

KS3 Science

Independent Learning

Booklets

Pressure

If you have internet at home, you can use bitesize to help you with some of the activities.

Try your hardest to work through the booklets

Pressure on surfaces

You may have been warned about swinging around on one leg of a chair. Apart from the risk that you will damage the chair or hurt yourself, the chair leg can damage the floor. This is because it puts too much pressure on the floor.

Calculating pressure

To calculate pressure, you need to know two things:

- the force or weight exerted
- the surface area over which the force or weight is spread

Pressure is calculated using this equation:

$$\text{pressure} = \text{force} \div \text{area}$$

Example

A force of 20 N acts over an area of 4 m². Calculate the pressure.

$$\begin{aligned} \text{pressure} &= \text{force} \div \text{area} \\ &= 20 \text{ N} \div 4 \text{ m}^2 = 5 \text{ N/m}^2 \end{aligned}$$

Notice that the unit of pressure here is N/m² (newtons per square metre). Sometimes you will see another unit being used. This is called the pascal and it has the symbol Pa.

1 Pa = 1 N/m², so in the example above the pressure is 5 Pa.

Using pressure

If you walk through snow, you usually sink into it. This is because your shoes have a small surface area. Your weight is only spread out over a small area, so the pressure on the snow is high. However, you will not sink so far into the snow if you are on skis. This is because your weight is spread out over a greater surface area, so the pressure on the snow is low.



Drawing pins make good use of different pressures for the same force

Drawing pins have a large round end for your thumb to push. The round end has a large area, so it exerts a low pressure to your thumb. The sharp end has a very small area. The same pushing force produces a high pressure there, so it pushes into the notice board.

If you swing round on one leg of a chair, you put four times as much pressure on one point of the floor as you do if you sit properly. This is because four chair legs spread the pressure over four times more area than one chair leg can.

Pressure in fluids

Liquids and gases are fluids. A fluid is able to change shape and flow from place to place. Fluids exert pressure on surfaces, and this pressure acts at 90° to those surfaces – we say that it acts normal to the surface.

Atmospheric pressure

The atmosphere exerts a pressure on you, and everything around you. You may have seen a demonstration of the effects of this atmospheric pressure.

The Magdeburg hemispheres are two metal cups that fit together. If most of the air is removed from inside them using a vacuum pump, it is almost impossible to pull them apart again. The pressure of the atmosphere acting on their outside surface pushes them tightly together. Once the air is let back in, the pressure inside equals the pressure outside again, and the cups can easily be separated.



Rubber seals being used as a demonstration of the Magdeburg hemispheres

The effects of pressure can be seen in the collapsing can experiment. Here some water is boiled in an empty drinks can and steam fills the can. If the can is turned upside down in a trough of cold water, the steam condenses and the air pressure inside goes down. The pressure of the air outside the can suddenly crushes the can.

Atmospheric pressure changes with altitude. The higher you go:

- the lower the weight of the air above you
- the lower the atmospheric pressure

For example, atmospheric pressure at sea level is about 100,000 Pa, but it is only about 21,000 Pa at the cruising height of an airliner.

Pressure in liquids

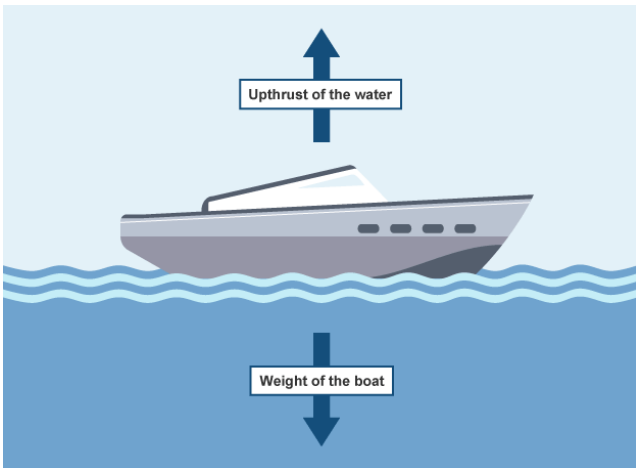
Just like the atmosphere, liquids exert pressure on objects. The pressure in liquids changes with depth. The deeper you go:

- the greater the weight of liquid above
- the greater the liquid pressure



Pressure in a liquid increases with depth so the jet coming from the bottom of the bucket travels further sideways

Liquid pressure is exerted on the surface of an object in a liquid. This pressure causes upthrust. An object placed in a liquid will begin to sink. As it sinks, the liquid pressure on it increases and so the upthrust increases. For a floating object, the upthrust is equal and opposite to the object's weight. An object will continue to sink if its weight is greater than the maximum upthrust.



The weight of the boat is balanced by the upthrust from the water

What is pressure?

Pressure can be thought of as the concentration of a force on an area and can be calculated using the equation: $\text{Pressure} = \text{force} \div \text{area}$

Force is measured in Newtons (N). Area can be cm^2 or m^2 and so pressure is measured in N/cm^2 or N/m^2 .

For example a person might weigh 400 N and stand on one foot which has an area of 80 cm^2 so the pressure this person puts on the ground is $400 \div 80 = 5 \text{ N}/\text{cm}^2$

You can see the effects of this equation in action if you press a drawing pin into a cork board. The pin point end pierces the cork board and stays in place, you couldn't do that with the flat end.

This is because the same force is concentrated onto a smaller area at the pin end which creates enough pressure for the pin point to pierce the cork board.

How to change the pressure

Skiers increase the area in contact with the snow by using skis. Their body weight is no longer concentrated on their feet but is spread out over the area of the skis. The lower pressure of the skis means the skier glides on the snow rather than sinking into it. In comparison, the smaller area of the boot creates a greater pressure, and as a result a person just wearing boots would sink into the snow.

Pressure in action

Footballers need to get a good grip on the ground. They use boots with studs in them.

The studs have a small area to make the pressure large enough to dig into the surface. That way they have better grip and will not slip.

What causes water pressure?

Water will naturally flow downhill. A reservoir holds a lot of water and is usually quite high up. The weight of water in the reservoir provides the pressure to force water through pipes lower down.

Water pressure is bigger if there is a greater height of water feeding the pipes below. You can demonstrate this by making three holes in a plastic bottle, one above the other, and then filling the bottle with water. The water will flow fastest out of the lowest hole because there is more weight of water above it.

Water pressure can be also created by pumps where water is needed to be pushed to places that are higher up.

Why does water flow through pipes?

Water pressure pushes water through any available hole. If you puncture a balloon several times and fill it with water you will see it coming out of all the holes in every direction.

Pipes are like holes for water to flow through. The pressure pushes water along the pipes even when they bend. We can use pipes to direct the water to a specific place. The pressure needs to be sufficient to make water flow quickly through the pipes but not too much because it can make the pipes come apart.

Why is knowledge of water pressure useful?

Understanding water pressure is important for plumbers who need to make sure that water can flow properly through all of the pipes.

High water pressure is used by dentists to clean teeth and it is also used by people at home using pressure washers to clean cars and driveways.

How to weigh a floating object without scales

- When objects float on water the force keeping the object afloat is called upthrust and this balances the weight of the object.
- When something is placed in the water, the water that moves out of the way. We say the object is displaced.
- For floating objects the weight of displaced water is equal to the weight of the object.

What is upthrust?

When objects float, they push water out of the way. We say the water is displaced.

The water pushes back with a force we call upthrust.

The water continues to be pushed out of the way until the upthrust equals the weight of the object.
Using upthrust to find the weight of an object

If the water that is displaced is weighed, we find it has the same weight as the object that is floating.
How does water pressure work?

As the water comes out of the holes, the water level drops, meaning the jets of water from all of the holes slow down.

Air pressure works in a similar way. The air pressure where you are, is determined by the weight of the atmosphere above you.

If you climb a tall mountain, the air pressure decreases because there is less air above you.

Who needs to know about water pressure?

Divers need to be aware of pressure in water. If you dive to the bottom of a swimming pool, your ears may start to hurt. This is due to the extra pressure around you.

Deep sea divers train themselves to go many times deeper and need to know how to cope with this extra pressure.

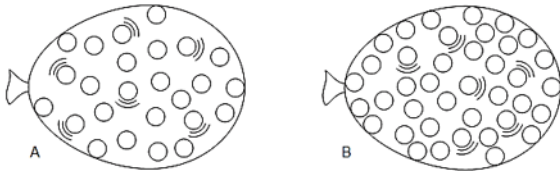
Submarines can go very deep. They must be designed carefully to handle the enormous water pressure at those depths.

At the bottom of the ocean the pressure is equivalent to an elephant standing on your finger, so submarines have to be very strong indeed!

Activities

Task 1 – Circle the correct answer

1. Which of these is under greater pressure?



5. Pressure is increased...

A ...when less particles hit the side

B ...when more particles hit the side

2. Which of these is under greater pressure?

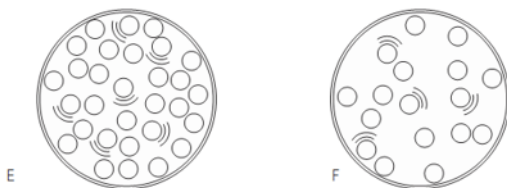


6. When you blow up a balloon, it gets bigger because...

A ...pressure increases inside

B ...pressure decreases inside

3. Which of these is under greater pressure?



4. When gas particles bump into something...

A ...they cause pressure

B ...they cause density

Task 2 – Complete the summary below with the keywords

- Gases are made of ----- that move -----
- The -----of the particles hitting the sides of the container causes the -----.
- ----- particles means more pressure
- Faster moving particles means ----- pressure

Keywords: higher, pressure, fast, more, number, particles

Task 3 - Calculate the pressure needed to pop the Pinata!

Piñata Popping!

The animal with the highest pressure wins!



REMEMBER:
 Pressure = force ÷ area
 Unit = N/cm³

	<p>Colin Force = 30 N Area = 5 cm³</p> <p>Pressure</p>		<p>Paula Force = 20 N Area = 10 cm³</p> <p>Pressure</p>
	<p>Ed Force = 100 N Area = 20 cm³</p> <p>Pressure</p>		<p>Zak Force = 50 N Area = 5 cm³</p> <p>Pressure</p>
	<p>Gary Force = 63 N Area = 7 cm³</p> <p>Pressure</p>		<p>Martin Force = 40 N Area = 8 cm³</p> <p>Pressure</p>

Task 4 – Crack the code, using the key work out the sentence

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	*

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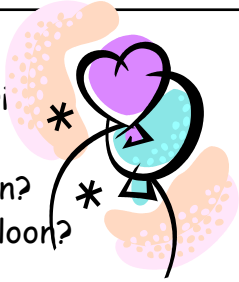


Task 5

Pressure and Balloons

Pressure is all around us, whether we notice it or not! The atmosphere exerts a pressure of 101,000 newtons per square meter. It's a good job your body exerts an equal pressure - otherwise you'd get crushed! Use the task below to show what you know about pressure.

Task:
 Create a poster to explain how pressure is caused and how it varies depending on the environment. Your explanations should use a balloon as an example. What happens when you inflate the balloon? How does this change the pressure inside and outside of the balloon?



Key words: pressure, force, particles, collisions, surface, gas, volume, increase, decrease, equilibrium.

Grade ladder:

What is your target grade? Use the grade ladder to help you reach it:

To get grade	You might have:
C	<ul style="list-style-type: none"> • Stated what will happen to the pressure inside the balloon as you inflate it. • Compared the pressure inside and outside of the balloon. • Drawn a pressure diagram of the inflated balloon.
B	<ul style="list-style-type: none"> • Stated the relationship between particles and pressure. • Drawn a diagram to show this relationship. • Stated what will happen to the pressure inside the balloon as you inflate it, relating your answer to the amount of gas. • Drawn a pressure diagram for an uninflated and an inflated balloon.
A	<ul style="list-style-type: none"> • Explained, using a diagram, how particles cause pressure. • Explain the pressure levels inside and outside of the balloon. • Explained, using the particle model, any pressure changes as more gas enters the balloon. • Relate any pressure changes to any changes in balloon size. • Drawn pressure diagrams at various stages of inflation.
A*	<ul style="list-style-type: none"> • Taken into account the force of the latex pushing on the air inside the balloon.

Optional fun task You can investigate pressure (floating and sinking) at home with just a few items. If you choose a few items from around the house (see table for some ideas). Work out what material you think the object is made from and then predict if you think it will float or sink.

You will need a bucket/ measuring jug/ container and fill it up with water. Simply drop your item in and see if it floats or sinks.

Science: Floating and sinking investigation.

WATER

Hypothesis (what do you think will float and what do you think will sink?)

OBJECT	MATERIAL	PREDICTION	FLOAT	SINK	CORRECT
<u>Coin</u>					
<u>Cube</u>					
<u>Balloon</u>					
<u>Button</u>					
<u>Ruler</u>					
<u>Pencil</u>					
<u>Cardboard</u>					

Extension – why don't you try the same items in some different liquids maybe oil or syrup.