

1. A woman pushed a 25 kg shopping cart across a tile surface. The woman applied a horizontal force of 45.0 N to the cart over a distance of 11.5 meters. The coefficient of sliding friction between the cart and the tile is 0.15.
- How much work did the woman do?
 - How fast is the cart going in the end?
 - How much energy is lost to friction?

$$a. W_w = 45\text{N} (11.5\text{m}) = 517.5 \text{ J}$$

$$b.) \quad W = \frac{1}{2} m v^2 \quad 2.74 \text{ m/s}$$

$$(517.5\text{J} - 423\text{J}) = \frac{1}{2} (25\text{kg}) v^2$$

$$F_f = 0.15 (25\text{kg}) 9.81 = 36.79 \text{ N}$$

$$c. W_w = 36.79 (11.5\text{m}) = 423\text{J}$$

$$b. F_f = 0.15 (25\text{kg}) 9.81 = 36.79 \text{ N}$$

$$(45\text{N} - 36.79) = a(25\text{kg})$$

$$a = 0.328 \text{ m/s}^2$$

$$v_f^2 = 0 + 2(0.328)(11.5) = 2.74 \text{ m/s}$$

2. In an attempt to keep her kids close to her cart, the woman has attached a spring to each child. The children attend to flee from the cart once they reach the candy isle. Child One applies a force of 24.3N to the spring and extends it 45.66cm from its equilibrium position. Child Two applies a force of 42.5N to extend the spring the spring 79.88 cm.
- How much work has Child One done in extending the spring?
 - How much work has Child Two done in extending the spring?
 - Prove whether or not they are using identical springs.

a. $24.3\text{N} = k (.4566\text{m})$

$$W_1 = 0.5(53.2\text{N/m})(0.4566\text{m})^2 = 5.54 \text{ J}$$

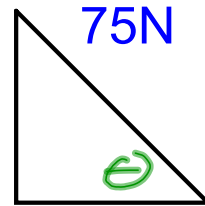
b. $42.5\text{N} = k (.7988\text{m})$

$$W_2 = 0.5(53.2\text{N/m})(0.7988\text{m})^2 = 16.97 \text{ J}$$

c. same spring same K value

3. Tired of each other's antics the Clemson mascot and the USC mascot decide to fight for the honor of Supreme mascot. Each mascot weighs in at 845N. After a lengthy battle at midfield one mascot drags the other mascot a distance of 40m on a friction free field. The task requires 1200J and is done by pulling on tail/ tail feathers with a force of 75N. What is the angle of the tail with the horizontal?

b. $W = Fx \cos\theta$



$$1200\text{J} = 75(40) \cos \theta$$

$$66.4^\circ$$

4. You attach yourself (250kg) to a spring and hang the spring from the Cooper River Bridge. You jump from the bridge and stretch the spring 35m before you begin to harmonically bounce from the bottom of the spring.
- What is the spring constant?
 - What is your period of bounce?

$$\begin{aligned} \text{a. } 250\text{kg} (9.81\text{m/s}^2) &= k (35\text{m}) \\ k &= 70.1 \text{ N/m} \end{aligned}$$

$$f = (1/(2\pi)) (\sqrt{(70.1/250\text{kg})})$$

$$f = 0.08 \text{ Hz}$$

$$T = 12.5 \text{ sec}$$

5. A spring has a spring constant of 440 N/m, how far must the spring be stretched to have 25 J of potential energy?

$$\begin{aligned} \text{a. } PE &= 0.5 kx^2 \\ 25\text{J} &= 0.5(440\text{N/m}) (x^2) \end{aligned}$$

$$x = 0.34 \text{ m}$$

6. The roller-coaster car shown in Fig 1 is dragged up to point 1 when it is released from rest. Assuming no friction, calculate the PE, KE and speeds at points 1, 2, 3. (add 100kg to problem)

a. 1 PE=_____ KE=_____ V=_____

b. 2 PE=_____ KE=_____ V=_____

c. 3 PE=_____ KE=_____ V=_____

6. The roller-coaster car shown in Fig 1 is dragged up to point 1 when it is released from rest. Assuming no friction, calculate the PE, KE and speeds at points 1, 2, 3. (add 100kg to problem)

a. 1 PE= 34335 J KE= 0 J V= 0 m/s

b. 2 PE= 0 J KE= 34335 J V= 26.2 m/s

c. 3 PE= 27468 J KE= 6867 J V= 11.7 m/s

a. $PE = 100\text{kg} (9.81) 35\text{m} = 34335 \text{ J}$

$KE = 0 \text{ J}$

$V = 0 \text{ m/s}$

b. $PE = 100\text{kg} (9.81) 0\text{m} = 0 \text{ J}$

$KE = 34335 \text{ J}$ (all energy is KE)

$34335 \text{ J} = 0.5(100\text{kg}) v^2$

c. $PE = 100\text{kg} (9.81) 28\text{m} = 27648 \text{ J}$

$KE = 34335 \text{ J} - 27648\text{J}$

$6867 \text{ J} = 0.5(100\text{kg}) v^2$

7. You (50kg) have decided to live life to its fullest. You have flown to Ticino, Switzerland to jump off of a dam that was made famous in the James Bond movie "GoldenEye" and it is the largest bungee jump in the world. You jump off the dam (position 1) with the bungee tied around your ankles. You fall 50m before the bungee begins to stretch. You come to a stop (position 2) some distance below the dam. The bungee has a $k = 10 \text{ N/m}$.

- How far below the top of the dam will you fall before coming to a stop? Hint: Quadratic equation
- What is your elastic PE at the bottom of her fall?

$$\text{KE}_1 + \text{gPE}_1 + \text{ePE}_1 = \text{KE}_2 + \text{gPE}_2 + \text{ePE}_2$$

$g = \text{gravitational}$ $e = \text{elastic (spring)}$

$$0.5 (50 \text{ kg}) 0^2 + \downarrow (50 \text{ kg}) (9.81) (50 + \Delta y) + 0 \text{ J} = 0.5 (50 \text{ kg}) 0^2 + \downarrow (50 \text{ kg}) (9.81) (0) \text{ m} + 0.5 (10 \text{ N/m}) \Delta y^2$$

$g = \text{gravitational}$ $e = \text{elastic (spring)}$

$$b. \quad 0 \text{ J} + (50 \text{ kg}) (9.81) (50 + \Delta y) + 0 \text{ J} = 0 \text{ J} + 0 \text{ J} + 5\Delta y^2$$

$$24525 + 490.5\Delta y = 5\Delta y^2$$

$$0 = 5\Delta y^2 + 490.5\Delta y + 24525 \quad \Delta y = 134$$

$$h = 134 + 50 \text{ m} = 184 \text{ m}$$

$$c. \quad \text{PE} = 0.5 (10 \text{ N/m}) \Delta y^2$$

$$\text{PE} = 89780 \text{ J}$$