# 23
\[ F = kx \]
\[ x = \frac{F}{k} = \frac{10N}{40x10^2 N/m} = 0.025 \text{ m} \]

# 28.
(a) \[ W = \frac{1}{2} k x^2 \]
\[ W = \frac{1}{2} (2.5 \times 10^3 N/m) (0.06 m)^2 \]
\[ = 4.5 J \]

(b) Work to stretch the spring from 6 cm to 8 cm is the work to stretch the spring to 8 cm minus the work to stretch the spring to 6 cm
\[ W_f = \frac{1}{2} k x_f^2 \]
\[ W_i = \frac{1}{2} k x_i^2 \]
\[ W = W_f - W_i \]
\[ = \frac{1}{2} k (x_f^2 - x_i^2) \]
\[ = \frac{1}{2} (2.5 \times 10^3 N/m) [\frac{1}{2} (0.08 m)^2 - (0.06 m)^2] \]
\[ = 3.5 J \]
$$W_T = \Delta K$$

$$W_T = K_f - K_i$$

$$K_f = K_i + W_T$$

$$K_i = \frac{1}{2} m u_0^2 = \frac{1}{2} (0.6 \text{ kg})(3.0 \text{ m/s})^2 = 2.70 \text{ J}$$

$$K_f = 2.70 \text{ J} + 2.55 \text{ J} = 5.25 \text{ J}$$

$$K_f = \frac{1}{2} m u_f^2$$

$$5.25 \text{ J} = \frac{1}{2} (0.6 \text{ kg}) u_f^2$$

$$u_f = 4.14 \text{ m/s}$$

**55.** (a) $U_A = m g h_A = (1.5 \text{ kg})(9.8 \text{ m/s}^2)(4.5 \text{ m})$

$$= 66.2 \text{ J}$$

$$U_B = m g h_B = (1.5 \text{ kg})(9.8 \text{ m/s}^2)(-3.0 \text{ m})$$

$$= -44.1 \text{ J}$$

(b) Using the ground as reference

$$\Delta U = U_B - U_A = -44.1 \text{ J} - 66.2 \text{ J} = -110.3 \text{ J}$$

Using the attic as reference,

$$h_A = 0 \text{ so } U_A = 0$$

$$h_B = -7.5 \text{ m}$$

$$U_B = (1.5 \text{ kg})(9.8 \text{ m/s}^2)(-7.5 \text{ m}) = -110.3 \text{ J}$$

$$\Delta U = U_B - U_A = (-110.3 \text{ J}) - 0 \text{ J} = -110.3 \text{ J}$$

Using the basement as the reference,

$$h_A = 7.5 \text{ m}$$

$$u_A = (1.5 \text{ kg})(9.8 \text{ m/s}^2)(7.5 \text{ m}) = 110.3 \text{ J}$$

$$h_B = 0 \text{ so } U_B = 0$$

$$\Delta U = U_B - U_A = 0 - 110.3 \text{ J} = -110.3 \text{ J}$$
61. (a) 

\[ K = \frac{1}{2} m u_0^2 = \frac{1}{2} (0.300\text{ kg})(10.0\text{ m/s})^2 \]

\[ = 15.0\text{ J} \]

\[ U = 0 \quad \text{This is the reference height} \quad \uparrow u_0 = 16\text{ m/s} \quad y = 0 \]

\[ E = K + U = 15.0\text{ J} + 0\text{ J} = 15.0\text{ J} \]

(b) Only gravity so \( E \) is conserved

\[ E = 15.0\text{ J} \]

\[ u = mg y = (0.300\text{ kg})(9.8\text{ m/s}^2)(2.50\text{ m}) = 7.35\text{ J} \]

\[ K + U = E \]

\[ K + 7.35\text{ J} = 15.0\text{ J} \]

\[ K = 7.65\text{ J} \]

(c) At max height \( U = 0 \) so \( K = 0 \)

\( E \) is conserved so \( E = 15.0\text{ J} \)

\[ E = K + U \]

\[ 15.0\text{ J} = 0\text{ J} + U \]

\[ U = 15.0\text{ J} \]

67. (a) Forces

Gravity - conservative
Normal - \( \perp \) to motion does no work

\[ E_i = E_f \]

Choose \( U = 0 \) at B

\[ K_i + U_i = K_f + U_f \]

\[ \frac{1}{2} m v_A^2 + mg h_A = \frac{1}{2} m v_B^2 + 0 \]

\[ v_B^2 = v_A^2 + 2 gh_A = (5.0\text{ m/s})^2 + 2(9.8\text{ m/s}^2)(5\text{ m}) = 123\text{ m}^2/\text{s}^2 \]

\[ v_B = 11.1\text{ m/s} \]
(b) To reach \(C\) we need \(E_A\) to be large enough to have \(\dot{S} = 0\) at \(C\), so we want \(E_C = K_C + U_C = 0 + U_C\).

\[ E_C = U_C = mgh_C; \quad E_A = K_A + U_A = \frac{1}{2} m \dot{V}^2 + mgh_A \]

find \(\dot{V}_A\):

\[ \frac{1}{2} m \dot{V}^2 + mgh_A = mgh_C \]

\[ \dot{V}_A^2 = gh_C - gh_A = 2g (h_C - h_A) = (9.8 \text{ m/s}^2)(8 \text{ m} - 5 \text{ m}) = 58.8 \text{ m}^2/\text{s}^2 \]

\(\dot{V}_A = 7.67 \text{ m/s}\) needed.

Since the coaster only has speed 5 m/s it will not reach \(C\).

(c) From (b) \(\dot{V} = 7.67 \text{ m/s}\)

78. \(P = \frac{W}{t}\)

\[ P = \frac{4.69 \times 10^5 \text{ J}}{5.05 \text{ s}} \]

\[ = 938 \times 10^3 \text{ W} \]

Find the work from Work-Energy Theorem:

\[ W = \Delta K = K_f - K_i \]

\[ W = \frac{1}{2} m \dot{V}_f^2 - 0 = \frac{1}{2} m \dot{V}_A^2 \]

\[ W = \frac{1}{2} (1500 \text{ kg}) \left[ \left( \frac{90 \text{ km}}{h} \right) \left( \frac{1000 \text{ m}}{\text{ km}} \right) \left( \frac{1 \text{ km}}{1000 \text{ m}} \right) \left( 3600 \text{ s} \right) \right]^2 \]

\[ = 4.69 \times 10^5 \text{ J} \]