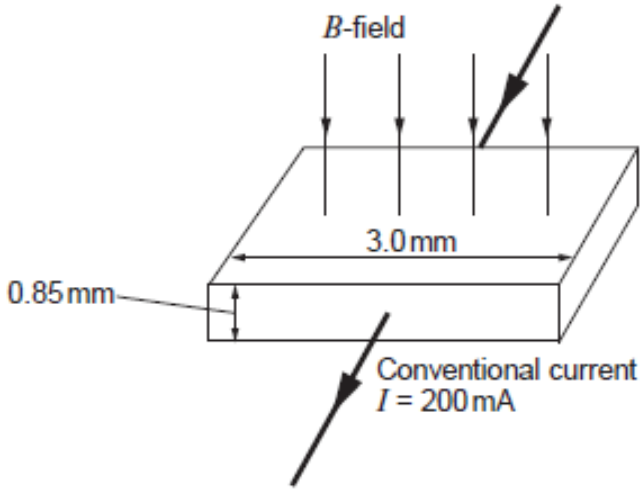
Physics

Question	Maximum Mark	Mark Awarded
#1	9	
#2	8	
#3	10	
#4	11	
#5	12	
#6	14	
#7	14	
Total	78	

#1

9. *(a)* The silicon chip shown in the diagram is used as a Hall probe with electrons as the charge carriers. Explain how the Hall voltage arises and which face of the chip becomes positively charged. [4]



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(b) The concentration of conduction electrons is $2.4 \times 10^{24}\,m^{-3}$. Calculate the mean drift velocity of the electrons. [2]

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(c) The Hall voltage, V_H, for this chip can be expressed as:

$$V_H = kB$$

where k is a constant and B is the magnetic flux density. Calculate a value for k and **state its unit.** [3]

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Question taken from Eduqas examination paper 842103, June 2019

#2

4. *(a)* Define electric current. [1]

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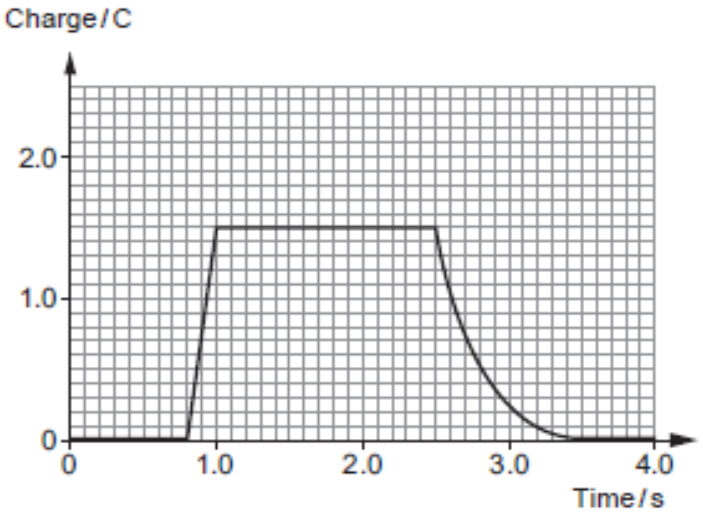
(b) The following graph shows how the **charge** that has passed a point in an electrical circuit varies with time.



(i) Describe how the **current** varies from $t = 0$ to $t = 2.5\,s$ giving appropriate values. [4]

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(ii) Calculate the **current** when $t = 3.0\,s$. [3]

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Question taken from Eduqas examination paper 842002, June 2018

#3

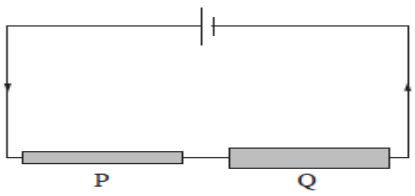
(a) Compare the movement of free electrons in a metal **before** and **after** a pd is applied to the metal. [3]

(b) (i) The current, I, in a wire of cross-sectional area, A, is given by the formula:

$$I = nAve$$

where n is the number of free electrons per unit volume and v is the drift velocity of these electrons. Derive the formula. Include a clearly labelled diagram. [4]

(ii) Wires P and Q are connected to a fixed voltage source. Wire Q is made of a different metal from wire P and has fewer free electrons per unit volume. [$n_P = 6.4 \times 10^{28}\,m^{-3}$ and $n_Q = 2.0 \times 10^{28}\,m^{-3}$]. The diameter of wire Q is twice the diameter of wire P.

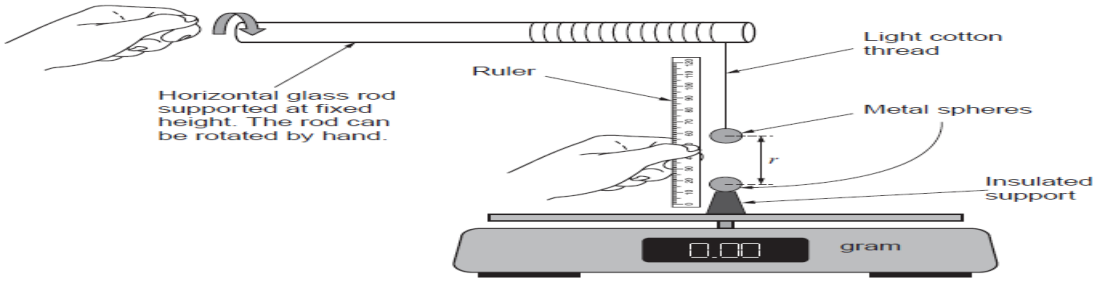


Determine the ratio $\frac{v_Q}{v_P}$. [3]

Question taken from Eduqas examination paper 842102, November 2020

#4

Two students, Ben and Sarah, use the following apparatus to investigate the 'inverse square' nature of Coulomb's law.



The **same** negative charge is placed on both spheres. The distance, r, between the centres of the spheres is varied and the reading on the top pan balance is noted. Sarah and Ben disagree on the best method to measure r.

Ben favours using a ruler with a resolution of 1 mm to measure it directly.

Sarah suggests measuring the diameter of the glass rod with Vernier calipers, with a resolution of 0.01 mm, to determine the circumference of the rod. The rod can then be rotated by hand, with each complete rotation corresponding to the calculated circumference.

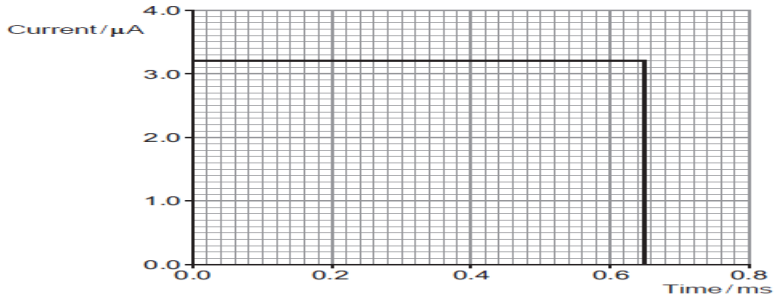
(a) (i) State an advantage and a disadvantage of each method. [4]

(ii) Suggest an improvement to **one** of the techniques which would increase the accuracy of measuring r. [1]

(b) When r = 20 mm, the reading on the top pan balance is 0.01 gram.

(i) Show that the value of Q_1Q_2, the product of the charges on the spheres, when r = 20 mm is approximately 4.4×10^{-18} C^2. [3]

(ii) One of the spheres is now discharged. The graph shows how the discharge current varies with time.



Show that the values given on the graph are consistent with the product Q_1Q_2 in *(b)*(i). [2]

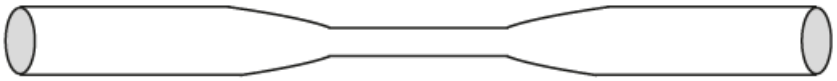
(iii) Hence, estimate the number of electrons on **one** sphere when the reading on the balance is 0.01 gram and r = 20 mm. [1]

Question taken from Eduqas examination paper 842102, June 2017

#5

(a) Calculate the mean drift velocity of the free electrons in a wire, which has a diameter of 0.50 mm and carries a current of 2.8 A. Assume each aluminium atom contributes 3 free electrons, and there are 6.0×10^{28} atoms per m^3 of aluminium. [4]

(b) The wire is thinner in a small section as shown below.



Paula claims that within the thinner section the mean drift velocity of the free electrons will be greater. Evaluate whether she is correct. [3]

(c) (i) State what is meant by a superconductor. [1]

(ii) State and explain **one** advantage and **one** disadvantage of using superconductors to carry large currents. [4]

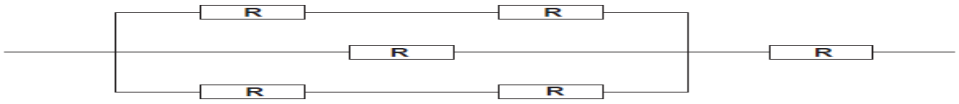
Advantage:

Disadvantage:

Question taken from Eduqas examination paper 842002, June 2017

#6

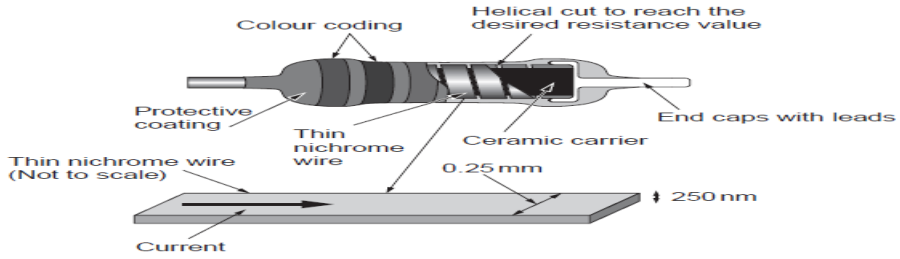
(a) The resistor network shown consists of six identical resistors, each of value **R Ω**.



(i) Determine, **in terms of R**, the total resistance of the network. [3]

(ii) **Draw a circle** around the resistor which dissipates the greatest power when a pd is applied across the arrangement. Explain your answer. [2]

(b) The alloy nichrome is commonly used to make 'Metal Film Resistors'. A cross-section through such a resistor is shown. The value of the resistor is determined by the length of the nichrome wire used in it.



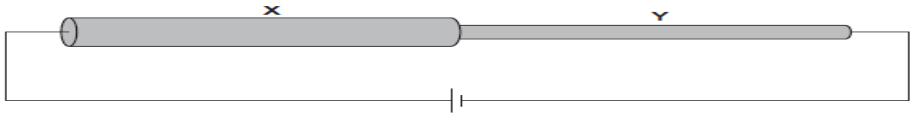
The wire used in such a resistor has a rectangular cross-section as shown. Determine the length of nichrome wire required to make a 2.0 kΩ resistor.
[Resistivity of nichrome = 1.20×10^{-6} Ω m] [2]

(c) The current I through a wire is related to the drift velocity, v, of free electrons through the wire by the equation:

$$I = nAve$$

(i) State the meaning of n. [1]

(ii) Two pieces of nichrome wire, **X** and **Y**, are joined end to end and connected to a battery as shown. The wires are of the same length but the diameter of **X** is **double** that of **Y**.



The table below shows the ratios of the values of n, I and v in the two wires. Write in the table the value of each ratio, giving an explanation for each of your answers.
Space is provided for calculations. [3]

Ratio	Value	Explanation
$\frac{n_X}{n_Y}$		
$\frac{I_X}{I_Y}$		
$\frac{v_X}{v_Y}$		

(iii) Wire **Y** is replaced with another wire **Z** of the same cross-sectional area as **Y** but double the length and made of a material with resistivity half that of **X**. Calculate the ratio:

$$\frac{\text{Power dissipated in wire Z}}{\text{Power dissipated in wire X}}$$

[3]

Question taken from Eduqas examination paper 842102, June 2017

#7

2. *(a)* (i) State what is meant by *electric current*. [1]

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(ii) Show that the unit of resistance, the ohm (Ω), can be expressed as: [2]

$$J\,s\,C^{-2}$$

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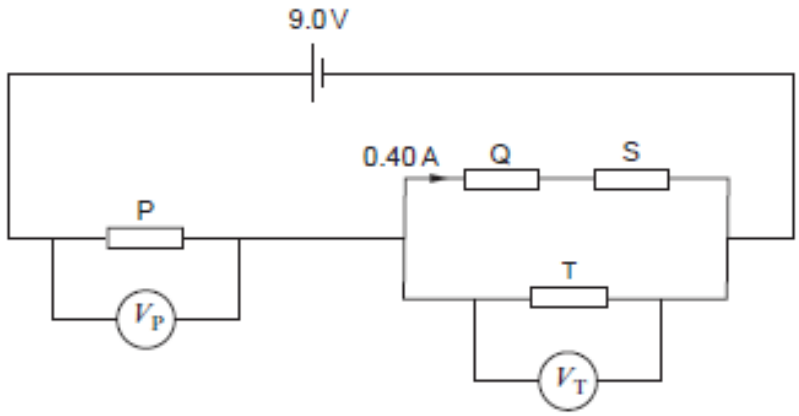
(b) The following circuit shows an arrangement of **identical resistors** labelled P, Q, S and T connected to a fixed pd of 9.0 V. V_P and V_T are the pds across P and T respectively. There is a current of 0.40 A in Q and S.



(i) Show that $V_P = 1.5\ V_T$. [2]

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(ii) Hence or otherwise show that the values given in the diagram are consistent with the resistance of each resistor being 4.5 Ω. [3]

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(c) Show that the total energy dissipated per second in the whole circuit is 15 times more than the energy dissipated per second in resistor Q. [3]

(d) Resistor T is now removed from the circuit. Explain the effect this will have on the ratio calculated in part *(c)*. [3]

Question taken from Eduqas examination paper 842102, June 2018