

Homework (Moodle Submission by 1/13)

Set 1 – Chapter 10

1, 2, 3, 5, 6, 7, 25, 26, 27, 28, 52, 53, 56, 57

Set 2 – Chapter 10

60, 63, 67, 70, 76, 79, 81, 83, 84, 85, 90, 93

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▶ EXAMPLE Problem 1

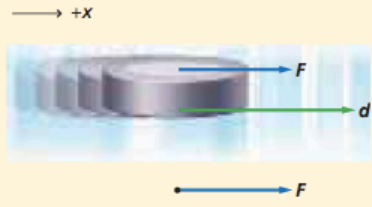
Work and Energy A 105-g hockey puck is sliding across the ice. A player exerts a constant 4.50-N force over a distance of 0.150 m. How much work does the player do on the puck? What is the change in the puck's energy?

1 Analyze and Sketch the Problem

- Sketch the situation showing initial conditions.
- Establish a coordinate system with +x to the right.
- Draw a vector diagram.

Known: $m = 105 \text{ g}$
 $F = 4.50 \text{ N}$
 $d = 0.150 \text{ m}$

Unknown: $W = ?$
 $\Delta KE = ?$



The diagram shows a hockey puck on ice. A coordinate system is established with the positive x-axis pointing to the right. A force vector F is shown as a blue arrow pointing to the right, and a displacement vector d is shown as a green arrow pointing to the right. Below the puck, another blue arrow labeled F points to the right.

2 Solve for the Unknown

Use the equation for work when a constant force is exerted in the same direction as the object's displacement.

$$W = Fd$$
$$= (4.50 \text{ N})(0.150 \text{ m}) \quad \text{Substitute } F = 4.50 \text{ N, } d = 0.150 \text{ m}$$
$$= 0.675 \text{ N}\cdot\text{m}$$
$$= 0.675 \text{ J} \quad 1 \text{ J} = 1 \text{ N}\cdot\text{m}$$

Use the work-energy theorem to determine the change in energy of the system.

$$W = \Delta KE$$
$$\Delta KE = 0.675 \text{ J} \quad \text{Substitute } W = 0.675 \text{ J}$$

3 Evaluate the Answer

- **Are the units correct?** Work is measured in joules.
- **Does the sign make sense?** The player (external world) does work on the puck (the system). So the sign of work should be positive.

Math Handbook
Operations with Significant Digits
pages 835–836

- 1. Refer to Example Problem 1 to solve the following problem.
 - a. If the hockey player exerted twice as much force, 9.00 N, on the puck, how would the puck's change in kinetic energy be affected?
 - b. If the player exerted a 9.00-N force, but the stick was in contact with the puck for only half the distance, 0.075 m, what would be the change in kinetic energy?

- 2. Together, two students exert a force of 825 N in pushing a car a distance of 35 m.
 - a. How much work do the students do on the car?
 - b. If the force was doubled, how much work would they do pushing the car the same distance?

- 3. A rock climber wears a 7.5-kg backpack while scaling a cliff. After 30.0 min, the climber is 8.2 m above the starting point.
 - a. How much work does the climber do on the backpack?
 - b. If the climber weighs 645 N, how much work does she do lifting herself and the backpack?
 - c. What is the change in the climber's energy?

- 5. Two people lift a heavy box a distance of 15 m. They use ropes, each of which makes an angle of 15° with the vertical. Each person exerts a force of 225 N. How much work do they do?

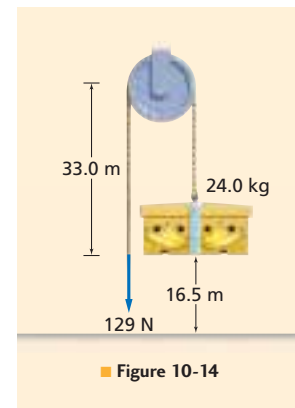
- 6. An airplane passenger carries a 215-N suitcase up the stairs, a displacement of 4.20 m vertically, and 4.60 m horizontally.
 - a. How much work does the passenger do?
 - b. The same passenger carries the same suitcase back down the same set of stairs. How much work does the passenger do now?

- 7. A rope is used to pull a metal box a distance of 15.0 m across the floor. The rope is held at an angle of 46.0° with the floor, and a force of 628 N is applied to the rope. How much work does the force on the rope do?

- 25. A sledgehammer is used to drive a wedge into a log to split it. When the wedge is driven 0.20 m into the log, the log is separated a distance of 5.0 cm. A force of $1.7 \times 10^4 \text{ N}$ is needed to split the log, and the sledgehammer exerts a force of $1.1 \times 10^4 \text{ N}$.
 - a. What is the IMA of the wedge?
 - b. What is the AMA of the wedge?
 - c. Calculate the efficiency of the wedge as a machine.

- 26. A worker uses a pulley system to raise a 24.0-kg carton 16.5 m, as shown in Figure 10-14. A force of 129 N is exerted, and the rope is pulled 33.0 m.

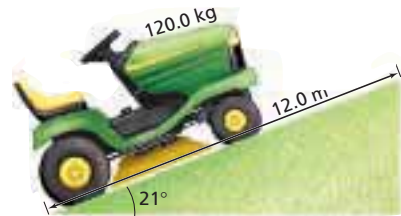
- What is the AMA of the pulley system?
- What is the efficiency of the system?



- 27. You exert a force of 225 N on a lever to raise a 1250 N rock a distance of 13 cm. If the efficiency of the lever is 88.7 percent, how far did you move your end of the lever?
- 28. A winch has a crank with a 45-cm radius. A rope is wrapped around a drum with a 7.5-cm radius. One revolution of the crank turns the drum one revolution.
 - What is the ideal mechanical advantage of this machine?
 - If, due to friction, the machine is only 75 percent efficient, how much force would have to be exerted on the handle of the crank to exert 750 N of force on the rope?
- 52. The third floor of a house is 8 m above street level. How much work is needed to move a 150-kg refrigerator to the third floor?
- 53. Haloke does 176 J of work lifting himself 0.300 m. What is Haloke's mass?
- 56. To keep a car traveling at a constant velocity, a 551-N force is needed to balance frictional forces. How much work is done against friction by the car as it travels from Columbus to Cincinnati, a distance of 161 km?
- 57. A cyclist exerts a force of 15.0 N as he rides a bike 251 m in 30.0 s. How much power does the cyclist develop?

- 60. A wagon is pulled by a force of 38.0 N exerted on the handle at an angle of 42.0° with the horizontal. If the wagon is pulled in a circle of radius 25.0 m, how much work is done?

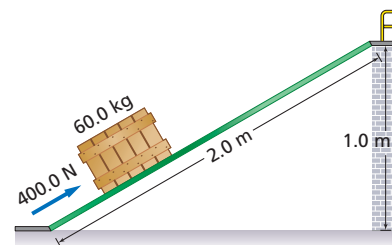
- 63. A 120-kg lawn tractor, shown in Figure 10-17, goes up a 21° incline that is 12.0 m long in 2.5 s. Calculate the power that is developed by the tractor.



- 67. Sau-Lan has a mass of 52 kg. She rides up the escalator at Ocean Park in Hong Kong. This is the world's longest escalator, with a length of 227 m and an average inclination of 31° . How much work does the escalator do on Sau-Lan?

- 70. Maricruz slides a 60.0-kg crate up an inclined ramp that is 2.0-m long and attached to a platform 1.0 m above floor level, as shown. A 400.0 N force, parallel to the ramp, is needed to slide the crate up the ramp at a constant speed.

- How much work does Maricruz do in sliding the crate up the ramp?
- How much work would be done if Maricruz simply lifted the crate straight up from the floor to the platform?



- 76. A 12.0-m-long conveyor belt, inclined at 30.0° , is used to transport bundles of newspapers from the mail room up to the cargo bay to be loaded onto delivery trucks. Each newspaper has a mass of 1.0 kg, and there are 25 newspapers per bundle. Determine the power that the conveyor develops if it delivers 15 bundles per minute.

- 79. Takeshi raises a 1200-N piano a distance of 5.00 m using a set of pulleys. He pulls in 20.0 m of rope.
 - a. How much effort force would Takeshi apply if this were an ideal machine?
 - b. What force is used to balance the friction force if the actual effort is 340 N?
 - c. What is the output work?
 - d. What is the input work?
 - e. What is the mechanical advantage?

- 81. A pulley system lifts a 1345-N weight a distance of 0.975 m. Paul pulls the rope a distance of 3.90 m, exerting a force of 375 N.
 - a. What is the ideal mechanical advantage of the system?
 - b. What is the mechanical advantage?
 - c. How efficient is the system?

- 83. A student exerts a force of 250 N on a lever, through a distance of 1.6 m, as he lifts a 150-kg crate.
 - If the efficiency of the lever is 90.0 percent, how far is the crate lifted?

- 84. What work is required to lift a 215-kg mass a distance of 5.65 m, using a machine that is 72.5 percent efficient?

- 85. The ramp in Figure 10-23 is 18 m long and 4.5 m high.
 - a. What force, parallel to the ramp (FA), is required to slide a 25-kg box at constant speed to the top of the ramp if friction is disregarded?
 - b. What is the IMA of the ramp?
 - c. What are the real MA and the efficiency of the ramp if a parallel force of 75 N is actually required?

- 90. Brutus, a champion weightlifter, raises 240 kg of weights a distance of 2.35 m.
 - a. How much work is done by Brutus lifting the weights?
 - b. How much work is done by Brutus holding the weights above his head?
 - c. How much work is done by Brutus lowering them back to the ground?
 - d. Does Brutus do work if he lets go of the weights and they fall back to the ground?
 - e. If Brutus completes the lift in 2.5 s, how much power is developed?

- 93. Sally does 11.4 kJ of work dragging a wooden crate 25.0 m across a floor at a constant speed. The rope makes an angle of 48.0° with the horizontal.
 - a. How much force does the rope exert on the crate?
 - b. What is the force of friction acting on the crate?
 - c. What work is done by the floor through the force of friction between the floor and the crate?