Name	Date started	Target end date

GCE AS / A LEVEL — RESISTANCE, TEMPERATURE & SUPERCONDUCTORS QUESTION PACK

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

REVISE
.wales

PHYSICS — UNIT 2 · RESISTANCE, TEMPERATURE & SUPERCONDUCTORS

PH2.2 Resistance — temperature dependence & superconductivity

How resistance of metals and semiconductors varies with temperature, including thermistors, light-dependent resistors and the resistivity collapse of a superconductor below T_C.

NEW 2015 SPEC · UNIT 2 TOPIC 2C

Estimated time for entire question pack: ~56 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 2c (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
12	PH1 Jan 12 Q2	10	
13	PH1 Jun 15 Q4	11	
14	PH1 Jun 09 Q4	6	
15	PH1 Jun 10 Q3	6	
16	PH1 Jun 12 Q2	7	
	Total	**40**	

Resistance, Temperature & Superconductors — what the new spec asks

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

Metals A

- Resistance increases approximately linearly with temperature for metals.
- Physical reason: increased lattice vibrations reduce mean free path.

Semiconductors & thermistors A

- Resistance decreases with temperature in intrinsic semiconductors.
- Negative-temperature-coefficient (NTC) thermistors and their I-V curves.

Superconductors A

- Below critical temperature T_c, resistance falls to zero.
- Type-I vs type-II behaviour; examples and applications.
- Importance of high-T_c superconductors.

Resistance, Temperature & Superconductors in one page

Quick-reference notes — revisit before each section.

Metals

Lattice ions vibrate more at high T ⇒ shorter mean free path ⇒ more collisions.

Approximately linear over normal lab range.

Semiconductors

Higher T ⇒ more electrons promoted across band gap.

NTC thermistor: classic negative temperature coefficient.

Superconductors

Below the critical temperature, $\rho = 0$.

Persistent currents; expulsion of magnetic flux (Meissner).

Applications

Loss-free power transmission (if economical at large scale).

Strong electromagnets for MRI, accelerators.

Plot shapes

Metal: roughly straight upward.

Semiconductor / thermistor: falling curve.

Superconductor: sharp drop to 0 at T_c.

Watch out for

NTC thermistor and superconductor are different effects.

Cooling a metal lowers R but never to zero (unless it goes superconducting).

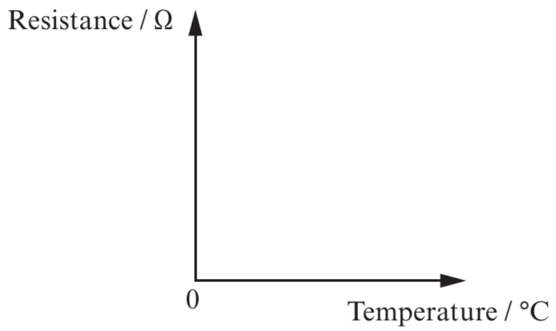
Questions begin overleaf.

Section index

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

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

(ii) Sketch, on the axis below, a graph of the results you would expect from the experiment. [2]



(b) (i) Explain in terms of particles how electrical resistance arises in metal conductors. [3]

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(ii) Hence suggest an explanation for your results to the experiment in part *(a)*. [2]

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4. *(a)* (i) Draw a labelled diagram of a suitable arrangement that would enable a student to investigate how the resistance of a metal wire changes between a temperature of **0 °C** and **100 °C**. [3]

(ii) Describe how the student would:

- obtain measurements of resistance across the full temperature range;
- ensure accurate results;
- analyse the data obtained. [5]

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(b) (i) A certain metal alloy has a *superconducting transition temperature* of –163 °C. Explain what is meant by the words in italics. [2]

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(ii) State how this alloy can be kept below its superconducting transition temperature. [1]

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4. (a) A student writes the following:

Superconducting wires do not become hot because electrons can flow through them without there being any transfer of energy.

Explain carefully, in terms of electrons, how energy is transferred in a normal conductor and why it does not occur in superconductors.

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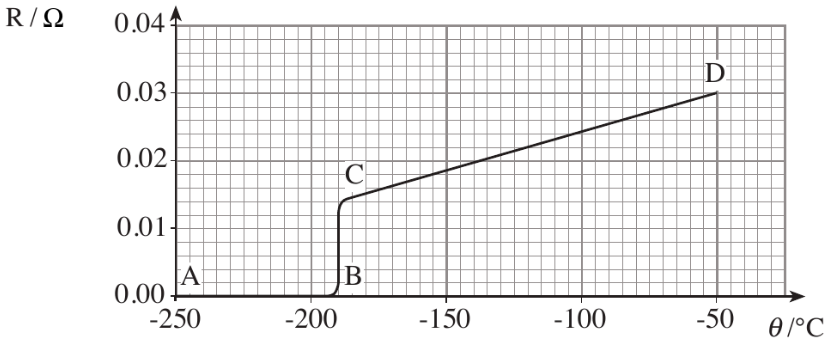
[3]

(b) The graph shows how the resistance, R, of a compound of europium varies with temperature, θ, for very low temperatures.



(i) Determine the superconducting transition temperature of the compound of europium.

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[1]

(ii) In what region of the graph would a potential difference of 0 V be required to maintain a current?

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[1]

(c) Certain 'high temperature superconductors' have transition temperatures which are above - 196 °C. State how these materials can be kept in their superconducting state.

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[1]

Examiner only

3. *(a)* What is a *superconductor*? [1]

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(b) With the aid of a sketch graph, explain the term *superconducting transition temperature.* [3]

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(c) Explain why superconductors are useful for applications which require large electric currents and name **one** such application. [2]

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2. *(a)* What is a *superconductor*? [1]

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(b) A metal conductor is placed in liquid helium. It is noted that at a certain temperature, as the metal cools, its resistance changes suddenly, dropping rapidly to zero.

(i) What name is given to the temperature at which this sudden change occurs? [1]

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(ii) Sketch a graph of resistance against temperature for the above conductor, labelling any key features of your graph. [2]

(iii) What potential difference would be needed to maintain a current in the conductor when it has been immersed in the liquid helium for some time? [1]

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(c) Conducting electrons in a superconductor do not cause a heating effect. Explain why conducting electrons **do** produce a heating effect in wires at room temperature. [2]

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END OF QUESTION PACK

5 questions · 40 marks · ~56 min

Source: WJEC PH1 (2008 modular spec)

Curated for WJEC Physics 2015 spec AS Unit 2 — Topic 2c (2.2)