The S4
BUMPER WORKBOOK
of Key Stage 3 Home Science
ANSWERS

Name:

Swansea University
Science for
Schools Scheme

Welcome to S4's Bumper Book of SCIENCE!

What will I be learning?

Here you can find Worksheets to accompany the science lesson videos on our website at **www.s4science.co.uk/keystage-2-3**

You can watch a video and then find the corresponding worksheet to complete.

Our science videos and worksheets cover the National Curriculum for Wales, and there is space on each worksheet where your teachers can give you feedback.

We are Swansea University Science for Schools Scheme and we hope you enjoy our Bumper Book of Science!

How do I use the workbook?

You can find all the science lesson videos that accompany these worksheets at www.s4science.co.uk/keystage-2-3.

You can also find content on our Trusted Partner page on **Hwb** (search for **'S4 Science'**).

If you have any problems finding content, or using the worksheets, you can contact us via your school, or at s4science@swansea.ac.uk. If you are old enough to use social media, you can also connect with us **@swansci4** on Twitter and **@science4schools** on Instagram.

Who are we?

S4 are part of the pan-Wales European Social Fund and Welsh Government funded Trio Sci Cymru consortium. We are a Swansea University science outreach project.

Video Key

All videos can be found at **www.s4science.co.uk/keystage-2-3**

S4 Online Lessons

Online science video lessons suitable for Key Stage 3. They include hands on experiments that you can do at home.

Lizzie Daly's Earth Live Lessons

20 minute 'explainer' lessons exploring a variety of conservation, biology, geography and earth science topics.

S4 Science Club

Extra experiments, explainers, and fun science activities!

Look out for the **go to our website and look for this video cover** message. This will help you to find the video on our website: **www.s4science.co.uk/keystage-2-3**

Workbook Answers

You will find answers to all the worksheets on our website: **www.s4science.co.uk/keystage-2-3**

Key Stage 4 & 5

We also have a range of resources for older pupils, find these at: **www.s4science.co.uk/keystage-4-5**

Contents

Video 1

Marshmallows in Space!

Go to our website and look for this video cover.

This worksheet accompanies our **'Marshmallows in Space!'** S4 Science Club video, you can find it at:

www.s4science.co.uk/keystage-2-3

What is it about?

This short video shows a bell jar experiment where a marshmallow, which is full of air, is subjected to a vacuum.

In the video, the air is pumped out of a bell-jar to decrease the air pressure inside the jar and create a vacuum, just like in space.

The video illustrates the effects the low pressures in space would have on the human body if astronauts did not wear space suits.

Marshmallows are soft and bouncy because they are filled with tiny pockets of air. As the air is pumped out of the bell jar the first thing that happens is that the air pressure in the jar decreases. The pockets of air inside the marshmallow expand in the low pressure, causing the marshmallow to grow. This would happen to the air in your lungs if you held your breath in the vacuum of space. After the air is let back into the jar (by releasing the vacuum pump) the air pressure returns to normal, the marshmallow looks like it is deflating and it is also stretched out of shape.

So, if you ever find yourself in space without a spacesuit – remember to breathe out!

What happens to our bodies in space?

Did you know that 2nd November 2000 was the last time that all living humans were on Earth at the same time?

Since that date, the International Space Station has had at least one person on it at all times. So, understanding how we survive space, and what happens to our bodies in space, is really important.

The human body is under immense pressures when entering, living in, and leaving, space. We have evolved to survive the conditions on Earth, and the conditions in space are very different. Because of this, going into space can have strange effects on the human body. Astronauts have to wear high-tech spacesuits to stay alive and healthy. If they went into the vacuum of space without their space suit, one of the things that would happen to them is the air in their lungs would expand – just like our marshmallow!

Spectacular space suit facts:

- Neil Armstrong and Buzz Aldrin, the first humans to land on the moon, spent 2 hours and 32 minutes on the moon and one of the things they were doing was testing out their space suits!
- Each astronaut on the early Apollo moon missions had three space suits, one for the space flight, one for training in and a spare in case anything went wrong.
- A really important test for a space suit is whether or not you can stand back up if you fall over wearing it!
- NASA used an x ray machine to check whether the sewers had left any pins in the space suits when they were making one. If they had the pin could fly out in the vacuum of space and injure the astronaut!
- These super space suit facts are from the book “The Spacesuit: How a Seamstress Helped Put Man on the Moon” by Alison Donald.

Marshmallows in space

Worksheet 1

Don't forget to find the video to go with this worksheet on our website, you're looking for the **Marshmallows in Space** video!

When was the last time that all living humans were on Earth at the same time?

The 2nd of November, 2000.

What do astronauts wear to help them survive in space?

A space suit.

When we remove the air from the bell-jar, does the air pressure inside the bell-jar increase or decrease?

It decreases, because there is less air.

Activity

Design a spacesuit mission patch

Astronauts usually have a patch on their spacesuit which shows which space mission they are part of. These patches are sometimes designed by the astronauts and have their names and pictures related to their mission. See below for some examples.

Imagine you are going on a mission to explore the surface of Mars to find a suitable spot for humans to start a colony (a place to live). Design the mission patch for your spacesuit.

Examples

My Science Ideas

What science ideas or questions has this video and worksheet given you?

Marshmallows in space

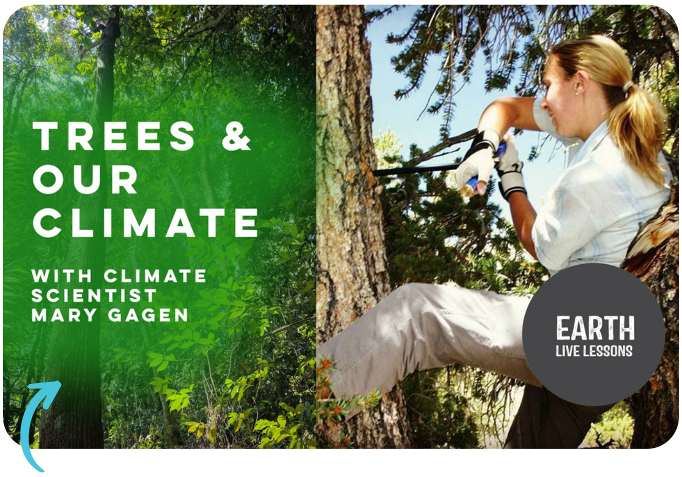
Worksheet 1 Teacher Feedback

Notes & Doodles

Video 2

Earth LIVE Lessons: Trees & Our Climate

- Professor Mary Gagen



Go to our website and look for this video cover.

This worksheet accompanies Lizzie Daly's Earth Live Lessons video, **'Trees & our Climate'**, you can find it at:

www.s4science.co.uk/keystage-2-3

What is it about?

Tree ring growth can be absolutely dated, and mapped onto a historical timeline. This tree ring data shows that the temperature changes we have experienced in the twentieth and twenty-first centuries are unprecedented in terms of speed, and are global.

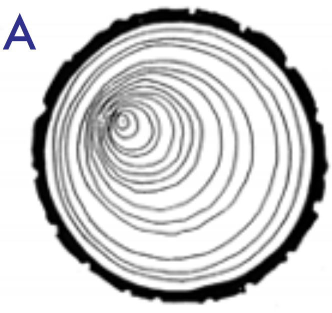
Notes & Doodles

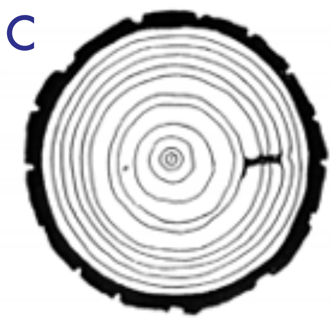
Trees & our climate

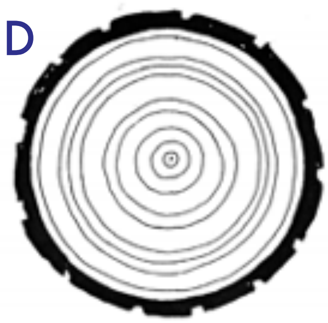
Worksheet 2

Don't forget to find the video to go with this worksheet on our website, you're looking for the **Trees & our Climate** video!

How old are the tree cross sections shown below?







Tree A is 15

Tree B is 14

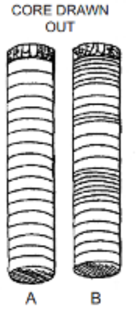
Tree C is 12

Tree D is 10

Not all trees grow at the same rate. Some rings are wide and some are narrow.

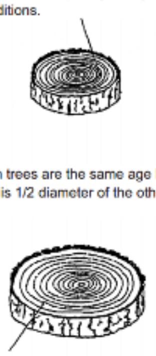
What might make a tree grow a narrow ring?

Any conditions that would limit growth. Limited water, sunlight or nutrients; extended hot or cold temperatures; disease; grazing by animals; air pollution; leaves dropping early. Many of these factors can be brought on by human activity, competition from other plants and climate change. Some factors feed into each other (eg) extended hot temperature can reduce the available water and lead to greater numbers of insects that may eat the tree's leaves.



A - fast growth
B - fast growth for the first 6 years followed by 7 years of slow growth.

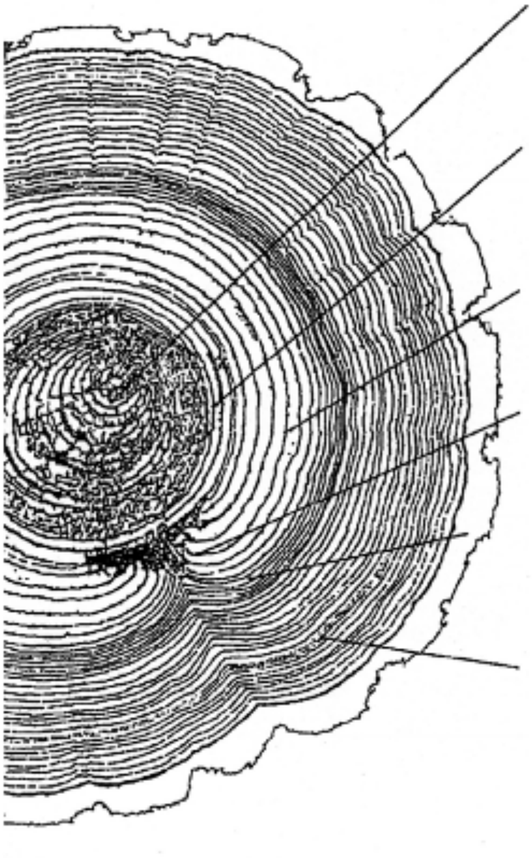
Rings narrow, dark and jammed together show poor growing conditions.



Both trees are the same age but one is 1/2 diameter of the other.

Rings wide, light, well spaced, show good growing conditions.

Tales trees tell



When this tree was 8 years old something brushed against it, making it lean. The rings are now wider on the lower side as the tree builds "reaction wood" to help support it.

The tree is growing straight again, but its neighbors are growing too, and their crowns and root systems take much of the water and sunshine the tree needs to grow. The rings are narrower.

The surrounding trees are harvested. The larger trees are removed and there is once again ample nourishment and sunlight. The tree can now grow rapidly again.

A fire sweeps through the forest. Fortunately the tree is only scarred, and year by year more and more of the scar is covered over by newly formed wood.

These narrow rings may have been caused by a prolonged dry spell. One or two dry summers would not have dried the ground enough to slow the tree's growth this much.

Another series of narrow rings may have been caused by an insect like the larva of the sawfly. It eats the leaves and leaf-buds of many kinds of coniferous trees.

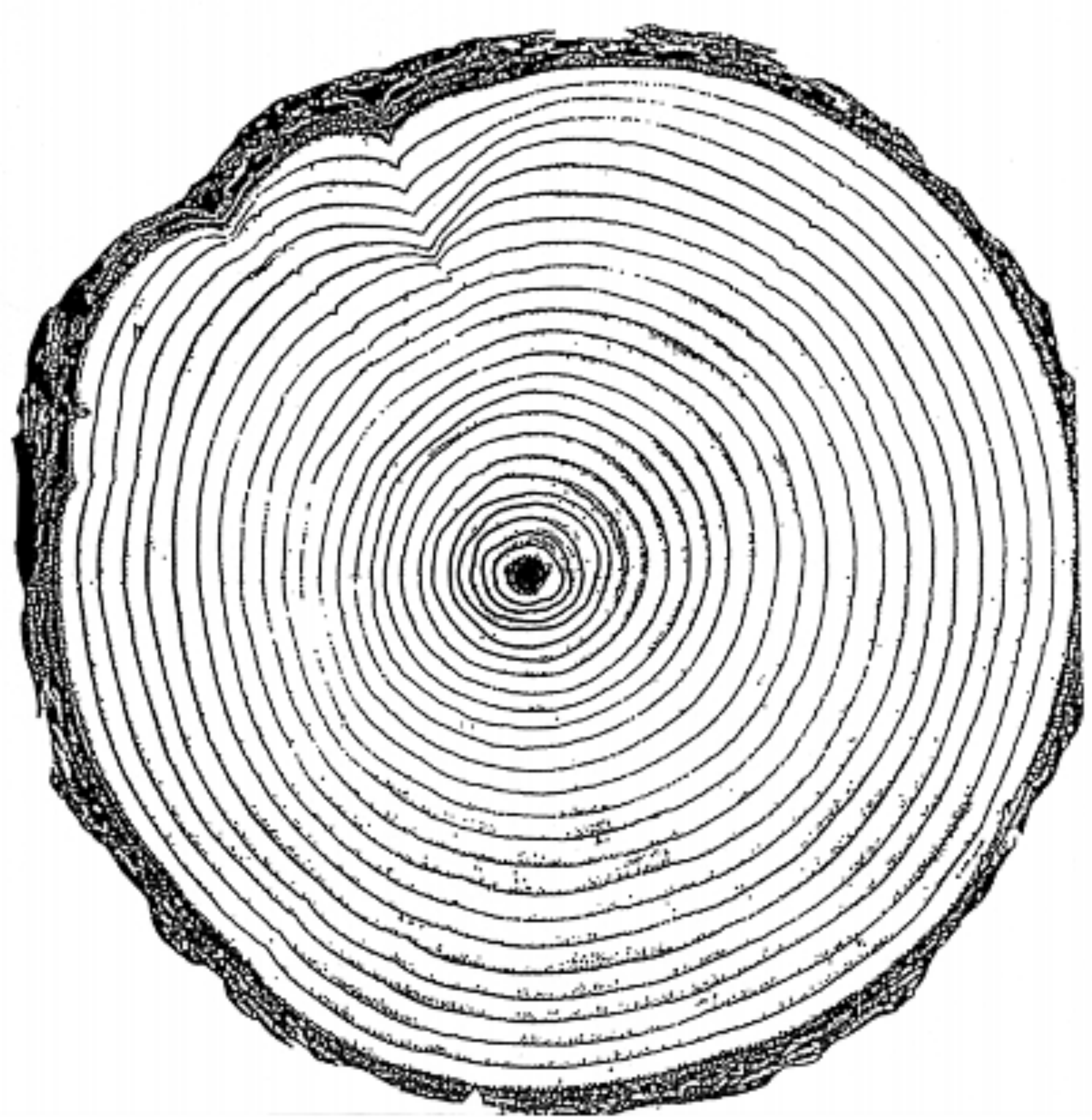
Make up some questions about the statements above.
(e.g. why did the tree grow narrow rings in some years?)

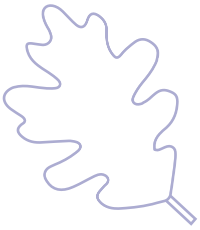
What is "reaction wood"?
The wood a tree builds up to support itself and twist the trunk back to an upright position when leaning. The wood grows faster on one side of the tree, creating an uneven ring.

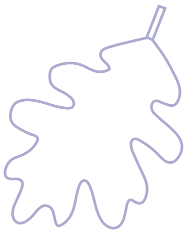
Are rings different year by year or do they follow trends?
They follow trends. The problems that can affect their growth are normally long-lasting factors that change gradually. Also, trees are resilient once established, requiring consistently bad conditions to affect their growth. They are unlikely to be greatly affected by just one bad year, except for extreme conditions such as a forest fire.

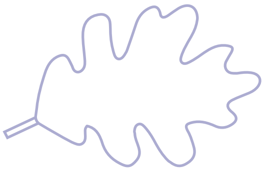
Why might looking at tree rings be useful?
Allows us to study past conditions that we might have no records of – some trees are older than human records. They can help us to understand the impacts of slow, long lasting problems, such as climate change, and inform us of any years with extreme events.

The outside ring is 2015. Count back to find the ring from the year you were born.









My Science Ideas

What science ideas or questions has this video and worksheet given you?

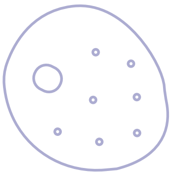
Trees & our climate

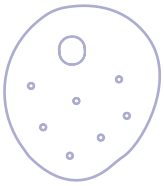
Worksheet 2 Teacher Feedback

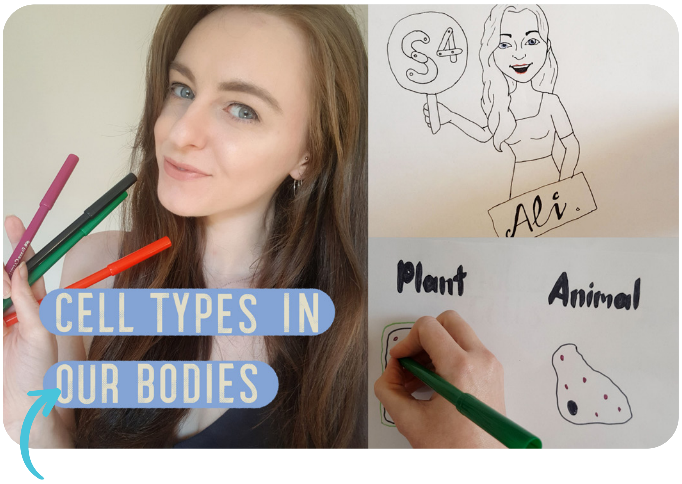
Notes & Doodles

Video 3

Cell Types in our Bodies







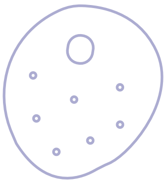
Go to our website and look for this video cover.

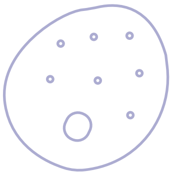
This worksheet accompanies our **'Cell Types in our Bodies'** S4 Lessons video, you can find it at:

www.s4science.co.uk/keystage-2-3

An Introduction to Cells

Cells are the smallest parts that make up all living things and are commonly called "the building blocks to life." There are different types of cells, including animal and plant cells, each containing a number of structures to help them survive. These special structures found within these cells are called "organelles" and each one has a different job which help our cells to function properly.



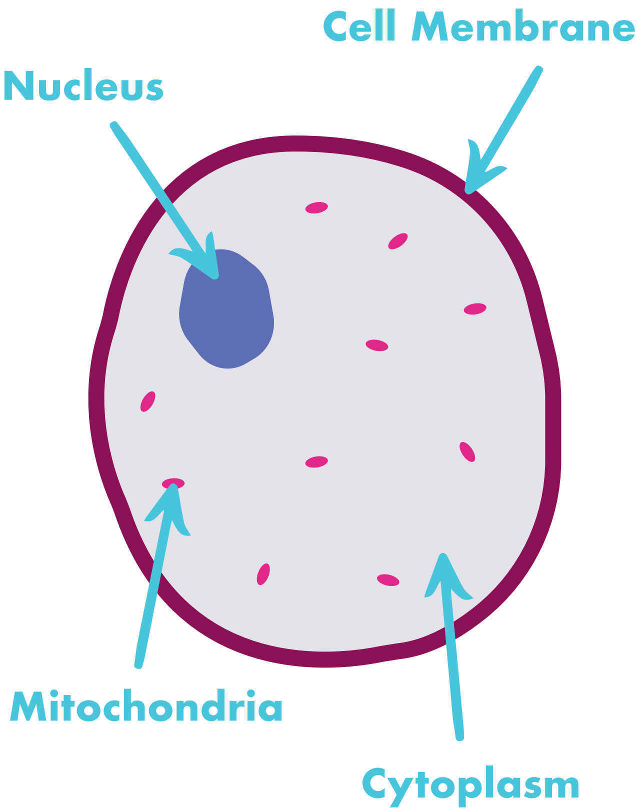


Animal Cells

The following organelles are found in an animal cell:

- **Nucleus:** An organelle found in most cells. It is where the majority of the cell's DNA is found.
- **Cell membrane:** The outside layer of a cell. It is semi-permeable, meaning that it lets selected substances into and out of the cell.
- **Mitochondria:** This organelle is responsible for making energy for the cell by taking in nutrients and breaking them down through respiration.
- **Cytoplasm:** This is a jelly-like substance found inside the cell that the organelles are found in. It is made mostly of water, but also contains nutrients and enzymes.

Animal Cells

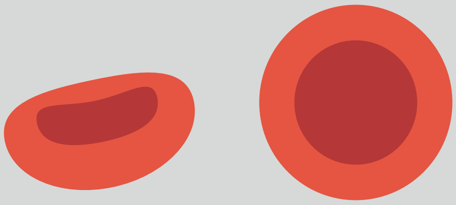


Red Blood Cells

An example of an animal cell is the red blood cell. These cells are the smallest cells found in the human body. Their job is to carry oxygen around our bodies.

They have a strange shape, a bit like a donut! This shape allows the red blood cell to be flexible. By being flexible, these cells are able to travel into the smallest parts of our bodies, like tiny blood vessels for example. This is

to make sure oxygen is transported everywhere throughout our body!



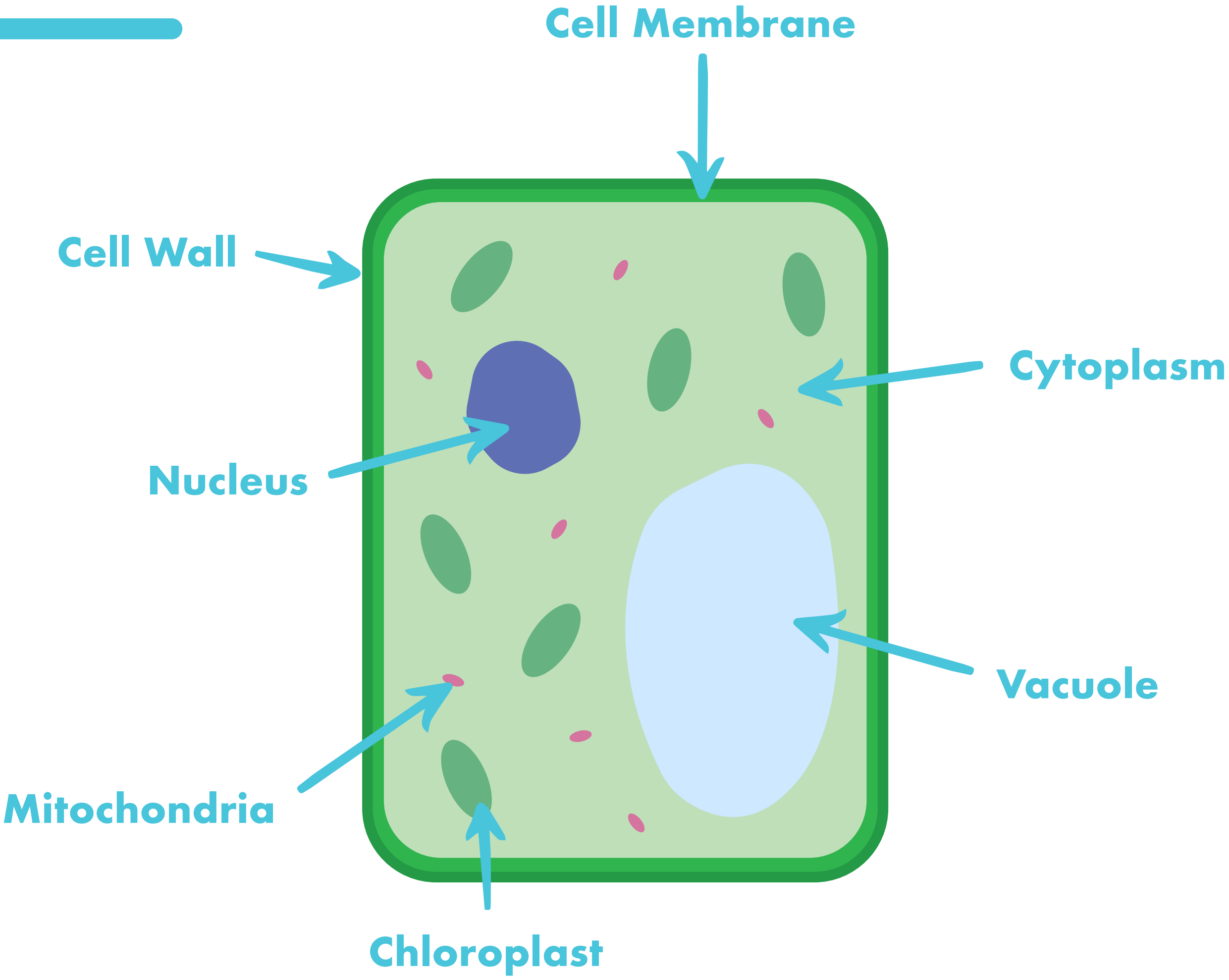
Plant Cells

Plant cells are a bit different to animal cells. Although they have a nucleus, cell membrane, mitochondria and cytoplasm, just like animal cells, they also have other organelles which help them survive!

The following organelles are found in plant cells in addition to those found in animal cells:

- **Cell Wall:** A rigid outer layer found in some cells, it surrounds the cell membrane and helps keep to a firm shape. This organelle provides support, structure and protection to plant cells.
- **Chloroplast:** The chloroplast of plant cells contains a molecule called Chlorophyll. These little green chlorophyll molecules convert light energy from the Sun into sugars for food. This process is called photosynthesis.
- **Vacuole:** The vacuole of a plant cell stores food and nutrients. They can also store waste products to protect the cell.

Plant Cells



Notes & Doodles

Cell types in our bodies

Worksheet 3

Don't forget to find the video to go with this worksheet on our website, you're looking for the **Cell Types in our Bodies** video!

What are the similarities and differences between an animal cell and a plant cell? Fill in the table below:

Similarities	Differences
Cell membrane	Cell wall
Nucleus	Chloroplasts
Mitochondria	Vacuole

Activity

Crossword Puzzle

Use the clues to complete the crossword!

						2 v									
1 c	y	t	o	p	l	a	s	m							
e						c									
l						u					4 c				
l						o					e				
s				3 c	h	l	o	r	o	p	l	a	s	t	
						e					l				
		6 c									m				
	5 p	h	o	t	o	s	y	n	t	h	e	s	i	s	
		l									m				
		o							8 o		b		9 n		
		r							x		r		u		
		o							y		a		c		
		p						7 o	g	a	n	e	l	l	e
		h							e		e		e		
		i							n				u		
		l											s		
		l													

Find the answers on our website
www.s4science.co.uk/keystage-2-3

Across

1. The jelly-like substance found inside of a cell (9)

3. This organelle is found in plant cells. It contains a molecule called Chlorophyll (11)

5. The process of converting light energy from the Sun into sugars for food (14)

7. The special structures found in cells which help them survive (9)

Down

1. The smallest part that makes up all living things and are the building blocks to life (5)

2. This organelle a plant cell stores food and nutrients. They can also store waste products to protect the cell (7)

4. This is the semi-permeable, outside layer of a cell (4,8)

6. The green molecules found in the Chloroplasts of a plant cell (11)

8. Red blood cells carry this around our body (6)

9. The organelle of a cell where most of the cells DNA is stored (7)

My Science Ideas

What science ideas or questions has this video and worksheet given you?

Cell types in our bodies

Worksheet 3 Teacher Feedback

Notes & Doodles

Video 4

Cells that Capture Light

Go to our website and look for this video cover.

This worksheet accompanies our **'Cells that Capture Light'** S4 Lessons video, you can find it at:

www.s4science.co.uk/keystage-2-3

What are we learning?

In this worksheet we're going to learn about **PHOTOSYNTHESIS AND SOLAR PANELS.**

Super Cells

There are many different types of cells in plants and animals.

Some plant cells are special and can capture light to use in photosynthesis to make energy (sugar) using light, carbon dioxide and water.

What colour are the parts of a plant where photosynthesis happens?

Green

Photosynthesis happens in the leaves.

Cells that capture light

Worksheet 4

Here's a worksheet you can do if you are unable to watch the **'Cells that Capture Light'** video.

1

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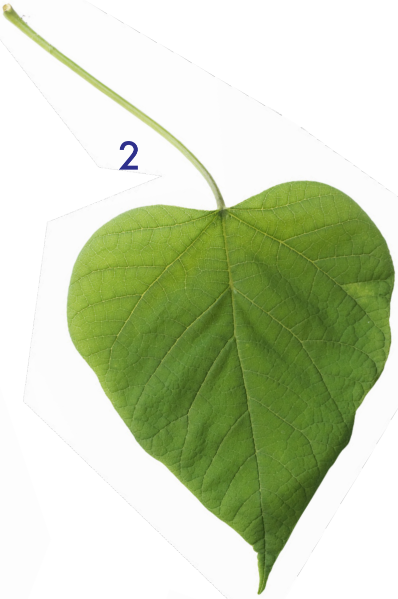

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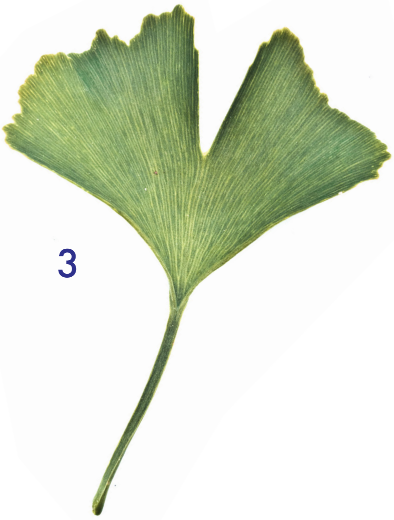

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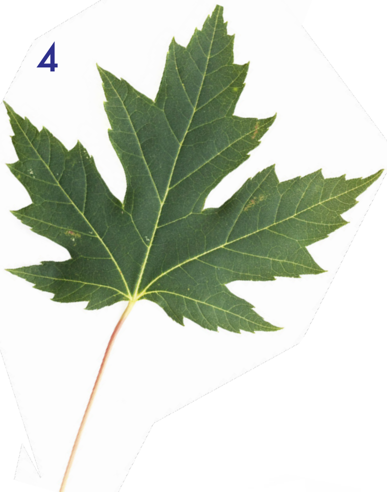

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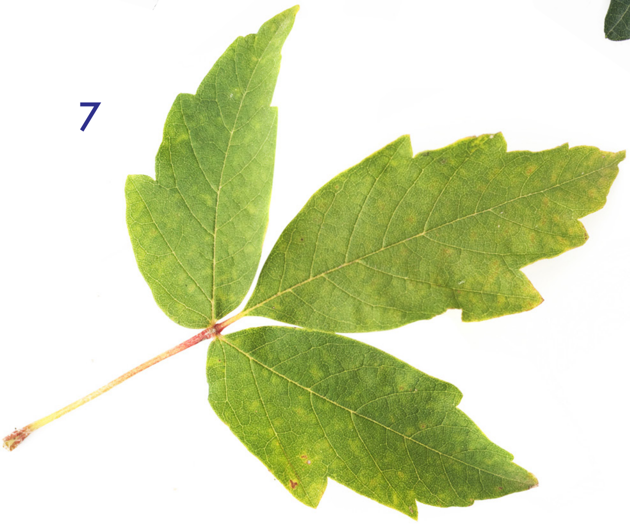


The picture above shows the different shapes of leaves. See how many different shaped leaves you can find in your garden or a local park.

Number	Leaf shape name	Found it?
1	Linear	
2	Cordate	
3	Flabellate	
4	Palmate lobed	
5	Pinnate lobed	
6	Ovate	
7	Trifoliate	

How do leaves create energy?

Flowers are often bright and colourful in order to attract insects for pollination, but most leaves are green. This colour is made by a **pigment** in the leaves and it allows plants to **photosynthesise** and make energy **(sugar).**

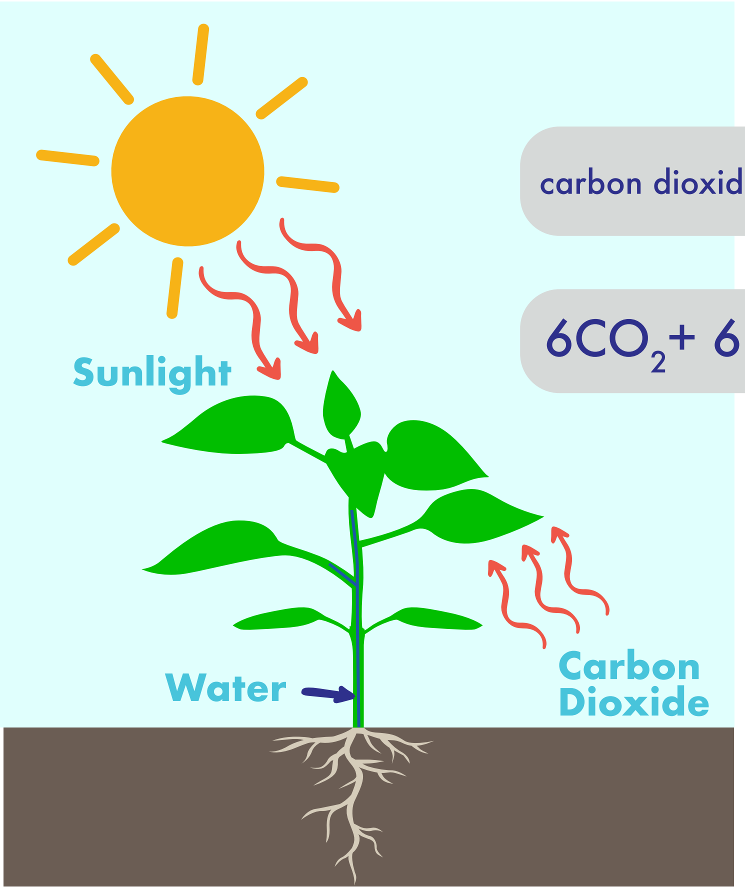
The green colour is made by a **pigment** called **chlorophyll.**

Chlorophyll gives leaves their green colour because it reflects green light and absorbs red and blue light. The light energy reaching leaves from the sun is absorbed by the chlorophyll and turned into energy in the form of sugar.

This process is called **photosynthesis.**

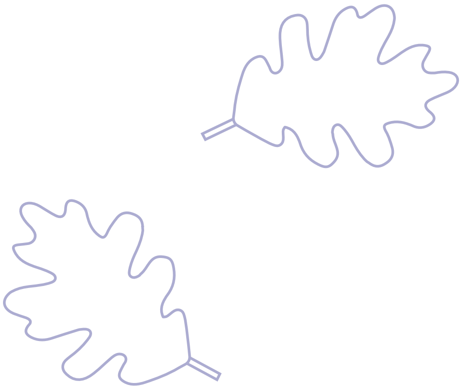
The word photosynthesis is made of the word “photo” which means light,
and “synthesis” which means putting something together.

Photosynthesis takes light, carbon dioxide and water and puts them together to make sugar.



$$\text{carbon dioxide} + \text{water} \xrightarrow{\text{sunlight}} \text{glucose} + \text{oxygen}$$

$$6CO_2 + 6H_2O \xrightarrow{\text{light energy}} C_6H_{12}O_6 + 6O_2$$



Fill in the blanks

glucose, water, carbon dioxide, oxygen

Carbon dioxide and **water** are combined, using energy from the sun to make **glucose** and **oxygen** during photosynthesis in plants.

How does the human body make energy?

Cells in animal bodies cannot make energy in the same way as plants can. Animals do not photosynthesise. This means we have to eat food to get energy.

However, humans have figured out a way to take energy from the sun and use it as an energy source for our homes using **solar power.**

Have a look around the area where you live and see how many houses with solar panels on you can spot.

Where do the panels sit on the house? Why do you think that is? What way do the panels face? Why do you think that is?

Solar panels need to get a lot of sunlight so they can produce electricity. They are usually put on roofs so that they are outside and high up. This means that the sunlight can reach them and won't be blocked out by nearby objects and other buildings. In the UK, we tend to point our solar panels towards the South and at an angle from the ground. This is to make sure they get as much sunlight as possible and the light will reach the panels if the Sun is high in the sky (at midday) or low in the sky (in the mornings and evenings).

Solar panels are also known as **photovoltaic cells.**

This means that these panels convert light into electricity.

PHOTO
Meaning light

+

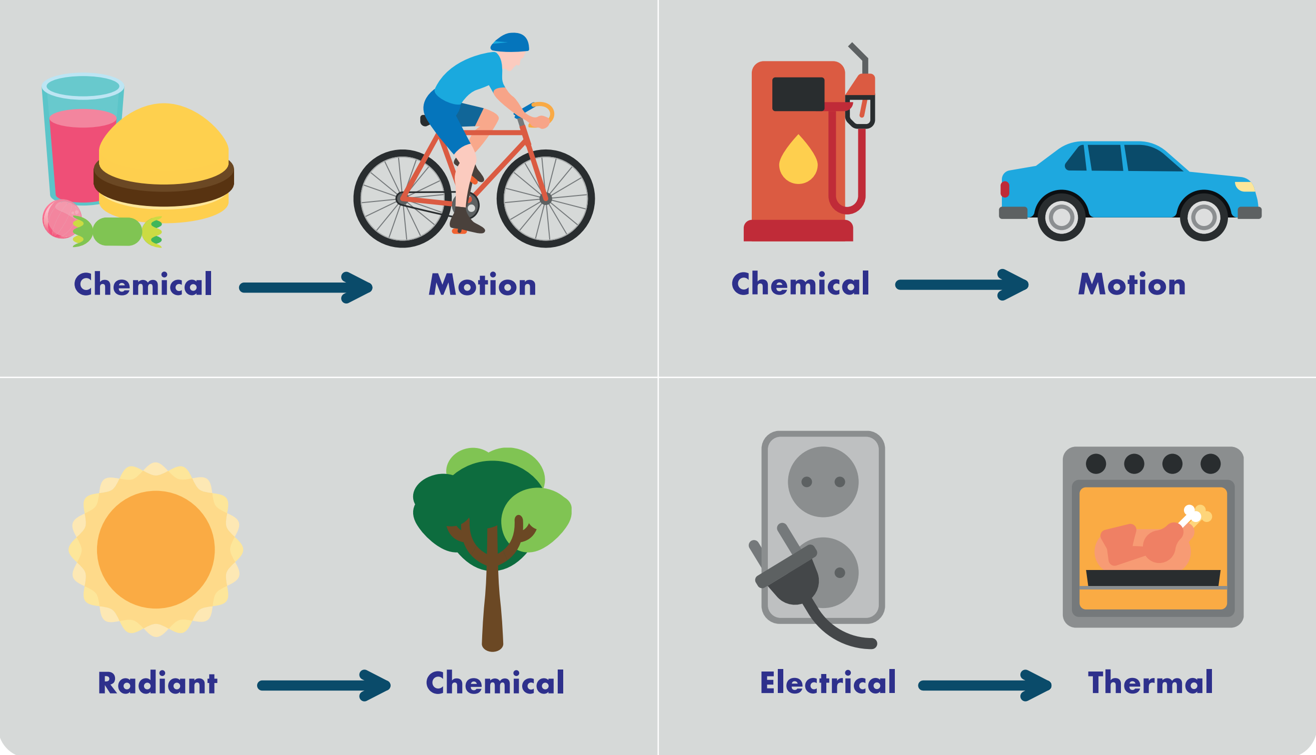
VOLTAIC
Meaning Electricity

How do solar panels work?

Solar panels work by converting the energy in sunlight into energy in electrons, producing electricity.

One of the fundamental laws of physics is that energy cannot be created, it can only be **transformed,** from one type to another. This is called the **First Law of Thermodynamics.**

Energy Transformations



Solar panels convert the sun's energy (photons) into electrical energy (electrons).

Everything in the universe is made of atoms and every atom is made up of smaller particles, one of these particles is called an **electron.**

An electron is a small, negatively charged particle which circles the outside of atoms.

Electrons inside the solar panel absorb particles of light energy called **photons.**

The energy from the photons makes the electrons move more. When the electrons have absorbed enough sunlight energy they escape the solar panel material to travel out as electrical energy down the panel's wiring. The panel has converted the sun's energy into electrical energy. **Electricity is the flow of charged particles and electrons.**

What are the two types of particles involved in making solar energy?

Electrons and photons

What is electricity?

Electricity is the nett movement of charged particles, like electrons.

Experiment

Making a Solar Heater

Materials

- Thermometer
- Stopwatch or Timer
- Clear container with lid
- Water

Results

Start Temperature °c

End Temperature °c

Instructions

1. Place your container of water in a sunny area (a garden or a windowsill)
2. Use the thermometer to measure the starting temperature of the water.
3. Put the lid on the container and start the stopwatch.
4. Measure the temperature of the water at regular intervals (every minute or two) for 20 minutes.
5. Think about how you could improve the design of your container to heat the water more efficiently. Could you use a container of a different shape, size, colour, material etc?
6. Repeat this procedure for different containers to find out which designs work best.

What happened to the temperature of the water after 20 minutes?

The temperature of the water should increase (get higher) as the water takes in energy from the Sun.

Kitchen science experiment

How Strong is the Sun's Energy?

Instructions

Step 1: choose a sunny day!

Step 2: get two empty plastic pop bottles and some black paint and two balloons.

Step 3: paint one of the bottles black and let it dry.

Step 4: once the painted bottle is dry take both outside and place them in a sunny spot and attach the balloons to the top of the bottles.

Step 5: watch what happens!

Describe what happened. Why do you think this happened?

You should see the balloon on the black bottle inflate more than the balloon on the white bottle. This is because black surfaces absorb all colours of light - no light is reflected off of them, which is why they look black. White surfaces reflect all colours of light. The black bottle is absorbing more photons (particles of light) than the white bottle, so it takes in more energy. This means it will heat up more. Heat makes gas expand (get bigger), so as the bottles get hotter, the air inside them will heat up and expand to fill up the balloons. The black bottle will get hotter than the white bottle, so the balloon on the black bottle will be filled by more air.

Question time!

How do plants make energy? Draw, or write, your answer below.

Plant cells absorb energy from the Sun. They use this energy to convert (change) carbon dioxide (a gas) and water into glucose (sugar) and oxygen (a gas). The plant can then use this glucose for energy.

More in-depth: Plant cells make their energy from sunlight in a process called photosynthesis. Plant cells contain organelles (small structures) called chloroplasts, which have a green pigment called chlorophyll. The chlorophyll looks green because it reflects green light and absorbs more of the red and blue light. The plant cell can then use the energy from the light it has absorbed to convert carbon dioxide and water into glucose and oxygen. Respiration than then take place inside the cell's mitochondria. During respiration, The plant cell will convert the glucose into energy.

How do solar panels make energy? Draw, or write, your answer below.

Solar cells (or solar panels) absorb energy from the Sun and convert (change) it into electricity.

More in-depth: Solar cells are an electrical device which are used to transfer light energy into electrical energy. Solar cells contain materials which absorb energy from light in order to excite (give energy to) and release electrons (small charged particles). The excited electrons are cchanneled out of the solar cell as electricity which can be used to power electrical devices. When the negatively charged electrons leave the solar cell, this leaves behind a positive charge, which attracts the electrons back towards the other side of the solar cell, creating a circuit.

True or False?

Tick the sentences which you think are true.

Solar power is good for the Earth. ✓
Solar panels can be put on a roof to make energy to use in the house. ✓
Solar power can always make energy, in any weather. ○
Solar power will eventually run out. ○
Solar panels are cheap to build. ○
Solar power is renewable. ✓
The sun shines on solar panels, which can then heat water or make electricity. ✓
Solar panels need a lot of space. ✓

My Science Ideas

What science ideas or questions has this video and worksheet given you?

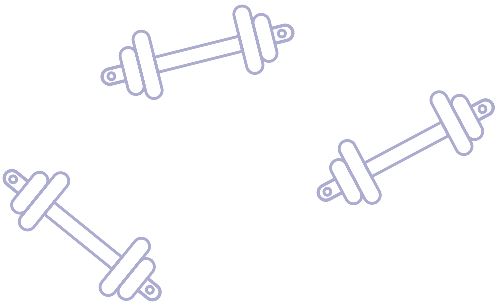
Cells that capture light

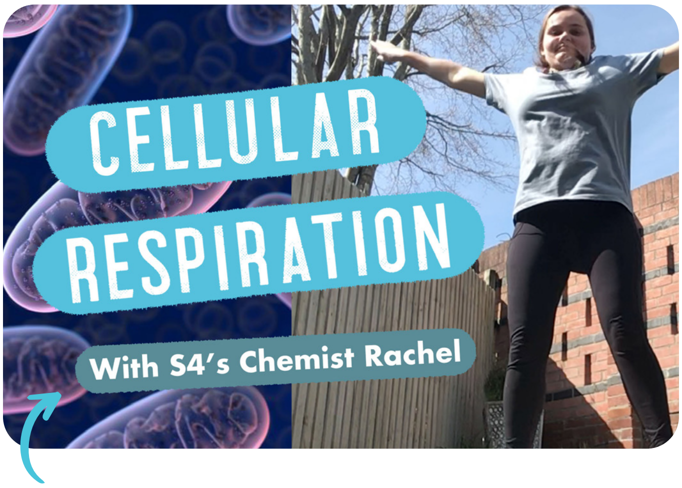
Worksheet 4 Teacher Feedback

Notes & Doodles

Video 5

Cellular respiration





Go to our website and look for this video cover.

This worksheet accompanies our **'Cellular Respiration'** S4 Lessons video, you can find it at:

www.s4science.co.uk/keystage-2-3

Why do we need energy?

Our bodies need energy for several reasons. We need it for growth and repair, for movement and for the many chemical reactions which take place inside our bodies which keep us healthy.

We get our energy from the food we eat. This energy is in the form of glucose. We measure this energy of food in a unit called a calorie.

What is a calorie?

A calorie is the amount of energy it takes to heat 1g of water by 1 degree. However, when we talk about calories from the food we eat, we are actually talking about a “kilocalorie” or 1000 calories.

Our bodies need energy from these calories every day for daily activities, including walking, running and even sleeping! On average, we burn about 2000 calories a day just from doing these daily activities. So it is important that we consume enough calories to have enough energy!

Respiration

The energy found in food is not the correct form of energy our bodies need. We need to release the energy from glucose found in the food using a chemical reaction which takes place in our cells. This reaction is called RESPIRATION which takes place in the mitochondria of our cells.

Aerobic Respiration

This type of respiration is what we use for everyday activities. During aerobic respiration, oxygen reacts with glucose to give us carbon dioxide and water. As a result, energy is released in the correct form our bodies need.

Anaerobic Respiration

Sometimes our bodies need a quick burst of energy. An example is when we do exercise. When we do exercise, our muscles need more energy because they are working harder. This means that we cannot get enough oxygen to the mitochondria of our cells for aerobic respiration to take place. Instead, our bodies respire anaerobically. In anaerobic respiration, glucose is transferred straight to the molecule called lactic acid. You may feel this lactic acid when you do exercise, it feels sore and begins to hurt! When we stop doing exercise, our bodies begin to respire aerobically again as the lactic acid is broken down.

Cellular respiration

Worksheet 5

Don't forget to find the video to go with this worksheet on our website, you're looking for the **Cellular Respiration** video!

Draw or write below what happens to your body when you exercise.

Key words to think about: heart, pulse, sweat, breathing, blood, muscles.

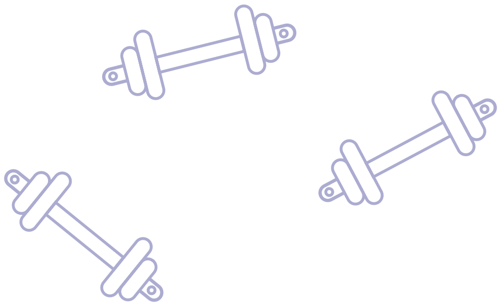
When I exercise, the cells in my muscles need more oxygen so they can produce energy to move. My breathing gets faster to get more oxygen into my body. The oxygen is transported from my lungs to my muscles by my blood cells. My heart pumps faster, which pumps blood around my body faster, so my muscles can get more oxygen. This makes my pulse feel faster and stronger. When the cells in my muscles produce kinetic (movement) energy, they also produce heat energy, so my body gets warmer. I my body produces sweat to cool itself down.

Tick the sentences which you think are true.

- The number of calories in food tells us how much energy it will give our bodies. ☑
- When we exercise, our pulse gets slower. ☐
- Our cells turn sugar into energy. This is called respiration. ☑
- If we eat more calories than we burn off, the extra energy is stored as muscle. ☐
- Our bodies get energy from the food we eat. ☑
- We burn more calories watching TV on the sofa than when we exercise. ☐
- Our cells turn sunlight into energy. ☐
- In respiration, our cells take in oxygen and give off carbon dioxide. ☑

Put these activities in order of how much energy they use up (number them 1 to 5).

Sleeping	1
Running really fast	5
Jogging slowly	4
Walking	3
Sitting and watching TV	2



Using a stopwatch or timer, measure 1 minute whilst doing your chosen exercise.

Exercise	**Average calories burnt in 1 minute**
Walking	3
Dancing	6
Riding a Bike	7
Push-Ups	3
Running	8
Sit ups	3

Ready, steady, GO!

Different foods contain different amounts of calories. You can choose to eat one of the foods listed below or figure out how many calories of your favourite snack you are allowed after your 1 minute of exercise. Simply look at the nutrition values on the back of the packet!

Food	Calories
1 Raisin	2
1 Carrot stick	1
1 Strawberry	5
1 Raspberry	1
1 Grape	2
1 Square of chocolate	25
1 Chocolate button	4
1 Giant chocolate button	15

Draw or write below what exercise you did and how long you did it for:

E.g. I danced for 2 minutes.

How much energy did you use up (in calories)?

I used up 12 calories..

What food did you choose? How much of that food were you allowed to have after doing your 1 minute of exercise?

My Science Ideas

What science ideas or questions has this video and worksheet given you?

Cellular respiration

Worksheet 5 Teacher Feedback

Video 6

Phase Transitions

Go to our website and look for this video cover.

This worksheet accompanies our **'Phase Transitions'** S4 Lessons video, you can find it at:

www.s4science.co.uk/keystage-2-3

What are we learning?

We will be learning what happens when matter changes phase.

Most substances are either a solid, a liquid, or a gas. These are the three **STATES OF MATTER.**

- **Solids have a definite shape** and do not take the shape of their container. Examples of solids: rocks, ice, trees, people.
- **Liquids do not have a definite shape** and will take the shape of their container. Liquids flow (move) because of gravity, and if there was no gravity they wouldn't flow. Examples of liquids: water, milk, lava, juice.
- **Gases do not have a definite shape.** They sometimes take the shape of their container and sometimes fly out of the top of their container. Air is a gas and has a certain weight. A gas will take the shape of its container if it is heavier than air or fly out of the top if it is lighter than air. Examples of gases: air, oxygen, carbon dioxide, steam.

When something changes from one state of matter to another (like liquid water changing to solid ice) it is called a **PHASE TRANSITION.**

Changing a substance's temperature is the easiest way to change its state of matter. For example, if we heat liquid water it turns into steam, which is a gas. Sometimes there are other things that we can do to create a phase transition. We will explore some of these, including changing the air pressure, adding a magnetic field and creating a chemical reaction.

Why is this important?

Solids, liquids and gases are the three most common states of matter. Each state of matter behaves in a specific way, making them suitable for different tasks. It is important for us to know if a material is a solid, liquid, or gas if we want to know how it will behave at a certain temperature, for example you wouldn't want to keep chocolate in your pocket on a hot day because it would melt and you wouldn't want to wash your bike outside on a cold day because the water would freeze.

It is also important for us to know when a phase transition will occur. For example:

- It can be dangerous when water on the road turns to ice, so we want to know when this will happen and find ways to turn the ice back into water.
- Phase transitions are important for our bodies too. When we sweat, the liquid evaporates and becomes a gas, which takes heat energy from our bodies to cool us down.

How are we showing this?

We are going to explore three ways in which we can change a substance's state of matter.

1. First, we will explore how changing the air pressure inside a bottle causes a liquid to change into a gas and back to a liquid. We are going to change the air pressure inside the bottle which will change the liquid in the bottle into a 'cloud' that you can see.
2. Next, we are going to make oobleck. Oobleck is not a solid, liquid or gas. It is a special type of matter called a Non-Newtonian fluid. Non-Newtonian fluids sometimes behave like liquids and sometimes behave like solids.
3. We are then going to watch a chemical reaction between two liquids. When these two liquids are mixed together, there will be a reaction between their particles which will turn the mixture from a liquid into a 'slime'. This slime is another example of a non-Newtonian fluid.

Phase transitions

Worksheet 6

Don't forget to find the video to go with this worksheet on our website, you're looking for the **Phase Transitions** video!

EXPERIMENT

MAKING A CLOUD IN A BOTTLE

MATERIALS:

- Matches
- Water
- Empty plastic bottle

DRAW CLOUDS IN HERE

Cloud in a bottle method

1. Fill your bottle with water. You should fill between 1/2 and 3/4 of the bottle with water.
2. Put the lid on the bottle and squeeze it to increase the pressure inside the bottle. Release the bottle to decrease the pressure inside the bottle. Repeat this a few times to see if anything happens.
3. Take the lid off of the bottle.
4. Light a match - or **ask an adult to light one for you.**
5. Drop the lit match into the bottle so that it falls into the water. Quickly put the lid back onto the bottle.
6. Squeeze the bottle to increase the pressure again and release to decrease the pressure.
7. You should now able to see a 'cloud' inside the bottle.
8. Think about what you could change to make the cloud more visible. If you put more or less water in the bottle, does it change how the cloud appears? What happens if you use colder or warmer water? Does this work with other liquids?

Caution! Do not try this with flammable liquids.

EXPERIMENT

Making Oobleck

MATERIALS:

- Cornflour/Corn starch
- Water
- Food colouring (optional)
- Bowl
- Spoon

Oobleck Method

1. Choose how much oobleck you would like to make. The recipe is the same for any amount of oobleck, you just need to make sure you use the right ratio of cornflour to water. You should use 2 parts cornflour to 1 part water. So, if you use 1 cup of cornflour, you should use 1/2 a cup of water.
2. Put the cornflour in your bowl.
3. If you are using food colouring, add a couple of drops to your water and stir.
4. Add the water slowly to the cornflour, stirring the mixture with a spoon as you go.
5. The end mixture should be a viscous (thick) liquid, like honey. If it is too stiff, add more water, if it is too runny, add more cornflour.
6. Now you can get messy! Try picking up the oobleck in your hands and playing with it. Now, keep your hands still above the bowl and watch the oobleck run through your fingers.

Notes & Doodles

Is it a solid, liquid, or gas? (tick the correct box)

	SOLID	LIQUID	GAS		SOLID	LIQUID	GAS
Milk	☐	☑	☐	Honey	☐	☑	☐
Water	☐	☑	☐	Steam	☐	☐	☑
Air	☐	☐	☑	Carbon dioxide	☐	☐	☑
Fish	☑	☐	☐	Ice cube	☑	☐	☐
Pencil	☑	☐	☐	Sand	☑	☐	☐

Complete each sentence with the words:

liquid

gas

solid

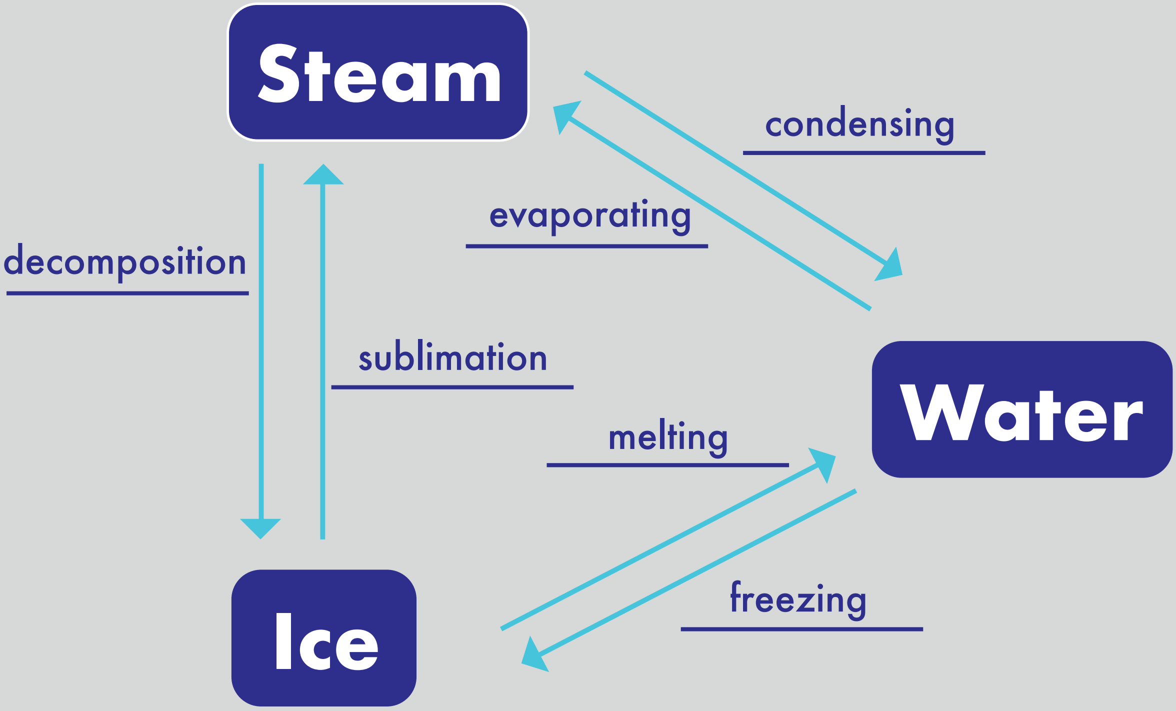
A solid has a definite shape. It does not take the shape of its container. If you put it in a bowl, it will stay the same shape and not move.

A liquid does not have a definite shape. It takes the shape of its container. If you put it in a bowl, it will move and become the same shape as the bowl.

A gas does not have a definite shape. It sometimes takes the shape of its container and sometimes flies out of the top of the container. It moves around to fill the space it is in.

Fill in the missing words in the diagram

Words to use: melting, freezing, evaporating, condensing, sublimation, decomposition



My Science Ideas

What science ideas or questions has this video and worksheet given you?

Worksheet 6 Teacher Feedback

Notes & Doodles

Video 7 / Worksheet 7

SLIME

'LET ME SCIENCE THAT FOR YOU'

Making slime is super fun, its gooey, sticky, you can make it all kinds of different colours, you can put things in it and it does weird things if you squish it slowly or squish it quickly.

This worksheet accompanies our **'The Science Behind Slime'** S4 Lessons video.

RECIPE

INGREDIENTS

- PVA glue
- Bicarbonate of soda
- Formil liquid bio (Lidl)
- Poster paint or food colouring

METHOD

- Roughly 1 part Formil to 4 parts PVA glue
- Add Formil slowly
- If too sticky - add more Formil
- If too tough - add more PVA

SLIME GAMES

Stretch your slime **sloooooooowly** – what happens?
Stretch your slime **quickly** – what happens?

When we make slime, we're doing polymer science, which is something a chemist does to make everything from nappies to paint, by joining materials together.

A polymer is a big chain of molecules joined together – it's a Greek word that means 'many parts'.

POLYMER PLASTIC!

Go to our website and look for this video cover.

Slime is lots of fun, BUT when we make slime we've made a PLASTIC!

It is only the water that is making the slime feel like a liquid – if we let the water evaporate we would end up with a solid lump of non-biodegradable plastic!

If we want to make slime, there are good ways to reduce the amount of plastic we make.

- Keep your slime! Don't keep making more, store it in an airtight box and reuse it.
- Don't add extra plastic (like glitter and beads) to your slime, it already has enough plastic in it!
- Once you are finished playing with the slime you can break it down with vinegar.

OR Make a biodegradable slime!

PSYLLIUM HUSK SLIME

Don't forget to find the video to go with this worksheet on our website, you're looking for the **The Science Behind Slime** video!

- 1 tablespoon of psyllium husk (you can get psyllium husk from a health food store).
- Add 1 cup of water to the psyllium husk powder, add a drop of food colouring, then mix really well.
- Microwave the mixture for 3 minutes (get an adult to help you). The mixture will be very hot after it has been microwaved.
- Chill the mixture in the fridge until it reaches room temperature.
- Your fully biodegradable slime is now ready!

My Science Ideas

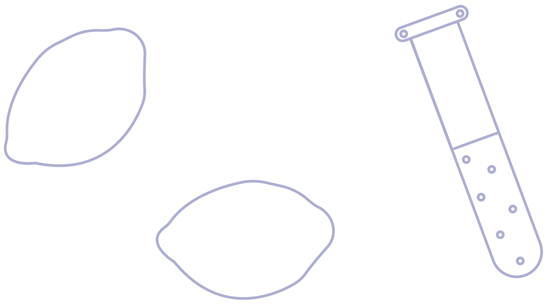
What science ideas or questions has this video and worksheet given you?

The science behind slime

Worksheet 7 Teacher Feedback

Video 8

Acids & Alkalis



Go to our website and look for this video cover.

This worksheet accompanies our **'Acids & Alkalis'** S4 Lessons video, you can find it at:

www.s4science.co.uk/keystage-2-3

What are we learning?

We'll be learning about ACIDS and ALKALIS.

Acids and alkalis have different chemical properties. Some common household foods are weak acids and alkalis. Acidic foods like oranges and vinegar taste sour, while things that are alkaline, like baking soda and toothpaste, taste bitter. When we want to know whether something is an acid or an alkali, we don't taste it, we measure its pH.

Notes & Doodles

pH Scale

To find out the pH of substances we use a **pH INDICATOR** solution. pH indicators are liquids which change colour to show whether something is acidic or alkali.

The picture above shows the colours that universal indicator solution goes when it is added to acids and alkalis,and the pH number that each colour indicates.

There are many pH indicators. Different indicators turn different colours in acids and alkalis.

The pH scale goes from 1 to 14.

- Substances with a pH number of 1 - 6 are **acidic.** The lower the pH number, the stronger the **acid.**
- Substances with a pH of number 8 – 14 are **alkali.** The higher the pH number, the stronger the **alkali.**
- Substances with a pH number of 7 are **neutral,** they are neither acidic or alkali.

Notes & Doodles

EXPERIMENT

RED CABBAGE pH INDICATOR SOLUTION

Red cabbage has a strong purple colour because it contains a molecule called anthocyanin. The molecule changes colour to red-pink when mixed with acids, and to bluish-green or yellow when mixed with alkalis. Red cabbage is a pH indicator.

SAFETY

- You will be using boiling water. Be careful not to touch any hot surfaces or spill the water.
- Ask an adult to help you with the chopping.

MATERIALS

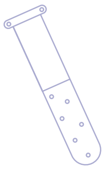
- Red cabbage
- Baking soda*
- Vinegar*
- Lemon*
- Lime*
- Toothpaste*
- Soda water*
- Sweets*
- Heatproof jug
- Spoon
- Scissors or knife
- Kettle
- Small containers
- Small spoons or stirrers

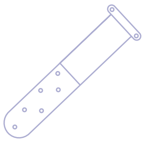
*Optional.

Method

1. Cut some red cabbage into small pieces and place them into a heatproof jug or bowl. Add boiling water until the cabbage pieces are covered.
2. Leave the cabbage in the hot water for a couple of minutes to brew (like tea). Carefully stir the mixture occasionally.
3. After 2-3 minutes the water should turn dark purple.
4. Leave it to cool. The liquid is your indicator solution.
5. Pour a small amount of the purple liquid into some small containers. Try not to get any cabbage pieces in the container - but if a few fall in, that's OK.
6. Add different household substances, like lemon, vinegar, baking soda or toothpaste, to each container. Add a bit at a time, stirring until the mixture changes colour.
7. What colour do the different mixtures turn the red cabbage pH indicator Record the colours of all the mixtures.

Red Cabbage Indicator





Acids & alkalis

Worksheet 8

Testing our red cabbage pH indicator solution

Don't forget to find the video to go with this worksheet on our website, you're looking for the **Acids & Alkalis** video!

Substance tested	Colour at the end		Acid or alkali (tick the correct box)	
	What do you expect?	What did you see?		
Baking soda		Blue	ACID ☐	ALKALI ☑
Vinegar		Pink	ACID ☑	ALKALI ☐
Water		Purple	ACID ☐	ALKALI ☐
Lemon		Pink	ACID ☑	ALKALI ☐
Lime		Pink	ACID ☑	ALKALI ☐
			ACID ☐	ALKALI ☐
			ACID ☐	ALKALI ☐
			ACID ☐	ALKALI ☐

Mix one of the acids with one of the alkalis. What happens? Draw or write your answer.

The acid in the red cabbage indicator was pink. The alkali in the red cabbage indicator was blue. When I mixed these two solutions together, bubbles were given off. The solution at the end was purple. This shows that the solution at the end was neutral.

What's happening?

When we mix an acid and an alkali together, they react with each other. We call this a **neutralisation reaction.**

The pH of the mixture changes to somewhere between the pH of the acid and the pH of the alkali.

For example, if you added an equal amount of acid at pH 6 to an alkali at pH 8, the end mixture would have a pH of 7 and would be neutral.

Why does pH have a small p and a capital H?

Great question! The H is the chemical symbol for Hydrogen. The first letter of a chemical symbol is always capital.. Take a look at a periodic

table of elements to learn more chemical symbols! The small p is a mathematical symbol that stands for a measurement of the concentration of hydrogen ions in the solution. It is sometimes called the 'power' of hydrogen.

COLOURING IN PAGE

Colour in the pH scales

Universal Indicator pH Scale

Red Cabbage Indicator pH Scale

QUICK QUIZ

Q1: A solution is determined to be an acid or alkali depending on the concentration of hydrogen ions in the solution.

(Write your answer in the box) A) helium B) sodium C) nitrogen D) hydrogen

Q2. What is a pH indicator solution? *(circle your answer)*

A) A chemical that contains pigments

B) A chemical that changes colour in acids and alkalis

C) A tool used to look at how acidic a solution is

[✓ D) All of the above]

Q3. What pH is considered to be neutral? *(circle your answer)*

A) 4 [✓ B) 7] C) 9 D)14 E) 2

Q4. A liquid is considered to be acidic if it has a lot of (what) in? *(circle your answer)*

[✓ A) Hydrogen ions]

B) Helium ions

C) Positive ions

D) Negative ions

E) Molecules

Q5. Concentrated acids and alkalis are considered to be very dangerous.

(circle your answer) [✓ True] / False

Go online and find out more about acids and alkalis. BBC Bitesize and Kiddle (The Kids Encyclopedia) are a good place to start. Use the box below to write down what facts you found out about acids and bases.

My Science Ideas

What science ideas or questions has this video and worksheet given you?

Acids & alkalis

Worksheet 8 Teacher Feedback

Notes & Doodles

Video 9

A Guided Tour of the Universe

With Astronomer Mark Thompson

S4 SUMMER SHOW 2020

Go to our website and look for this video cover.

This worksheet accompanies our **'A Guided Tour of our Universe!'** S4 Science Club video, you can find it at:

www.s4science.co.uk/keystage-2-3

What's the show about?

S4's Summer Showcase 2020 is all about space! Mark Thompson is an astronomer who studies distant objects in space. In our 2020 Summer Science Show, Mark takes us on a virtual, guided tour of the universe.

Show Notes Box

Telescopes use the radiation that distant objects in space emit (give off) to study those objects.

There are lots of different types of radiation.

Visible light, the light we can see with our eyes, is one type of radiation that telescopes can detect and measure. The ***Electromagnetic Spectrum*** is made of seven types of ***Electromagnetic Radiation.***

The Electromagnetic Spectrum

The electromagnetic spectrum is a group of seven types of radiation, including radio waves, visible light, and x-rays. These can travel as waves, even in space.

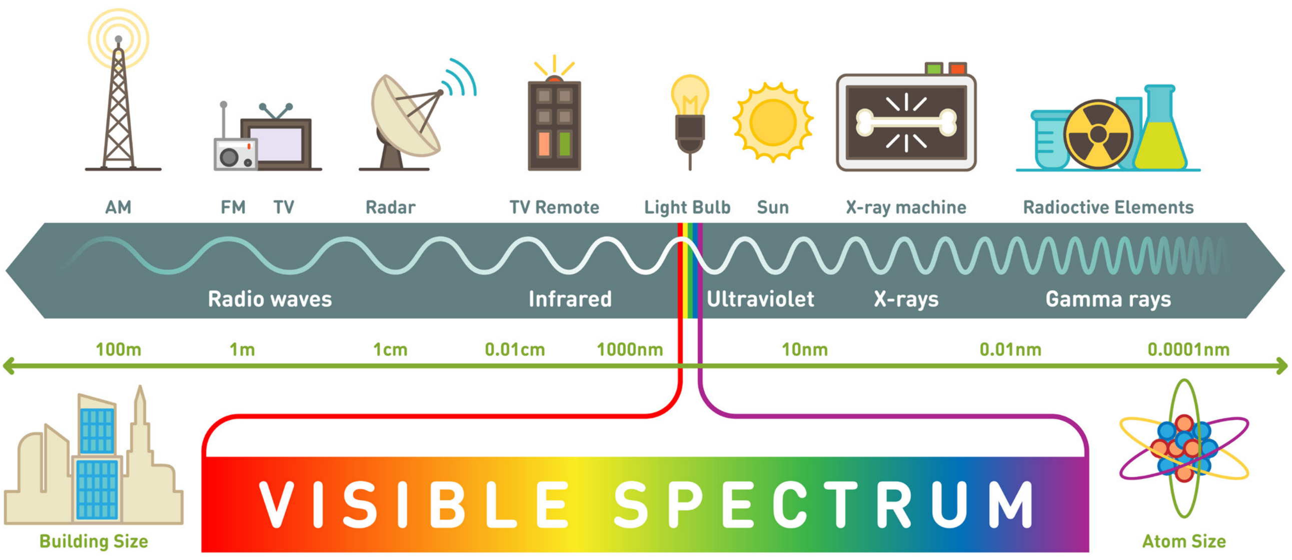
The seven types of radiation in the electromagnetic spectrum are grouped by the lengths of their waves (called their wavelength), which give them different properties, or behaviours.

To study the universe, we use telescopes that can detect all the different types of radiation within the electromagnetic spectrum.

This helps us to understand and study distant objects in more detail than if we just look at the visible light they emit (give off).

Astronomers and space scientists use observations of the radiation space objects emit to learn about stars and other objects in space, including what materials they are made from.

Electromagnetic Spectrum



Worksheet 9

MAKE A VISIBLE LIGHT SPECTRUM

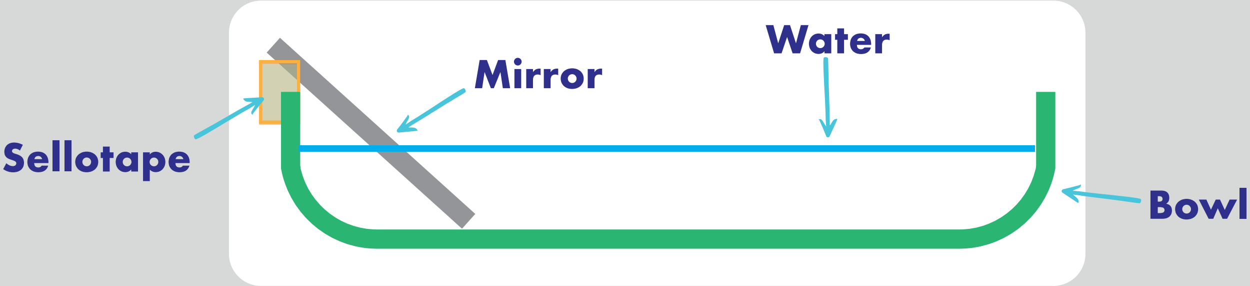
– ALSO KNOWN AS A RAINBOW!

You will need:

- A shallow bowl
- A small mirror (a compact or hand mirror will work well – we used a mirror from an old make-up palette)
- Sellotape/plasticine/blu-tack
- Water
- Bright sunlight or the torch on a smartphone
- A piece of white paper

Method:

1. Pour some water into your bowl, so it is about 3 quarters full.
2. Put your mirror into the bowl. You should lean it against the side of the bowl so it is at a 45° angle (diagonal). Part of the mirror should be underwater. Use the Sellotape, plasticine or blu-tack to hold it in place.



3. Shine the torch into the part of the mirror that is underwater or put the bowl in a sunny spot, so the sunlight can shine on the mirror underwater.
4. Hold the white paper above the mirror. Adjust the angle of the paper and move it around until you see the rainbow appear on it!
5. If you are doing this experiment inside with a torch, turn off the lights to make the room as dark as possible and try to spot the rainbow on your ceiling or walls.

What is happening?

The white light from the Sun (or from the torch) is actually all the visible colours (wavelengths) of light – from red to violet – at once.

When all the wavelengths of light are together, we see ‘white light’ rather than the individual colours of the rainbow.

Each colour of light has a different wavelength and they appear in a rainbow in the order of their wavelengths. Red light has the longest waves and is on the outside of the rainbow and violet light has the shortest waves and is on the inside of the rainbow (have a look for some upside-down rainbows next time you’re out, or online!)

Some materials and objects can split white light into all its different colours by bending it. When we shine the white light into the water, it bends. Each colour of light bends by a slightly different angle because different colours of light move at different speeds in water.

Don’t forget to find the video to go with this worksheet on our website, you’re looking for the **A Guided Tour of our Universe** video!

When we reflect the light back out of the water using the mirror, we are reflecting the white light which has been split apart into all of the different colours of light, so a rainbow appears! **The water has split the white light into its different wavelengths.**

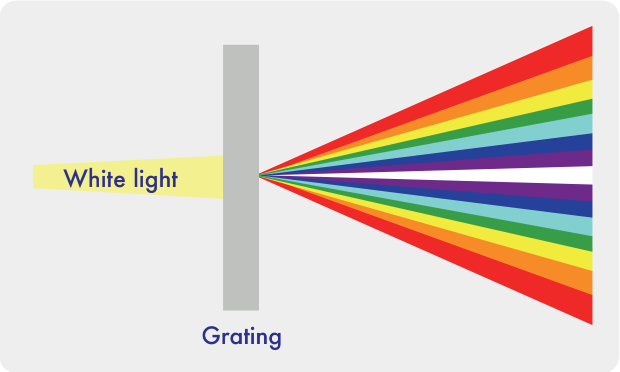
Why is this important?

Our eyes can only see visible light and not the rest of the ***Electromagnetic Spectrum***, but telescopes can be used to detect all types of radiation in the spectrum. Some telescopes use a tool called a ***diffraction grating*** to split radiation from stars into its different wavelengths.

Different materials emit different wavelengths of radiation.

Astronomers can use telescopes with diffraction gratings to measure all the different wavelengths of radiation emitted by a distant object, which will tell them what materials it is made from.

Diffraction Grating



Why do we study distant objects in space?

> “We revolve around the Sun like any other planet.”
> *– Nicolaus Copernicus (1543)*

A long time ago, humans thought that the Earth was the centre of the universe and everything we could see in the sky orbited around us. This was called the Geocentric model of the universe (Geo means ‘Earth’ and centric means ‘at the centre’).

Astronomers studied the motions of the Sun, stars and other planets and discovered that the Earth and all the other planets in our Solar System actually orbited around the Sun. The Geocentric model of the universe was wrong, and they developed the heliocentric model of the universe instead (Helios means ‘Sun’ and centric means ‘at the centre’).

Galileo and Jupiter...

Not all scientists believed Copernicus. Many thought that Earth was the most important thing in space and so everything should orbit around Earth.

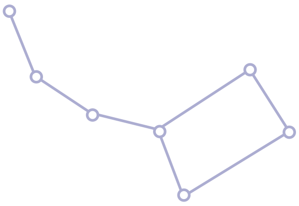
How did scientists find out that the planets orbit the Sun?

Galileo used a telescope to look at Jupiter in 1610 and he saw, for the first time in human history, that there were moons orbiting Jupiter. If all things in space orbited the Earth, then how could this be? Galileo then observed that, just like the moon, Venus went through phases of being partially visible, then fully. This could only happen if it was going around the Sun, not the Earth. Galileo’s proof, that the planets orbit the Sun, caused so much trouble that he was tried for heresy (believing something that was against religion) by the Roman Inquisition and placed under house arrest for the rest of his life.

RESEARCH BOX

Get online and do some personal research about Galileo and the heliocentric model.

What did you find out? You can share your findings with **@swansci4** using the **#s4summershow**



Our star

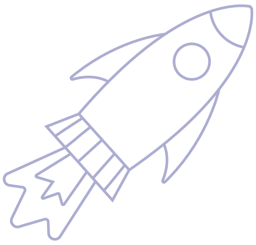
Milky Way Galaxy

As astronomers studied the skies more and more, it became clear that the Sun itself isn’t particularly special. It is a star, and a pretty average star at that!

The Sun is one of billions of stars in our galaxy, which is called the Milky Way. There are more than 100 billion galaxies in our universe.

That’s a lot of stars! In fact, if you could count every single grain of sand on Earth, this number would be smaller than the number of stars in our universe.

By studying these stars, we have learned a lot about our place in the universe, our past and our eventual fate.



Our past – how did we get here?

All the stars we can see in the sky were formed inside nebulae.

Nebulae (plural of nebula)

A nebula is a giant cloud of gas and dust in space. Nebulae are mostly made from hydrogen and helium gas, with small amounts of some other materials, like oxygen, carbon and dust.

Try this activity

Nebulae are some of the most beautiful and colourful objects in space. Some nebulae are given names after things they resemble (look like). Can you match each of these names to the picture of its nebula?

Ring Nebula, Pillars of Creation (in the Eagle Nebula), Butterfly Nebula, Cat's Eye Nebula, Crab Nebula, Horsehead Nebula

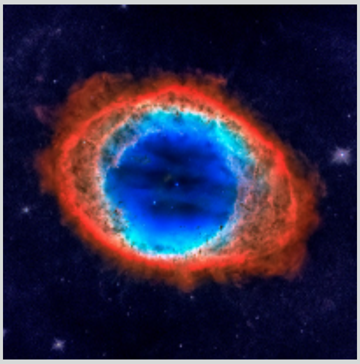
Image Credit: NASA/ESA/Hubble

Butterfly Nebula

Image Credit: NASA, ESA, HEIC, and The Hubble Heritage Team (STScI/AURA)

Cat's Eye Nebula

Crab Nebula



Ring Nebula

Image Credit: NASA/ESA/Hubble Heritage Team

Horsehead Nebula

Pillars of Creation

Some nebulae are called Stellar Nurseries, because they are where new stars form. Our Sun and everything in our solar system, including Earth, formed inside a Stellar Nursery.

Inside Stellar Nurseries, the gases contract (squish together) in different regions (areas) to produce stars.

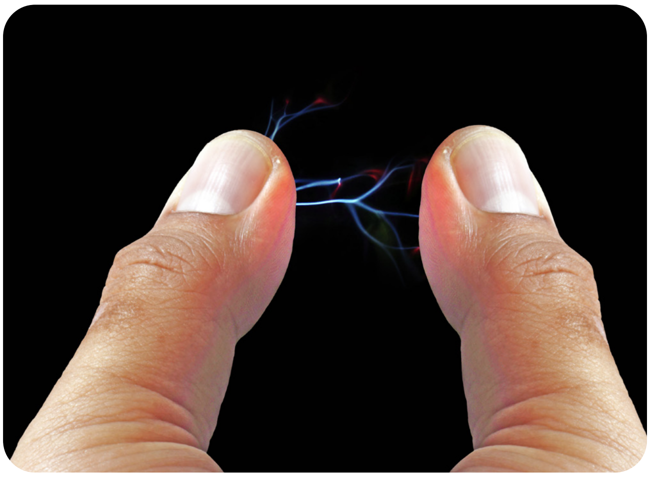
The dust and gases in nebulae are very diffuse (spread apart) but some small, charged particles are pulled together by ***electrostatic forces,*** which is the force that causes static electricity. Eventually, the particles start to form larger lumps and the larger lumps form bigger lumps until eventually, a star is born. All because of static electricity!

Try this!

1. THE PRANKSTER

You will need:

- A carpet
- A pair of socks
- A metal doorknob, or someone willing to be shocked (very mildly!)



Method:

1. Put on the socks.
2. Move along the carpet, shuffling your feet as you go, so that your socks rub against the carpet.
3. Touch a metal doorknob or a person (with their permission) with one finger. Electricity should move between you and the doorknob or other person, which you will feel as a small electric shock.
4. If you try this in the dark, you might be able to see a spark of electricity – just remember to be careful and remove anything you might trip over before you switch off the lights.

What is happening?

When you rub your socks against the carpet, electrons move from the ground to your body, so you become negatively charged.

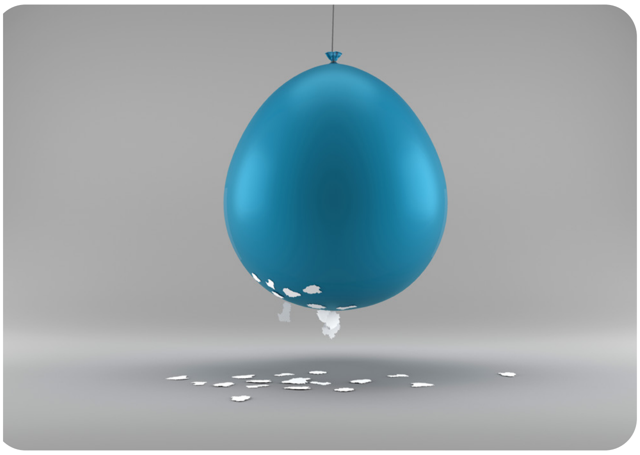
When you touch a metal doorknob or another person, the extra electrons jump through the air to reach them. This fast movement of electrons causes the electric shock that you feel.

Try this at home!

2. THE MAGICIAN

You will need:

- A balloon or a plastic comb
- A tap
- Small bits of paper or aluminium foil



Method:

1. Blow up the balloon.
2. Rub the balloon against your hair, or a jumper, to build up a charge on the surface of the balloon.
3. If you are using a plastic comb, comb your hair a few times.
4. Turn a tap on, then slowly turn down the water until you have a very thin stream of water flowing.
5. Move the balloon or comb slowly towards the water. The stream of water should bend as the water is attracted towards the balloon or comb.
6. Make sure the balloon is dry, then rub it against your hair or jumper to recharge the surface.
7. Put the small bits of paper or foil on a flat surface.
8. Hold the balloon above the paper/foil and slowly lower it. The paper/foil bits should ‘jump’ up and stick to the balloon.

What is happening?

When you rub the balloon against your hair or a jumper, the surface of the balloon becomes negatively charged. Positive charges in the water, paper and foil are attracted to the negatively charged balloon, so they are pulled towards it.

Why is it important?

The charged particles in a nebula will be attracted to each other and collect together to create small clumps. Gravity then pulls these clumps together.

The clumps will continue to grow, so their gravitational force will get stronger and stronger,
pulling in more and more material from the nebula.

As they get larger, the pressures and temperatures inside the large clumps rises. When the temperature and pressure at the centre of a clump becomes high enough, hydrogen atoms will crash together and fuse (join) to make helium atoms. Heat and light energy are released in this process.

This is the birth of a star!

Further into space, further back in time

Light and time.

This ability to look back in time by looking a long way into space is based on the fact that light has a speed limit.

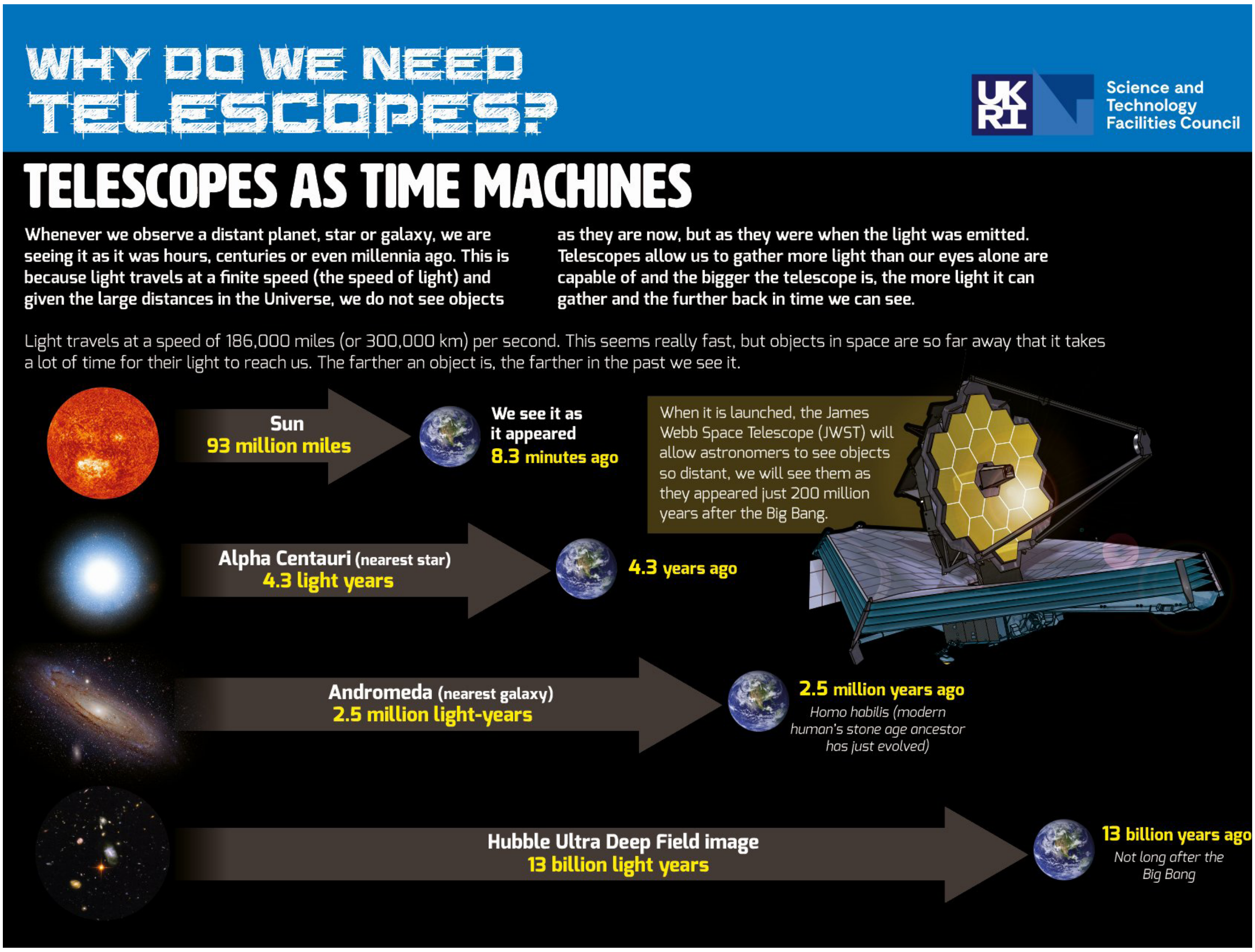
The speed of light is 186,000 miles per second. That means that sunlight (photons) reaching Earth now, left the sun just over eight minutes ago.

The further into space you look with a telescope, the more time has passed since the light you are observing set off on its journey towards your telescope.

If you look at a star that is 30 ‘light years’ away, you are seeing what that star looked like 30 years ago, because the light reaching your telescope from that star left the star 30 years ago.

The same applies to stars that are millions of light years away. The telescope is observing what that star looked like millions of years ago.

Telescopes



WHY DO WE NEED TELESCOPES?

UKRI Science and Technology Facilities Council

TELESCOPES AS TIME MACHINES

Whenever we observe a distant planet, star or galaxy, we are seeing it as it was hours, centuries or even millennia ago. This is because light travels at a finite speed (the speed of light) and given the large distances in the Universe, we do not see objects as they are now, but as they were when the light was emitted. Telescopes allow us to gather more light than our eyes alone are capable of and the bigger the telescope is, the more light it can gather and the further back in time we can see.

Light travels at a speed of 186,000 miles (or 300,000 km) per second. This seems really fast, but objects in space are so far away that it takes a lot of time for their light to reach us. The farther an object is, the farther in the past we see it.

Sun
93 million miles

We see it as it appeared
8.3 minutes ago

When it is launched, the James Webb Space Telescope (JWST) will allow astronomers to see objects so distant, we will see them as they appeared just 200 million years after the Big Bang.

Alpha Centauri (nearest star)
4.3 light years

4.3 years ago

Andromeda (nearest galaxy)
2.5 million light-years

2.5 million years ago
Homo habilis (modern human's stone age ancestor has just evolved)

Hubble Ultra Deep Field image
13 billion light years

13 billion years ago
Not long after the Big Bang

The closest known nebula to Earth is called the Helix Nebula. It is about 700 light-years away from Earth, which means it takes 700 years for the light from this nebula to reach us here on Earth.

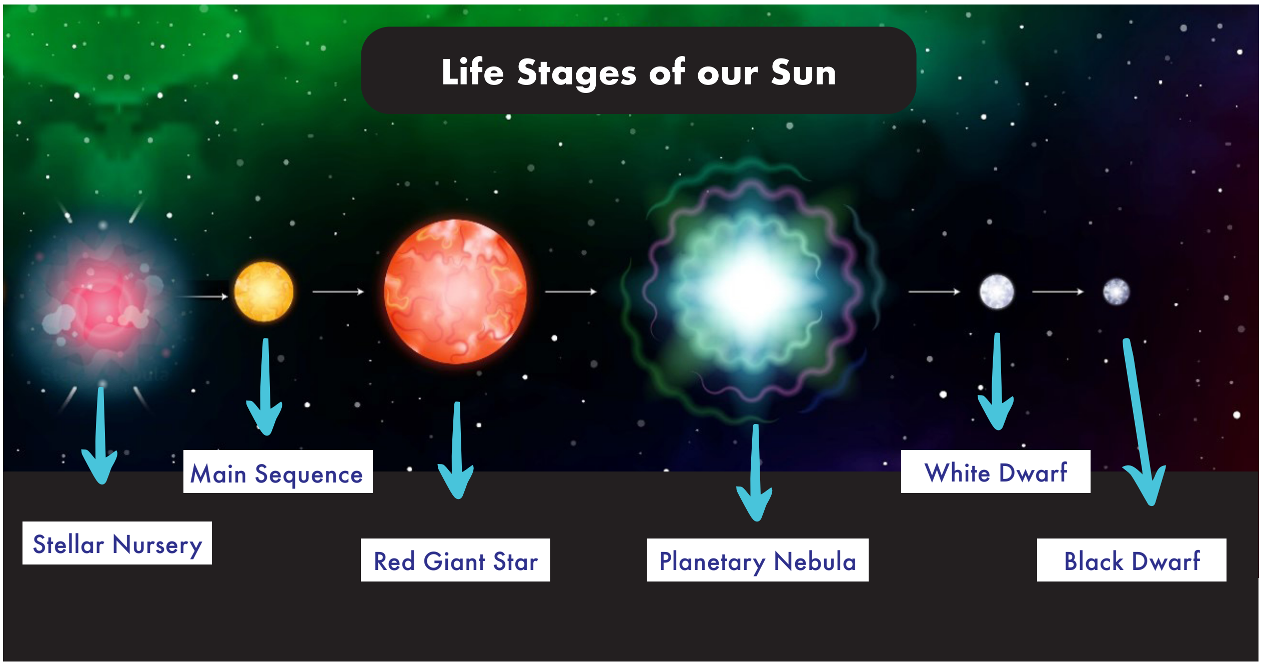
When we look at the Helix nebula with a telescope, we are seeing what it looked like 700 years ago.

When we look at the Helix nebula, we are looking back in time.

We can see objects much further away than this. The further they are from Earth, the longer it takes for the light from these objects to reach us, so the further we are looking back in time. This means we can use objects that are a very long way away in space, to study the history of our universe.

Our present – where are we now?

Our Sun is now in the main sequence stage of its life cycle.



During the main sequence, stars will fuse hydrogen in their core (centre) to form helium and release energy. This is called nuclear fusion.

The colour and temperature of a main sequence star depend on its size. Small stars are red and orange in colour and cooler than large stars, which are blue and white in colour. **Our Sun is a yellow, average-sized star.**

Notes & Doodles

Try this at home!

THE COLOUR OF STARS

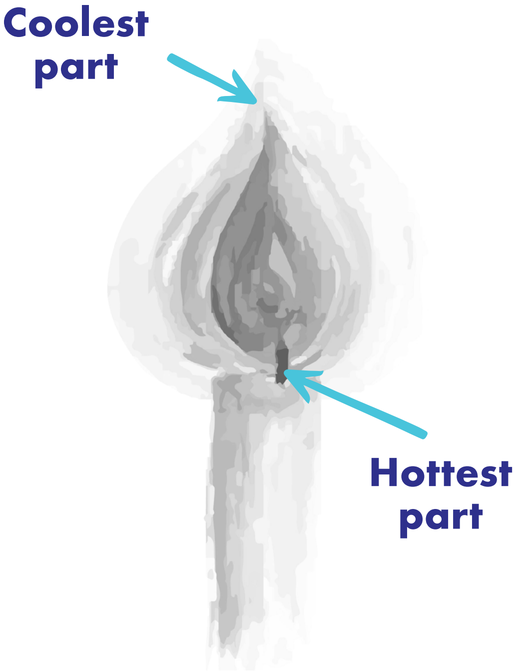
You will need:

- A candle
- A candle holder
- Matches
- Colouring pencils

Get permission from an adult before doing this activity and get help using matches. Take care around flames and any hot materials. Do not touch the flame.

Method:

1. Put the candle securely in the holder.
2. Light the candle.
3. Study the colours you can see in the candle flame and add these colours to the candle drawing on the right.
4. The hottest part of the flame is at the wick (string) and the flame gets cooler as you move away from the wick.



What is happening?

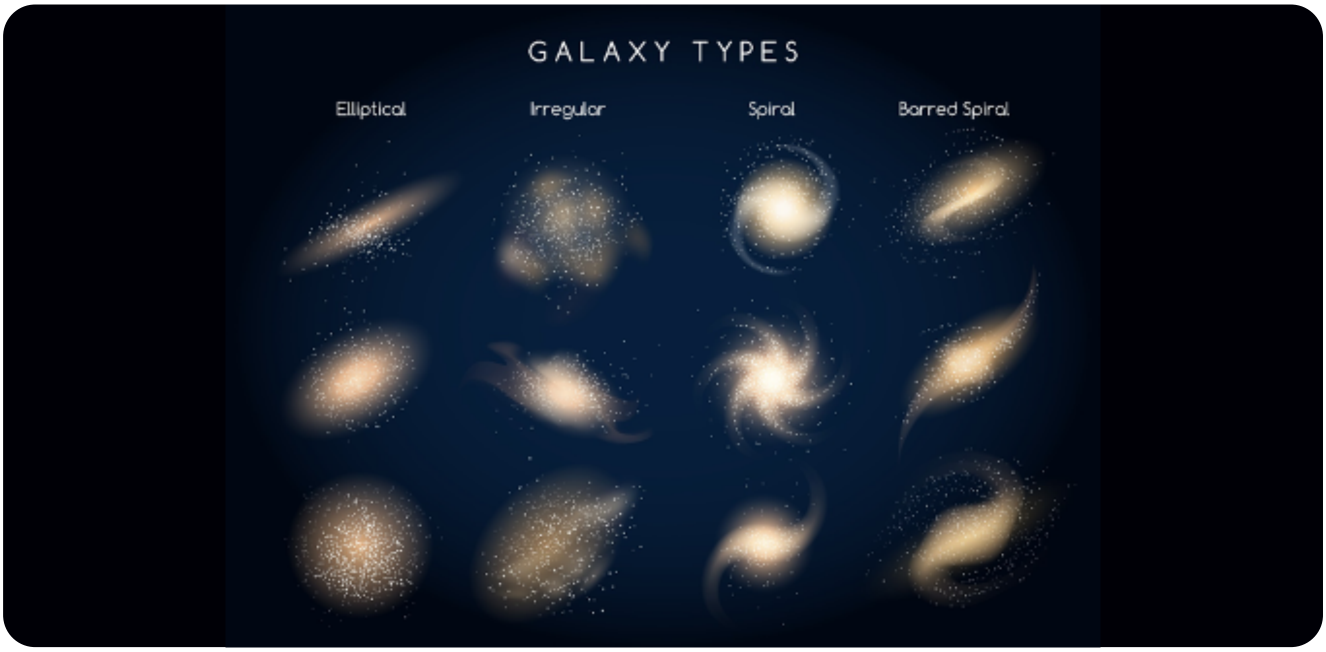
Stars are much hotter than the flame of a candle, but the relationship between temperature and colour is the same for stars as it is for the candle flame.

The blue part of the candle flame is hotter than the yellow and red parts. Blue stars are hotter than yellow and red stars.

Galaxies

Stars are found within galaxies.

A galaxy is a huge collection of dust, gas, billions of stars, and their solar systems (including planets). They can be a few different shapes, including round, oval, spiral and barred.

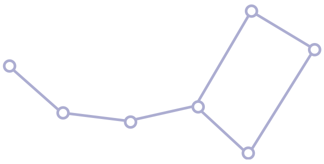


Milky Way

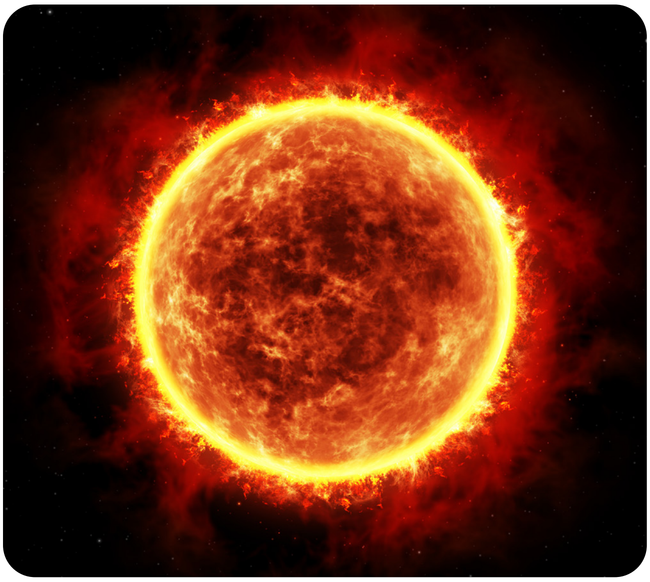
We live in a spiral galaxy called the Milky Way. We are probably about two thirds of the way out along one of the spiral arms.

We are here

Our future – what will happen to our Sun in the future?



When an average-sized star (like our Sun) uses up all its fuel, it expands (grows) and turns red as it cools down. When that happens, our sun will have become a ***Red Giant.***



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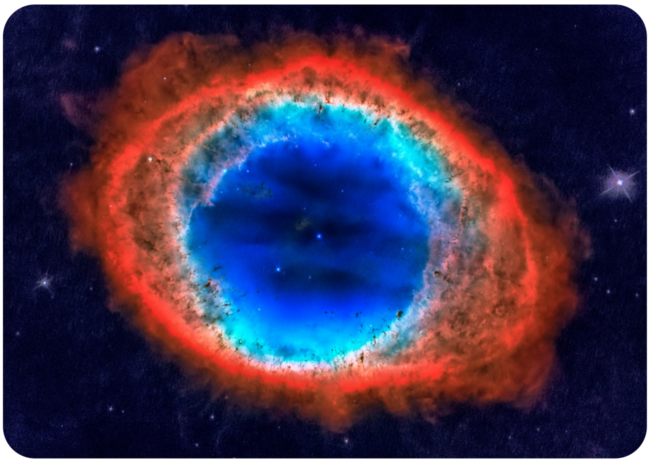


A small dense core, called a white dwarf is left behind. A ***white dwarf*** is so dense that a chunk of its surface, the size of a matchbox, would weigh the same as 15 elephants! The white dwarf will cool and dim to become a ***black dwarf.*** This is what will happen to our Sun in about 5 billion years.

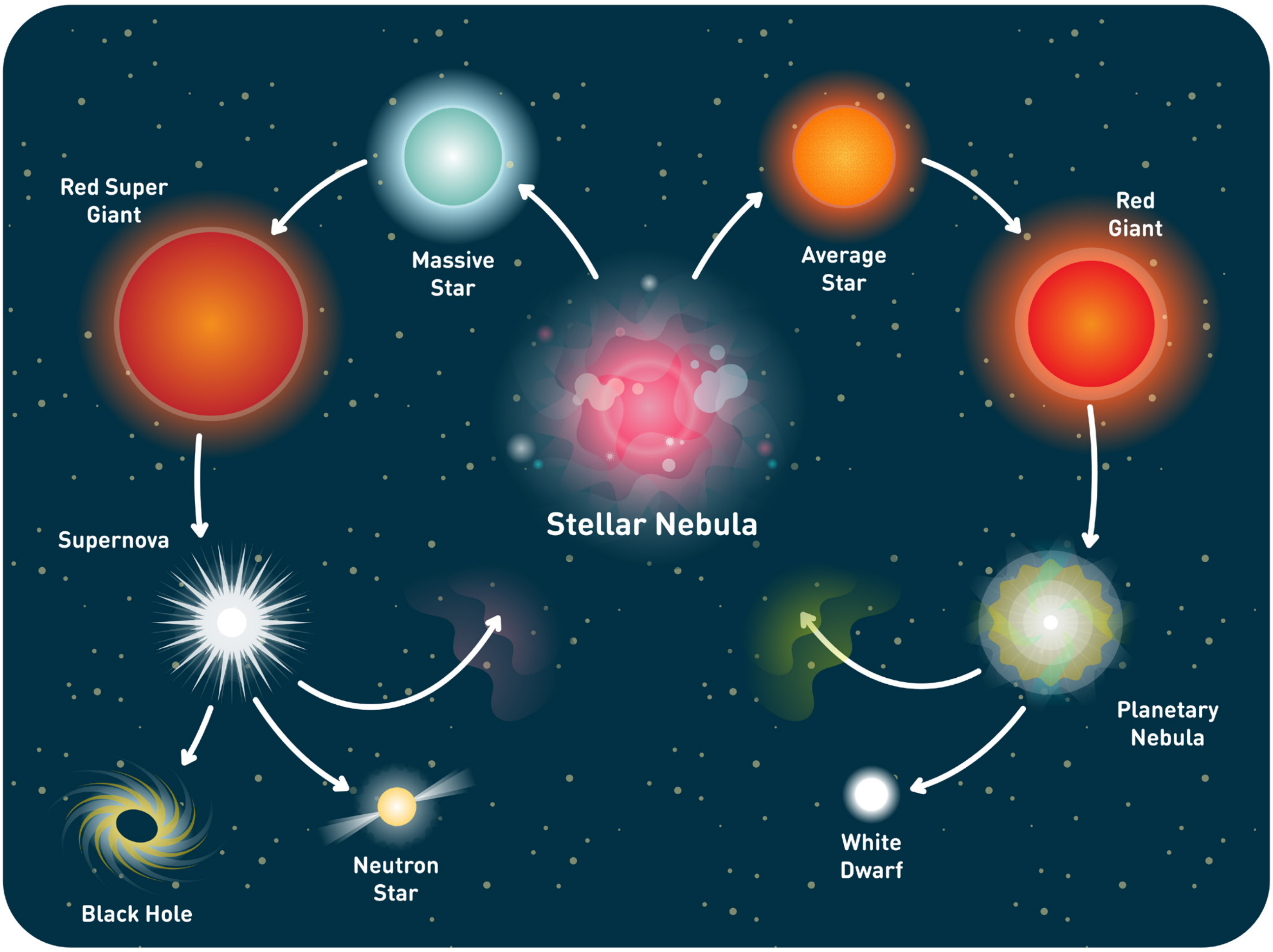
When a larger star (more than 7 times bigger than our Sun) comes to the end of its life, it will expand and cool to become a Red Supergiant.

The death of a Red Supergiant is much more spectacular. There will be a fiery explosion called a ***supernova,*** creating a type of nebula called a ***supernova remnant.*** This can shine as bright as an entire galaxy and can take a few days to fade completely.

The core of the star is left behind as a neutron star. These are even denser than white dwarfs and spin around really fast, sometimes several hundred times a second.

However, if the star was big enough (more than 20 times bigger than our Sun), it will become a black hole. Black holes have such strong gravity that nothing can escape them, not even light!

Star life cycle



Notes & Doodles

My Science Ideas

What science ideas or questions has this video and worksheet given you?

A guided tour of our universe

Worksheet 9 Teacher Feedback

EARTH
LIVE LESSONS

Lizzie Daly's Earth Live Lesson Worksheets

If you have a question to ask Lizzie about this Live Lesson you can connect with her **@LizzieRDaly** on Twitter using **#EarthLiveLesson**

Video 10 / Worksheet 10

Stories from a Bear Biologist
With Wes Larson

Hi! Thank you for watching our Earth Live Lessons. I hope you are enjoying them. Now it is time to show what you know! Good luck!

Lizzie

Go to our website and look for this video cover.

This worksheet accompanies Lizzie Daly's Earth Live Lessons Video, **'Stories from a Bear Biologist'** you can find it at:

www.s4science.co.uk/keystage-2-3

Q1. Name the three species of bear that Wes has been studying.

Polar Bear, Black Bear & Sloth Bear

Q2. What is the smallest bear in North America?

The Black Bear

Q3. What is the largest species of bear?

The Polar Bear

Q4. Name two US National Parks where you be able to view bears.

Yellowstone and Glacier National Parks

Q5. Where in Europe would you find wild bears?

France and Spain

Bears are less likely to attack people who are in tight groups.

[✓ True]/ False

Visit **www.greatbigstory.com/series/mission-wild** and learn more from Wes Larson.

Write your notes here:

Q6. State 3 NEW things that you have learnt:

1.

2.

3.

My Science Ideas

What science ideas or questions has this video and worksheet given you?

Stories from a bear biologist

Worksheet 10 Teacher Feedback

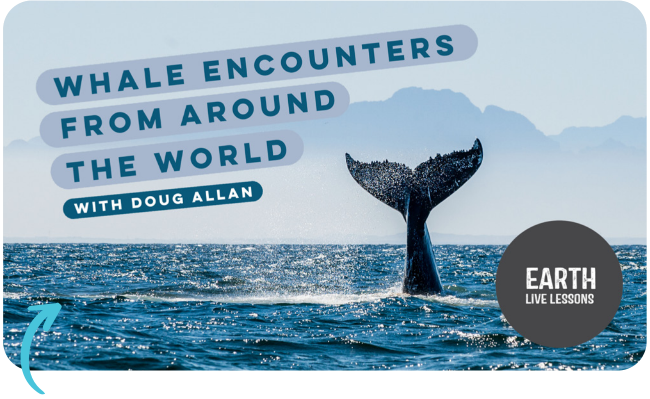
Video 11 / Worksheet 11

Whale Encounters from Around the World

With Doug Allan

Hi! Thank you for watching our Earth Live Lessons. I hope you are enjoying them. Now it is time to show what you know! Good luck!

Lizzie



Go to our website and look for this video cover.

This worksheet accompanies Lizzie Daly's Earth Live Lessons Video, **'Whale Encounters'** you can find it at:

www.s4science.co.uk/keystage-2-3

Q1. A humpback and a blue whale are both types of:
(circle your answer)

[✓ a) Baleen whale] b) Toothed whale

Q2. What's another name for a whale nose?

Blowhole

Humpback whales are known for being aggressive.

True / [✓ False]

Q3. Name 3 baleen whales

1. Humpback Whale
2. Blue Whale
3. Bow Head Whale

Q4. Name 2 types of tooth whale.

1. Dolphin
2. Sperm whale or beluga

Q5. Can you name one of the most endangered species of whales?

Arctic white

Q6. State 3 NEW things that you have learnt:

1.

2.

3.

EARTH
LIVE LESSONS

Can you think of ways to conserve the whale population? Write your ideas here.

Governmental

- International bans on whaling.
- Creating marine protected areas.
- Legislation on climate change and ocean pollution to prevent habitat degradation.

What can you do?

- Buy sustainable source seafood, or stop eating seafood altogether.
- Support marine protection organizations and sign petitions.
- Reduce your use of disposable plastic – a lot of plastic ends up in the ocean.
- Think about your cleaning products – everything once washed away goes back to the sea....do they contain toxic or harmful chemicals that
- Ship collisions are a big issue for whale mortality. Try to avoid buying products made abroad to reduce shipping impact.

My Science Ideas

What science ideas or questions has this video and worksheet given you?

Whale encounters

Worksheet 11 Teacher Feedback

Video 12 / Worksheet 12

Inside the Volcano
With Ryan Atkinson

Hi! Thank you for watching our Earth Live Lessons. I hope you are enjoying them. Now it is time to show what you know! Good luck!

Lizzie

Go to our website and look for this video cover.

This worksheet accompanies Lizzie Daly's Earth Live Lessons Video, **'Into the Volcano'** you can find it at:

www.s4science.co.uk/keystage-2-3

Q1. How many countries are on the border of the Democratic Republic of Congo (DRC)? *(circle your answer)*

a) 6 b) 4 [✓ c) 7]

Q2. Can you name one?

Tanzania, Uganda, South Sudan, Central African Republic,
Zambia, Angloa, Congo

Q3. What is the name of the molten rock that flows from volcanoes?
(circle your answer)

a) mud b) ice [✓ c) lava]

A gorilla's nose print is unique

[✓ True] / False

Q4. State 3 NEW things that you have learnt:

1.

2.

3.

Make a Volcano!

EARTH
LIVE LESSONS

Ingredients

- 10 ml of dish soap
- 100 ml of cold water
- 400 ml of white vinegar
- Food colouring
- Baking soda slurry (fill a cup about 1⁄2 with baking soda, then fill the rest of the way with water)
- Empty 2 litre soda bottle

Method

- Combine the vinegar, water, dish soap and 2 drops of food colouring into an empty pop/water bottle.
- Use a spoon to mix the baking soda slurry until it is all a liquid.
- **Eruption time!** ... Pour the baking soda slurry into the soda bottle quickly and step back!

My Science Ideas

What science ideas or questions has this video and worksheet given you?

Inside the volcano

Worksheet 12 Teacher Feedback

Video 13 / Worksheet 13

Why Wetlands are Nature's Superheroes!
with Dr Christian Dunn

Hi! Thank you for watching our Earth Live Lessons. I hope you are enjoying them. Now it is time to show what you know! Good luck!

Lizzie

Go to our website and look for this video cover.

This worksheet accompanies Lizzie Daly's Earth Live Lessons Video, **'Why Wetlands are Nature's Superheroes!'** you can find it at:

www.s4science.co.uk/keystage-2-3

Q1. What sort of wetland would you find in a coastal region? *(circle your answer)*

[✓ a) Mangrove]   b) Bogs   c) Marshes

Q2. How much more CO^2 is stored in wetlands compared to forests?

Twice as much.

Q3. List the 4 qualities that make wetlands nature's superheroes.

1. Biodiversity

2. Cleaning water

3 Flood protection

4. Climate control.

Q4. Why are 'leaky' dams, built by beavers, good for flood protection?

Beavers make dams that are leaky to allow water to trickle at a manageable rate.

Q5. What organisation is responsible for looking after wetlands in the UK?

The Wildlife Trust.

In 1940 USA, beavers were dropped by parachutes to remote wetlands that needed flood management.

[✓ True]/ False

Q6. What are the similarities and differences between the following:

a) Fens and bogs.

Both are one of the four types of wetland. Both fall under the wetland category 'mire' which forms peat in the ground. This is because the water logging in the grounds stops plant matter from fully decomposing. Fens are rich in minerals and alkali, making them home to a large variety of grasses. Bogs are very low in minerals and acidic, making them hostile to most plant life. Bogs are also dome shaped while fens are on dips or flats. As a result, bogs only get their water from rain while fens can also be fed by ground water, rivers, lakes and streams.

b) Marshes and swamps.

Both are one of the four types of wetland. Both have a larger variety of plant species than fens and bogs. Both form around bodies of surface water such as lakes and rivers, forming a transition between aquatic and terrestrial systems. However, Swaps can form around salt-water bodies while mires are always freshwater. Mires are home to herbaceous (non-woody) plants while swaps are dominated by woody plants such as trees.

Q7. State 3 NEW things that you have learnt:

1.

2.

3.

EARTH
LIVE LESSONS

My Science Ideas

Why wetlands are nature’s superheroes!

Worksheet 13 Teacher Feedback

Worksheet Answers

You will find the answers to all of the questions in this workbook on our website:

www.s4science.co.uk/ keystage-2-3

Notes & Doodles

Notes & Doodles

UNDEB EWROPEAIDD
EUROPEAN UNION

Llywodraeth Cymru
Welsh Government

**Cronfa Gymdeithasol Ewrop
European Social Fund**

Swansea
University
Prifysgol
Abertawe