



Questions

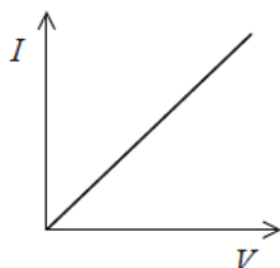
Q1.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

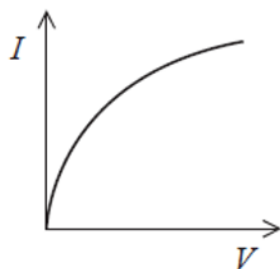
Which of the following graphs shows how current I varies with potential difference V for a negative temperature coefficient thermistor?

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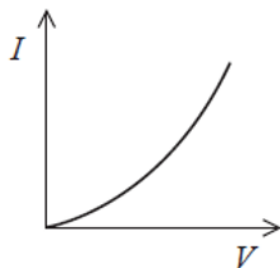
☐ A



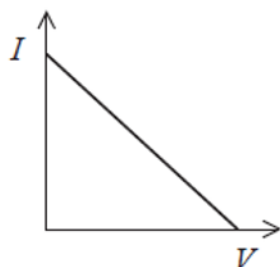
☐ B



☐ C



☐ D



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(Total for question = 1 mark)



Q2.

A student carried out an experiment to determine the resistivity of a metal in the form of a wire. She made the following measurements:

length of wire = 0.20 m
resistance of wire = 50 mΩ
diameter of wire = 0.36 mm

Determine the metal of the wire using information from the table below.

Metal	Resistivity / Ωm
aluminium	2.7×10^{-8}
tungsten	5.6×10^{-8}
iron	1.0×10^{-7}

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(Total for question = 3 marks)

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Q3.

The equation $I = nqvA$ can be used to establish the drift velocity v of electrons in a copper wire.

(a) State what is meant by drift velocity.

(1)



(b) A copper wire has a cross-sectional area of $2.64 \times 10^{-7} \text{ m}^2$ and carries a current of 1.31 A. Calculate the drift velocity of the electrons in this copper wire.

$$n = 8.49 \times 10^{28} \text{ m}^{-3}$$

(2)

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Drift velocity =

(Total for question = 3 marks)

Q4.

Wire P and wire Q are connected in series across a battery.
 Wire P has a charge carrier density n and a diameter d .
 Wire Q has a charge carrier density $2n$ and a diameter $2d$.
 The drift velocity of the charge carriers in wire P is v .

Which of the following is the drift velocity of the charge carriers in wire Q?

- ☐ A $\frac{v}{8}$
- ☐ B $\frac{v}{4}$
- ☐ C v
- ☐ D $4v$

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(Total for question = 1 mark)



Q5.

The photograph shows an electric skateboard.



(Source: www.digitaltrends.com)

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One particular type of electric skateboard uses an electric motor connected to a 22 V rechargeable lithium-ion battery. A fully-charged battery is able to pass 36,000 C of charge through the circuit and will allow continuous operation of the skateboard for 40 minutes.

(a) Calculate the total energy stored in a fully-charged lithium-ion battery.

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Total energy stored =

(b) The electric skateboard travels at a speed of 16 kilometres per hour.

(i) Calculate the time taken for the electric skateboard to travel 2.0 m.

(2)

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Time taken =

(ii) While the electric skateboard is in use, the battery provides a constant current.

Calculate the number of electrons that flow past a point in the circuit during the time taken for the electric skateboard to travel 2.0 m.



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Number of electrons =

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(Total for question = 7 marks)

Q6.

A student is planning an experiment to determine a value for the resistivity of a metal in the form of a wire, by a graphical method.

(a) State the physical quantities she should measure, suggesting a suitable measuring instrument for each quantity.

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(b) Describe how she should use her measurements to determine an accurate value for the resistivity of the wire using a graphical method.

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(Total for question = 6 marks)

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Q7.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

Two copper wires of identical cross-sectional area are placed in series in a circuit.

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

- ☐ **A** charge carrier density
- ☐ **B** current
- ☐ **C** drift velocity
- ☐ **D** potential difference

(Total for question = 1 mark)

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Q8.

The resistance of some electrical components decreases as the applied potential difference increases.

Which row of the table contains two components that behave in this way?



☐ A	diode	ohmic conductor
☐ B	ohmic conductor	filament lamp
☐ C	negative temperature coefficient thermistor	diode
☐ D	negative temperature coefficient thermistor	filament lamp

(Total for question = 1 mark)

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Q9.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

The definitions for current and potential difference both include

- ☐ A charge.
- ☐ B resistance.
- ☐ C time.
- ☐ D work done.

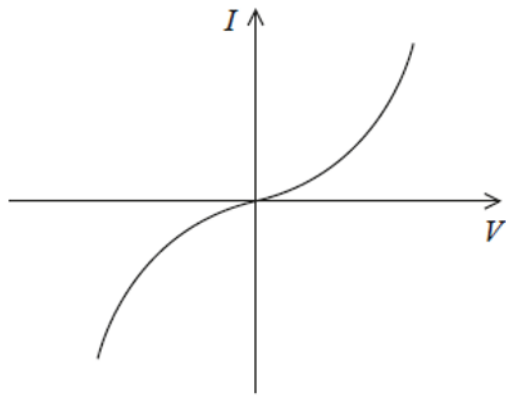
(Total for question = 1 mark)

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Q10.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

Which electrical component has the current-potential difference graph shown?



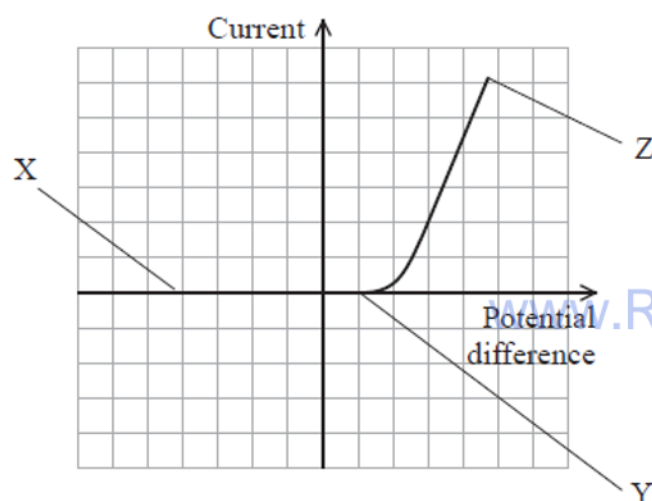
- ☐ **A** diode
- ☐ **B** filament lamp
- ☐ **C** resistor
- ☐ **D** thermistor

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(Total for question = 1 mark)

Q11.

The current-potential difference graph for an ideal diode is shown. The graph has been labelled at three separate points by the letters X, Y and Z.



At which point(s) is the resistance of this diode infinite.

- ☐ **A** X and Y
- ☐ **B** Y and Z
- ☐ **C** X only



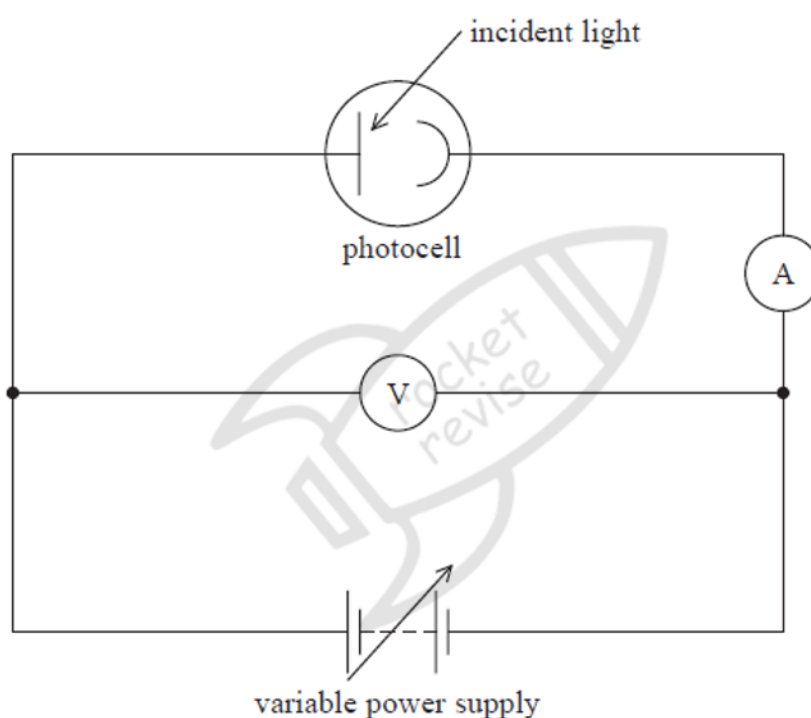
☐ D Z only

(Total for question = 1 mark)

Q12.

Photocells make use of the photoelectric effect. The following circuit can be used to determine the work function of a metal used in a photocell.

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(a) State what is meant by the work function of a metal.

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(b) This photocell works with ultraviolet light but does not work with visible light.

Explain why.

(2)



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(c) An experiment was carried out using this circuit. The potential difference applied to the photocell opposes the movement of the electrons through the photocell, reducing the current.

(i) The variable power supply was initially set at 0 V and the reading on the ammeter was 2.4 μA .

The intensity of the ultraviolet light was then increased without changing the frequency.

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Explain what happened to the reading on the ammeter.

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(ii) The variable power supply was adjusted until the reading on the ammeter became 0 μA . The reading on the voltmeter was 3.59 V.

Calculate the work function, in joules, of the metal used in the photocell.

frequency of ultraviolet used = 2.00×10^{15} Hz

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Work function = J

(Total for question = 10 marks)

Q13.

Answer the question with a cross in the box you think is correct ☐ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐ .

Which of the following statements about physical quantities or units is correct?

- ☒ **A** Current is a derived quantity.
- ☐ **B** Power is a derived quantity.
- ☐ **C** The coulomb is a base unit.
- ☐ **D** The volt is a base unit.

(Total for question = 1 mark)

Q14.

A copper wire has a cross-sectional area of $5.0 \times 10^{-7} \text{ m}^2$. There is a current in the wire of 0.93 A. Copper has 8.4×10^{28} conduction electrons per metre cubed.

Which of the following gives the magnitude of the drift velocity v in m s^{-1} for the conduction electrons in this wire?



- ☐ A $v = \frac{0.93}{(8.4 \times 10^{28})(5.0 \times 10^{-7})}$
- ☐ B $v = \frac{(8.4 \times 10^{28})(1.6 \times 10^{-19})(5.0 \times 10^{-7})}{0.93}$
- ☐ C $v = \frac{(8.4 \times 10^{28})(5.0 \times 10^{-7})}{0.93}$
- ☐ D $v = \frac{0.93}{(8.4 \times 10^{28})(1.6 \times 10^{-19})(5.0 \times 10^{-7})}$

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(Total for question = 1 mark)

Q15.

Answer the question with a cross in the box you think is correct ☐ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐ .

A small metal cube, with sides of length x , is connected in a circuit. The current through the cube, between opposite faces, is I and the potential difference across the cube is V .

Which of the following gives the resistivity of the metal?

- ☐ A $\frac{Vx}{I}$
- ☐ B $\frac{V}{Ix}$
- ☐ C $\frac{Ix}{V}$
- ☐ D $\frac{I}{Vx}$

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(Total for question = 1 mark)

Q16.



Answer the question with a cross in the box you think is correct ☐ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐ .

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

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(Total for question = 1 mark)

Q17.

Answer the question with a cross in the box you think is correct ☐ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐ .

The temperature of a thermistor is increased.

Which row in the table identifies the effect of the temperature increase on the number of conduction electrons and the amplitude of lattice vibrations?

	Number of conduction electrons	Amplitude of lattice vibrations
☒ A	increases	increases
☒ B	decreases	increases
☒ C	increases	stays the same
☒ D	decreases	stays the same

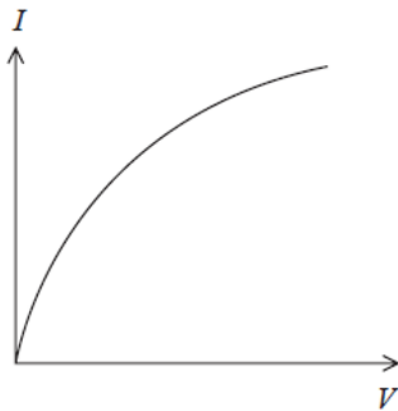
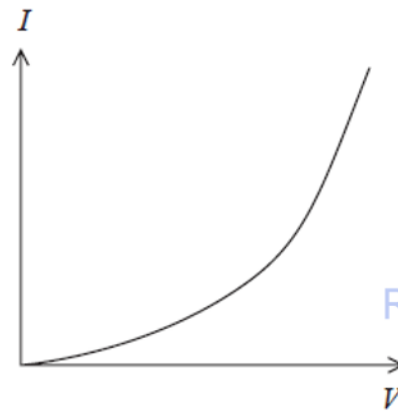
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(Total for question = 1 mark)



Q18.

* The graphs show how current I varies with potential difference V for a filament bulb and for a negative temperature coefficient thermistor.

**Filament bulb****Thermistor**

Explain the shape of each graph. Your answer should include reference to the movement of conduction electrons in each component.

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Q19.

In a series circuit, 3.1×10^{19} electrons pass a particular point in a time of 30 seconds.

Which of the following gives the magnitude of the current in amperes in this circuit?

☐ A $\frac{(3.1 \times 10^{19}) \times (1.6 \times 10^{-19})}{30}$

☐ B $\frac{3.1 \times 10^{19}}{(1.6 \times 10^{-19}) \times 30}$

☐ C $(3.1 \times 10^{19}) \times (1.6 \times 10^{-19}) \times 30$

☐ D $\frac{(3.1 \times 10^{19}) \times 30}{1.6 \times 10^{-19}}$

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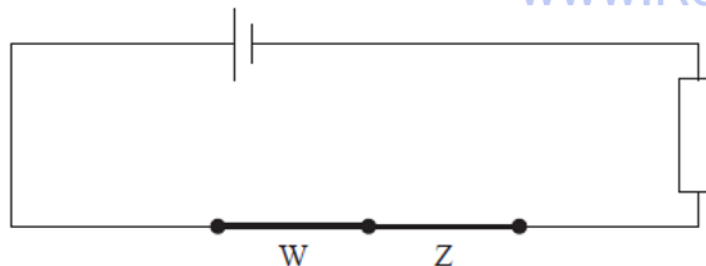
(Total for question = 1 mark)

Q20.

Two copper wires, W and Z, are joined as shown. Wire W has twice the diameter of wire Z.



W and Z are connected in series with a cell and resistor, as shown.



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(a) State the purpose of the resistor in this circuit.

(1)



(b) The current I in a conductor is given by the formula

$$I = nqvA$$

Complete the following table, which shows ratios of quantities for wires W and Z. The first row has been completed for you.

(4)

Ratio	Value	Reason
$\frac{n_w}{n_z}$	1	Both wires are made of the same material
$\frac{I_w}{I_z}$		
$\frac{v_w}{v_z}$		

(Total for question = 5 marks)

Q21.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

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 mark)



Q22.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The unit of resistance is the ohm.

Which of the following is equivalent to the ohm?

- ☐ **A** $\text{J C}^{-2} \text{s}$
- ☐ **B** $\text{J C}^2 \text{s}^{-1}$
- ☐ **C** $\text{J C}^{-1} \text{s}^{-1}$
- ☐ **D** J C s

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(Total for question = 1 mark)

Q23.

A copper wire of radius 0.40 mm carries a current of 5.1 A.

Calculate the drift velocity of the electrons in the wire.

number of charge carriers per m^3 for copper = 8.5×10^{28}

(2)
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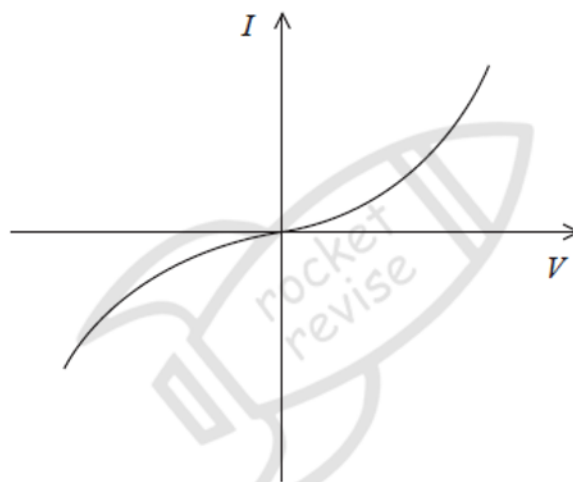
Drift velocity =

(Total for question = 2 marks)

Q24.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

A graph of current against potential difference for an electrical component is shown.



Which component would give this graph?

- ☐ **A** diode
- ☐ **B** filament bulb
- ☐ **C** ohmic conductor
- ☐ **D** thermistor

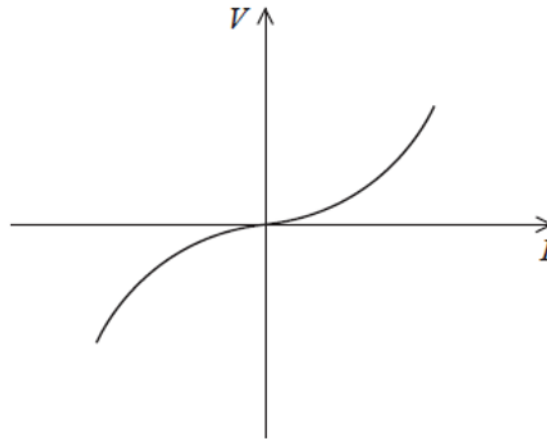
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(Total for question = 1 mark)

Q25.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The graph shows how potential difference V varies with current I for an electrical component.



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Which electrical component is represented by this graph?

- ☒ **A** diode
- ☒ **B** filament lamp
- ☒ **C** ohmic conductor
- ☒ **D** thermistor

(Total for question = 1 mark)

Q26.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

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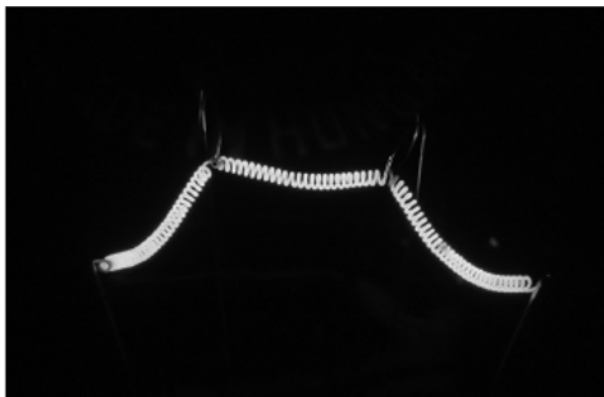
Which of the following units is equivalent to the volt?

- ☒ **A** C s^{-1}
- ☒ **B** J s^{-1}
- ☒ **C** J C^{-1}
- ☒ **D** J s



Q27.

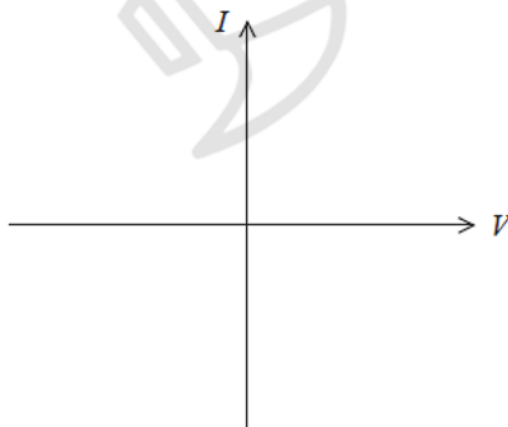
The photograph shows a thin, coiled, tungsten wire used in a filament light bulb.



(Source: © goran cakmazovic/Shutterstock)

(a) Complete the sketch graph to show how current varies with potential difference for a filament bulb.

(2)



(b) The tungsten wire has a diameter of 0.046 mm and a length of 580 mm. When emitting light, there is a current of 0.44 A in the filament and a potential difference of 140 V across the filament.

(i) Calculate the drift velocity v of the electrons in the tungsten wire.

number of charge carriers per m^3 in tungsten = 1.26×10^{29}

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$V = \dots\dots\dots$

(ii) When the potential difference across the tungsten filament is 140 V the current in the filament is 0.44 A.

The table shows typical resistivity values for tungsten at different temperatures.

Temperature / °C	20	700	1700	2700	3200
Resistivity / Ωm	0.55×10^{-7}	2.43×10^{-7}	5.57×10^{-7}	9.04×10^{-7}	10.85×10^{-7}

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Deduce the temperature of the filament.

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(Total for question = 8 marks)

Q28.

A nichrome wire of length 0.45 m has a cross-sectional area of $2.5 \times 10^{-7} \text{ m}^2$.
The resistance of the wire is 2.0 Ω .

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(a) Calculate the resistivity of nichrome.

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Resistivity =



(b) A potential difference of 3.0 V is applied across the nichrome wire.

Calculate the drift velocity of the conduction electrons in the nichrome wire.

number of conduction electrons per $\text{m}^3 = 9.0 \times 10^{28} \text{ m}^{-3}$

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Drift velocity =

(c) A student suggests that the drift velocity will double if the length of wire used in the circuit is halved.

Comment on this suggestion.

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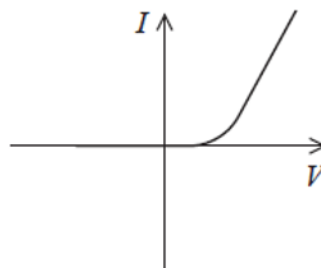
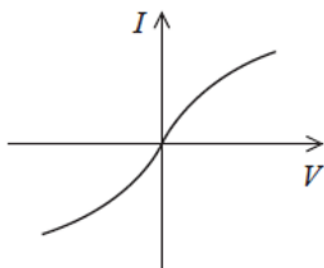
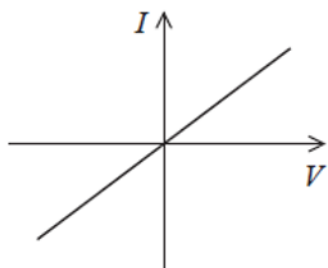
(Total for question = 8 marks)

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Q29.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The graphs show how current I varies with potential difference V for three components.



Which of the following components is **not** represented by any of the three graphs?

- ☐ **A** diode
- ☐ **B** filament bulb
- ☐ **C** negative temperature coefficient thermistor
- ☐ **D** ohmic conductor

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(Total for question = 1 mark)

Q30.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The current at a point in a circuit is 1.25 A.

Which of the following expressions gives the number of electrons passing the point in 45 seconds?

- ☐ **A** $\frac{1.25 \times 45}{1.60 \times 10^{-19}}$
- ☐ **B** $\frac{1.25 \times 1.60 \times 10^{-19}}{45}$
- ☐ **C** $\frac{1.60 \times 10^{-19}}{1.25 \times 45}$
- ☐ **D** $\frac{45}{1.25 \times 1.60 \times 10^{-19}}$

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(Total for question = 1 mark)



Q31.

Answer the question with a cross in the box you think is correct (☒). If you change your mind, put a line through the box (☒) and then mark your new answer with a cross (☒).

The number of conduction electrons in a light dependent resistor changes as light intensity increases.

Which of the following best explains how the number of conduction electrons changes?

- ☐ **A** It decreases because the lattice ions vibrate with a larger amplitude.
- ☐ **B** It increases because the lattice ions vibrate with a larger amplitude.
- ☐ **C** It increases because the electrons gain energy from the photons of light.
- ☐ **D** It decreases because electrons are released due to the photoelectric effect.

(Total for question = 1 mark)

Q32.

Answer the question with a cross in the box you think is correct (☒). If you change your mind, put a line through the box (☒) and then mark your new answer with a cross (☒).

At a point in a circuit there is a current of 3.0 A.

Which of the following gives the total charge passing this point in 2.0 minutes?

- ☐ **A** 0.025 C
- ☐ **B** 1.5 C
- ☐ **C** 6.0 C
- ☐ **D** 360 C

(Total for question = 1 mark)



Q33.

Select one answer from A to D and put a cross in the box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

As temperature increases, the resistance of a negative temperature coefficient thermistor changes.

Which of the following describes the reason for this change?

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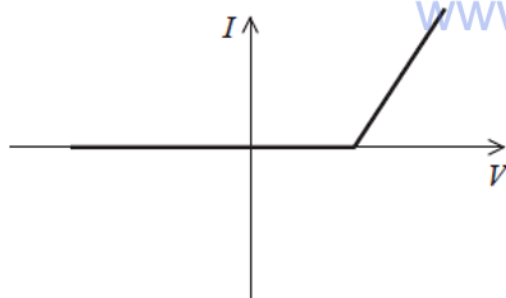
- ☐ **A** Collisions between electrons and ions occur less frequently.
- ☐ **B** More conduction electrons are released.
- ☐ **C** The ions in the thermistor vibrate less.
- ☐ **D** The ions in the thermistor vibrate more.

(Total for question = 1 mark)

Q34.

Select one answer from A to D and put a cross in the box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The graph shows how current I varies with potential difference V for an electrical component.



Which component is represented by this graph?

- ☐ **A** Diode



- ☐ **B** Filament lamp
- ☐ **C** Ohmic conductor
- ☐ **D** Thermistor

(Total for question = 1 mark)

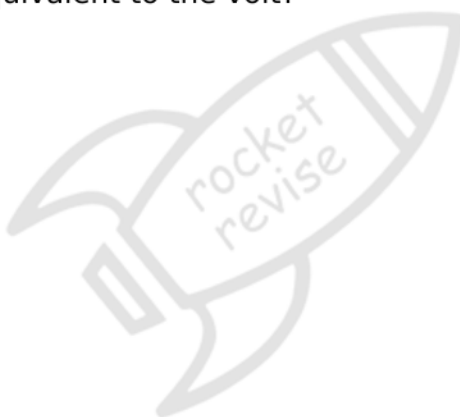
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Q35.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

Which of the following units is equivalent to the volt?

- ☐ **A** J s^{-1}
- ☐ **B** W s^{-1}
- ☐ **C** J C^{-1}
- ☐ **D** W C^{-1}



(Total for question = 1 mark)

Q36.

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Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☐ and then mark your new answer with a cross ☐.

When the temperature of a metal wire increases, the resistance of the wire increases.

Which of the following explains this increase in resistance?

- ☐ **A** the amplitude of the lattice vibrations decreases
- ☐ **B** the amplitude of the lattice vibrations increases



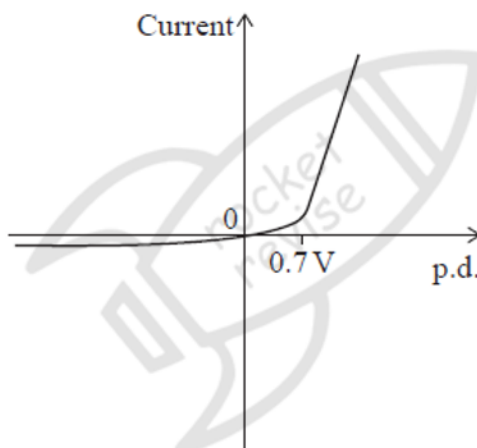
- ☐ **C** the number of conduction electrons decreases
- ☐ **D** the number of conduction electrons increases

(Total for question = 1 mark)

Q37.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The current-potential difference (p.d.) graph for a diode is shown.



Which of the following statements is correct for this diode?

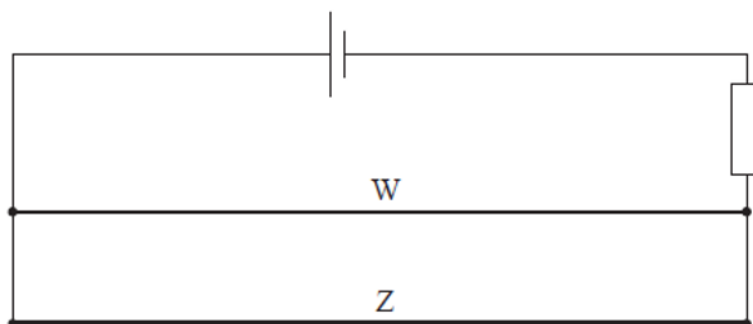
- ☐ **A** This diode does not conduct in the reverse direction.
- ☐ **B** The resistance of this diode in the reverse direction is infinite.
- ☐ **C** The resistance of this diode decreases when the p.d. is above 0.7 V.
- ☐ **D** This diode does not conduct when the p.d. is below 0.7 V.

(Total for question = 1 mark)

Q38.



Equal lengths of two copper wires, W and Z, are connected in parallel in a circuit as shown.



Wire Z has twice the diameter of wire W.

(a) Explain why the drift velocity of the charge carriers is the same value in wires W and Z.

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(4)

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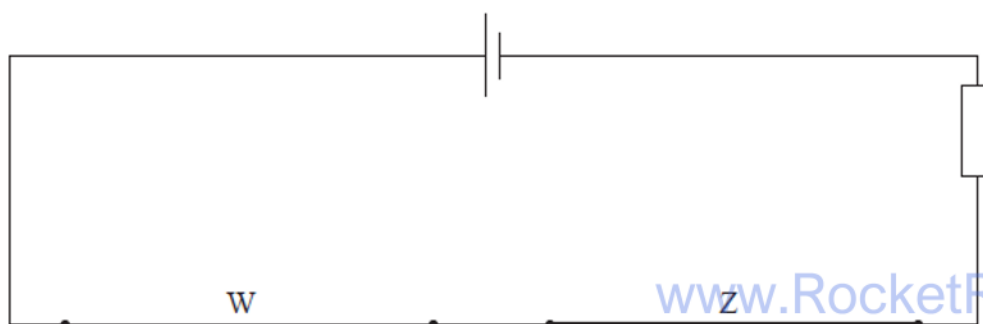
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(b) Wires W and Z are now connected in series as shown.



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Complete the table by placing a cross in the correct box for each quantity.

(4)



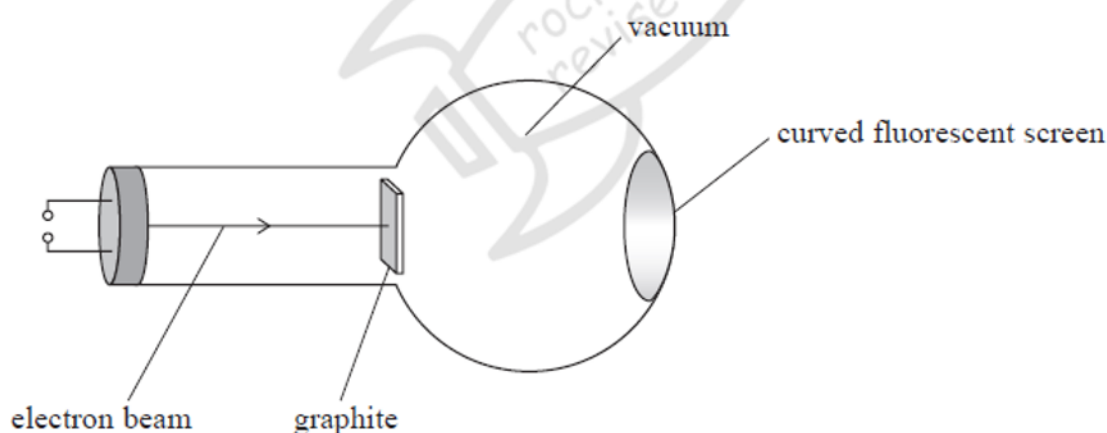
Quantity	Same value for W and Z	Larger value in W	Larger value in Z
Current in the wires			
Resistance of the wires			
Potential difference across the wires			
Drift velocity of the charge carriers in the wires			

(Total for question = 8 marks)

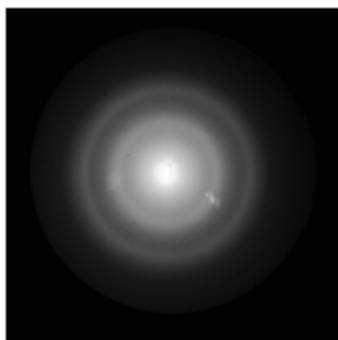
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Q39.

A teacher demonstrated the behaviour of electrons travelling through graphite. An electron beam was directed through a thin piece of graphite towards a fluorescent screen, as shown.



The electrons produced a pattern on the fluorescent screen as shown below.



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(Source: © ANDREW LAMBERT PHOTOGRAPHY/SCIENCE PHOTO LIBRARY)

(a) This demonstration can be used to make conclusions about the behaviour of the electrons and the structure of the graphite.



State these conclusions.

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(b) The electrons were accelerated through a potential difference (p.d.) of 2400 V before interacting with the graphite.

(i) Show that the work done on each electron is about 4×10^{-16} J.

(2)

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(ii) Calculate the maximum velocity of the electrons.

(2)

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Maximum velocity =

(iii) The accelerating p.d. was then increased.

Explain how the pattern on the screen would change.

(3)

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Q40.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

As the temperature of the filament in a bulb decreases, the resistance of the filament changes.

Which of the following is the reason for this change in resistance of the filament?

- ☐ **A** Lattice vibrations decrease
- ☐ **B** Lattice vibrations increase
- ☐ **C** Number of conduction electrons decreases
- ☐ **D** Number of conduction electrons increases

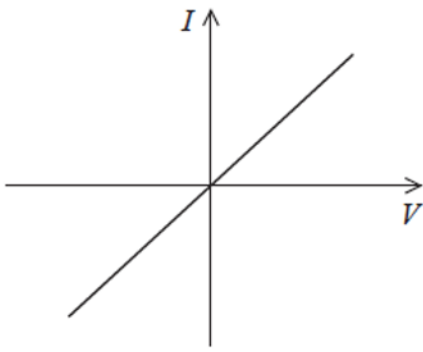
(Total for question = 1 mark)

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Q41.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

The graph shows how current I varies with potential difference V for an electrical component.



Which component is represented by the graph?

- ☐ **A** diode
- ☐ **B** filament lamp
- ☐ **C** resistor at constant temperature
- ☐ **D** thermistor

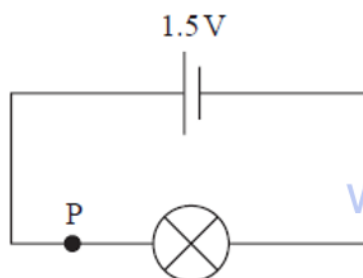
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(Total for question = 1 mark)

Q42.

Answer the question with a cross in the box you think is correct ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

A lamp is connected in the circuit as shown. The cell has negligible internal resistance.



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In 30 seconds, the charge passing point P is 0.4 C.

Which of the following gives the energy, in joules, transferred by the cell during this time?



- ☐ A $1.5 \times 0.4 \times 30$
- ☐ B 1.5×0.4
- ☐ C $\frac{1.5 \times 0.4}{30}$
- ☐ D $\frac{1.5}{0.4 \times 30}$

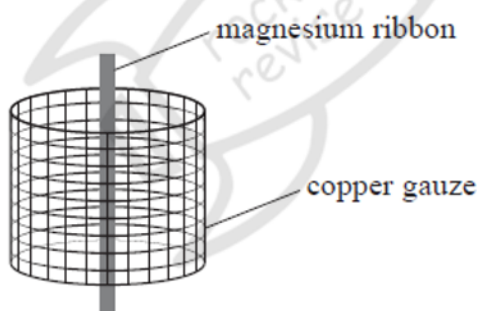
(Total for question = 1 mark)

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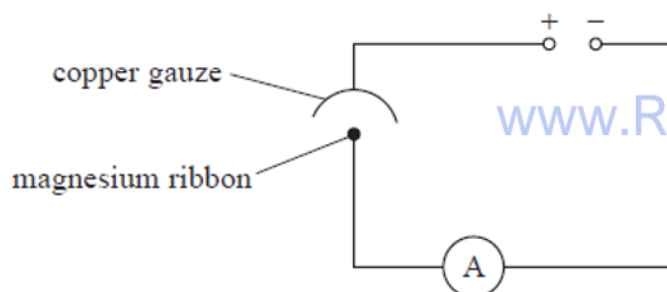
Q43.

Some students investigated the photoelectric effect.

They used a piece of magnesium ribbon placed inside a cylinder of copper gauze as shown. There was an air gap between the copper gauze and the magnesium ribbon.



The copper gauze was connected to the positive terminal of a power supply. The magnesium ribbon and a sensitive ammeter were connected to the negative terminal of the power supply, as shown.



The students made the following observations:

- when light from an ultraviolet lamp was incident on the gauze and ribbon, a current was detected by the ammeter.
- when the polarity of the power supply was reversed, the current decreased to zero.



*(a) Explain these observations.

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(b) The students reconnected the circuit so that a current was detected when ultraviolet light was incident on the gauze and ribbon.

(i) The students replaced their original lamp with an ultraviolet lamp with a much greater intensity.

Explain the effect this had on their experiment.

(3)

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(ii) The ultraviolet lamp was replaced by a laser which emitted red light of wavelength 633 nm.

Deduce whether the photoelectric effect will occur.

work function of magnesium = 3.7 eV

(Total for question = 13 marks)

Q44.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ~~☒~~ and then mark your new answer with a cross ☒.

In a current-carrying copper wire, the drift velocity of the electrons is very small.

Which of the following best explains this?

- ☐ **A** The charge on an electron is very small.
- ☐ **B** The cross-sectional area of the wire is very small.
- ☐ **C** The current in the wire is very large.
- ☐ **D** The number of electrons per unit volume for copper is very large.

(Total for question = 1 mark)