

## EPSE Project 1: Sample Diagnostic Questions - Set 3

### **Circuit behaviour**

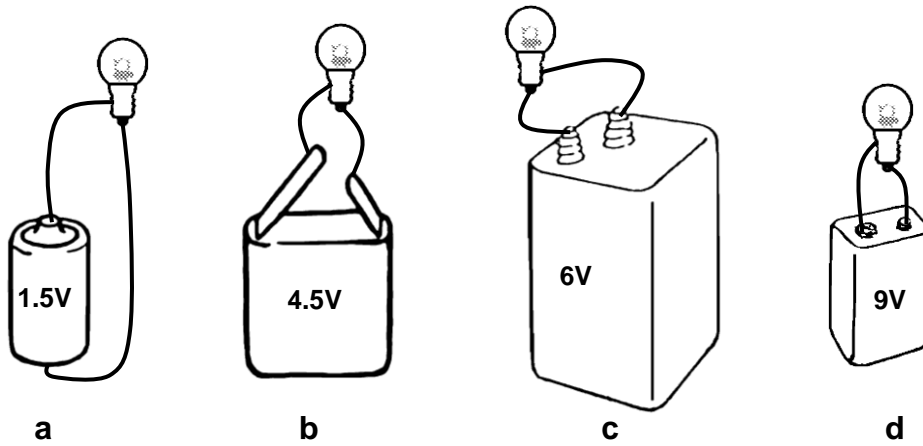
These questions probe pupils' understanding of the behaviour of simple electric circuits. Most are about series circuits, and check that pupils understand the relationships between the battery voltage and the current, and between the resistance in the circuit and the current. We have found Q5 in this set poses particular problems for pupils – many of whom think that one ammeter reading will decrease but the other will stay the same. (This really goes back to their understanding of current as a 'conserved' quantity in a series circuit.)

Qs7-10 probe understanding of the effect of adding a resistor in series or parallel to one already present. We have found that very few pupils can answer correctly about the parallel combinations; they seem not to 'see' this as providing an additional route for current, thus making the resistance less (and the current from the battery bigger). This is a point worth drawing attention to in teaching – having a 'picture' in your mind of what is going on is likely to be more useful than trying to remember the 'rules'!

These questions are taken from a larger bank of diagnostic questions and tasks developed by the *Evidence-based Practice in Science Education (EPSE) Research Network*. The EPSE network was funded between 1999 and 2003 by the UK Economic and Social Research Council (ESRC) as part of the *Teaching and Learning Research Programme (TLRP)*.

1

Four different batteries are used to light a bulb. All the bulbs are identical.



(a) Which battery lights the bulb brightest?

Tick ONE box (✓)

- Battery a
- Battery b
- Battery c
- Battery d
- All the bulbs will be the same brightness.

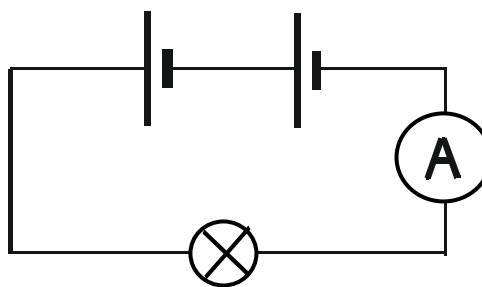
(b) How would you explain this?

Tick ONE box (✓)

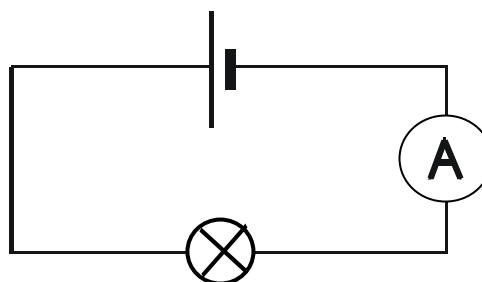
- It is the biggest battery, so it contains most electricity.
- It has the largest voltage, so it pushes the biggest current round.
- It is a torch battery, which is designed for lighting bulbs.
- It is a bicycle lamp battery, which is designed to give a bright light.
- The bulbs are identical, so they light equally brightly.

2

Two batteries are connected to a bulb.  
The bulb is lit.  
There is a reading on the ammeter.



One of the batteries is then removed.



(a) What happens to the reading on the ammeter?

Tick ONE box (✓)

- It gets bigger.
- It stays the same.
- It gets less, but not zero.
- It drops to zero.

(b) Which of the following is the best explanation for this?

Tick ONE box (✓)

- One battery exerts a smaller 'push' on the electric charges.
- The bulb always needs the same amount of current to make it light.
- The resistance in the circuit is less.

How confident are you that your answers to this question are correct? Tick ONE box (✓)

Very confident

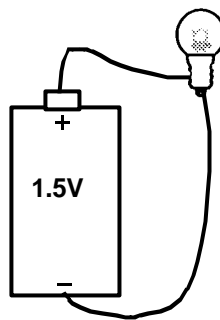
Fairly confident

Not confident

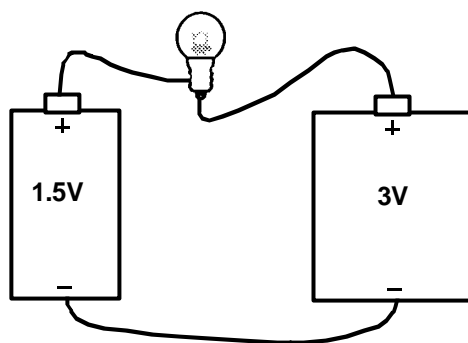
Just guessing

3

This bulb lights when it is connected to a 1.5V battery.



Another 3V battery is then connected into the circuit, like this:



(a) What happens to the bulb now?

Tick ONE box (✓)

- It is lit – and brighter than before.
- It is lit – the same brightness as before
- It is lit – but a lot dimmer than before.
- It is not lit.

(b) How would you explain this?

Tick ONE box (✓)

- The two batteries together add to 4.5V.
- The two batteries together add to 1.5V.
- Current cannot pass through a battery in the wrong direction.
- The bulb is connected to the positive terminal of both batteries, so there is no current through it.

How confident are you that your answers to this question are correct? Tick ONE box (✓)

Very confident

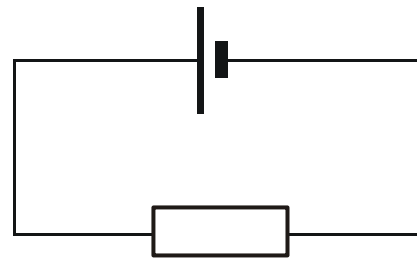
Fairly confident

Not confident

Just guessing

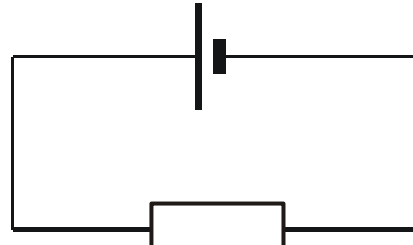
4

The resistor in this circuit,  $R_1$ , has a small resistance.



$R_1$  - small resistance

It is replaced by  $R_2$ , which has a large resistance.



$R_2$  - large resistance

(a) What happens to the current in the circuit?

Tick ONE box (✓)

- It gets bigger.
- It stays the same.
- It gets less, but not zero.
- It drops to zero.

(b) How would you explain this?

Tick ONE box (✓)

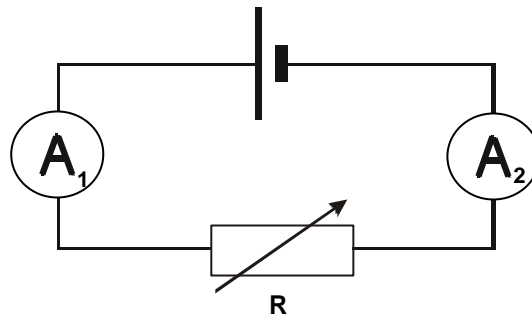
- The battery is not strong enough to push any current through a larger resistor.
- The battery cannot push as big a current through a larger resistor.
- A large resistance needs more current than a small resistance.
- It is the same battery, so it supplies the same current.

How confident are you that your answers to this question are correct? Tick ONE box (✓)

Very confident  Fairly confident  Not confident  Just guessing

5

This circuit consists of two ammeters and a variable resistor, R. There is a reading on both ammeters.



The resistance of R is **increased**.

(a) What happens to the reading on ammeter  $A_1$ ?

(b) What happens to the reading on ammeter  $A_2$ ?

Tick ONE box (✓)

Tick ONE box (✓)

It gets bigger.

It gets bigger.

It stays the same.

It stays the same.

It gets smaller.

It gets smaller.

(c) How would you explain this?

Tick ONE box (✓)

A large resistance needs more current than a small resistance.

It is the same battery, so it supplies the same current.

Increasing the resistance makes the current smaller everywhere in the circuit.

Increasing the resistance makes the current smaller after the resistor. It has no effect on the current before it.

Increasing the resistance makes the current smaller after the resistor. So the current before it gets bigger.

How confident are you that your answers to this question are correct? Tick ONE box (✓)

Very confident

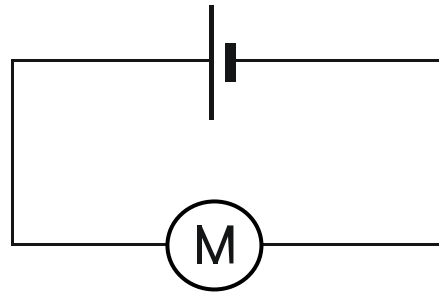
Fairly confident

Not confident

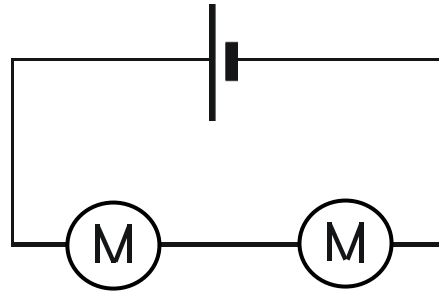
Just guessing

6

This circuit consists of a battery and a motor.  
The motor is running.



A second identical motor is added.



(a) What happens to the current in the circuit?

Tick ONE box (✓)

- It gets bigger.
- It stays the same.
- It gets less, but not zero.
- It drops to zero.

(b) How would you explain this?

Tick ONE box (✓)

- The battery is not strong enough to push any current through two motors.
- The battery cannot push as big a current through two motors.
- It is the same battery, so it supplies the same current.
- Two motors need more current than one on its own.
- The current is shared between the two motors, so each gets half.

How confident are you that your answers to this question are correct? Tick ONE box (✓)

Very confident

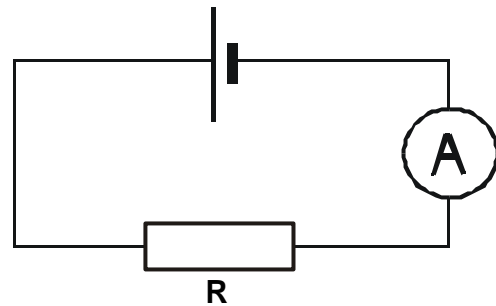
Fairly confident

Not confident

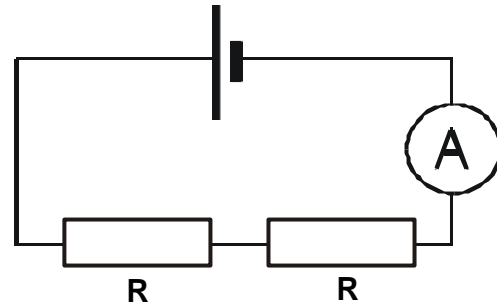
Just guessing

7

Sam makes this circuit.  
There is a reading on the ammeter.



He then adds a second identical resistor.



(a) What happens to the reading on the ammeter?

Tick ONE box (✓)

- It gets bigger.
- It stays the same.
- It gets less, but not zero.
- It drops to zero.

(b) How would you explain this?

Tick ONE box (✓)

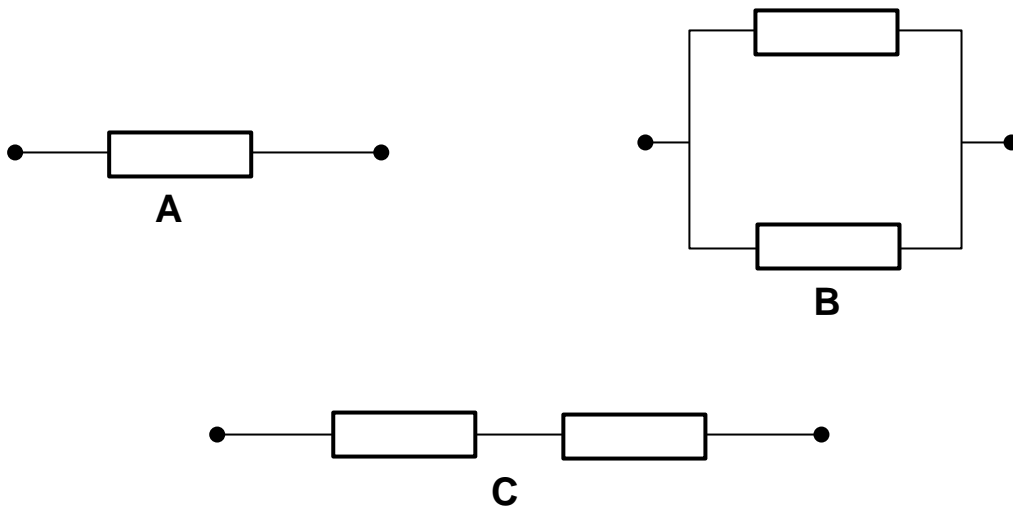
- The battery is not strong enough to push any current through two resistors.
- The battery cannot push as big a current through two resistors.
- It is the same battery, so it supplies the same current.
- Two resistors need more current than one on its own.
- The current is shared between the two resistors, so each gets half.

How confident are you that your answers to this question are correct? Tick ONE box (✓)

Very confident  Fairly confident  Not confident  Just guessing



All the resistors in the diagrams below are identical.



(a) How does the resistance of combination B compare with the resistance of A?

Tick ONE box (✓)

- The resistance of B is bigger than A.
- The resistances of A and B are the same size.
- The resistance of B is smaller than A.

(b) How does the resistance of combination C compare with the resistance of A?

Tick ONE box (✓)

- The resistance of C is bigger than A.
- The resistances of A and C are the same size.
- The resistance of C is smaller than A.

How confident are you that your answers to this question are correct? Tick ONE box (✓)

Very confident

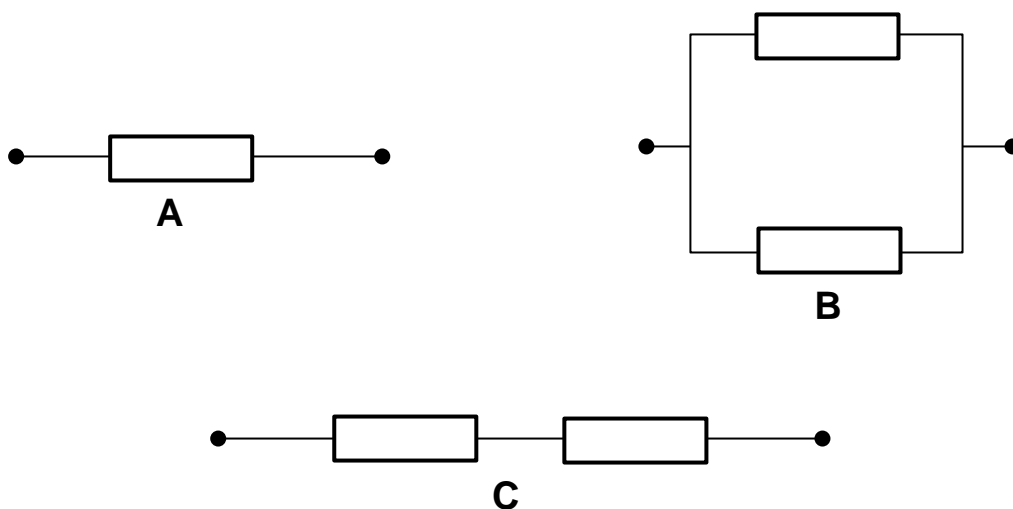
Fairly confident

Not confident

Just guessing

9

All the resistors in the diagrams below are identical.



Put these groups of resistors in order, from the one with the largest total resistance to the one with the smallest total resistance.

Write your answer in the table below:

Resistance	Code letter
Largest	
↓	
Smallest	

How confident are you that your answer to this question is correct? Tick ONE box (✓)

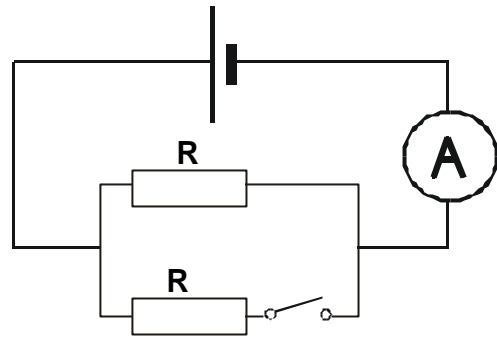
Very confident

Fairly confident

Not confident

Just guessing

The two resistors in this circuit are identical.  
The switch is open.  
There is a reading on the ammeter.



The switch is then **closed**.

(a) What happens to the reading on the ammeter?

Tick *ONE* box (✓)

- It gets bigger.
- It stays the same.
- It gets smaller.

(b) How would you explain this?

Tick *TWO* boxes (✓) below—one from each group

The total resistance is now bigger.

The total resistance stays the same.

The total resistance is now smaller.

The battery cannot push as big a current round the circuit.

The second resistor provides an extra path for current to flow.

It is the same battery, so it always supplies the same current.

How confident are you that your answers to this question are correct? Tick *ONE* box (✓)

Very confident  Fairly confident  Not confident  Just guessing