

REVISION PAPER SOLUTIONS

(1)

Q 1

(a) Assume K.E. of body is converted into Work Done by ground in stopping it.

$$K.E. = \frac{1}{2}mv^2 = 0.5 \times 0.06 \times 900^2$$

$$W.D. = F \times d = F \times 0.7$$

$$K.E. = W.D.$$

$$0.5 \times 0.06 \times 900^2 = 0.7F$$

$$\therefore F = \frac{0.5 \times 0.06 \times 900^2}{0.7} = 3471.43 \text{ N}$$

to 2 D.P.

(b) Similar to (a)

$$K.E. = W.D.$$

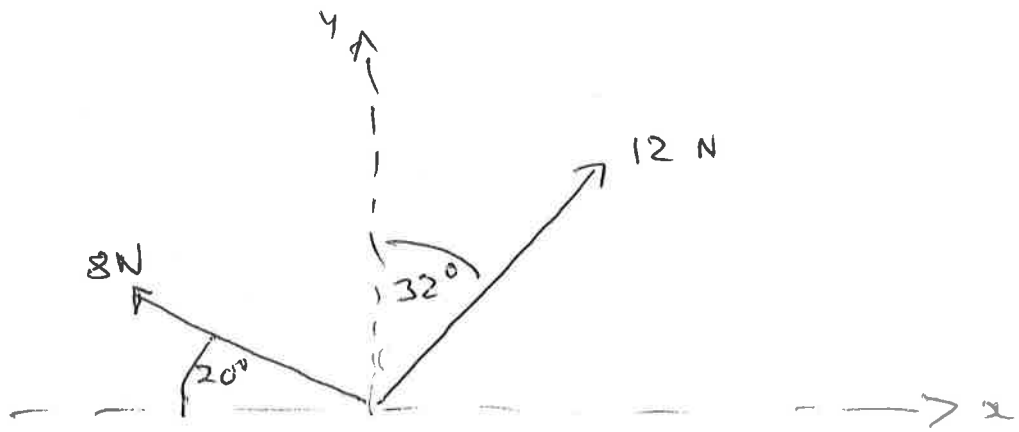
$$0.5 \times 0.07 \times 900^2 = F \times 0.9$$

$$\therefore F = \frac{0.5 \times 0.07 \times 900^2}{0.9}$$

$$F = 31,500 \text{ N}$$

Q 1 (c)

②



Resolve forces in Horizontal direction to get net horizontal force F_H

$$F_H = 12 \cos 58^\circ - 8 \cos 20^\circ = 6.359 - 7.518$$

↑
angle
force makes
with x direction

negative because the 8 N force
is pointing in -ve x direction

$$\underline{F_H = -1.159 \text{ N}}$$

Written to 3 DP
if final answer
is to 2 DP

Resolve forces in Vertical Direction

$$F_V = 12 \cos 32^\circ + 8 \cos 70^\circ = 10.177 + 2.736$$

↑
angle 8 N force makes
with vertical direction

$$\underline{F_V = 12.913 \text{ N}}$$

Now to find the magnitude & direction of the resultant force F_R

(3)

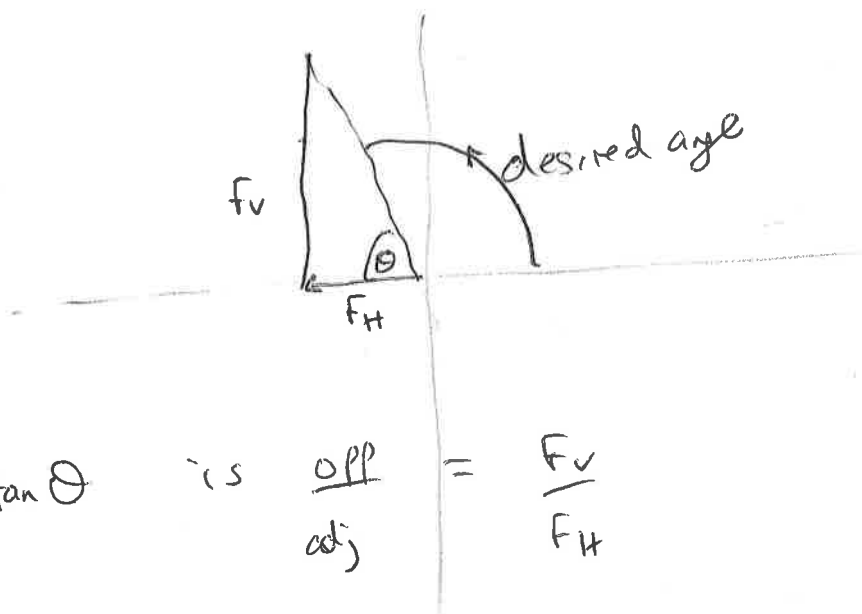
MAGNITUDE
Pythagoras

$$F_R = \sqrt{F_H^2 + F_V^2} = \sqrt{168.088}$$

$$F_R = 12.96 \text{ N to 2 DP}$$

DIRECTION

Butt - end F_H & F_R :



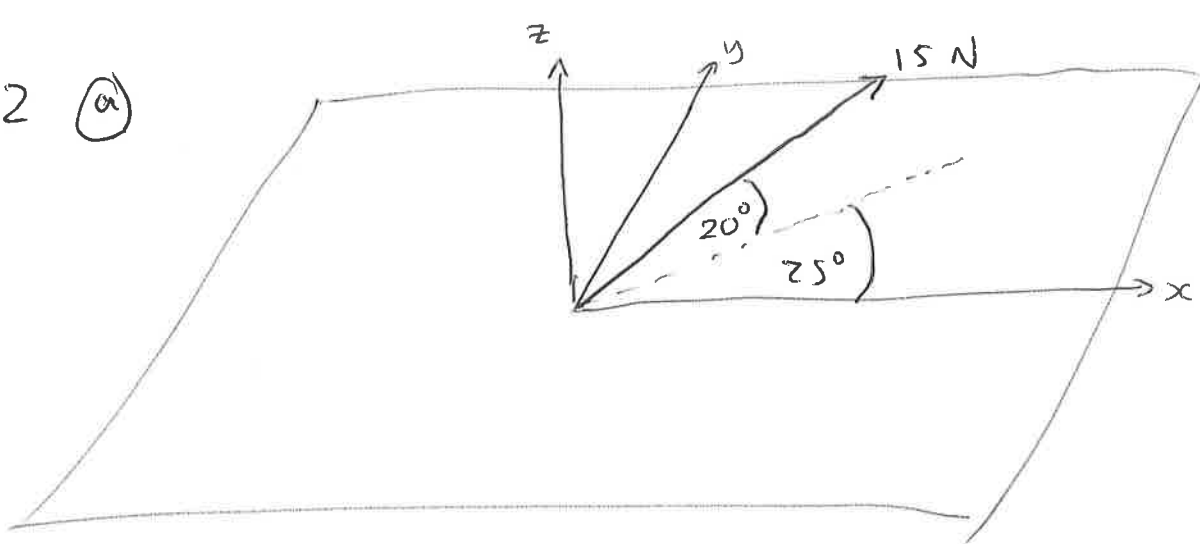
$$\tan \theta \text{ is } \frac{\text{opp}}{\text{adj}} = \frac{F_V}{F_H}$$

$$\tan \theta = \frac{12.913}{-1.159} = -11.142$$

$$\therefore \theta = 84.87^\circ \text{ to 2 DP}$$

We normally refer to the POSITIVE x direction
so the angle F_R makes with POS x axis is
 $180 - 84.87$
 $= \underline{95.13^\circ}$

Q2 (a)



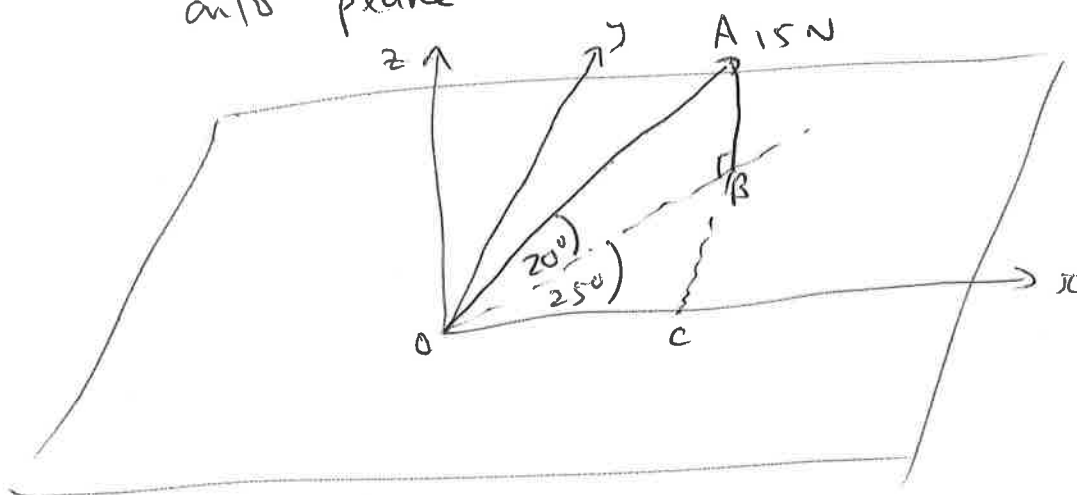
Interpret diagram :

20° is angle 15 N force makes with plane
 $\therefore 15\text{ N}$ force must make 70° with z axis

$$\underline{F_z = 15 \cos 70^\circ = 5.13\text{ N}}$$

To find F_x and F_y we add some lines.

Drop the perpendicular from tip of force
 onto plane to get point B in ΔOAB



Then draw perpendicular from B to x axis to
 get point C

Method
 To find F_x and F_y we FIRST find OB from ΔOAB
 then USE OB in ΔOBC to
 find F_x (OC) and F_y (BC)

ⓐ

First then we find OB :

In $\triangle OAB$:

$$OB = 15 \cos 20^\circ = 14.095$$

then

In $\triangle OBC$

$$F_x = OC = OB \cos 25^\circ = 14.095 \cos 25^\circ$$

$$F_x = 12.77 \text{ N} \quad \text{to 2 DP}$$

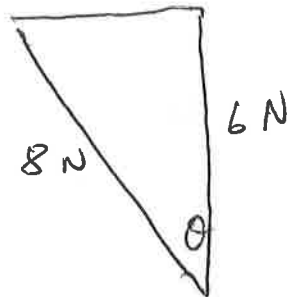
and again in $\triangle OBC$

$$F_y = BC = OB \sin 25^\circ = 14.095 \sin 25^\circ$$

$$F_y = 5.96 \text{ N} \quad \text{to 2 DP}$$

ⓑ

Simple Trig here



$$\cos \theta = \frac{\text{adj}}{\text{hyp}} = \frac{6}{8}$$

$$\therefore \theta = \cos^{-1}\left(\frac{6}{8}\right)$$

$$\theta = \underline{41.41^\circ \text{ to 2 DP}}$$

REVISION PAPER SOLUTIONS

Q1

(a) Assume K.E. of body is converted into Work Done by the ground

$$K.E. = \frac{1}{2}mv^2 = 0.5 \times 0.07 \times 900^2$$

$$W.D = \text{Force} \times \text{distance} = F \times 0.9$$

$$K.E. = W.D$$

$$0.5 \times 0.07 \times 900^2 = 0.9 F$$

$$F = \frac{0.5 \times 0.07 \times 900^2}{0.9}$$

$$F = 31,500 \text{ N}$$

(b) Similar to (a):

Assume $K.E. = W.D$

$$0.5 \times$$

Q3

(5)

(a) Isothermal $\rightarrow$ constant temperature $\therefore$ Boyle's Law $PV = \text{constant}$

$$P_1 V_1 = P_2 V_2$$

$$3 \times 10^5 \times 0.7 = 6 \times 10^5 \times V_2$$

$$\frac{3 \times 10^5 \times 0.7}{6 \times 10^5} = V_2$$

$$V_2 = 0.35 \text{ m}^3$$

(b) Work Done by gas = $\int_{V_1}^{V_2} P dV$

But $P = \frac{nRT}{V}$

$$\therefore W.D = \int_3^5 \frac{nRT}{V} dV = nRT \int_3^5 \frac{1}{V} dV$$

$$W.D = nRT \left[\ln V \right]_3^5$$

$$W.D. = 0.2 \times 8.31 \times 313.15 \left[\ln 5 - \ln 3 \right]$$

$$W.D. = 265.86 \text{ Joules.}$$

Q3 (c)

First Law of Thermodynamics

(6)

$$\Delta Q = \Delta U + \Delta W$$

↑ ↑ ↑
heat given to change in work done by gas
gas internal energy

Remember $\Delta U = mc\Delta T$

$$\therefore \Delta Q = mc\Delta T + \Delta W$$

$$500 = 0.04 \times 800 \times \Delta T + 150$$

$$350 = 0.04 \times 800 \times \Delta T$$

$$= \Delta T$$

$$\frac{350}{0.04 \times 800}$$

$$\Delta T = 10.94 \text{ K to 2 D.p.}$$

Q 5
(a)

$$\text{extension} = 6 \times 10^{-4} \text{ m}$$

$$\text{strain} = 0.02$$

$$\text{strain} = \frac{\text{extension}}{\text{orig. length}}$$

$$\text{orig length} = \frac{\text{extension}}{\text{strain}} = \frac{6 \times 10^{-4}}{0.02}$$

$$\underline{L = 0.03 \text{ m}}$$

(b)

$$\text{Stress} = \frac{\text{Force}}{\text{Area}} \quad \therefore \text{find Force and Area}$$

$$\text{Area} = 2 \times 10^{-5} \text{ cm}^2 = 2 \times 10^{-5} \times 10^{-4} \text{ m}^2$$

$$\text{Area} = 2 \times 10^{-9} \text{ m}^2$$

$$\text{Force} = \text{mass} \times \text{accel}^n = 400 \times 9.81$$

$$F = 3924 \text{ N}$$

$$\therefore \text{stress} = \frac{F}{A} = \frac{3924}{2 \times 10^{-9}}$$

$$\text{stress} = 1.96 \times 10^{12} \text{ Pa} \quad \text{to 2 D.P.}$$

Q5 (c) Continued

(8)

To find strain use Hooke's Law

$$E = \frac{\text{stress}}{\text{strain}}$$

$$\therefore \text{strain} = \frac{\text{stress}}{E} = \frac{1.96 \times 10^{12}}{90 \times 10^9}$$

$$\text{strain} = 21.78 \quad \text{to 2 DP}$$

Q4. (a) Stefan's Law

$$\text{Radiant Power} = \dot{q} = A \epsilon \sigma T^4 \quad (T \text{ in K})$$

$$\dot{q} = 7 \times 0.9 \times 5.67 \times 10^{-8} \times 873.15^4$$

$$\dot{q} = 207,624.71 \text{ Watts to 2 DP}$$

(b) de Broglie $p = \frac{h}{\lambda} \quad (p = mv)$

$$\therefore \lambda = \frac{h}{p} = \frac{6.626 \times 10^{-34}}{9.109 \times 10^{-31} \times 3 \times 10^7}$$

$$\lambda = 2.24 \times 10^{-11} \text{ m}$$

Q4 continued

9

(c) ~~For~~ For a rectangular pulse

$$\text{Power} = \frac{\text{Energy}}{\text{time of pulse}}$$

$$P = \frac{10}{50 \times 10^{-6}}$$

$$\underline{P = 200,000 \text{ W}}$$

(e) $\text{acceleration} = \frac{v - u}{t}$

$$a = \frac{18 - 6}{0.3} = \frac{12}{0.3}$$

$$\underline{a = 40 \text{ ms}^{-2}}$$

Q6

(a) Restoring force $\propto$ displacement from Equilibrium

$$(b)(i) \quad \omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{400}{6}}$$

$$\omega = 8.16 \text{ radians s}^{-1}$$

To find frequency:

$$\omega = 2\pi f$$

$$f = \frac{\omega}{2\pi} = \frac{8.16}{2\pi}$$

$$f = 1.30 \text{ Hz to 2 DP}$$

To find Period:

$$T = \frac{1}{f}$$

$$\underline{T = 0.77 \text{ s to 2 DP}}$$

Q6 continued
b (ii)

(11)

$$E = \text{Energy} = \int kx \, dx$$

$$E = \int_0^{0.08} 400x \, dx$$

$$E = 400 \int_0^{0.08} x \, dx$$

$$E = 400 \left[\frac{x^2}{2} \right]_0^{0.08}$$

$$\underline{E = 1.28 \text{ Jals}}$$

Q7 (a)

(12)

$$I = \int r^2 dm$$

For rectangular beam $dm = \frac{M}{L} dr$

$$\therefore I = \int_0^L r^2 \frac{M}{L} dr$$

$$I = \frac{M}{L} \int_0^L r^2 dr$$

$$I = \frac{M}{L} \left[\frac{r^3}{3} \right]_0^L$$

$$I = \frac{M}{L} \cdot \frac{L^3}{3} = \frac{ML^2}{3}$$

$$I = \frac{3 \times 5^2}{3} = 25 \text{ kg m}^2$$

⑥

Gurney constant $= \sqrt{2E} = 3000 \text{ m s}^{-1}$

Use spherical Gurney formula:

$$\frac{v}{\sqrt{2E}} = \left[\frac{M}{C} + \frac{3}{5} \right]^{-0.5}$$

gives

$$v = 3038.22 \text{ m s}^{-1}$$

to 2 D.P.

