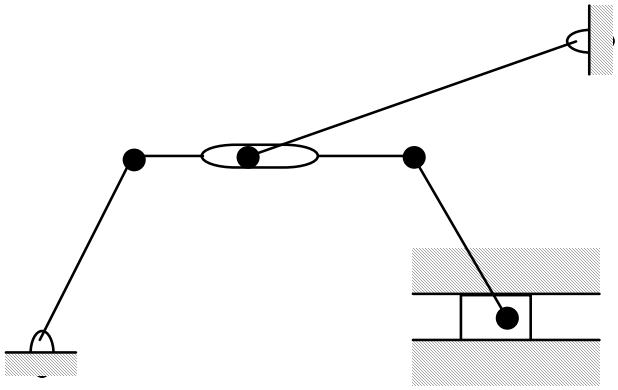
1. How many degrees of freedom does the following mechanism have?

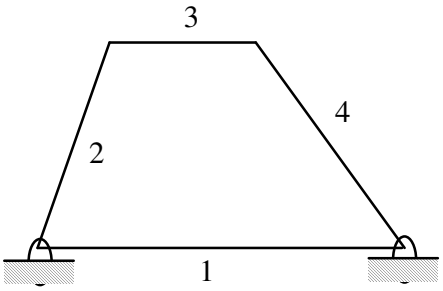


Answer: n=6
J1=6
J2=1
DOF=2

2. What is the linkage type?

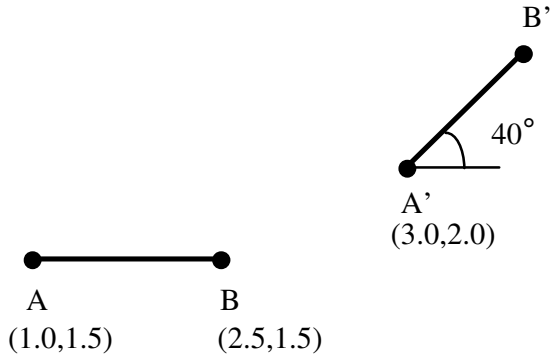
L=5
S=2
P=2
Q=3.5
L+S>P+Q, so Double rocker

If link 2 is the input and link 4 is the output, what is the range of motion of link 2?
Indicate whether it is limited inwards or outwards.
Restricted out, unrestricted inwards
If link 4 is the input and link 2 is the output, what is the range of motion of link 4?
Indicate whether it is limited inwards or outwards.
Restricted out, unrestricted inwards



Length 1 = 5 cm
Length 2 = 3 cm
Length 3 = 2 cm
Length 4 = 3.5 cm

5. Find the displacement matrix for the object shown. What are the coordinates of point B"?



$$\mathbf{D} = \begin{bmatrix} \cos 40 & -\sin 40 & 3-(1*\cos 40-1.5*\sin 40) \\ \sin 40 & \cos 40 & 2-(1*\sin 40+1.5*\cos 40) \\ 0 & 0 & 1 \end{bmatrix}$$

$$\mathbf{D} = \begin{bmatrix} .266 & -.6428 & 3.1981 \\ .6428 & .766 & .2081 \\ 0 & 0 & 1 \end{bmatrix}$$

B' = [4.1489, 2.9641]

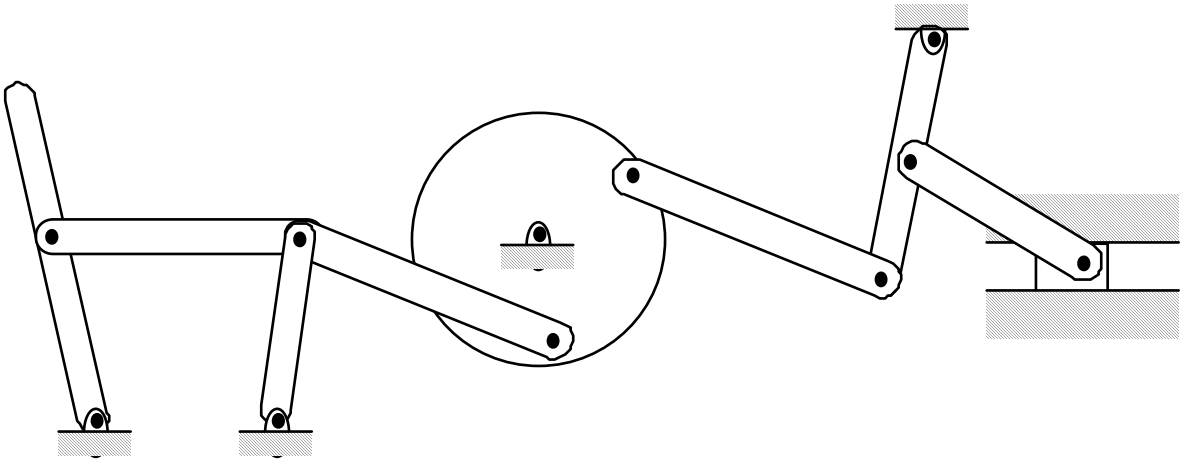
6. Design a cam which will perform the motion indicated. The follower is to be a translating roller (5 mm radius) with a 5 mm offset. Draw **only** the first two stages. Use the vertical line as the initial stage line and the intersection of the lines as the center of rotation of the cam. The smallest radius of the cam is to be 30 mm.

Cam position	Follower position
0°	0. mm
30°	3. mm
60°	4. mm
90°	5. mm
120°	5.75 mm
150°	6. mm
180°	6.25 mm

The follower returns to 0 mm in the reverse of what is indicated from 0° to 180°.

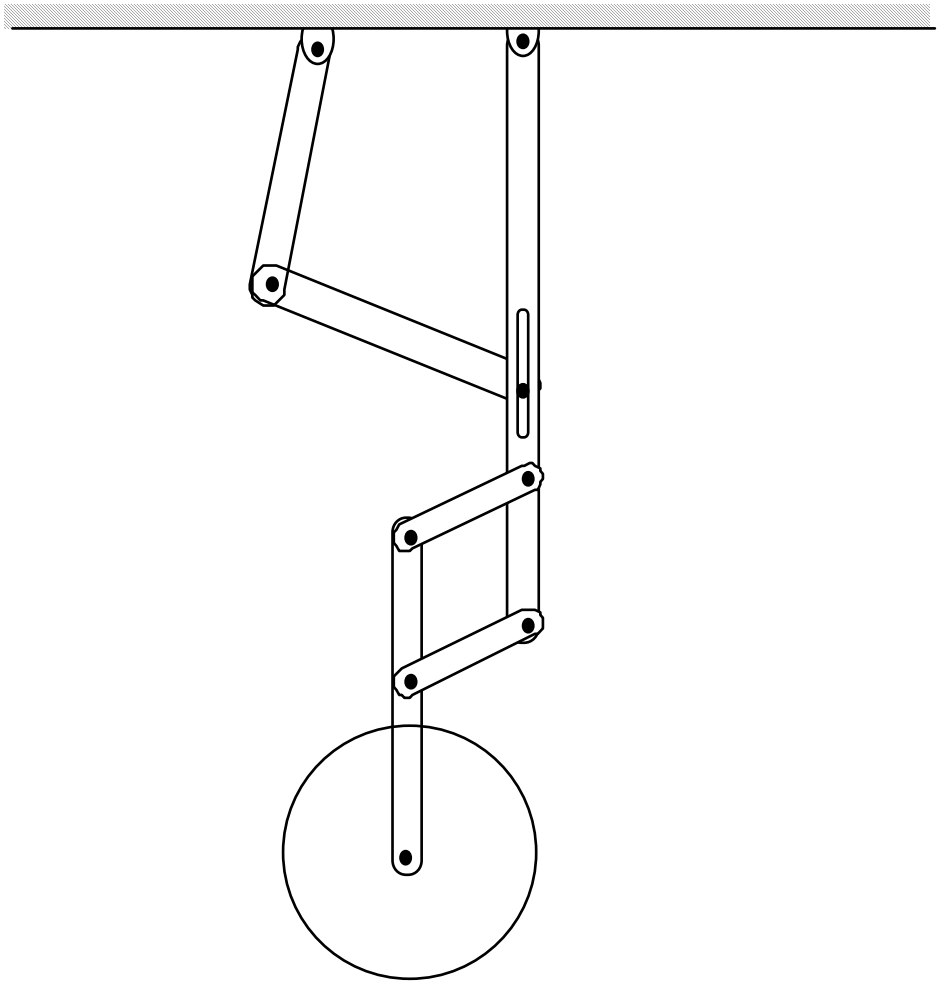
Hand draw this solution. Many possible solutions

1. (5 pts) How many degrees of freedom does the following mechanism have?



n=10
J1=13
J2=0
DOF=1

1. (15 pts) A proposed aircraft landing gear is shown below. How many degrees of freedom does the following mechanism have? Include the wheel.

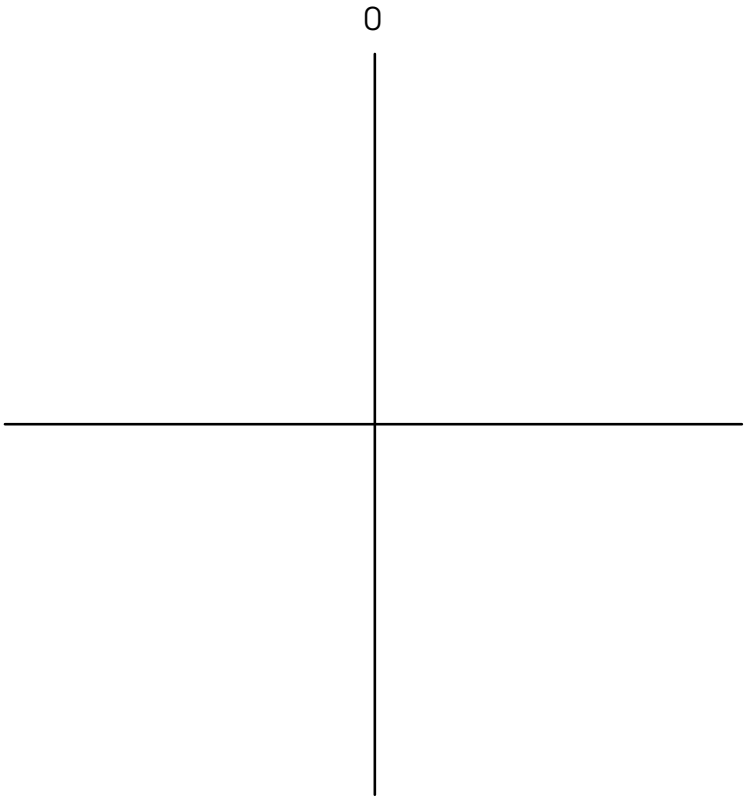


n=8
J1=8
J2=2 Note: you might consider the wheel as just 1 dof
DOF= 3

6. (10 pts) Design a cam which will perform the motion indicated. The follower is to be a translating flat-faced with a 5 mm offset. Draw **only** the first two stages. Use the vertical line as the initial stage line and the intersection of the lines as the center of rotation of the cam. The smallest radius of the cam is to be 25 mm (1 inch).

Cam position	Follower position
0°	0. mm
30°	3. mm
60°	4. mm
90°	5. mm
120°	5.75 mm
150°	6. mm
180°	6.25 mm

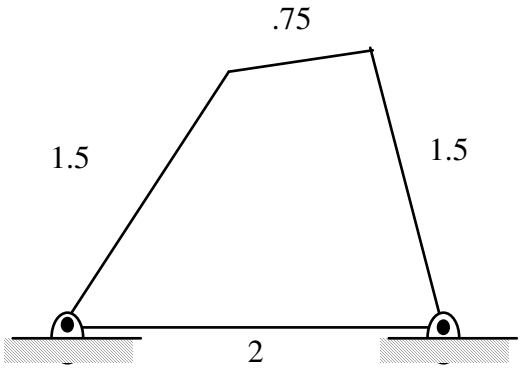
The follower returns to 0 mm in the reverse of what is indicated from 0° to 180°.



Do by hand

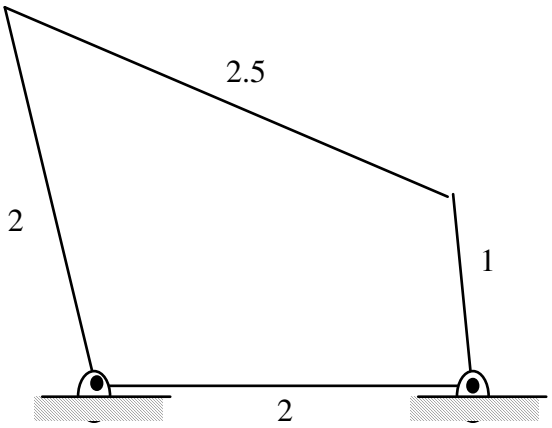
2. (10 pts) What type of four bar linkages are shown? The numbers next to the links are the lengths.

a.



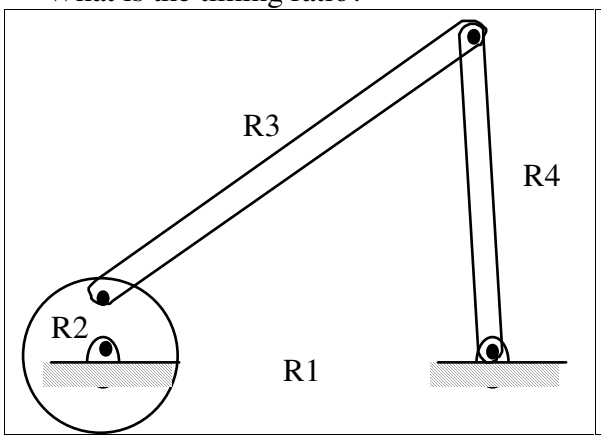
L=2
S=.75
P=1.5
Q=1.5
L+S<P+Q and S is oppositeto ground, so double rocker

b.



L=2.5
S=1
P=2
Q=2
L+S<P+Q and S is adjacent to ground, crank/rocker

5. (20 pts) What is the range of motion of the rocker for the mechanism shown? The drawing is not to scale.
What are the transmission angles at each end of the rocker motion?
What is the timing ratio?



R1 = 25 mm
R2 = 5 mm
R3 = 20 mm
R4 = 15 mm

Use law of cosines to find angles. You will get two isosceles triangles: 15-15-25 and 25-25-15 mm on the sides.

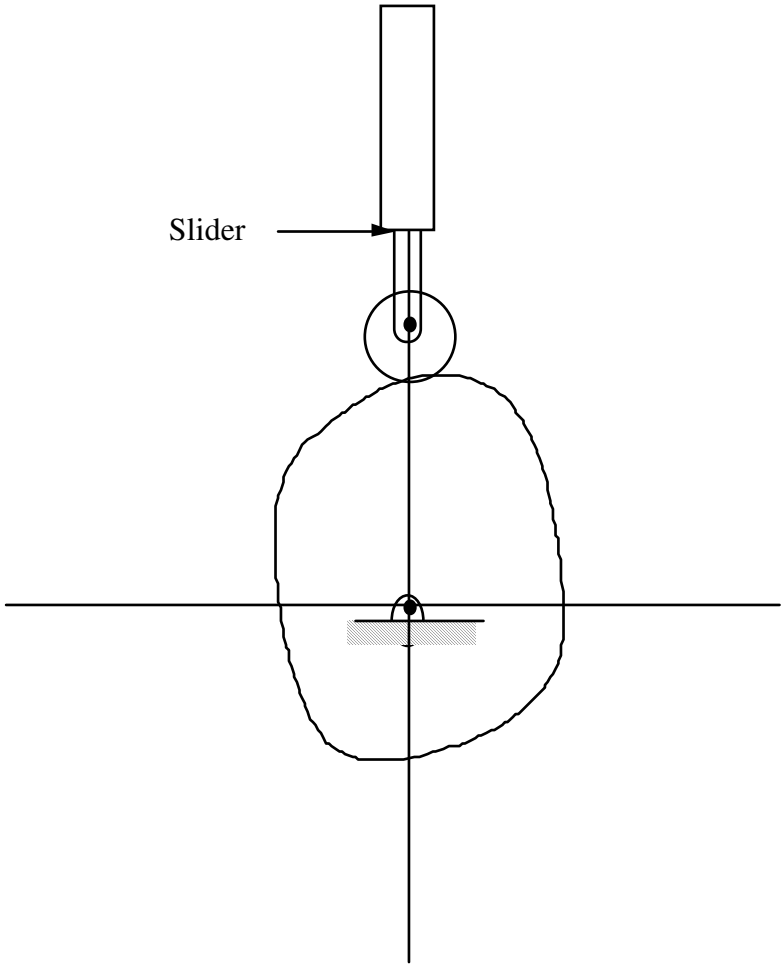
The range of motion is 38.9°.

The transmission angles are 112.88° and 72.54°

Alpha for the timing ratio is 1.36° so the timing ratio is 1.0152

6. (10 pts) An analysis of the cam and follower shown found that the pressure angle was too large. How could the cam and/or cam follower be redesigned so that the highest pressure angle is decreased. The cam always rotates in the same direction, clockwise.

Offset the follower to the left, increase the base circle diaeter, increase the roller diameter.

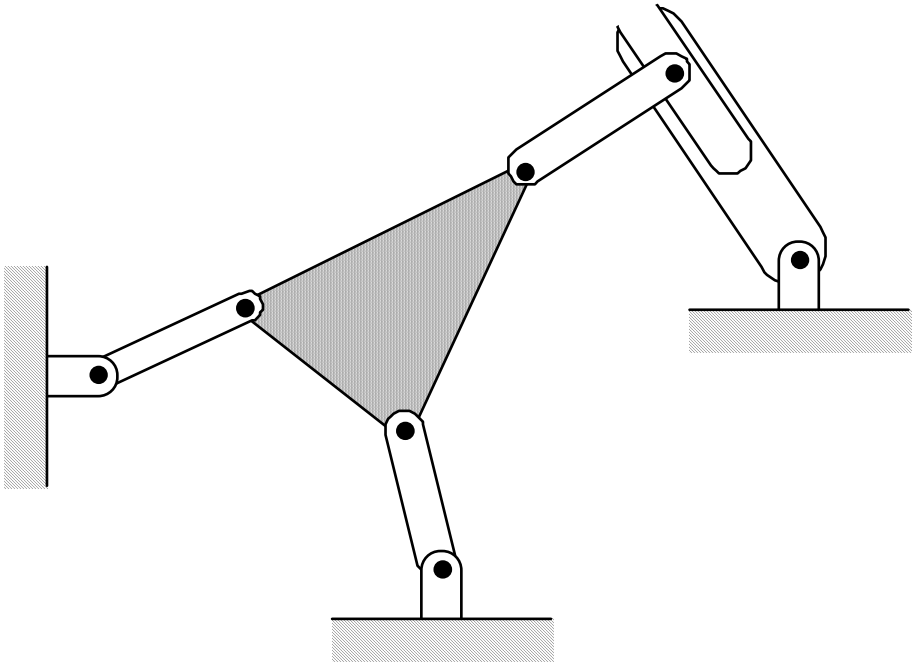


3. A rigid body undergoes a rotation about the origin of 36.7° (3-4-5) about the z-axis. If a reference point on the body is initially located at x=1, y=2, where is the reference point after the rotation? If the body then undergoes a translation of $\Delta x=2$, $\Delta y=-1$, where is the final location of the reference point?

4. It is desired to have a maximum lift of 1 inch of the follower when a cam is made a 180° rotation. No other specifications are given. Describe the follower lift profile that you would use and justify your design. Make any sketches required to explain your design.

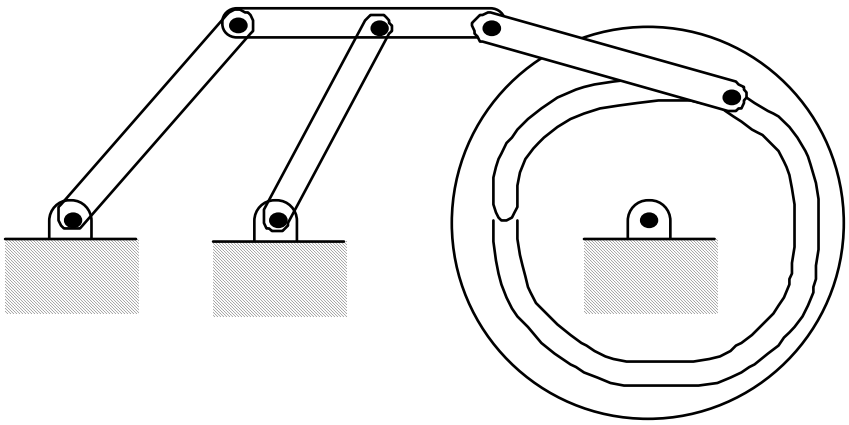
It does not really matter so much about the motion as much as your justification for using that motion.

2. How many degrees of freedom does the following planar mechanism have?



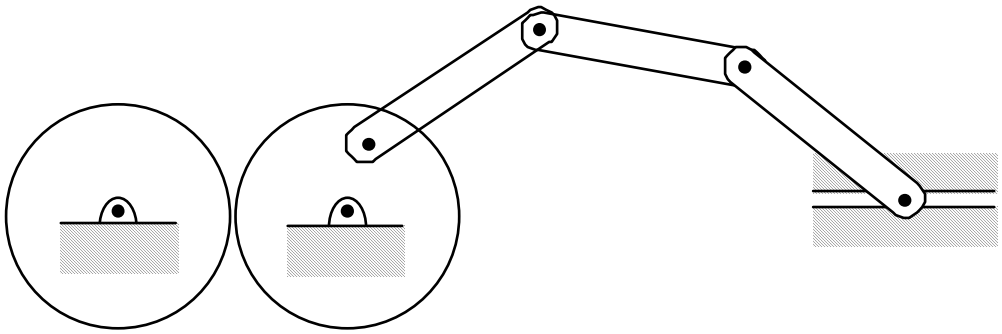
n=6
J1=6
J2=1
DOF = 2

2. (10 pts) How many degrees of freedom does the following mechanism have. The wheel is a face cam (a slot in the face of the wheel). The follower is a pin on the link that rides in the slot.



n=6
J1=6
J2=1
DOF=2

2. (10 pts) How many degrees of freedom does the following mechanism have? The circles represent gears in mesh.



n=6
J1=5
J2=2
DOF=3