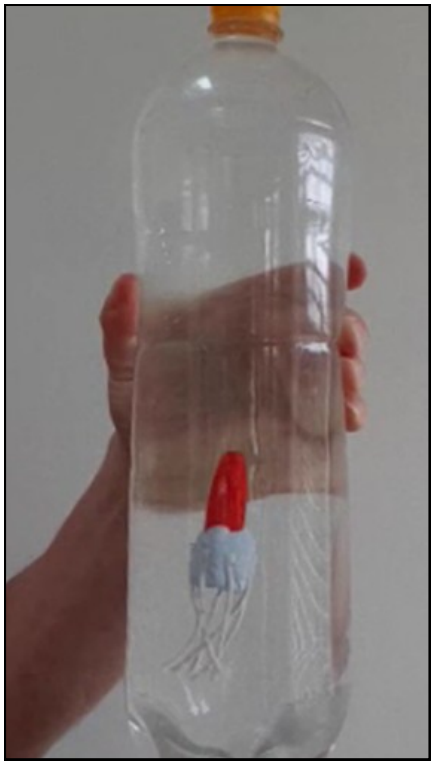
Professor Brainstorm's

Make A Diver



Safety First

CHOKING HAZARD: We will be using a pen cap to make this diver. Most pen lids have a small hole in the end so that if a child swallows one they can still breathe. In order to make the diver, we need to seal this small hole – so it is vitally important that the children do not put the pen caps in their mouths.

About this Activity

(Information for Parents and Teachers)

This activity introduces young children to the idea of sinking and floating - but older ones will be fascinated to find out how it works.

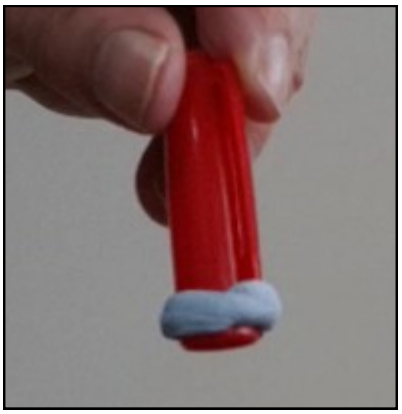
What you Need

- A pen cap, e.g. from a felt-tip pen
- A small amount of blutack
- A screw-top drinks bottle

How to make a Diver

(You can watch a video of this on Professor Brainstorm's YouTube channel - search for 'Professor Brainstorm Science')

1. First of all examine your pen cap. Pen caps often have a small 'air hole' at the end. If this is the case, you will need to block up the air hole before you make your diver. This can be done by simply pushing a small amount of blu tack into the cap using a pen or pencil. (Note – once you have sealed up the air hole it is vitally important that the children **do not put the pen cap in their mouth.**)
2. Next you need to add some ballast to the pen cap. To do this put some blu tack around the open end of the pen cap (see photo on right) - making sure that you do not block the opening.



3. The aim is to add enough blu tack so that the pen cap *just* floats. This is a trial-and-error process. Carefully place your pen cap in a bowl of water. If the pen cap floats high up in the water (and particularly if it tips over to one side) you need to add more blu tack. (But obviously if the pen cap sinks you need to remove some blu tack!) Your diver is now ready for use.
4. Now fill the bottle with water. You need to fill it right to the top.
5. Place the bottle upright in a bowl or on a tray. (There may be a small spillage of water!) Carefully place the diver in the neck of the bottle (with the open end of the pen cap facing down). Ensure that your bottle is full to the brim - and then screw the lid on tightly.
6. Squeeze the bottle - and the diver should sink. Stop squeezing - and it should float back to the top again. (Note - it is important to keep your bottle upright at all times. If the bottle falls over, the air will come out of the diver. If this happens you need to take the diver back out of the bottle - and repeat Step 5.)

How does it work? (An explanation for Parents and Teachers)

This type of toy is called a Cartesian diver, named after the French scientist and philosopher René Descartes.

The best way to understand the workings of a Cartesian diver is in terms of **density**. (This is a difficult concept for primary children. We will try to discover how it works without using the term 'density' in the section below.)

In the following discussion we have to remember that when the Diver is in the bottle it is effectively made up of three parts - the plastic pen cap (which is less dense than water), the blu tack (which is more dense than water) and the air which is trapped inside the pen cap (which is less dense than water).

- The density of the diver is initially slightly less than the density of water. (We know that this is true because the diver floats.)
- When we squeeze the bottle, the air inside the diver is compressed. (Since liquids are almost incompressible, the air inside the diver is the only thing in the bottle which can be compressed.)
- Compressing the air increases the density of the air – and so increases the overall density of the diver.
- When the air is sufficiently compressed, the overall density of the diver becomes greater than the density of water - and so the diver sinks.
- Once you stop squeezing the bottle, the air inside the diver expands, the density is reduced, and the diver floats up to the surface again.

How does it work? (An explanation for Children)

We can start to discover how the Diver works by trying the following experiment. (Children who are able can follow these steps by themselves - using the **Worksheet** at the end of these notes.)

- Start out by removing the blu tack from the pen cap. (You don't need to remove the blu tack from inside the pen cap.) Put the pen cap and the blu tack in the water separately. You will see that the pen cap floats, but the blu tack sinks.
- Now fix the blu tack around the bottom of the pen cap (as before). The pen cap floats when the open end of the pen cap is facing down, but sinks when the open end is facing up. (Sometimes the pen cap may float with the open end facing up – but if you push it down gently until the open end is below the water, it sinks. In contrast, when the open end is facing down, if you push it below the water it floats back up again.)
- We can conclude that it is the air inside the pen cap which makes it float. When the open end of the pen cap is facing down in the water, some air is trapped inside the pen cap. The air remains trapped inside as long as the pen cap continues to float upright. If the open end of the pen cap is facing up, the pen cap fills with water, so the pen cap sinks.
- As further proof that it is air which makes the diver float, place the diver inside the bottle, then turn the bottle upside down. If you look carefully you will see bubbles of gas rushing out of the pen cap as the bottle turns over. And now that the air has escaped from the pen cap, the pen cap does not float back up to the top.

To do the next stage of the activity you will need to find a transparent pen cap. If you make a diver using the transparent pen cap, when you put the diver in the bottle you should be able to see that the water comes a little way up into the pen cap. (Of course, the space above the water line is where the air is trapped.)

How does it work? (An explanation for Children - continued)

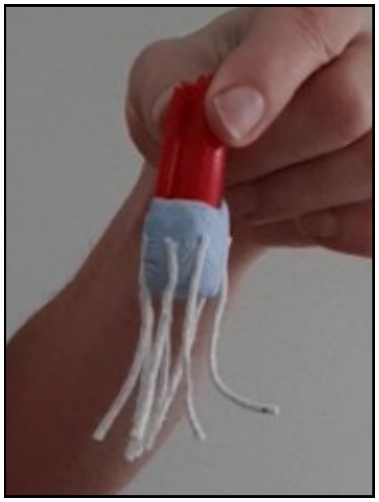
Watch the level of the water line inside the pen cap carefully. As you squeeze the bottle, you will see that the water line rises slightly (by a few millimetres). This means that the air inside the pen cap is now taking up less space. And of course if you squeeze hard enough, the diver sinks.

Watch carefully again as you stop squeezing. This time the water level inside the pen cap goes down, so the air inside the pen cap is now taking up more space - and the diver floats to the top again.

So it is the air inside the diver which causes the diver to float. If we compress the air inside the diver (by squeezing the bottle), the diver sinks. If we allow the air to expand (i.e. we stop squeezing the bottle), the diver floats again.

Now try this ...

- Press some bits of string or wool in to the blu tack (as shown in the picture on the right) to make your diver look more like a sea creature!
- See how long you can keep the diver in the middle of the bottle - without it going either to the bottom or top of the bottle.
- Try this with a friend. Squeeze the bottle so that the diver goes to the bottom of the bottle. Then see if you can pass the bottle to your friend without the diver going back up.



Professor Brainstorm's Make a Diver - Worksheet

Remove the blu tack from your pen cap diver. (You don't need to remove the blu tack from inside the pen cap.) **Place the pen cap in a bowl of water. Does it float?**

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Place the blu tack in the water. Does it float?

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Fix the blu tack on to the pen cap again, then place the pen cap in the water with the open end facing down. Does it float?

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Now turn the pen cap the other way up - so the open end is facing up. Does it float this time?

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When the open end of the pen cap is facing down, there is something inside the pen cap which helps it to float. Can you work out what it is?

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If you put the pen cap diver in the bottle, and turn the bottle upside down, why does the diver stop working?

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