Chosen problems and their final solutions of Chap. 1 (Waldron)

1. The drawings shown below are pictorial representations of real mechanisms that are commonly encountered. Make a freehand sketch of the kinematic schematic representation of each mechanism.

Sol:

2. Calculate the mobility, or number of degrees of freedom, of each of the mechanisms in Problem 1.
Sol: (a) 1, (b) 1, (c) 1.
3. What is the number of members, number of joints, and mobility of each of the planar linkages shown below?

Sol: (a) $m = 1$, (b) $m = 0$, (c) $m = 1$.

4. What are the number of members, number of joints, and mobility of each of the planar linkages shown below?

Sol: (a) $m = 1$, (b) $m = 2$, (c) $m = 1$.

5. Determine the mobility of each of the planar linkages shown below.

Sol: (a) $m = 0$, (b) $m = 0$, (c) $m = 3$.

6. Determine the mobility of freedom associated with the mechanism.

Sol: $m = 1$. 
7. Determine the mobility of each of the planar linkages shown below. Show the equations used to determine your answers.

Sol: (a) \( m = 2 \), (b) \( m = 2 \).

8. Determine the mobility of each of the planar linkages shown below. Show the equations used to determine your answers.

Sol: (a) \( m = 3 \), (b) \( m = 0 \), (c) \( m = 1 \).

9. Determine the mobility of freedom of each of the planar linkages shown below. Show the equations used to determine your answers.

Sol: (a) \( m = 1 \), (b) \( m = 0 \), (c) \( m = 3 \).
10. Determine the mobility of each of the planar linkages shown below. Show the equations used to determine your answers.

Sol: (a) $m = 3$, (b) $m = 5$, (c) $m = 1$.

11. If position information is available for all points in the planar linkage shown below, can all of the velocities be determined uniquely if the value of $\omega$ is given?

Sol: No.

12. Determine the mobility associated with the mechanism below. The round part rolls without slipping on the pieces in contact with it.

Sol: $m = 1$. 
13. Determine the mobility for each of the mechanisms shown. Show the equations used to determine your answers.

Sol: (a) \( m = 5 \), (b) \( m = 2 \), (c) \( m = 1 \).

14. Determine the mobility for each of the mechanisms shown. Show the equations used when determining your answers.

Sol: (a) \( m = 2 \), (b) \( m = 2 \).

15. Determine the mobility associated with the mechanism below. The figure is a schematic of the entire linkage for a large power shovel used in strip mining. It can cut into a bank 20 m high and can dump to a height of 14.5 m. Link 7 is connected to link 8 with a revolute joint.

Sol. \( m = 3 \).
16. In the figure is a portion of the support mechanism for the dipper on a large earth-moving machine used in removing overburden in strip mining operations. The fixed centers for the portion of the mechanism really move, but useful information can be obtained by observing the dipper motion relative to the "frame" as shown in the sketch. Both links 4 and 5 are mounted at \( O_4 \). Links 4 and 6 are parallel and of equal length. The dipper is moved by a hydraulic cylinder driving crank 5 about its fixed cylinder. Determine the number of degrees of freedom of the mechanism.

Sol: \( m = 1 \).

17. Determine the mobility of each mechanism shown below. Show the equations used to determine your answers.

Sol: (a) \( m = 1 \), (b) \( m = 1 \), (c) \( m = 2 \), (d) \( m = 4 \), (e) \( m = 3 \).
18. Determine which (if either) of the following linkages can be driven by a constant-velocity motor. For the linkage(s) that can be driven by the motor, indicate the driver link.

Sol: (a) Yes, if the 2" link is the driver, it is a crank-rocker mechanism. (b) Yes, if the 2" link is the driver, it is a crank-rocker mechanism.

19. For the four-bar linkages below, indicate whether they are crank-rocker, double-crank, or double-rocker mechanisms, if the shortest link (disregarding the fixed link) is the driver.

Sol: (a) crank-rocker mechanism, (b) double-rocker mechanism, (c) double-crank mechanism.

20. You are given a set of three links with lengths 2.4 in, 7.2 in, and 3.4 in. Determine the range of the length of the fixed link such that it is a crank-rocker mechanism.

Sol: 6.2 in < r₁ < 8.2 in.