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INVESTIGATING THE ATMOSPHERE: AIR TAKES UP SPACE

Class level
1st – 6th Class

Skills
Predicting, Experimenting, Observing, Analysing

Strand: strand unit
Living Things: Myself

Materials: Properties and characteristics of materials

Cross - curricular links
Geography: Planet Earth in Space

Maths: Measures, Length, Ratio, Capacity

Learning objectives
The child should be enabled to: ".. use all the senses to become aware of and explore environments" (SESE: Science, page 41) "..recognise that a gas, such as air, occupies space....." (SESE: Science, page 88)

Equipment
1. Balloons
2. Plastic syringes (no needles!) *+ for 5th/6th classes only: plastic tubing which fits airtight onto the syringes*
3. Narrow straws, plastic pipettes, blu-tack, water
4. Bowl of water, plastic or glass cup, tissues.

Follow-up activity: Glass bottle, funnel, tape *(or rubber O-ring, available in DIY stores)*, water.

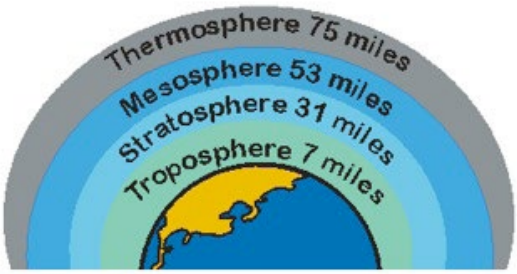



Preparation
Accessing a video of a meteor exploding as it meets the atmosphere would be helpful, e.g. the Chelyabinsk Meteor which exploded over the Urals in Russia in February 2013.

http://upload.wikimedia.org/wikipedia/commons/e/

Background information
Air takes up space.

A layer of air, called the **Atmosphere,** surrounds the Earth like a thick blanket. The atmosphere is the air that plants and animals breathe to survive. Most of the air is concentrated about 5 kilometres (3 miles) above the surface of the Earth, because gravity pulls the layers of air down towards the Earth's surface.



The air gets thinner (less oxygen) the further you go from the Earth, so mountain-climbers find it harder to breathe the higher they go. The Earth's atmosphere or air is made up of a variety of gases (mainly nitrogen and oxygen) and other particles.

When meteorites or **spacecraft are approaching the Earth at high speed** from Space, where there is little or no air (i.e. a vacuum), and get near Earth's atmosphere, they could have a big crash, involving huge heat, when they meet this 'blanket' of air.

Meteorites usually disintegrate and burn up when they crash into Earth's atmosphere (but some have got through and made big dents in the Earth called craters (see DPSM activity 'Moon, Craters and Meteorites'). Obviously it would not be good for spacecraft (which can be travelling extremely fast, e.g. 28000 km/hour) to burn up when they re-enter the Earth's atmosphere, so various methods are used to prevent this, e.g. slowing down and using insulating materials.

Refer to more DPSM activities:

(i) Moving Air; (ii) Pneumatics (Compressed Air).

Engaging/Trigger Questions:

Show the video of a meteorite exploding far up in the sky.

Discuss why the meteorite travelled a long distance through outer space (a vacuum) without exploding, and why it did not wait to explode until it crashed into the Earth (*it hit the atmosphere*). Ask the children to suggest some possible explanations.

Other discussions could be based around:

Air being necessary for us to breathe and stay alive;

Astronauts carrying oxygen with them into space.

Can they think of other places where air is stored? (*Tyres of bikes and cars, bubbles, footballs.....)*

Suggested trigger questions:

Can you see air? Smell it/ feel it /taste it? *(Probably not. But you can hear and feel moving air, e.g. on a windy day or near a fan; and you can see air if there are impurities in it, e.g. dust in sunshine or smoke).*

If you take everything (i.e. all the people and all the things) out of this room, what is left? *(Nothing? Are you sure?).* Discuss what a vacuum is.

What do you call the layer of air surrounding the Earth? *(The atmosphere).*

What happens when things crash? *(Discussion could include: The heat caused by friction. Children can rub or clap their hands – what do they feel? planes going on fire when they crash, due to the intense heat).*

When spacecraft are returning to Earth at high speed after a mission in Space, what do they meet first? *(Air, i.e. the atmosphere).*What you think they have to do? *(Slow down).* Otherwise what would happen? *(They would break up, burn up).*

How do you think they can be prevented from burning up? *(They are covered in insulating materials, and also they slow down).*

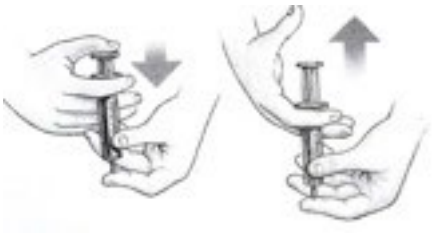
Activities: (predict, test prediction by experimenting, observe, propose explanation).

INVESTIGATING AIR AND THE ATMOSPHERE - Air takes up Space

1. Fill a Balloon with Air

Take a balloon and blow it up (i.e. fill it with air and do not explode it). Can you describe what is happening. *(As the air enters the balloon from your lungs, the air takes up space in the balloon. The balloon expands because the air inside needs to take up more space).*

2. Fill a Syringe with Air and Feel the Air Pushing



(This part of the activity is similar to part of the DPSM Activity on Pneumatics 'Air and Water Power').

(a) Pull the plunger of the syringe out towards you, then push it in again. Was this easy? What was happening inside the syringe? *(The syringe filled with air, and then was pushed out again).*

(b) Pull the plunger again, and this time cover the other end of the syringe with your finger. Press down on the plunger. Was this easy? What did you feel? Can you explain what was happening inside the syringe. Was there any difference this time, and if so why? *(It is easy to push the plunger in a little bit, but gets harder because air is trapped inside the syringe and resists the plunger. The more compressed the air becomes the harder it is to push the plunger).*

(c) Let the plunger go. What happens? *(The plunger shoots back up and then stops)*
Why do you think this happens? *(The air which was compressed in the syringe expands back to its original state and pushes the plunger back out).*

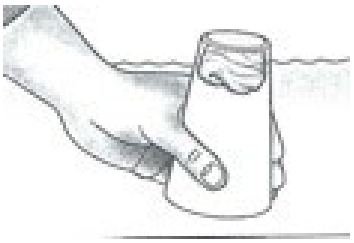
3. Fill a Straw with Water from the Top

Block up the bottom of a narrow straw with a piece of blu-tack. Then try to fill the straw from the top with water, using a pipette.

Was this difficult? If so, why do you think it was not easy? *(Air got in the way).*

Slowly release the blu-tack. What happens and why? *(The water moves down, because the air escapes).*

4. Dry Tissue under Water



Crumple the tissues up into a ball and push them tightly into the bottom of the cup, so that they do not fall out when the cup is turned upside down. *(A few tissues tightly packed are less inclined to fall out than one tissue).*

Predict what will happen to the water and tissue when you turn the cup upside down in the water.

Now turn the cup upside down and place it under the water in the bowl. Take it out and feel the tissue.

What do you notice?

Why do you think the tissue did not get wet? *(Air prevented the water going up into the cup).*

Discuss where air pockets can occur: in water pipes, capsized canoes, central heating radiators, etc.

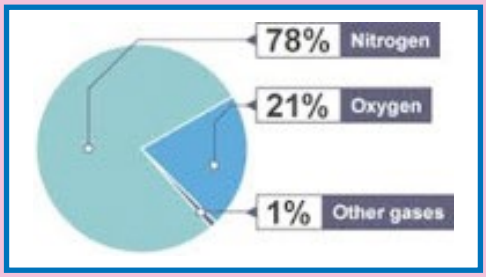
Safety

In Activity 2, always use sterile syringes that have not been used for medical purposes.

Be careful with the sizes of syringes – a big syringe could push out a small syringe with great force.

Maths

A. Air is a mixture of gases, and this pie chart represents how much of each gas is in the air. The 'other gases' consist of carbon dioxide, argon and very small amounts of other gases.



1. Approximately what fraction of the air consists of (i) nitrogen (ii) oxygen?
2. What is the approximate ratio of nitrogen to oxygen in the air?
3. Can you convert the three percentages above to decimals?

B. In Activity 2, when using two different-sized syringes connected by tubing, calculate the ratio of the sizes of syringes. Then measure the distances the two syringes moved.

1. Is there any connection between these two ratios?
2. Investigate which combination of syringes gives the greatest movement.

Analysis/Conclusion

Air takes up space (even though you cannot see it).

Follow-up activity

Filling a Bottle Using a Funnel

Put the funnel into the mouth of the bottle and ask the children to predict what will happen when they pour water into the funnel. They then pour water into the funnel and observe what happens *(The water flows into the bottle)*.

Now, secure the funnel onto the bottle so there is no space between the two. THIS SPACE MUST BE TOTALLY AIRTIGHT. The children again predict what will happen when they pour water into the funnel. They then pour water into the funnel.

N.B It can be difficult to get an airtight seal. A rubber O-ring, available in DIY stores, placed around the neck of the funnel, and then a hand pressing down on the funnel, can produce a good seal. Tape, well-sealed, may work also).

Observe what happens. What do you see? What do you hear?

Why was it hard for the water to get in? (*Air inside the bottle got in the way*).

What else do you notice? (*If there is a fully airtight seal no water passes into the bottle because the air is in the way and cannot escape. If there is a slight air leak there is a glug-glug sound of some water getting in while bubbles of air escape*).

Children Can:

1. Find out more about central heating radiators not giving out much heat because of air getting trapped in them – 'air locks', and how this air is released.
2. Explore the five different layers which make up the atmosphere – find out their names, and at what approximate level you will find clouds, aeroplanes, the ozone layer, satellites, the International Space Station, etc.

Did You Know?

1. In October 2014 Space X Dragon Spacecraft, returning to Earth carrying a cargo of biological samples (including plants grown in space) from the International Space Station, produced intense heat as it plunged into the atmosphere. The temperature was nearly 3000° Fahrenheit (1649°Celsius). It was protected from burning by a very strong heat shield.

2. On Monday 19 January 2015 an amateur photographer captured a fireball photo over Dalkey Island, south Co. Dublin. (photo in Irish Examiner on Tues 20 January 2015)

   "It is definitely a fireball or bright meteor," confirmed David Moore the editor of the Astronomy Ireland magazine. "These objects come through the atmosphere at 70,000mph, burning up as they enter and are extremely rare to photograph."

3. A fisherman survived for 60 hours in an air pocket under an upturned boat which capsized off the coast of Nigeria in May 2013.

Useful Websites:

1. For a meteor hitting the Earth's atmosphere above the UK, see **www.esero.org.uk/news/meteor-fireball-seen-across-the-uk**
2. For more about the layers which make up the atmosphere see **www.ducksters.com/science/atmosphere.php**
3. For a more detailed investigation on the ' Dry Tissue Under Water' activity see the NASA (National Aeronautics and Space Administration of the USA) 'Aeronautics Educator's Guide': **http://www.nasa.gov/pdf/205704main_Dunked_Napkin.pdf**