Name	Date started	Target end date

GCE AS / A LEVEL — RESISTIVITY QUESTION PACK

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

REVISE
.wales

PHYSICS — UNIT 2 · RESISTIVITY

PH2.2 Resistance — resistivity & R = ρL/A

Defining resistivity, applying R = ρL/A to wires and rods, and analysing practical experiments to determine the resistivity of a metal.

NEW 2015 SPEC · UNIT 2 TOPIC 2B

Estimated time for entire question pack: ~1 h 25 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 2b (2.2).

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
6	PH1 Jan 12 Q1	10	
7	PH1 Jun 11 Q5	11	
8	PH1 Jun 12 Q6	10	
9	PH1 Jun 13 Q4	10	
10	PH1 Jan 10 Q5	10	
11	PH1 Jan 14 Q5	10	
Total		**61**	

Resistivity — what the new spec asks

WJEC GCE AS / A Level Physics (from 2015) · Unit 2: Electricity & Light · Topic 2.2.

Resistivity A

- Define resistivity ρ via R = ρL/A.
- Units Ω m; orders of magnitude for metals, semiconductors and insulators.

Geometry effects A

- Effect of doubling L or A on R.
- Reasoning about uniform-cross-section wires versus tapered conductors.

Measurement A

- Use of micrometer / vernier for diameter, ruler for L.
- Plot R against L and extract ρ from the gradient.
- Estimating uncertainty in a resistivity experiment.

Crib sheet »

Resistivity in one page

Quick-reference notes — revisit before each section.

Definition

ρ is a property of the material; units Ω m.

Copper: ρ ~ 1.7×10^{-8} Ω m.

Geometry

Double L ⇒ double R.

Double A (or radius squared) ⇒ halve R.

Measuring

Use ohmmeter or V-I method for R.

Length with ruler; diameter with micrometer.

$A = \pi(d/2)^2$.

Plotting

Gradient = ρ/A.

Intercept ideally 0 — non-zero hints at contact resistance.

Uncertainty

d enters as d^2, so % error doubles.

Take several diameter readings around the wire.

Strategy

1. List R, L, A (convert $mm^2 \Rightarrow m^2$).
2. Solve ρ = RA/L.
3. Check the order of magnitude (~10^{-8} for metals).

Section index

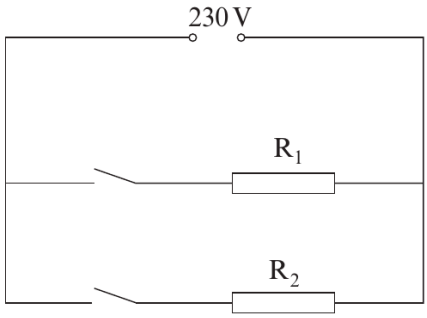
Use this index to jump straight to the section you need.

Examiner only

1. *(a)* (i) State Ohm's law. [2]

(ii) What can be said about the resistance of a conductor that obeys Ohm's law? [1]

(b) The heating circuit of a hairdryer consists of two heating elements R_1 and R_2 connected in parallel as shown. The elements are made from wire of the same material of resistivity $95 \times 10^{-8}\,\Omega$m and diameter 1.4×10^{-4}m.



(i) The length of wire used to make R_1 is 3.2 m. Show that the resistance of R_1 is approximately 200 Ω. [3]

(ii) Calculate the power output from the heating circuit with only R_1 switched on. [1]

(iii) With both elements switched on the **total resistance** is only a third of the resistance of R_1 on its own. Calculate the resistance of R_2. [3]

Examiner only

(iv) Explain which element, R_1 **or** R_2, would provide the greater power output from the heating circuit. [2]

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(v) Calculate the total current with both elements switched on. [1]

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Examiner only

5. *(a)* Starting from a relevant equation, show that the unit of resistivity is Ω m. [2]

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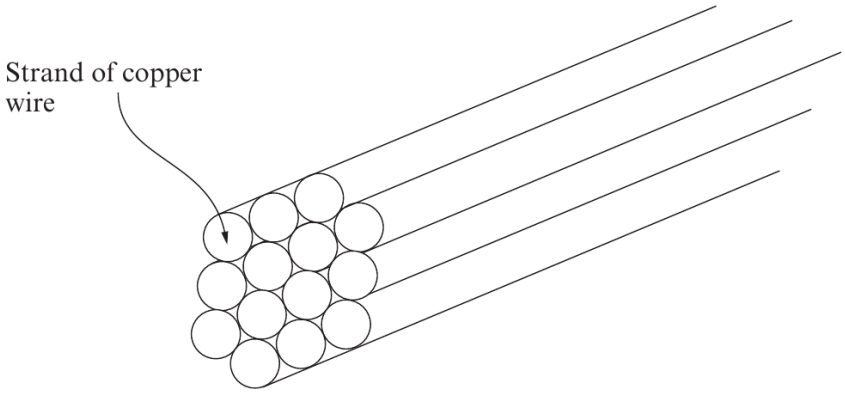
(b) A cable consists of 14 strands of copper wire, each of **diameter** 1.3 mm.



(i) Show that the cross-sectional area of **one** strand of the copper wire is approximately 1.3×10^{-6} m^2. [1]

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(ii) Hence calculate the resistance of one strand of length 20.0m. [1]
[Resistivity of copper = 1.7×10^{-8} Ω m].

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(iii) Determine the combined resistance of the 14 strand cable. [2]

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Examiner only

(iv) Showing your working clearly, calculate the ratio:

$$\frac{\text{Energy dissipated in one second in a } \textbf{single strand} \text{ carrying a current of 3.0 A}}{\text{Energy dissipated in one second in the } \textbf{whole cable} \text{ carrying a current of 3.0 A}} \quad [3]$$

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(v) Give an advantage of the 14 strand copper cable over

(I) a single strand copper cable of 1.3 mm diameter, [1]

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(II) a solid core cable of the same total cross-sectional area. [1]

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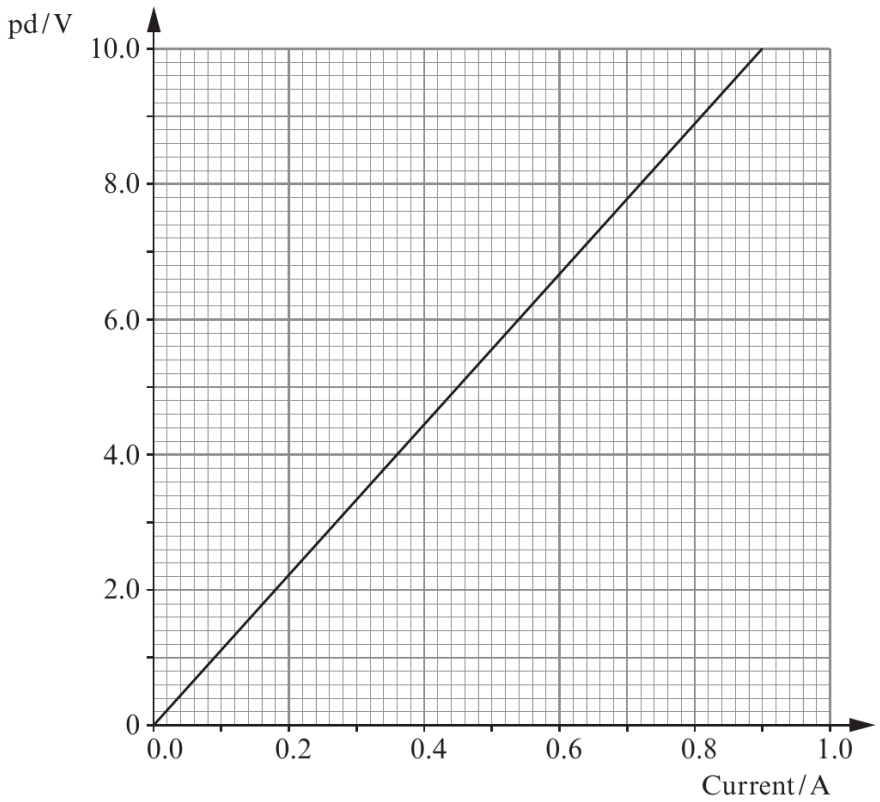
Examiner only

6. Experiments are carried out to determine the material from which a metal wire is made. Initially the resistivity of the metal is found. The wire's density is then determined and the results compared with known values of resistivity and density.

(a) As a first step to finding the resistivity, an experiment investigates the relationship between pd and current for the wire. The results are shown in the graph.



(i) Draw a circuit diagram to show how the above results could be obtained. The apparatus available includes a battery, a switch, a variable resistor, an ammeter and a voltmeter. [2]

Examiner only

(ii) The wire has length 3.2 m and **diameter** 0.20 mm. Use this information and the graph to calculate the resistivity of the material in the wire. [4]

(iii) Using the information in the table, write down **two** possible materials for the wire. [1]

Material	Resistivity / Ω m	Density / kg m^{-3}
Iron	0.97×10^{-7}	7 850
Platinum	1.06×10^{-7}	21 400
Tin	1.12×10^{-7}	7 300
Nichrome	1.10×10^{-6}	8 400

(b) The mass of the wire is found to be 0.74 grammes. Explaining how you obtain your answer, determine the material from which the wire is made. [3]

Examiner only

4. *(a)* (i) Draw a labelled diagram of the apparatus you could use to determine the relationship between the resistance and length of a metal wire. [3]

(ii) Sketch a graph to show the relationship you would expect to find. [1]

Examiner only

(iii) Describe how you would use your graph to find the resistivity of the metal. You should describe the **additional measurement** you need to make and how you would use it. [3]

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(b) A metal wire has resistance $\boldsymbol{R}$ and is in the form of a cylinder of length $\boldsymbol{l}$ and uniform cross-sectional area $\boldsymbol{A}$. The wire is now stretched to **three** times its original length in a process that keeps the volume constant. Show, in clear steps, that the resistance of the wire increases to $\mathbf{9}\boldsymbol{R}$. [3]

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Examiner only

5. *(a)* (i) Draw a labelled diagram of the apparatus you could use to determine the relationship between the resistance and length of a wire. [3]

(ii) State what measurements you need to make. [2]

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(iii) What further measurement would you need to make to determine the resistivity of the metal and what apparatus would you use to make this measurement? [1]

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(iv) Explain how a value of the resistivity is determined from your measurements. [3]

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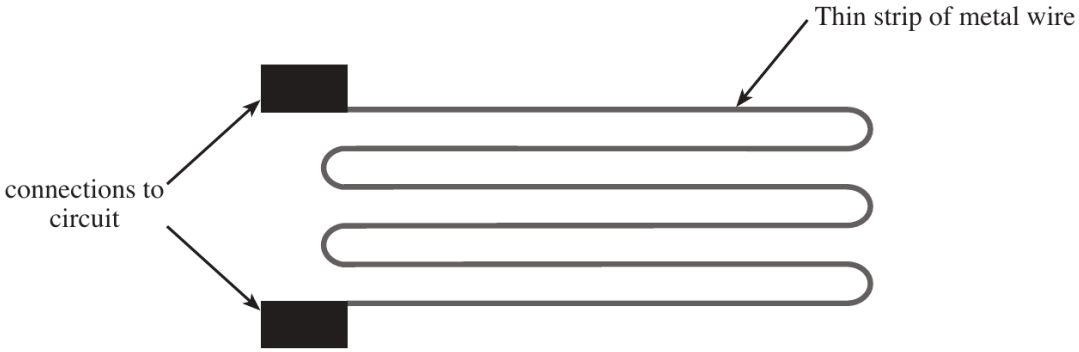
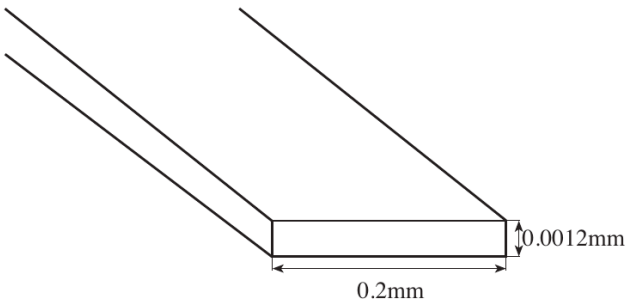
Examiner only

(b) A strain gauge is a device used to monitor distortions in structures such as bridges and buildings. It consists of a thin strip of metal wire as shown which is then attached to the structure under test.



(i) When the structure extends, the wire in the strain gauge gets **thinner** and **longer** thus changing its resistance. Using the resistivity equation explain whether the resistance of the strain gauge increases or decreases when the structure extends. [4]

(ii) Calculate the resistivity of the metal in a strain gauge which has a resistance of 650 Ω and a total length of 32 cm. The thin metal strip is 0.2 mm wide and 0.0012 mm thick as shown. [2]



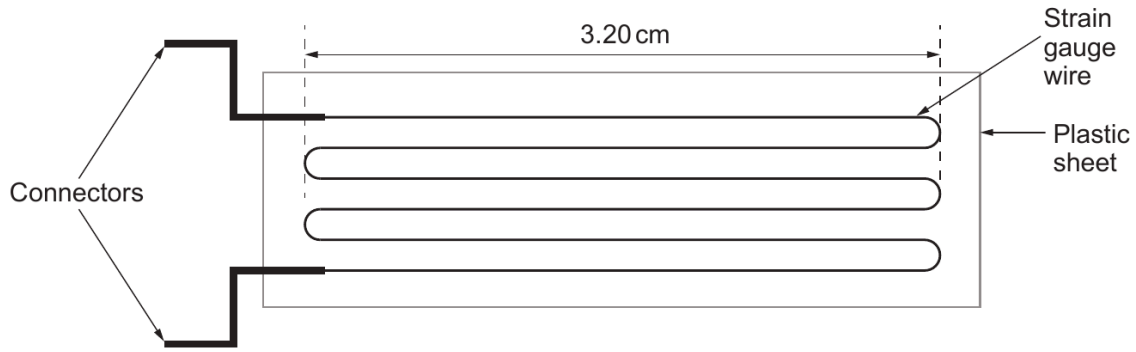
Thin metal strip (magnified - not to scale)

Examiner only

5. A resistance strain gauge is a device used to detect very small changes in structures such as buildings and bridges. It consists of a very fine wire glued onto a thin plastic sheet. The gauge is attached to the structure under test, so that when the structure deforms the wire is either stretched or compressed.

(a) If the wire is stretched it gets **longer** and **thinner**. Using an equation to justify your answer, explain the effect that stretching the wire has on its resistance. [3]

(b) The diagram shows a typical strain gauge. The wire is of circular cross-section and is arranged in a zig-zag pattern.



(i) Show that the resistance of the wire in the strain gauge is 56 Ω. Assume that its **diameter** is 1.75×10^{-5} m and its resistivity, $\rho = 7.0 \times 10^{-8}\,\Omega$m. [3]

Examiner only

(ii) Calculate the change in length needed to produce a 0.1% variation in resistance in the strain gauge opposite. For this calculation, **ignore changes in cross-sectional area.** [2]

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(iii) Suggest why it is beneficial for the wire to be arranged in a zig-zag pattern. [2]

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END OF QUESTION PACK

6 questions · 61 marks · ~1 h 25 min
Source: WJEC PH1 (2008 modular spec)
Curated for WJEC Physics 2015 spec AS Unit 2 — Topic 2b (2.2)