



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.**

(see note 2 below)

SURNAME: Farnhill

FORENAME(S): 1-Larry

7	Number of Answer Books handed in	1
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List the numbers of the questions you have attempted	Office Use
1	14
2	13 1/2
3	9 1/2
	~~37~~
Office Use	61.6

$$1) \quad 1500 \times 9.81 \\ = 14715 \times 1.2 \\ = \frac{17658}{0.32} = 55181.25 \text{ Nm}$$

2/2

$$b) \quad T = \frac{1}{\sin \alpha} \times \frac{2}{3} \mu \times F = \frac{(r_o^3 - r_i^3)}{(r_o^2 - r_i^2)}$$

$$\sin \alpha = \frac{3}{2} \times \frac{T}{\mu} \times \frac{(r_o^2 - r_i^2)}{(r_o^3 - r_i^3)}$$

$$F = \frac{\sin(7)}{2} \times \frac{3}{0.2} \times \frac{3000 \times (0.05^2 - 0.045^2)}{(0.05^3 - 0.045^3)}$$

$$F = \frac{38449.55 \text{ N}}{2}$$

2

$$F = 19224.78 \text{ N}$$

c) reduce the cone angle as this will create more torque but also allow more slip as less force is required to clamp for clamp load and greater contact patch can be realised by less force

$$d) \quad KE = \frac{1}{2} I \omega^2 \quad \omega = 10000 \times \frac{2\pi}{60} \\ = 1047.2 \text{ rad/s}$$

$$\frac{2KE}{\omega^2} = I \quad \frac{2 \times 1 \times 10^6}{1047.2^2} = 0.911 \text{ kgm}^2$$

$$h = 0.25 \times 0.207 \\ = 0.1767$$

$$I = m h^2$$

$$\frac{I}{h^2} = m$$

$$\frac{0.911}{0.1767^2} = 29.17 \text{ kg}$$

3/4

2) $mass = area \times thickness \times density$

$$\frac{mass}{area \times density} = thickness$$

$$\frac{24.17}{(\pi 0.25^2) \times 7870} = \frac{0.015m}{7700} = 15mm$$

$$= 48mm$$

f) To reduce package size you could have 2 small plates with same mass could be used to make the cylinder height smaller for tighter package areas.

2) $m = 5500 \times (20 \times 100)$
 $m = 7500 kg$

$$RR = 7500 \times 9.81 \times 0.005$$

$$RR = 367.875N$$

$$7500 \times 1$$

$$= 7500N$$

$$Total = 7500 + 367.875$$

$$= 7867.875N$$

$$1000 \times \frac{40}{3600} = 11.1$$

b)

$$7867.87 \times 11.1 = 11.1 seconds$$

$$\left(\frac{11.1}{2}\right) \times 11.1 = 61.72m$$

$$c) \quad KE = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 7500 \times 11.1^2$$

$$= 462962.963 \text{ J}$$

$$KE = 367.875 \times 61.72$$

$$= 22705.245 \text{ W}$$

$$= 462962.963 + 22705.245$$

$$= 485668.208 \text{ J} \times \left(\frac{1}{0.8}\right) = \underline{607085.265}$$

$$d) \quad \text{aero} = \frac{1}{2} \times (2 \times 3) + 0.7 \times 1.2 \times 11.1^2$$

$$= 311.1 \text{ W}$$

$$KE = \underline{367.85} \quad = 600 - (61.72 \times 2)$$

$$= 476.56$$

$$\text{Total} = 678.96 \text{ W}$$

$$= 678.96 \times 476.56$$

$$= 323.565.176 \text{ J} \times \left(\frac{1}{0.8}\right)$$

$$= \underline{404456.46 \text{ J}}$$

$$e) \quad KE = \frac{1}{2}mv^2$$

$$= \frac{1}{2} \times 7500 \times 11.1^2$$

$$= 462962.963 - 22705.245$$

$$= 440257.718 \times 0.8$$

$$= \underline{352206.17 \text{ J}}$$

$$K) = 607085.26 + 404456.46 - 352206.17$$

$$= \underline{659335.55 \text{ J}}$$

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

$$\frac{2KE}{\omega^2} = I \quad \frac{2 \times 1.2 \times 10^6}{104.72^2} = 218.85 \text{ kgm}^2$$

$$1000 \times \frac{2\pi}{60} = 104.72 \text{ rad/s} \quad \frac{104.72}{8} = 13.09$$

$$5000 \times \frac{2\pi}{60} = 523.6 \quad \frac{523.6}{8} = 65.45$$

$$\frac{2 \times 1.2 \times 10^6}{523.6^2} = 74.40 \text{ kgm}^2 \quad = 523.6 - 104.72 = 418.88$$

$$T = I \alpha$$

$$T = 104.72 \times 218.85 = 22881.0875 \text{ Nm}$$

$$T = 74.40 \times 523.6 = 38955.84 \text{ Nm}$$

$$T = 74.40 \times 204.44 = 15208.336 \text{ Nm}$$

$$\frac{38955.84}{58376}$$

$$\frac{404.104.72}{218.85} = 0.47 \text{ seconds}$$

$$0.47 \times 22881.0875 = 10753.481 \text{ Nm}$$

$$= 218.85 - 74.40 = 144.45 \text{ rad/s}^2$$

$$= 38955.84 - 22881.0875 = 16074.75 \text{ Nm}$$

$$T = I \alpha$$

$$K = \frac{15374.75}{144.45} = 106.456 \text{ rad/s}^2 \times 60$$

$$106.436 = a$$

$$t_{\text{time}} = 60 \text{ seconds}$$

$$\frac{\text{velocity}}{\text{acceleration}} = \text{Time}$$

$$\frac{106.436 \times 60}{6} = \text{velocity} = 6386.16 \text{ rad/s}$$

$$\left(\frac{6386.16}{2} \right) \times 60 = 205084.8 \text{ rad/s}$$

$$205084.8 \times 15374.75 = 3153127.57 \times 10^3 \text{ Nm}$$

$$\left(\frac{6386.16}{106.436} \right) \times 60$$

$$\left(\frac{106.436}{2} \right) \times 60 = 3192.68 \times 15374.75 = 3600 \text{ Nm}$$

$$T = 38455.84$$

$$= \left(\frac{15374.75}{106.436} \right) \times 60$$

$$\times 15374.75$$

$$\frac{2 \times kE}{w^2}$$

$$= \frac{10000 \times 2\pi}{6283.18}$$

$$= \frac{5000 \times 2\pi}{15707.96}$$

$$= 15707.96 - 6283.18 = 9424.783$$

$$\frac{2 \times 1.2 \times 10^6}{9424.783^2} = 254.64 \text{ kg/m}^2$$

$$T = 0.05 \times 9424.783$$

$$T = 471.23 \text{ Wm}$$

$$T = 254.64$$

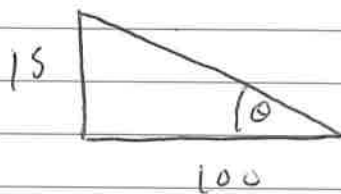
$$\frac{2 \times 1.2 \times 10^6}{6283.18^2} = 0.06 \text{ kg/m}^2$$

$$\frac{2 \times 1.2 \times 10^6}{15707.96^2} = 9.726 \times 10^{-5}$$

$$0.05 \text{ rad/s} \text{ } 0.05 \text{ kg/m}^2$$

$$\frac{13\frac{1}{2}}{20}$$

3)



$$m = 1800 \text{ kg}$$

$$\tan \theta = \frac{15}{100} \quad \theta = \tan^{-1} \frac{15}{100}$$

$$\theta = 8.5^\circ$$

$$= m g \sin \theta$$

$$= m g \cos \theta \sin \theta$$

$$= 1800 \times 9.81 \times \frac{15}{100} \quad \sin \theta \text{ m/s}$$

$$= 2648.7 \text{ N}$$

$$2648.7 \times 0.7$$

$$2.8$$

$$m g \sin \theta \cos \theta$$

$$= 617.175 \text{ N}$$

$$= 1800 \times 9.81 \times \cos(8.5)$$

$$= 17409.04712 \text{ N}$$

$$2$$

$$= 4366.010 + \left(\frac{617.175}{2.8} \right)$$

$$= 4145.58 \text{ N} + 586.417 \text{ N}$$

$$= 8732.02106 \text{ N per axle}$$

$$= 4366.010 \text{ per wheel}$$

$$= 4586.417 \times 2$$

$$= 9172.83 \text{ N per rear wheel axle}$$

$$b) \frac{9172.83}{2} + 4586.42 \text{ W} + 0.1$$

$$2$$

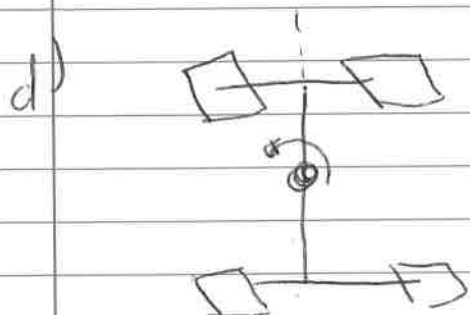
$$(458.642 \times 2)$$

$$1800$$

$$= 0.51 \text{ m/s}^2$$

$$\begin{aligned}
 c) &= 458.62 \times 3 = 1375.926 \\
 &= 1375.926 + 458.62 \\
 &= \frac{1834.546}{1800} = 1.1 \text{ m/s}^2
 \end{aligned}$$

$$\frac{458.62 + 458.62}{1800} = 2.8 \text{ m/s}^2$$



The vehicle will want to steer towards the ice as there is more force acting on the right tyres causing more grip and creates a moment in which the vehicle will

ice asphalt rotate towards the ice, the driver will need to counteract this moment by steering away from the ice to keep the car going in a straight line. The rear wheel drive BMW will want to oversteer, and will ~~start wheelspin~~ this will be difficult to drive as the driver will need to be gentle with throttle application to ensure he doesn't over or under correct at the resultant moment and spin the car.

$$\begin{aligned}
 e) \quad F_R &= 0.035 \times 1800 \times 9.81 \\
 &= 618.03 \text{ N} \times 2.7 = J \\
 &= \frac{1668.681}{1000 \times \frac{10}{3600}} = \frac{1668.681}{2.777} = 600
 \end{aligned}$$

$$KE = \frac{1}{2} mv^2$$

$$= \frac{1}{2} \times 1800 \times 2.7^2$$

$$= 6561 \text{ J}$$

$$\begin{aligned}
 \text{power} &= 618.03 \times 2.7 \\
 &= 1668.681 \text{ W}
 \end{aligned}$$

$$\frac{1716.75}{0.075} = \frac{1668.681}{\left(\frac{5}{2}\right)} = 2224.408$$

9/4

9 1/2

Question No.

Examiner On

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