

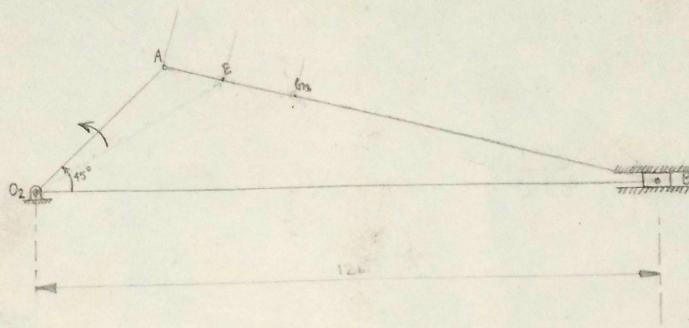
GIVEN DATA

$O_2A = 12\text{cm}$
 $AB = 34\text{cm}$
 $AE = 4\text{cm}$
 $AG_3 = 9\text{cm}$
 $\omega_{O_2A} = 120 \text{ rad/s}$ counterclockwise

PROBLEM NO.1

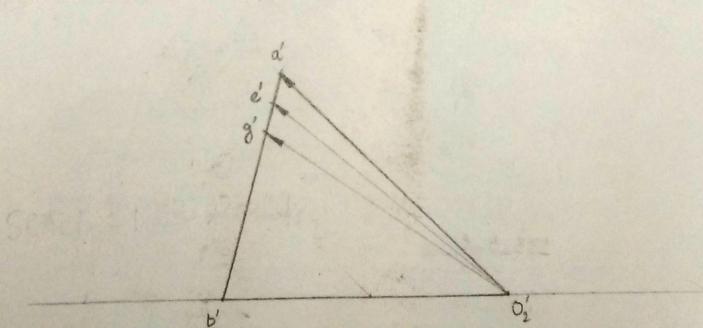
SPACE DIAGRAM

SCALE: $1\text{mm} = 0.291\text{mm}$



VELOCITY DIAGRAM

SCALE: $1\text{mm} = 240 \text{ mm/s}$



VELOCITY RELATION

$$\begin{aligned}
 \vec{V}_A &= 144 \text{ m/s} \\
 V_A &= 14400 \text{ mm/s} \\
 \vec{V}_{B/O_2} &= 13320 \text{ mm/s} \\
 V_{E/O_2} &= 13680 \text{ mm/s} \\
 \vec{V}_{B/A} &= 10560 \text{ mm/s} \\
 \omega_{BA} &= 31.05 \text{ rad/s} \\
 \vec{V}_{G_3/O_2} &= 13200 \text{ mm/s} \\
 V_{E/O_2} &= 12720 \text{ mm/s}
 \end{aligned}$$

VELOCITY RELATION

$$\begin{aligned}
 \vec{V}_A &= \vec{V}_{A/O_2} \\
 V_A &= \omega_{O_2A} \cdot O_2A = 14400 \text{ mm/s} \\
 \vec{V}_{B/A} &= \vec{V}_B - \vec{V}_A \\
 \vec{V}_B &= \vec{V}_A + \vec{V}_{B/A} \\
 \vec{V}_B &= \vec{V}_{B/O_2} \\
 \vec{V}_B &= 53 \times 240 = 13320 \text{ mm/s} \\
 \vec{V}_E &= 56 \times 240 = 13680 \text{ mm/s} \\
 \vec{V}_{G_3} &= 54 \times 240 = 13200 \text{ mm/s} \\
 \omega_{BA} &= \vec{V}_{B/A} \div AB \\
 &= \frac{10560}{340} = 31.05 \text{ rad/s}
 \end{aligned}$$

ACCELERATION DIAGRAM

SCALE: $1\text{mm} = 24600\text{mm/sec}^2$

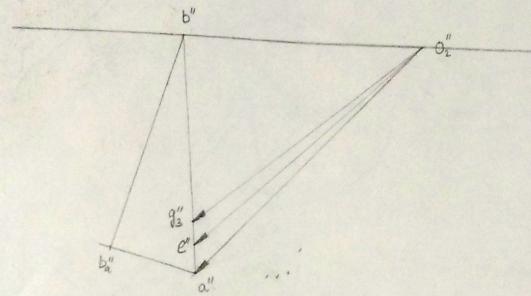
$$\bar{A}_{AB}^N = 327981\text{mm/sec}^2$$

$$A_{B/A_2} = 1254600\text{mm/sec}^2$$

$$\bar{A}_{A/A_2}^T = 1728000\text{mm/sec}^2$$

$$\alpha_{BA} = \frac{A_{BA}}{AB}$$

$$\alpha_{BA} = 3545.2 \text{ rad/sec}^2$$



ACCELERATION RELATION

$$\bar{A}_A = \bar{A}_A^N + \bar{A}_A^T \rightarrow 0$$

$$A_A = \omega_{BA}^2 \times R_{AB} \\ = 1728000\text{mm/sec}^2$$

$$\bar{A}_{B/A} = \bar{A}_{B/A}^T + \bar{A}_{B/A}^N$$

$$A_{B/A_2} = 51 \times 24600 \\ = 1254600\text{mm/sec}^2$$

$$\bar{A}_{A/B}^N = \frac{V_{AB}^2}{R_{AB}} = \frac{(44 \times 240)^2}{340} \\ = 327981\text{mm/sec}^2$$

$$A_E = 67 \times 24600 \\ = 1648200\text{mm/sec}^2$$

$$A_{B_3} = 63.5 \times 24600 \\ = 1562100\text{mm/sec}^2$$

$$\alpha_{B/A} = A_{B/A}/AB$$

$$= 3545.3 \text{ rad/sec}^2$$

[Anticlockwise]

$$= 67.5 \times 24600 \\ = 1648200\text{mm/sec}^2 \\ = 1562100\text{mm/sec}^2$$

RESULT TABLE

QUANTITY	MAGNITUDE	DIRECTION
\vec{v}_B	13320 mm/sec	$\angle 180^\circ$
\vec{v}_E	12720 mm/sec	$\angle 139^\circ$
\vec{v}_{G_3}	13200 mm/sec	$\angle 145^\circ$
ω_{BA}	31.05 rad/sec	\curvearrowright
\bar{A}_B	1254600 mm/sec^2	$\angle 180^\circ$
\bar{A}_E	1648200 mm/sec^2	$\angle 221^\circ$
\bar{A}_{B_3}	1562100 mm/sec^2	$\angle 216^\circ$
α_{BA}	3545.3 rad/sec^2	\curvearrowright

PROBLEM NO. 2

GIVEN DATA

$$OP = 8 \text{ cm}$$

$$PR = 18 \text{ cm}$$

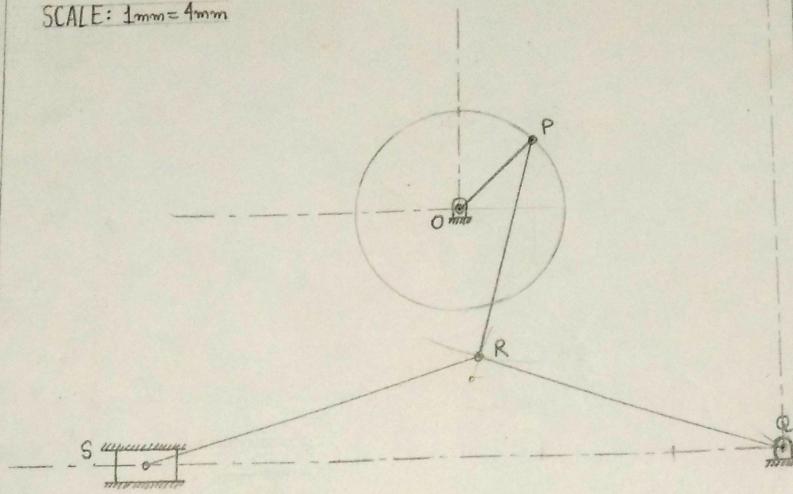
$$SR = 27 \text{ cm}$$

$$QR = 24 \text{ cm}$$

$$\omega_{op} = 120 \text{ rad/s}$$

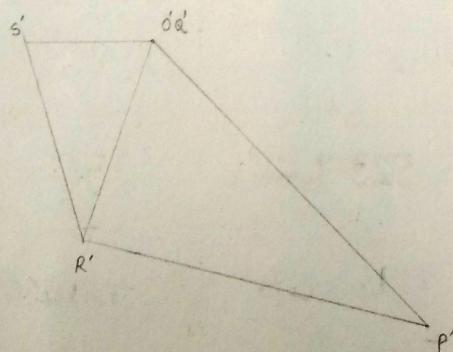
clockwise

SCALE: 1 mm = 4 mm



VELOCITY DIAGRAM

SCALE: 1 mm = 14.3 mm/s



VELOCITY RELATION

$$\begin{aligned}\vec{v}_P &= \vec{v}_{P/O} \\ &= \omega \times OP \times \text{scale} \\ &= 1005.3 \text{ mm/sec}\end{aligned}$$

$$\begin{aligned}\vec{v}_{R/P} &= \vec{v}_R - \vec{v}_P \\ \Rightarrow \vec{v}_R &= \vec{v}_{R/P} + \vec{v}_P\end{aligned}$$

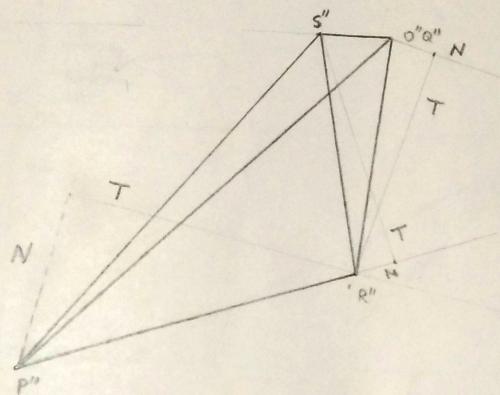
$$\begin{aligned}v_{R/O} &= O'R \times \text{Scale Factor} \\ &= 37.2 \times 14.36 \\ &= 534 \text{ mm/sec}\end{aligned}$$

$$\begin{aligned}v_S &= O'S \times \text{Scale Factor} \\ &= 23.5 \times 14.3 \\ &= 336 \text{ mm/sec}\end{aligned}$$

$$\begin{aligned}\omega_{SR} &= \frac{s'R' \times \text{Scale Factor}}{RS} \\ &= \frac{37 \times 14.36}{270} \\ &= 1.96 \text{ rad/s}\end{aligned}$$

ACCELERATION DIAGRAM

SCALE: $1\text{ mm} = 126.32 \text{ mm/sec}^2$



ACCELERATION RELATION

$$A_{plo} = \omega^2 \times OP \\ = 12632 \text{ mm/sec}^2$$

$$\bar{A}_{RP}^N = V_{RP}^2 / RP \\ = 4509 \text{ mm/sec}^2$$

$$\bar{A}_{RQ}^N = \frac{V_{RQ}^2}{RQ} \\ = 1166.4 \text{ mm/sec}^2$$

$$A_s = O''S'' \times \text{Scale} \\ = 1768.4 \text{ mm/sec}^2$$

$$A_R = O''R'' \times \text{scale} \\ = 6211.6 \text{ mm/sec}^2$$

$$\alpha_{SR} = \frac{O''S'' \times \text{scale}}{SR} \\ = 23.19 \text{ rad/sec}^2$$

RESULT TABLE

QUANTITY	MAGNITUDE	ANGLE
\vec{V}_s	333.8 mm/s	180°
\vec{V}_R	523.9 mm/s	250°
ω_{SR}	1.96 rad/s	CLOCKWISE \curvearrowright
\vec{A}_s	1833 mm/s^2	180°
\vec{A}_R	6211.6 mm/s^2	268°
α_{SR}	23.19 rad/sec ²	CLOCKWISE \curvearrowright

GIVEN

PROBLEM NO: 3

SPACE DIAGRAM

$$O_2 A = 13 \text{ mm}$$

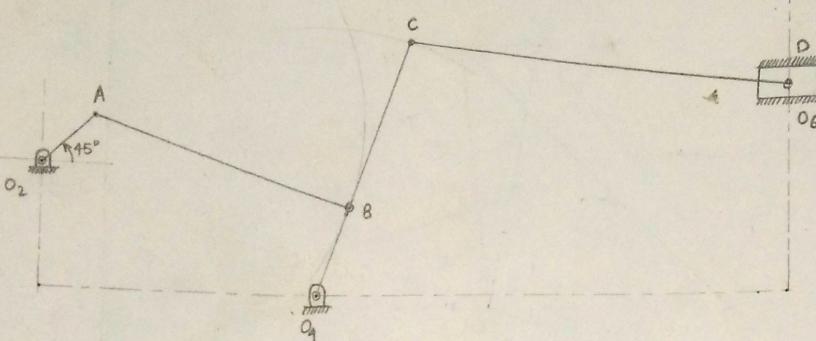
$$AB = 49 \text{ mm}$$

$$O_4 C = 50 \text{ mm}$$

$$CD = 70 \text{ mm}$$

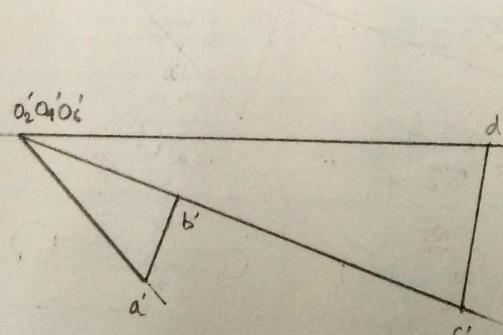
$$\omega_{O_2 A} = 30 \text{ rad/s}$$

(Clockwise)



VELOCITY DIAGRAM

SCALE: 1mm = 11.47 mm/s



VELOCITY RELATION

$$V_{A/O_2} = \omega_{O_2 A} \times O_2 A$$
$$= 30 \times 13$$
$$= 390 \text{ mm/s}$$

$$V_B = V_{B/O_4}$$
$$= O_4 b' \times \text{scale}$$
$$= 30 \times 11.47$$
$$= 344.1 \text{ mm/s}$$

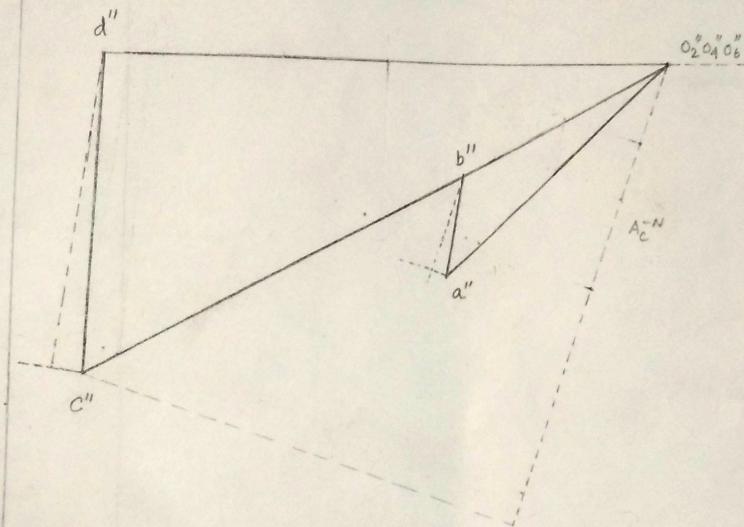
$$V_c = O_4 c' \times \text{scale}$$
$$= 8.3 \times 11.47 \times 10$$
$$= 952.0 \text{ mm/s}$$

$$\omega_{O_4 C} = \frac{V_c}{O_4 c'}$$
$$= \frac{952}{50} = 19.04 \text{ rad/s}$$

$$\omega_{DC} = \frac{V_{ac}}{DC}$$
$$= \frac{28 \times 11.47}{70}$$
$$= 4.58 \text{ rad/s}$$

ACCELERATION DIAGRAM

SCALE: $1\text{mm} = 195\text{mm/s}^2$



ACCELERATION RELATION

$$A_A = \omega_{A_03}^2 \times O_2 A \\ = 30^2 \times 13 \\ = 11700 \text{ mm/s}^2$$

$$\bar{A}_{BA}^N = \frac{V_{BA}^2}{BA} \\ = 604.1 \text{ mm/s}^2$$

$$\bar{A}_{B_04}^N = \frac{V_{B_04}^2}{B_04} \\ = 6578 \text{ mm/s}^2$$

$$\bar{A}_{C_04}^N = \frac{V_{C_04}^2}{C_04} \\ = 18126 \text{ mm/s}^2$$

$$\bar{A}_{DC}^N = \frac{V_{DC}^2}{DC} \\ = 994.22 \text{ mm/s}^2$$

$$A_B = O_4 b'' \times \text{scale} \\ = 23 \times 390 \\ = 8970 \text{ mm/s}^2$$

$$A_C = O_4 c'' \times \text{scale} \\ = 63 \times 390 \\ = 24570 \text{ mm/s}^2$$

RESULT TABLE

QUANTITY	MAGNITUDE	DIRECTION	
V_B	344.1 mm/s	341°	
V_C	952 mm/s	341°	$\alpha_{O_4 C} = \frac{A_{O_4 C}}{O_4 C}$
V_{D_04}	952 mm/s	0°	$= \frac{24570}{50}$
$\omega_{O_4 C}$	19.04 rad/s	C	$= 491.4 \text{ rad/s}^2$
ω_{DC}	4.58 rad/s	C	
A_B	8970 mm/s^2	209°	$\alpha_{D_04} = \frac{A_{D_04}}{D_04}$
A_C	24570 mm/s^2	209°	$= \frac{167.1}{50}$
A_D	21060 mm/s^2	180°	$= 167.1 \text{ rad/s}^2$
$\alpha_{O_4 C}$	491.4 rad/s^2	C	
α_{DC}	167.1 rad/s^2	C	

GIVEN

$$OA = 75 \text{ cm}$$

$$BD = 100 \text{ cm}$$

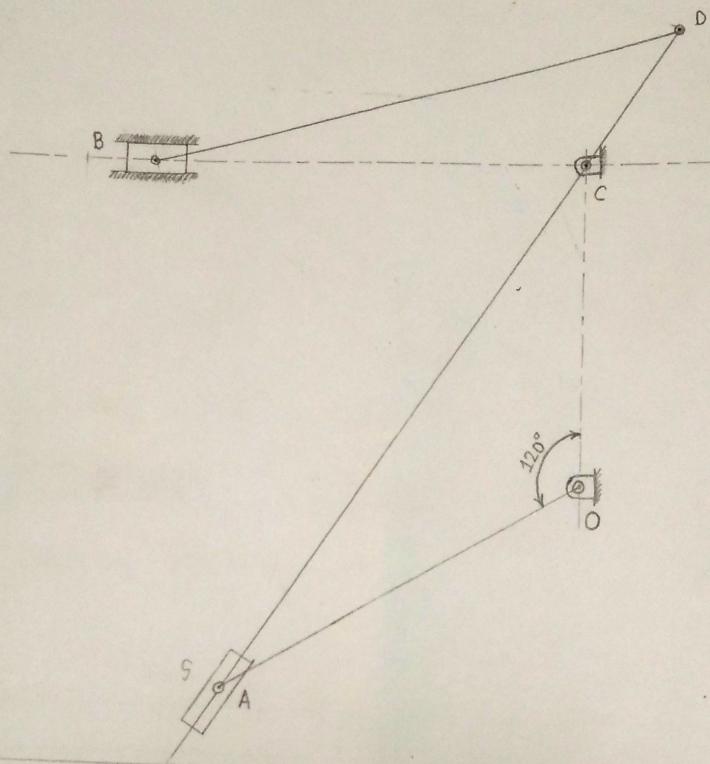
$$CD = 30 \text{ cm}$$

$$\omega_{OA} = 10\pi \text{ rad/s}$$

PROBLEM NO: 07

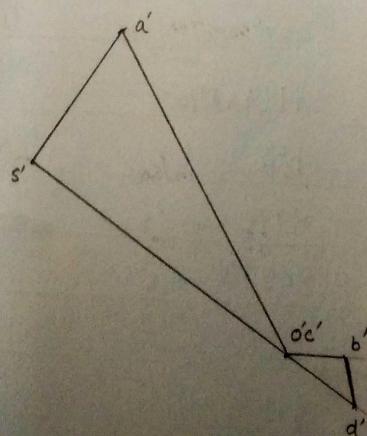
SPACE DIAGRAM

$$\text{SCALE: } 1 \text{ mm} = 10 \text{ mm}$$



VELOCITY DIAGRAM

$$\text{SCALE: } 1 \text{ mm} = 392.7 \text{ mm/s}$$



VELOCITY RELATION

$$V_A = V_{A/O}$$

$$= \omega_{OA} \times OA \times \text{Scale}$$

$$= 23562 \text{ mm/sec}$$

$$\vec{V}_A = \vec{V}_{SC} + \vec{V}_{AS}$$

$$\vec{V}_B = \vec{V}_{B/C}$$

$$= B'C' \times \text{Scale}$$

$$= 10 \times 392.7$$

$$= 3927 \text{ mm/sec}$$

$$\vec{V}_{BD} = \vec{V}_{B/D}$$

$$= B'D' \times \text{Scale}$$

$$= 8 \times 392.7$$

$$= 3141.6 \text{ mm/sec}$$

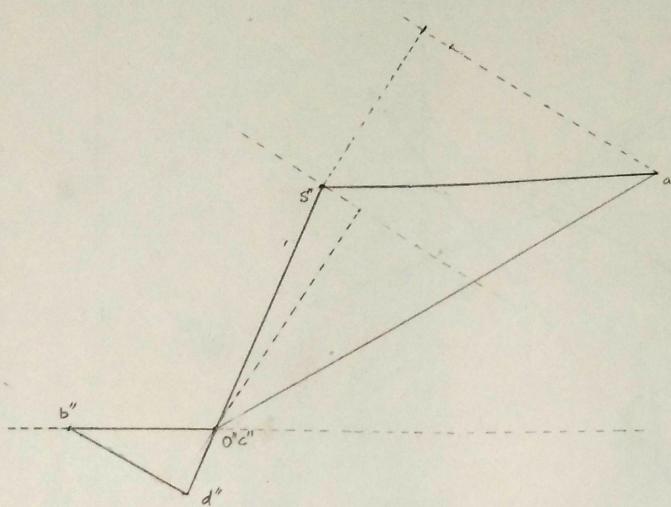
$$\omega_{BD} = \frac{\vec{V}_{BD}}{BD}$$

$$= \frac{3141.6}{1000}$$

$$= 3.141 \text{ rad/sec}$$

ACCELERATION DIAGRAM

SCALE: $1\text{ mm} = 7402.2\text{ mm/sec}^2$



ACCELERATION RELATION

$$A_A = \bar{A}_{OA}^N$$

$$\begin{aligned}\bar{A}_{OA}^N &= \omega_{02}^2 \times OA \\ &= (10\pi)^2 \times 750 \\ &= 740220\text{ mm/sec}^2\end{aligned}$$

$$O'a'' = 740220\text{ mm/sec}^2$$

$$\begin{aligned}c''b'' &= \frac{V_{BC}^2}{BC} \\ &= 192457.2\text{ mm/sec}^2\end{aligned}$$

$$\begin{aligned}\bar{A}_{SC}^N &= \frac{(SC)^2}{SC} \\ &= 384346.9\text{ mm/sec}^2\end{aligned}$$

$$\begin{aligned}\bar{A}_B^{CH} &= 2 \times \omega_{SC} \times V_{AB} \\ &= 384914.4\text{ mm/sec}^2\end{aligned}$$

$$\begin{aligned}c''d'' &= (c'd') \times \text{scale} \\ &= 103630.8\text{ mm/sec}^2\end{aligned}$$

QUANTITY	MAGNITUDE	DIRECTION
V_B	3927 mm/sec	0°
ω_{BD}	3.141 rad/sec	\curvearrowright
A_B	19260.52 mm/sec ²	180°
α_{BD}	117.65 rad/sec ²	\curvearrowleft

PROBLEM NO: 8

SPACE DIAGRAM

SCALE: $1\text{mm} = 10\text{mm}$

$$O_2B = 90\text{ cm}$$

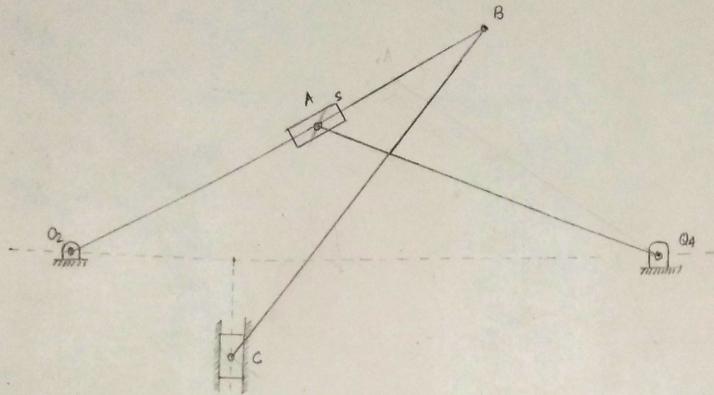
$$O_4A = 70\text{ cm}$$

$$BC = 80\text{ cm}$$

$$O_2O_4 = 110\text{ cm}$$

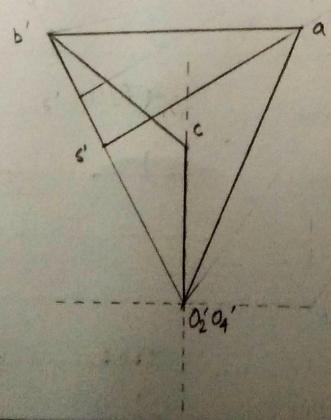
$$\omega_{O_2B} = 40\text{ rad/s}$$

(\circlearrowleft)



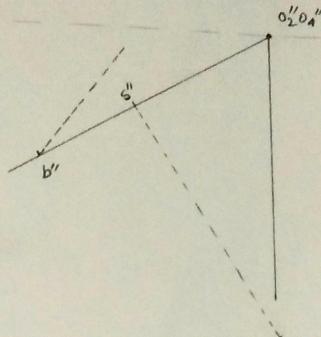
VELOCITY DIAGRAM

SCALE: $1\text{mm} = 720\text{ mm/sec}$



ACCELERATION DIAGRAM

SCALE: $1\text{mm} = 28800\text{mm/sec}^2$



RESULT TABLE

QUANTITY	MAGNITUDE	DIRECTION
V_c	18000 mm/sec	90°
ω_{cb}	27.9 rad/sec	1
A_c		
α_{cb}		