Assignment 14: The Pendulum

1. Cameron is attempting to hypnotize a dinosaur. He uses a pendulum that is 1.13 meters long. What is its period?

$$T = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{1.13m}{9.8 m/s^2}} = \boxed{2.134 \, s}$$

2. Tionay wants to make a pendulum that has a period of 4 seconds. What should the length of the pendulum be?

$$T = 2\pi\sqrt{\frac{L}{g}} \quad \Bigg| \quad L = g*\left(\frac{T}{2\pi}\right)^2 = 9.8 m/s\left(\frac{4s}{2\pi}\right)^2 = \boxed{3.972 \, m}$$

3. Jason displaces a pendulum so that it has a height of 2 cm compared to the central equilibrium position. What is the speed of the pendulum as it passes through the center of its path?

$$PE_i + \cancel{KE_i}^0 + \cancel{W}^0 = \cancel{PE_f}^0 + KE_f$$

$$\cancel{m} \cdot g \cdot h_i = \frac{1}{2}\cancel{m}v_f^2$$

$$v_f = \sqrt{2gh} = \sqrt{2(9.8 m/s^2)(0.02m)} = \boxed{0.626 \, m/s}$$

4. Paola has a pendulum that is moving at 1 m/s at the bottom of its arc. What is the maximum height the pendulum will reach?

$$\cancel{PE_i}^0 + KE_i + \cancel{W}^0 = PE_f + \cancel{KE_f}^0 \quad \Bigg| \quad h_f = \frac{v_i^2}{2g} = \boxed{0.051 m}$$

$$\frac{1}{2}\cancel{m}v_i^2 = \cancel{m} \cdot g \cdot h_f$$

5. Jade replaces the pendulum bob in her grandfather clock (T=2 seconds) with a bottle of high-fructose corn syrup. The mass of the bob was 2 kg, and the mass of the high fructose corn syrup is 0.5 kg. If the center of mass of the corn syrup is in the same place as the bob's center of mass was previously located, what is the new period of the pendulum?

$$T = 2 \; seconds. \qquad Mass \; has \; no \; effect.$$

6. Michael is designing a clock that will tell accurate time on the moon ($g_{moon} = 1.67$ m/s^2). What should the length of the pendulum be in order for the period of the pendulum to be 1 second?

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$L = g\cdot\left(\frac{T}{2\pi}\right)^2$$

$$L = 1.67 \text{ m/s}^2 \cdot \left(\frac{1s}{2\pi}\right)^2 = \boxed{0.042 \text{ m}}$$

7. Maribel in a spaceship that has landed on the dwarf-planet Pluto. You measure a 1 meter long pendulum's period to be 7.1 seconds. What is the acceleration due to gravity on Pluto?

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$g = \frac{L}{\left(\frac{T}{2\pi}\right)^2}$$

$$g = \frac{1m}{\left(\frac{7.1s}{2\pi}\right)^2} = \boxed{0.783 \text{ m/s}^2}$$

8. Daisy is in a spinning carnival wheel (in space). The wheel has a diameter of 10 meters, and makes one rotation in 4 seconds.

   a) What is Daisy's centripetal acceleration?

   $d = 10m$, $r = 5m$

   $$V = \frac{\Delta d}{\Delta t} = \frac{2\pi r}{\Delta t} = \frac{2\pi(5m)}{4s} = 7.854 \text{ m/s}$$

   $$a_c = \frac{V_T^2}{r} = \frac{7.854 \text{ m/s}^2}{5m}$$

   $$a_c = \boxed{12.377 \text{ m/s}^2}$$

   b) Daisy holds a necklace that is 20 cm long in her hand. What is the period of the necklace's motion?

   $$T = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{0.20 \text{ m}}{12.377 \text{ m/s}^2}} = \boxed{0.8 \text{ s}}$$

   c) Name two things that could be done to make the necklace swing slower.

   – make the chain longer

   – decrease the speed of the wheel.