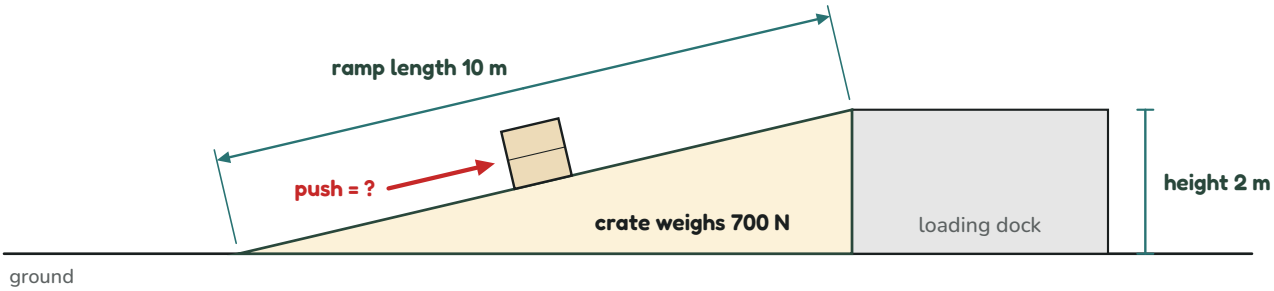
Work, Power and Simple Machines

Grades 6-8

Name _____ Date _____

Directions: Work = force × distance (W = F × d), in joules (J). Power = work ÷ time (P = W ÷ t), in watts (W). Write the formula, put in the numbers and give each answer with its unit. Items 5 to 7 use the ramp drawing; ignore friction there.

lever | pulley | wedge | screw | wheel and axle | inclined plane



Drawing not to scale. The ramp length is measured along its sloping surface. The push arrow is parallel to that surface.

1. A beach winch drags a kayak 12 m across the sand. Its cable pulls with 85 N the whole way. Calculate the work the winch does. _____

2. The winch in item 1 needs 15 s for that pull. Calculate its power. _____

3. A warehouse robot arm raises a 90 N carton straight up 4 m in 6 s. Work: _____ Power: _____

4. Which simple machine is each object? Choose from the bank. (a) a chisel driven into a block of wood: _____ (b) a rowboat oar pivoting on the side of the boat: _____ (c) the grooved wheel that the cable of a gym weight machine runs over: _____

5. For a ramp without friction, mechanical advantage = ramp length ÷ ramp height. Find the mechanical advantage of the ramp in the drawing. _____

6. Push = weight ÷ mechanical advantage. How large a push along the ramp moves the crate up at steady speed? _____ How much work does that push do over the whole ramp? _____

7. Trade-off. Hoisting the crate straight up onto the dock, with no ramp, takes 700 N. Calculate the work for that straight lift, then explain what the ramp user gains and what the ramp user gives up.

8. A 250 W motor has to do 3,000 J of work. Rearrange the power formula to find how many seconds the job takes.

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Answer key

One point for each blank in items 1 to 6 (number with its unit; item 4 takes the machine name and item 5 has no unit). Item 7: three points (work, gain, cost). Item 8: two points (rearranged formula, time).

1. **1,020 J**
   W = F × d = 85 × 12 = 1,020 J.

2. **68 W**
   P = W ÷ t = 1,020 ÷ 15 = 68 W.

3. **Work 360 J; power 60 W**
   90 × 4 = 360 J; 360 ÷ 6 = 60 W.

4. **(a) wedge; (b) lever; (c) pulley**
   The slanted faces of a chisel push the wood apart: a wedge. An oar is a rigid bar that turns on a pivot at the side of the boat: a lever. A grooved wheel that a cable runs over is a pulley.

5. **5**
   10 ÷ 2 = 5. Mechanical advantage has no unit: meters divided by meters cancel.

6. **Push 140 N; work 1,400 J**
   700 ÷ 5 = 140 N; 140 × 10 = 1,400 J.

7. **Straight lift: 700 × 2 = 1,400 J, the same work as on the ramp. Gain: a smaller force (140 N instead of 700 N). Cost: a longer distance (10 m instead of 2 m).**
   A machine trades force for distance; it never reduces the work. On a real ramp friction makes the work a little greater than for the straight lift.

8. **t = W ÷ P = 3,000 ÷ 250 = 12 s**
   Check: 250 W × 12 s = 3,000 J.