1. Points $A$ and $B$ are attached to the ends of the link shown in the figure. The link rotates with angular velocity $\omega$ as shown. Draw the vector $\mathbf{\omega} \times \mathbf{r}_{B/A}$.

\[ \omega = 2 \text{ rad/s} \]
\[ \overline{AB} = 2 \text{ in.} \]

![Diagram of point A and B with vectors](image)

2. Points $A$ and $B$ are attached to the ends of the link shown in the figure. The link rotates with angular velocity $\omega$ as shown. Draw the vector $\mathbf{\omega} \times (\mathbf{\omega} \times \mathbf{r}_{B/A})$.

\[ \omega = 2 \text{ rad/s} \]
\[ \overline{AB} = 2 \text{ in.} \]

![Diagram of point A and B with vectors](image)

3. Points $A$ and $B$ are attached to the ends of the link shown in the figure. The vector $\mathbf{\phi} \times \mathbf{r}_{B/A}$ is also shown. What is the angular acceleration $\mathbf{\phi}$ of the link?

\[ \mathbf{\phi} = \text{rad/s}^2 \]
\[ \text{CCW or CW?} \]

![Diagram of point A and B with vectors](image)
4. Points $A$ and $B$ are attached to the ends of the link shown in the figure. Their accelerations $\mathbf{a}_A$ and $\mathbf{a}_B$ are also shown in the figure. Complete the acceleration diagram and determine the angular acceleration $\dot{\omega}$ of the link?

\[\dot{\omega} = \text{ rad/s}^2 \quad \text{CCW or CW?}\]

5. Slider B moves toward A with a speed of $1 \text{ in./s}$. At the same time Link 2 rotates with angular velocity of $\omega_2 = 2 \text{ rad/s CCW}$. Draw the Coriolis acceleration of $B$ with respect to an observer at $A$.

6. Slider B moves toward A with constant speed of $1 \text{ in./s}$. At the same time Link 2 rotates with constant angular velocity of $\omega_2 = 2 \text{ rad/s CCW}$. Draw the acceleration of $B$. 

\[\omega_2 = 2 \text{ rad/s} \quad \text{B} \quad v_{B/A} = 1 \text{ in./s}\]
7. An observer is attached to Link 2 at A, as shown in the figure. The velocity \( \mathbf{v}_B \) of B is given. Complete the velocity diagram associated with the equation \( \mathbf{v}_B = \mathbf{v}_A + \mathbf{v}_{B/A} + \omega_2 \times \mathbf{r}_{B/A} \).

8. An observer is attached to Link 2 at A, as shown in the figure. Complete the acceleration diagram associated with the equation
\[
\mathbf{a}_B = \mathbf{a}_A + \mathbf{a}_{B/A} + \omega_2 \times (\omega_2 \times \mathbf{r}_{B/A}) + 2\omega_2 \times \mathbf{v}_{B/A} + \ddot{\omega}_2 \times \mathbf{r}_{B/A}
\]

9. Disk 2, of radius \( R = 1 \text{ in.} \), rolls on the ground without slip. Point A moves with constant velocity \( v_A = 2 \text{ in./s} \), as shown in the figure. Point B, on disk 2, is the instantaneous point of contact between disk 2 and the ground. Draw the acceleration of point B.
10. Disk 2, of radius $R = 1$ in., rolls on the ground without slip. Point $A$ moves with constant velocity $v_A = 2$ in./s, as shown in the figure. Draw the acceleration of point $B$.\[\text{Scale}\ 1\text{ in. } \frac{1}{s^2}\]

11. Disk 3, with center $B$, rolls on Link 2 without slip. What is the direction of the acceleration of point $B$ with respect to an observer at $A$, which is attached to Link 2?

(a) In the direction parallel to $\overline{AB}$

(b) In the direction perpendicular to $\overline{AB}$

(c) In the direction parallel to Link 2

(d) In the direction perpendicular to Link 2

(e) At infinity, perpendicular to the ground

Circle your answer

12. Points A and B are attached to a rigid body. Which one of the following cases is impossible?

\textbf{Answer:} Case \underline{___________}
13. Link 2 rotates with angular velocity $\omega_2 = 1 \text{ rad/s}$ as shown in the figure. Slider 3 slides on link 4. Draw a velocity diagram for pin $A$ and determine form it the angular velocity of link 4.

14. Link 2 rotates with constant angular velocity $\omega_2 = 1 \text{ rad/s}$ as shown in the figure. Slider 3 slides on link 4. Draw an acceleration diagram for pin $A$ and determine form it the angular acceleration of link 4. (You may use some of the quantities obtained in Question 13)
15. Disk 4 rolls on the ground without slip. Complete the velocity diagram associated with the equation $\mathbf{v}_B = \mathbf{v}_A + \mathbf{v}_{B/A} + \mathbf{r}_{B/A} \times \mathbf{\omega}$, and determine $\omega_3$ from it.

16. Disk 4 rolls on the ground without slip. Draw the velocity diagram associated with the equation $\mathbf{v}_B = \mathbf{v}_A + \mathbf{v}_{B/A} + \mathbf{r}_{B/A} \times \mathbf{\omega}$, and determine $\omega_4$ from it.
17. Disk 3 rolls on the ground with no slip. Point $B$ on disk 3 moves to the right with velocity $\mathbf{v}_B = 2$ in./s. Complete the velocity diagram expressing the velocity of $B$ with respect to an observer at $A$, which is attached to link 2, and determine the angular velocity $\omega_2$ of link 2.

18. Disk 3 rolls on the ground with no slip. Point $B$ on disk 3 moves to the right with \textbf{constant} velocity $\mathbf{v}_B = 2$ in./s. Draw the acceleration diagram expressing the acceleration of $B$ with respect to an observer at $A$, which is attached to link 2, and determine the angular acceleration $\dot{\omega}_2$ of link 2. (You may use some of the quantities obtained in Question 17)
19. Slider 2 slides on the ground with velocity $v_A = 2\text{ in./s}$. Slider 4 slides on link 3. Complete the velocity diagram expressing the velocity of $B$ with respect to an observer at $A$, which is attached to link 3, and determine the angular velocity $\omega_4$ of link 4.

![Velocity Diagram](image1.png)

20. Slider 4 slides on link 2. Slider 5 slides on link 3. Pin $C$ connects slider 4 to slider 5. The angular velocities of links 2 and 3 are shown in the figure. By using velocity diagram, determine the velocity $v_C$ of pin $C$.

![Velocity Diagram](image2.png)
Bonus Question 21

21. The velocity $v_P$ of point $P$ in the pantograph is shown in the figure below. By using velocity diagram determine the velocity $v_B$ of point $B$.

**Dimensions:** Links 2, 3, and 4 are 1.5 in. long.
Link 5 is 4 in. long.

$\mathbf{v}_P = 10 \text{ in./s}$
Bonus Question 22

22. A rigid body $\mathcal{R}$ with two points, $A$ and $B$, attached to it, are shown in the figure. The accelerations of $A$ and $B$ are also shown. Draw the point $C$ on $\mathcal{R}$ which has zero acceleration.