



## Series and Parallel Circuits

### Instructions and answers for teachers

These instructions should accompany the OCR resource 'Series and Parallel Circuits' activity which supports OCR GCSE (9–1) Twenty First Century Physics B.



#### The Activity:

The checkpoint activity is a selection of activities designed to check the key areas from Key Stage 3 before moving forward to Key Stage 4. The activities can be done individually or together.



This activity offers an opportunity for English skills development.

#### Associated materials

'Series and Parallel Circuits' Checkpoint Task learner activity Sheet



This resource is an exemplar of the types of materials that will be provided to assist in the teaching of the new qualifications being developed for first teaching in 2016. It can be used to teach existing qualifications but may be updated in the future to reflect changes in the new qualifications. Please check the OCR website for updates and additional resources being released. We would welcome your feedback so please get in touch.





## Task Instructions

The activity consists of a series of four questions on current and potential difference in series and parallel circuits, and on the necessity for complete circuits. The first question is intended to diagnose student understanding of the importance of complete circuits and the effect of short circuiting. All but the very weakest students should be able to deal with this question easily.

The second question is aimed at giving students a chance to show their knowledge and understanding of the effects of the number of cells and bulbs on the potential difference at various points around series circuits. The main ideas that students will need to use are that more cells gives a greater total potential difference and that the potential difference is used up over the various resistances in the circuit.

The third question is similar to the second, except that it concentrates on the effect of cells and resistance on the current around the circuit. In this case, both series and parallel circuits are considered and the effect of short circuiting some of the components is also considered. The main ideas which students will need to use are that current is divided at a junction in a circuit but stays the same in any closed loop and that any short circuited component can be discounted, as there is a lower resistance route for the current.

The final question uses the idea of a two way switch to be able to turn on a light from the front or back door of a house to diagnose student understanding of complete circuits in a more everyday setting.

The activity can be used as a test before teaching the topics at KS4, in which case the teacher should be able to identify any difficulties the students have and correct these before moving on. It could also be used as a focus for discussion in an introductory lesson to the KS4 work; students might be asked to discuss the work in groups and develop clear reasons for their answers before feeding back to the class or to each other on their answers and reasons. In the latter case the teacher will need to attend carefully to the groups so that any difficulties can be identified and dealt with before moving on.

For less able students the circuits could actually be made and this will give a more kinaesthetic and concrete aspect to the work. For more able students, the questions could be used as a starter for a lesson at the beginning of the work on circuits, just to remind students of their previous work.



1 a) In the circuit shown below, what happens if:

i) only switch A is closed?

Bulbs X and Z both light up. With switch A closed there is one complete circuit and this includes bulbs X and Z.

ii) only switch B is closed?

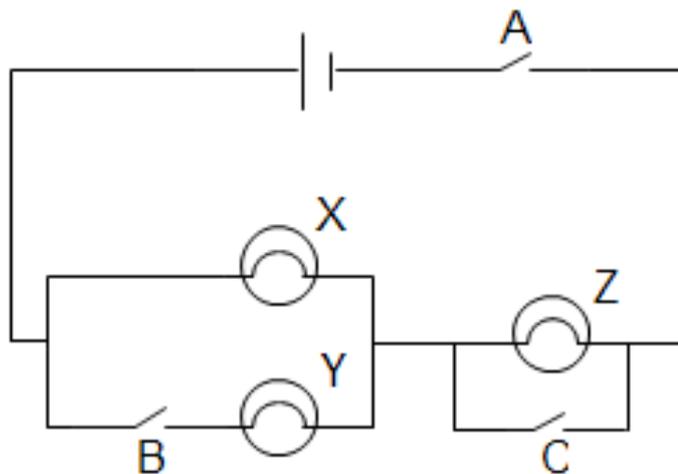
Nothing lights up. With only switch B closed there is no complete circuit and so no current can flow.

iii) both A and C are closed?

X lights up. With switches A and C closed there is a complete circuit; all of the current must pass through bulb X but it has a 'choice' to go through bulb Z or through switch C; since the latter has a much lower resistance, the current will pass through C rather than the bulb Z and so Z will not light up.

iv) all of the switches are closed?

X and Y light up. There is a complete circuit but with switch B closed half of the current will flow through bulb X and half through bulb Y (as they have equal resistance) and, as in part (iii) the current will flow through C rather than bulb Z.



b) In the circuit shown below, what happens if:

i) only switch A is closed?

X, Y and Z all light up. There is a single complete circuit and so the current must pass through all three bulbs.

ii) only switch B is closed?

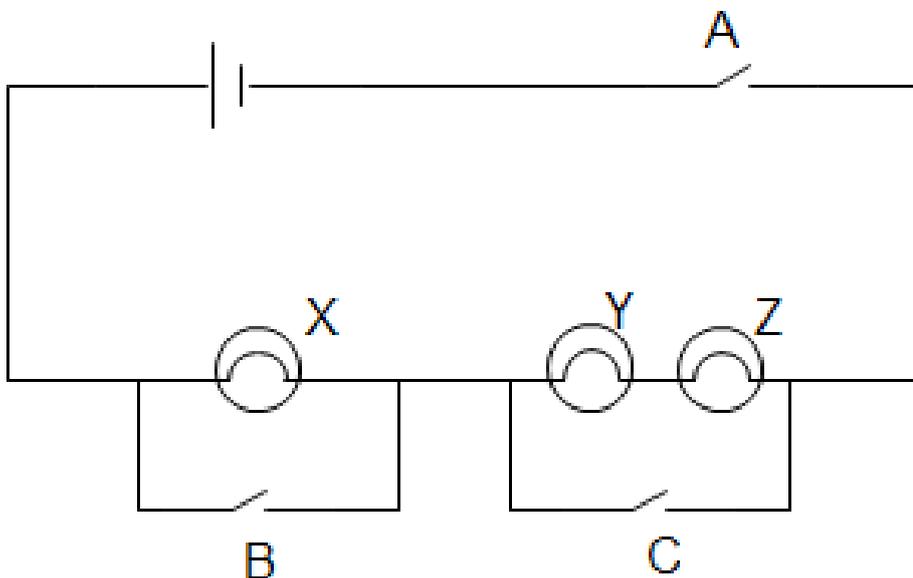
Nothing lights up. There is no complete circuit and so no current can flow.

iii) both switches A and C are closed?

Y and Z light up. There is a complete circuit but the current has a 'choice' between passing through bulb X (high resistance) or switch B (low resistance) and most will flow through B, meaning X is not lit up. All of the current must flow through bulbs Y and Z.

iv) all of the switches are closed?

Nothing lights up. There is a complete circuit and a current will flow but it has a low resistance route through switches B and C and so little will flow through the bulbs, hence they will not light.



c) In the circuit shown below, what happens if:

i) only switch A is closed?

Nothing lights up. There is no complete circuit and so no current flows.

ii) only switch B is closed?

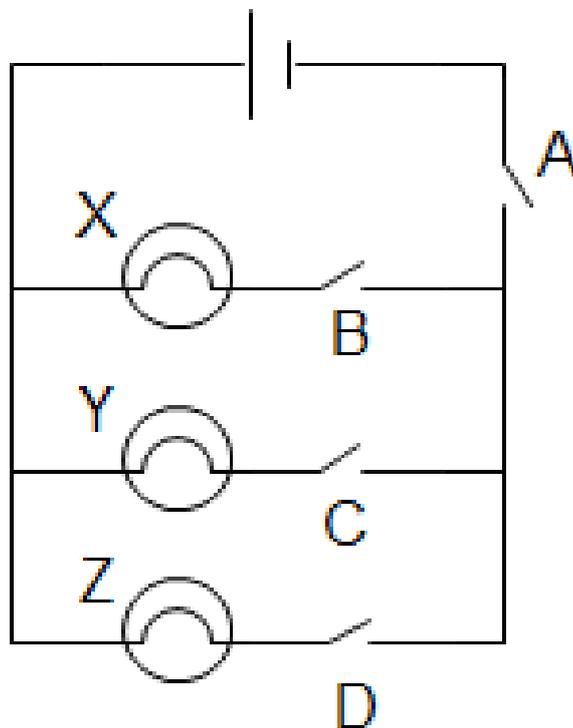
Nothing lights up. There is again no complete circuit and so no current can flow.

iii) both switches A, B and C are closed?

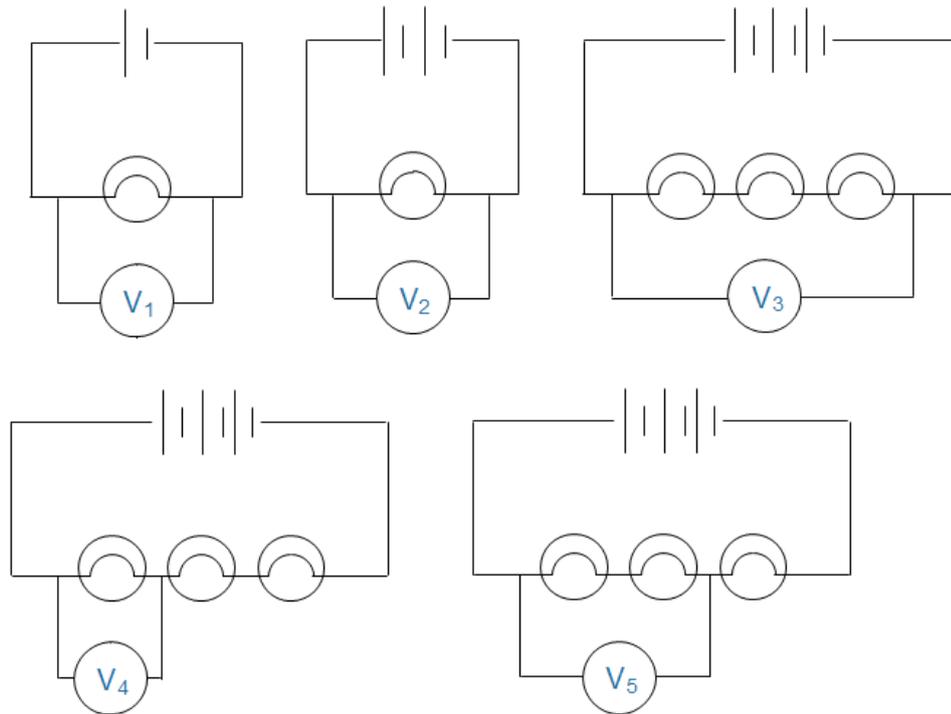
X and Y light up. There are two complete circuits, allowing current to flow through bulb X and switch B and bulb Y and switch C; as these have equal resistance, equal current will flow in each.

iv) all of the switches are closed?

X, Y and Z all light up. This time there are three equal resistance circuits and so all the bulbs will light.



2. In these 5 circuits, all the bulbs are the same, and all the cells are the same:



a) Which voltmeter will have the highest reading? Why do you think this is?

$V_3$  – we are measuring the ‘voltage’ across three cells; you may want to emphasise that each bulb has the same potential difference across it as  $V_1$ , but that collectively the bulbs have three times this potential difference, to more able students.

b) Which circuit will have the biggest current flowing? Can you explain why?

The second circuit will have the largest current as it has the largest ‘voltage’ per bulb; in this circuit there are two cells to one bulb, in all the others there is one cell per bulb.

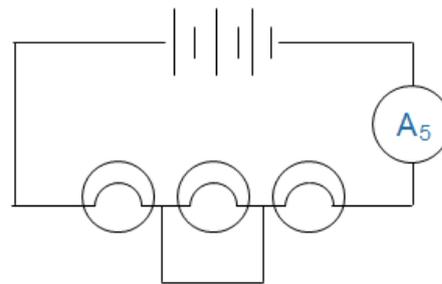
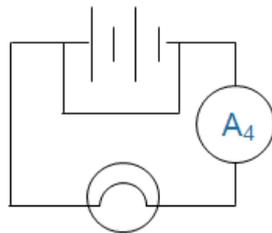
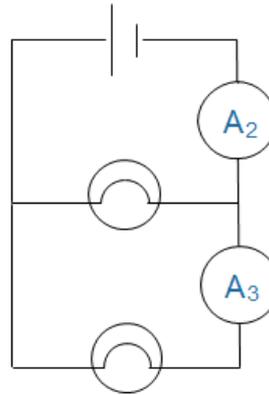
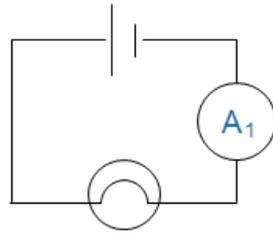
c) Starting with the highest, write down the voltmeter readings in order.

$V_3$ ,  $V_2$  and  $V_5$ ,  $V_1$  and  $V_4$ .  $V_3$  was explained in part (a);  $V_2$  has two cells to one bulb and  $V_5$  has one cell per bulb but there are two bulbs, so twice the ‘voltage’;  $V_1$  and  $V_4$  have one cell per bulb and measure the ‘voltage’ across one bulb.

d) Will the bulb with  $V_2$  across it be brighter than the bulb with  $V_5$  across it?

The bulb with  $V_2$  across it will be brighter than the bulb with  $V_5$  across it, as the voltage for each bulb is twice as much in this circuit; there is twice as much energy for the bulb in  $V_2$  than for the bulbs in  $V_5$ .

3. In these 4 circuits, all the bulbs are the same, and all the cells are the same:



a) What is the reading on ammeter  $A_4$ ?

The reading on  $A_4$  will be (very nearly) zero. There are two complete circuits, one through the bulb and one through the short circuit; as the latter has a much lower resistance, very little current will flow through the bulb.

b) In which circuit will the bulb(s) be brightest?

The bulbs will be brightest in the last circuit ( $A_5$ ). Due to the low resistance route around the middle bulb, each bulb has the 'voltage' from one and a half cells; in  $A_1$  it is one cell per bulb, in  $A_2/A_3$  there is one cell's 'voltage' per bulb but the energy has to be shared;  $A_4$  was dealt with in part (a).

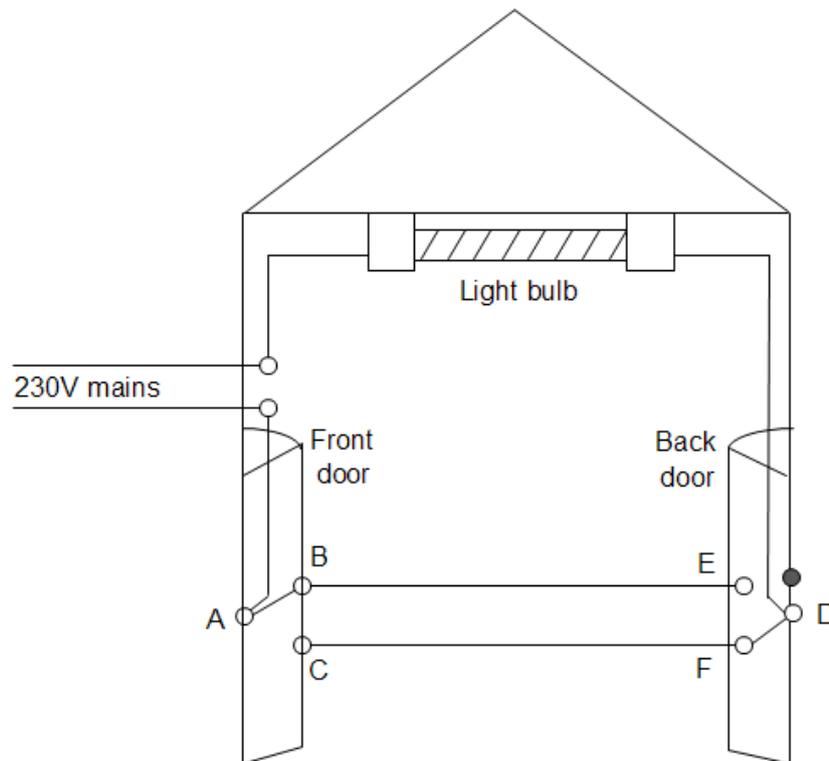
c) Which ammeter has the highest reading? Can you explain why?

$A_2$ . The combined resistance of the two bulbs in parallel will be less than either bulb and so a larger current can flow in the common part of the circuit.

d) Starting with the highest, write down the ammeter readings in order.

$A_2, A_5, A_1, A_3, A_4$

4. The diagram below shows a house with a circuit using 2-way switches. Point A can be connected to either point B or point C. This circuit is being used to turn the light on at either the front door of the house or the back door.



- a) How can you turn the light on?

Move the switch at the front door from B to C OR move the switch at the back door from F to E. Both of these will make a complete circuit and the light will come on.

- b) Explain how the circuit works. You can use letters from the diagram to help you.

In the diagram, there are two breaks in the circuit, one between A and C and the other between D and E. When either switch is moved, the circuit is made complete and the light will come on. We can break the circuit again, and so turn the light off, by moving either switch to the open position.

- c) Why is this a good circuit to use for this job?

The circuit can be switched on and off at two points and so we do not have to cross the room in the dark to switch the light on if we come in through the wrong door. The circuit is also simple to make, requiring only two switches and some extra wire.



# GCSE (9–1) Twenty First Century Physics B

## KS3 – KS4 Transition Guide

### Checkpoint Task

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