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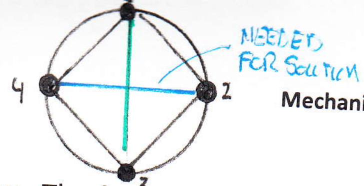
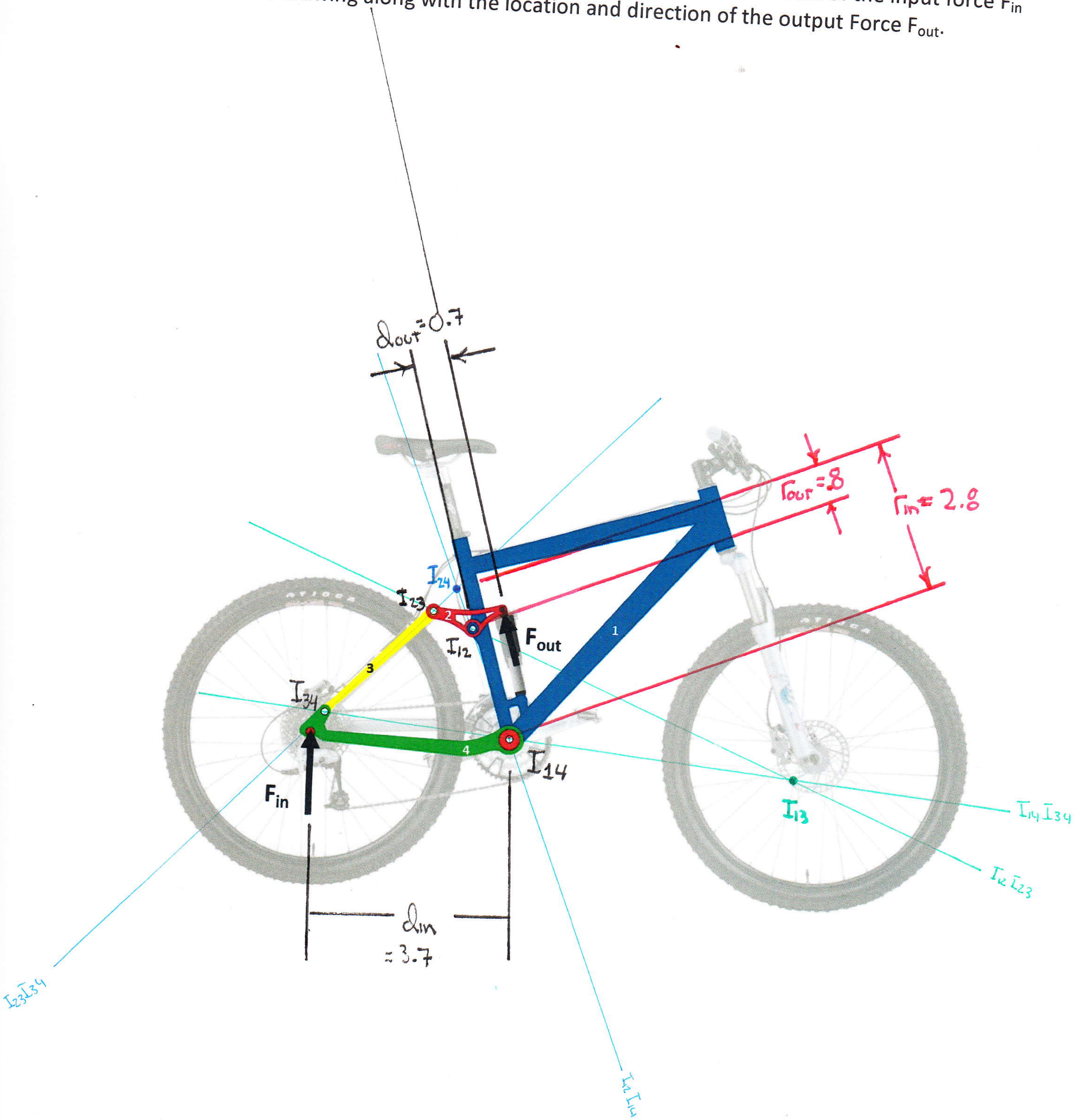
Signature: ______________________________

Print Name: SOLUTION

Exam Date: 19 FEBRUARY 2016




**PROBLEM 1:** A shock is being designed for the bike below. The frame can be considered the ground link and the other links are numbered. The direction and location of the input force $F_{in}$ is shown on the drawing along with the location and direction of the output Force $F_{out}$.



**1a.** Determine the Mechanical Advantage of this system. Use the figure above for the construction of the relevant features that will allow you to calculate the mechanical advantage. Write all calculations below.

$$MA = \frac{d_{in}}{d_{OUT}} \cdot \frac{r_{OUT}}{r_{in}} = \frac{3.7}{0.7} \cdot \frac{0.8}{2.8} = \boxed{1.5}$$

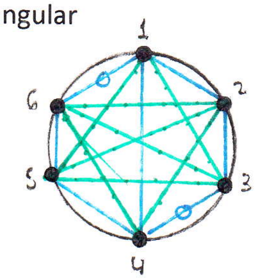
**1b.** If the input force $F_{in}$ is 200lb, what force will the shock see?

$$MA = \frac{F_{OUT}}{F_{in}}$$

$$1.5 = \frac{F_{OUT}}{F_{in}} = \frac{F_{OUT}}{200lb} \Rightarrow F_{OUT} = 1.5(200lb) = \boxed{300lb}$$

**PROBLEM 2:** The mechanism below has an input link (link 2) length of 1.6 inches. The input angular velocity $\omega_2$ is 20-1/s.

$V_{I23} = \omega_2 \cdot r_2 = (20\,^1/s)(1.6\,in) = 32\,^{in}/s$




**2a:** Locate ALL instant centers associated with this mechanism.

**2b:** Determine the Linear velocity of Link 6.

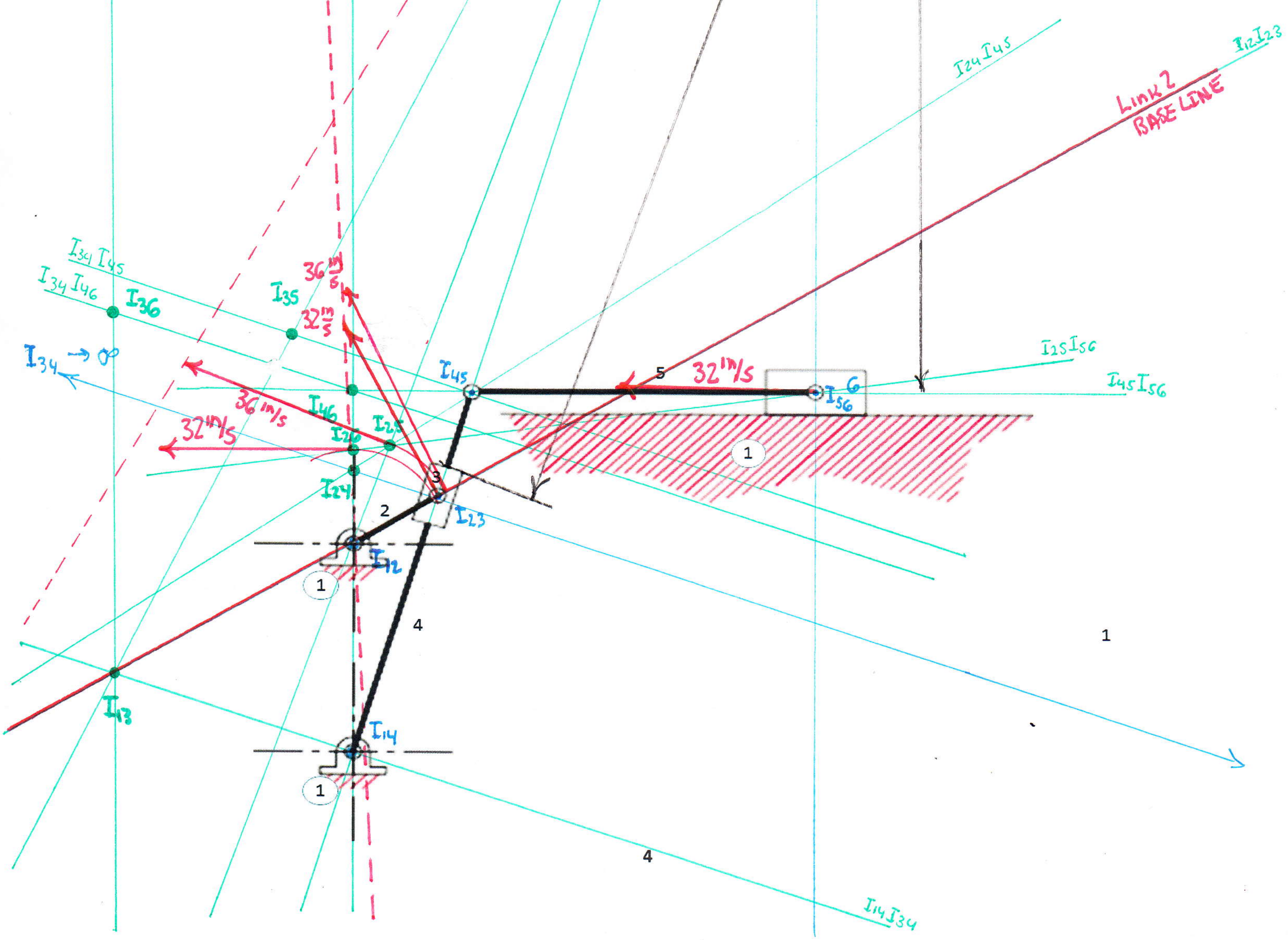
Using $V_{I26} = \boxed{32\,^{in}/s}$

**2c:** Determine the Angular Velocity of Link 5.

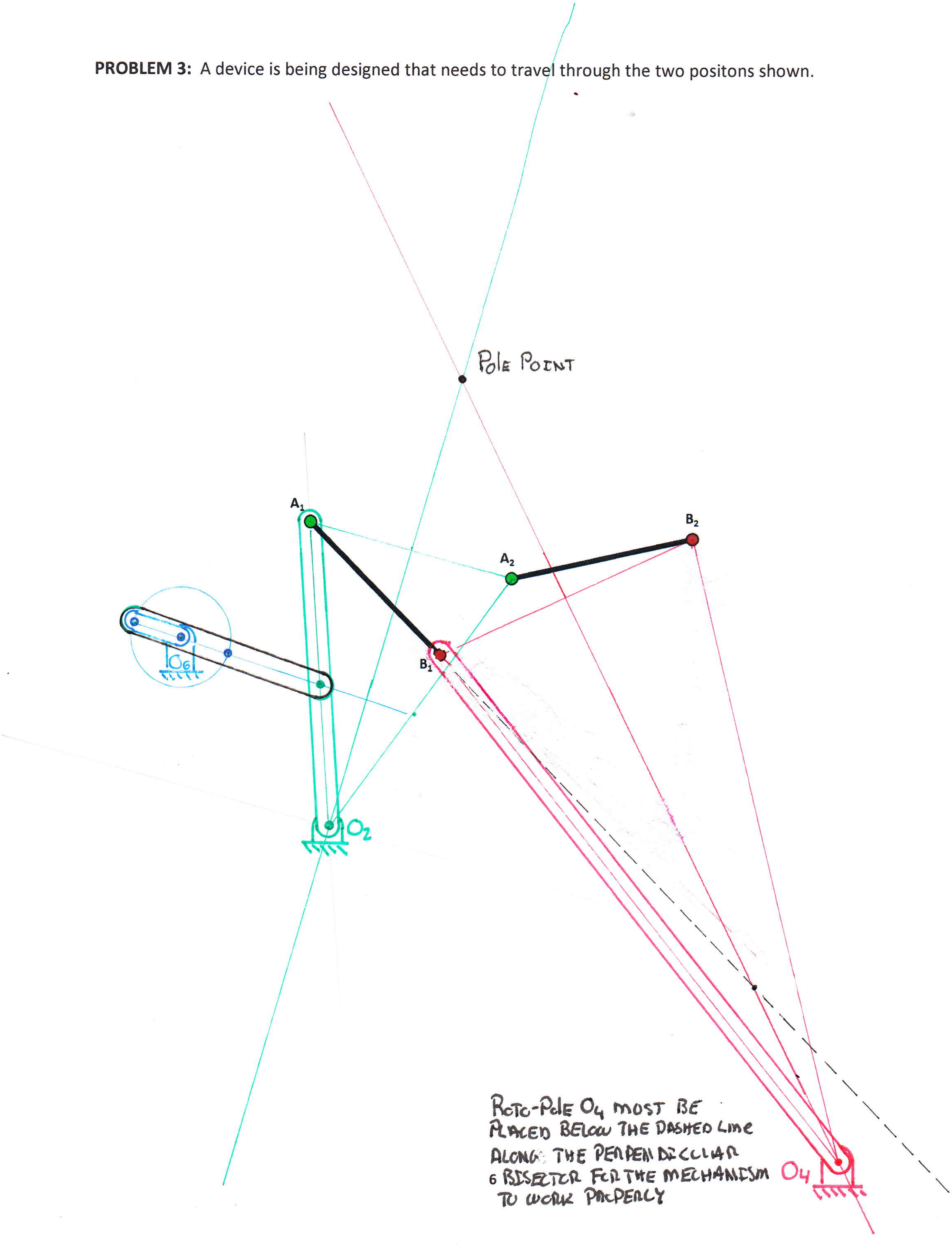
$\omega_5 = \dfrac{36\,^{in}/s}{19.3\,in} = \boxed{1.86\,^1/s}$

or

$\omega_5 = \dfrac{32\,^{in}/s}{17.2} = 1.86\,^1/s$



**PROBLEM 3:** A device is being designed that needs to travel through the two positons shown.



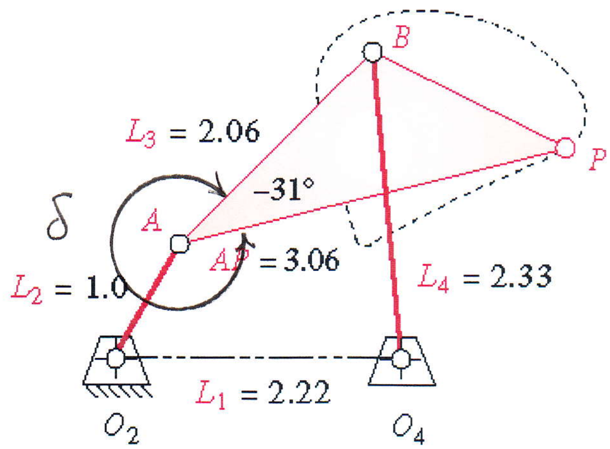
**3a:** Can the mechanism be designed for rocker output if all the ground connections (roto-poles) must be below the two positons shown? Explain your answer in terms of a construction on the figure below.

NO, BECAUSE THE POLE-POINT IS ABOVE THE MECHANISM AND THIS IS THE ONLY LOCATION OF THE ROTO-POLE THAT WILL GIVE ROCKER MOTION FOR THE POSITIONS SHOWN.

**3b:** Use the figure above to design the rest of the mechanism that will move from position 1 above to position 2 and back in a single cycle. Design the drive dyad (NON-quick return) for the mechanism. The link that the drive dyad attaches to must rotate through 40° in traveling from positon 1 to position 2. The complete drive mechanism must be to the left of the mechanism and completely on the page.

**PROBLEM 4:** The drive link of the mechanism below is rotating with an angular velocity of 5 1/s and an angular acceleration of -20 $1/s^2$ when the drive link makes a 70° angle with the horizontal. Input the appropriate parameters into the program that you wrote for this class to determine all the angular and linear positions, velocities, and accelerations for this mechanics including point P. (PRINT OUT THE RESULTS OF YOUR PROGRAM AND STAPLE IT AFTER THIS PAGE)

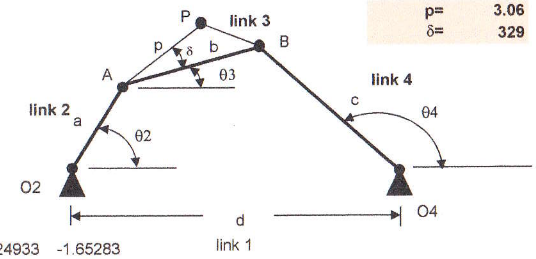
$\delta = 360 - 31 = \underline{\underline{329°}}$



## 4-Bar Linkage

| | | | | | |
|---|---|---|---|---|---|
| a= | 1 | Link 2 | | | |
| b= | 2.06 | Link 3 | | | |
| c= | 2.33 | Link 4 | | | |
| d= | 2.22 | Link 1 | | | |
| $\theta_2 =$ | 70 | 1.221730476 | | | |
| $\dot{\theta}_2 =$ | 5 | $1/s$ | | | |
| $\ddot{\theta}_2 =$ | -20 | $1/s^2$ | | | |
| By= | 2.31 | -1.11 | | | |
| Bx= | 1.88 | 0.17 | | | |
| $\theta_3 =$ | 41.5 | -94.7 | 0.724933 | -1.65283 | |
| $\theta_4 =$ | 98.3 | -151.5 | 1.715498 | -2.64339 | |
| $\dot{\theta}_3 =$ | -1.3755E+00 | 1.9213E+00 | | | |
| $\dot{\theta}_4 =$ | 1.2229E+00 | -6.7706E-01 | | | |
| $\ddot{\theta}_3 =$ | 1.7497E+01 | 1.3903E+00 | | | |
| $\ddot{\theta}_4 =$ | 7.4064E+00 | 1.1481E+01 | | | |

| | |
|---|---|
| K1= | 7.3033E-01 |
| K2= | 5.0037E-01 |
| K3= | 1.1923E+00 |
| K4= | -2.5671E+00 |




| | |
|---|---|
| p= | 3.06 |
| δ= | 329 |

| | x comp | y comp | mag | angle | $e_r$ i | $e_r$ j | $e_\theta$ i | $e_\theta$ j |
|---|---|---|---|---|---|---|---|---|
| r04= | 2.22 | 0.00 | 2.220 | 0.0 | 1.000 | 0.000 | 0.000 | 1.000 |
| rA= | 0.34 | 0.94 | 1.000 | 70.0 | 0.342 | 0.940 | -0.940 | 0.342 |
| rBA= | 1.54 | 1.37 | 2.060 | 41.5 | 0.749 | 0.663 | -0.663 | 0.749 |
| rBO4= | -0.34 | 2.31 | 2.330 | 98.3 | -0.144 | 0.990 | -0.990 | -0.144 |
| rB= | 1.88 | 2.31 | 2.978 | 50.7 | 0.633 | 0.774 | -0.774 | 0.633 |
| rPA= | 3.01 | 0.56 | 3.060 | 10.5 | 0.983 | 0.183 | -0.183 | 0.983 |
| rP= | 3.35 | 1.50 | 3.671 | 24.1 | 0.913 | 0.408 | -0.408 | 0.913 |
| vA= | -4.70 | 1.71 | 5.000 | 160.0 | -0.940 | 0.342 | -0.342 | -0.940 |
| vBA= | 1.88 | -2.12 | 2.833 | -48.5 | 0.663 | -0.749 | 0.749 | 0.663 |
| vB= | -2.82 | -0.41 | 2.849 | -171.7 | -0.990 | -0.144 | 0.144 | -0.990 |
| vPA= | 0.77 | -4.14 | 4.209 | -79.5 | 0.183 | -0.983 | 0.983 | 0.183 |
| vP= | -3.93 | -2.43 | 4.619 | -148.3 | -0.851 | -0.526 | 0.526 | -0.851 |
| aA= | 10.24 | -30.33 | 32.016 | -71.3 | 0.320 | -0.947 | 0.947 | 0.320 |
| aBA | -26.82 | 24.40 | 36.254 | 137.7 | -0.740 | 0.673 | -0.673 | -0.740 |
| aB | -16.57 | -5.94 | 17.605 | -160.3 | -0.941 | -0.337 | 0.337 | -0.941 |
| aPA= | -15.48 | 51.58 | 53.853 | 106.7 | -0.287 | 0.958 | -0.958 | -0.287 |
| aP= | -5.24 | 21.25 | 21.883 | 103.8 | -0.239 | 0.971 | -0.971 | -0.239 |

| ALT | x comp | y comp | mag | angle | i | j | i | j |
|---|---|---|---|---|---|---|---|---|
| r04= | 2.22 | 0.00 | 2.220 | 0.0 | 1.000 | 0.000 | 0.000 | 1.000 |
| rA= | 0.34 | 0.94 | 1.000 | 70.0 | 0.342 | 0.940 | -0.940 | 0.342 |
| rBA= | -0.17 | -2.05 | 2.060 | -94.7 | -0.082 | -0.997 | 0.997 | -0.082 |
| rBO4= | -2.05 | -1.11 | 2.330 | -151.5 | -0.878 | -0.478 | 0.478 | -0.878 |
| rB= | 0.17 | -1.11 | 1.127 | -81.2 | 0.154 | -0.988 | 0.988 | 0.154 |
| rPA= | -1.79 | -2.48 | 3.060 | -125.7 | -0.584 | -0.812 | 0.812 | -0.584 |
| rP= | -1.44 | -1.55 | 2.115 | -133.1 | -0.683 | -0.731 | 0.731 | -0.683 |
| vA= | -4.70 | 1.71 | 5.000 | 160.0 | -0.940 | 0.342 | -0.342 | -0.940 |
| vBA= | 3.94 | -0.32 | 3.958 | -4.7 | 0.997 | -0.082 | 0.082 | 0.997 |
| vB= | -0.75 | 1.39 | 1.578 | 118.5 | -0.478 | 0.878 | -0.878 | -0.478 |
| vPA= | 4.77 | -3.43 | 5.879 | -35.7 | 0.812 | -0.584 | 0.584 | 0.812 |
| vP= | 0.08 | -1.72 | 1.722 | -87.5 | 0.044 | -0.999 | 0.999 | 0.044 |
| aA= | 10.24 | -30.33 | 32.016 | -71.3 | 0.320 | -0.947 | 0.947 | 0.320 |
| aBA | 3.48 | 7.34 | 8.126 | 64.7 | 0.428 | 0.904 | -0.904 | 0.428 |
| aB | 13.72 | -22.99 | 26.772 | -59.2 | 0.513 | -0.859 | 0.859 | 0.513 |
| aPA= | 10.05 | 6.69 | 12.071 | 33.7 | 0.832 | 0.554 | -0.554 | 0.832 |
| aP= | 20.29 | -23.64 | 31.155 | -49.4 | 0.651 | -0.759 | 0.759 | 0.651 |

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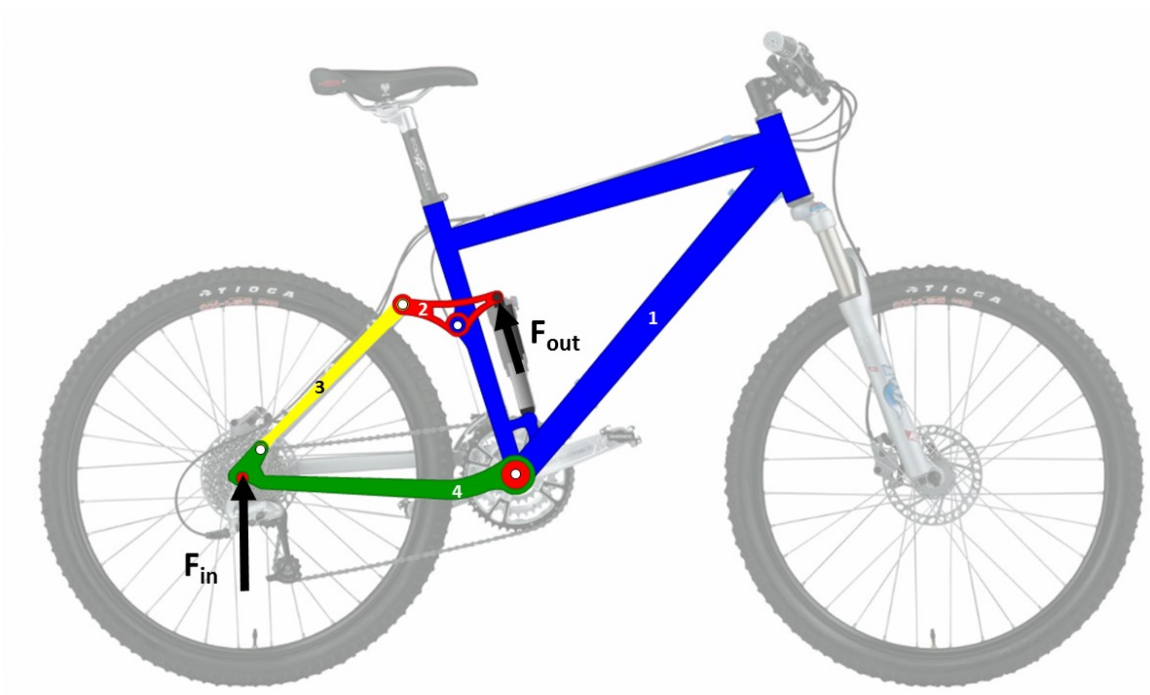

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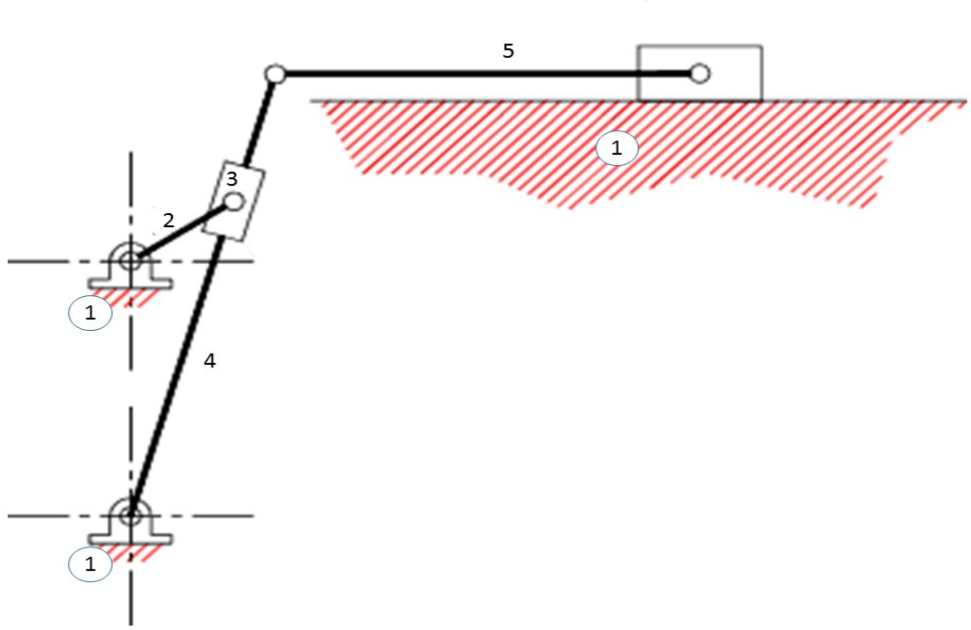


1

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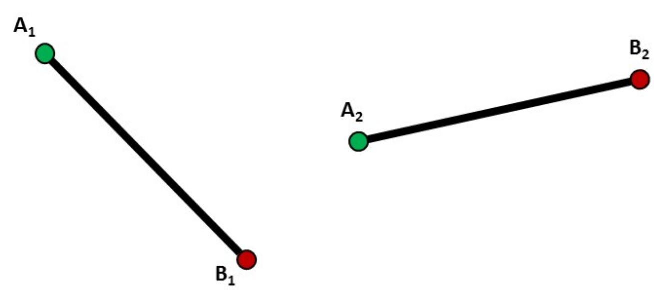

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