The Spark Magazine

PUZZLES, QUIZZES, EXPERIMENTS

ISSUE No17

STATIC ELECTRICITY

ELECTRIC ANIMALS

FUTURE TRANSPORT

MEET A MATERIALS RESEARCH CHEMIST

GLASGOW SCIENCE CENTRE
Celebrating 21 years

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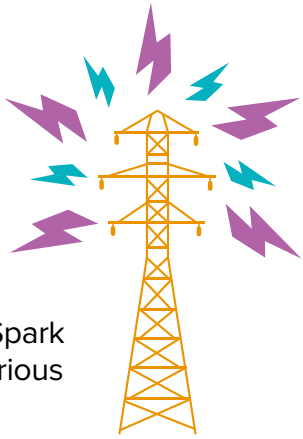


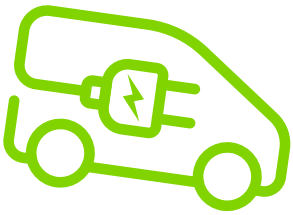
HELLO!

Welcome to another exciting issue of The Spark magazine! Crammed full of creative and curious experiments, puzzles, quizzes, and facts.

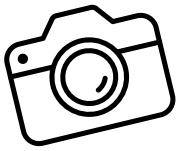
In this issue we are exploring all things electric. What is electricity and how does it work? We're also finding out how plants and humans get energy, and discovering animals who use electricity to hunt down their prey!

Try your hand at some shocking static science and design your own renewable form of transport in this electrifying edition of The Spark magazine!

Best wishes,
Glasgow Science Centre



SHARE YOUR PICS WITH US

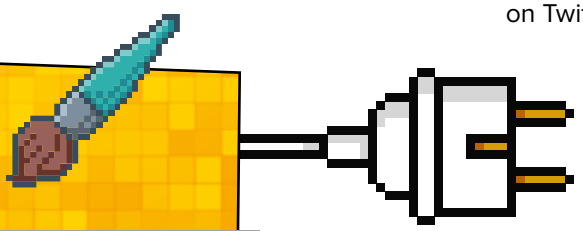


If you try any of our activities, please show us how they turned out! Send your favourite pictures to CLDteam@gsc.org.uk or share with us @TheBothyGSC on Twitter.

MINI GAME

Paint by Pixels

Colour in the pixels using the key below.
What electric object is it?



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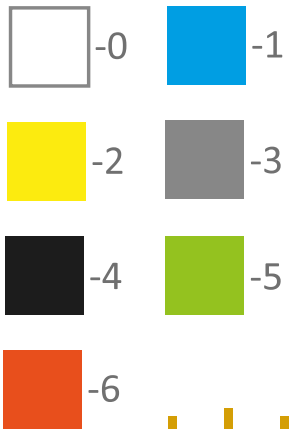
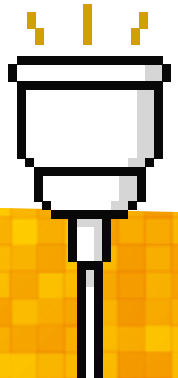
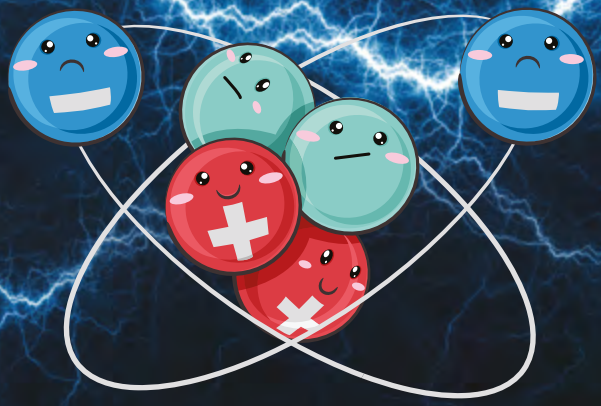
Colour key





What is Electricity?



Electricity is a form of energy, and it can be generated at power stations from fossil fuels like gas, coal and oil. We can also generate renewable electricity using power sources like the sun or wind.

We use electricity every day to heat and light up our homes, to play video games and watch TV, and sometimes we use electricity to drive in electric cars and buses. But how does it work?

DID YOU KNOW?

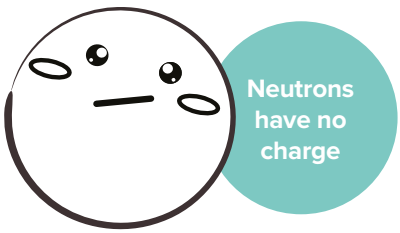
Protons and neutrons huddle together in the middle of the atom, called the nucleus, and the electrons orbit them.

Electricity is the movement of tiny charged particles, which are found in atoms. Everything in the universe is made from atoms.

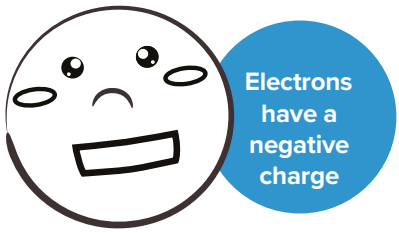
Each atom is made up of even smaller particles, called protons, neutrons and electrons.

Colour us in!

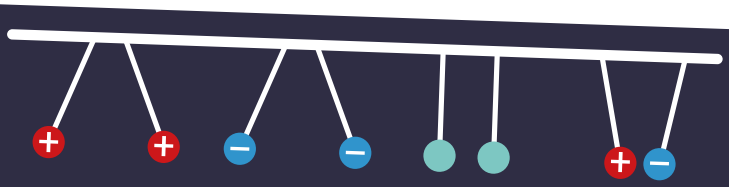
Protons



Neutrons



Electrons



Positive and negative charges pull towards each other, but particles of the same charge will push away from each other.

The movement of electrons around a circuit is called a current, and this current is what powers our electrical devices.

Scan here to learn more about energy with our GSC@Home video.

DID YOU KNOW?

GLASGOW SCIENCE CENTRE

Did you know that the Glasgow Science Centre logo is partly inspired by the movement of electrons. **Can you see it?**

Electrifying Experiments

Static electricity is the build-up of an electrical charge on the surface of an object.

What Happens?

Try these six experiments to see the power of static electricity

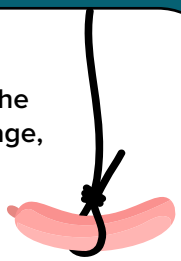
1

Rip up some paper into small pieces and put them onto a plate.

Rub a balloon on your T-shirt for 10 secs then hold the balloon close to the paper. **What happens?**

2

Tie a piece of string around the middle of an uncooked sausage, then wash your hands.



Ask a friend to hold onto the string so the sausage is hanging freely. Rub a balloon on your T-shirt then bring the balloon towards the sausage. **What happens?**

3

On a black piece of paper, pour a small pile of salt. Then sprinkle some pepper onto the salt. Take a plastic spoon and rub it with a dry dish cloth to build up a charge on the spoon.

Bring the rounded surface of the spoon towards the pile of salt and pepper.

What happens?

4

Turn on the cold water tap at the sink and let it run slowly with a steady flow.

Run a plastic comb through your hair for 30 secs to build up a charge on the comb.

Bring the comb close to the running water.

What happens?

Does anything unusual happen to your hair while you are combing it?

5

Rub a balloon on your T-shirt. Hold the balloon over your friend's hair.

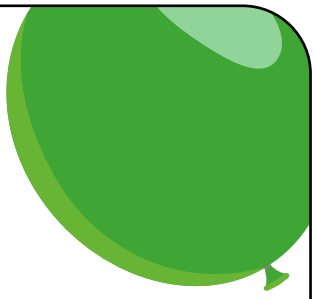
What happens?

6

Place an empty drinks can on its side on a table.

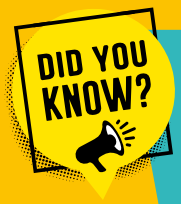
Rub a balloon on your T-shirt, and hold the balloon close to the can.

What happens?

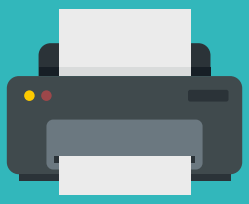


What causes static electricity?

A static charge happens when two surfaces rub against each other, like the balloon and the T-shirt, and electrons are transferred from one object to the other. One of the objects will lose electrons and become positively charged. The other will gain electrons and have a negative charge.



Static electricity has several uses in our day-to-day life. Printers and photocopiers use static electricity to attract the ink to the paper.



While visiting Glasgow Science Centre, you might get the chance to try our Van de Graaff generator. It creates a static charge and when you touch it, your hair will stand on end!

Plant Power

The Sun is a renewable energy source that plays an important role in our daily lives, from warming the Earth to generating electricity with solar panels. Plants would not be able to grow, reproduce, or survive if the Sun did not shine.

Plants require three things to survive: sunlight, water, and carbon dioxide. Plants use the energy from the Sun to make food using water, carbon dioxide in the air and nutrients in the soil. This process is called photosynthesis.

Try this experiment to see the importance of sunlight.

What will you need?

- A packet of basil seeds (other seed types can be used: grass, chives, and beans)
- Three small plastic cups
- Potting soil
- A watering can
- A notebook & pencil
- Three different growing locations: full sun, partial sun and little or no sunshine

What to do

Step 1. Take the three small plastic cups and fill them about three-quarters full with the soil.

Step 2. Sprinkle your chosen seeds evenly on the surface of the soil.

Step 3. Cover the seeds with a little bit more soil, then water the seeds.

Step 4. Place each cup in a different growing environment: one in full/direct sunlight, one in a location that gets some Sun, and the last cup in a location that gets little to no sun – like in a drawer or cupboard.

Over the next two weeks, water the seeds when the soil gets dry and track their growth. Predict what you think will happen and take notes in your notebook.

What did you notice? Was your prediction correct?

Food Energy

The food we eat is a type of stored energy. Food stores chemical energy that powers our bodies when we digest what we eat. This energy is very important as it allows us to stay warm, to play games, ride our bikes and live our lives.

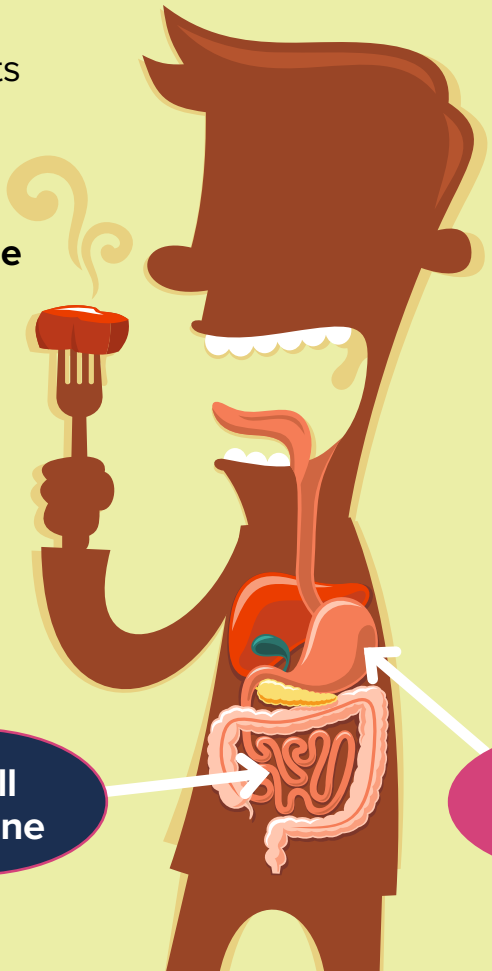
Energy is measured in joules. Food energy is measured in kilojoules (kJ) or kilocalories (kcal). 1 kilojoule equals 1,000 joules, and 1 kilocalorie equals 4.2 joules.

The amount of energy we need depends on our ages and what we are doing.

10-year-old boys need about **8,500 kJ or 2,030** kcals a day

10-year-old girls need about **8,100 kJ or 1,935** kcals a day

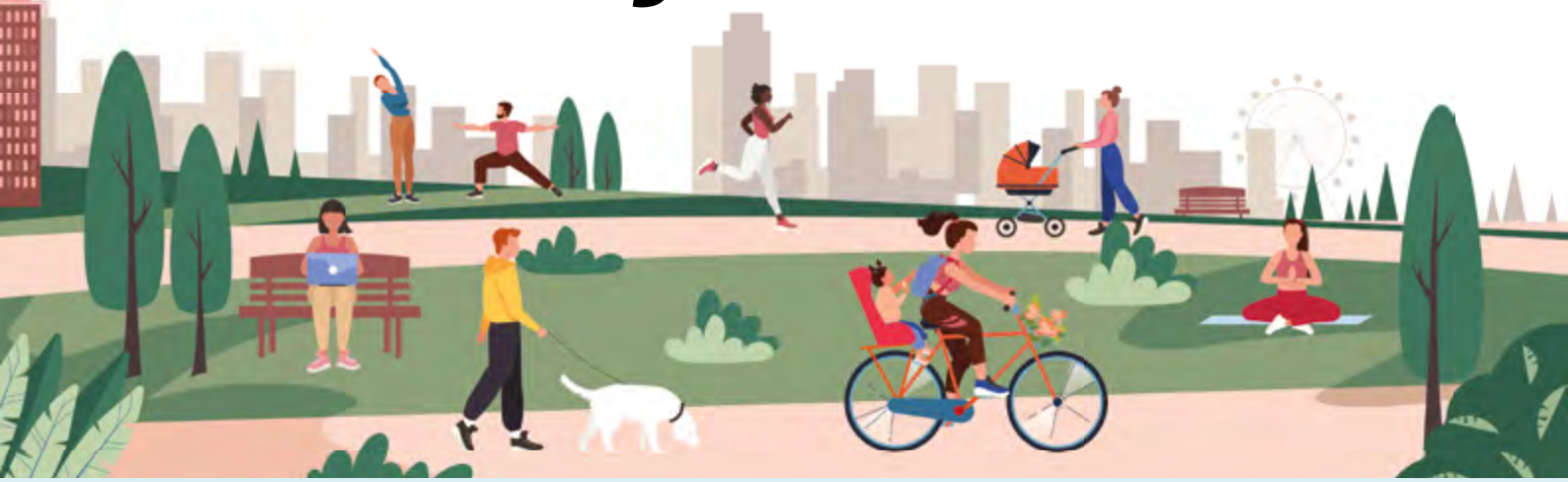
It is important to have a **balanced diet** and eat lots of different food groups so we can get **all the nutrients we need to be healthy**, as well as get **the energy we need**.



When we eat food **enzymes in our digestive system break down the carbohydrates** into a sugar called **glucose**.

Glucose is absorbed in the small intestine and goes into our **blood stream to give us the energy** we need immediately, or it can be stored for later.

How much energy do you use?



We burn calories while exercising, playing games and doing homework. What exercise do you think uses the most calories?

Cycling
120 Kcals

Running
160 Kcals

Trampolining
55 Kcals

Swimming
95 Kcals

You may be surprised to know that even while we are sleeping, we are burning calories: around 45- 50 calories an hour!

Electricity is measured in units of power called **watts**. A watt is the **amount of energy** that a device uses in a second.

A 10-watt light bulb uses **10 joules in a second**.

When resting, the human body can produce **100 watts of energy!** That's enough to **power a light bulb**.

Some humans can produce a whopping **2,000 watts of energy when sprinting.**

Shocking facts about **the electric eel!**

The electric eel is not an eel at all, it is a fish called an **'Electric knifefish'** that lives in the dark muddy waters of the **Amazon River**, where getting around can be very tricky.

There are over **350 different species of fish** that can **generate electricity!**

The eel **creates weak electrical signals** which it uses like a radar system to **navigate its way around** in the dark environment.

It can also use this system to **hunt and find food**. Then it uses a stronger **electric shock to stun its prey** before **eating it alive**.

DID YOU KNOW?

Electric eels can **generate up to 860 volts of electricity** – the most **powerful shock** of any known animal!

@EelectricMiguel

An electric eel called Miguel Wattson, who lives at the Tennessee Aquarium, has his own Twitter account. His tweets are triggered by his electrical activity.

How do electric eels generate electricity?

The eels have **three electric organs** running the length of their body. Inside these organs are **thousands of disc-shaped cells called electrocytes**. These modified muscle cells act as a biological battery, creating an **electrical current** strong enough to travel several metres.

File name:

Future Transport

Your mission, if you choose to accept it, is to design a brand-new method of transport.

We have lots of ways of travelling and exploring the world: cars, boats, planes or even rockets to explore the stars beyond our planet.

The problem is that most of these methods of transport are not very good for our planet because they mainly use fossil fuels for energy.

When we use fossil fuels like oil, coal, and natural gas they release carbon dioxide into the atmosphere.

All the extra carbon dioxide in the atmosphere acts like a greenhouse around our planet, trapping lots of extra heat and causing global warming.

This can lead to changes in our climate and extreme weather effects like flooding, heatwaves, and droughts.

What fuel will power your new method of transport? Will it be solar powered? Wind powered?

Or maybe you can even invent your own energy source!

Scan here to watch our Future Transport video for more information.

Design your vehicle

TOP SECRET

My vehicle is _____

It is fuelled by _____

For inspiration for new fuel sources visit OurFuture.Energy where you can find lots of information on renewable technologies.

Share your design with us on twitter @GSC1

It takes all sorts of scientists, engineers and designers to come up with solutions to problems like this.

What skills do you think are important to work in this field?

A Battery that Stores Heat

I'M A... MATERIALS RESEARCH CHEMIST

Meet Emily Goddard

I work for Sunamp, a company which makes thermal batteries. These batteries don't store electricity, they store heat. The batteries work in the same way as reusable handwarmers where you click a disc and the liquid inside crystallises (turns into a solid) and heats up. But these batteries are thousands of times bigger.

They can store enough heat not just to warm up your hands, but your whole house! This can help people save money on energy bills by storing heat when it's not needed from a wide choice of energy sources, including solar panels and heat pumps. This stored heat can then be used when it is needed, instead of using gas or electricity. They're also much smaller than traditional water cylinders and lose less heat.

The batteries contain a phase-change material (or PCM) which takes in a lot of energy when it melts and releases it as heat when it freezes. You then re-charge the batteries by heating them up and melting the PCM again. I look for new PCMs that work at different temperatures, so they can be used for all different things. A PCM that can heat water until it boils would be far too hot for your shower, while one that melts and freezes at 18°C would be a bit chilly for that so I develop ones that are in-between.

Ice was used as a PCM to cool food and buildings as long as 3,800 years ago! I like the fact we're using a concept that's been used for thousands of years and updating it to help people be more energy efficient, use less fossil fuel, and save money on their energy bills.

An infra-red photo of a hand warmer showing the heat that is generated when the PCM freezes. The orange area is at a temperature of 50.3°C.

The heat battery on the right is much smaller than a standard hot water cylinder on the left.

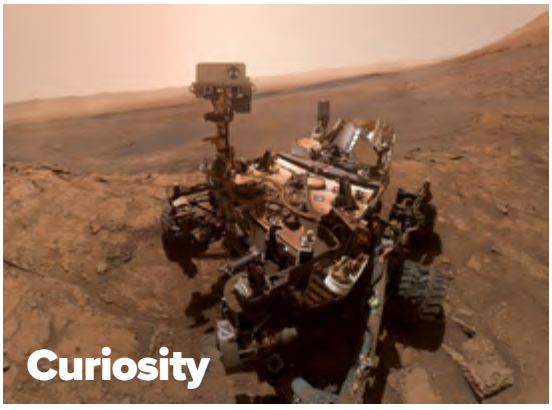
Materials chemistry is everywhere — from the strings in tennis racquets, the paint on your walls and the plastic in your lunchbox, to the silicon chips in computers and the sutures used to stitch wounds — materials chemists will have been involved in developing and improving all of these.

How do we get electricity in space?

The International Space Station (ISS) orbits 354 km (220 miles) above Earth. There are no wires connecting it to Earth to get power, so how does it get its electricity?

The ISS has an innovative set of solar arrays, which contain thousands of solar cells. They are made from silicon which convert light into electricity. Specialised motors turn the arrays to always face the Sun to harness solar energy.

The panels can generate 84 – 120 kilowatts of electricity, enough to power 40 houses. This keeps the astronauts warm, powers their experiments and charges the station's batteries.



NASA currently has **two robotic vehicles** operating on Mars: **Curiosity and Perseverance**. These rovers don't have plug points to charge their batteries, so how do they get their power?

They are **powered by a small nuclear battery** called a Multi-Mission Radioisotope Thermoelectric Generator. It uses the fuel plutonium-238 to generate just over **100 watts of electrical power.** This power supply has enabled Curiosity to **explore Mars for 10 years** so far!

Why do you think a solar panel might not work very well for these rovers?

Fun Fact

Ingenuity, the first rotocopter to fly on Mars, carried tiny pieces of fabric from the Wright Flyer, the first powered aircraft to take to Earth's skies, in 1903.

BRIGHT SPARKS!

Are you a bright spark? Test your knowledge with our tricky questions! Check your answers on the back page.

1 What units are used to measure energy?

- [ ] A) Watts
- [ ] B) Joules
- [ ] C) Amps

2 Electricity is the movement of which tiny particles?

- [ ] A) Protons
- [ ] B) Neutrons
- [ ] C) Electrons

3 Which of these particles are positively charged?

- [ ] A) Electrons
- [ ] B) Protons
- [ ] C) Neutrons

4 Photocopiers use static electricity to stick ink to paper?

- [ ] True
- [ ] False

5 Which of these weather events is an example of static electricity?

- [ ] A) Lightning
- [ ] B) Thunder
- [ ] C) Rainbows

6 On average, how much energy is in a bolt of lightning?

- [ ] A) 1 thousand joules
- [ ] B) 1 million joules
- [ ] C) 1 billion joules

7 Along with water and carbon dioxide, what type of energy does a plant need to survive?

- [ ] A) Solar
- [ ] B) Geothermal
- [ ] C) Wind

8 Which of these organs help us get energy from our food?

- [ ] A) Kidney
- [ ] B) Heart
- [ ] C) Small instestine

9 Which of these activities uses the most energy?

- [ ] A) Cycling
- [ ] B) Running
- [ ] C) Swimming

10 The human body at rest produces enough energy to power which one of these household objects?

- [ ] A) Lightbulb
- [ ] B) Television
- [ ] C) Fridge

11 How much electricity can an electric eel produce?

- A) 100 volts
- B) 350 volts
- C) 860 volts

12 What are the cells inside the electric organ of an electric eel called?

- A Electrocytes
- B) Electrolysis
- C) Electrolytes

13 How many solar cells are on the solar arrays on the International Space Station?

- A) 150,500
- B) 262,400
- C) 380,750

14 How many kilometres of wire are used in the electrical system on the International Space Station?

- A) 5 km
- B) 13 km
- C) 18 km

15 How long will the battery used on the Mars rovers last for?

- A) 14 years
- B) 18 years
- C) 20 years

16 What was used to power Opportunity, the first Mars rover?

- A) Nuclear power
- B) Solar power
- C) Wind power

17 What is the real name of the Curiosity rover?

- A) The Mars Science Laboratory
- B) Automated Science on Mars
- C) The Mars Robotic Vehicle

18 Which place has the most lightning strikes in the world?

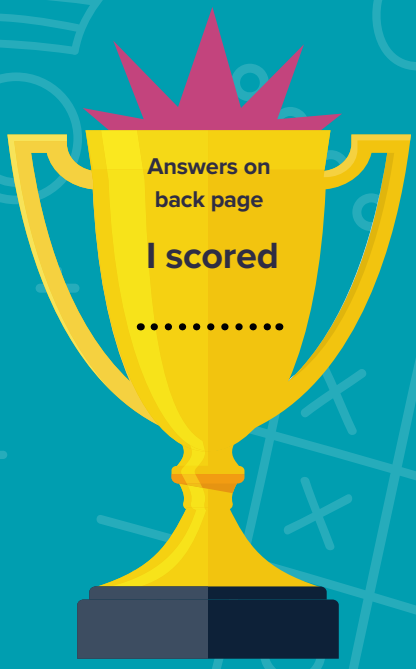
- A) Lake Victoria, East Africa
- B) Lake Maracaibo, Venezuela
- C) Lake Superior, North America

19 How much of Scotland's energy comes from renewable sources?

- A) 60%
- B) 75%
- C) 95%

20 Cows contribute more greenhouse emissions each year than cars do?

- True
- False



ABOUT US

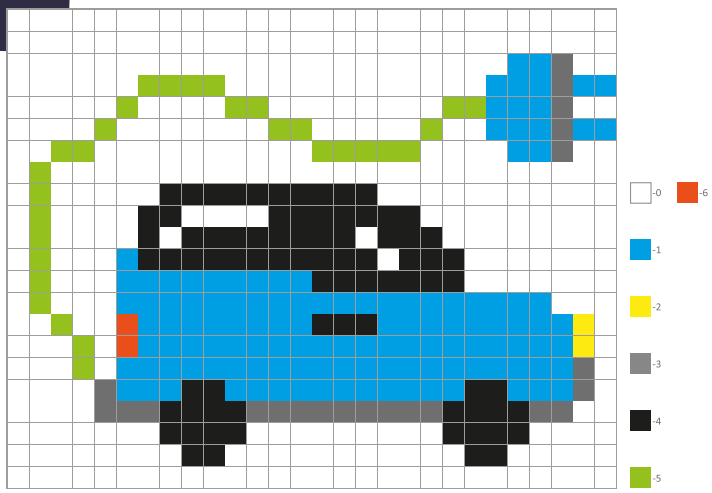
Glasgow Science Centre is a 5-star visitor attraction located beside the River Clyde. We are home to hundreds of interactive exhibits where you can discover how the world works.

Glasgow Science Centre is a registered Scottish charity SC030809.

For more information and bookings, visit: glasgowsciencecentre.org

PUZZLE SOLUTIONS

Paint by Pixels



Bright Spark QUIZ ANSWERS

Q1 B. Energy is measured in joules. Watts are the measure of electricity use per second and Amps measure the rate of electricity flow.

Q2 C. Electrons – electricity is the movement of tiny charged particles called electrons.

Q3 B. Protons are positively charged, neutrons have no charge and electrons are negatively charged.

Q4 True. Static electricity attracts the ink onto the paper.

Q5 A. Lighting is a good example of static electricity.

Q6 C. One billion joules of energy are contained in an average bolt of lightning.

Q7 A. Solar power - plants need sunlight plus carbon dioxide, water and nutrients from the soil to survive.

Q8 C. The small intestine absorbs sugars like glucose, the energy from food.

Q9 B. Running – a child running for 30 minutes would use about 160 kcals of energy.

Q10 A. Lightbulb - the human body at rest produces 100 watts of electricity, enough to power a standard lightbulb.

Q11 C. 860 volts – a shocking amount of energy can be generated by the electric eel.

Q12 A. Electrocytes - thousands of these cells can be found inside the electric organs of electric animals.

Q13 B. 262,400 solar cells are contained on the solar arrays of the International Space Station.

Q14 B. 13 km of wires carry electricity around the International Space Station.

Q15 A. 14 years – the nuclear battery has been designed to last for 14 years of continuous work.

Q16 B. Solar power - the solar panels on the Opportunity rover allowed it to generate electricity from the sun.

Q17 A. The Mars Science Laboratory is the original name of the Curiosity rover.

Q18 B. Lake Maracaibo in Venezuela can receive about 15,000 lightning strikes a night over 300 days of the year.

Q19 C. 95% - Scotland generates over 95% of its electricity from renewable sources.

Q20 True. Cows produce methane gas which is 28 times more powerful at warming the planet than the carbon dioxide produced by cars each year.

There's more to learn!

To learn more amazing facts about electricity visit **OurFuture.Energy** where you can read about careers in the energy industry, discover innovations in electricity production and download activity resources for the home and classroom.

WE WANT YOUR FEEDBACK

We would love to hear what you think!

We hope you liked this issue, but if you didn't, what could we change? What other things would you like to see? What topics are you most interested in?

You can send feedback and pictures to CLDteam@GSC.org.uk or message us on Twitter @TheBothyGSC

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