Instructor's Solutions Manual
to accompany

Machines and Mechanisms: Applied Kinematic Analysis
Fourth Edition

David Myszka

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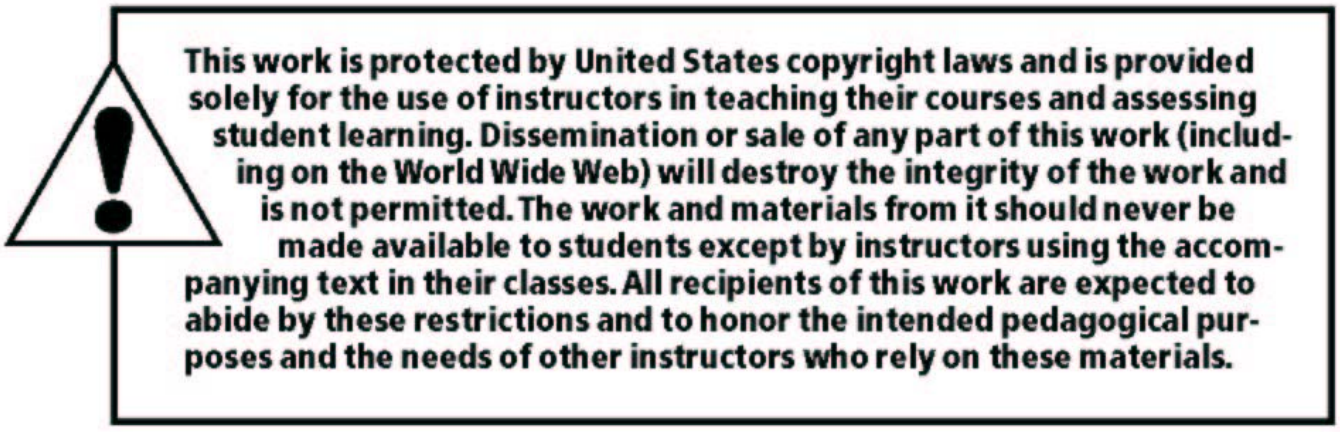

10 9 8 7 6 5 4 3 2 1

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Solution Manual to Accompany:

Machines and Mechanisms

Applied Kinematic Analysis

4th Edition

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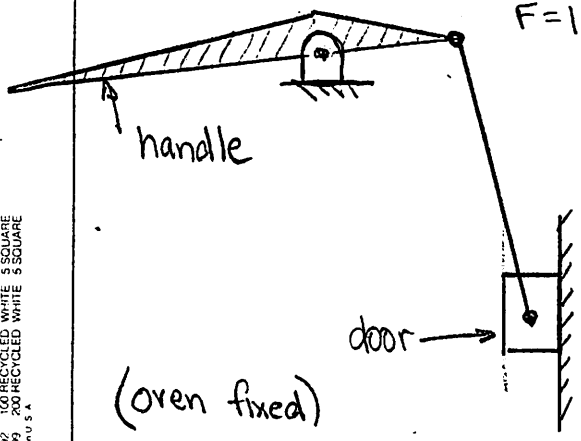
CHAPTER 1

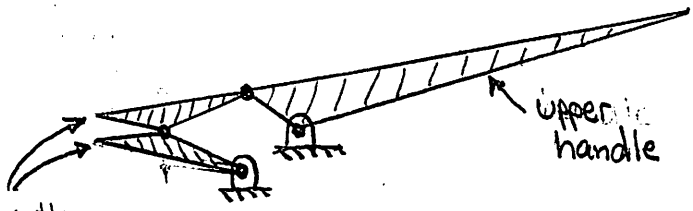
1-1



n=4
J=4
F=1

(oven fixed)

1-2

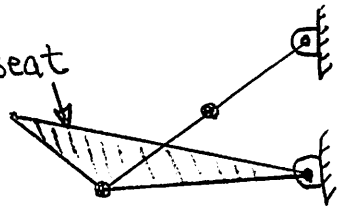


(lower handle fixed)

n=4, J=4, F=1

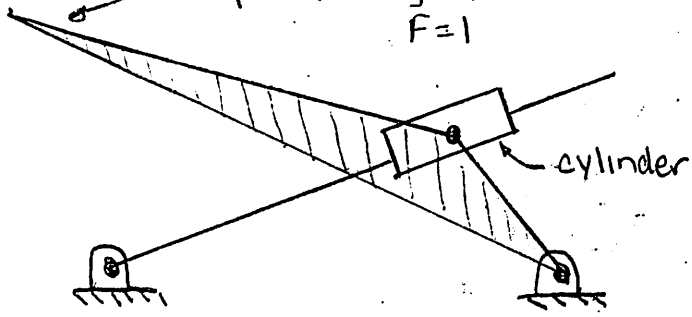
1-3

n=4, J=4, F=1



(seat back fixed)

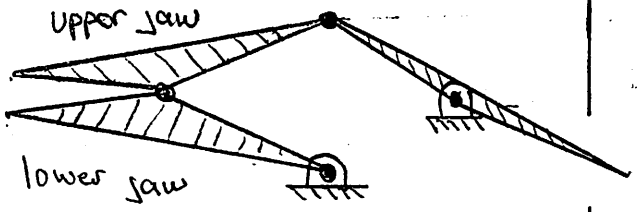
1-4



n=4
J=4
F=1

1-5

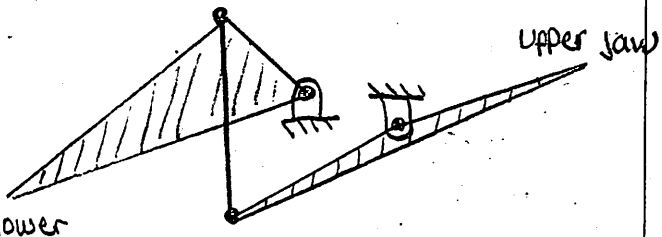
n=4, J=4, F=1



(upper handle fixed)

1-6

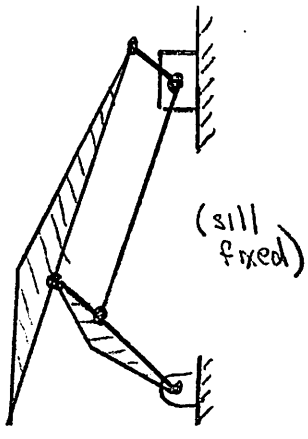
n=4, J=4, F=1



(upper handle/lower jaw fixed)

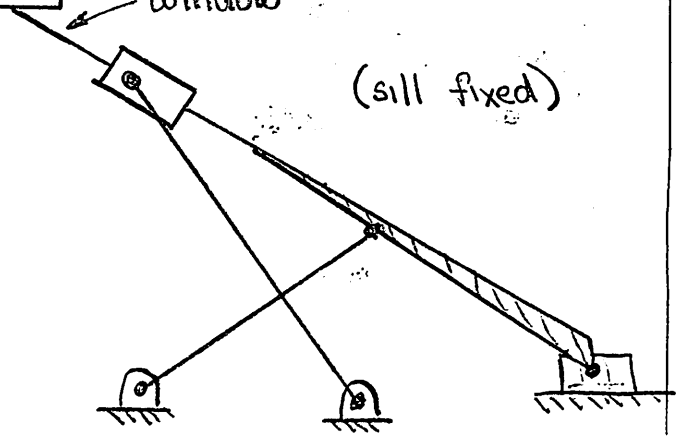
1-7

n=6
J=7
F=1



(sill fixed)

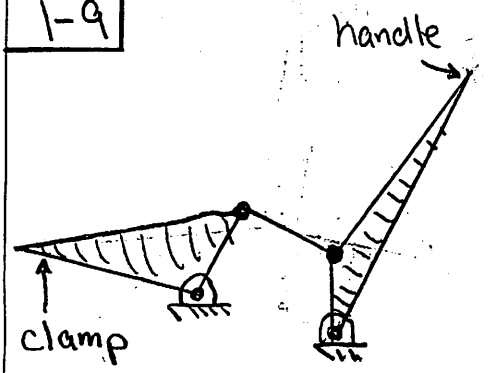
1-8



n=6, J=7, F=1

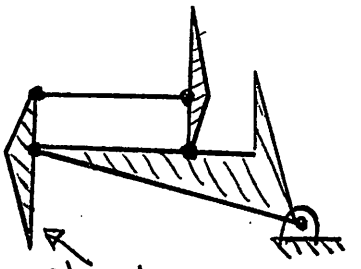
(sill fixed)

1-9



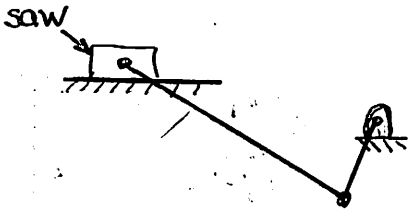
n=4
j=4
F=1

1-10



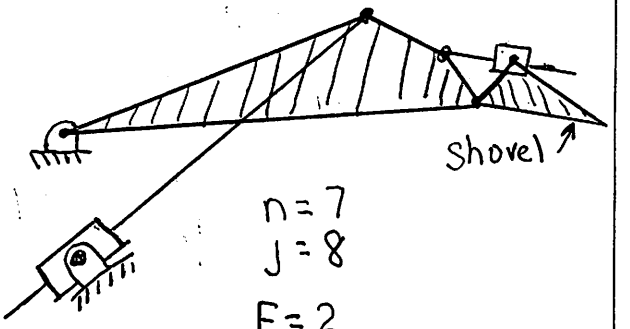
n=5
j=5
F=2

1-11



n=4
j=4
F=1

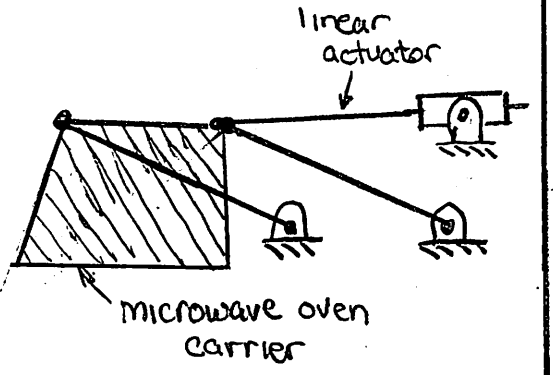
1-12



n=7
j=8
F=2

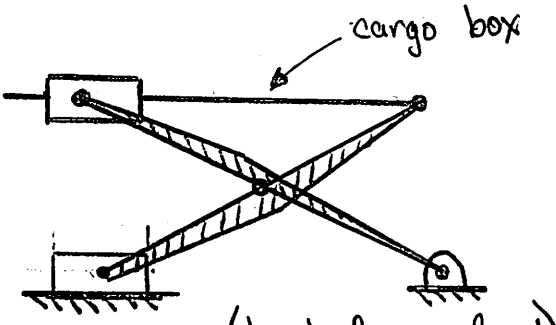
1-13

n=6, j=7, F=1

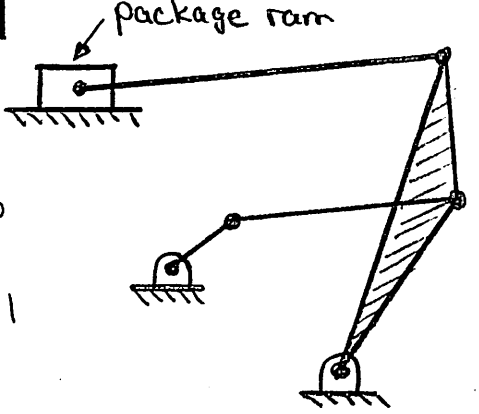


1-14

n=6, j=7, F=1



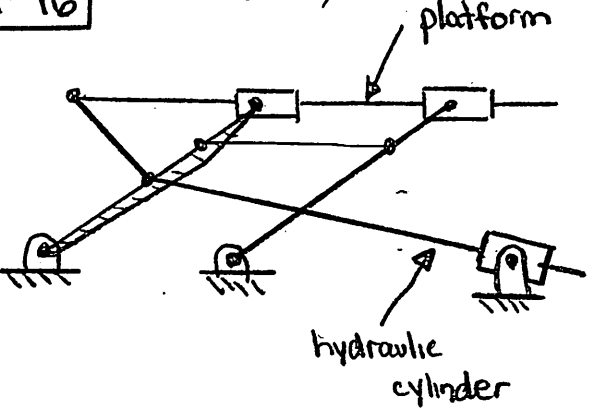
1-15



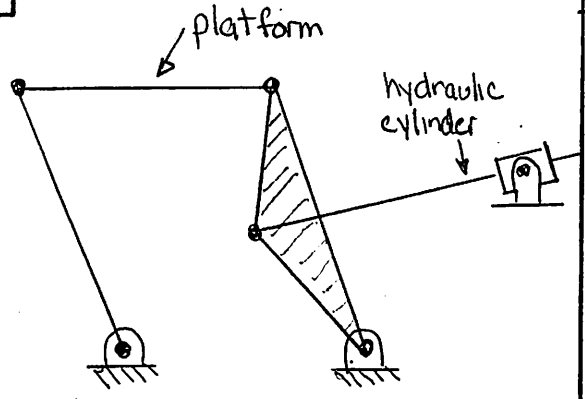
n=6
j=7
F=1

1-16

n=10, j=13, F=1

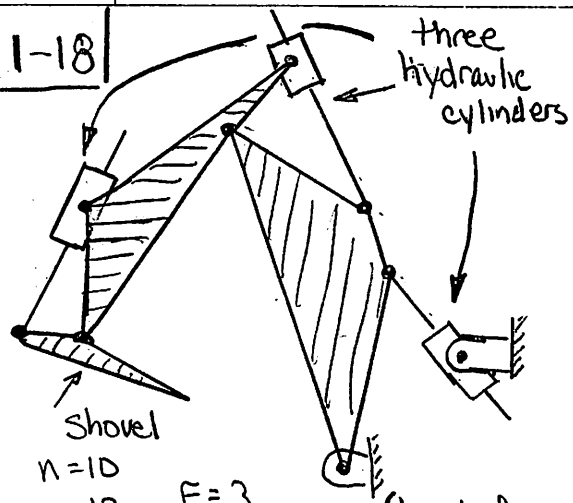


1-17



$n = 6$, $J_p = 7$, $F = 1$

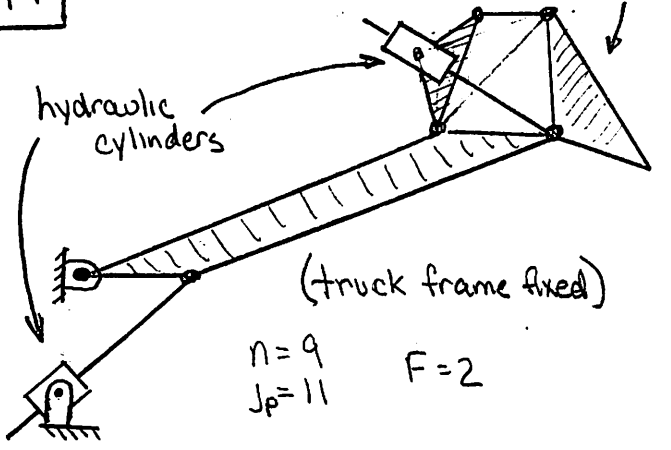
1-18



$n = 10$
$J = 12$ $F = 3$

(truck frame fixed)

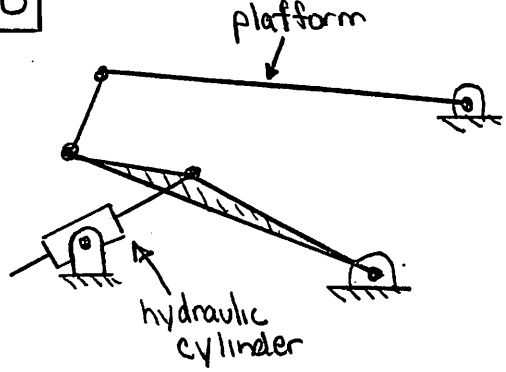
1-19



(truck frame fixed)

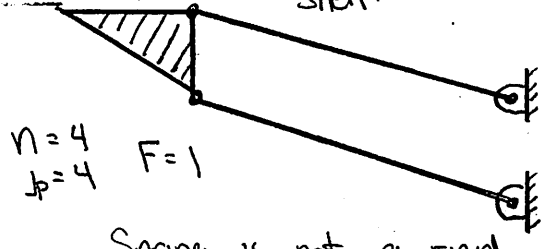
$n = 9$
$J_p = 11$ $F = 2$

1-20



$n = 6$, $J_p = 7$, $F = 1$

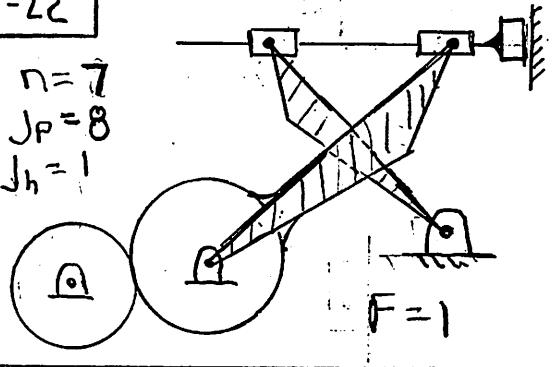
1-21



$n = 4$
$J_p = 4$ $F = 1$

Spring is <u>not</u> a rigid body

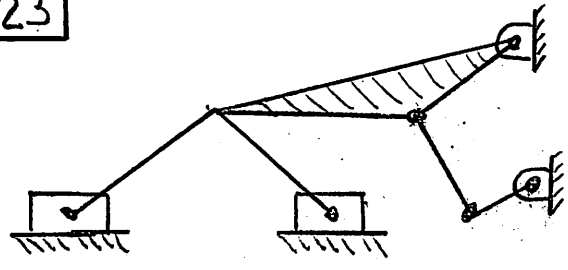
1-22



$n = 7$
$J_p = 8$
$J_h = 1$

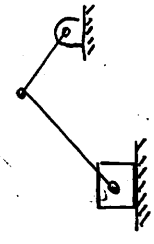
$F = 1$

1-23



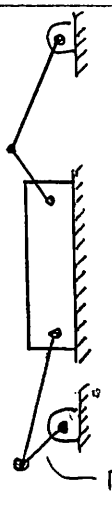
$n = 8$
$J_p = 10$
$F = 1$

1-24



$n = 4$
$J_p = 4$
$F = 1$

1-25



$n = 6$
$J = 7$
$F = 1$

1-26 Links = 4 Joints = 4 (3 pins, 1 sliding)

$DOF = 3(4-1) - 2(4) = 1$ //

1-27 Links = 4 Joints = 4 (4 pins)

$DOF = 3(4-1) - 2(4) = 1$ //

1-28 Links = 4 Joints = 4 (4 pins)

$DOF = 3(4-1) - 2(4) = 1$ //

1-29 Links = 4 Joints = 4 (3 pins, 1 sliding)

$DOF = 3(4-1) - 2(4) = 1$ //

1-30 Links = 4 Joints = 4 (4 pins)

$DOF = 3(4-1) - 2(4) = 1$ //

1-31 Links = 4 Joints = 4 (4 pins)

$DOF = 3(4-1) - 2(4) = 1$ //

1-32 Links = 6 Joints = 7 (6 pins, 1 sliding)

$DOF = 3(6-1) - 2(7) = 1$ //

1-33 Links = 6 Joints = 7 (5 pins, 2 sliding)

$DOF = 3(6-1) - 2(7) = 1$ //

1-34 Links = 4 Joints = 4 (4 pins)

$DOF = 3(4-1) - 2(4) = 1$ //

1-35 Links = 5 Joints = 5 (5 pins)

$DOF = 3(5-1) - 2(5) = 2$ //

1-36 Links = 4 Joints = 4 (3 pins, 1 sliding)

$DOF = 3(4-1) - 2(4) = 1$ //

1-37 Links = 7 Joints = 8 (6 pins, 2 sliding)

$DOF = 3(7-1) - 2(8) = 2$ //

1-38 Links = 6 Joints = 7 (5 pins, 1 sliding)

$DOF = 3(6-1) - 2(7) = 1$ //

1-39 Links = 6 Joints = 7 (5 pins, 2 sliding)

$DOF = 3(6-1) - 2(7) = 1$ //

1-40 Links = 6 Joints = 7 (6 pins, 1 sliding)

$DOF = 3(6-1) - 2(7) = 1$ //

1-41 Links = 10 Joints = 13 (10 pins, 3 sliding)

$DOF = 3(10-1) - 2(13) = 1$ //

1-42 Links = 6 Joints = 7 (6 pins, 1 sliding)

$DOF = 3(6-1) - 2(7) = 1$ //

1-43 Links = 10 Joints = 12 (9 pins, 3 sliding)

$DOF = 3(10-1) - 2(12) = 3$ //

1-44 Links = 9 Joints = 11 (9 pins, 2 sliding)

$DOF = 3(9-1) - 2(11) = 2$ //

1-45 Links = 6 Joints = 7 (6 pins, 2 sliding)

$DOF = 3(6-1) - 2(7) = 1$ //

1-46 Links = 4 Joints = 4 (4 pins)

$DOF = 3(4-1) - 2(4) = 1$ //

1-47 Links = 8 Primary Joints = 10 (6 pins, 4 sliding)
Higher Joints = 1 (gear)

$DOF = 3(8-1) - 2(10) - 1 = 1$ //

1-48 Links = 8 Joints = 10

$DOF = 3(8-1) - 2(10) = 1$ //

1-49 Links = 4 Simple joints = 4 (3 pin + 1 sliding)

$DOF = 3(4-1) - 2(4) = 1$ //

1-50 Links = 6 Joints = 7 (6 pins, 1 sliding)

$DOF = 3(6-1) - 2(7) = 1$ //

1-51 $s = 1.5, l = 14, p = 12, q = 4$

s = side

$1.5 + 14 < 14 + 4$

$15.5 < 18$ (yes)

⇒ crank-rocker

1-52 $s = 4, l = 12, p = 12, q = 5$

s = side

$4 + 12 < 12 + 5$

$16 < 17$ (yes)

⇒ crank-rocker

1-53 $s = 3, l = 12, p = 8, q = 4$

s = side

$12 + 12 < 8 + 4$

$15 \nless 12$ (no)

⇒ triple-rocker

1-54 $s = 3, l = 12, p = 12, q = 5$

s = side

$3 + 12 < 12 + 5$

$15 < 17$ (yes)

⇒ crank-rocker

Answers to the Chapter 1 Case Study Questions:

Case 1-1.

1. As link A rotates clockwise, 90^0, slide C will move to the left.
2. As link A rotates clockwise, 90^0, the ball trapped in slide C will drop down the lower, left chute.
3. As link A continues another 90^0, clockwise, link A will be oriented straight down and slide C will return to the original position shown in the figure.
4. This device allows one feeder bowl to distribute balls to two separate stations.
5. The chamfers on slide C allow relief as a ball drops into the empty slot as slide C moves under chute D.
6. This device would be useful in that only one feeder bowl will need to be filled and monitored.

Case 1-2.

1. As handle A is rotated counterclockwise, flapper C rotates clockwise.
2. As flapper C is raised, the water in the tank is allowed to flow through the opening.
3. A buoyancy force will offset the water pressure, keeping the flapper in the upper position.
4. As the water level lowers to the level of the flapper, the flapper will lower with the water line.
5. Item D floats on top of the water. As the water level lowers, float D also lowers.
6. As item D rotates counterclockwise, item F is also rotates counterclockwise.
7. Item F is a valve that controls water flow, In the upper position, it fills the tank. In the lower position, water flow is cut off.
8. These mechanisms allow a rapid flow of water from the tank, slowly refill the tank, then shut-off the water flow.
9. The water pressure in residential areas does produce the required flow rate for a water closet.

Case 1-3.

1. In the shown configuration, the water level in bucket B_1 is raising, as the flow into the bucket exceeds the amount that is leaking from the holes at the bottom of the bucket.
2. In the shown configuration, the water level in bucket B_2 is lowering, as the water is leaking from the holes at the bottom of the bucket.
3. If bucket B_2 were forced upward, rocker arm C would rotate clockwise.
4. If bucket B_2 were forced upward, rocker arm R would rotate counterclockwise.
5. Rocker arm R controls a directional valve, channeling the water flow to either the upper pipe or the lower pipe.
6. As water drains from one bucket, making it lighter, and fills the other, making it heavier, the weight shift cases the rocker C to rotate and reverse the direction of the water flow. The process repeats itself and rotates rocker C back to the original position. The continual motion is oscillation of rocker C.
7. As rocker C rotates, channel S moves between left and right positions. This allows the steel rod, which is constantly moving, to be coiled onto a reel placed on the left side or a reel on placed on the right side.
8. Since water is abundant and a common cooling medium in most foundries, water flow can be used to drive some machinery.

Answers to the Chapter 2 Case Study Questions:

Case 2-1.

1. As handle A is rotated, moving threaded rod B to the left, grip C also moves to the left and slightly upward. Notice that links E and F are pivoting in the middle, thus grip C is constrained to a swinging motion.
2. As handle A is rotated, moving threaded rod B to the left, grip D moves to the right and slightly downward. Since links E and F are pivoting in the middle, grip D will have motion opposing grip C.
3. The purpose of this mechanism is to serve as a machining clamp for the workpiece.
4. The spring, G, pulling on link D would cause is to return to an upward and rightward position.
5. The purpose of spring G is, ultimately, to keep a positive contact between the threaded rod and link C.
6. Links E and F have a peculiar configuration to avoid interference with the workpiece, throughout the range of motion of the clamp.
7. Such a device could be called a machining clamp.
8. Since link C is moving in a swinging motion, the rounded end on the threaded rod, assures a consistent point contact with link C.

Chapter 3.

3-1 $\cos\theta = 5/18 \Rightarrow \theta = 73.8°$ //

3-2 $A = \sqrt{(18)^2 - (5)^2} = 17.3$ in //

3-3 $\tan 60° = \frac{x}{6} \Rightarrow x = 10.4$ in //

3-4 $\theta = 180 - (60 + 90) = 30°$ //

$\cos 60° = \frac{6}{R} \Rightarrow R = 12$ in //

3-5 a) $\tan\theta = \frac{6}{4} \Rightarrow \theta = 56.3°$ //

$R = \sqrt{(6)^2 + (4)^2} = 7.2$ in //

b) $\theta = 180 - (90 + 60) = 30°$ //

$\cos 30° = \frac{5}{R} \Rightarrow R = 5.8$ in //

c) $\tan\theta = \frac{5}{8} \Rightarrow \theta =$

$R = \sqrt{(5)^2 + (8)^2} = 9.4$ in //

3-6 $\tan\beta = \frac{x}{y} = \frac{150}{275} \Rightarrow \beta = 28.6°$ //

hypotenuse = $2s$

$2s = \sqrt{(150)^2 + (275)^2} \Rightarrow s = 156.6$ mm //

3-7 $\tan 35° \approx \frac{x}{16} \Rightarrow x = 11.2$ in //

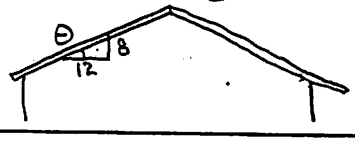
$2s = \sqrt{(16)^2 + (11.2)^2} \Rightarrow s = 9.8$ in //

3-8 $s = 10 \Rightarrow$ hypotenuse $= 20$ in

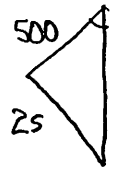
$\sin 35° = \frac{x}{20} \Rightarrow x = 11.5$ in //

$\cos 35° = \frac{y}{20} \Rightarrow y = 16.4$ in //

3-9 $\tan\theta = \frac{8}{12} \Rightarrow \theta = 33.7°$ //



3-10

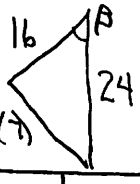


law of cosines

$2s = \sqrt{(500)^2 + (850)^2 - 2(500)(850)\cos 35}$

$s = 175$ mm //

3-11



$\cos\beta = \frac{(16)^2 + (14)^2 - (24)^2}{2(16)(14)}$

$\beta = 42.9°$ //

3-12

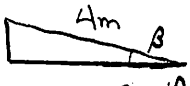
$L = 52/\sin 30$

$= 104$ in //

$104\text{ in}\left(\frac{1\text{ ft}}{12\text{ in}}\right)$

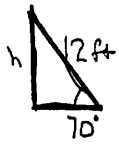
$= 8$ ft 8 in //

3-13



$\sin\beta = 1.5/4 \Rightarrow \beta = 22.0°$ //

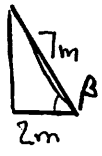
3-14



$\sin 70° = \frac{h}{12}$

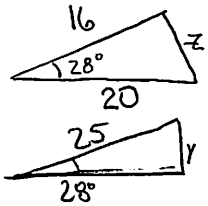
$h = 11.3$ ft //

3-15



$\cos\beta = \frac{2}{7} \Rightarrow \beta = 73.4°$ //

3-16



law of cosines

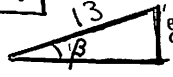
$z = \sqrt{(16)^2 + (20)^2 - 2(16)(20)\cos 28}$

$= 9.5$ ft //

$\sin 28° = y/25$

$\Rightarrow y = 11.7$ ft //

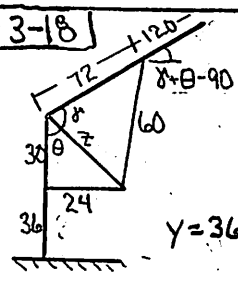
3-17



$\sin\beta = 8/13$

$\Rightarrow \beta = 38.0°$ //

3-18



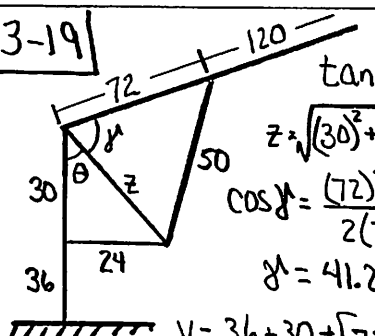
$\tan\theta = 24/30 \Rightarrow \theta = 38.7°$

$z = \sqrt{(24)^2 + (30)^2} = 38.4$ in

$\cos\gamma = \frac{(72)^2 + (38.4)^2 - (60)^2}{2(72)(38.4)} \Rightarrow \gamma = 56.$

$y = 36 + 30 + [72 + 120]\sin(38.7 + 56.4 - 90) = 83.1$ //

3-19



$\tan\theta = \frac{24}{30} \Rightarrow \theta = 38.7°$

$z = \sqrt{(30)^2 + (24)^2} = 38.4$ in

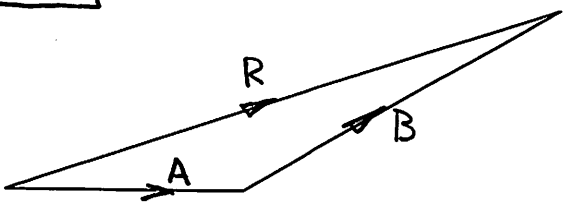
$\cos\gamma = \frac{(72)^2 + (38.4)^2 - (50)^2}{2(72)(38.4)}$

$\gamma = 41.2°$

$y = 36 + 30 + [72 + 120]\sin(\theta + \gamma - 90)$

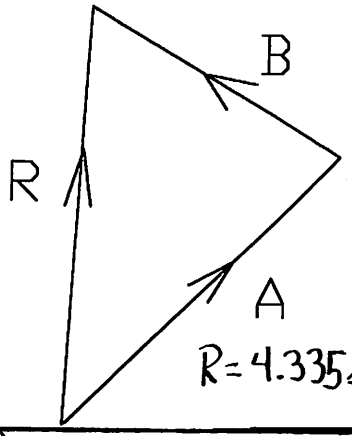
$= 66 + (192)\sin(-10.1°) = 32.3$ in

3-20



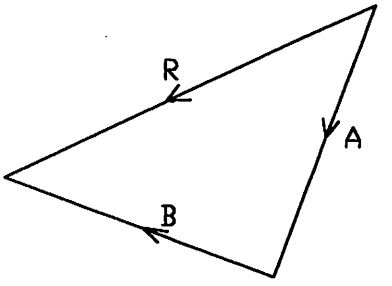
measuring: $R = 24.18 \angle 18.1°$

3-21



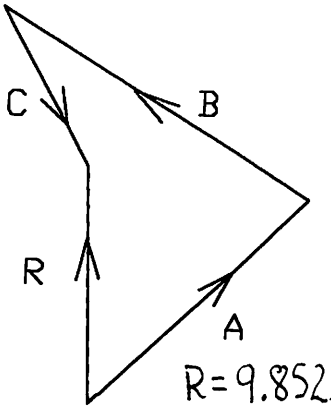
$R = 4.335 \angle 86.9°$

3-22



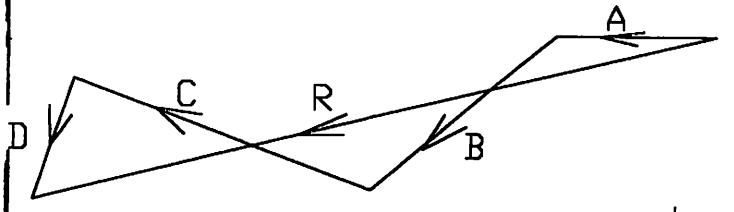
$R = 212.13 \angle 25°$

3-23



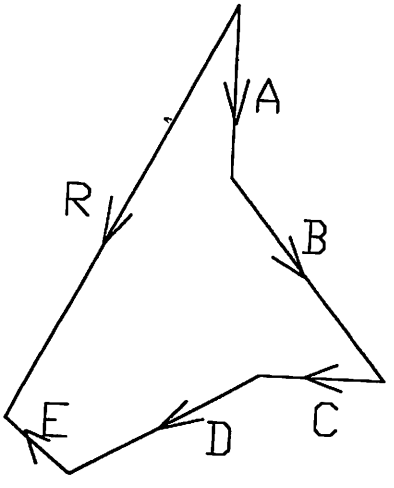
$R = 9.852 \angle 87.66°$

3-24



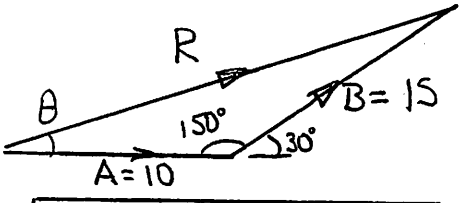
$R = 221.20 \angle 13.49°$

3-25



$R = 110.14 \angle 62.97°$

3-26

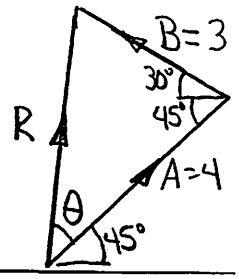


$R = \sqrt{(10)^2 + (15)^2 - 2(10)(15)\cos 150} = 24.18$

$\theta = \sin^{-1}\left(\frac{15}{24.18}\sin 150\right) = 18.07°$

$R = 24.18 \angle 18.07°$

3-27



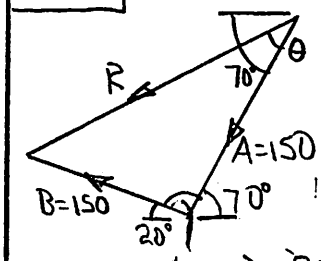
$R = \sqrt{(4)^2 + (3)^2 - 2(4)(3)\cos 75} = 4.335$

$\theta = \sin^{-1}\left[\frac{3}{4.335}\sin 75\right] = 41.9°$

$(45 + 41.9) = 86.9°$

$R = 4.335 \angle 86.9°$

3-28



$R = \sqrt{150^2 + 150^2 - 2(150)(150)\cos 90}$

$= 212.13$

$\theta = \sin\left[\frac{150}{212.13}\sin 90\right]$

$= 45°$

$180 - (20 + 70) = 90$

$(70 - 45) = 25$

$R = 212.13 \quad 25°$

3-29

$R_x = 12.5\cos 45 - 15\cos 30 + 7.5\cos 60$

$= -0.40$

$R_y = 12.5\sin 45 + 15\sin 30 - 7.5\sin 60 = 9.84$

$R = \sqrt{(-0.4)^2 + (9.84)^2}$ 9.85

$\theta = \tan^{-1}\left(\frac{9.84}{0.40}\right) = 87.66°$

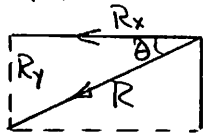
$R = 9.85 \quad 87.67°$

3-30

$R_x = -50 - 75\cos 40 - 100\cos 20$

$-40\cos 70 = -215.1$

$R_y = 0 - 75\sin 40 + 100\sin 20 - 40\sin 70 = -51.6$



$R = \sqrt{(-215.1)^2 + (-51.6)^2}$

$= 221.2$

$\theta = \tan^{-1} 51.6/215.1 = 13.4$

$R = 221.2 \quad 13.4°$

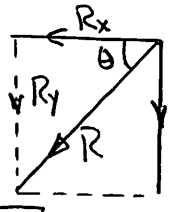
3-31

$R_x = 0 + 60\sin 40 - 30 - 50\cos 30$

$-20\sin 50 = -50.05$

$R_y = -40 - 60\cos 40 - 0 - 50\sin 30 + 20\cos 50$

$= -98.11$



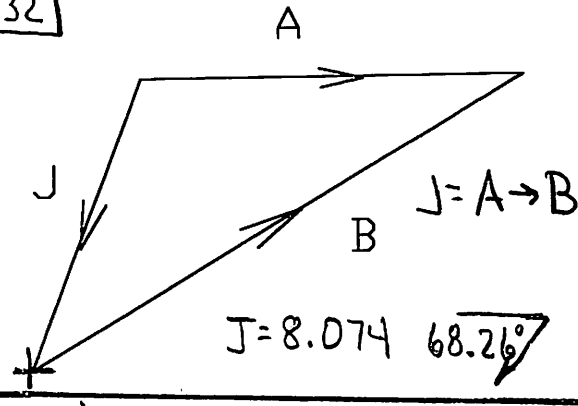
$R = \sqrt{(-50.05)^2 + (98.11)^2}$

$= 110.14$

$\theta = \tan^{-1} 98.11/50.05 = 62.97°$

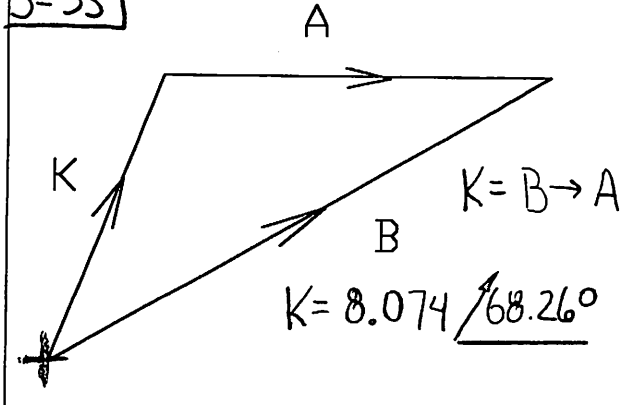
$R = 110.14 \quad 62.97°$

3-32



$J = 8.074 \quad 68.26°$

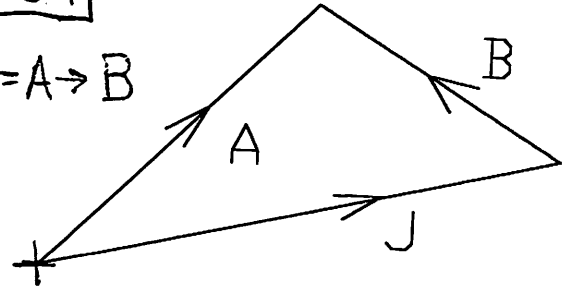
3-33



$K = 8.074 \angle 68.26°$

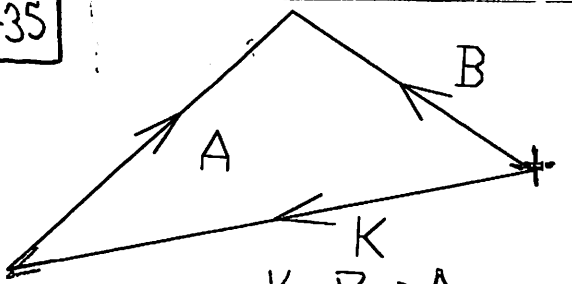
3-34

$J = A \rightarrow B$



$J = 5.587 \angle 13.76°$

3-35



$K = B \to A$

Measuring:

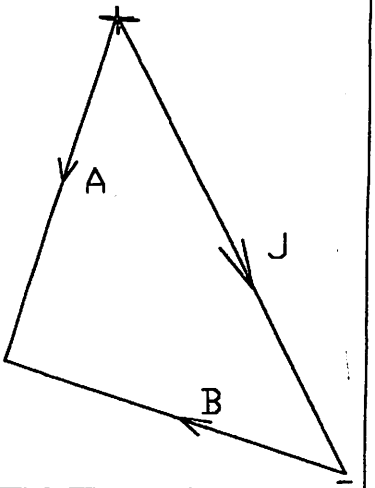
$K = 5.587 \quad \overline{13.76°}$

3-36

$J = A \to B$

Measuring:

$J = 212.13 \quad \overline{65°}$

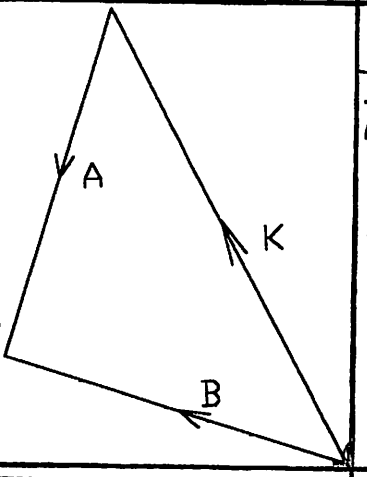


3-37

$K = B \to A$

Measuring:

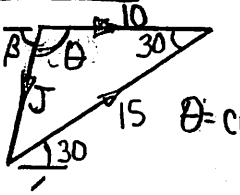
$K = 212.13 \quad \overline{65°}$



3-38

$J = \sqrt{10^2 + 15^2 - 2(10)(15)\cos 30}$

$= 8.074$



$\theta = \cos^{-1}\left(\frac{8.074^2 + 10^2 - 15^2}{2(8.074)(10)}\right) = 111.74°$

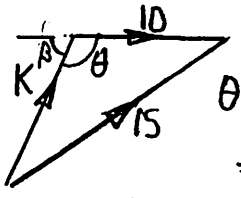
$\beta = 180 - 111.74 = 68.26°$

$J = 8.074 \quad \overline{68.26°}$

3-39

$K = \sqrt{10^2 + 15^2 - 2(10)(15)\cos 30}$

$= 8.074$



$\theta = \cos^{-1}\left(\frac{8.074^2 + 10^2 - 15^2}{2(8.074)(10)}\right)$

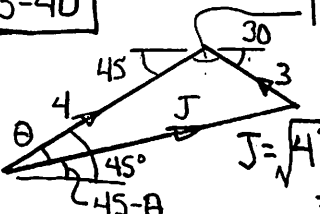
$= 111.74°$

$\beta = 180 - \theta = 68.26$

$K = 8.074 \quad \overline{68.26°}$

3-40

$180 - (45 + 30) = 105$



$J = \sqrt{4^2 + 3^2 - 2(4)(3)\cos 105}$

$= 5.587$

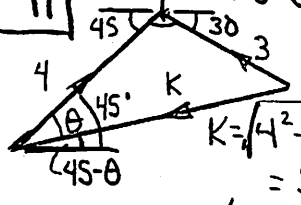
$\theta = \sin^{-1}\left(\frac{3}{5.587}\sin 105\right) = 31.24°$

$45 - \theta = 13.76°$

$J = 5.587 \quad \overline{13.76°}$

3-41

$180 - (45 + 30) = 105$



$K = \sqrt{4^2 + 3^2 - 2(4)(3)\cos 105}$

$= 5.587$

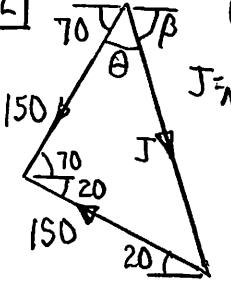
$\theta = \sin^{-1}\left(\frac{3}{5.587}\sin 105\right) = 31.24°$

$45 - \theta = 13.76°$

$K = 5.587 \quad \overline{13.76°}$

3-42

$(70 + 20) = 90°$



$J = \sqrt{150^2 + 150^2 - 2(150)(150)\cos 90}$

$= 212.13$

$\theta = \sin^{-1}\left(\frac{150}{212.13}\sin 90\right)$

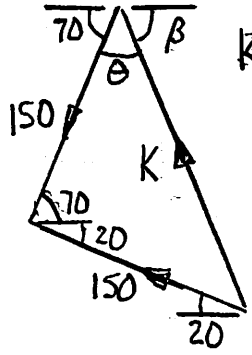
$= 45°$

$\beta = 180 - (\theta + 70) = 65°$

$J = 212.13 \quad \overline{65°}$

3-43

$70+20=90$



$K=\sqrt{150^2+150^2-2(150)(150)\cos 90}$

$=212.13$

$\theta=\sin^{-1}\left(\frac{150}{212.13}\sin 90\right)$

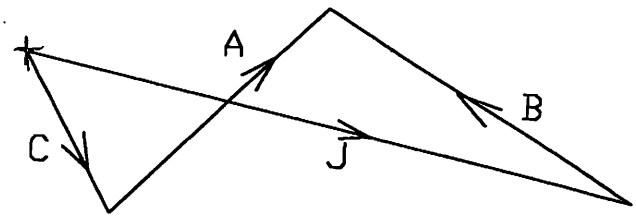
$=45°$

$\beta=180-(\theta+70)=65°$

$K=212.13 \quad \underline{65°}\uparrow$

3-44

$J=C\nrightarrow A\rightarrow B$

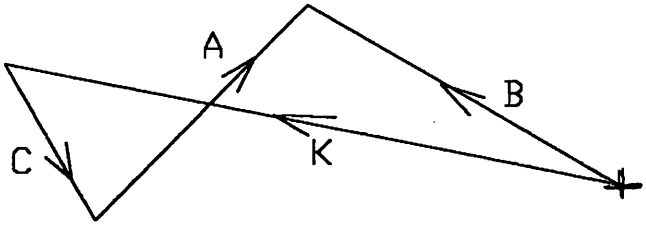


Measuring:

$J=26.094 \quad \underline{\downarrow 11.40°}$

3-45

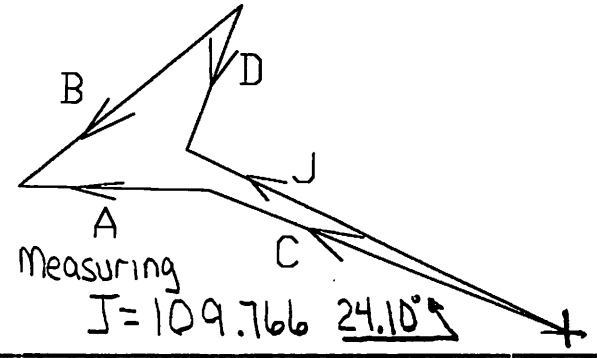
$K=B\rightarrow A\rightarrow C$



Measuring: $K=26.094 \quad \underline{11.40°}\uparrow$

3-46

$J=C\nrightarrow A\rightarrow B\nrightarrow D$

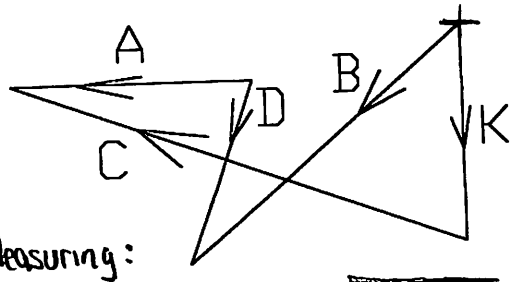


Measuring

$J=109.766 \quad \underline{24.10°}\uparrow$

3-47

$K=B\rightarrow D\nrightarrow A\rightarrow C$

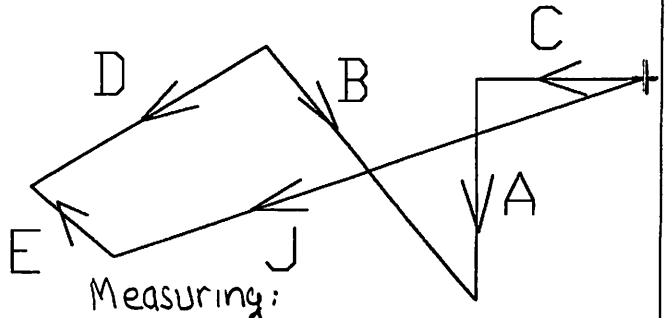


Measuring:

$K=44.824 \quad \underline{\downarrow 89.75°}$

3-48

$J=C\nrightarrow A\rightarrow B\nrightarrow D\rightarrow E$

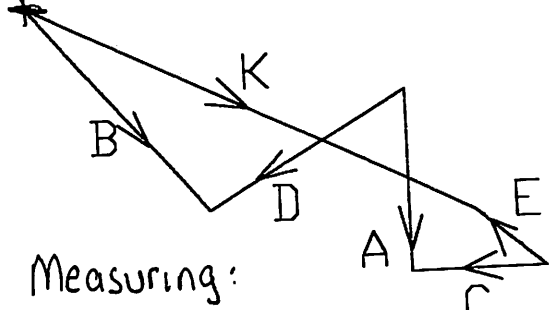


Measuring:

$J=101.679 \quad \underline{18.28°}\downarrow$

3-49

$K=B\rightarrow D\nrightarrow A\rightarrow C\nrightarrow E$



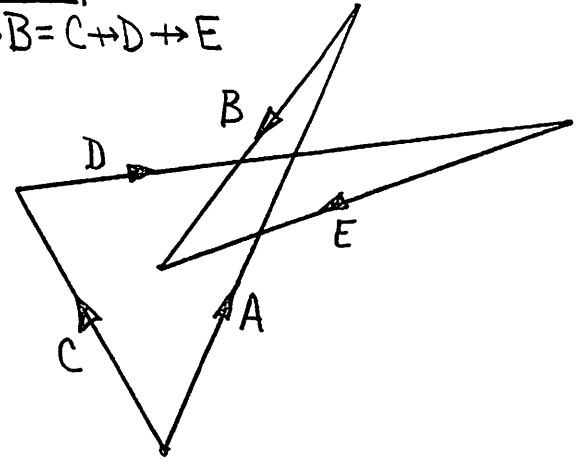
Measuring:

$K=107.869 \quad \underline{\downarrow 26.49°}$

3-50

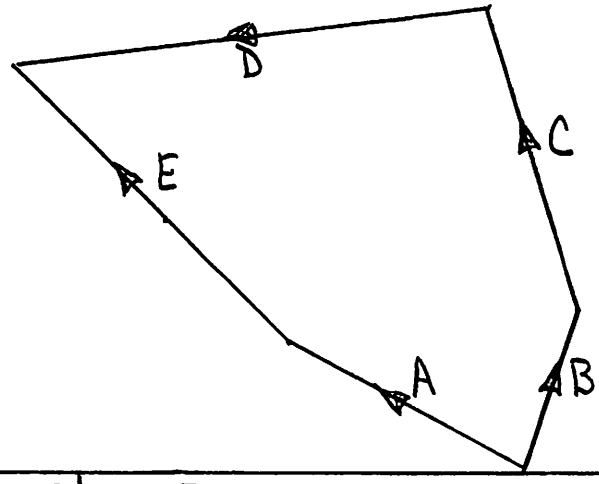
$A\rightarrow D\nrightarrow B=C\nrightarrow E$

$A\nrightarrow B=C\nrightarrow D\nrightarrow E$



3-51 $A \to C \leftrightarrow E = D \leftrightarrow B$

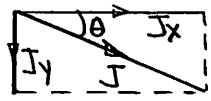
$A \leftrightarrow E = B \leftrightarrow C \leftrightarrow D$



3-52 $J = C \leftrightarrow A \to B$

$J_x = (7.5\cos 60) + (12.5\cos 45) - (-15\cos 30)$
$= 25.58$

$J_y = (-7.5\sin 60) + (12.5\sin 45) - (15\sin 30)$
$= -5.16$



$J = \sqrt{(25.58)^2 + (-5.16)^2}$
$= 26.10$

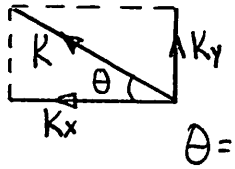
$\theta = \tan^{-1}(5.16/25.58) = 11.40°$

$J = 26.10 \angle 11.40°$

3-53 $K = B \to A \to C$

$K_x = (-15\cos 30) - (12.5\cos 45) - (7.5\cos 60)$
$= -25.58$

$K_y = (15\sin 30) - (12.5\sin 45) - (-7.5\sin 60)$
$= 5.16$



$K = \sqrt{(-25.58)^2 + (5.16)^2}$
$= 26.10$

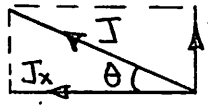
$\theta = \tan^{-1}(5.16/25.58) = 11.40°$

$K = 26.10 \angle 11.40°$

3-54 $J = C \leftrightarrow A \to B \leftrightarrow D$

$J_x = (-100\cos 20) + (-50) - (-75\cos 40) + (-40\cos 70) = -100.2$

$J_y = (100\sin 20) + (0) - (-75\sin 40) + (-40\sin 70) = 44.8$



$J = \sqrt{(-100.2)^2 + (44.8)^2}$
$= 109.8$

$\theta = \tan^{-1}(44.8/109.8) = 24.1$

$J = 109.8 \angle 24.1°$

3-55 $K = B \to D \leftrightarrow A \to C$

$K_x = (-75\cos 40) - (-40\cos 70) + (-50) - (-100\cos 20) = 0.20$

$K_y = (-75\sin 40) - (-40\sin 70) + (0) - (100\sin 20) = -44.82$

$K = \sqrt{(0.20)^2 + (-44.82)^2} = 44.82$

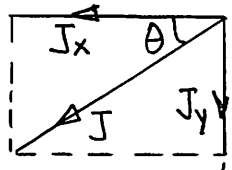
$\theta = \tan^{-1}(44.82/0.2) = 89.7°$

$K = 44.82 \angle 89.7°$

3-56 $J = C \leftrightarrow A \to B \leftrightarrow D \to E$

$J_x = (-30) + (0) - (60\sin 40) + (-50\cos 30) - (-20\sin 50) = -96.55$

$J_y = 0 + (-40) - (-60\cos 40) + (-50\sin 30) - (20\cos 50) = -31.89$



$J = \sqrt{(-96.55)^2 + (-31.89)^2}$
$= 101.68$

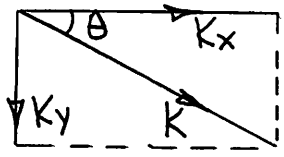
$\theta = \tan^{-1}(31.89/96.55) = 18.3°$

$J = 101.68 \angle 18.3°$

3-57 $K = B \to D \nrightarrow A \to C \nrightarrow E$

$K_x = (60\sin 40) - (-50\cos 30) + (0) - (-30) + (-20\sin 50) = 96.54$

$K_y = (-60\cos 40) - (-50\sin 30) + (-40) - 0 + (20\cos 50) = -48.11$



$K = \sqrt{(96.54)^2 + (-48.11)^2} = 107.86$

$\theta = \tan^{-1}\left(\frac{48.11}{96.54}\right) = 26.5°$

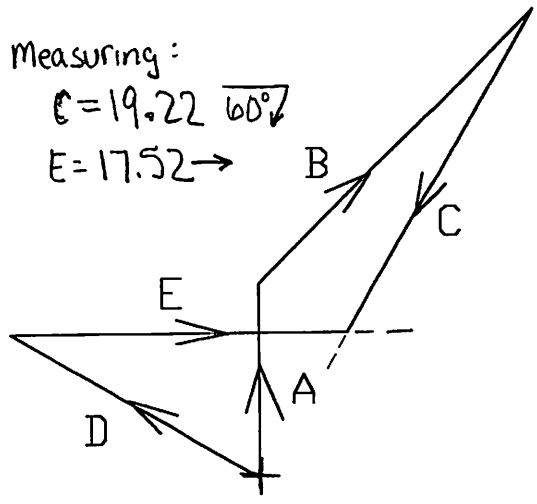
$K = 107.86 \angle 26.5°$

3-58 $A \nrightarrow B \nrightarrow C = D \nrightarrow E$

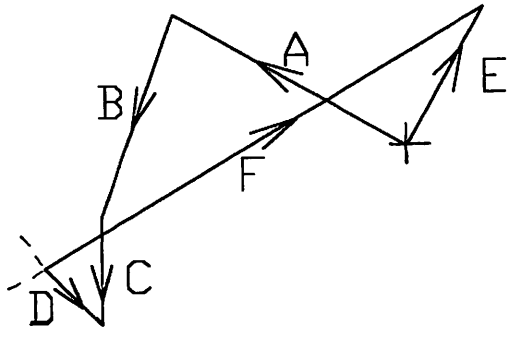
Measuring:

$C = 19.22 \angle 60°$

$E = 17.52 \rightarrow$



3-59 $A \nrightarrow B \nrightarrow C \to D = E \to F$



Measuring:

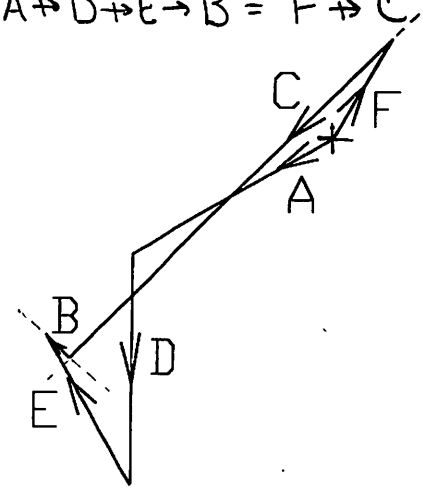
$D = 38.12 \angle 45°$

$F = 238.9 \angle 30°$

3-60 $A \to B \to C \nrightarrow D = \to E \nrightarrow F$

rewriting:

$A \nrightarrow D \nrightarrow E \to B = F \nrightarrow C$



measuring

$B = 8.81 \angle 45°$ $C = 117.7 \angle 45°$

3-61 $A \nrightarrow B \nrightarrow C = D \nrightarrow E$

assume directions $C \nearrow$ $E \rightarrow$

horiz:

$0 + (20\cos 45) + C\cos 60 = -15\cos 30 + E$

vert:

$10 + (20\sin 45) + C\sin 60 = 15\sin 30 + 0$

$C = -19.2$

substituting $\Rightarrow E = 17.5$

$C = 19.22 \angle 60°$ & $E = 17.52 \rightarrow$

3-62 $A \nrightarrow B \nrightarrow C \to D = E \to F$

horiz assume directions $D \nwarrow$, $F \nearrow$

$(-125\cos 30) + (-100\cos 70) + (0) - (-D\cos 45) = (75\cos 60) - (F\cos 30)$

$D = (179.95 - F\cos 30)/\cos 45$ ①

vert:

$(125\sin 30) + (-100\sin 70) + (-50) - (D\sin 45) = (75\sin 60) - (F\sin 30)$

$D = (F\sin 30 - 146.42)/\sin 45$ ②

using ① & ② simultaneous

$F = 23.89$, $D = -38.12$

$F = 238.9 \angle 30°$ $D = 38.12 \angle 45°$

3-63 $A \to B \to C \leftrightarrow D = \to E \leftrightarrow F$

assume directions B ↖, C ↗

horiz:

$(-60\cos 30) - (-B\cos 45) - (C\cos 45) + 0$

$= -(-45\cos 60) + (30\sin 30)$

$B = (C\cos 45 + 89.46)/\cos 45$ — ①

vert:

$(-60\sin 30) - (B\sin 45) - (C\sin 45) + (-60)$

$= -(45\sin 60) + (30\cos 30)$

$B = (-77.0 - C\sin 45)/\sin 45$ — ②

Solving ① & ② simultaneously

$B = 8.81$, $C = -117.7$

$B = 8.81$ 45° $C = 117.7$ 45°

Answers to the Chapter 3 Case Study Questions:

Case 3-1.

1. As key 2 is pressed, rocker plate A rotates back, or clockwise in the left end-view.
2. Spring C provides resistance to rotating the rocker plate, counterclockwise in the left end view.
3. Spring B provides resistance to pressing the keys, 1 and 2.
4. As key 2 is pressed, the rocker plate A rotates back, and releases key 1. the Spring under key 1 forces key 1 into an upward position.
5. The purpose of this mechanism is to hamper two keys from being in the downward position at the same time.
6. Spring B, acting on key 1, is in compression and forcing button 1 upward.
7. Spring C is in tension, forcing rocker plate A to rotate counterclockwise in the right end view. Stop D prevents any further rotation than the position shown.
8. A cassette tape player uses similar mechanical means to prevent the play, rewind or fast forward buttons to be pressed at the same time.
9. As mentioned, pin D serves as a stop for rocker plate A. It prevents further clockwise rotation as seen from the right end view.

Case 3-2.

1. As driveshaft A turns, collar B also turns because of a keyed connection.
2. The motion of the shaft and collar is transmitted to gear C because the protrusion of link D is seated into the notch in collar B.
3. If link D were forced upward, the protrusion would come out of the notch in collar B. Nothing would be left driving gear C, so it would stop rotating.
4. Link D would dislodge from the notch if gear C would be exposed to significant resistance to rotation.
5. The tendency of link D to have upward motion must overcome the spring tension.
6. This device is intended to stop the rotation of the gear, if significant resistance is encountered.
7. Such a device is called a slip clutch.
8. This device would stop the winding mechanism if wire became jammed, thus supplying resistance on gear C.
9. To reset this device, link D must be place under link F and aligned with the notch in collar B.
10. The spring must be in tension. Therefore, it pulls link F to the right, and link E to the left.

Case 3-3.

1. As handle A is rotated, moving threaded rod B to the left, grip C also moves to the left and slightly upward. Notice that links E and F are pivoting in the middle, thus grip C is constrained to a swinging motion.
2. As handle A is rotated, moving threaded rod B to the left, grip D moves to the right and slightly downward. Since links E and F are pivoting in the middle, grip D will have motion opposing grip C.
3. The purpose of this mechanism is to serve as a machining clamp for the workpiece.
4. The spring, G, pulling on link D would cause is to return to an upward and rightward position.
5. The purpose of spring G is, ultimately, to keep a positive contact between the threaded rod and link C.
6. Links E and F have a peculiar configuration to avoid interference with the worikpiece, throughout the range of motion of the clamp.
7. Such a device could be called a machining clamp.
8. Since link C is moving in a swinging motion, the rounded end on the threaded rod, assures a consistent point contact with link C.

4-1 $t = .1s$

$x = 3\cos[50(.1)+40] = 2.121''$

$t = 1.5s$

$x = 3\cos[50(1.5)+40] = -1.268''$

$\Delta x = (-1.268) - (2.121) = -3.389 = 3.389'' \leftarrow$

4-2 $t = 3.8s$

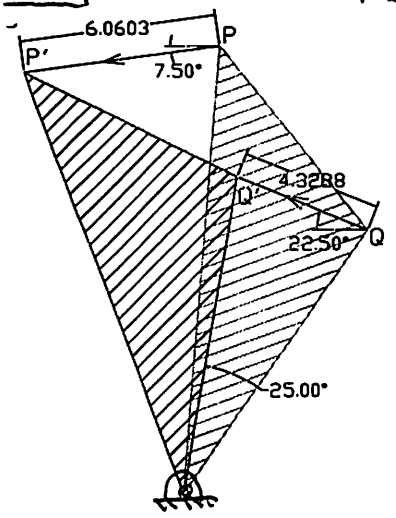
$x = 3\cos[50(3.8)+40] = -1.928$ in

$t = 4.7s$

$x = 3\cos[50(4.7)+40] = .261$ in

$\Delta x = .261 - (-1.928) = +2.189 = 2.189$ in $\rightarrow$

4-3

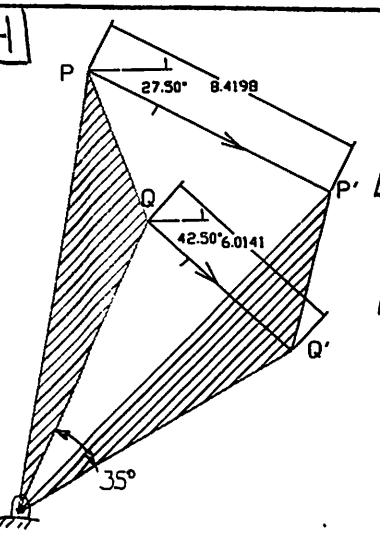


Measuring:

$\Delta R_P = 6.060$ 7.50°

$\Delta R_Q = 4.329$ 22.50°

4-4

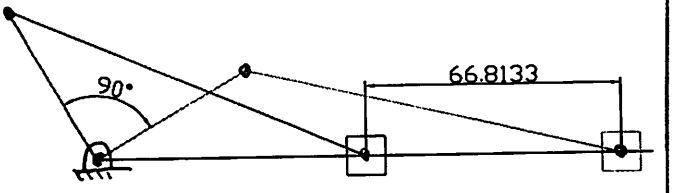


Measuring:

$\Delta R_P = 8.420$ 27.50°

$\Delta R_Q = 6.014$ 42.50°

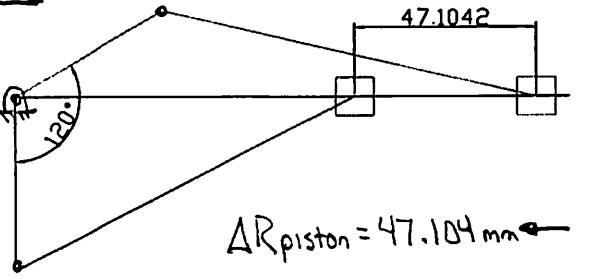
4-5



measuring:

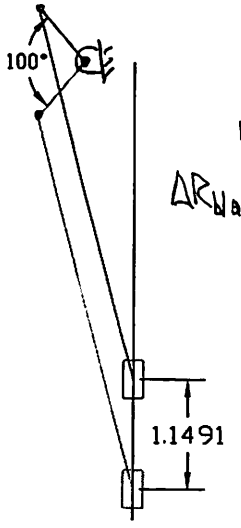
$\Delta R_{piston} = 66.813$ mm $\leftarrow$

4-6



$\Delta R_{piston} = 47.104$ mm $\leftarrow$

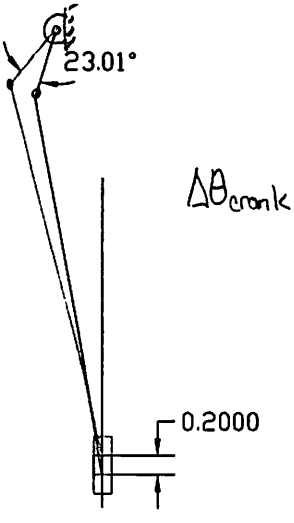
4-7



measuring:

$\Delta R_{blade} = 1.149'' \uparrow$

4-8



$\Delta\theta_{crank} = 23.01°$, ccw