1. Determine the angular velocity of link $OB$ if the piston has a velocity of 2 m/s to the right at the instant shown.
2. If the velocity of point $A$ is 3 m/s to the right, determine the velocity of point $B$ and angular velocity of the bar.
3. If the center $O$ of the gear is given a velocity of $v_o=10 \text{ m/s}$, determine the velocity of the slider block $B$ at the instant shown.
\[ \omega_{\text{gear}} = \frac{v_O}{OC} = \frac{10}{0.175} = 57.143 \text{ rad} / \text{s} \]

\[ v_A = \omega_{\text{gear}}(\overline{AC}) = 57.143(0.125 + 0.175) = 17.143 \text{ m} / \text{s} \]

\[ \frac{\overline{AP}}{\sin 30^\circ} = \frac{\overline{PB}}{\sin 120^\circ} = \frac{\overline{AB}}{\sin 30^\circ} \quad \Rightarrow \quad \overline{AP} = \overline{AB} = 0.6 \text{ m} \]

\[ \overline{PB} = 2(0.6) \cos 30^\circ = 1.039 \text{ m} \]

\[ \omega_{\text{AB}} = \frac{v_A}{\overline{AP}} = \frac{17.143}{0.6} = 28.57 \text{ rad} / \text{s} \]

\[ v_B = \omega_{\text{AB}}(\overline{PB}) = 29.69 \text{ m} / \text{s} \]
4. The flexible band $F$ is attached at $E$ to the rotating sector and leads over the guide pulley. Determine the angular velocities of $AD$ and $BD$ for the position shown if the band has a velocity of 4 m/s.
the band has a velocity of of 4 m/s

**Point O:** IC for member OAE (Absolute IC)
**Point B:** IC for link BD (Absolute IC)
**Point C:** IC for link AD (Relative IC)

\[
\omega_{oa} = \frac{4}{0.2} = 20 \text{ rad/s}
\]

\[
v_A = \omega_{oa} \overrightarrow{OA} = 20(0.125) = 2.5 \text{ m/s}
\]

\[
\omega_{ad} = \frac{v_A}{AC} = \frac{2.5}{0.2} = 12.5 \text{ rad/s}
\]

\[
v_D = \omega_{ad} \overrightarrow{CD} = 12.5(0.15) = 1.875 \text{ m/s}
\]

\[
\omega_{bd} = \frac{v_D}{BD} = \frac{1.875}{0.25} = 7.5 \text{ rad/s}
\]
The oil pumping unit consists of a walking beam $AB$, connecting rod $BC$, and crank $CD$. If the crank rotates at a constant rate of 6 rad/s (counterclockwise), determine the speed of the rod hanger $H$ at the instant shown. Also find the angular velocities of members $BC$ and $AB$.

\[ v_C = \omega_{CD} \overline{CD} = 6(0.9) = 5.4 \text{ m/s} \]

\[ \tan \alpha = \frac{0.45}{2.7} \Rightarrow \alpha = 9.46^\circ \ Quadrant \ II \overline{CP} = \frac{3}{\tan \alpha} = 18 \text{ m} \]

\[ \omega_{BC} = \frac{v_C}{\overline{CP}} = \frac{v_B}{BP} \Rightarrow \omega_{BC} = \frac{5.4}{18} = 0.3 \text{ rad/s} \]

\[ v_B = \omega_{BC} \overline{BP} = 0.3 \left( \frac{\sqrt{3^2 + 18^2}}{18.248} \right) = 5.474 \text{ m/s} \]

\[ \omega_{AB} = \frac{v_B}{EB} = \frac{5.474}{\sqrt{2.7^2 + 0.45^2}} = 2 \text{ rad/s} \]

\[ v_H = \omega_{AB} \overline{AE} = 2(2.7) = 5.4 \text{ m/s} \]
6. In relation to the elongation of the hydraulic piston $AC$, the velocity of point $A$ on the slider is $v = 1.25 \text{ m/s}$ for the instant when $\theta = 36.87^\circ$. At this moment $BD$ is horizontal and $DE$ is vertical. Determine the angular velocities of arms $BD$ and $DE$ and the hydraulic piston $AC$ for this instant.

\[ v_r = 1.25 \sin \theta = 0.75 \text{ m/s} \]
\[ v_\theta = 1.25 \cos \theta = 1 \text{ m/s} \]

\[
\omega_{BC} = \frac{1}{AC} = \frac{1}{0.25} = 4 \text{ rad/s}
\]
\( \omega_{BC} = 4 \text{ rad/s} \)
\[ v_B = \omega_{BC} \overline{BC} = 4(0.125) = 0.5 \text{ m/s} \]

\[ \omega_{BD} = \frac{v_B}{BP} = \frac{v_D}{DP} \]

\[ \overline{BP} = 250 \text{ mm} \quad \overline{DP} = 200 \text{ mm} \]

\[ \omega_{BD} = \frac{0.5}{0.25} = 2 \text{ rad/s} \]

\[ v_D = \omega_{BD} \overline{DP} = 2(0.2) = 0.4 \text{ m/s} \]

\[ \omega_{DE} = \frac{v_D}{DE} = \frac{0.4}{0.1} = 4 \text{ rad/s} \]
7. Motion of the roller A against its restraining spring is controlled by the downward motion of the plunger E. For an interval of motion the velocity of E is \( v = 0.2 \, \text{m/s} \). Determine the velocity of A when \( \theta \) becomes 90°.
\[ \tan \alpha = \frac{60}{160} \implies \alpha = 20.56^\circ \]

\[ \beta = 90 - (\alpha + 36.87) = 32.57^\circ \]

\[ v_D = \frac{v}{\cos \beta} = \frac{0.2}{\cos 32.57^\circ} = 0.237 \text{ m/s} \]

\[ \overline{DP} = \sqrt{160^2 + 60^2} = 170.88 \text{ mm} \]

\[ \omega_{DBA} = v_D \frac{DP}{0.17088} = 1.386 \text{ rad/s} \]

\[ v_A = \omega_{DBA} \overline{AP} = 1.386(0.2) = 0.277 \text{ m/s} \]
8. A device which tests the resistance to wear of two materials $A$ and $B$ is shown. If the link $EO$ has a velocity of 1.2 m/s to the right when $\theta = 45^\circ$, determine the rubbing velocity $v_A$. 

![Diagram of the testing device]

The diagram shows a mechanism with links and angles indicating the movement and distances involved in the wear test.
\[ \omega_{DOA} = \frac{v_O}{PO} = \frac{1.2}{0.1156} = 10.38 \text{ rad/s} \]

\[ v_A = \omega_{DOA} \overline{PA} = 10.38(0.1156 + 0.15) = 2.76 \text{ m/s} \]