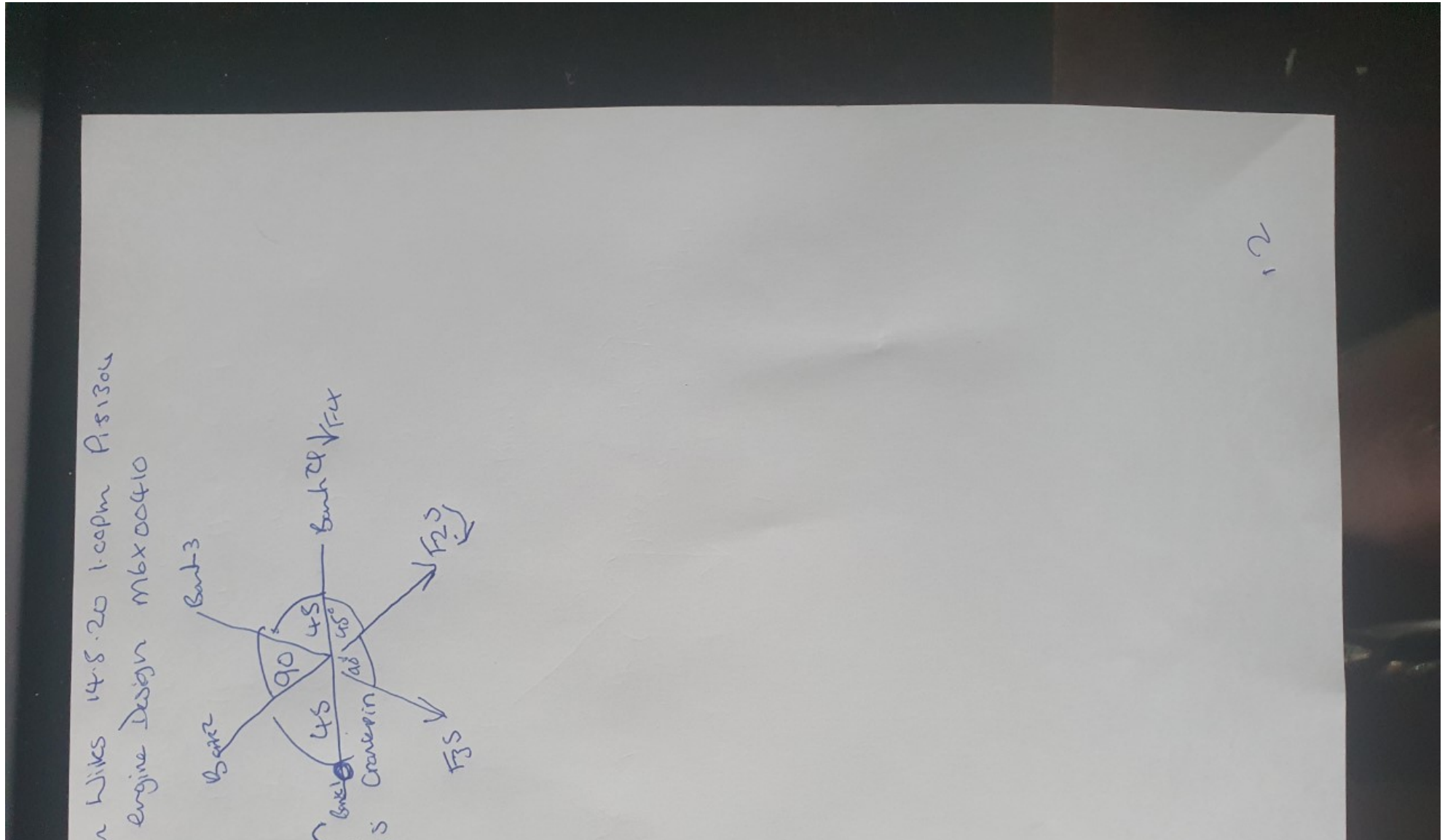


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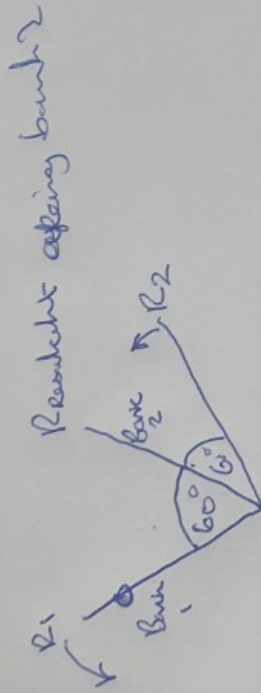
Billy Wilks <BillyWilks@live.co.uk>

Thu 14/05/2020 15:15

To: William Wilks (P151304) <wwilks.151304@student.uwtsd.ac.uk>



Wilks P151304 14.5.20 1:00pm
 engine design M6x00410



$$R_2 = \frac{M_{rec}}{2} - R_{L2}$$

$$\text{back} = \frac{M_{rec} R_{L2}^2 \cos 60^\circ}{2} + \frac{M_{rec} R_{L2}^2 \cos 60^\circ}{2}$$

$$= M_{rec} R_{L2}^2 \cos 60^\circ$$

$$\text{moment} = M_{rec} R \cos 60^\circ$$

$$= 0.36 \times 40 \times 0.5$$

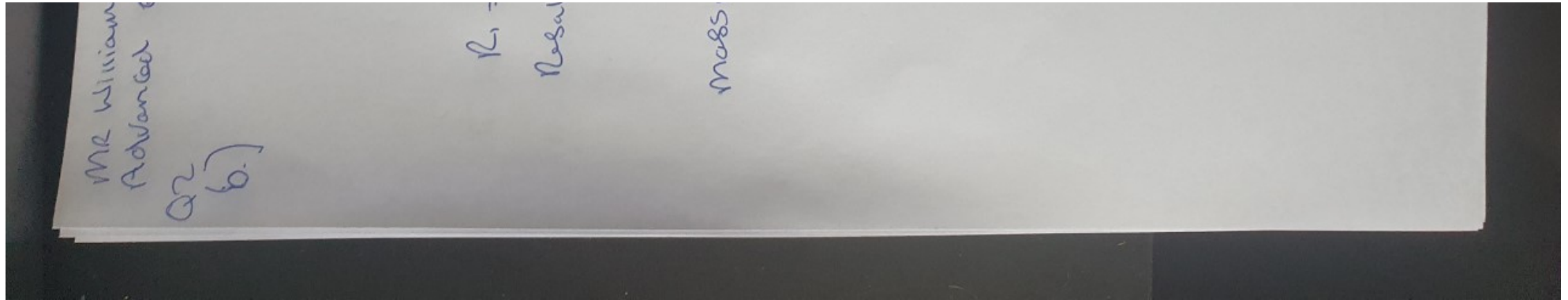
$$= 7.2 \text{ kg}\cdot\text{mm}$$

8

Mr Wilks
 Advansted

Q2
 9)

q
 F1



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c) First order Reverse mass moment

$$\frac{M_{rec} \cdot R}{2} \text{ kg} \cdot \text{mm} \text{ its a twin}$$

$$\text{So } M_{rec} \cdot R = 15.75 \text{ kg} \cdot \text{mm}$$

d) Balance shaft need to Rotate Counter Clock wise, Equal to engine speed. Use a Gear pair of equal diameter



e) To full balance make First order Reverse mass moment equal to:

$$M_{balance} \omega^2 = \frac{2M_{rec} R \omega^2}{2}$$

In this case

$$y = \frac{M_{rec} R}{m_{balance}}$$

$$y = \frac{15.75}{2.5}$$

$$y = 6.3 \text{ mm}$$

4

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b.)

run offset Centre of Gravity Counterbalance
Create a balancing Counterweight for Ca



$$\text{So } M_{\text{crank}} \cdot \alpha \cdot \omega^2 = (2M_{\text{crank}} + M_{\text{counter}}) R \cos^2$$

$$\alpha = \frac{(2M_{\text{crank}} + M_{\text{counter}}) R}{M_{\text{crank}}}$$

$$\alpha = \frac{32.35}{5}$$

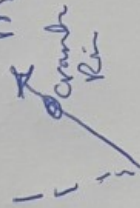
$$\alpha = 7.47 \text{ m/s}^2$$

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Q1a)

The rotating part of the Car-Rod also creates a Centrifugal force at magnitude

$M_{rot} R_{cr}^2$
Along the direction of the Crank Pin



So the total first order forces

$$\frac{M_{rec} R_{cr}^2}{2} \text{ Reverse} + \frac{(M_{rot} + M_{rec}) R_{cr}^2}{2} \text{ Forward}$$

$$\text{So First order Forward} = \frac{(M_{rot} + M_{rec}) R_{cr}^2}{2}$$

In this case twin cylinder so

$$= 2 \left(\frac{M_{rot} + M_{rec}}{2} \right) R_{cr}^2$$

$$M_{rot} = \frac{2}{3} \text{ Crank + } \frac{\text{shaft}}{\text{mass}}$$

$$M_{rec} = \text{Piston + } \frac{\text{Crank}}{\text{mass}}$$

$$\therefore \text{Mass Moment Forward} = (2 M_{rot} + M_{rec}) R_{cr}$$

$$2 \left(2 \times 240 + 380 \right) 45$$

$$2 \left(2 \times 0.24 + 0.35 \right) 45$$

$$2 \times 37.35 \text{ kg} \cdot \text{mm}$$

2

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Q2.

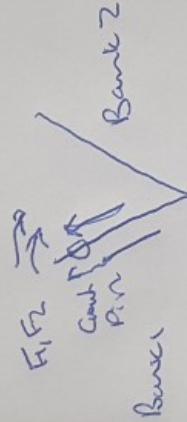
Piston mass = 240 Grams
Crank-Rod mass = 366 Grams
Stroke = 80 mm
Crank-Rod length = 140 mm

$$m_{rec} = 240 + \frac{1}{3} 360$$

$$= 360 \rightarrow 0.36 \text{ kg}$$

$$m_{rot} = \frac{2}{3} 360$$

$$= 240 \rightarrow 0.24 \text{ kg}$$



Twice over forces are along the same bank

$$F_1 = F_2 = (m_{rot} + \frac{m_{rec}}{2}) R \omega^2$$

Resultant Vector

$$= 2 (m_{rot} + \frac{m_{rec}}{2}) R \omega^2$$

Resultant mass moment

$$= 2 (m_{rot} + \frac{m_{rec}}{2}) R$$

$$= 2 (0.24 + \frac{0.36}{2}) 40$$

$$= 2 (0.24 + 0.18) 40$$

$$= 2 \times 0.42 \times 40$$

$$= 33.6 \text{ kg} \cdot \text{mm}$$

7

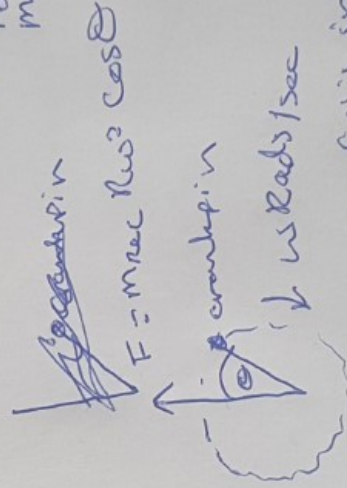
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Q1)

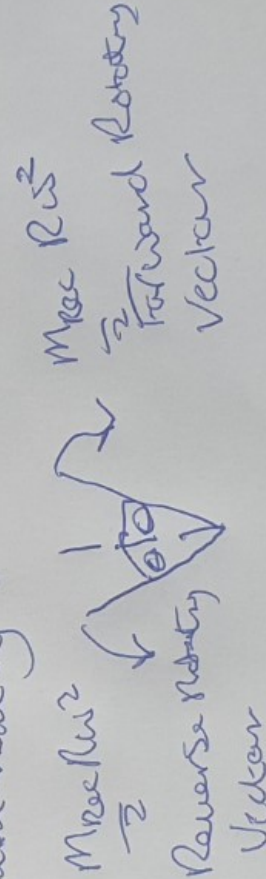
Piston mass = 240g/kms
Crank mass = 330 grams inline with
Big end ball = 20 grams
Bore is = 90 mm
Crank mass = 3 kg
Cen-rod L = 440 mm

a) The Reciprocating mass Results in a first order force along the cylinder axis

$$m_{rec} = \text{Piston} + \frac{1}{3} \text{Crank mass}$$

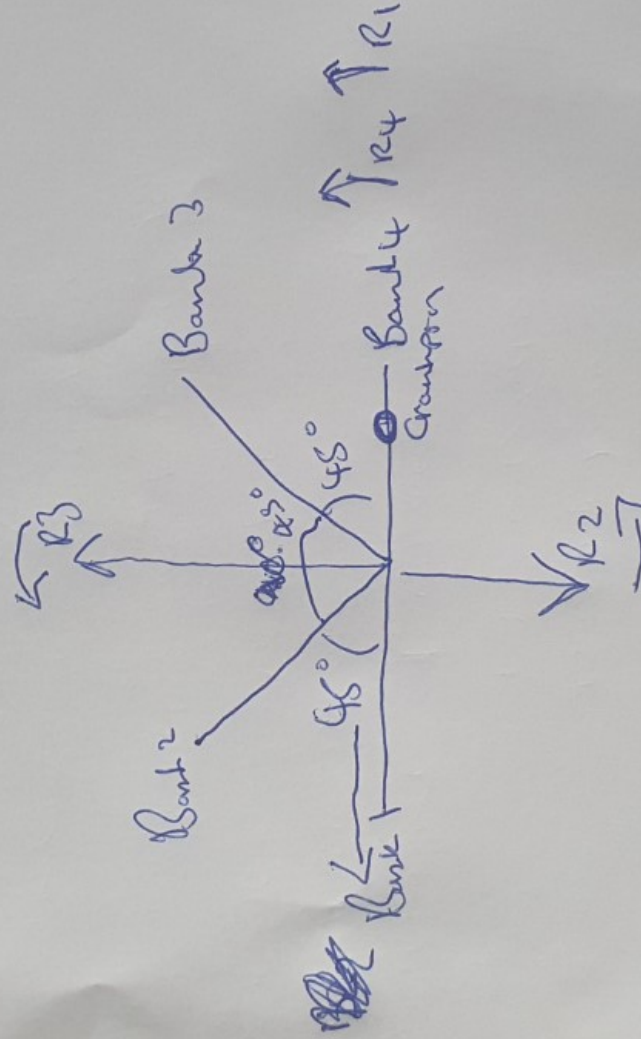


The Cylinder force can then be split into two Crank Rotating constant amplitude ~~force~~ Vectors since mathematically the same.



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e) Balance the first order forward using a crank-shaft with offset CoG.
Balance the resultant reverse vector with a counter rotating balance shaft.



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 h.

Mass moment
 of each bar
 static

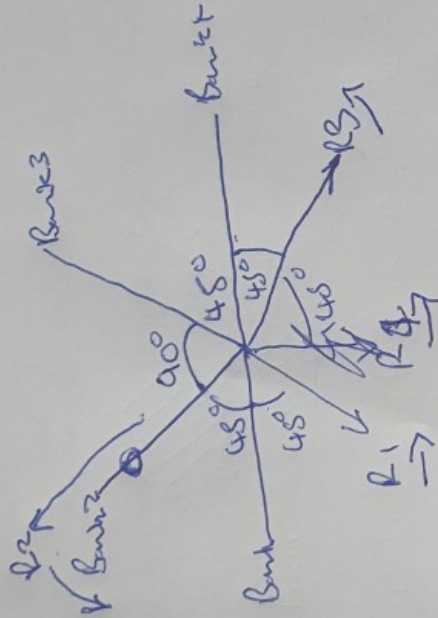
$$2 \times 2 \frac{1}{2} \times \frac{R}{L} m_{\text{bar}} R_{\text{bar}}^2$$

$$2 \times \frac{48}{140} \times 0.35 \times 45$$

$$28.0625 \text{ kg}\cdot\text{mm}$$

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19.



Resubmits vertical component down

Resultante Vertikal Komponente $\sin \alpha$

$$R_2 - R_3 + R_1 \sin \alpha + R_4 \sin \alpha$$

$$R_2 - 123 + 12$$

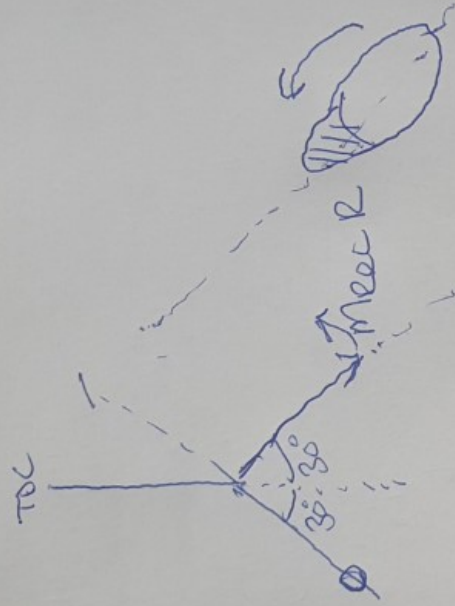
Door

$$\text{Mass moment} = \frac{1}{2} \cdot \rho \cdot A \cdot L^2$$

$$1.7 \times 10^{-8} \times 0.7$$

12.24 kg-mm





Engine is horizontal



If ~~crank~~ $m_{crank} \propto \omega^2 = m_{rot} \omega^2$

make $m_{rec} = \frac{m_{rot}}{2} \rightarrow \frac{2 m_{rot}}{2} = m_{rot}$

$m_{crank} \propto \omega^2$

To understand make

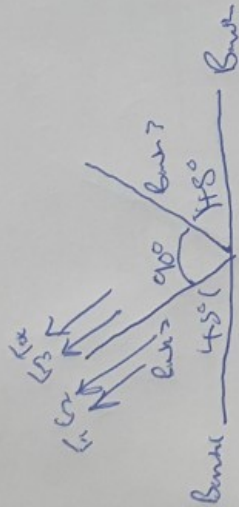
$$m_{crank} \propto \omega^2 = (2 m_{rot} + m_{rec}) R$$

$$221.6 \text{ kg} \cdot \text{mm}$$

5

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Q2C.



First order vector is along Burst 2

$$\text{Mass moment} = 4 \left(M_{\text{ROT}} + \frac{M_{\text{REC}}}{2} \right) R$$

$$= 4 (0.24 + 0.18) 40$$

$$= 4 \times 0.42 \times 40$$

$$= 67.2 \text{ kg} \cdot \text{mm}$$

9

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