

$$1/12$$

Q.2)

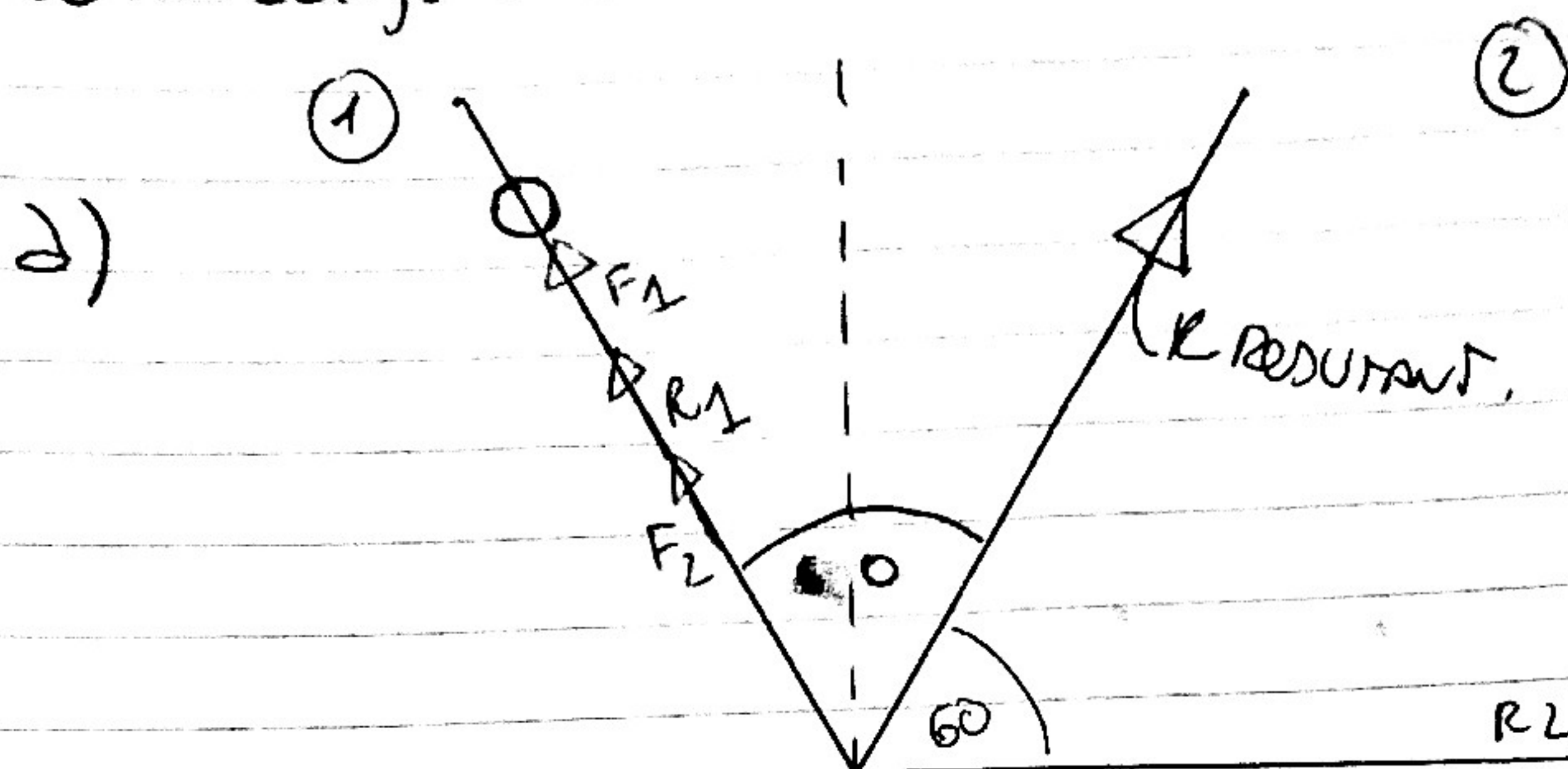
c) $Piston = 240\text{ g} = 0,24\text{ kg}$

CONWd = 0,36 kg

$$St_{wake} = 80 \text{ km}$$

$$l = c \cdot \text{length} = 140$$

$$R = \frac{80}{2} = 40 \text{ m}$$



$$\underline{M_{rec}} = P_{STON} + P_{IN} + \frac{1}{3} P_{ad} = 0,24 + \frac{1}{3} \cdot 0,36 = 0,36 \text{ kg}$$

$$MR_{OT} = \frac{2}{3} \text{ contol} = \frac{2}{3} \cdot 0,36 = 0,24 \text{ kg}$$

2) $\Rightarrow$ FORWARD MAGNITUDE.

$\Rightarrow$ FORWARD MAGNITUDE.

$$F_{TOT} = 2 \left(\pi k_B T + \frac{\pi e c}{2} \right) \cdot R = 2 \left(0,24 + \frac{0,36}{2} \right) \cdot 40$$

$$= 33,6 \text{ kg} \cdot \text{mm}$$

b) Resultant, is along BANK (2) (look. sketch above)

$$R_{\text{resultant}} = R_1 \cdot \cos(60) + R_2 \cdot \cos(60)$$

$$R_1 = R_2 = R$$

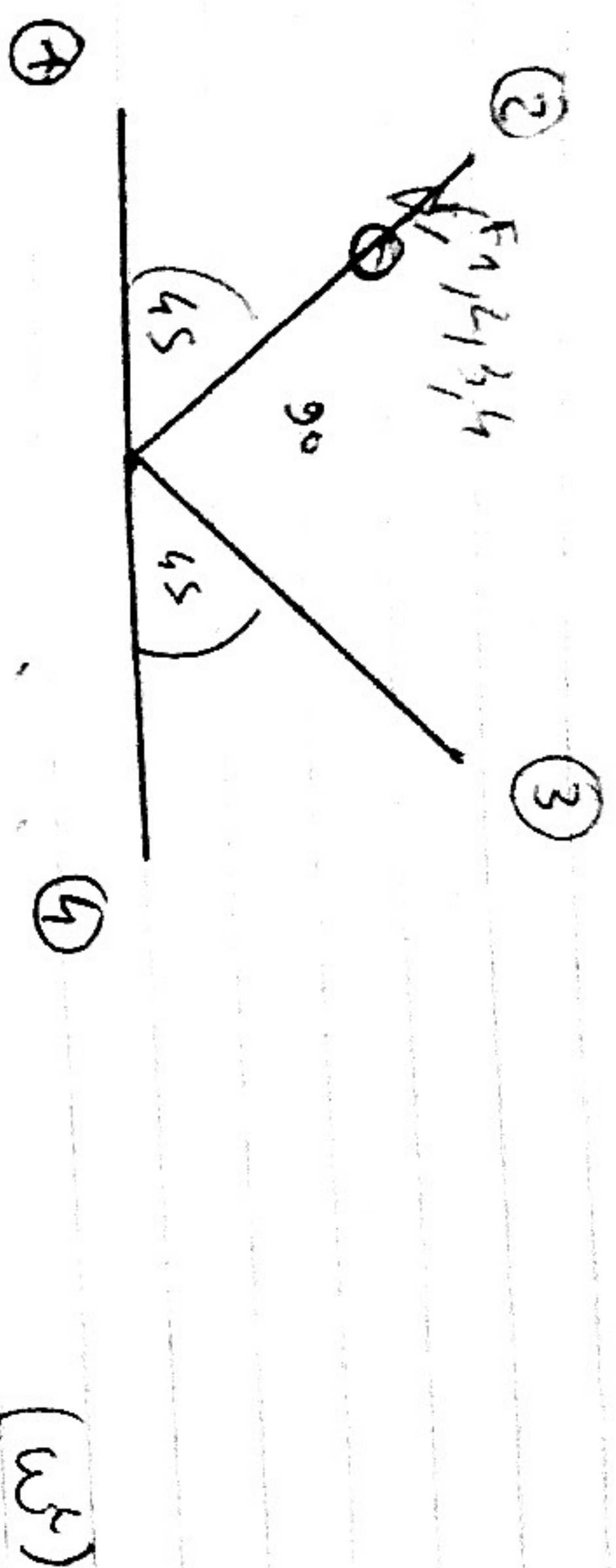
$$R = \frac{m_{rec}}{2} \cdot R\omega^2 \Rightarrow \frac{0,36}{2} \cdot (40) = 7,2$$

$$\hookrightarrow k_{\text{REKURANT}} = 7,2 \cdot \left(\frac{1}{2}\right) + 7,2 \cdot \left(\frac{1}{2}\right) = 7,2 \text{ kg} \cdot \text{mm}$$

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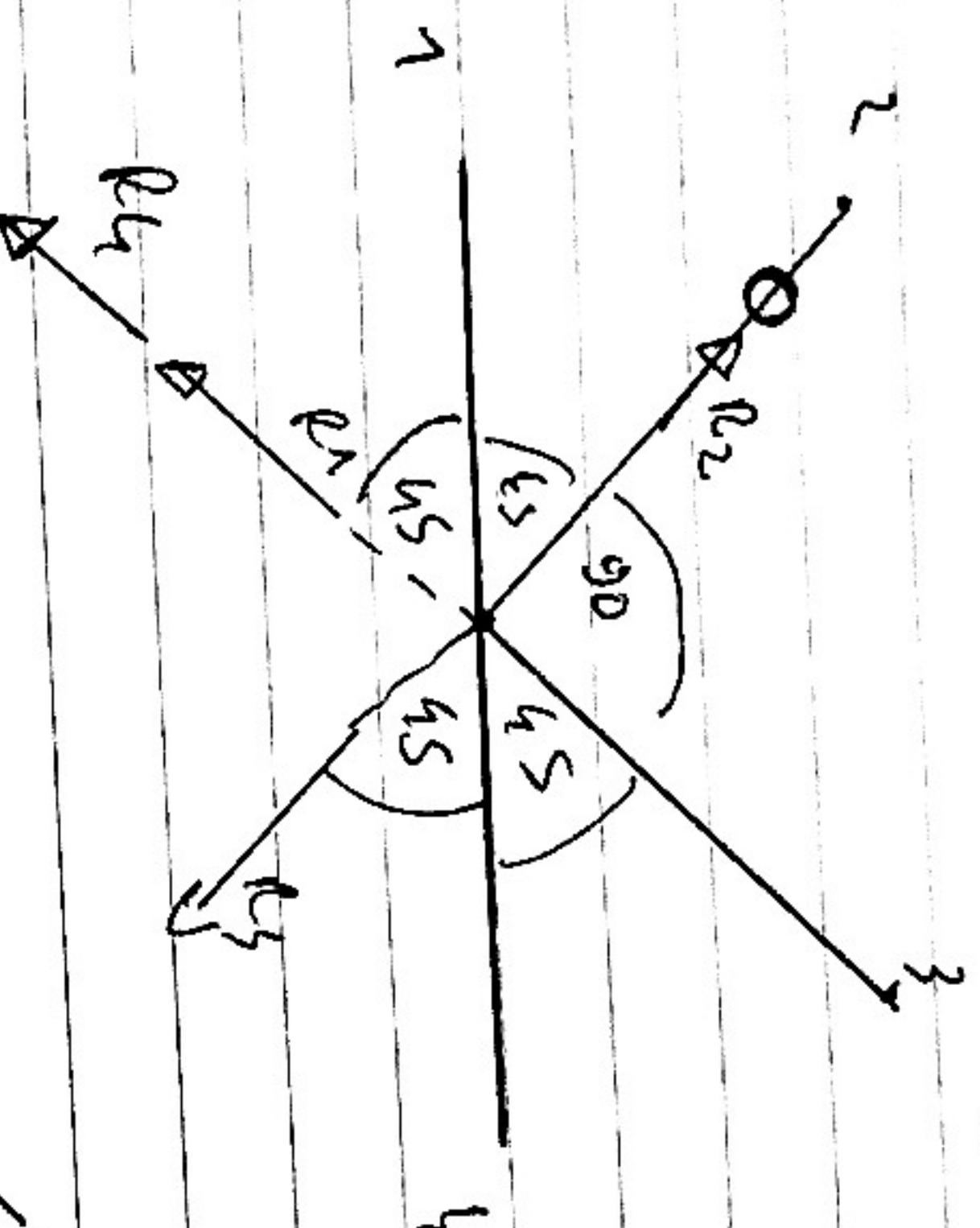
c)



$$F_{TOT} = \text{ventout} = 4 \cdot F = 4 \cdot \left(M_{TOT} + \frac{M_{rec}}{2} \right) \cdot R$$

$$= 4 \cdot (16, 8) \cdot 0,36 = 67,2 \text{ kg} \cdot \text{mm}$$

d)



$R_2 = R_3$ opposite $R_1 - R_3 = 0$ they cancel.

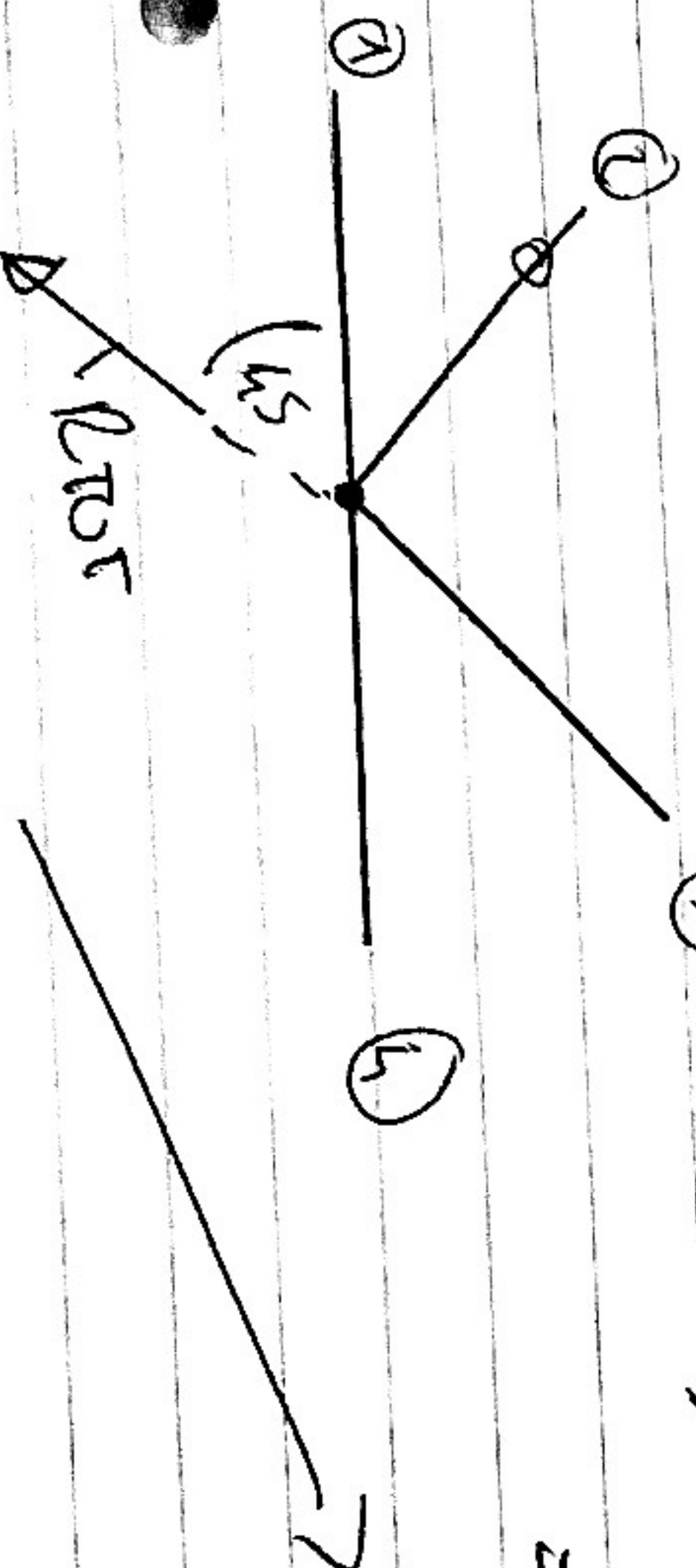
The ventout is 45° before have ①
 and is equal to

$$P_{TOT} = 2 \cdot (R_1 + R_4) \quad R_1 = R_4 = R$$

$$= 2 \cdot (2R) = 4R$$

$$= 4 \cdot \frac{M_{rec}}{2} \cdot (R)$$

$$= 4 \cdot \frac{0,36}{2} \cdot (40) = 28,8 \text{ kg} \cdot \text{mm}$$



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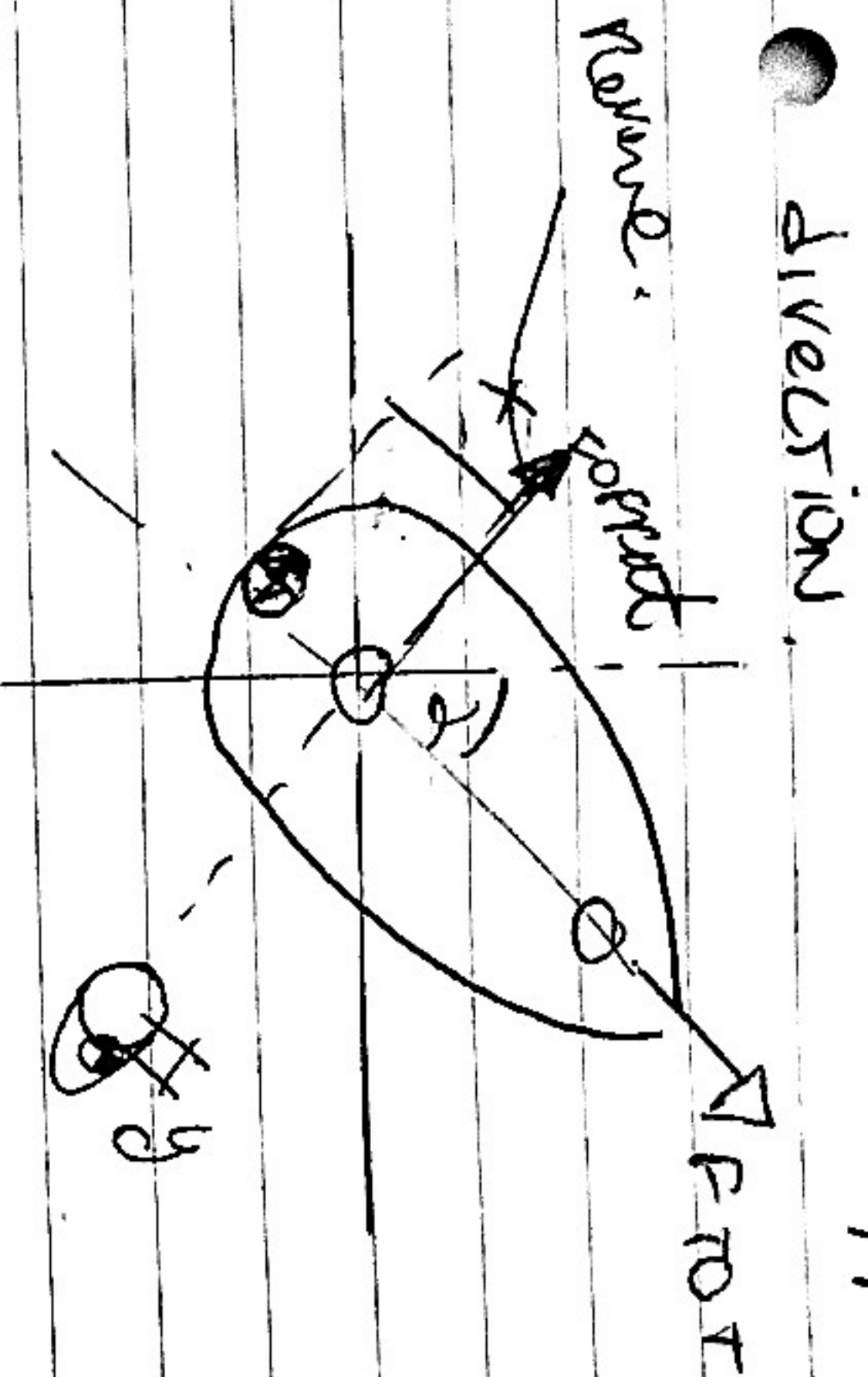
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e). The forward vector can be balanced by an eccentric mass on the CRANK SHAFT.

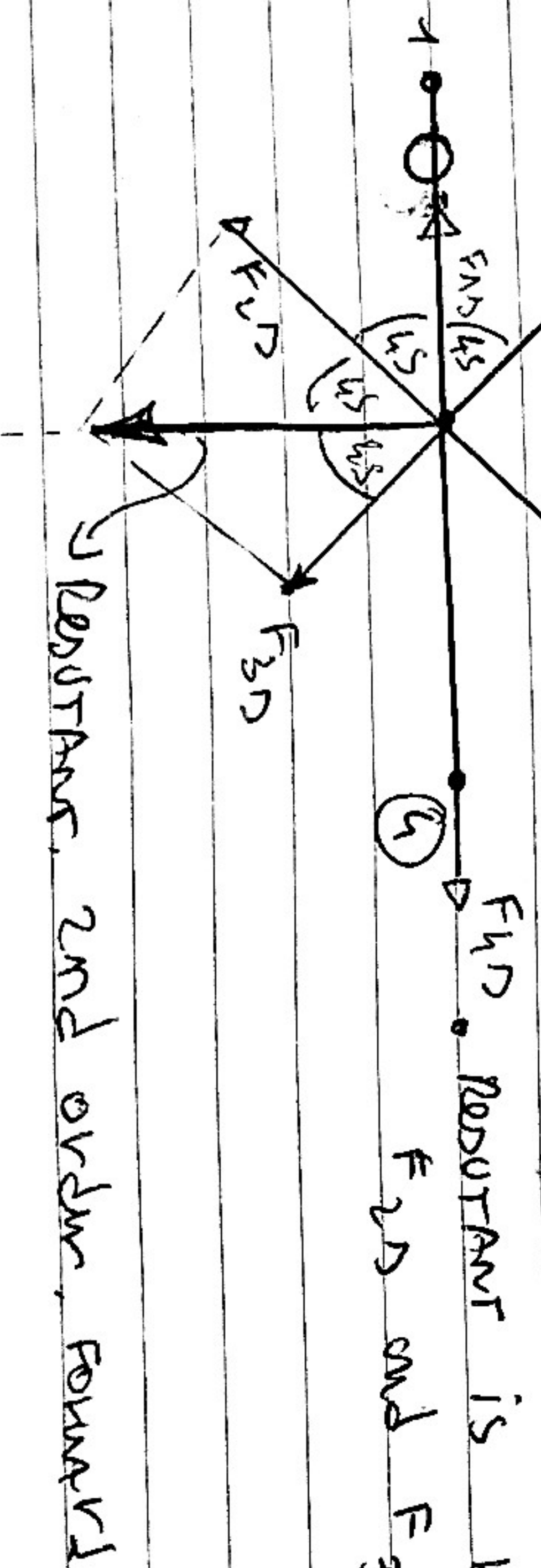
The resultant 1st order reverse can be balanced by a counter rotating shaft, which rotates at the same speed of the engine. It has to be placed with its eccentric opposite to the reverse vector.



F) Resultant reverse rotates 135° counter clockwise. And lays on bank 4

2) ② ③ • F_{1D} symmetric with F_{4D} so they cancel

Remains F_{3D} with F_{2D}
Resultant is between F_{2D} and F_{3D} .



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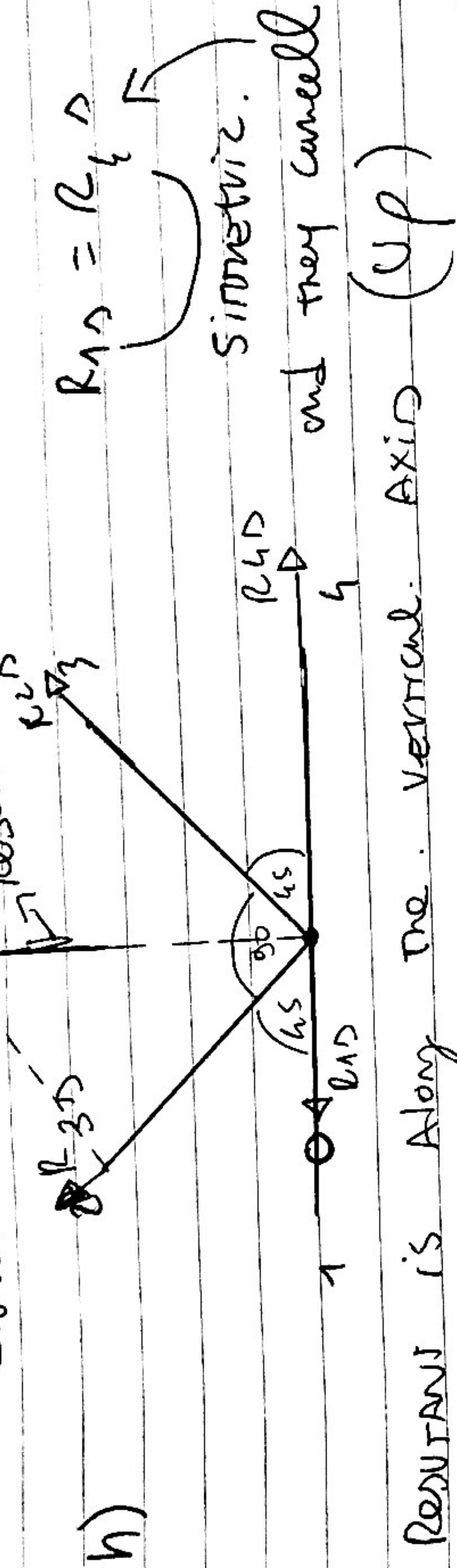
2ND ORDER RESULTS = $F_{2D} \cdot \cos(45) + F_{3D} \cdot \cos(45)$

$F_{2D} = F_{3D} = F_D = \frac{1}{2} R \cdot M_{rec} \cdot R$

= $0,5 \cdot \frac{40}{140} \cdot 0,36 \cdot 40 = 2,05 \text{ kg} \cdot \text{mm}$

$R_{TOT} = 2,05 \cdot \cos(45) + 2,05 \cdot \cos(45) = 2,90 \text{ kg} \cdot \text{mm}$

RESULTANT

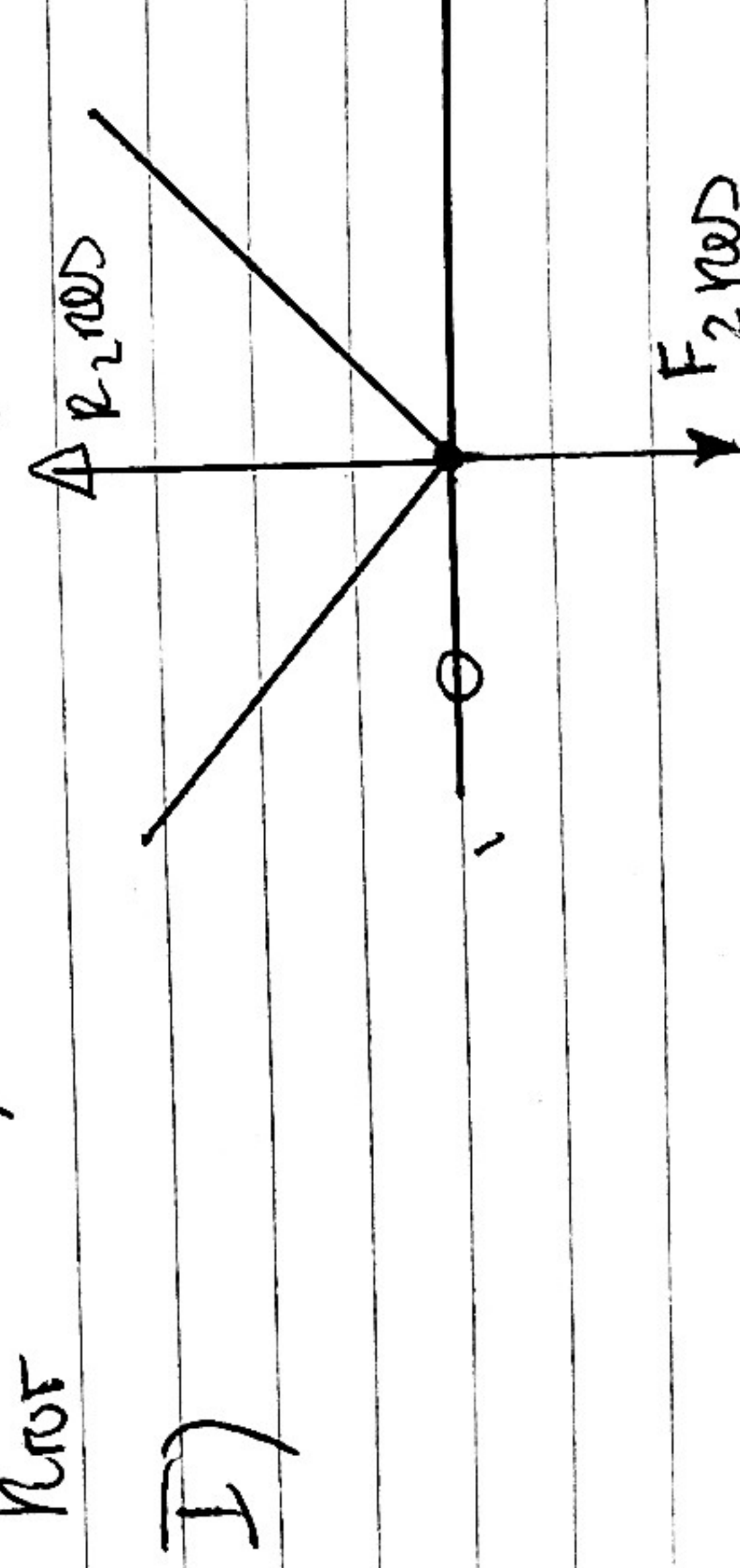


$R_{TOT} = R_{2D} \cdot \cos(45) + R_{3D} \cdot \cos(45)$

$R_{2D} = R_{3D} = R$

$R = \frac{1}{2} \cdot \frac{40}{140} \cdot (0,36) \cdot (40) = 2,05 \text{ kg} \cdot \text{mm}$

$R_{TOT} = 2,05 \cdot \cos(45) + 2,05 \cdot \cos(45) = 2,90 \text{ kg} \cdot \text{mm}$



$R_{2 \text{ resultant}} = F_{\text{resultant}}$ SO COMBING TOTAL

Force = 0

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If the CRANK SHAFT NORMED the total FORCE.

• CHANGED

FORCE. It is equal to 0 JUST

- The total FORCE. is equal to zero 300T when the PIN is ON BANK ① OR BANK ②.

~~MANIFOLD IS 500CC~~ ~~2~~ ~~OR~~ ~~3~~ ~~STRE~~

500CC

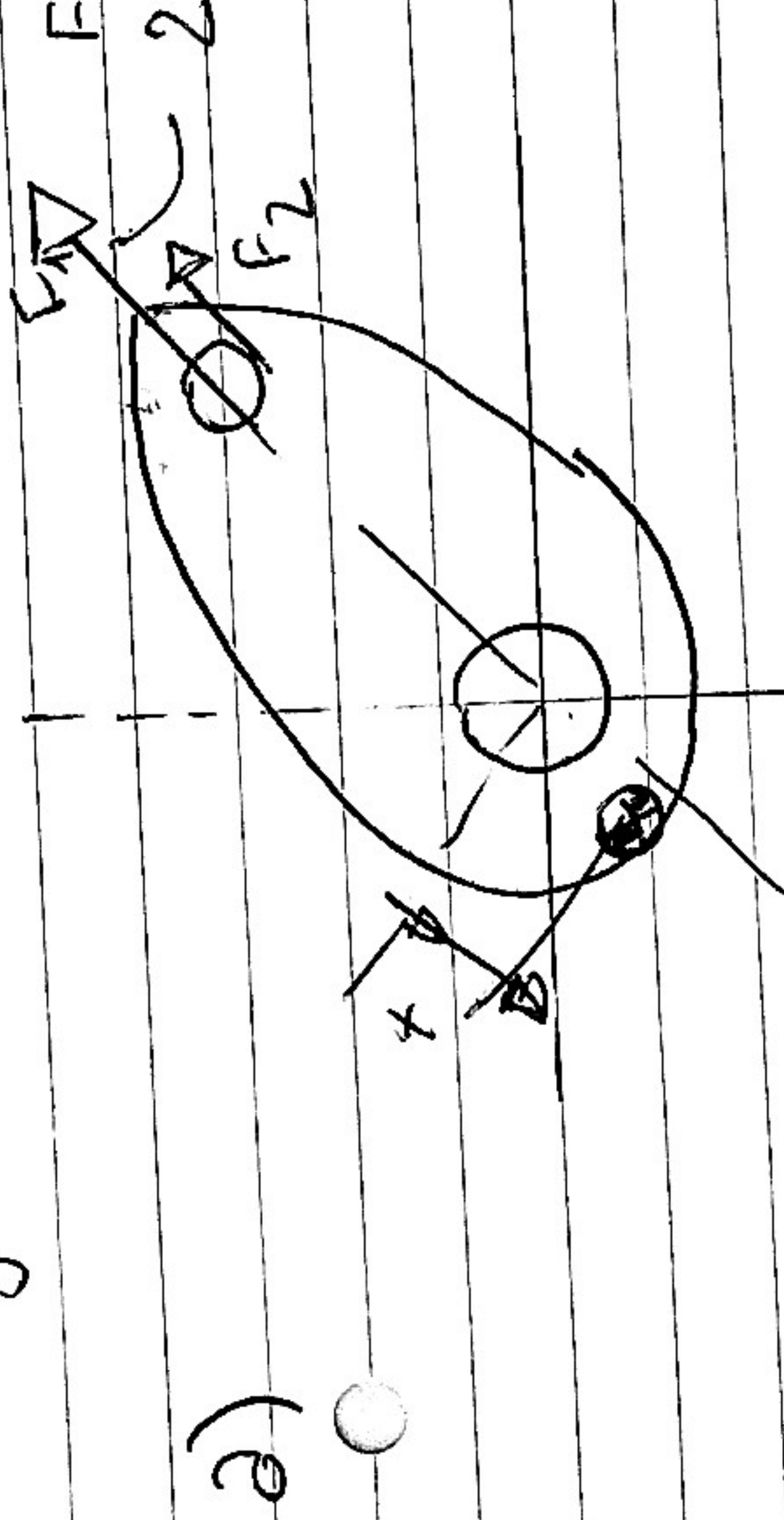
Q1) ~~4 stroke~~

INCINE PARALLEL TWIN

• PISTON = 240 g = 0,24 kg. STROKE = 90 mm

• ROD = 0,330 kg $m_{CRANK} = 5 \text{ kg}$

• big END BEARING = 20 g $L = 140 \text{ mm}$



• $m_{rot} = \frac{2}{3} m_{rod} = \frac{2}{3} \cdot 0,33 = 0,22 \text{ kg}$

• $m_{rec} = \text{PISTON} + \text{PIN} + \text{BEARING} + \frac{1}{3} m_{rod} = 0,24 + 0,02 + \frac{1}{3}(0,33)$
 $= 0,37 \text{ kg}$

Total MT. 1st order, FORWARD: $2 \cdot \left(m_{rot} + \frac{m_{rec}}{2} \right) \cdot R$

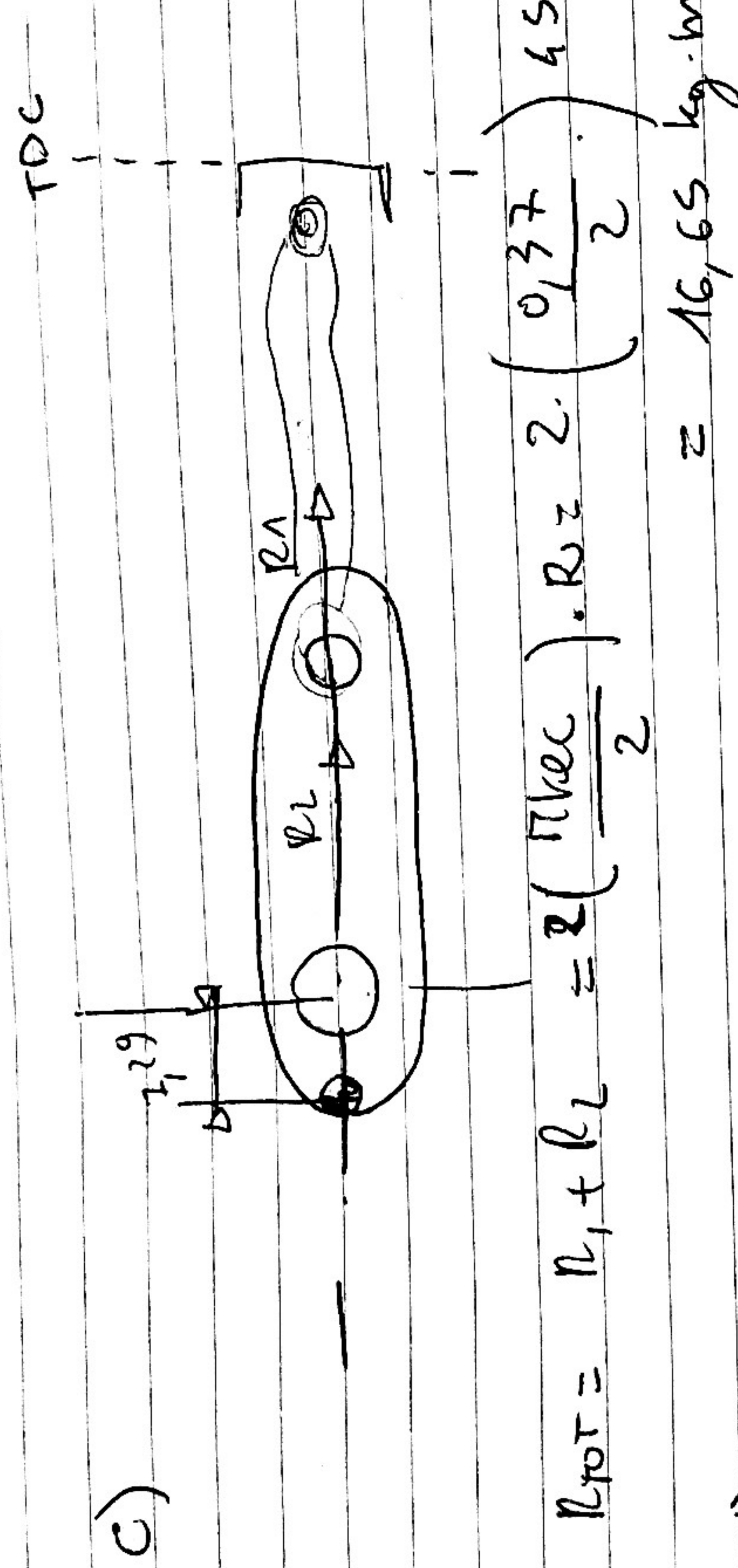
$$= 2 \cdot \left(0,22 + \frac{0,37}{2} \right) \cdot \left(\frac{90}{2} \right) = 36,45 \text{ kg} \cdot \text{mm}$$

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b) For 100% balance.

$$M_{CRAN} \cdot (x)_{OPPOSITE} = 2 \cdot \left(m_{ROT} + \frac{m_{KEC}}{2} \right) \cdot R.$$

$$x_{OPPOSITE} = \frac{36,45}{5} = 7,29 \text{ mm}$$



d) I would use a series of

gears as follows:

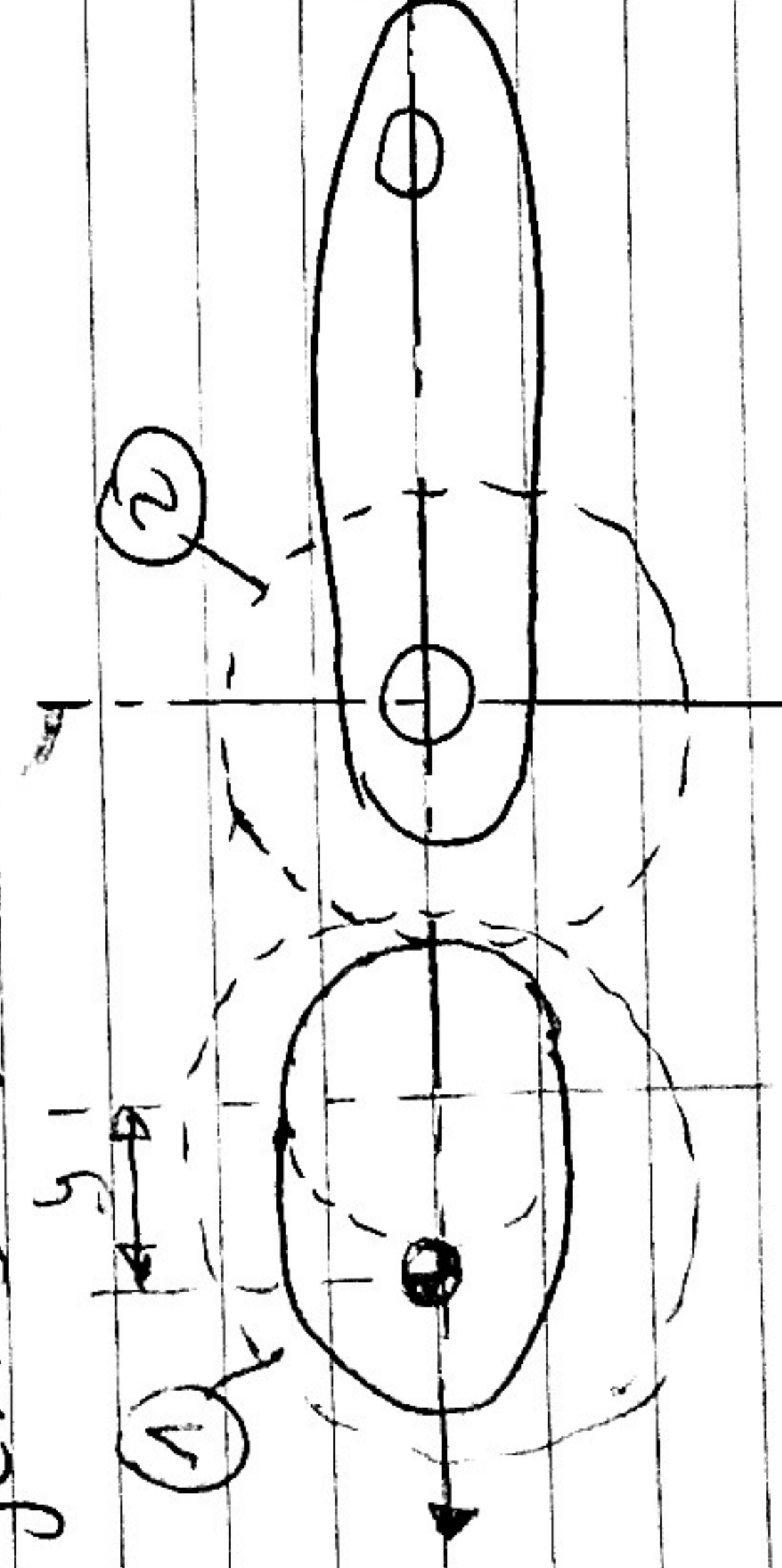
GEARS SPEC

① bal. SMR

$z = 40$ (number of teeth)

② EVANG SMR

$z = 40$ (number of teeth)



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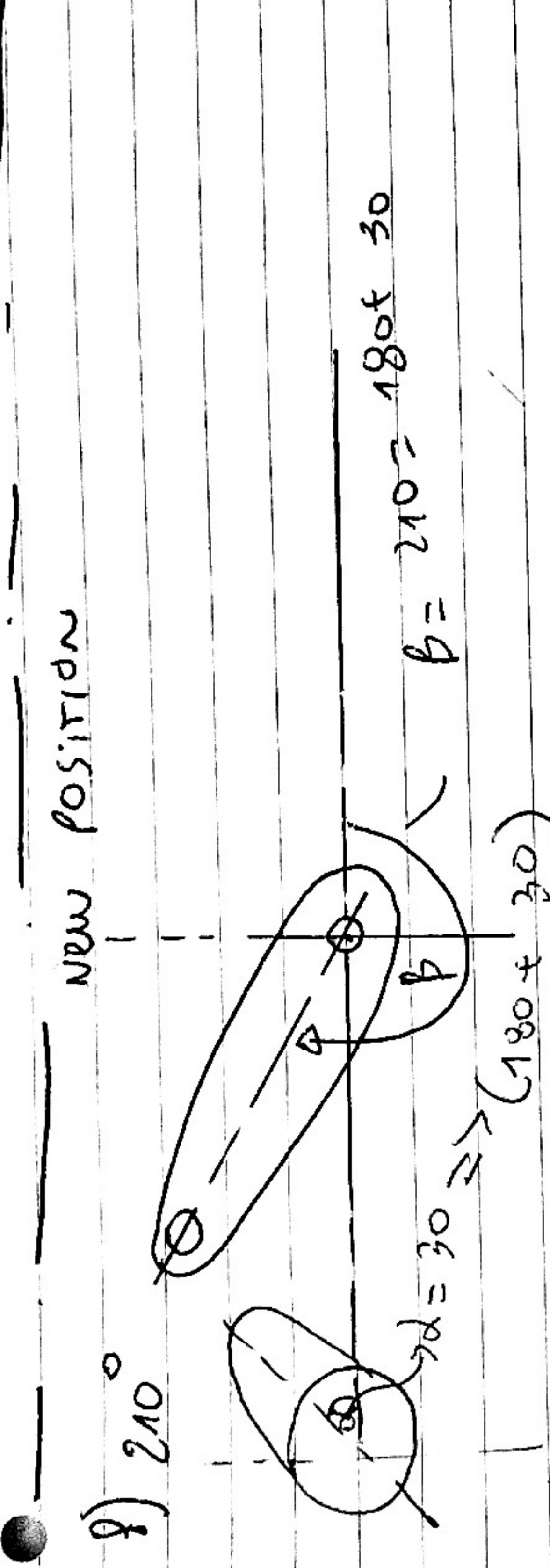
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c) $m = 2,5 \text{ kg}$
bal

For balance.

$m_{bal} \cdot (y) = \text{TOTAL REVERSE VELOCITY}$

$$y = \frac{16,65}{2,5} = 6,66 \text{ mm}$$

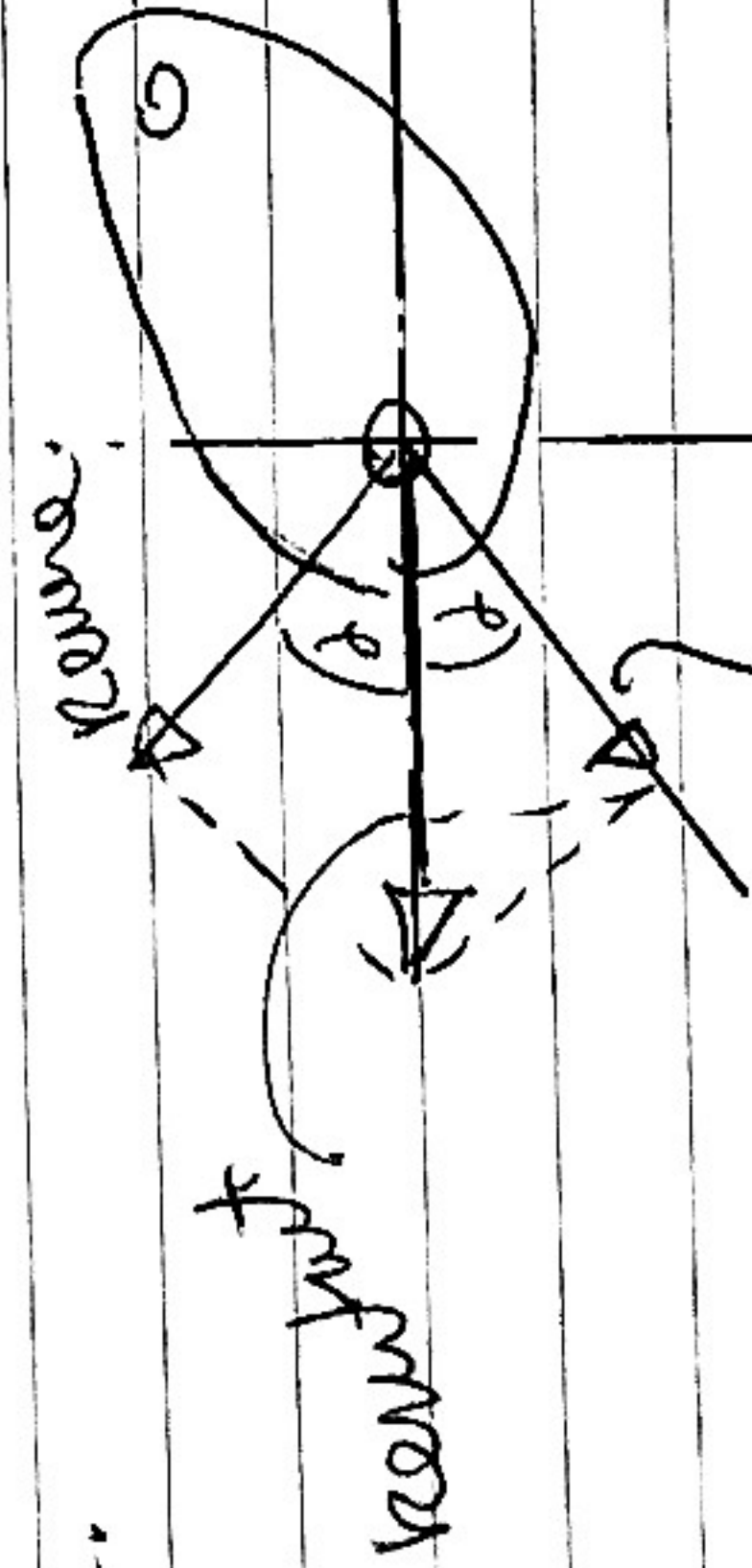


9) When balance shaft cannot be used, the AIN is to cancel the FORWARD vector, with CENTRIFUGAL force horizontal.

CRANK SHAFT FORCE, TO HAVE a RESULTANT FORCE

BETWEEN THE REVERSE VECTOR AND THE CENTRIFUGAL FORCE OF ME.

CRANK.



$m_{crank} \cdot (x) = \text{FORWARD VECTOR}$

$$m_{crank} \cdot r = \frac{m_{rec} \cdot r}{2} \quad m_{crank} \cdot (x) = 2 \cdot \left(\frac{m_{rec} + m_{tot}}{2} \right) \cdot r$$



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

$$m_{rec} \cdot 2m_{rot} \cdot R = m_{rec} \cdot R - 2m_{rot} \cdot R = m_{rec} \cdot R$$

$$2m_{rec} \cdot R - m_{rec} \cdot R = m_{rec} \cdot R$$

$$2-1=1 \quad [m_{rec} \cdot R = m_{rec} \cdot R]$$

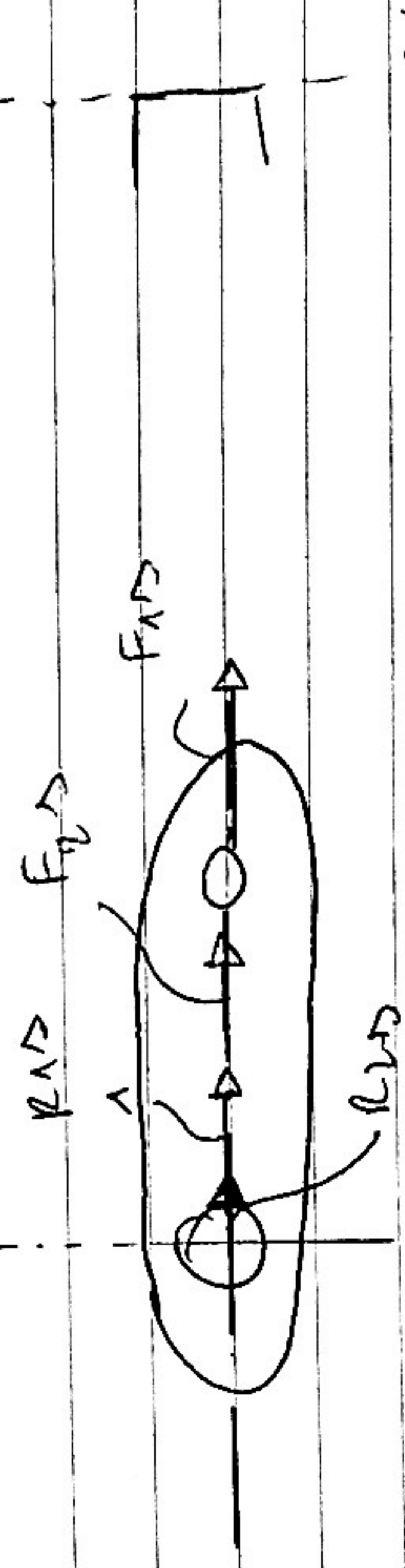
RESULTANT

$$R_{RESULTANT} = m_{rec} \cdot R \cdot \sin(\alpha) + m_{rec} \cdot R \cdot \sin(\alpha)$$

For a small value of $\alpha \Rightarrow$ $\sin$ is negligible

$$R_{RESULTANT} = 2 \cdot m_{rec} \cdot R = 2 \cdot (0.37) \cdot 45 = 33.3 \text{ kg} \cdot \text{m}$$

(h) ENGINE AT TOC



Forward

$$F_{1D} = F_{2D} = \frac{1}{2} \frac{R}{L} \cdot m_{rec} \cdot R$$

$$\text{Total Forward} = 2 \cdot \left(\frac{1}{2} \right) \cdot \frac{R}{L} \cdot m_{rec} \cdot R = \frac{45}{140} \cdot 0.37 \cdot 45$$

$$= 5.35 \text{ kg} \cdot \text{m}$$

Which is equal value to me. Reverse Total

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Reverse total. = 3,35

$$M_{bal} \cdot \omega (y) (2\omega)^2 = \frac{R}{L} \cdot M_{rec} \cdot \omega^2$$

$$M_{bal} \cdot y \cdot 4 \omega^2 = \frac{R}{L} \cdot m_{rec} \cdot R \omega^2$$

$$M_{bal} \cdot 4(y) = \frac{R}{L} \cdot M_{rec} \cdot R$$

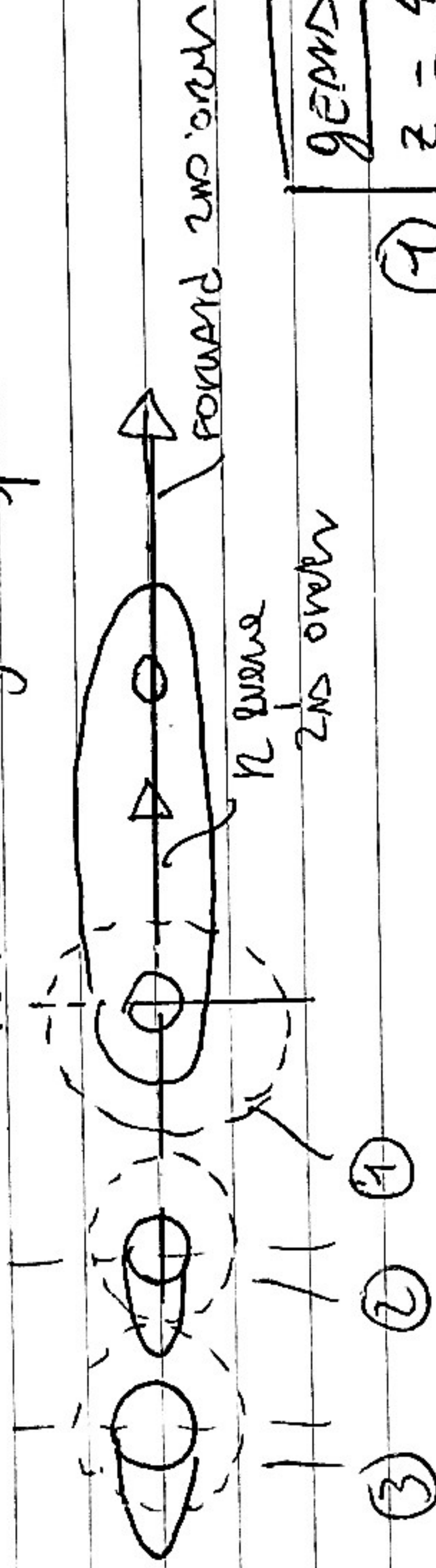
$$M_{bal} (y) = \frac{R}{4L} \cdot m_{rec} \cdot R$$

$$= \frac{45}{4} \cdot 0,37 \cdot 45 =$$

$$= 4 \cdot (140)$$

$$= \boxed{1,337 \text{ kg} \cdot \text{mm}}$$

Schematic. ↓ • the two balance shafts will rotate at twice engine speed.



gears	TEETH
① z = 40	40
② z = 20	20
③ z = 20	20

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SEW 1

Q4) PISTON: 240 g = 0,240

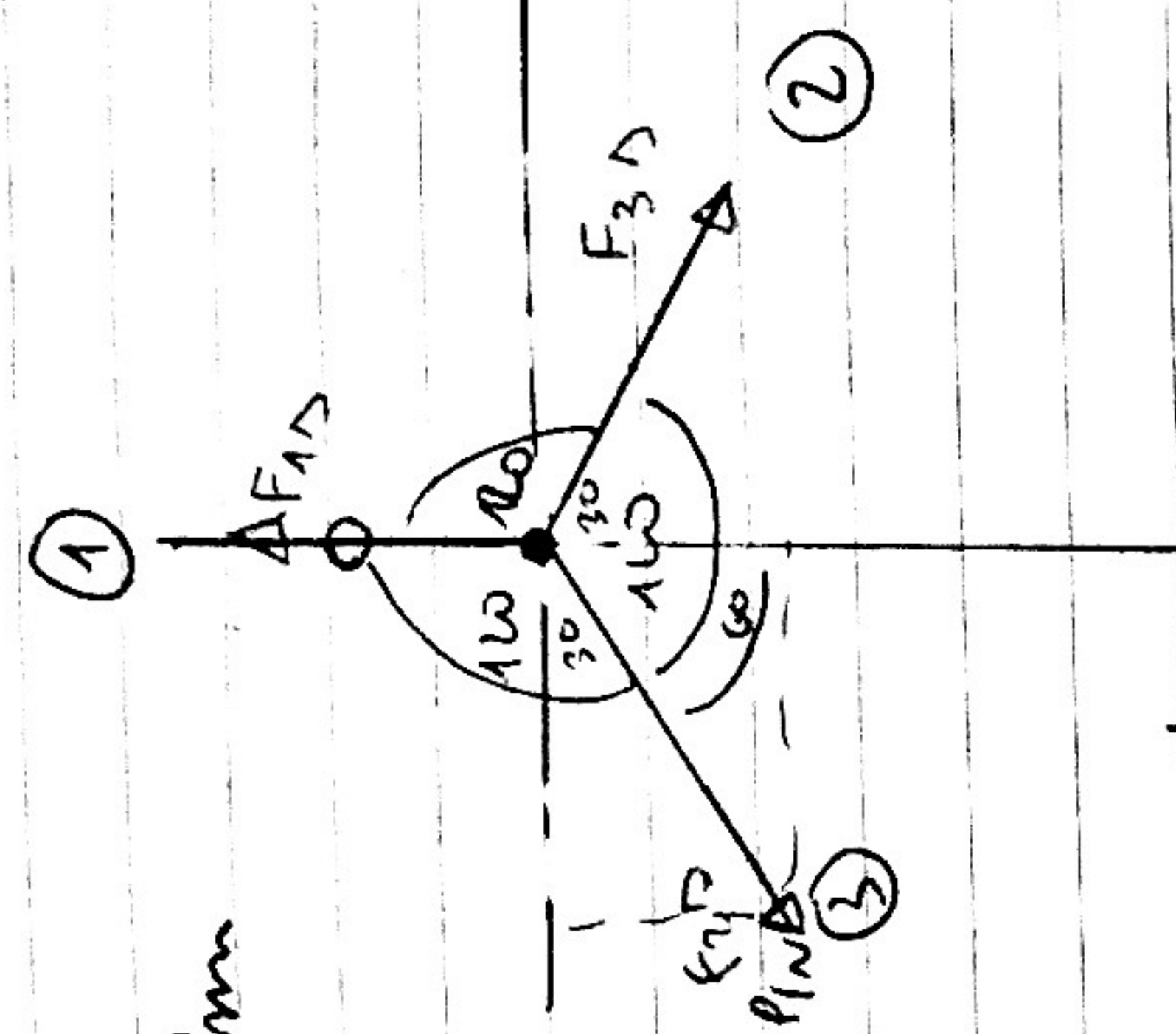
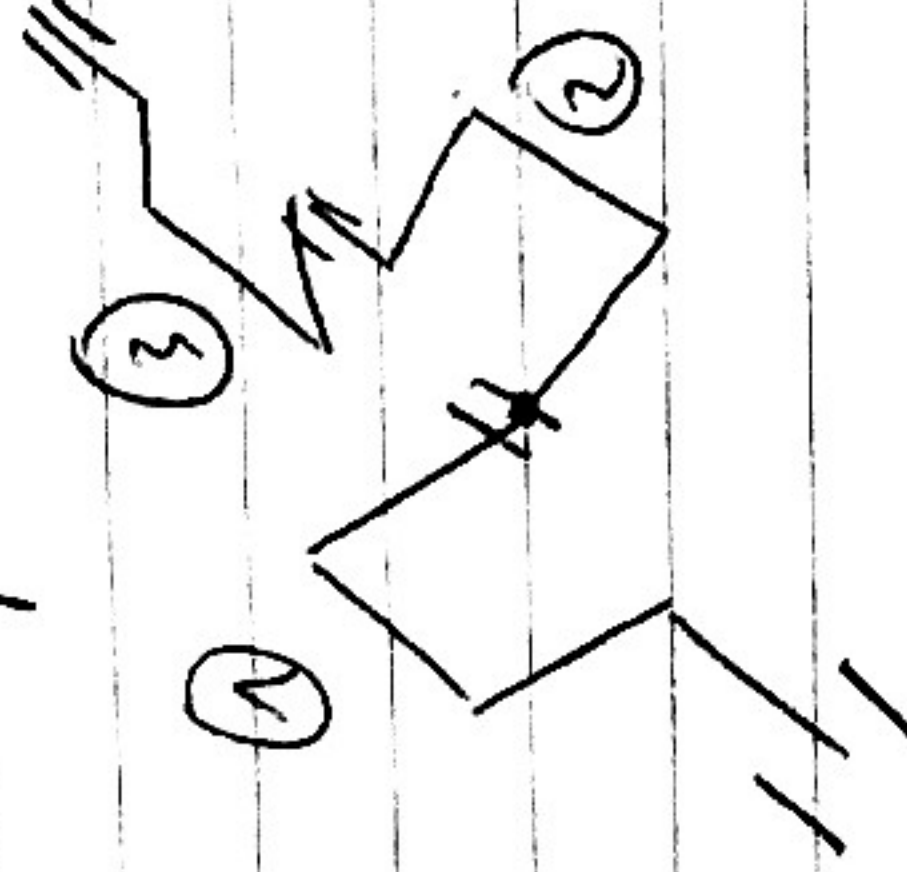
CONROD = 0,3 kg.

C. CONG = 150 mm

STROKE = 90 mm

R = 45 mm

bore sp. = 100 mm



$$2) M_{rec} = \frac{1}{3} \cdot 0,3 + P_{iston} = 0,34 \text{ kg}$$

$$M_{rot} = \frac{2}{3} \cdot C \cdot rod = \frac{2}{3} \cdot 0,3 = 0,2 \text{ kg}$$

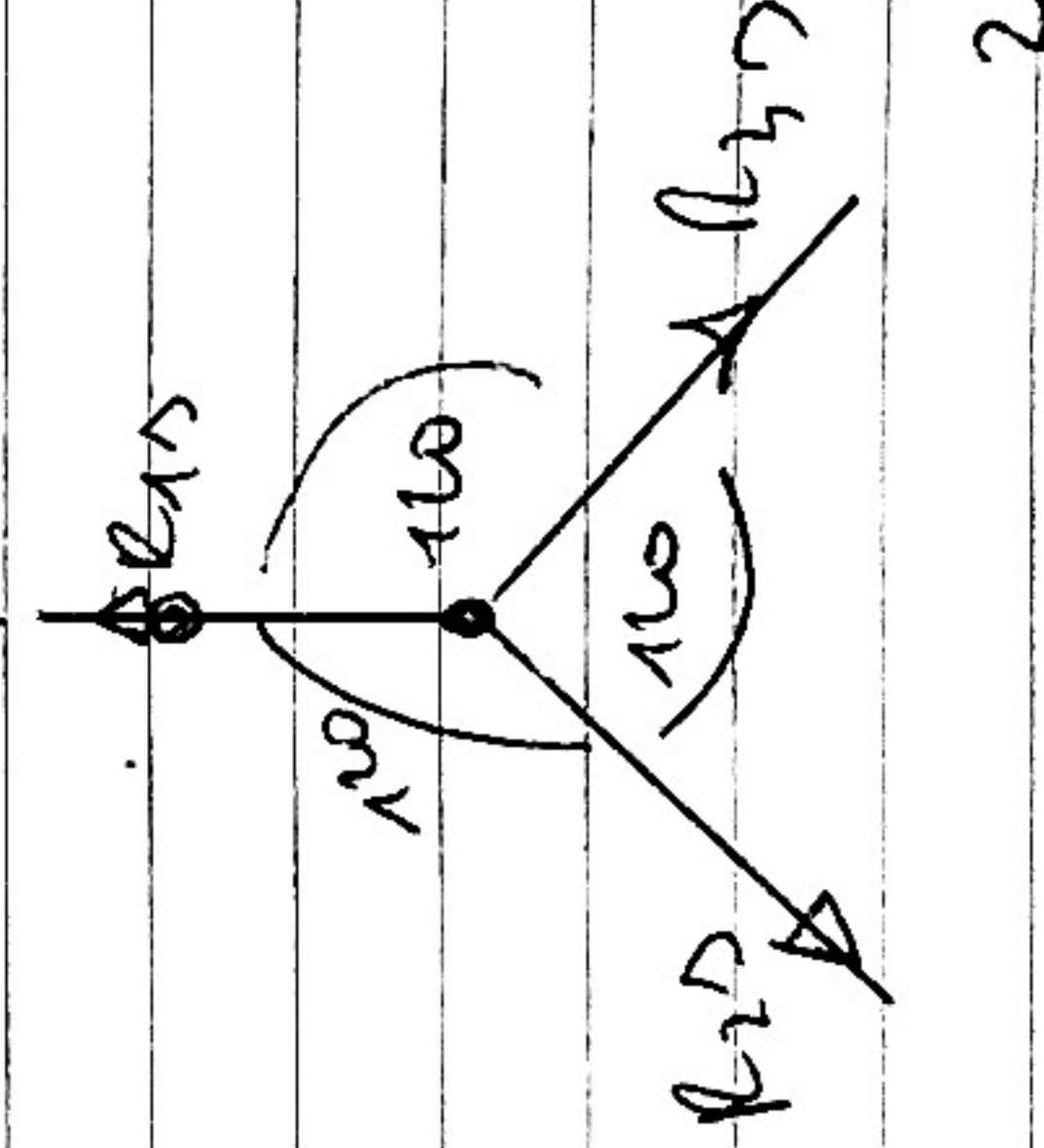
$$F_{resultant} \text{ 2ND order} = F_{3D} \cdot \cos 60 + F_{2D} \cdot \cos 60 = F_{1D}$$

$$= F_{1D} \Rightarrow \frac{1}{2}$$

$$= \frac{1}{2} \cdot \frac{45}{150} \cdot 0,34 \cdot 15 = 2,295 \text{ kg} \cdot \text{mm}$$

FORWARD. RESULTANT. 2ND. ORDER IS "0" BECAUSE THEY ARE
SINUSOIDAL.

b)

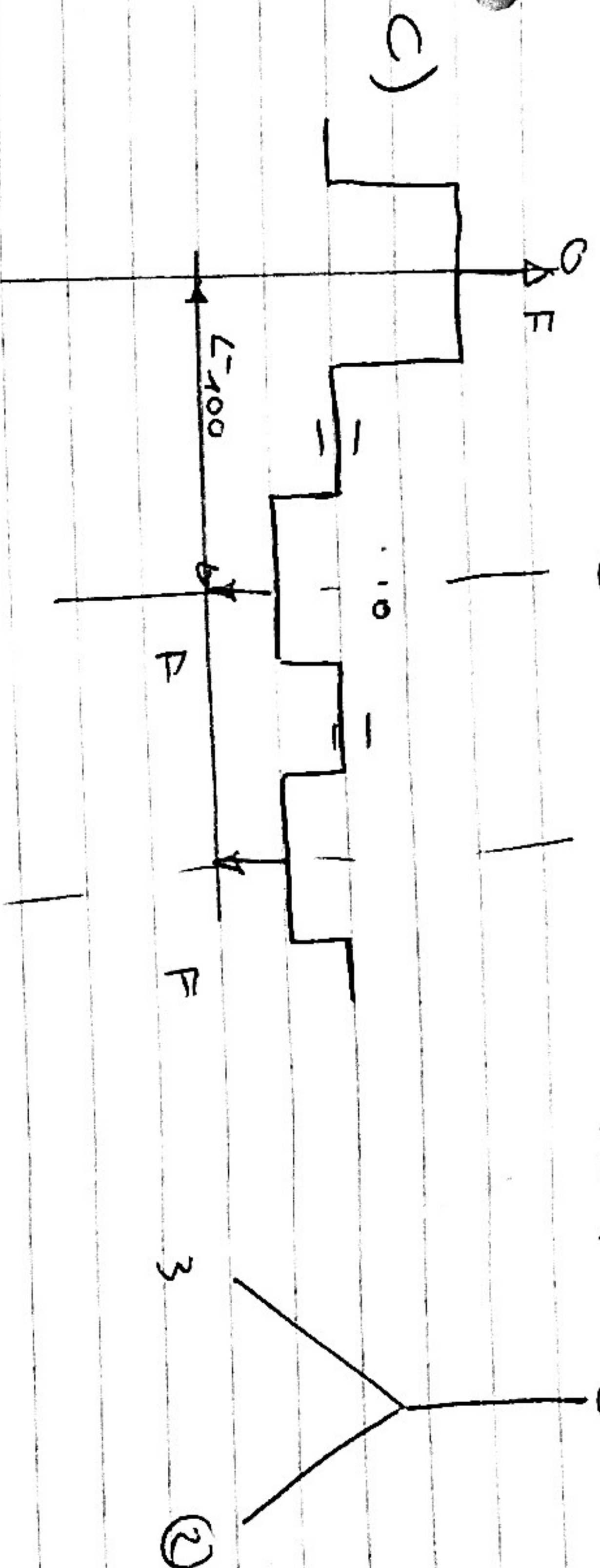


RESULTANT = 0

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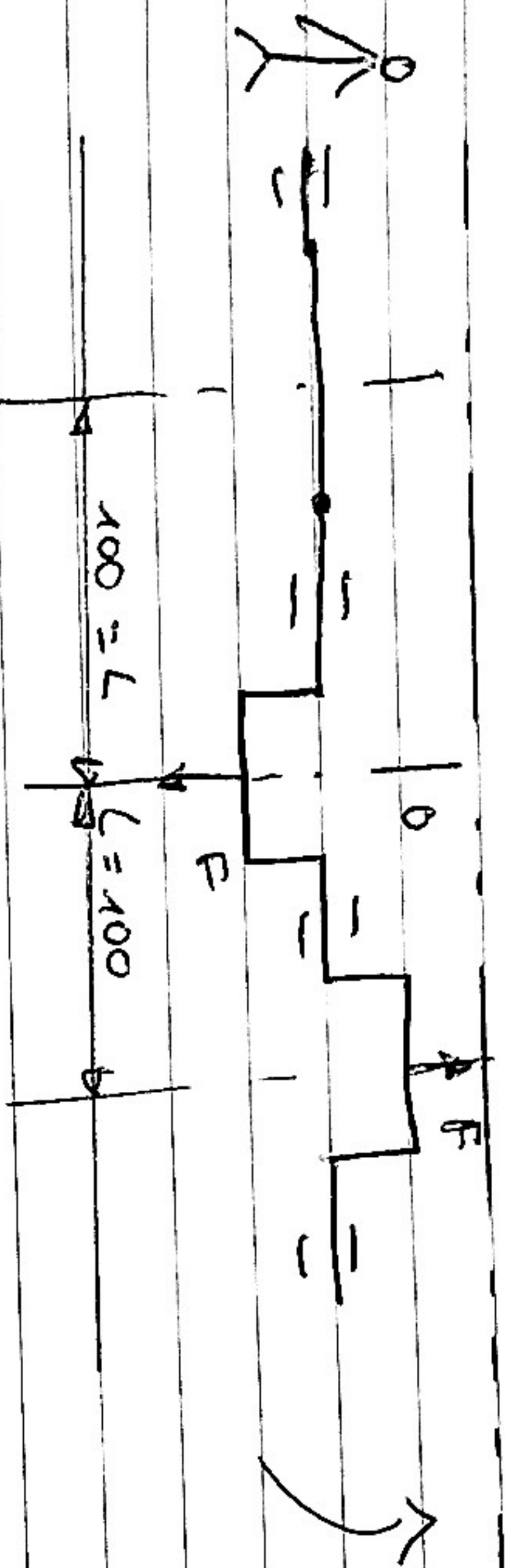
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$$M_{II} = F \cdot L + F \cos 60^\circ \cdot L$$

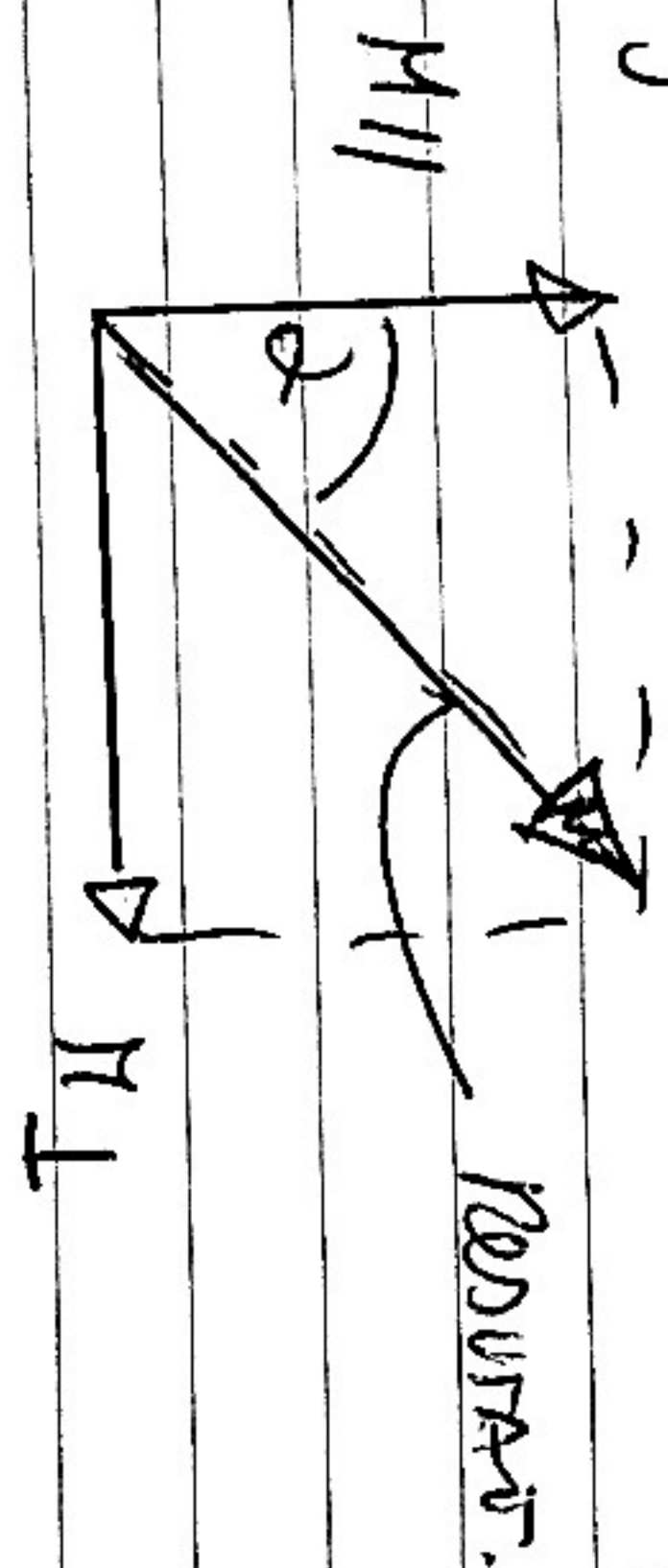
$$= F L \cdot \frac{3}{2} = 2995 \cdot (100) \cdot \frac{3}{2} = 344,25 \text{ kg} \cdot \text{mm} \cdot \text{mm}$$



$M_{II} = \text{perpendicular}$

$$\text{Anticlockwise} = F \cdot \cos(30^\circ) 100 = 2,295 \cdot \left(\frac{\sqrt{3}}{2}\right) \cdot 100 = 198,75 \text{ kg} \cdot \text{mm}$$

The M_{II} (perp) moves the. From of the char. right to the right. So follow following. Diagram



$$\alpha = \tan^{-1}(0,577)$$

$$\tan \alpha = \frac{M_{II_{\perp}}}{M_{II}} = \frac{198,75}{344,25} = 0,577 = \underline{\underline{30^\circ}}$$

All inline cylinder

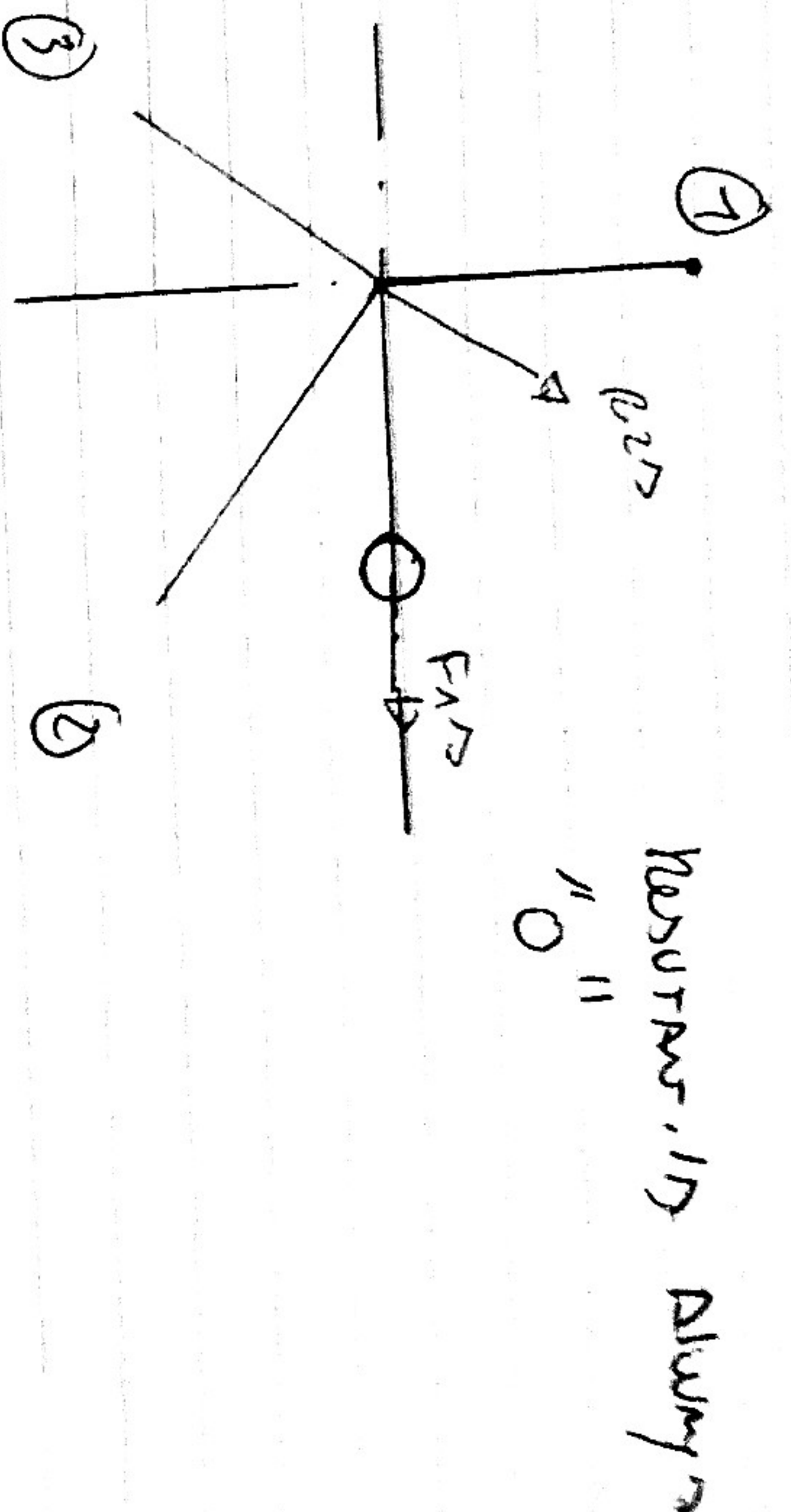
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e)



h) the overall ~~the~~ resultant moment of the second order rotate, as the pm rotate.