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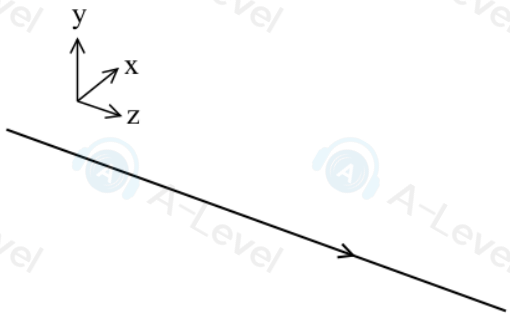
3 x, y and z are three perpendicular directions. A polarised light wave is travelling in the z direction.



Which of the following describes the direction of the oscillations of the polarised light wave?

☒ **A** They must be in the x direction.

☒ **B** They must be in a plane which is perpendicular to the x direction.

☒ **C** They must be in the z direction.

☒ **D** They must be in a plane which is perpendicular to the z direction.

(Total for Question 3 = 1 mark)

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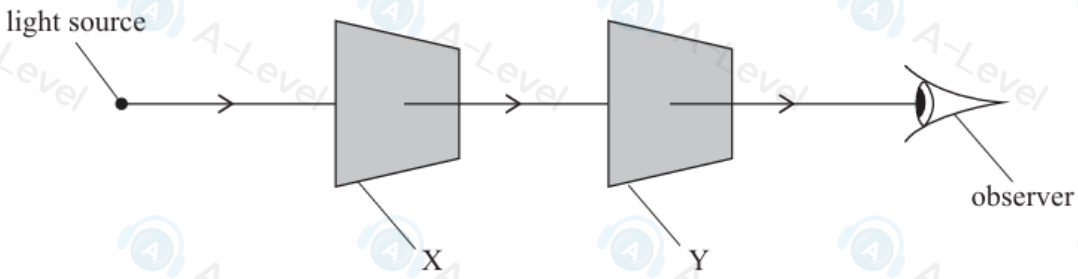
9 Two polarising filters, X and Y, are arranged between a light source and an observer, as shown.



The intensity of light reaching the observer is a maximum.

The observer rotates filter X. The observer then rotates filter Y so that the intensity of light is a maximum again.

Which row of the table shows possible angles of rotation for the filters?

	Header	Header
A	90°	180°
B	180°	270°
C	270°	90°
D	360°	270°

9 Two copper wires are placed in series in a complete circuit. The electrons in the two wires have different values of drift velocity.

Which of the following must be different for the two wires?

- ☒ **A** charge carrier density
- ☒ **B** cross-sectional area
- ☒ **C** current
- ☒ **D** length

(Total for Question 9 = 1 mark)

10 Two photographs, X and Y, were taken of the same car windscreen. Photograph Y was taken through a polarising filter.

Photograph X

Photograph Y

(Source: © Etan J. Tal)

Which row of the table is correct?

		Light transmitted through windscreen	Light reflected from windscreen
☒	**A**	plane polarised	plane polarised
☒	**B**	plane polarised	unpolarised
☒	**C**	unpolarised	plane polarised
☒	**D**	unpolarised	unpolarised

(Total for Question 10 = 1 mark)

2 A filament lamp is a source of unpolarised light.

A polarising filter is placed between a filament lamp and an observer. The filter is rotated in the plane perpendicular to the direction of travel of the light.

Which of the following is observed as the filter is rotated through an angle of 90°?

- ☒ **A** The light intensity changes from maximum to minimum.
- ☒ **B** The light intensity changes from minimum to maximum.
- ☒ **C** The light intensity does not change.
- ☒ **D** The light intensity is zero throughout the rotation.

(Total for Question 2 = 1 mark)

1 The equation $I = nqvA$ relates the current in a sample of a material to the movement of free charge carriers in the sample.

Which of the following is a correct definition of one of the terms in this equation?

A n represents the number of charge carriers in the sample

B q represents the total charge stored in the sample

C v represents the drift velocity of the charge carriers in the sample

D A represents the surface area of the sample

(Total for Question 1 = 1 mark)

3: Which of the following units is equivalent to the coulomb?

☒ **A** As^{-1}

☒ **B** JV^{-1}

☒ **C** WA^{-1}

☒ **D** WV^{-1}

(Total for Question 3 = 1 mark)

2 Which of the following describes the oscillations in polarised waves?

☒ **A** in a single plane which is perpendicular to the direction of wave travel

☒ **B** in many planes, which include the direction of wave travel

☒ **C** in many directions and parallel to the direction of wave travel

☒ **D** in one direction and perpendicular to the direction of wave travel

(Total for Question 2 = 1 mark)

5 The unit of resistance is the ohm.

Which of the following is equivalent to the ohm?

☒ **A** $JC^{-2}s$

☒ **B** $JC^{2}s^{-1}$

☒ **C** $JC^{-1}s^{-1}$

☒ **D** JCs

(Total for Question 5 = 1 mark)

2 Unpolarised light with a power of 8 W is incident on a polarising filter.

What is the power of the light after passing through the filter?

- ☒ **A** 8W
- ☒ **B** 4W
- ☒ **C** 2W
- ☒ **D** 0

(Total for Question 2 = 1 mark)

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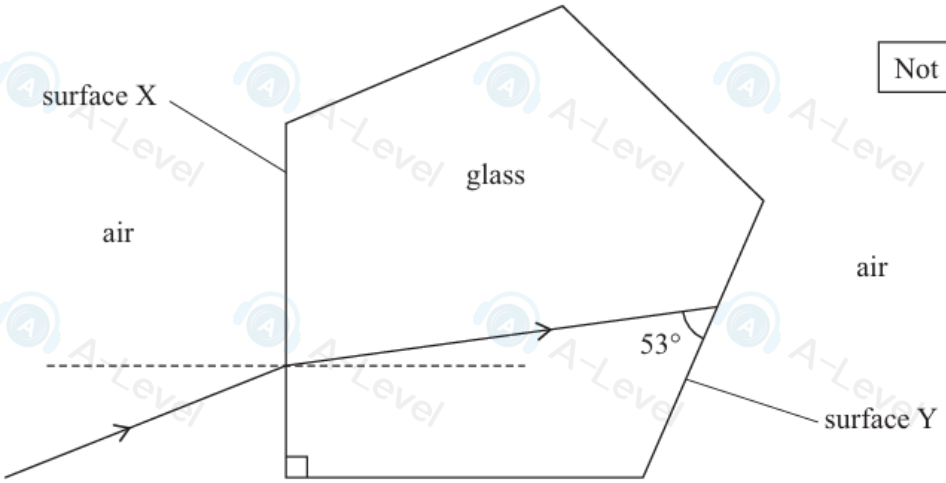
18 A camera includes a five-sided glass prism.

The diagram shows a ray of light incident on the prism at surface X. The ray of light is then transmitted to surface Y.



(a) Explain why the ray of light refracts at surface X, as shown.

(2)

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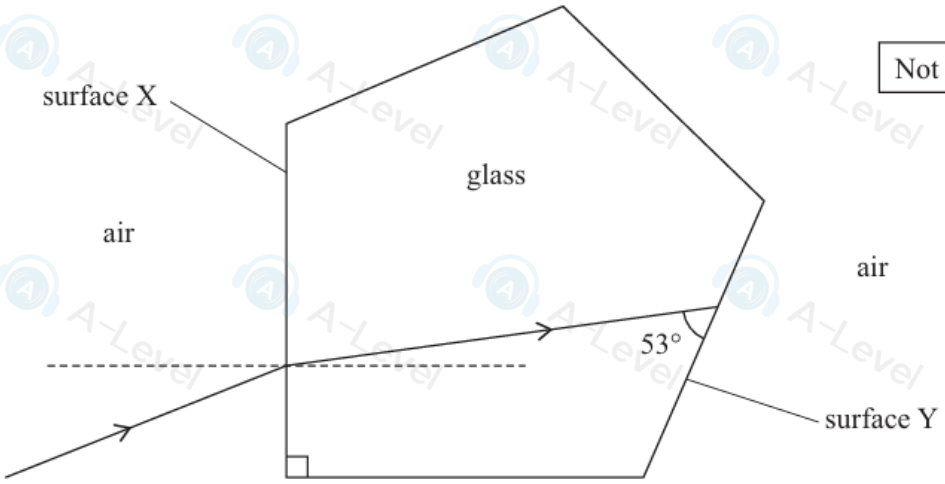
The diagram shows a ray of light incident on the prism at surface X. The ray of light is then transmitted to surface Y.



(a) Explain why the ray of light refracts at surface X, as shown.

(2)

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(b) At surface Y the ray of light must be reflected.

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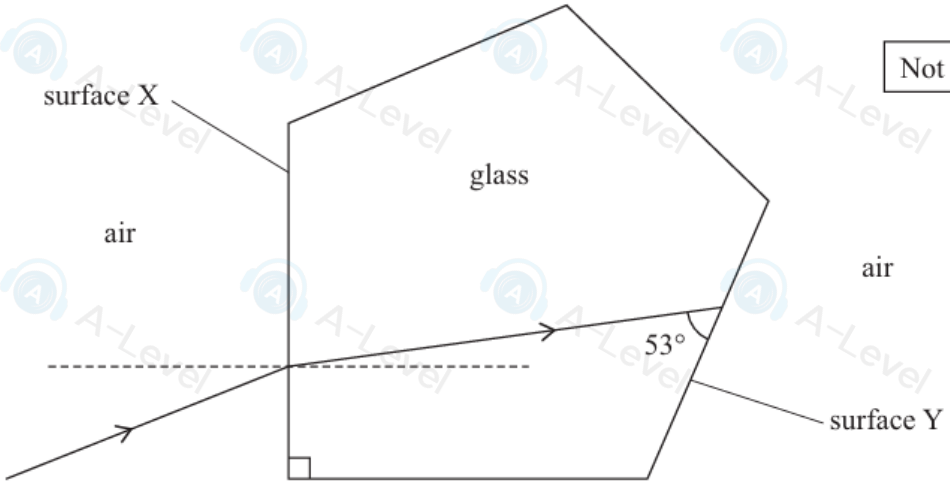

(a) Explain why the ray of light refracts at surface X, as shown.

(2)

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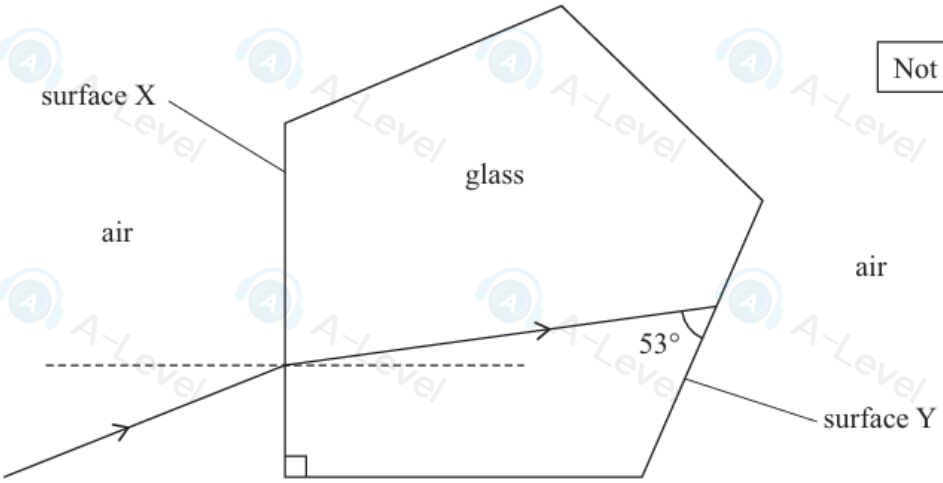

(a) Explain why the ray of light refracts at surface X, as shown.

(2)

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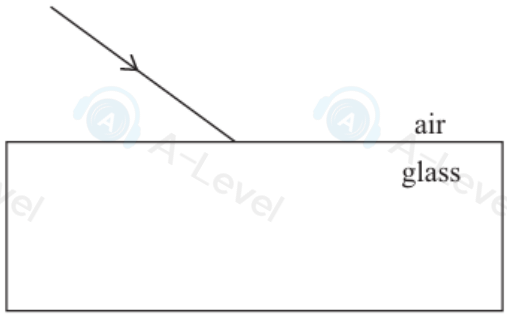
(b) At surface Y the ray of light must be reflected.

12: A student uses a ray box to direct a narrow ray of light onto the surface of a glass block, as shown.



(a) (i) Determine the angle of incidence.

(1)

Angle of incidence = ...

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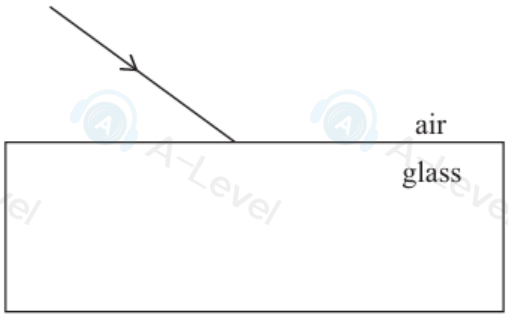
12: A student uses a ray box to direct a narrow ray of light onto the surface of a glass block, as shown.



(a) (i) Determine the angle of incidence.

(1)

Angle of incidence = ...

(ii) Calculate the angle of refraction in the glass block.

refractive index of glass block = 1.5

(2)

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(b) The light from the ray box is unpolarised. When reflected by glass, some of this light will become polarised.

(i) Explain the difference between unpolarised light and polarised light.

(3)

DO NOT WRITE IN THIS AREA

(b) The light from the ray box is unpolarised. When reflected by glass, some of this light will become polarised.

(i) Explain the difference between unpolarised light and polarised light.

(3)

(ii) The student uses a polarising filter to view the light reflected by the glass block.

Explain what she would observe as she rotates the filter.

(3)

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18 The photograph shows a typical lightning strike which occurs as a result of an electrical discharge through the atmosphere in a narrow channel between a cloud and the ground.

(Source: © Joshua Lewis/EyeEm/Getty Images)

The high current in a lightning strike heats the air sufficiently to cause rapid expansion; the resulting shock wave is heard as thunder.

(a) A teacher says that a lightning strike taking place 1 km away from the observer will result in a time of 3 s between seeing the lightning and hearing the thunder.

Determine whether the teacher is correct.

speed of sound in air = 340 m s^{-1}

(3)

(b) The following data was collected for one particular lightning strike:

distance between cloud and ground = 400 m
current = 25 000 A
duration of lightning strike = 30 μs
potential difference between cloud and ground = 1.2×10^9 V
diameter of lightning channel = 5.0 cm

(i) Calculate the total charge transferred during the lightning strike.

(2)

Total charge transferred = ...

(ii) Calculate the power dissipated by the lightning strike.

(2)

Power dissipated = ...

(iii) Show that the resistivity of the air in the lightning channel is about 0.2 Ω m.

(3)

(iv) The accepted value for the resistivity of air is $10^{16}\ \Omega m$.

Suggest why the value calculated from the data is so much less than the accepted value.

(1)

(c) Air consists mainly of nitrogen and oxygen molecules. Analysis of the light produced during a lightning strike shows a weak line spectrum.

(i) Explain the process by which nitrogen atoms produce a line spectrum.

(4)

(ii) State why the line spectrum produced by oxygen atoms in the air would be different from the line spectrum produced by nitrogen atoms.

(1)

(Total for Question 18 = 16 marks)

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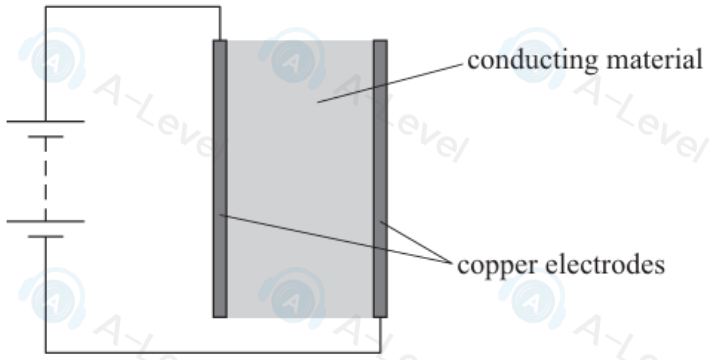
14 An electrical heating system consists of heating panels.

Each panel is made from a thin sheet of conducting material attached to two copper electrodes. The electrodes are connected to a power supply, as shown.



(a) A student uses a sample of the conducting material to determine its resistivity.

(i) State what is meant by resistivity of a material.

(1)

.....

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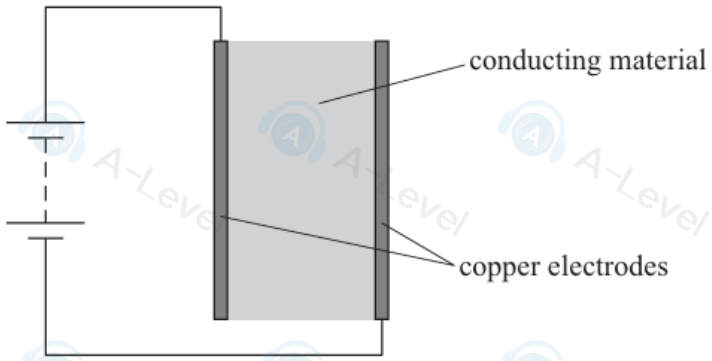
14 An electrical heating system consists of heating panels.

Each panel is made from a thin sheet of conducting material attached to two copper electrodes. The electrodes are connected to a power supply, as shown.



(a) A student uses a sample of the conducting material to determine its resistivity.

(i) State what is meant by resistivity of a material.

(1)

.....

.....

(ii) Describe how the student could determine a value for the resistivity of the conducting material.

You do **not** need to draw a circuit diagram.

(4)

.....

(b) Copper has a low resistivity compared with the resistivity of the conducting material.

Explain how the low resistivity of copper affects the drift velocity of electrons in the copper electrodes.

(2)

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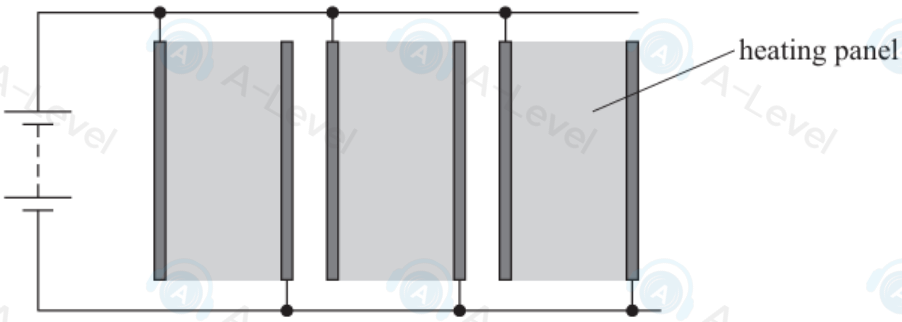
(c) The power output of the heating system can be changed by connecting more panels in parallel with the power supply, as shown.



Explain how adding panels in parallel changes the power output of the system.

(2)

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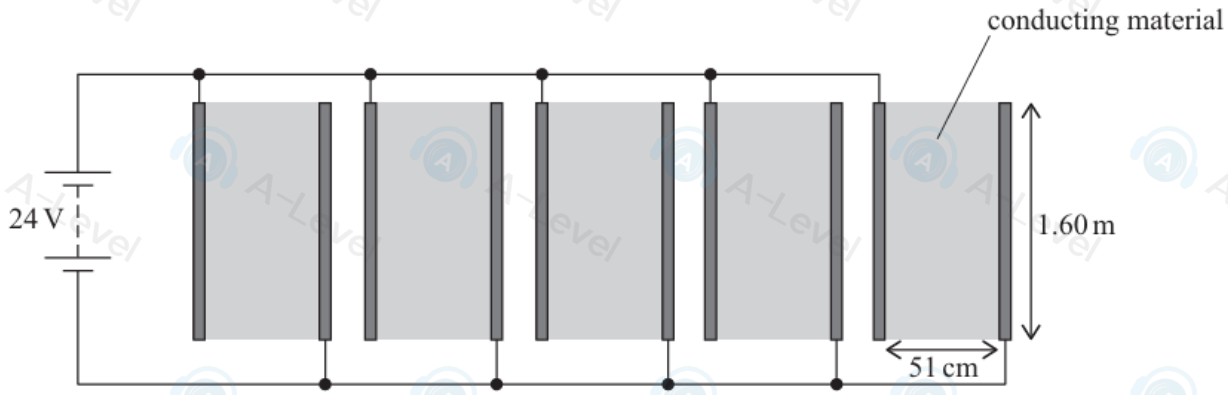
(d) A student designs a heating system using five heating panels, as shown.



To be safe, the maximum power of the student's heating system should be less than 350 W.

Deduce whether the student's heating system is safe.

resistivity of conducting material = $6.4 \times 10^{-3}\,\Omega\,m$
thickness of conducting material = 0.48 mm

(5)

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