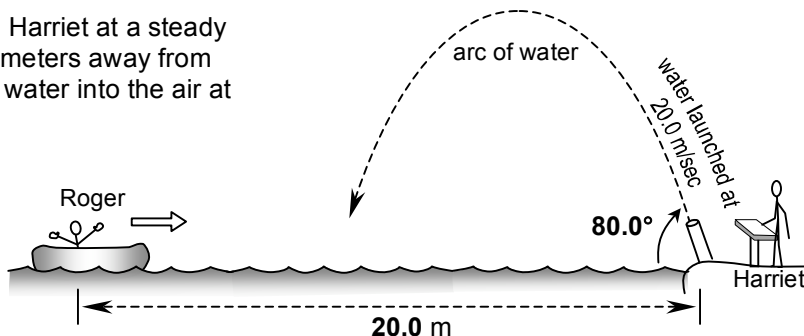
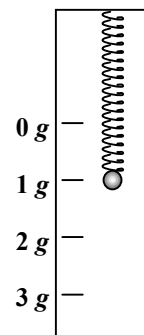


4. Roger is in a raft drifting downstream toward Harriet at a steady speed. At the exact moment that he is **20.0** meters away from her, she presses a button that shoots some water into the air at **20.0** meters/sec at an angle of **80.0°**. The water arcs through the air and lands right on top of Roger.



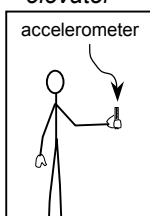
- How high vertically does the water rise?
- At what speed was Roger drifting downstream toward Harriet?

5. A small heavy ball is hanging from a spring as shown at the right. At the moment it reads "**1 g**" (**9.80** meters/sec²) as gravity pulls downward against the upward force of the spring. When set up this way, the ball on the spring acts like an **accelerometer** (an acceleration meter). Imagine that you hold this accelerometer in front of you (vertically) everywhere you go throughout an entire day.



- Suppose you hold this accelerometer stationary while you stand in the classroom. Which one exerts more force on the ball: *gravity* or the *spring*?
- Now hold the accelerometer in the following 4 situations. In each situation, how much will it read? Choose one of the following answers: Will it read **zero g**, $\frac{1}{2} g$, **1 g**, or **2 g**? Explain your choice for each case.

Case 1
Inside a falling elevator



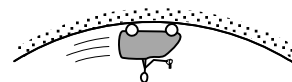
Case 2
At the top of a roller coaster loop



Case 3
At the bottom of a loop



Case 4
At the top of the loop while upside down



6. We live on a spinning earth. That means we are moving in circles as the earth turns. The Earth has diameter **$D = 12800$** km. Suppose that Miguel (**80.0** kg) lives on the equator.
- Calculate the gravitational force that the earth exerts on Miguel.
 - Calculate Miguel's speed " v " (meter/sec) due simply to the spin of the earth.
 - Using $a_c = v^2 / R$, calculate the net force (centripetal force) needed to keep Miguel moving at steady speed v in a circle of diameter = **$D = 12800$** km. (The speed v is your answer to question (b) above.)
 - Compare answer (a) to answer (c). Then think about the following statement:
Joey says, "In order for Miguel to keep moving in a circle by standing on a spinning earth, a net force must act on him; gravity is just about the right amount of strength to be this net force."
Explain why you agree or disagree with Joey.

7. The building at point **A** below is the loading station for a new roller coaster. Point **B** is the unloading station. Each car on this new roller coaster will get pulled by chain up to the top of the first hill "**T**" and then it must be able to coast freely with no other power source all the way to **B**. All along the track, it will encounter a small amount of friction. After the car reaches point **B**, a chain will pull it back to **A** on a separate flat track that is not shown on this diagram. Design the rest of the track from point **T** to point **B**. (Make up your own design.)

