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?

Since gravity acts vertically, only the vertical displacement needs to be considered.

$W = Fd = (215\ \text{N})(4.20\ \text{m}) = 903\ \text{J}$

b. The same passenger carries the same suitcase back down the same set of stairs. How much work does the passenger do now?

Force is upward, but vertical displacement is downward, so

$W = Fd \cos \theta$

$= (215\ \text{N})(4.20\ \text{m})(\cos 180.0°)$

$= -903\ \text{J}$

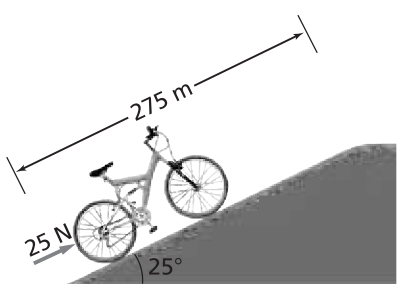
7. A rope is used to pull a metal box a distance of 15.0 m across the floor. The rope is held at an angle of 46.0° with the floor, and a force of 628 N is applied to the rope. How much work does the force on the rope do?

$W = Fd \cos \theta$

$= (628\ \text{N})(15.0\ \text{m})(\cos 46.0°)$

$= 6.54\times10^3\ \text{J}$

8. A bicycle rider pushes a bicycle that has a mass of 13 kg up a steep hill. The incline is 25° and the road is 275 m long, as shown in **Figure 10-4.** The rider pushes the bike parallel to the road with a force of 25 N.



■ **Figure 10-4** (Not to scale)

a. How much work does the rider do on the bike?

Force and displacement are in the same direction.

$W = Fd$

$= (25\ \text{N})(275\ \text{m})$

$= 6.9\times10^3\ \text{J}$

b. How much work is done by the force of gravity on the bike?

The force is downward (−90°), and the displacement is 25° above the horizontal or 115° from the force.

$W = Fd \cos \theta$

$= mgd \cos \theta$

$= (13\ \text{kg})(9.80\ \text{m/s}^2)(275\ \text{m})(\cos 115°)$

$= -1.5\times10^4\ \text{J}$

page 264

9. A box that weighs 575 N is lifted a distance of 20.0 m straight up by a cable attached to a motor. The job is done in 10.0 s. What power is developed by the motor in W and kW?

$P = \frac{W}{t} = \frac{Fd}{t} = \frac{(575\ \text{N})(20.0\ \text{m})}{10.0\ \text{s}}$

$= 1.15\times10^3\ \text{W} = 1.15\ \text{kW}$

10. You push a wheelbarrow a distance of 60.0 m at a constant speed for 25.0 s, by exerting a 145-N force horizontally.

a. What power do you develop?

$P = \frac{W}{t} = \frac{Fd}{t} = \frac{(145\ \text{N})(60.0\ \text{m})}{25.0\ \text{s}} = 348\ \text{W}$

b. If you move the wheelbarrow twice as fast, how much power is developed?

***t* is halved, so *P* is doubled to 696 W.**

11. What power does a pump develop to lift 35 L of water per minute from a depth of 110 m? (1 L of water has a mass of 1.00 kg.)

$P = \frac{W}{t} = \frac{mgd}{t} = \left(\frac{m}{t}\right)gd$

where $\frac{m}{t} = (35\ \text{L/min})(1.00\ \text{kg/L})$

Thus,

$P = \left(\frac{m}{t}\right)gd$

$= (35\ \text{L/min})(1.00\ \text{kg/L})(9.80\ \text{m/s}^2)(110\ \text{m})(1\ \text{min}/60\text{s})$

$= 0.63\ \text{kW}$

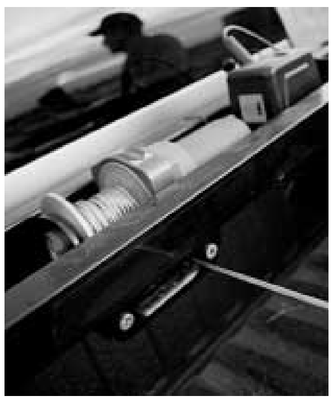
12. An electric motor develops 65 kW of power as it lifts a loaded elevator 17.5 m in 35 s. How much force does the motor exert?

$$P = \frac{W}{t} = \frac{Fd}{t}$$

$$F = \frac{Pt}{d} = \frac{(65\times10^3\ \text{W})(35\ \text{s})}{17.5\ \text{m}}$$

$$= 1.3\times10^5\ \text{N}$$

13. A winch designed to be mounted on a truck, as shown in **Figure 10-7,** is advertised as being able to exert a 6.8×10^3-N force and to develop a power of 0.30 kW. How long would it take the truck and the winch to pull an object 15 m?



■ **Figure 10-7**

$$P = \frac{W}{t} = \frac{Fd}{t}$$

$$t = \frac{Fd}{P}$$

$$= \frac{(6.8\times10^3\ \text{N})(15\ \text{m})}{(0.30\times10^3\ \text{W})} = 340\ \text{s}$$

$$= 5.7\ \text{min}$$

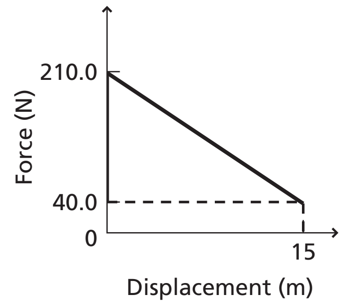
14. Your car has stalled and you need to push it. You notice as the car gets going that you need less and less force to keep it going. Suppose that for the first 15 m, your force decreased at a constant rate from 210.0 N to 40.0 N. How much work did you do on the car? Draw a force-displacement graph to represent the work done during this period.

The work done is the area of the trapezoid under the solid line:

$$W = \frac{1}{2}d(F_1 + F_2)$$

$$= \frac{1}{2}(15\ \text{m})(210.0\ \text{N} + 40.0\ \text{N})$$

$$= 1.9\times10^3\ \text{J}$$



Section Review

10.1 Energy and Work pages 257–265

page 265

15. Work Murimi pushes a 20-kg mass 10 m across a floor with a horizontal force of 80 N. Calculate the amount of work done by Murimi.

$W = Fd = (80\ \text{N})(10\ \text{m}) = 8\times10^2\ \text{J}$

The mass is not important to this problem.

16. Work A mover loads a 185-kg refrigerator into a moving van by pushing it up a 10.0-m, friction-free ramp at an angle of inclination of 11.0°. How much work is done by the mover?

$y = (10.0\ \text{m})(\sin 11.0°)$

$= 1.91\ \text{m}$

$W = Fd = mgd \sin\theta$

$= (185\ \text{kg})(9.80\ \text{m/s}^2)(10.0\ \text{m})(\sin 11.0°)$

$= 3.46\times10^3\ \text{J}$

17. Work and Power Does the work required to lift a book to a high shelf depend on how fast you raise it? Does the power required to lift the book depend on how fast you raise it? Explain.

No, work is not a function of time. However, power is a function of time, so the power required to lift the book does depend on how fast you raise it.