Name	Date started	Target end date

GCE AS / A LEVEL — KIRCHHOFF & SERIES/PARALLEL QUESTION PACK

Legacy PH1 · New spec Unit 2 Topic 3a · AS unit, 20% of A-level

REVISE
.wales

PHYSICS — UNIT 2 · KIRCHHOFF & SERIES/PARALLEL

PH2.3 D.C. Circuits — Kirchhoff's laws & resistor networks

Applying Kirchhoff's first (current) and second (voltage) laws to multi-loop circuits, and solving series and parallel networks with mixed resistors and ammeters / voltmeters.

NEW 2015 SPEC · UNIT 2 TOPIC 3A

Estimated time for entire question pack: ~1 h 14 min

Derived from the legacy PH1 paper's pace of 80 marks in 1¼ hours.

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive practice question pack**, not a single mock paper. It contains every question from the legacy WJEC PH1 papers (2008 modular spec) that maps onto new-spec Unit 2 Topic 3a (2.3).

Questions are ordered chronologically within each section.

INSTRUCTIONS

Use black ink or black ball-point pen. Answer all questions in the spaces provided.

The number of marks is given in brackets at the end of each question or part-question. A calculator is required. The Data Booklet is allowed.

For Examiner's use only

Q	Source	Max	Mark
1	PH1 Jun 14 Q4	14	
2	PH1 Jun 15 Q2	11	
3	PH1 Jan 11 Q1	12	
4	PH1 Jun 13 Q2	16	
	Total	**53**	

Kirchhoff & Series/Parallel — what the new spec asks

WJEC GCE AS / A Level Physics (from 2015) · Unit 2: Electricity & Light · Topic 2.3.

Kirchhoff's laws A

- First law: $\Sigma I_{in} = \Sigma I_{out}$ at any junction (charge conservation).
- Second law: $\Sigma \varepsilon = \Sigma IR$ around any closed loop (energy conservation).
- Apply both laws to multi-loop circuits with mixed elements.

Series & parallel A

- Combine resistors using $R_s = R_1 + R_2$ and $1/R_p = 1/R_1 + 1/R_2$.
- Reasoning about how p.d. and current redistribute under load changes.

Meters A

- Ammeter in series, low resistance; voltmeter in parallel, high resistance.
- Effect of non-ideal meters on a circuit.

Kirchhoff & Series/Parallel in one page

Quick-reference notes — revisit before each section.

KCL

$\Sigma I_{in} = \Sigma I_{out}$ at any node.

From conservation of charge.

KVL

$\Sigma\varepsilon = \Sigma IR$ around any closed loop.

From conservation of energy per unit charge.

Sign conventions

Choose a loop direction (clockwise).

$+\varepsilon$ if traversed - to +; $-IR$ if traversed in current direction.

Series

$R_{tot} = R_1 + R_2 + \ldots$

$V_{tot} = V_1 + V_2 + \ldots$

Parallel

$1/R_{tot} = 1/R_1 + 1/R_2 + \ldots$

I splits inversely with R.

Strategy

1. Pick mesh currents.
2. Apply KVL to each loop.
3. Solve simultaneous equations.

Section index

Use this index to jump straight to the section you need.

End of cover material.

Examiner only

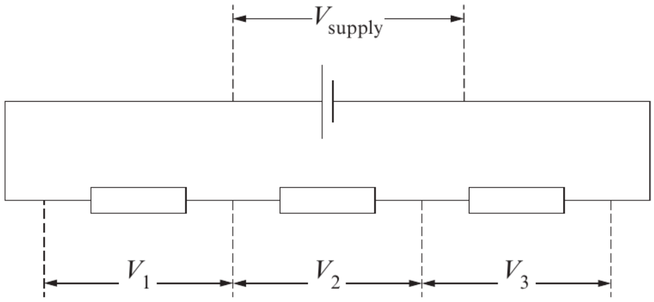
4. *(a)* Define the *potential difference* between two points in an electric circuit. [2]

....

....

....

(b) Three resistors are connected as shown.



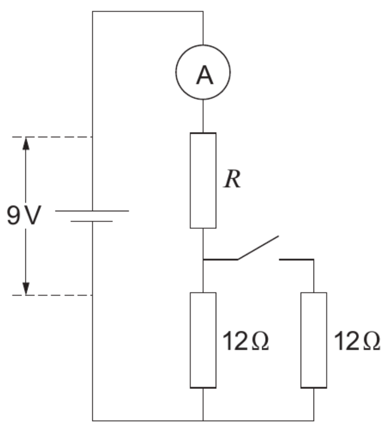
(i) Complete the equation that relates **all** of the potential differences in the circuit: [1]

V_{supply} = ...

(ii) The equation you wrote down in *(b)*(i) is an example of which conservation law? [1]

....

(c)



(i) In the circuit shown, with the **switch open**, the ammeter reads 0.5 A. Show that $R = 6\,\Omega$. [2]

....

....

....

(ii) The switch is now **closed**.

(I) Calculate the (new) potential difference across R. [2]

....

....

....

(II) Calculate the (new) current through the ammeter. [2]

....

....

(III) More 12 Ω resistors can be connected in parallel with the 12 Ω resistors. Determine the **total** number of 12 Ω resistors needed for the current through the ammeter to be 1.2 A. [4]

....

....

....

....

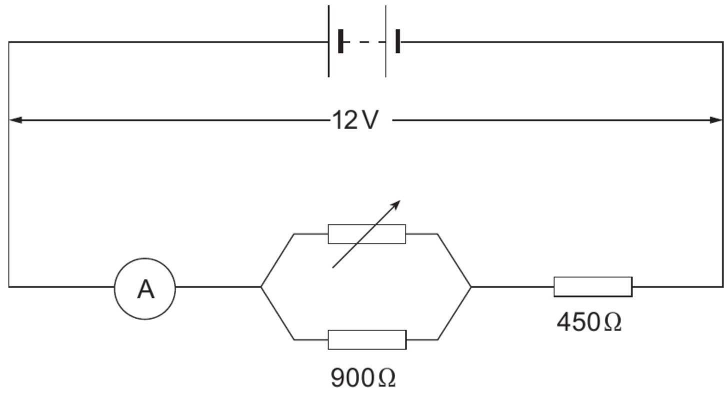
....

2. *(a)* The unit of electrical resistance is the ohm (Ω). Two of the following are correct alternative units to the ohm. **Circle the correct two.** [2]

VA^{-1} **$V^{-1}A$** **WA^{-2}** **Cs^{-1}**

Space for working if needed.

(b) The circuit shows a variable resistor connected to two fixed resistors, an ammeter and a battery of emf 12V. The battery has negligible internal resistance.



The variable resistor is adjusted so that the ammeter reads 0.01A.

(i) Calculate the potential difference across the 450Ω resistor. [1]

....

....

(ii) Calculate the potential difference across the 900Ω resistor. [1]

....

....

(iii) Calculate the resistance of the parallel combination of the 900Ω resistor and the variable resistor. [2]

....

....

....

Examiner only

(iv) Calculate the resistance of the variable resistor. [2]

(c) The variable resistor is adjusted so that its resistance decreases. Explain in clear steps what happens to the potential difference across the 900 Ω resistor. [3]

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Examiner only

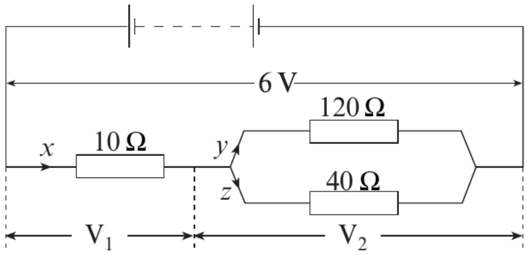
1. *(a)* (i) Using the idea of electric charge explain what is meant by *the electric current* in a conductor. [1]

....

(ii) The unit of electric current is the ampère (A). One of the following is a correct alternative unit to the ampère. Circle the correct one. [1]

$J\,C^{-1}$ $C\,s^{-1}$ $J\,s^{-1}$ $V\,A^{-1}$

(b)



(i) Write down the relationship between the currents x, y and z in the circuit. [1]

....

(ii) The relationship you wrote down in *(b)*(i) is a consequence of which conservation law? [1]

....

(c) Calculate

(i) the resistance of the combination of the three resistors, [3]

....

....

....

....

(ii) the current x, [1]

....

....

Examiner only

(iii) the potential differences, V_1 and V_2, [2]

....

....

....

(iv) the currents y and z. [2]

....

....

....

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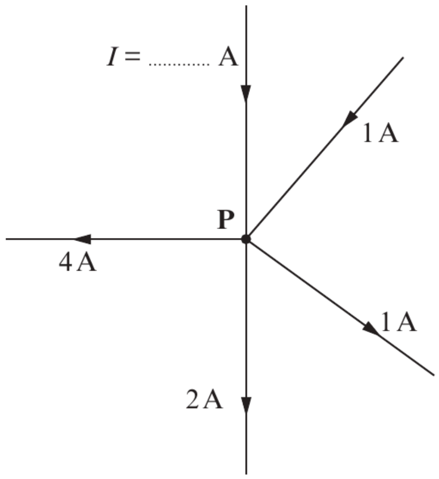
2. *(a)* When a quantity of charge flows into a junction in a circuit, an equal quantity must flow out again. In this way the flow of charge is conserved in any circuit.

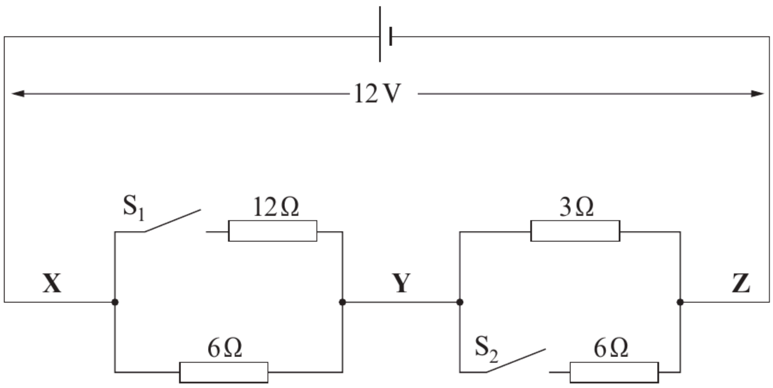
(i) What name is given to the rate of flow of charge? [1]

....

(ii) Apply the above conservation law to the junction at **P** to determine the value of I. [1]



(b) Resistors are connected as shown in the diagram, and a pd of 12 V is applied across them. S_1 and S_2 are switches.



(i) Calculate the resistance of the circuit when both S_1 and S_2 are closed. [3]

....

....

....

....

Examiner only

(ii) Hence determine the pd between **X** and **Y** and also the pd between **Y** and **Z** when both switches are closed. [2]

(iii) How would your answers to *(b)*(ii) differ (if at all) with both switches open? Explain your answer. [2]

(iv) Determine the switch settings that would allow a current of 1.5 A to flow through the cell. [2]

(v) Determine the power developed in the circuit when both switches are open. [2]

(vi) Determine the switch settings that allow the maximum power to be developed in the circuit. Justify your answer. [3]

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END OF QUESTION PACK

4 questions · 53 marks · ~1 h 14 min

Source: WJEC PH1 (2008 modular spec)

Curated for WJEC Physics 2015 spec AS Unit 2 — Topic 3a (2.3)