken out of the examination venue.**

1	Student Number	P150613
2	Title of Examination Paper	Vehicle Dynamics
3	Module Code	MSX00407
4	Date and Time of Examination	9am 11/1/19
5	Examination Venue	Vivian Hall
6	Seat Number	G094
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	9
2	6
3	9
	24
Office Use	40

1) ~~Roll~~ grip = $\mu \times M \times g$
 $= 1.2 \times 1200 \times 9.81$
 $= 17638 \text{ N}$

$= 1.2 \times 750 \times 9.81$
 $= 8829 \text{ per wheel}$
 $8829 \times 2 = 17658 \text{ N total}$

2/2

B) $T = \frac{2}{3} \mu F \frac{(r_0^3 - r_1^3)}{(r_0^2 - r_1^2)}$

Not a cone?

4/6

$\frac{3}{2} \frac{T(r_0^2 - r_1^2)}{\mu(r_0^3 - r_1^3)} = F$

$\frac{3 \times 3000(0.05^2 - 0.0475^2)}{2 \times 0.2(0.05^3 - 0.0475^3)} = 307624.89 \text{ N}$

c) the angle α may be too small, increasing it would cause slip at lower ~~force~~ torque, a weaker spring force could then be used.

1/3



d) $E = 1\,000\,000$ $KE = \frac{1}{2} I \omega^2$
find I
 $\text{rpm} = 10\,000 \times \frac{2\pi}{60} = 1047.2 \text{ rad/s}$
 $\phi = 0.5 \text{ m}$
 $r = 0.25 \text{ m}$ $\rho = 7700 \text{ kg/m}^3$ $I = mk^2$

$$KE = \frac{mv^2}{2}$$

$$\frac{2 \times KE}{v^2} = m = \frac{2 \times 1\,000\,000}{1047.2^2} = 1.8238 \text{ kg}$$

e) $I = mk^2$ $\therefore k = 0.25 \times 0.707 = 0.17675 \text{ m}$

$$I = 1.8238 \times 0.17675^2$$

$$= 0.057 \text{ kgm}^2$$

$$m = A \times \phi \times \rho$$

$$A = \pi r^2$$

$$= \pi 0.25^2$$

$$= 0.196 \text{ m}$$

$$\frac{m}{A \times \rho} = L$$

$$\frac{1.8238}{0.196 \times 7700} = L = 1.2 \times 10^{-3} \text{ m}$$

f) Using a more cylindrical or cone shaped flywheel could reduce packaging size.

2) A) Frontal A = 6 m^2 Density air
 $CD = 0.7 \text{ kg/m}^3$
 Rolling resistance = 0.005 N per N
 Velocity = $40 \text{ kph} = 11.11 \text{ m/s}$
 accel/decel = 1 m/s^2
 mass/burden = 7500 kg
 drag force speed = $20 \text{ kph} \times \frac{1000}{3600} = 5.55 \text{ m/s}$
 Efficiency = 80%
 dist = 600 m
 energy left = 20%

~~kinematics~~

$$V^2 = U^2 + 2as$$

$$V^2 = 0 + 2 \times 1 \times 600$$

$$V^2 = 1200$$

$$V = \sqrt{1200}$$

$$V = 34.6$$

$$F = ma$$

$$= 7500 \times 1$$

$$F = ma$$

$$= 7500 \times 1$$

$$= 7500 \text{ N}$$

$$\text{aerof resistance} = 0.5 \times 6 \times 1.2 \times 0.7 \times 5.55^2$$

$$= 77.6 \text{ N}$$

$$\text{rolling res} = \text{weight} \times 0.05$$

$$= m \times g \times 0.05$$

$$= 7500 \times 9.81 \times 0.05$$

$$= 3678.75 \text{ N}$$

$$367 \text{ N}$$

$$\therefore \text{total resistive} = 77.6 + 3678.75 = 3756.4 \text{ N}$$

$$\therefore 7500 + 3756.4 = 11256.4 \text{ N total force}$$

$\frac{3}{4}$

B) ~~kinematics~~

$$V^2 = U^2 + 2as$$

$$\frac{V^2}{2a} = s = \frac{5.55^2}{2 \times 1} = 15.4 \text{ m}$$

$\frac{1}{2}$
1

$\frac{D}{s}$

$$\frac{61.7}{11.11} = 5.55 \text{ s}$$

$$\frac{15.4}{5.55} = 2.75$$

$$W = \frac{J}{s}$$

$$P = F \times V$$

$$2.7s$$

$$5.55s$$

c)

$$P = 114897 \times \frac{5.55}{1000} = \underline{127651.12 \text{ W}} \quad 63768.1 \text{ W}$$

$$\begin{aligned} J &= W \times S \\ &= 127651.12 \times 5.55 \\ &= 708463.75 \\ &= \underline{708.4 \text{ kJ}} \end{aligned}$$

$$\begin{aligned} J &= 63768.1 \times 2.7 \\ &= 172173.87 \text{ J} \\ &= \underline{172.2 \text{ kJ}} \end{aligned}$$

d)

$$E = 1.2 \text{ MJ} = 1200000 \text{ J}$$

$$\omega_0 = 1000 \text{ rpm} \times \frac{2\pi}{60} = 104.7 \text{ rad/s} \quad \checkmark$$

$$\omega_1 = 5000 \times \frac{2\pi}{60} = 523.6 \text{ rad/s} \quad \checkmark$$

$$T = 60 \text{ s}$$

~~$$KE = \frac{1}{2} I \omega^2$$~~

~~$$I = 2 \text{ MK}^2$$~~

~~$$KE$$~~

$$\frac{1}{5}$$

$$W = J/s$$

$$W = \frac{1200000}{60}$$

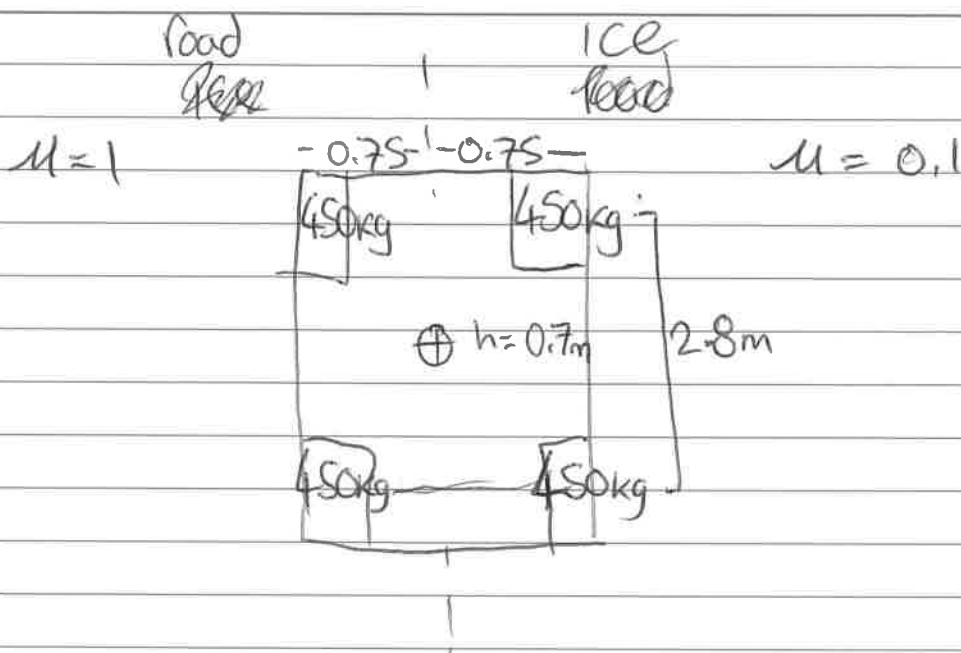
$$= 2000 \text{ W}$$

$$P = T\omega$$

$$\frac{P}{\omega} = T = \frac{2000}{523.6} = 3.81 \text{ Nm}$$

$$\frac{6}{2}$$

3) A



A) ~~$\mu \times m \times g$~~ + ~~$\mu \times m \times g$~~

$$m \times g = 900 \times 9.81 = 8829\text{N rear axle vert force}$$

B) $\mu \times m \times g$
 $1 \times 450 \times 9.81$
 $= 4414.5\text{N}$

$$\mu \times m \times g$$

$$0.1 \times 450 \times 9.81$$

$$= 441.45\text{N}$$

open diff $F_L = F_R$

$$441.45 \times 2 = 882.9\text{N}$$

$$a = \frac{F}{m} = \frac{882.9}{1800} = 0.49\text{m/s}^2$$

C) torSen 3:1

$$\therefore 441.45 \times 3 = 1324.35$$

$$441.45 - 441.45 = 0$$

$$441.45 \times 3 = 1324.35\text{N}$$

$$a = \frac{F}{m} = \frac{1324.35}{1800} = 0.73\text{m/s}^2$$

d) So $F_L + F_R = 4414.5 + 4414.5 = 4855.95 \text{ N}$

$$a = \frac{F}{m} = \frac{4855.95}{1800} = 2.698 \text{ m/s}^2$$

equal torque between wheels so no input needed from driver to keep straight

2/
5

[illegible]