3 examples:
2 objects, Atwood,

Homework (Moodle Submission by 1/13)

Set 1 – Chapter 10
1, 2, 3, 5, 6, 7, 25, 26, 27, 28, 52, 53, 56, 57

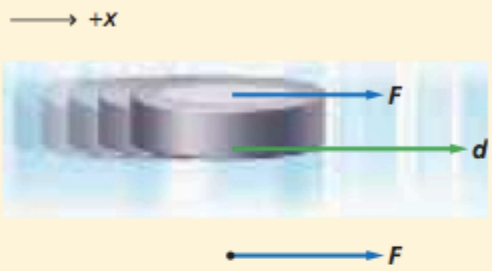
Set 2 – Chapter 10
60, 63, 67, 70, 76, 79, 81, 83, 84, 85, 90, 93

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:	Unknown:
$m = 105$ g	$W = ?$
$F = 4.50$ N	$\Delta KE = ?$
$d = 0.150$ m	

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.

$W = Fd$

$= (4.50\ \text{N})(0.150\ \text{m})$ Substitute $F = 4.50$ N, $d = 0.150$ m

$= 0.675\ \text{N·m}$

$= 0.675\ \text{J}$ $1\ \text{J} = 1\ \text{N·m}$

Math Handbook
Operations with Significant Digits
pages 835–836

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

$W = \Delta KE$

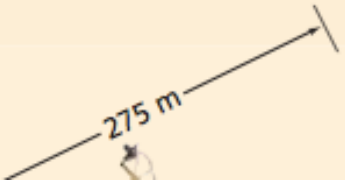
$\Delta KE = 0.675\ \text{J}$ Substitute $W = 0.675$ J

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.

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 1.7×10^4 N is needed to split the log, and the sledgehammer exerts a force of 1.1×10^4 N.
   a. What is the *IMA* of the wedge?
   b. What is the *MA* 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.
   a. What is the *MA* of the pulley system?
   b. What is the efficiency of the system?
27. You exert a force of 225 N on a lever to raise a 1.25×10^3-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.

a. What is the ideal mechanical advantage of this machine?

b. 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?

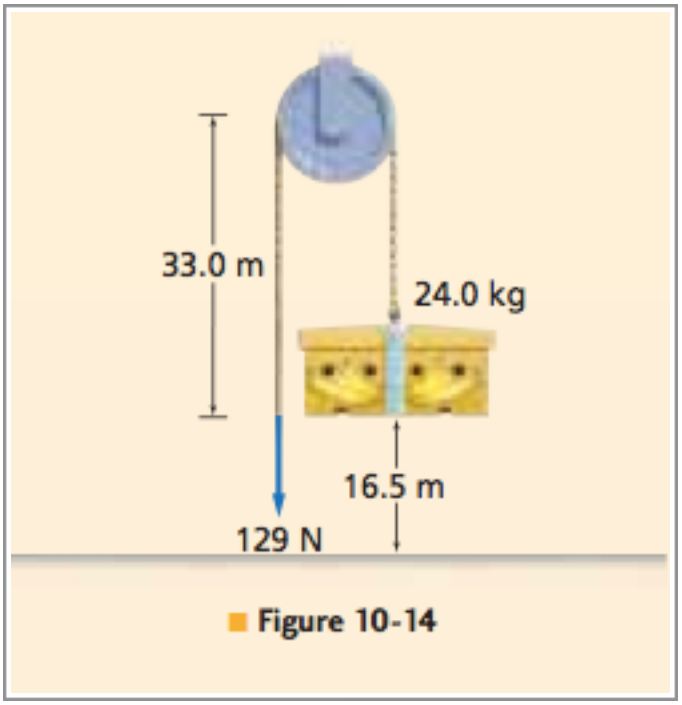


Figure 10-14

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. Cycling 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?

58. A student librarian lifts a 2.2-kg book from the floor to a height of 1.25 m. He carries the book 8.0 m to the stacks and places the book on a shelf that is 0.35 m above the floor. How much work does he do on the book?

59. A force of 300.0 N is used to push a 145-kg mass 30.0 m horizontally in 3.00 s.
a. Calculate the work done on the mass.
b. Calculate the power developed.

60. Wagon 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?

61. Lawn Mower Shani is pushing a lawn mower with a force of 88.0 N along a handle that makes an angle of 41.0° with the horizontal. How much work is done by Shani in moving the lawn mower 1.2 km to mow the yard?

62. A 17.0-kg crate is to be pulled a distance of 20.0 m, requiring 1210 J of work to be done. If the job is done by attaching a rope and pulling with a force of 75.0 N, at what angle is the rope held?

63. Lawn Tractor 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.

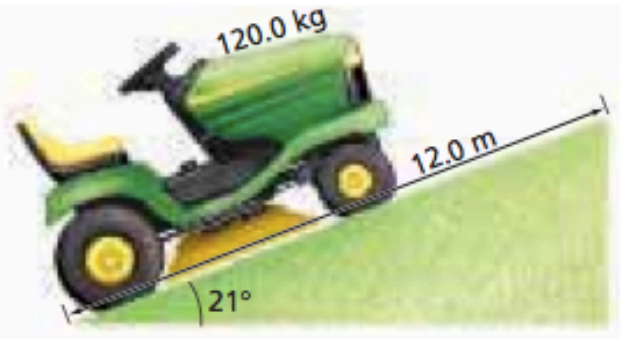


Figure 10-17

67. Escalator 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 in **Figure 10-19.** A 400.0-N force, parallel to the ramp, is needed to slide the crate up the ramp at a constant speed.

a. How much work does Maricruz do in sliding the crate up the ramp?

b. How much work would be done if Maricruz simply lifted the crate straight up from the floor to the platform?

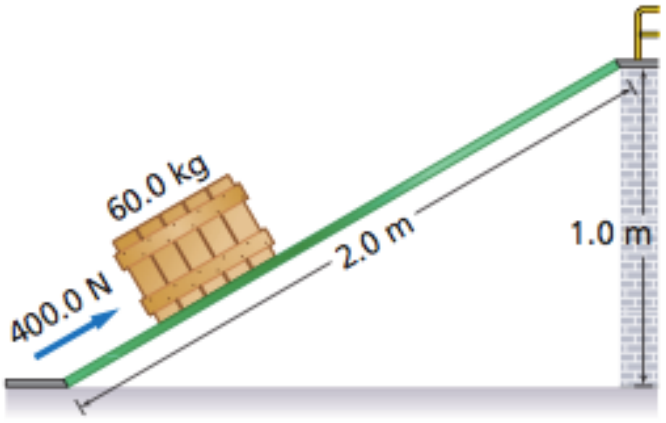


Figure 10-19

76. Conveyor Belt 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.

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?

82. A force of 1.4 N is exerted through a distance of 40.0 cm on a rope in a pulley system to lift a 0.50-kg mass 10.0 cm. Calculate the following.

a. the *MA*

b. the *IMA*

c. the efficiency

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 (F_A), 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?

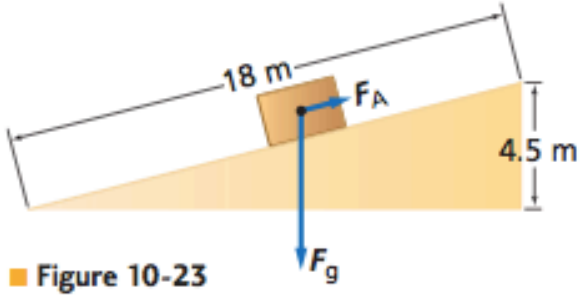


Figure 10-23

79. Piano 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?

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?