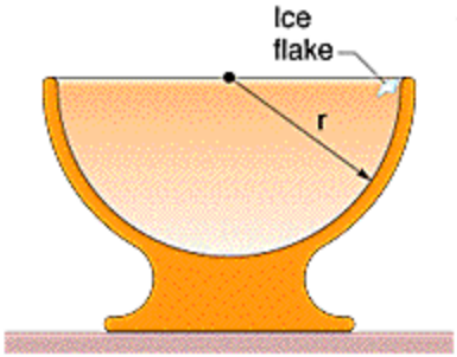
Quantitative Problems
(Given, Find, Solution REQUIRED)

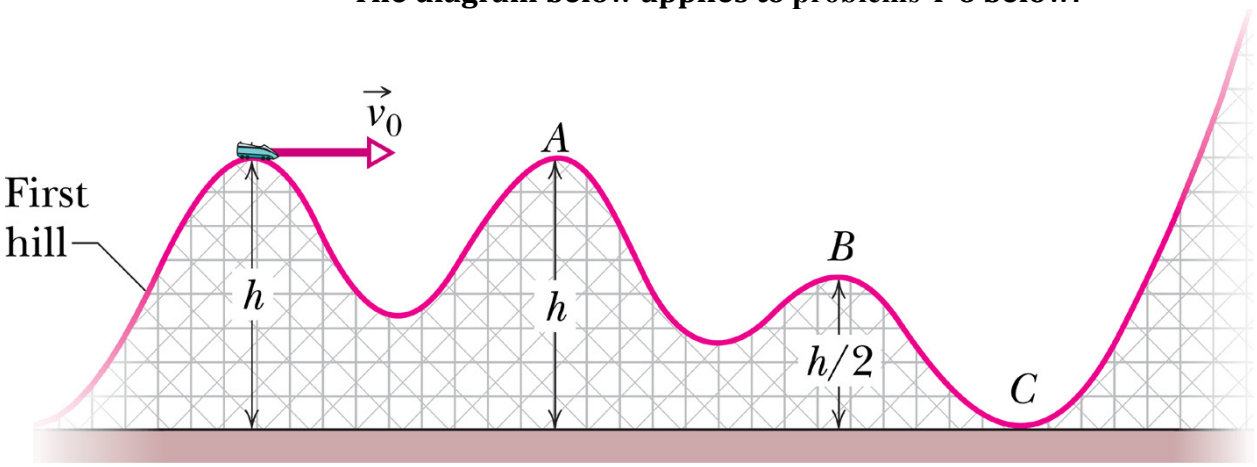
1. **An arrow of mass 0.02 [kg] is place into crossbow of spring constant 1330 [N/m] and is shot. The crossbow string is stretched back 8 [cm]. What will be the speed of the arrow as it leaves the crossbow?**

2. **In the figure below, a 0.0024 [kg] ice flake is released from the edge of a hemispherical bowl whose radius r is 0.36 [m]. The flake-bowl contact is frictionless.**
   a. **What is the speed of the flake when it reaches the bottom of the bowl?**
   b. **If we substituted a second flake with twice the mass, what would its speed be?**



3. **A toy car of mass 1 [kg] is on horizontal track. It sits directly in front of spring which has been compressed 0.25 [m]. The spring constant of the spring is k = 127 [N/m]. What is the velocity of the car just as it leaves the spring?**

The diagram below applies to problems 4-6 below:

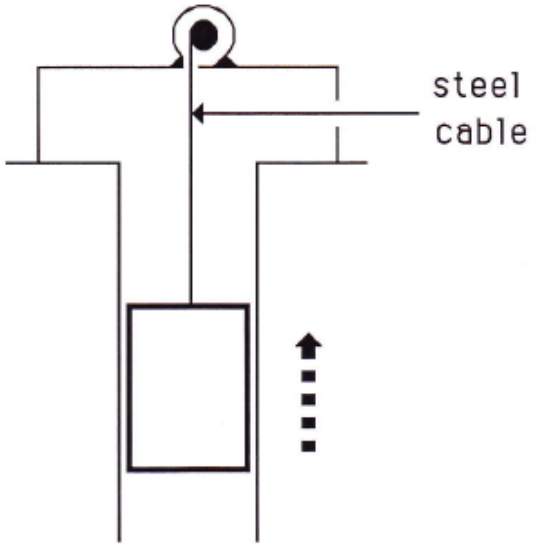


4. **A frictionless rollercoaster car of mass m = 825 [kg] has a velocity of v_0 = 17.0 [m/s] at height h = 42 [m] when it is at the top of the first hill. What will be the car's speed at point B?**

5. **What is the velocity of the rollercoaster at point C assuming the track is frictionless?**

6. **Another track with the exact dimensions is now used. The rollercoaster again leaves the top of the first hill with a velocity of v_0 = 17.0 [m/s]. However, 250,000 [J] of energy are lost due to friction as it travels from the top of the first hill to point C. What is the velocity of the rollercoaster at point C?**

The diagram below applies to problems 7-8



7. **Imagine that you are in an elevator that is being pulled up by a steel cable as shown above. Your mass is 60 [kg]. If the elevator is moving upward at a <u>constant speed</u>, what force does the elevator apply to you (i.e., F_N) while it is moving upwards? (Hint: draw an FBD of "you" while inside the elevator).**

8. **In the elevator problem above, the elevator is now ACCELERATING UPWARD at a rate of 5 [m/s^2]. What force does the elevator apply to you now while it is accelerating upwards? Use the same hint as above.**

9. **In the elevator problem above, the elevator is now ACCELERATING DOWNWARD at a rate of 9.8 [m/s^2]. What force does the elevator apply to you now while it is accelerating downwards? Use the same hint as above.**

10. **Newton's Universal Law of Gravitation states that any object that possesses mass provides a gravitational pull on any other object that has mass. If your mass is 70 [kg] and the mass of your cell phone is 0.2 [kg] and you are 1 [m] from your phone, how much "gravitational force" do you apply to your cell phone? How much force does your cell phone apply to you?**

Qualitative Problems

Short answer (in a complete sentence) or a fully labeled graph
(Given, Find, Solution NOT required)

11. Who provided data that shows that there is NO center of the universe?

12. What quantity is used to measure the inertia of an object?

13. When did the US find out that Germany was working on nuclear fission reactions; before WWII, during WWII, or after WWII?

14. What led many European scientists to flee Europe for the US?

15. Which is faster…the speed of gravity or the speed of light?

1. 20.63 [m/s]

2a. 2.66 [m/s]
2b. 2.66 [m/s]

3. 2.82 [m/s]

4. 26.47 [m/s]

5. 33.35 [m/s]

6. 22.49 [m/s]

7. 588 [N]

8. 888 [N]

9. 0 [N]

10. 9.34×10^{-10} [N]