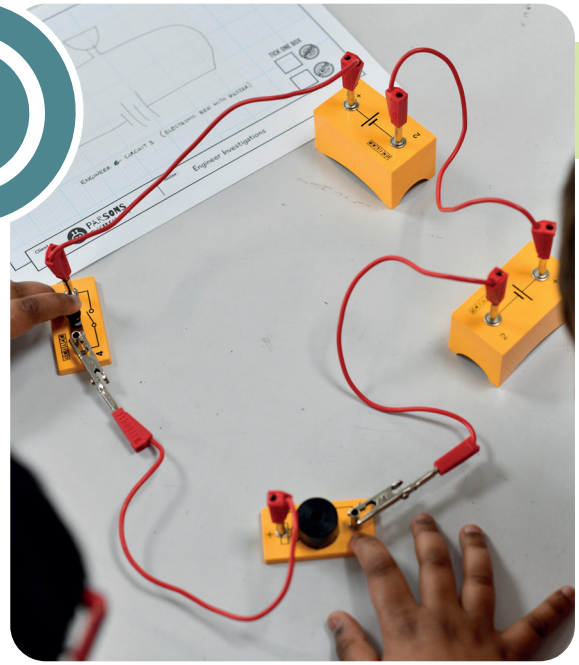
Phizzi enquiry

Circuit analyst

Target audience: Year 4 and Year 6



Big idea

Many common electrical components (eg. a bulb or buzzer) have two connection points, or terminals; these two terminals need to be connected by wires (or other conducting material) to the two terminals of a battery (or other power supply). Several components can be operated from a battery by connecting them with wires in a single closed loop from one battery terminal to the other (a series circuit). The order of the components in a circuit makes no difference to how they operate. A switch is a device that completes or breaks a circuit.

	Prior learning	New learning	Future learning
Physics knowledge development	• To be able to construct a simple series electrical circuit, identifying and naming its basic parts, including cells, wires, lamps, switches and buzzer (Y4).	• To identify whether or not a lamp will light in a simple series circuit, based on whether or not the lamp is part of a complete loop with a battery (Y4).	• To compare and give reasons for variations in how components function (Y6).
Working scientifically skills development	• To make systematic and careful observations.	• To identify differences, similarities or changes related to simple scientific ideas and processes. • To describe and evaluate other people's scientific ideas.	• To make and record observations and measurements using a range of methods for different investigations; to evaluate the reliability of methods and suggest possible improvements.
Mastery of subject specific vocabulary	electricity, cell, battery, bulb, lamp, open switch, closed switch, buzzer, crocodile clip, connect, loop, complete circuit, component, series, circuit diagram, circuit symbol, bright/dim, loud/quiet	flat, repair, fault, faulty, short circuit, loose connection, blown bulb, trouble shoot, terminals, voltage	ammeter, voltmeter, parallel, resistor, variable resistor, fuse, LED

English

- Write a formal letter to the manager of the company, suggesting which of the engineers is making mistakes in their circuits and which engineers work accurately.

Maths

- Use a Carroll diagram to group and classify the circuits.

This enquiry is taken from the Ogden Phizzi Electricity CPD. Phizzi CPD is part of the Ogden School

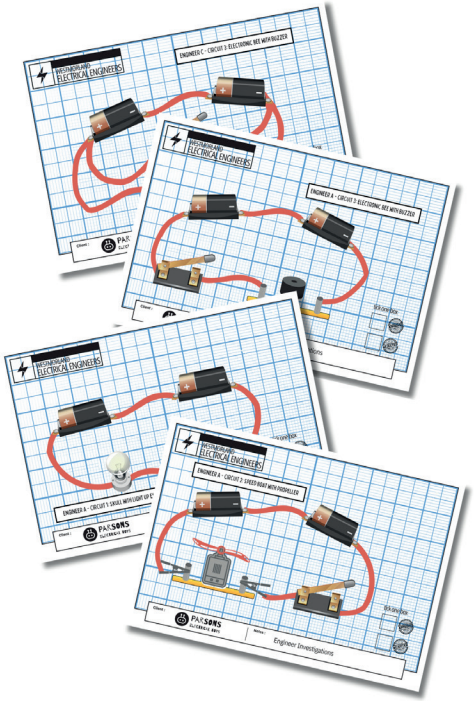
Partnerships programme and covers the four main areas of primary physics. www.ogdentrust.com.

Big question

Which circuit designs have mistakes in them?

Context

Parsons Electronic Toy Company keep having toys returned because the circuits are faulty. They have deduced that the circuit diagrams that are being sent to the factory are not all correct. Can you work out which engineer is making mistakes? Which of the circuit drawings/diagrams show working circuits?



Background science for teachers

There are many reasons why a circuit may not work, and this type of enquiry is good for encouraging an analytical approach to diagnosing problems.

- Check for short circuits which can cause overheating.
- Check that the batteries are connected positive terminal to negative terminal.
- Look for breaks in the circuit.

Method

1. Look carefully at the circuit drawing/diagram and predict whether you think it will work or not – justify your ideas to your team.
2. Build the circuit, exactly as shown in the drawing/diagram. If the circuit smells or feels hot, disconnect the battery immediately.
3. Record the circuit number and the name of the engineer in your books. If the circuit is faulty, you should explain why it doesn't work and draw a corrected circuit/circuit diagram.
4. Swap circuit drawing/diagrams with another group and repeat steps one to three.
5. When you have checked all the circuits, deduce which of the engineers is making mistakes and needs some extra training.

Equipment

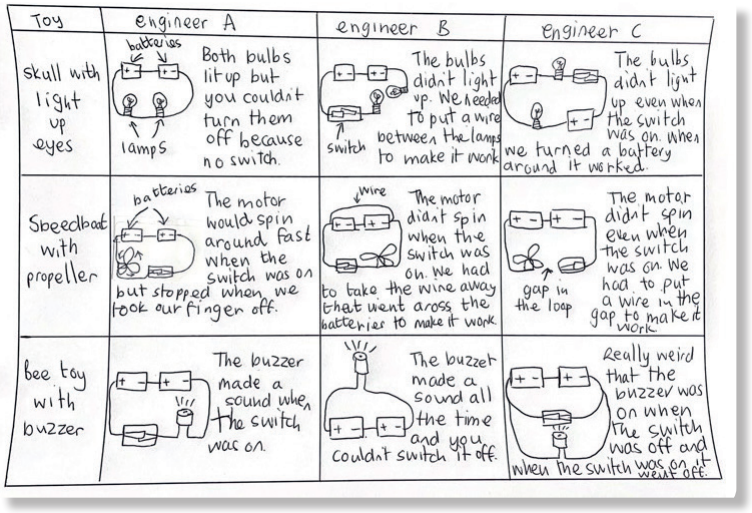
- Full circuit sets – switches, wires, batteries, lamps, buzzers, motors
- Circuit drawing/diagrams – set 1 pictorial representations for Year 4, set 2 circuit diagram representations for Year 6 (pdf in electronic pack)

Notes for teachers

This identifying and classifying enquiry can be used in Year 4 for pupils to practise their skills in circuit construction and testing their predictions about whether circuits will work or not. It can also be revisited in Year 6 with a focus on interpreting and evaluating circuit diagrams as well as reviewing ideas about circuits.

Recording observations

Year 4 pupils construct the 9 circuits shown on the cards and describe their observations and ideas. Pupils could draw their own representations of the circuits they make, take photographs, or cut and stick pre-prepared images an annotate them. Pupils can apply their science ideas to discuss what would happen to the toys if each circuit was used.

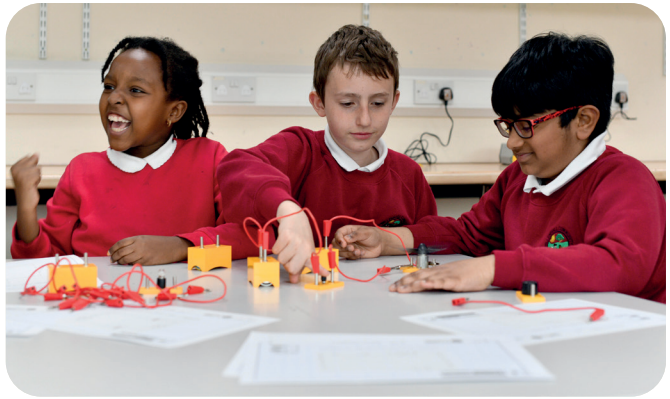


Toy	engineer A	engineer B	engineer C
Skull with light up eyes	batteries, lamps — Both bulbs lit up but you couldn't turn them off because no switch.	switch — The bulbs didn't light up. We needed to put a wire between the lamps to make it work.	The bulbs didn't light up even when the switch was on. When we turned a battery around it worked.
Speedboat with propeller	batteries — The motor would spin around fast when the switch was on but stopped when we took our finger off.	wire — The motor didn't spin when the switch was on. We had to take the wire away that went across the batteries to make it work.	gap in the loop — The motor didn't spin even when the switch was on. We had to put a wire in the gap to make it work.
Bee toy with buzzer	The buzzer made a sound when the switch was on.	The buzzer made a sound all the time and you couldn't switch it off.	Really weird that the buzzer was on when the switch was off and when the switch was on it went off.

Recording observations

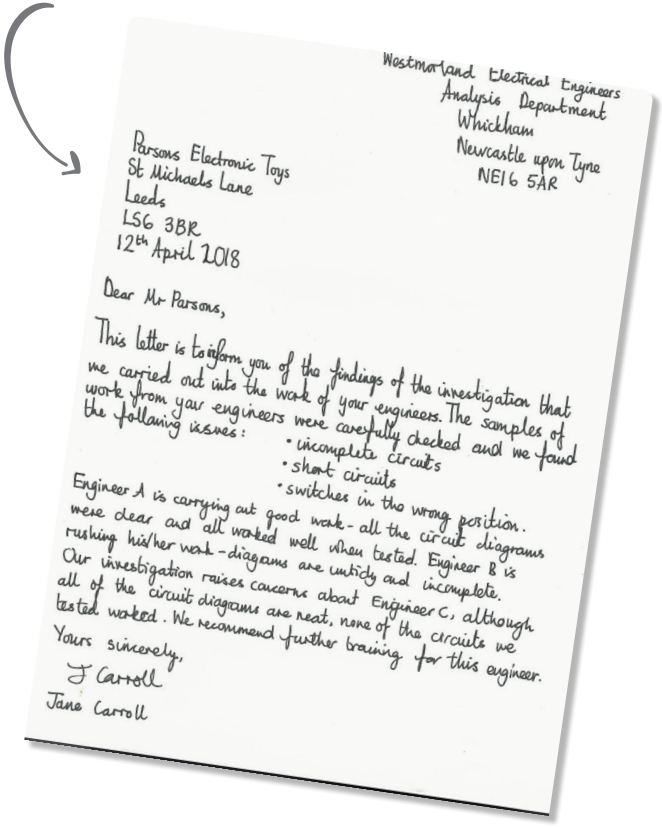
Year 6 pupils make notes on their findings from constructing the 9 circuits from the circuit diagrams provided. Where the circuit doesn't work, they could draw the circuit diagram that should have been drawn by the engineer.

	Circuit	Findings
Engineer A	1	Circuit diagrams neat and tidy. When switch is closed the lamp lights – good circuit. ✓
	2	Circuit diagram – neat and accurate. When the switch is closed the motor spins – good circuit. ✓
	3	Circuit diagram – neat and accurate. When switch is closed the buzzer sounds – good circuit. ✓
Engineer B	1	Diagram untidy and incomplete. The circuit diagram has a wire missing. ✗
	2	Diagram untidy and incomplete. The circuit diagram has a wire missing. ✗
	3	Diagram untidy. No switch in the circuit so the buzzer can't be switched off. ✓✗
Engineer C	1	Diagram carefully drawn. One battery is the wrong way round so the lamp will never light. ✗
	2	Diagram is carefully drawn. A wire is drawn across the batteries causing a short circuit so the motor will never spin. ✗
	3	Diagram is carefully drawn. The switch is connected across the circuit so that when it is off the buzzer is on and when it is on the buzzer is off. ✗



Communicating ideas in writing

Pupils could write a letter to the toy factory to report their findings and advise the manager which engineer could improve their circuit diagrams and may need some extra training.



Westmorland Electrical Engineers
Analysis Department
Whickham
Newcastle upon Tyne
NE16 5AR

Parsons Electronic Toys
St Michaels Lane
Leeds
LS6 3BR
12th April 2018

Dear Mr Parsons,

This letter is to inform you of the findings of the investigation that we carried out into the work of your engineers. The samples of work from your engineers were carefully checked and we found the following issues:

- incomplete circuits
- short circuits
- switches in the wrong position.

Engineer A is carrying out good work - all the circuit diagrams were clear and all worked well when tested. Engineer B is rushing his/her work - diagrams are untidy and incomplete. Our investigation raises concerns about Engineer C, although all of the circuit diagrams are neat, none of the circuits we tested worked. We recommend further training for this engineer.

Yours sincerely,

J Carroll

Jane Carroll

Links to everyday life

Pupils can discuss and predict what circuits might be like in simple everyday electronic devices such as hairdryers, torches, fans or doorbells. Learning could be extended at home by making predictions about what might make up the circuits in simple electrical toys or other devices.

Remembering

Q. What are the reasons a circuit might not work? (Year 4)

Q. What equipment do you need to draw a circuit diagram? (Year 6)

Understanding

Q. What are five key rules to remember when drawing circuit diagrams? (Year 6)

Explain why we have a set of internationally recognised circuit symbols. (Year 6)

Applying

Q. What steps would you take to make the faulty circuits work? (Year 4)

Q. What questions would you ask in an interview to find out which engineer needs help with drawing circuit diagrams? (Year 6)

Analysing

List at least four possible reasons why a circuit might not behave how you expect it to.

- The batteries are flat.
- The batteries or components are the wrong way round.
- The bulb has blown.
- There is a loose connection.
- There is a short circuit.

Evaluating

Q. Your circuit isn't working – what steps do you take to find out what the problem is?

A. Systematically check the batteries and components. Trace the flow of electricity around the circuit, making sure there is one loop. Check batteries are connected positive to negative.

Creating

- Invent your own set of circuit symbols to help communicate your ideas about circuits and explain them. (Year 4)
- Create a flow diagram that could be kept in the circuit box to help children making circuits in the future. (Year 6)