

## Problems 2.3

- 1 a) Determine the kinetic energy of a 1200 kg roller coaster car that is moving with a speed of 15 m/s.

$$m = 1200 \text{ kg}$$

$$v = 15 \text{ m/s}$$

$$E_k = \frac{1}{2} m v^2$$

$$= \frac{1}{2} (1200 \text{ kg}) (15 \text{ m/s})^2$$

$$= 135000 \text{ J}$$

$$= \underline{1.4 \times 10^5 \text{ J}}$$

- b) If the car in part a) was moving with three times the speed, what would be its new kinetic energy?

When the speed is tripled,  $E_k$  will be 9 times larger.

$$(9)(135000 \text{ J}) = 1215000 \text{ J}$$

$$= \underline{1.2 \times 10^6 \text{ J}}$$

or

$$m = 1200 \text{ kg}$$

$$v = (3)(15 \text{ m/s}) = 45 \text{ m/s}$$

$$E_k = \frac{1}{2} m v^2$$

$$= \frac{1}{2} (1200 \text{ kg}) (45 \text{ m/s})^2$$

$$= 1215000 \text{ J} = \underline{1.2 \times 10^6 \text{ J}}$$

A 2.0 kg boulder is dropped from a height of 5.0 m. What is the kinetic energy of the boulder as it hits the ground?

$$v_1 = 0$$

$$m = 2.0 \text{ kg}$$

$$\Delta d = 5.0 \text{ m}$$

$$a = 9.80 \text{ m/s}^2$$

$$v_2^2 = v_1^2 + 2a\Delta d$$

$$= 0 + 2(9.80 \text{ m/s}^2)(5.0 \text{ m})$$

$$v_2^2 = 98 \text{ m}^2/\text{s}^2$$

$$v_2 = \underline{9.9 \text{ m/s}}$$

$$E_k = \frac{1}{2} m v^2$$

$$= \frac{1}{2} (2.0 \text{ kg}) (9.9 \text{ m/s})^2$$

$$E_k = \underline{98 \text{ J}}$$

3. A 12.0 N object has kinetic energy of 275 J. What is the speed of the object?

$$F = 12.0 \text{ N}$$

$$g = 9.80 \text{ N/kg}$$

$$E_k = 275 \text{ J}$$

$$v = ?$$

$$F = ma$$

$$12.0 \text{ N} = m (9.80 \text{ N/kg})$$

$$m = 1.22 \text{ kg}$$

$$E_k = \frac{1}{2} m v^2$$

$$275 \text{ J} = \frac{1}{2} (1.22 \text{ kg}) v^2$$

$$v^2 = 450 \text{ m}^2/\text{s}^2$$

$$v = \underline{21.2 \text{ m/s}}$$

4. How much work must be done to accelerate a 0.20 kg hockey puck from 11 m/s to 17 m/s?

$$m = 0.20 \text{ kg}$$

$$v_i = 11 \text{ m/s}$$

$$v_f = 17 \text{ m/s}$$

$$W = \Delta E_k = ?$$

$$\Delta E_k = E_{kf} - E_{ki}$$

$$= \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

$$= \frac{1}{2} (0.20 \text{ kg}) \left( \frac{17 \text{ m}}{\text{s}} \right)^2 - \frac{1}{2} (0.20 \text{ kg}) \left( \frac{11 \text{ m}}{\text{s}} \right)^2$$

$$= 28.9 - 12.1$$

$$= 16.8 \text{ J}$$

$$\Delta E_k = 17 \text{ J}$$

5. A 3.0 kg box was lifted vertically and then dropped.  
a) How much work was required to lift the box 75.0 m?

$$m = 3.0 \text{ kg}$$

$$\Delta d = 75.0 \text{ m}$$

$$W = ?$$

$$F = mg$$

$$= (3.0 \text{ kg})(9.80 \text{ N/kg})$$

$$= 29.4 \text{ N}$$

$$W = F \Delta d$$

$$= (29.4 \text{ N})(75.0 \text{ m})$$

$$= 2205 \text{ J}$$

$$W = 2200 \text{ J}$$

- b) If the box was dropped from a height of 75.0 m, what would its kinetic energy be just before it reached the ground?

• Total Mechanical energy at maximum height would be equal to the work done:  $E_T = 2200 \text{ J}$

• Kinetic energy just before the box reached the ground would equal the total mechanical energy:  $E_k = 2200 \text{ J}$

- c) What would its velocity be just before it hit the ground?

$$v = ?$$

$$m = 3.0 \text{ kg}$$

$$E_k = 2200 \text{ J}$$

$$E_k = \frac{1}{2} m v^2$$

$$2200 \text{ J} = \frac{1}{2} (3.0 \text{ kg}) v^2$$

$$v^2 = 1466.7 \text{ m}^2/\text{s}^2$$

$$v = 38 \text{ m/s}$$

6. A 0.25 kg hockey puck is traveling at 18.0 m/s.  
a) What is its kinetic energy?

$$m = 0.25 \text{ kg}$$

$$v = 18.0 \text{ m/s}$$

$$E_k = ?$$

$$E_k = \frac{1}{2} m v^2$$

$$= \frac{1}{2} (0.25 \text{ kg}) (18.0 \text{ m/s})^2 = 41 \text{ J}$$

- b) In order to achieve a velocity of 18.0 m/s, how much work was done?

Since work is equal to  $\Delta E_k$  and  $\Delta E_k = E_{kf} - E_{ki}$   
 $41 \text{ J} - 0 \text{ J}$ ; work will equal  $41 \text{ J}$ .