Kitchen physics

An experiment that students can carry out at home as an exercise to get them to observe and discuss their thoughts.

Figure 1

Equipment

- Kitchen Scales
- Glass or plastic cup
- Spoon

It's more of a way to get students to observe and discuss their thoughts than gain curricular knowledge.

What to do?

Place the scales on a flat surface away from anything that might be damaged by any spillage and switch on. Place a glass ¾ full of water on the scales as shown in Figure 1.

Ask some questions. What would the reading on the scales be if a bottle top with a 5p coin were floated on the water in the glass? More, less the same (Figure 2)?

Try it out. Carry out the experiment.

What would be the reading on the scales if we placed only the bottle top and 5p coin on the scales (Figure 3)?

Now remove the bottle top and coin and place a spoon in the glass of water (Figure 4).

Ask some questions. Why has the reading on the scales increased?

Now what do you think the reading on the scales would be if we suspended the spoon partially submerged (not touching the sides or bottom of the glass) in the water (Figure 5)?

Ask some questions. Does the mass of water change when the spoon is suspended in the water?

So what's happening? We're used to seeing pictures and diagrams showing the effect of the buoyancy force in reducing the apparent weight of a mass suspended in a fluid. In most of these diagrams the 'system' consists of the water and suspended mass. Clearly the spoon is displacing water; taking up space that water could occupy and experiencing a buoyancy force equal to the weight of the displaced water. If we extend the system to include the scales the downward force is that of the water, the displaced water and the glass.

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Figure 2 - What is the reading on the scale?

Figure 3 - The bottle top and coin placed on the scales.

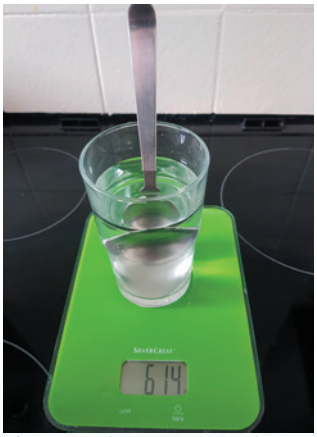

Figure 4 - Place a spoon in the glass of water.

Figure 5 - The spoon partially submerged.

A BGE Explanation

Did you notice that when the bottle top was floating it had sunk into the water a little? If you add another coin, it will sink deeper (Figure 6). Add too many coins and it will no longer be able to float.

Figure 6 - Bottle top slightly sunk after adding the coin.

There are two forces on the floating object - the force of gravity (also known as weight) acts downwards and the buoyancy force acts upwards (Figure 7). Anyone who has ever been in a swimming pool will have felt this buoyancy force. When leaving a bath or swimming pool we no longer have a buoyancy force from the water on us and therefore 'feel heavier'.

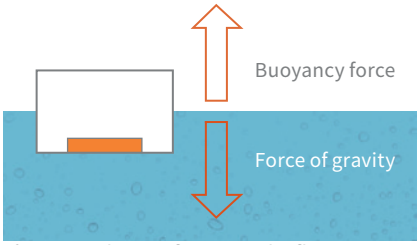

Figure 7 - The two forces on the floating object.

In a nutshell:

- Displacing water creates a buoyancy force.
- The buoyancy force is equal to the weight of the displaced water
- If you can't displace enough water to balance the force of gravity, you sink completely.

If you were standing on a set of bathroom scales and someone gave you a book to hold, you would expect the reading on the scales to go up because you were supporting an additional object. Similarly, when the water is supporting a floating bottle top and coin, the reading on the balance increases. When the spoon is suspended in the water it displaces some water so there is still a buoyancy force on it even though it is being held. Again, because the water is (in this case partially) supporting an object, the reading on the balance goes up.

Other things to try

- Try dissolving some salt in the glass of water.

  Notice the new reading on the scales (Figure 8).

- Repeat the suspended spoon experiment (make sure you lower the spoon to the same level as before, Figure 9).

  Compare the difference in readings in this experiment with the previous experiment.

  Why do you think the readings are different? <<

Figure 8 - New reading after dissolving some salt in the glass of water.

Figure 9 - Repeat the suspended spoon experiment.