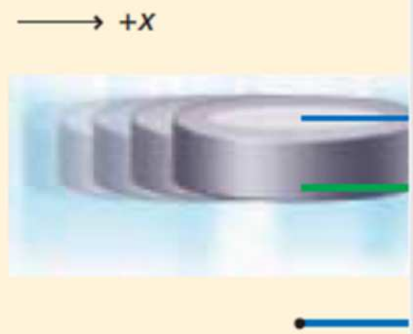
▶ EXAMPLE **Problem 1**

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:

$m = 105$ g → .105 Kg

$F = 4.50$ N

$d = 0.150$ m

Unknown:

$W = ?$

$\Delta KE = ?$

$W = F\Delta d$

$= (4.50)(.150)$

$= .675$ J

$W = \Delta KE = .675$ J

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?

(1) a) $F = 9.00\ N$

$m = .105\ kg$

$\Delta d = .150\ m$

$\Delta KE = \_\_\_\ J$

$\Delta KE = W = F\Delta d$

$= (9.00)(.150)$

$\Delta KE = 1.35\ J$

b) $F = 9.00\ N$

$\Delta d = .075\ m$

$\Delta KE = W = F\Delta d$

$= (9.00)(.075)$

$= .675\ J$

$\Delta KE \uparrow, F \uparrow$ } direct

$\Delta KE \uparrow, \Delta d \uparrow$ } prop.

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?

(a) $W = F\Delta d$

$= (825)(35)$

$= 28875 \text{ J}$

$\underline{2.9 \times 10^4 \text{ J}}$ or $\underline{29000 \text{ J}}$

(b) $W = (1650)(35)$

$= 57750 \text{ J}$

$= \underline{5.8 \times 10^4 \text{ J}}$ or $\underline{58000 \text{ J}}$

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?

(a) $W = F\Delta d = mgh = (7.5)(9.8)(8.2) = 602.7\ J$

$= 6.0 \times 10^2\ J$

(b) $W_{net} = W_B + W_c$

$W_c = F_c \Delta d = (645N)(8.2m)$

$W_c = 5289\ J$

$\therefore W_{net} = 602.7 + 5289$

$= 5891.7\ J = 5.9 \times 10^3\ J$

(c) Same as part (b).

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?

$F = 575 N$

$\Delta d = 20.0 m$

$t = 10.0 s$

$P = \_\_\_ W$

$P = \_\_\_ kW$

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

$$P = \frac{F \Delta d}{t} = \frac{(575)(20.0)}{(10.0)}$$

$$\boxed{P = 1150 W}$$

$$\boxed{P = 1.15 kW}$$

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?

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

$\Delta d = 60.0\,m$

$t = 25.0\,s$

$F = 145\,N$

(a) $P = \_\_\_\_\ W$

$$P = \frac{F\Delta d}{t} = \frac{(145)(60.0)}{(25.0)}$$

$P = 348\ W$

(b) $P \uparrow,\ v \uparrow$

power will double!

$$P = Fv$$
$$= F(2v)$$
$$= 2(Fv)$$
$$\Downarrow$$
$$2P$$

twice as big!

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.)

$m = 35\ kg$ (b/c $\frac{35 L}{} \Big| \frac{1.00 kg}{1 L}$)

$t = \frac{1 min}{} \Big| \frac{60 s}{1 min} = 60 s$

$\Delta d = 110\ m$

$P = \underline{\quad\quad}\ W$

$F = mg = (35)(9.8) = 343\ N$

$P = \frac{F \Delta d}{t} = \frac{(343)(110)}{(60)}$

$P = 628.83$

$P = 630\ W$

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?

$P = 65\,kW = 65000\,W$

$\Delta d = 17.5\,m$

$t = 35\,s$

$F = \_\_\_\_\,N$

$$t * P = \frac{F\Delta d}{t} * t$$

$$\frac{tP}{\Delta d} = \frac{F\Delta d}{\Delta d}$$

$$\therefore F = \frac{Pt}{\Delta d} = \frac{(65000)(35)}{(17.5)}$$

$F = 130000\,N$

or $1.3 \times 10^5\,N$

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

$F = 6.8\times10^3\ N$

$P = 0.30\ kW = 300\ W$

$\Delta d = 15\ m$

$t = \_\_\_\ s$

$t * P = \frac{F\Delta d}{t} * t$

$\frac{Pt}{P} = \frac{F\Delta d}{P}$

$t = \frac{F\Delta d}{P} = \frac{(6800)(15)}{(300)}$

$t = 340\ s$