

Mechanical Advantage Worksheet

Name: _____

Date: _____

A wheelbarrow has a mechanical advantage of 2.2. The output distance extends from the load's center of mass to the wheel and the input distance is from the handles to the wheel. For an output distance of 0.45 m, what is the input distance?

1. List the given and unknown values.

Given: *mechanical advantage* = 2.2

Output distance = 4.5 m

Unknown: *input distance* = ? m

2. Use the mechanical advantage equation, and rearrange it to solve for output distance and input distance.

Because the given information involves only distance, only the first form of the equation is needed.

$$\text{Mechanical advantage} = \frac{\text{input distance}}{\text{output distance}}$$

$$\text{Output distance} = \frac{\text{input distance}}{\text{mechanical advantage}}$$

$$\text{input distance} = (\text{mechanical advantage}) (\text{output distance})$$

$$\text{Mechanical advantage} = \frac{\text{output force}}{\text{input force}}$$

$$\text{Input force} = \frac{\text{output force}}{\text{Mechanical advantage}}$$

$$\text{Output force} = (\text{mechanical advantage}) (\text{input force})$$

3. Substitute output distance and mechanical advantage values into the equation, and solve.

$$\text{Input distance} = (\text{mechanical advantage}) (\text{output distance})$$

$$= (2.2) (4.5)$$

$$= \mathbf{0.99 \text{ m}}$$

Solve the Following Problems.

1. If an input force of 202 N is applied to the handles of the wheelbarrow in the sample problem, how large is the output force that just lifts the load? (Hint: Look at the mechanical advantage for the above sample problem)
2. Suppose you need to remove a nail from a board by using a claw hammer. What is the input distance for a claw hammer if the output distance is 2.0 cm and the mechanical advantage is 5.5?
3. The power steering in an automobile has a mechanical advantage of roughly 75. If the input force on the steering wheel is 49 N, what is the output force that turns the car's front wheels?
4. An axe used to split wood is driven into a piece of wood for an input distance of 3.0 cm. If the mechanical advantage of the axe is 0.85, how far apart (output distance) is the wood split?
5. The mechanical advantage of an automobile's wheel and axle is 0.0893. If the wheel's output force is 2220 N, what is the input force that turns the axle?
6. An Archimedean screw is a screw within a closely fitting cover, so that water can be raised when the screw is turned. Suppose the screw has a mechanical advantage of 12.5. If the screw is turned several times, so that the input distance is 15.7 m, how much has water been lifted upward by the screw (output distance)?

7. A mover uses a ramp to load a crate of nails onto a truck. The crate, which must be lifted an output distance of 1.4 m from the street to the bed of the truck, is pushed along the length of the ramp. If the input distance on the ramp is 4.6 m long and friction between the ramp and crate can be ignored, what is the mechanical advantage of the ramp?

8. A complex arrangement of pulleys forms what is called the block in a block and tackle. The rope used to lift the pulleys and the load is the tackle. A block and tackle is used to lift a truck engine, which has a weight and output force of nearly 7406 N. The input force required to lift this weight using the block and tackle is 308.6 N. What is the mechanical advantage of the block and tackle?

9. It has been proposed that the stones of the Pyramids in Egypt were raised by using ramps. Suppose one of these ramps had a mechanical advantage of 3.86. If an input force of 6350 N was provided by laborers, what would the output force on the stone have been?

10. A wedge with a mechanical advantage of 0.78 is used to raise a house corner from its foundation. If the output force is 7500 N, what is the input force?

11. A penny-farthing is a style of bicycle with a very large front wheel and a small rear wheel. The cyclist, who sits high above and behind the front wheel, pedals this wheel directly. The distance the pedals are turned (input distance) in one rotation is about 0.64 m. If the mechanical advantage of the penny-farthing is 0.16, how far does the large wheel turn in one rotation (output distance)?

12. A block and tackle with a mechanical advantage of 48 is used to lift a piano 11 m to the third floor of a building (output distance). Although the arrangement of pulleys in the block and tackle makes it easy to lift the piano, it takes a long time because of the length of rope that must be pulled to lift the piano a small amount. What is the length, or input distance, of the rope that must be pulled?

13. The input distance of a screw is equal to the circumference of the screw multiplied by the number of times it is turned. If a screw with a circumference of 19 mm is turned 4 times, so that it penetrates into a piece of wood a distance of 8.5 mm (output distance), what is the screw's mechanical advantage?

14. Over 100 hydraulic jacks were used to lift the massive Ekofisk offshore complex in the North Sea. An output force of 390,000,000 N was required to raise the complex. What input force would have to be provided to each jack if the overall mechanical advantage of the jacks was 1500? (Hint: First find the input force for all of the jacks and then divide it by the number of jacks)