

## Solutions to Period 7 Exercises

### **E.1** A car jack

- a) reduces the work a person must do to raise a car.
- b) reduces the force a person must exert to raise a car.
- c) reduces the energy a person needs to raise a car.
- d) both a. and c. are correct.
- e) both a. and b. are correct.

**E.1 = b**

**E.2** Sarah uses a long lever to raise a weight of 300 lbs. She must push down with force of 30 lbs. to move the weight. When she does, her end of the lever moves down a distance of 6 inches. Assuming no energy is wasted, which of the following statements is **NOT** correct?

a) The weight will move up by 0.6 inches.

$$D_{out} = \frac{F_{in} D_{in}}{F_{out}} =$$
$$\frac{\cancel{30 \text{ lbs}} \times 6 \text{ in}}{\cancel{300 \text{ lbs}}} = 0.6 \text{ in}$$

b) The work done by Sarah is 30 ft.-lbs.

$$W = F D = 30 \text{ lbs} \times 0.5 \text{ ft} = 15 \text{ ft-lbs}$$

c) The gravitational potential energy of the weight is increased by 15 ft.-lbs.

$$E_{pot} = M g h = 30 \text{ lbs} \times 0.5 \text{ ft} = 15 \text{ ft-lbs}$$

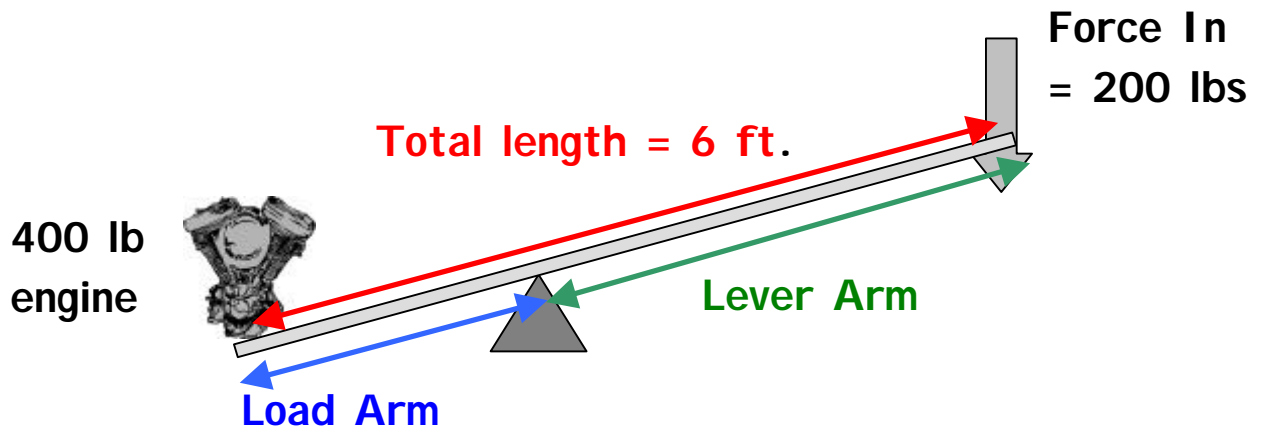
d) The upward force of the lever on the weight is 300 lbs.

$$F_{out} = \text{weight of load} = 300 \text{ lbs}$$

e) All of the above answers are correct.

**E.2 = b**

**E.3** Jim wants to lift a 400-lb car engine using a 6-foot long lever. The maximum force Jim can apply is 200 lbs. How long should the lever and load arms be so that Jim can just lift the engine with this lever? (The total length of the load arm plus lever arm is 6 feet. We assume that the lever is frictionless.)



Solve by reasoning:

The force out (400 lbs) is twice the force in (200 lbs). Therefore, the lever arm must be twice as long as the load arm. Since the **total length is 6 feet**, the **lever arm is 4 ft.** and the **load arm is 2 ft.**

Or, use equation 7.5:  $F_{in} \times L_{lever} = F_{out} \times L_{load}$   
with  $L_{lever} = 6 \text{ ft} - L_{load}$

$$200 \text{ lbs} \times (6 \text{ ft} - L_{load}) = 400 \text{ lbs} \times L_{load}$$

$$1,200 \text{ ft-lbs} - 200 L_{load} \text{ ft-lbs} = 400 L_{load} \text{ ft-lbs}$$

$$1,200 \text{ ft-lbs} = 600 L_{load} \text{ ft-lbs}$$

$$1,200 \text{ ft-lbs} / 600 \text{ lbs} = 2 \text{ ft} = L_{load}$$

$$L_{lever} = 6 \text{ ft} - L_{load} = 6 \text{ ft} - 2 \text{ ft} = 4 \text{ ft}$$

**E.4** If you want to lift a heavy weight using a small force, you want to use a machine whose mechanical advantage is

- a) greater than 1.
- b) less than 1.
- c) zero.
- d) negative.
- e) A large force is required to lift a heavy weight.

**E.4 = a**

**E.5** A pulley requires a force of 10 N to raise a 25 N block. You must pull the pulley rope a distance of 4 meters to raise the block 1 meter. What is the theoretical mechanical advantage of the pulley? What is the actual mechanical advantage of the pulley?

- a) theoretical MA = 2.5; actual MA = 4
- b) theoretical MA = 4; actual MA = 1
- c) theoretical MA = 4; actual MA = 2.5
- d) theoretical MA = 6.25; actual MA = 10
- e) theoretical MA = 10; actual MA = 6.25

$$MA_{\text{theoretical}} = \frac{D_{in}}{D_{out}} = \frac{4}{1} = 4$$

$$MA_{\text{actual}} = \frac{F_{out}}{F_{in}} = \frac{25}{10} = 2.5$$

**E.5 = c**

## Solutions to Period 7 Exercises

$$\mathbf{E.1 = b}$$

$$\mathbf{E.2 = b}$$

$$\mathbf{E.3 = c}$$

$$\mathbf{E.4 = a}$$

$$\mathbf{E.5 = c}$$