Total Equilibrium

1. Consider introducing this activity with the following class demonstration, providing a discrepant event to discuss:

1. Ask the students whether golf balls float or sink. They will say that golf balls sink.
2. Place a golf ball in the bottom of a 1000 mL graduated cylinder and add about 500 mL previously prepared saturated salt solution (the students will assume this is fresh water). The students will be surprised that the ball floats.
3. Slowly and gently add fresh water to the top. The students will now be surprised that the ball stays somewhere in the middle of the column. Discuss.

2. The suspended object can be anything, but its density must be somewhere between the densities of the top and bottom layers of liquid. A golf ball worked well for our example of saturated solution of sodium chloride in water on the bottom and tap water on the top.

3. The vessel will need some height to achieve the effect. To minimize the total volume of liquid required, we chose a graduated cylinder.

4. Attach a cup hook or eye hook to the golf ball ahead of time. You may want to make a pilot hole with a nail or drill. This procedure should be done by an adult.

5. Consider having students measure and/or calculate the densities of the water at the top and the water at the bottom. A plastic tube and syringe can be used to extract water from various depths. A turkey baster could also work.

Sample Data

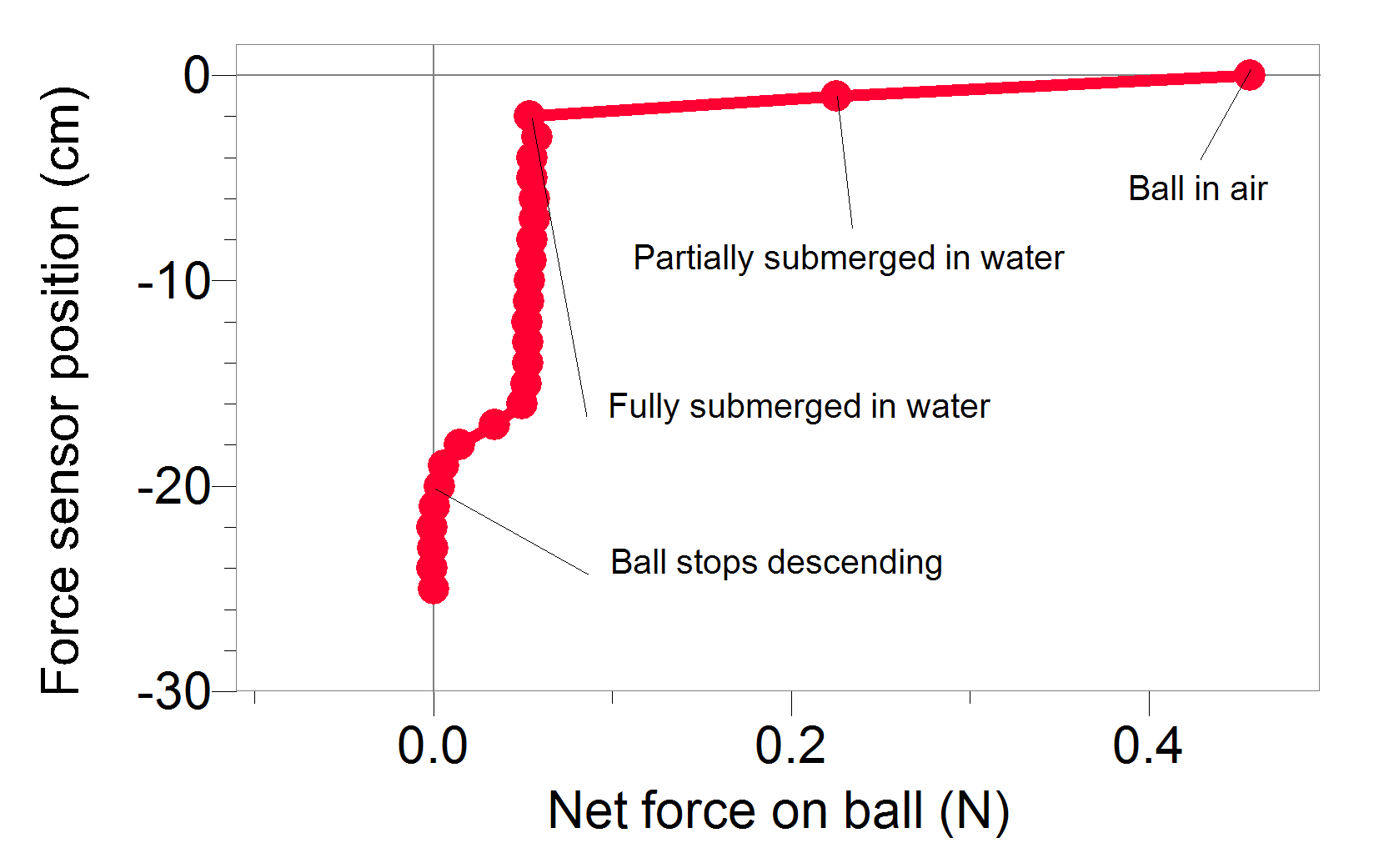
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Figure 1 Changes in net force on a golf ball as it is lowered through fresh water at the top of the graduated cylinder, enters a salinity gradient, and eventually stops descending   
due to the buoyant force of the highly saline water in the bottom

Answers to Questions

1. Answers will vary. For the sample data shown, the ball weighed 0.457 N in air.

0.457 N x 1 kg = 0.0466 kg

9.8 N

0.0466 kg x 1000 g = 46.6 g

1 kg

2. Answers will vary. For the sample data shown, the ball displaced 39 mL of water. Therefore, its volume was 39 cm3.

3. Answers will vary. For the sample data shown, the density was

46.6 g = 1.19 g/cm3

39 cm3

4. The density of the ball, 1.19 g/cm3, is higher than the density of the fresh water on top, so the ball will sink. However, the density of the salt water on the bottom is higher than that of the ball, so the ball will float on that layer. This keeps the ball suspended between the two layers.