Lab Combine - Energy

Overview

You will be working on a lab combination this week that will help prepare you for the exam. The objective is to develop your ability to use energy in different types of problems.

Problems

You are on an asteroid that is far from any other objects. The asteroid has a density of 5 g/cm^2 = 5000 kg/m^3 (similar earth's density) and a radius of 10 km. [$V=4/3\pi r^3$ so $M_a=2.1 \times 10^{16}$ kg] Note: $G=6.67 \times 10^{-11}$ Nm^2/kg^2

1. What is the escape velocity for a golf ball thrown from the surface of this asteroid?
2. How fast is your golf ball traveling far from the asteroid if you launch it with a velocity that is twice the escape velocity?
3. What is the orbital velocity for a golf ball in an orbit 10 km above the surface of the asteroid? How fast would you need to launch your golf ball to put it in this orbit?
4. What would be the result of launching a golf ball with a spring compressed by 0.4 m given that k=61.3 N/m and a golf ball is 0.05 kg? Could you physically compress this spring?

You are trying to boil some water. Your pot holds 1 liter (1 kg) of water and is on a 4kW stove Assume that the stove is perfect and so every second 4000J is put into the liter of water. The water temperature is initially 50 F (10 C) and the room temperature is 72 F (22 C).

5. Assuming the pot radiates heat at 1kW, how long does it take the water to reach the boiling point (boiling temperature)? The heat capacity of water if 4200 J/kg/K.
6. Assuming the pot radiates heat at a rate proportional to the temperature difference $\Delta T=(T_{water} - T_{room})$ that is $50\Delta T$ W/K, how long does it take the water to reach the boiling point (temperature)? [Hint: The water is initially less than room temperature and is heated by the room – use the "Heat Flow" program to model this situation]

Racing Carts

Use your lab equipment and/or use the computer simulation code "Racing Carts" to model and verify answers to the following situations. Be careful that you choose a small enough time interval in computer simulations – check to be sure that the result does not change as the time interval decreases.

7. Two carts ($m_1 > m_2$) are pushed with the same force for the same distance.
    a. Which cart has greater energy?
    b. Which cart has greater momentum?
8. Two carts ($m_1 > m_2$) are pushed with the same force for the same time.
    a. Which cart has greater energy?
    b. Which cart has greater momentum?
9. Two carts ($m_1 = 3m_2$) are pushed for the same distance.
    a. Determine the force needed for each cart so they have the same energy.
    b. Determine the force needed for each cart so they have the same momentum.
10. Two carts ($m_1 = 3m_2$) are pushed for the same time.
    a. Determine the force needed for each cart so they have the same energy.
    b. Determine the force needed for each cart so they have the same momentum.