

Examination Answer Books

12 Pages

Instructions to Candidates

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.**

Complete, fold and seal

(see note 2 below)

SURNAME:

HART

FORENAME(S):

MAXIMILIAN

1	Student Number	1700625
2	Title of Examination Paper	VEHICLE DYNAMICS
3	Module Code	MSX00407
4	Date and Time of Examination	11/01/17 09:00
5	Examination Venue	VIVIAN HALL
6	Seat Number	6104
7	Number of Answer Books handed in	1

List the numbers of the questions you have attempted	Office Use
1	17
2	18
3	9
	~~44~~
Office Use	73.3

① ~~Traction force rear = (1500)(9.81) = 14715N~~

~~$\therefore \text{Per wheel} = \frac{14715}{2} =$~~

a) Traction force rear = (1500)(9.81)(1.2) = 17658N

$\therefore \text{Per wheel} = 8829N$

Torque = force $\times$ radius = (8829)(0.32) = 2825Nm.

b) $3000 = \frac{1}{\sin 7^\circ} \times \frac{2}{3} \times 0.2 \times F \times \left(\frac{0.05^3 - 0.0475^3}{0.05^2 - 0.0475^2} \right)$

$\therefore 3000 = 0.0800F \quad \therefore F = 37490N.$

c) If the angle α is too tight the ~~can~~ surfaces may not release properly causing a jam. Equally, if the clutch wears slightly it could start to slip at a torque lower than max. vehicle output causing premature wear and loss of power.

The clutch slip torque must be calculated, calibrated and set and then the force increased to match accordingly to ensure correct calibration.

d) $1 \times 10^6 = \frac{1}{2}(I)(1047.2^2)$

$10,000\text{rpm} \rightarrow 1047.2\text{radsec}^{-1}$

$\therefore I = 1.82\text{kgm}^2$

$K = \frac{0.25}{\sqrt{2}} = 0.1768$

$I = Mk^2 \quad \therefore M = \frac{1.82}{0.1768^2} = 58.24\text{kg}$

$\therefore \text{vol} = \frac{58.24}{\text{density}} = V \rightarrow V = (\pi r^2) L$

$\hookrightarrow L = \text{thickness}$

$\rightarrow \text{density} = 7700\text{kg/m}^3 \quad \therefore \text{vol} = 7.56 \times 10^{-3}$

$\therefore L = 0.04\text{m} = \text{thickness.}$

$$40 \text{ kph} = 11.11 \text{ m s}^{-1}$$

$$20 \text{ kph} = 5.56 \text{ m s}^{-1}$$

Question No.

Examiner Only

$$\text{Total Mass} = 5500 + (20 \times 100) = 7500 \text{ kg}$$

(2)

a) Acceleration force = $(7500)(1) = 7500 \text{ N}$
 Rolling Res = $(7500)(9.81)(0.005) = 367.88 \text{ N}$
 Aero Res = $(0.5)(6)(0.7)(1.2)(5.56^2) = 77.90 \text{ N}$

$$\therefore \text{Total Force reqd.} = 7945.78 \text{ N}$$

b) $V_0 = 0$ $V = 11.11$ $a = 1$

$$\therefore 11.11^2 = 0 + (2)(1)(x) \quad \therefore x = 61.72 \text{ m}$$

c. $Wd = f \cdot d = (7945.78)(61.72) = 490382 \text{ J}$

$$\eta = 80\% \quad \therefore \frac{490382}{0.8} = 612978 \text{ J.}$$

d. Rolling Res. = 367.88 N

$$\text{Aero Res.} = (0.5)(6)(0.7)(1.2)(11.11^2) = 311.05 \text{ N}$$

$$\therefore \text{Total Resistive force} = 678.93 \text{ N}$$

$$Wd = f \cdot d = (678.93)(600) = 407358 \text{ J}$$

$$\eta = 80\% \quad \therefore \frac{\text{ans}}{0.8} = \underline{\underline{509196 \text{ J}}} \quad \rightarrow \text{At. Max. distance of } 600 \text{ m}$$

e. $KE = \frac{1}{2}(m)v^2 = (0.5)(7500)(11.11^2) = 462870.4 \text{ J}$

$$\text{Rolling Res} = 367.88 \text{ N} \quad | \quad \text{Aero Res} = 77.90 \text{ N}$$

$$\therefore \text{Resistance work} = (445.78)(61.72) = 27526.92 \text{ J}$$

$$\therefore 462870.4 - 27526.9 = 435343.09 \text{ J}$$

f. Work to accelerate = 612978 J
 Work for constant speed = 509196 J
 Recovered energy = 435343.09 J

$\therefore$ Total energy used per cycle = 686830.91 J ✓

$\therefore$ Capacity of flywheel = $\frac{686830}{0.2} = 3434150 \text{ J}$
 $= \underline{\underline{3.4 \text{ MJ}}}$

g. 1000 rpm $\rightarrow$ 104.72 radsec⁻¹ | 5000 rpm $\rightarrow$ 523.598 radsec⁻¹

$1.2 \times 10^6 = (0.5) (I) (523.598^2)$

$\therefore I = 8.75 \text{ kgm}^2 @ 5000 \text{ rpm}$

$\omega = 523.598$ | $\omega_0 = 104.72$ | $t = 60$

$\therefore 523.598 = 104.72 + 60\alpha$

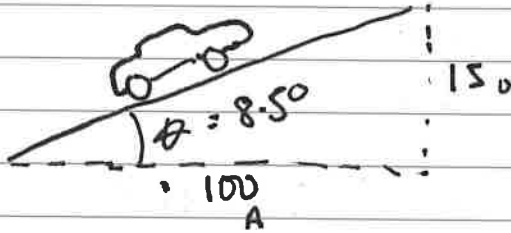
$\therefore$ angular acceleration $\alpha = 6.98 \text{ radsec}^{-2}$

$T = I \alpha = (8.75)(6.98) = 61.09 \text{ Nm}$

18
20

③

a)



$$\theta = \tan^{-1}\left(\frac{15}{100}\right) = 8.5^\circ$$

$$\therefore \text{Vert. Force} = (900)(9.81)(\cos \theta) = 8732.02 \text{ N.}$$

b. 8732.02 N on rear axle $\therefore 4366.01 \text{ N}$ ^{corner force}

$$\text{Left tractive force} = (4366.01)(1) = 4366.01 \text{ N}$$

$$\text{Right tractive force} = (4366.01)(0.1) = 436.62 \text{ N}$$

$$\text{Open diff} \therefore \sum \text{tractive forces} = (436.62 + 436.62) = 873.20 \text{ N}$$

$$\text{acceleration} = \frac{\text{force}}{\text{mass}} = \frac{873.20}{1800} = 0.49 \text{ ms}^{-2}$$

c. Left tractive force = 4366.01 N

Right tractive force = 436.62 N

$$\rightarrow (436.62 \times 3)$$

3:1 Torsen $\therefore$ Left tractive force = 1309.86 N

$$\therefore \sum \text{Tractive forces} = 1746.48 \text{ N}$$

$$\text{acceleration} = \frac{1746.48}{1800} = 0.97 \text{ ms}^{-2}$$

d. Left tractive force = 4366.01 N
 Right tractive force = 436.62 N

Brake bias OTC $\therefore \sum \text{tractive forces} = 4802.63 \text{ N}$

$\therefore \text{acceleration} = \frac{4802.63}{1800} = 2.67 \text{ ms}^{-2}$

- The imbalance of the wheel torques will create a moment about the centre of the car, steering it towards the low μ surface. The driver will have to steer left to counter this and keep a straight course, overcoming the yaw torque.

$\rightarrow 4366.01 - 436.62 = 3929.39 \text{ N resultant force}$
 $3929.39 \times \frac{1.5}{2} = 2947.04 \text{ Nm moment about centre}$
 $\frac{2947.04}{(2.8 \div 2)} = \text{lateral steering force required}$

e. $10 \text{ mph} = 2.78 \text{ ms}^{-1}$ ✓

~~Left~~ wheel braking $\therefore \text{tractive force} = 436.62 \text{ N}$

$T = (436.62)(0.35) = 152.82 \text{ Nm}$

Question No.

Examiner Only

Arholwr yn unig

Rhify Cwestiwn