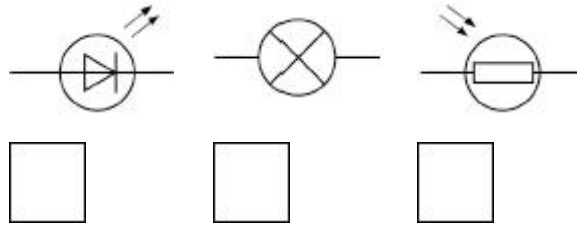


Q1.

A filament lamp breaks if the electric current in the filament becomes too big.

(a) What is the correct symbol for a filament lamp?

Tick (✓) **one** box.



(1)

(b) What is meant by an electric current?

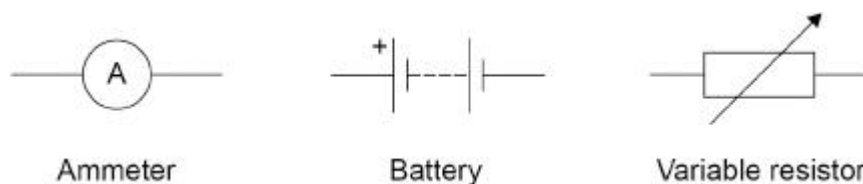
Tick (✓) **one** box.

- The energy carried by each unit of charge
- The flow of electrical charge
- The number of electrons in a circuit
- The speed at which charge moves

(1)

A manufacturer investigated the maximum current value of some filament lamps.

(c) The figure below shows the symbols for an ammeter, a battery and a variable resistor.



The manufacturer connected an ammeter, battery, filament lamp and variable resistor in series.

Draw a circuit diagram to show the manufacturer's circuit.

Include the symbol for a filament lamp from part (a)

(1)

- (d) How could the manufacturer increase the current in the filament lamp?

Tick (✓) **one** box.

Add an extra ammeter to the circuit.

Decrease the resistance of the variable resistor.

Use a battery with a smaller potential difference.

(1)

- (e) When the potential difference across a filament lamp was 0.75 V, the current in the filament lamp was 0.16 A.

Calculate the power of the filament lamp.

Use the equation:

$$\text{power} = \text{potential difference} \times \text{current}$$

$$\text{Power} = \text{_____ W}$$

(2)

- (f) Write down the equation which links charge flow (Q), current (I) and time (t).

(1)

- (g) The manufacturer increased the current in the filament lamp to 200 mA.

Calculate the charge flow through the filament lamp in 15 s.

$$\text{Charge flow} = \text{_____ C}$$

(3)

- (h) The manufacturer increased the current in the filament lamp from 200 mA.

The filament in the lamp broke when the current reached 320 mA.

How many times greater than 200 mA was the current at which the filament broke?

_____ times greater

(1)

- (i) The manufacturer tested lots of filament lamps.

The current at which the filament lamps broke was 320 ± 60 mA.

What is the range of currents at which the filament lamps broke?

Tick (✓) **one** box.

60 mA to 320 mA

260 mA to 320 mA

320 mA to 380 mA

260 mA to 380 mA

(1)

(Total 12 marks)

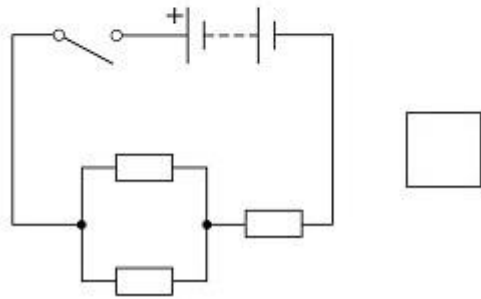
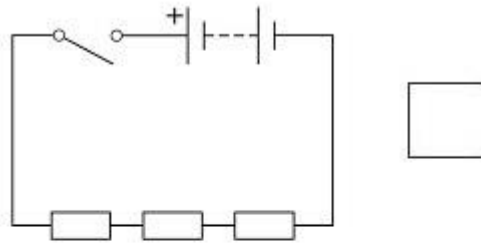
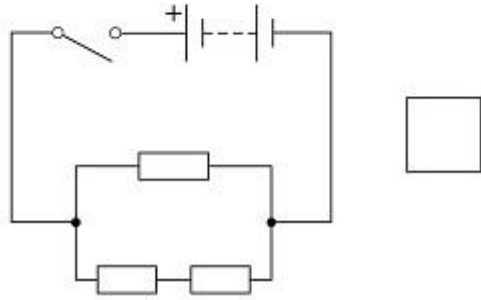
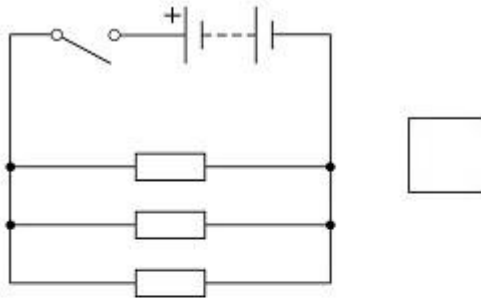
Q2.

A student investigated electrical circuits.

The student built a circuit with three resistors in series.

- (a) Which circuit diagram shows a circuit containing three resistors in series?

Tick (✓) **one** box.



(1)

(b) The student determined the total resistance of the circuit.

To determine the resistance, the student needed extra components in the circuit.

Which **two** components did the student need?

Tick (✓) **two** boxes.

Ammeter

Diode

Fuse

Variable resistor

Voltmeter

(2)

The student built circuits with different numbers of resistors in series.

All the resistors used were identical.

(c) The student switched the circuits off between readings.

Why did the student need to switch the circuits off?

Tick (✓) **one** box.

So the battery could recharge

So the current would increase

So the potential difference would increase

So the temperature of the resistors would remain constant

(1)

The table below shows the student's results.

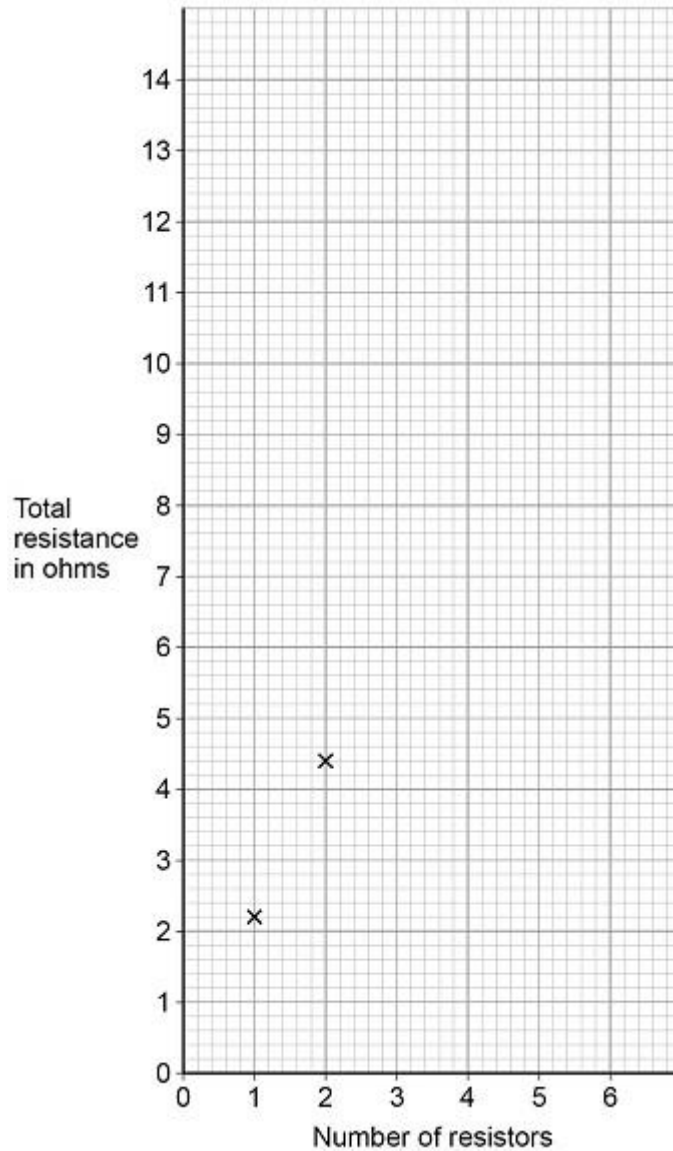
Number of resistors	Total resistance in ohms
1	2.2
2	4.4
3	6.6
4	8.8
5	11.0
6	13.2

(d) Complete the graph below using data from the table.

You should:

- plot the rest of the results
- draw a line of best fit.

Figure



(3)

- (e) The student concluded that there was a linear relationship between resistance and the number of resistors.

How do the results support this conclusion?

(1)

- (f) The student could have connected the resistors in parallel instead of in series.

How would the total resistance of three resistors in parallel compare with the total resistance of three resistors in series?

Tick (✓) **one** box.

Higher

Lower

The same

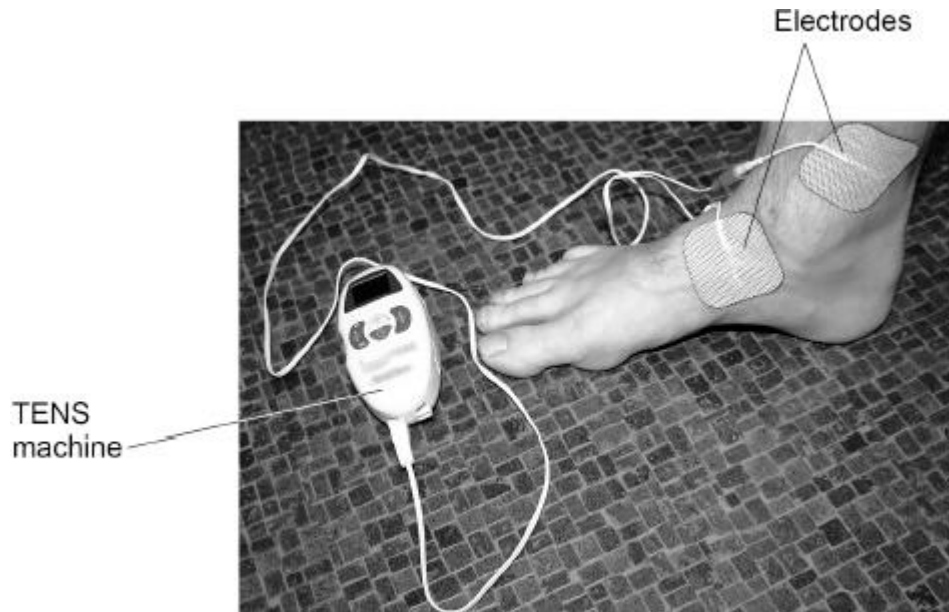
(1)
(Total 9 marks)

Q3.

A TENS machine uses an electrical current to relieve pain.

Figure 1 shows the electrodes of a TENS machine connected across an ankle.

Figure 1



- (a) The maximum power of the TENS machine is 240 mW.

The potential difference across the battery in the TENS machine is 2.5 V.

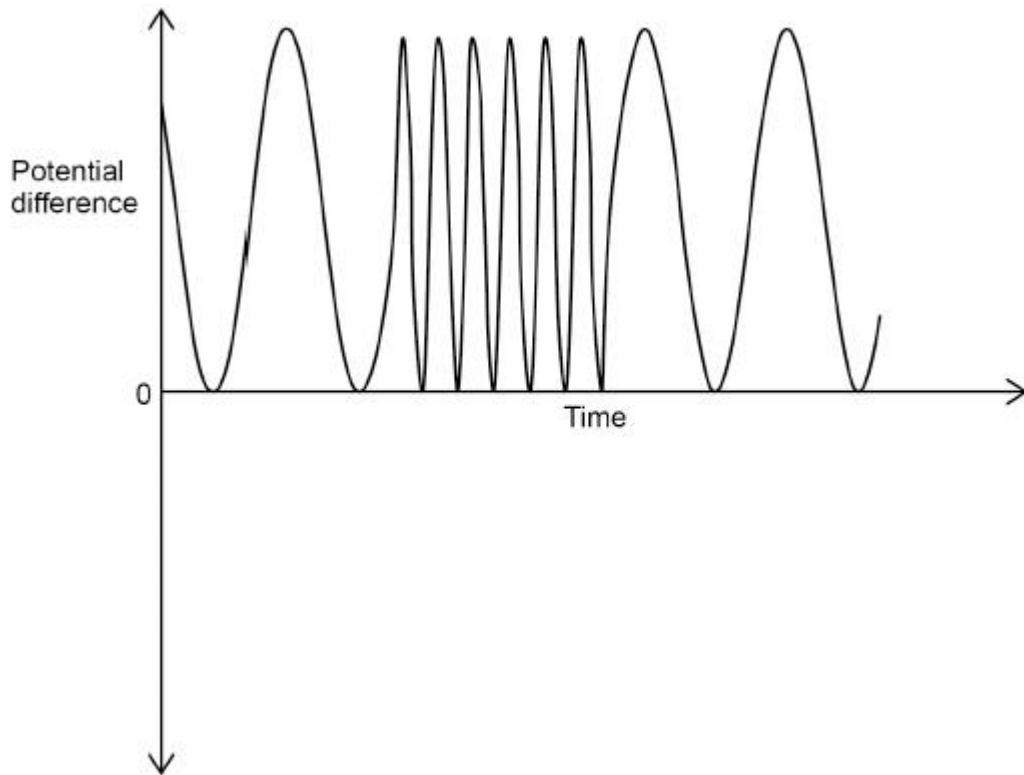
Calculate the maximum current from the battery.

Maximum current = _____ A

(4)

- (b) **Figure 2** is a sketch graph showing how the potential difference across the electrodes varies with time.

Figure 2



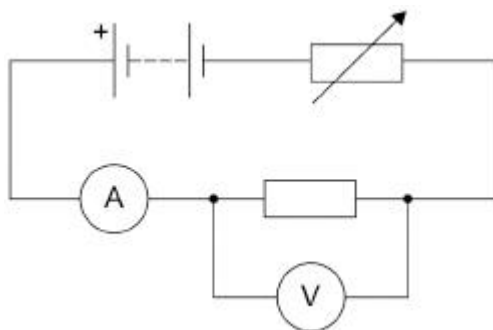
A student concluded that there was an alternating potential difference across the electrodes.

How does **Figure 2** show that the student was **not** correct?

(1)

Figure 3 shows a circuit the student built using the battery from the TENS machine.

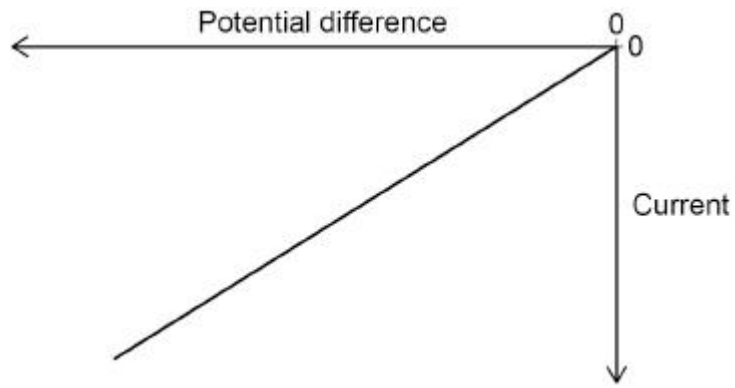
Figure 3



The student recorded how the current in the resistor varied with the potential difference across the resistor.

Figure 4 shows a sketch graph of the results.

Figure 4

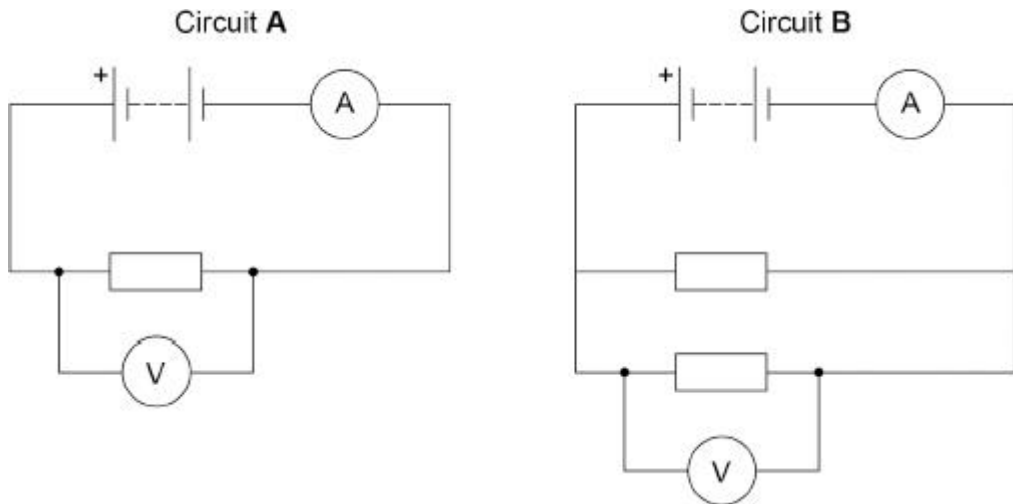


(c) What relationship does **Figure 4** show?

(1)

(d) **Figure 5** shows two more circuits that the student built using the battery from the TENS machine.

Figure 5



The resistors all have the same resistance.

Compare the readings on the voltmeter and ammeter in circuit **A** and circuit **B**.

Voltmeter _____

Ammeter _____

(3)

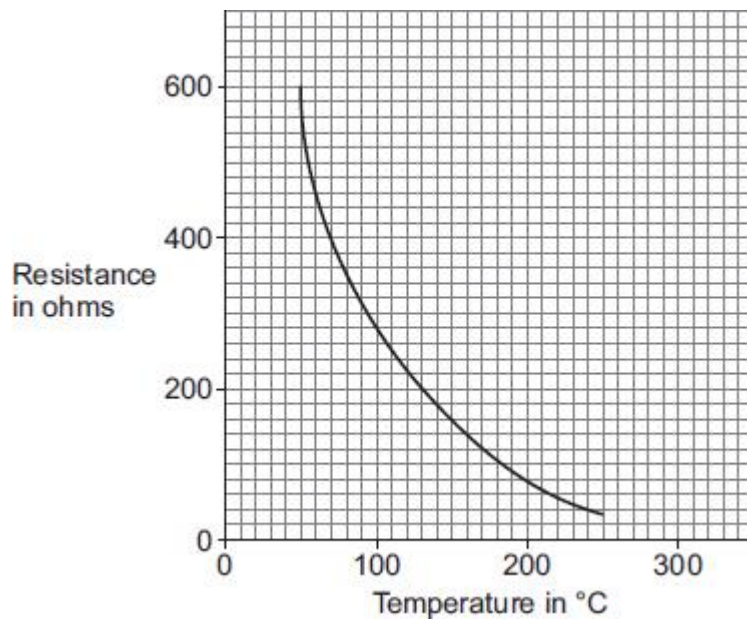
Q4.

A thermistor is used in an oven as part of a temperature sensor.

- (a) Draw the circuit symbol for a thermistor.

(1)

The graph below shows how the resistance of the thermistor varies with temperature.



- (b) Identify the temperature range when the thermistor is most sensitive to temperature change.

Tick (✓) **one** box.

Between 50 and 100 °C

Between 100 and 150 °C

Between 150 and 200 °C

Between 200 and 250 °C

(1)

(c) The potential difference across the thermistor is 15 V.

The current in the thermistor is 0.015 A.

Calculate the energy transferred by the thermistor in 20 minutes.

Energy transferred = _____ J

(5)

(d) The power output of the heating element in the oven is 0.72 kW.

The current in the heating element in the oven is 12 A.

Calculate the resistance of the heating element.


Resistance = _____ Ω

(4)

(Total 11 marks)

Mark schemes

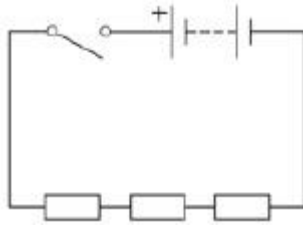
Q1.

- (a)  1
- (b) the flow of electrical charge 1
- (c) all 4 components connected in a series circuit
allow a cell instead of a battery
allow an LED or LDR symbol instead of a lamp
ignore the + sign on the battery symbol 1
- (d) decrease the resistance of the variable resistor 1
- (e) $P = 0.75 \times 0.16$ 1
 $P = 0.12 \text{ (W)}$ 1
- (f) charge flow = current \times time
 $Q = It$ 1
- (g) $200 \text{ mA} = 0.2 \text{ A}$ 1
 charge flow = 0.2×15
allow a correct substitution using an
incorrectly/not converted value for current 1
 charge flow = 3.0 (C)
allow a correct calculation using an
incorrectly/not converted value for current 1
- (h) 1.6 1
- (i) 260 mA to 380 mA 1

[12]

Q2.

- (a)



- (b) ammeter 1
- voltmeter 1
- (c) so the temperature of the resistors would remain constant 1
- (d) 4 points correctly plotted 1
allow tolerance of $\pm\frac{1}{2}$ a small square
allow 1 mark for 3 points correctly plotted 2
- straight line of best fit 1
- (e) line of best fit is straight 1
allow resistance increases by 2.2Ω each time
allow resistance increases by same amount each time
- (f) lower 1

[9]

Q3.

- (a) $240 \text{ mW} = 0.24 \text{ W}$ 1
- $0.24 = 2.5 \times I$ 1
allow a correct substitution using an incorrectly/not converted value of power
- $I = \frac{0.24}{2.5}$ 1
allow a correct re-arrangement using an incorrectly/not converted value of power
- $I = 0.096 \text{ (A)}$ 1
allow a correct calculation using an incorrectly/not converted value of power

- (b) because the potential difference is always positive
allow because potential difference does not change direction

1

- (c) potential difference is (directly) proportional to current

1

- (d) voltmeter: the reading is the same in both circuits

1

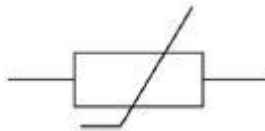
ammeter: the reading in circuit **B** is twice the reading of circuit **A**
allow 1 mark for the reading in circuit B is bigger than circuit A

2

[9]

Q4.

- (a)



1

- (b) between 50 and 100°C

1

- (c) $t = 1200$ (s)

1

$Q = 0.015 \times 1200$

this mark may score if t is not / incorrectly converted

1

$Q = 18$ (C)

this mark may score if t is not / incorrectly converted

1

$E = 18 \times 15$

this mark may score if t is not / incorrectly converted

1

$E = 270$ (J)

or

$P = 0.015 \times 15$ (1)

$P = 0.225$ (W) (1)

$t = 1200$ (s) (1)

$$E = 0.225 \times 1200 \text{ (1)}$$

$$E = 270 \text{ (J) (1)}$$

allow an answer consistent with their value of t

1

(d) $P = 720 \text{ (W)}$

1

$$720 = 12^2 \times R$$

this mark may score if P is not / incorrectly converted

1

$$R = \frac{720}{12^2}$$

this mark may score if P is not / incorrectly converted

1

$$R = 5.0 \text{ (}\Omega\text{)}$$

allow an answer consistent with their value of P

1

[11]