DISCOVERING SCIENCE

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Many scientific concepts can be understood and demonstrated through simple experiments, using locally available low-cost material. This article presents a few simple but exciting experiments that can be used to understand foundational principles in physics.

We often come across natural phenomena that amaze us or leave us astonished. Observing these phenomena keenly and exploring the science behind their occurrence can make such experiences a lot more enjoyable, and can result in a better understanding of scientific concepts.

Similarly, explaining foundational concepts described in science textbooks through simple experiments, using low-cost material or activities in the classroom, can make teaching learning processes in science education far more enjoyable and effective. Such experiments not only excite students but also enhance their interest in, and promote their understanding of science.

We present a few simple experiments here, which you could perform in class or encourage your students to perform at home. Each of these experiments will help students question and discover the underlying scientific concepts for themselves and, in the process, learn a great deal of science.

Experiment 1: Lung capacity

Describe the experiment in the corresponding activity sheet to your students. Ask them what they expect to find. Then, encourage them to perform the experiment in groups of two and share their results. Surprisingly enough, the bag will be fuller when it's held away from the mouth and opened wider. Once they have arrived at this response, ask your students if they can explain why this happens?

In the first case (a), the only air that enters the bag is what you exhale or force out of your lungs. While a healthy adult can hold about 6 l of air in her lungs (called vital capacity), she can inhale/exhale only about 0.5 l of air in a single breath (called tidal volume). However, in the second case (b), the air that enters the bag is more than what you can exhale. This phenomenon could be explained by Bernoulli's principle which states that: 'for a streamline fluid flow, the sum of the pressure, the kinetic energy per unit volume and the potential energy per unit volume remain constant'. When you force air out of your mouth, the high velocities at which the air molecules travel cause an increase in their kinetic energy. But, since their potential energy remains unchanged, the pressure of the air forced out of your mouth drops. As a result, surrounding air rushes in to fill this partial vacuum and gets trapped in the bag.

Experiment 2: Drinking with straws

Describe the experiment in the corresponding sheet to your students. Again, ask them to predict the results of the experiment before actually testing it out. Again, divide them into groups of two and ask them to share the results of the experiment. It may seem strange, but drinking with two straws is really difficult. Encourage your students to think about why this is so.

In the first case (a), as you start sucking from one straw, you draw out all the air from the straw into your mouth, creating a partial vacuum inside the straw. This leads to a drop in air pressure inside the straw. However, atmospheric pressure continues to act on the water in the glass. The difference in pressure at the two ends of the straw makes the liquid rise up into the straw and flow into your mouth, allowing you to drink the liquid from the glass. In the second case (b), when you try to drink with one straw inside and one outside the glass, air gets sucked up from outside the glass through the second straw. As a result, there is no vacuum created inside the straw, and its air pressure remains the same as the atmospheric pressure on the liquid in the glass. Without a difference in pressure to pull it upwards, the liquid doesn't rise up, and drinking becomes very difficult.

Experiment 3: Deflating balloons

Set up the experiment in the corresponding Activity Sheet – I with your students. As with the previous experiments, ask students to predict the result of the experiment before you open the valve of the intravenous tube as in Activity Sheet – II. Once you open the valve, ask students what they observe. Also ask them if they can come up with the reason for their observation.

Many of us tend to think that once the valve is opened, the bigger balloon (a) would deflate just enough to make the smaller balloon (b) equal to it in size. However, in reality, it is the smaller balloon that deflates — making it even smaller and the bigger balloon even larger. To understand this, let's look at how air pressure inside a balloon varies with its diameter. When air is initially forced into a balloon, the elasticity of the rubber opposes its expansion, causing the air pressure inside it to increase rapidly, reaching a peak. The small balloon in our experiment is at or close to this level of air pressure. Once it reaches this level, the balloon starts expanding in size and increasing in volume more easily. Any further addition of air only causes a drop in pressure inside the balloon. In other words, the internal pressure of the bigger balloon reaches a maximum and then drops to a minimum as its size increases. You can observe this behavior the next time you blow up a balloon — you will need a great deal of force in the beginning, but after the balloon expands to a particular size, less force is needed to inflate it further. Therefore, when the valve allowing air flow between the two balloons is opened, air flows from the region of high pressure (or the small balloon) to that of low pressure (or the big balloon). As a result, the bigger balloon becomes even larger in size. Once the air pressure is equalized between the two balloons, the flow of air ceases and their sizes remain unaltered.

References

1. Wikipedia contributors, "Two-balloon experiment," Wikipedia, The Free Encyclopedia. URL: HYPERLINK "https://en.wikipedia.org/w/index.php?title=Two-balloon_experiment&oldid=830073077%20"https://en.wikipedia.org/w/index.php?title=Two-balloon_experiment&oldid=830073077 (accessed June 5, 2018).

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