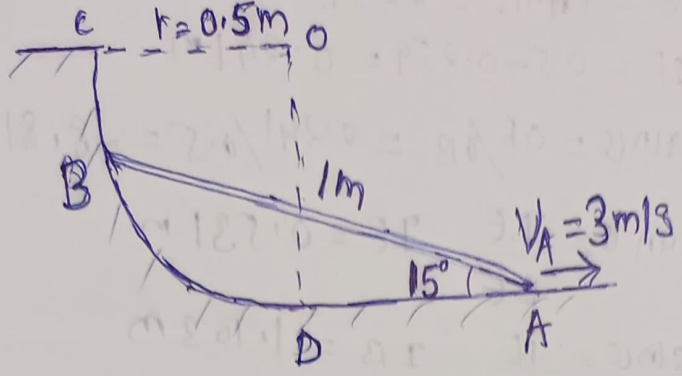
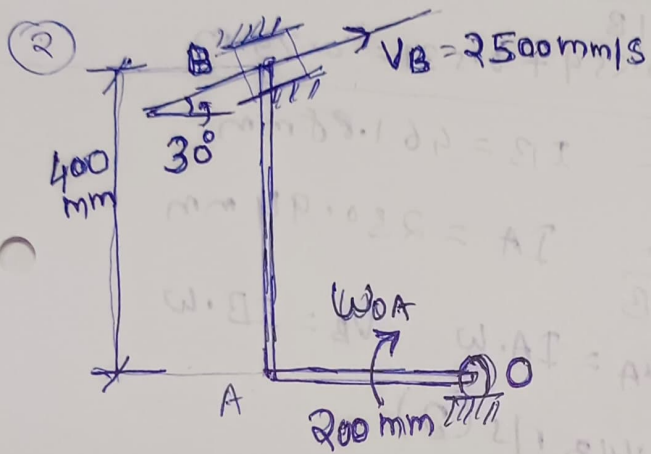
PRACTICE PROBLEMS ICR

(1)



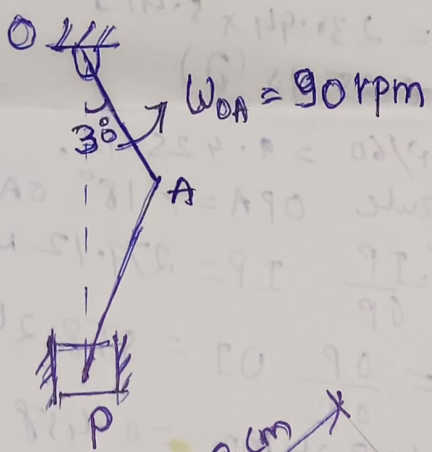
Find velocity of B for given position.

(2)



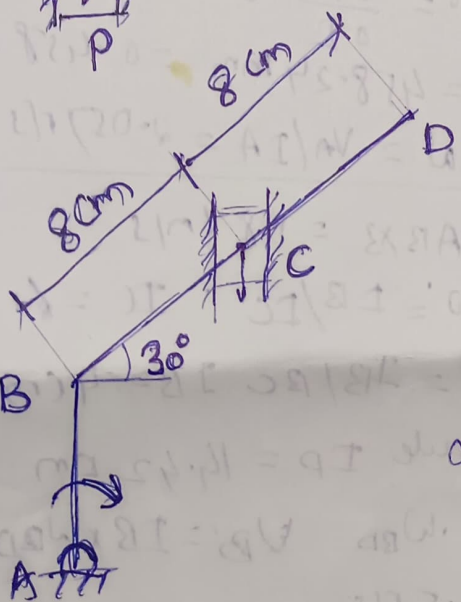
Locate ICR of link AB
Find angular velocity of link OA.

(3)

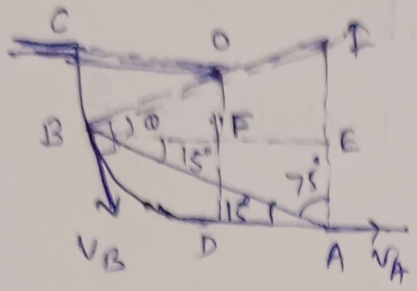


OA = 100mm
AP = 400 mm
Determine velocity of 'P'.

(4)



AB = 6 cm
BC = 8cm
CD = 8cm
ω_{AB} = 3r/s.
Find velocity of 'C' & 'D' & angular velocity of link BD. (ω_{BD})



$BE = 1\cos 15° = 0.966\,m$ $\quad AE = FD$

$AE = 1\sin 15° = 0.259$

$OF = 0.5 - 0.259 = 0.241\,m$

$\sin\theta = OF/OB = 0.241/0.5 = 28.816°$

$\tan\theta = \frac{IE}{BE}$ $\quad IE = 0.531\,m$

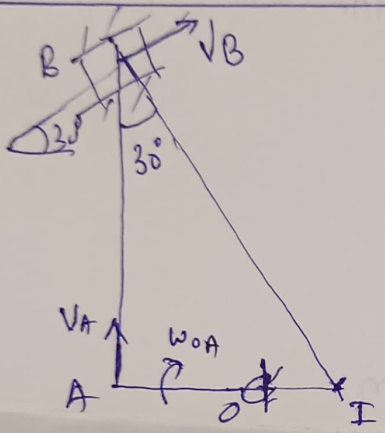
$\sin\theta = \frac{IE}{IB}$ $\quad IB = 1.103\,m$

$IA = 0.259 + 0.531 = 0.79\,m$

$\omega = \frac{V_A}{IA} = \frac{3}{0.79} = \frac{V_B}{1.103}$

$\omega = 3.796\,r/s$ ↺

$V_B = 4.187\,m/s$ ∠61.18°



$\cos 30° = \frac{AB}{IB}$ $\quad IB = 461.88\,mm$

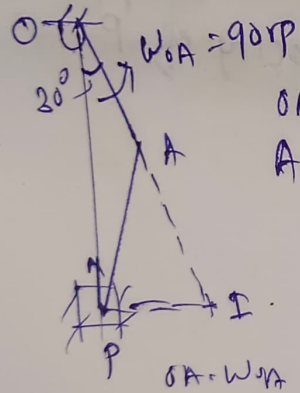
$\tan 30° = \frac{IA}{AB}$ $\quad IA = 230.94\,mm$

$V_A = OA \cdot \omega_{OA} = IA \cdot \omega \qquad V_B = IB \cdot \omega$

$\therefore \omega = 5.413\,r/s$ (↺)

$200 \cdot \omega_{OA} = 230.94 \times 5.413$

$\omega_{OA} = 6.25\,r/s$ (↺)



$OA = 100\,mm$

$AP = 400\,mm$

$\omega = 2\pi N/60 = 9.425\,r/s.$

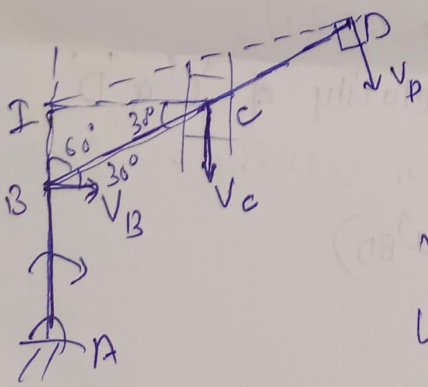
Sine Rule $\quad OPA = 7.18° \quad OAP = 142.82°$

$\tan 30° = \frac{IP}{OP}$ $\quad IP = 279.12\,mm$

$\cos 30° = \frac{OP}{OI}$ $\quad OI = 558.24\,mm$

$AI = 458.24\,mm = 0.458\,m$

$V_A = 0.1 \times 9.425 = 0.942\,m/s \qquad \omega = V_A/IA = 2.057\,r/s.$



$V_B = AB \times 3 = 18\,cm/s$

$\tan 30° = IB/IC \quad IC = 6.93\,cm$

$\cos 60 = IB/BC \quad IB = 4\,cm$

cosine rule $\quad ID = 14.42\,cm$

$V_C = IC \cdot \omega_{BD} \qquad V_B = IB \times \omega_{BD}$

$\omega_{BD} = 4.5\,r/s.$

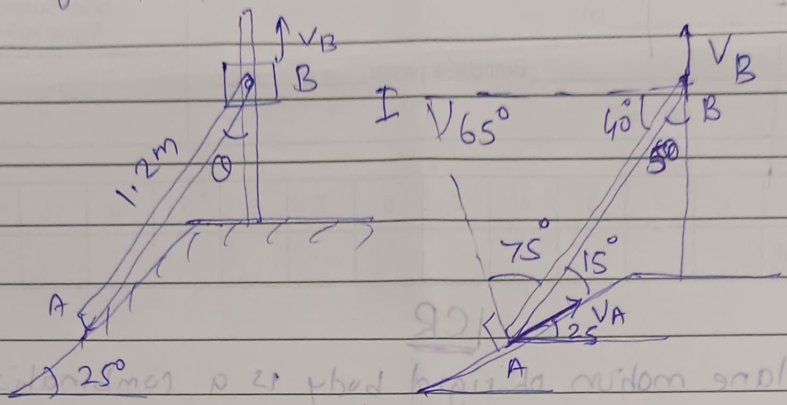
$V_C = 6.93 \times 4.5 = 31.18\,cm/s$

$ID \cdot \omega_{BD}$

$V_D = 14.42 \times 4.5$

$= 64.89\,cm/s$

(1) Fig shows collar B moves upward with constant vel. 1.5 m/s At instant when $\theta = 50°$ determine angular vel. of rod & vel. of end A.



$$\omega = \frac{V_A}{IA} = \frac{V_B}{IB}$$

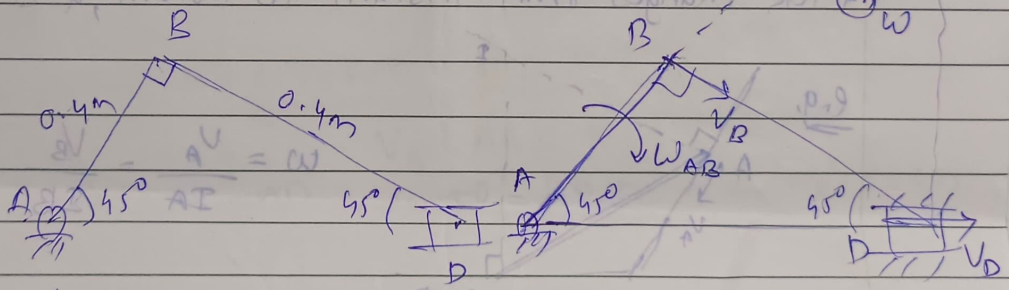
By Sine Rule $\frac{1.2}{\sin 65°} = \frac{IA}{\sin 40°} = \frac{IB}{\sin 75°}$

$IA = 0.851$ m $\quad IB = 1.279$ m

$$\omega = \frac{V_A}{0.851} = \frac{1.5}{1.279} = 1.173 \text{ rad/s} (\circlearrowleft)$$

$V_A = 0.998$ m/s $\quad \overset{V_A}{\rightarrow}$ 25°

(2) Given $V_D = 3$ m/s $\quad AB = BD = 0.4$ m



$V_B = AB \times \omega_{AB}$, $V_D = ID \times \omega$

$AD = \sqrt{(0.4)^2 + (0.4)^2} = 0.5659$ m

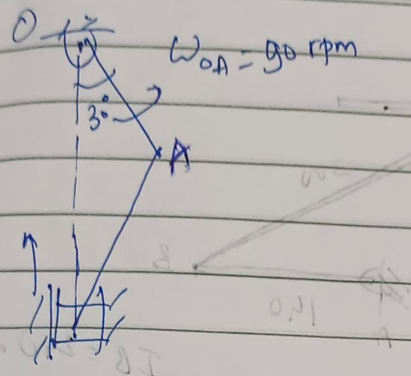
$\tan 45° = ID/AD \quad \therefore ID = 0.5659$ m

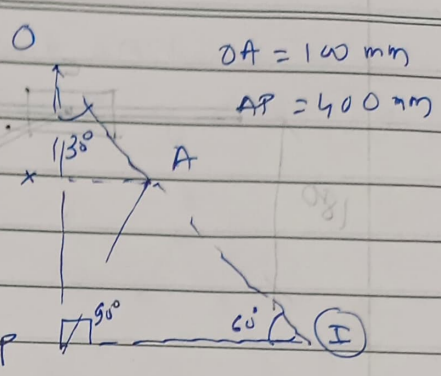
$3 = 0.5659 \times \omega \quad \therefore \omega = 5.3$ rad/s $(\circlearrowleft)$

$V_B = IB \times \omega = 0.4 \times 5.3 = 2.12$ m/s

$\omega_{AB} = 2.12/0.4 = 5.3$ rad/s $(\circlearrowleft)$

For crank & connecting rod mech. det. vel. of cross head P & angular vel. of rod AP Take OA = 100 mm AP = 400 mm





$\sin 90°$ $\quad V_A = OA \times \omega_{OA}$ 9.42

$= 100 \times$ ~~90 rpm~~

$V_A = 0.942$ m/s ~~$= 500 =$ mm/s.~~

$\sin 30 = \frac{AX}{OA}$

$\cos 30° = \frac{OX}{100} = OX = 86.6$ mm $\quad AX = 50$

$\sin\theta = \frac{50}{400} = \theta = 7.18°$ $\quad \cos 7.18 = \frac{XP}{AP}$

$XP = 396.86$ mm

$OP = 483.46$ mm

$\frac{OP}{\sin 60°} = \frac{IP}{\sin 30°} = \frac{IO}{\sin 90}$

$\frac{483.46}{\sin 60} = 558.25$ $\quad IP = 279.12$ mm

$IO = 558.25$ mm

$IA = 458.25$ mm.

$V_A = IA \times \omega_{AP}$

$0.942 = 0.458 \times \omega$

$\omega = 2.057$ r/s.

$\omega_{OA} = 90$ rpm

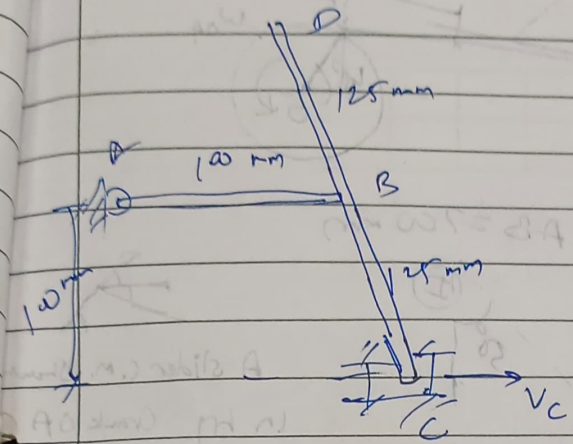
$\omega = \frac{2\pi N}{60}$

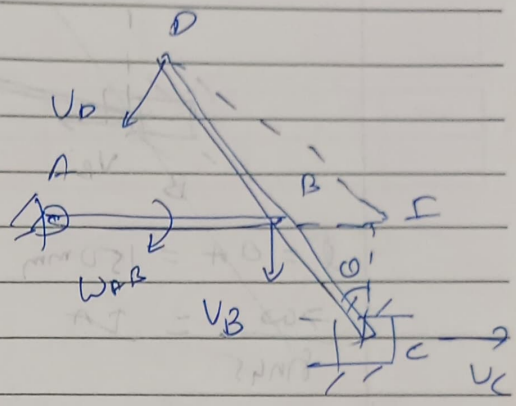
9.42 r/s.

$V_P = IP \times \omega_{AP} = 574.08$ mm/s.

$V_P = 0.574$ m/s.

(5) At position shown in fig crank AB has an angular vel. of 3 r/s clockwise. Find vel. of slider C & pt. D at this instant.





$V_B = AB \times W_{AB} = 0.1 \times 3 = 0.3$ m/s (↓)

$V_B = IB \times \omega$ $\quad V_C = IC \times \omega$.

$\cos\theta = \frac{IC}{BC} = \frac{100}{125} = 36.87°$ $\quad \tan\theta = \frac{IB}{BC}$

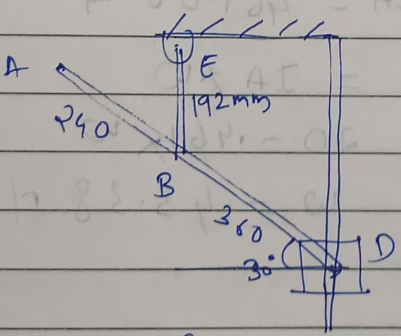
$IB = 75$ mm $\quad 0.075$ m

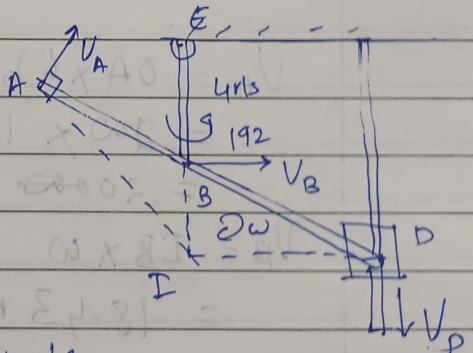
$ID^2 = IC^2 + CD^2 - 2(IC)(CD)\cos\theta$

$ID = 180.27 = 0.18$ m

$\omega = 4$ r/s. $\quad V_C = 0.4$ m/s $\quad V_D = 0.72$ m/s.

(6)* Rod EB in mechanism shown in fig. has ang. vel. of 4 r/s. at the instant under obs. in counter clockwise dirn. Cal 1) ang. vel. of rod AD. 2) Vel. of collar D & pt. A.





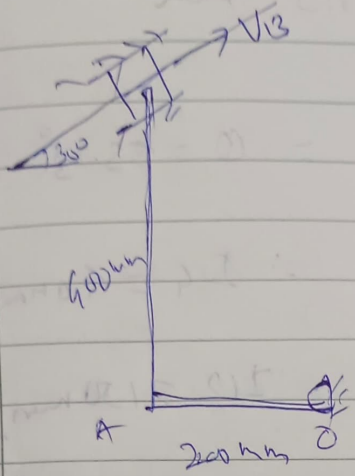
$V_B = EB \times W_{EB} = 192 \times 4 = 768$ mm/s.

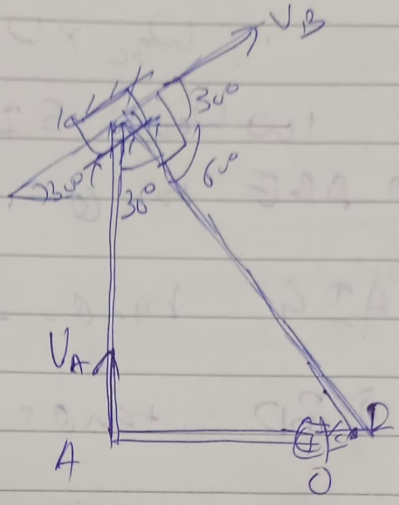
$\sin 30 = \frac{IB}{BD} = 180$mm $\quad \cos 30 = \frac{ID}{BD} = 311.76$mm

$768 = 180 \times \omega = 4.26$ r/s $\quad V_D = 311.76 \times 4.26 = 1330.21$ mm/s.

$IA = \sqrt{AD^2 + ID^2 - 2(AD)(ID)\cos 38}$ $\quad V_A = 1557.31$ mm/s.

For link & slider mechanism shown in fig. locate ICR of link AB. Find ang vel. of OA (link) vel. of slider at B = 2500 mm/s.





$V_B = IB \cdot \omega$ $\quad V_A = OA \times \omega_{OA}$

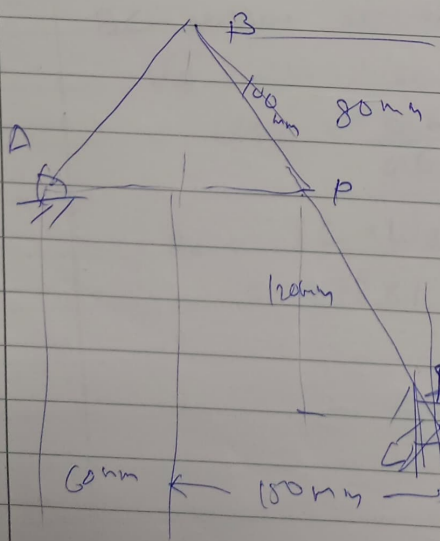
$\cos 30 = \frac{400}{IB}$ $\quad IB = 461.8$ mm.

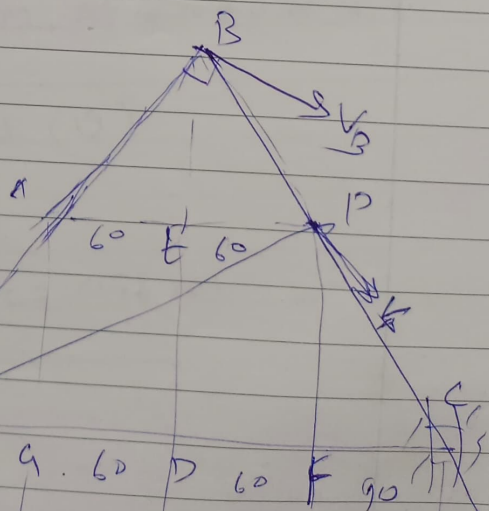
$\tan 30° = \frac{IA}{AB} = IA = 230.94$ mm.

$2500 = 461.8 \times \omega_{AB}$ $\quad \omega = 5.41$ r/s.

$200\,\omega_{OA} = IA \times \omega$ $\quad \omega_{OA} = 6.25$ r/s.

Bar BC shown in fig. has ang. vel. of 5 r/s (↻) when it is in position given. Det. ang. vel. of bar AB & also linear vel. of pt P on bar.





Candidate Roll No. _____ (In figures)

Name: _____ Test Exam.

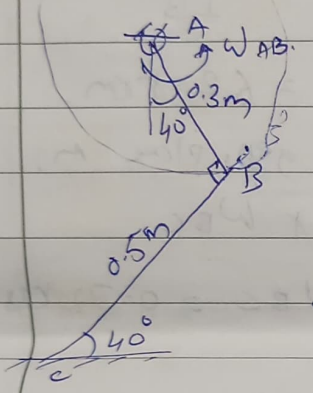
Date: _____ 20 | Junior Supervisor's full Signature with Date

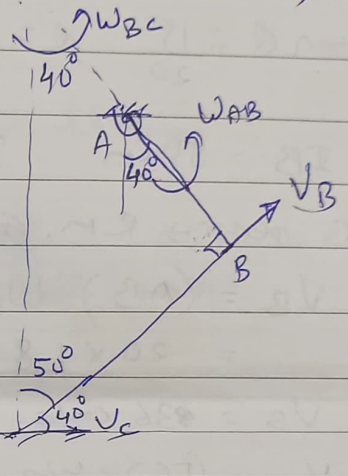
Examination: _____ Branch/Semester _____

Subject: _____

Question No.	1	2	3	4	5	6	7	8	9	10	11	12	Total
Marks Obtained													

(1) In fig. rod AB has ang. vel. 2 r/s counterclockwise. End C of rod BC is free to move on horz. surface. Det. i) ang. vel. of BC ii) vel. of C.





Using sine rule.

$$\frac{0.5}{\sin 40^\circ} = \frac{IB}{\sin 50^\circ} = \frac{IC}{\sin 90^\circ}$$

$IB = 0.6\ m$

$IC = 0.78\ m.$

AB performs rotational m. @ A

$\therefore V_B = (AB) \times \omega_{AB}.$ $\quad V_B = 0.6\ m/s.$

$= 0.3 \times 2$

BC performs general plan m. At given instant pt. I

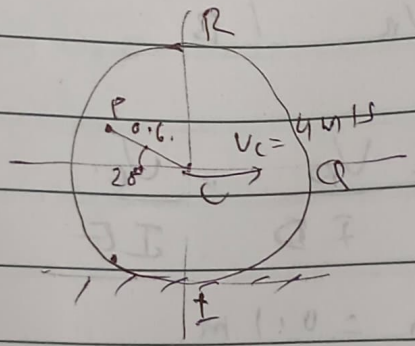
$V_B = IB \times \omega_{BC}$

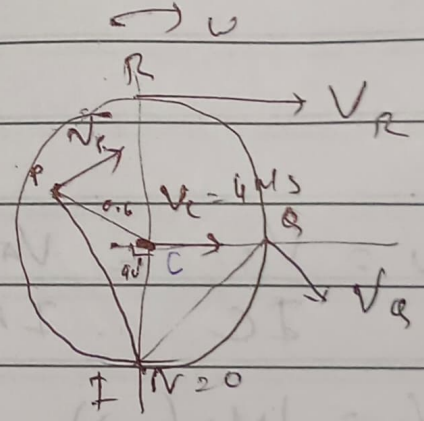
$\therefore \omega_{BC} = \frac{0.6}{0.6} = 1\ r/s.\ (\circlearrowleft)$

$V_C = IC \times \omega_{BC}$

$= 0.78 \times 1$ $\quad V_C = 0.78\ m/s$

(4) A wheel of 2m dia. rolls without slipping on flat surface. Centre of wheel is moving with vel. of 4 m/s towards right. Det. ang. vel. of wheel & vel. of P, Q & R shown on it.

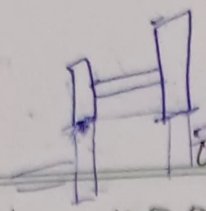




Let wheel rotate with ang. vel. ω To det. vel.s of P, Q & R join these pts to I.

$$\therefore \omega = \frac{V_C}{IC} = \frac{V_P}{IP} = \frac{V_Q}{IQ} = \frac{V_R}{IR}$$

$$\omega = \frac{4}{1} = \frac{V_P}{IP} = \frac{V_Q}{IQ} = \frac{V_R}{IR}$$



$\omega = 4$ rad/s (↻)

$V_P = 4IP = 4IR = 4Ig$ — (I)

Use geometry.

$IP = \sqrt{(IC)^2 + (CP)^2 - 2IC \cdot CP \cos 110°}$

$IP = 1.33$ m.

$IR = 2$ m.

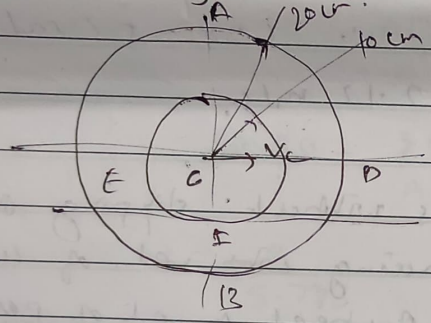
$Ig = \sqrt{(IC)^2 + (Cg)^2} = \sqrt{1^2 + 1^2} = 1.414$ m.

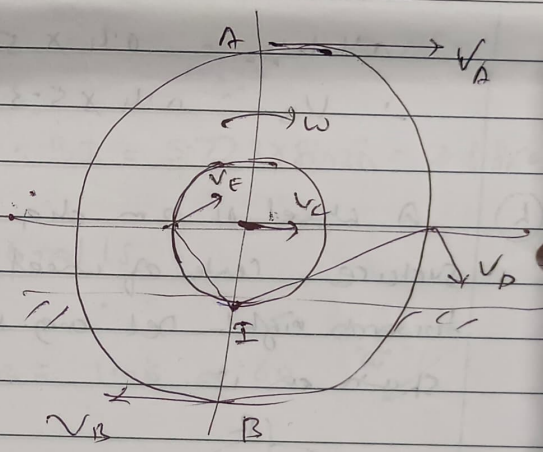
$\therefore V_P = 5.3224$ m/s ⊥ar to IP

$V_R = 8$ m/s →

$V_g = 5.656$ m/s ↘ 45° V_g

(5) A compound wheel rolls without slipping as shown. Det. vel. of pt A, B, D & E if rolling wheel C is having vel. 1 m/s.





$\omega = \frac{V_C}{IC} = \frac{V_A}{IA} = \frac{V_B}{IB} = \frac{V_D}{ID} = \frac{V_E}{IE}$ — (*).

$V_C = 1$ m/s (→) $IC = 10$ cm $= 0.1$ m.

$\omega = \frac{1}{0.1}$ $\omega = 10$ rad/s (↻)

$V_A = 10\,IA$ $V_B = 10\,IB$ $V_D = 10\,ID$

& $V_E = 10\,IE$

$IA = IC + CA = 30\,cm = 0.3\,m.$

$IB = BC - CI = 20 - 10 = 0.1\,m.$

$ID = \sqrt{(IC)^2 + (CD)^2} = \sqrt{10^2 + 20^2} = 22.36$

$= 0.233\,m$

$DE = \sqrt{IC^2 + CE^2} = \sqrt{10^2 + 10^2} = 14.14\,cm$

$= 0.141\,m.$

$V_A = 3\,m/s \rightarrow$

$V_B = 10 \times 0.1 = 1\,m/s \leftarrow$

$V_D = 10 \times 0.234 = 2.34\,m/s$ 1er to ID

$V_E = 10 \times 0.141 = 1.414\,m/s$ 1er to IE