3. This is an example of a first-class lever.

Lever Z

Explain your selection.

The fulcrum is between the load and the effort. Also, the load and effort are both in the same direction.

4. This is an example of a second-class lever.

Lever Y

Explain your selection.

The load is between the effort and the fulcrum.

5. This is an example of a third-class lever.

Lever X

Explain your selection.

The effort is between the load and the fulcrum.

Problem 3.5 The lever in Figure 3-7 has an efficiency of 75%. The load on the lever is 150 lb. Use this information to answer the following questions. Show your math work in the spaces provided.

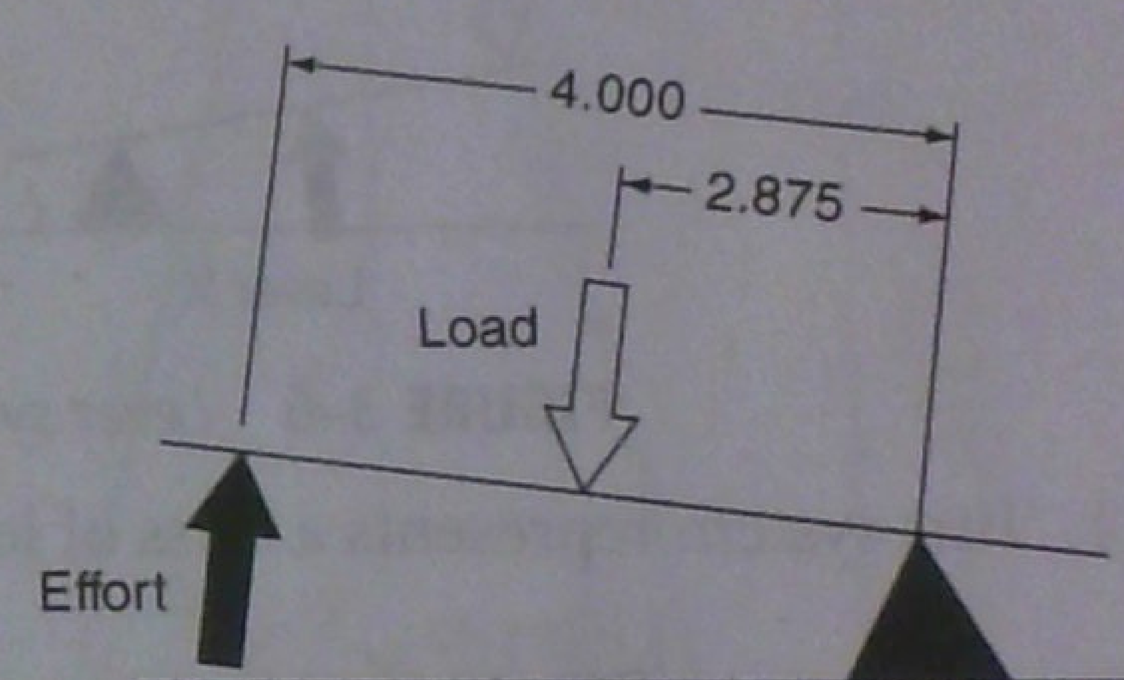

FIGURE 3-7 *A lever.*

1. Figure 3-7 is an example of what class of lever?

2nd Class

2. What is the ideal mechanical advantage (IMA) of the lever?

$IMA = \frac{4}{2.875}$

IMA = 1.391

3. What is the actual mechanical advantage (AMA) of this system?

$\eta = \frac{AMA}{IMA}$, $\eta(IMA) = AMA$

AMA = 1.04

4. What is the *ideal effort force* (E_I) that would be needed to move the lever in the absence of friction?

$\frac{L}{E_I} = IMA$ $\frac{L}{IMA} = E_I$

$E_I = \frac{150}{1.391}$

E_I = 107.836

5. What is the actual effort force (E_A) that must be applied to the lever to move the load?

$$\frac{L}{AMA} = E_a \qquad \frac{150}{1.04}$$

E_A = 144.23

6. How could you alter this machine to increase its ideal mechanical advantage (IMA)?

Make the effort farther from the fulcrum and the load closer to the fulcrum.

Problem 3.6 In Figure 3-8, a 40-lb bucket of water is being raised from a deep well using a winch system that is 85% efficient. The winch axle diameter is 4 in., and the crank handle is located 12 in. from the center axis of the axle. Use this information to answer the following questions. Show your math work in the spaces provided.

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FIGURE 3-8 *A wheel and axle system.*

1. What is the ideal mechanical advantage (IMA) of the wheel and axle?

$$IMA = \frac{r_w}{r_a} = \frac{12}{4}$$

IMA = $= 3:1$

2. What is the actual mechanical advantage (AMA) of the wheel and axle?

$$\frac{AMA}{IMA} = \eta \qquad \eta(IMA) = AMA$$

AMA = 2.55:1 $\qquad 0.85(3) = AMA$

3. Under *ideal* conditions, how much effort must be applied to the crank handle to raise the bucket of water?

$$IMA = \frac{L}{E_I} \qquad E_I = \frac{L}{IMA}$$

E_I = 13.3 $\qquad E_I = \frac{40}{3}$

4. What is the *actual* amount of effort force (E_A) that must be applied to the crank handle to raise the bucket of water?

$$AMA = \frac{L}{E_a} \qquad E_a = \frac{L}{AMA} = \frac{40}{2.55}$$

E_A = 15.69

Problem 3.7 The pulley system in Figure 3-9 is 70% efficient. The 160-lb load must be moved a vertical distance of 72 in. Use this information to answer the following questions. Show your math work in the spaces provided.

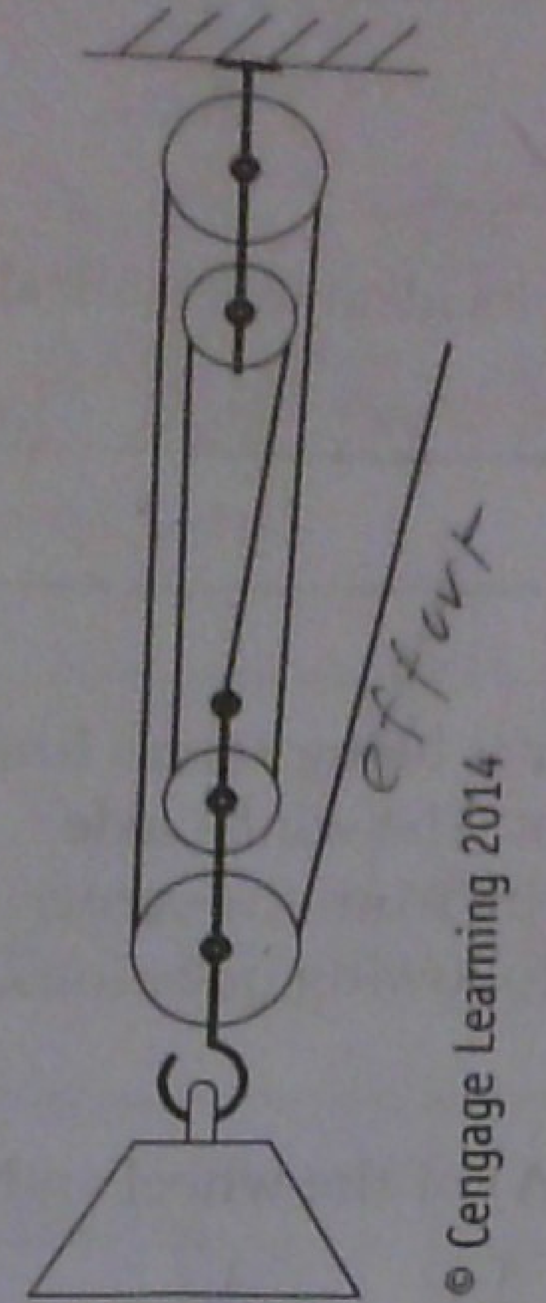

FIGURE 3-9 *A pulley system.*

1. What is the ideal mechanical advantage (IMA) of this pulley system?

IMA = 5

2. What is the actual mechanical advantage (AMA) of this pulley system?

$\eta = \frac{AMA}{IMA}$ $\eta(IMA) = AMA$

$0.7(5)$

AMA = 3.5

3. What is the length of the effort cable (d_E) that must pass through the user's hands to raise the load to the desired height?

IMA

$5(72")$

d_E = 360"

4. What is the ideal effort force (E_I) that would be needed to move the load using the pulley system?

$IMA = \frac{L}{E_I}$ $E_I = \frac{L}{IMA}$

$E_I = \frac{160}{5}$

E_I = 32

5. What is the actual effort force (E_A) that would be needed to move the load using the pulley system?

$AMA = \frac{L}{E_A}$ $E_A = \frac{L}{AMA}$

$E_A = \frac{160}{35}$

E_A = 45.74

Problem 3.8 The vise in Figure 3-10 contains a 3/8-16 UNC-threaded rod. A 500-lb holding force can be generated by turning the 4-in.-long handle. The actual mechanical advantage (AMA) of the machine is 250. Use this information to answer the following questions. Show your math work in the spaces provided.

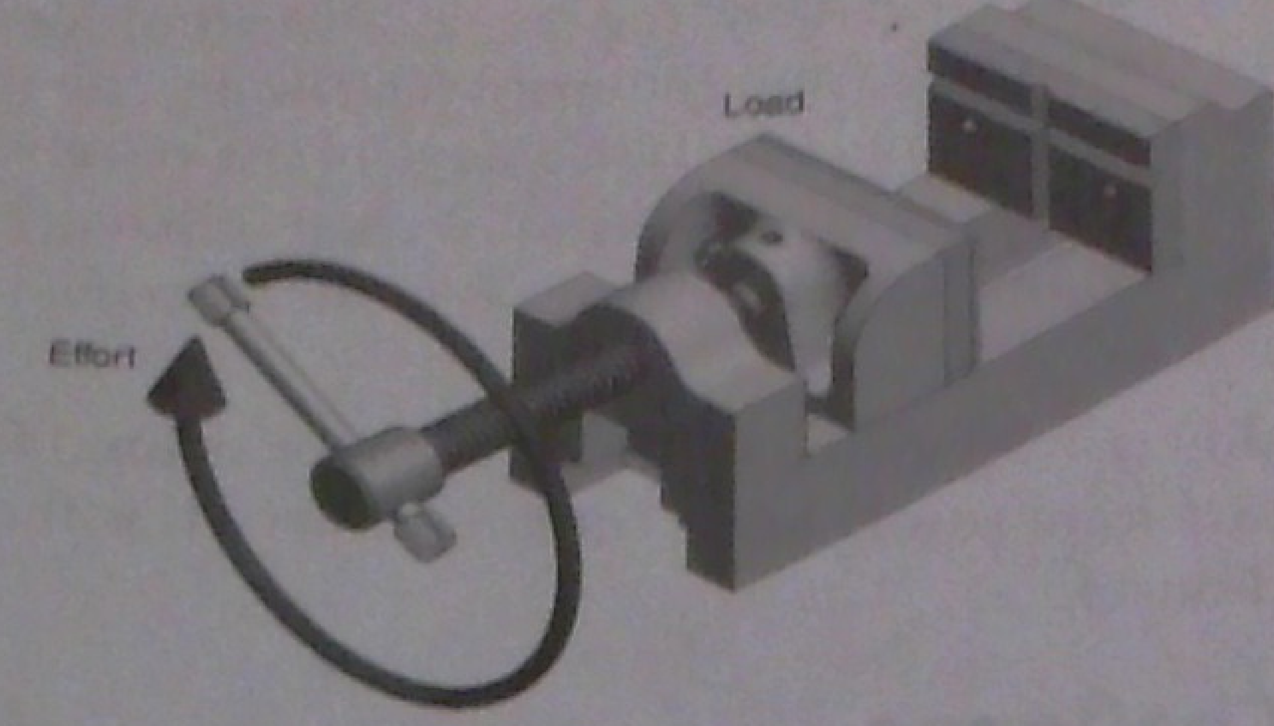

FIGURE 3-10 *A screw-actuated vise.*

1. What is the pitch of the screw thread? *See Equation 3-14 in your textbook.*

p = $\frac{1}{16}$ $\frac{1}{\#\text{of threads}}$

2. What is the ideal mechanical advantage (IMA) of the screw?

IMA = 402.12 $\frac{\text{distance of 1 revolution}}{\text{pitch}} = \frac{2\pi(4)}{\frac{1}{16}}$

3. What is the efficiency (η) of the screw system?

η = 0.621 $\frac{AMA}{IMA}$ $\frac{250}{402.12}$

4. What is the ideal effort force (E_I) that must be applied to the vise handle to hold a load?

E_I = 1.243 $IMA = \frac{L}{E_I}$ $\frac{L}{IMA}$ $\frac{500}{402.12}$

5. What is the actual effort force (E_A) that must be applied to the vise handle to hold a load?

E_A = 2 $\frac{L}{AMA}$ $\frac{500}{250}$