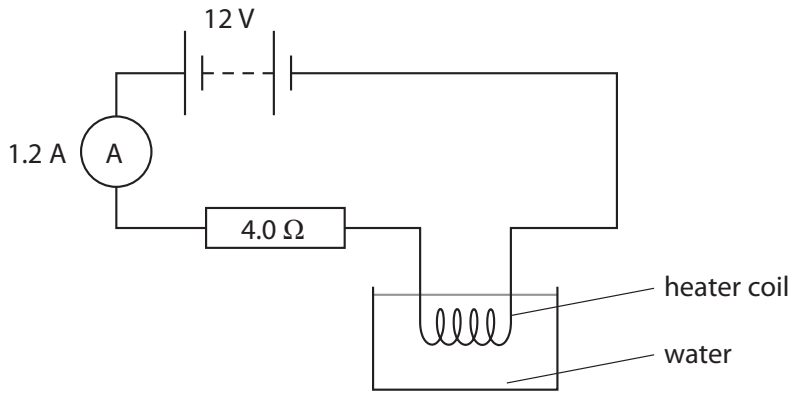
1 The diagram shows a heater coil and a resistor connected to a 12 V battery and an ammeter. The ammeter reading is 1.2 A.



(a) (i) State the equation linking voltage, current and resistance.

(1)

$V = I R$

(ii) Calculate the voltage across the 4.0 Ω resistor.

(2)

$V = I R = 1.2 \times 4$

$= 4.8\ V$

Voltage = 4.8 V

(iii) Show that the voltage across the heater coil is about 7 V.

(2)

$12 - 4.8 = 7.2$

(iv) Calculate the energy transferred to the heater coil in 5.0 minutes.

(3)

$E = Pt \qquad P = IV = 1.2 \times 7.2 = 8.64\ W$

$8.64 \times (5 \times 60) = 2592\ J$ Energy transferred = 2600 J

(v) At first, the temperature of the water increases.

After a while, the temperature reaches a steady value below the boiling point of water.

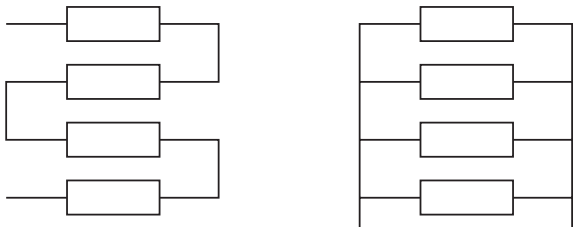
Explain why the temperature reaches a steady value.

(2)

As the water heats up it loses heat faster to the environment eventually the water reaches a temperature at which the rate of energy loss to the environment equals the rate of energy gained by the heating coil so the temperature stops increasing.

(b) Resistors can be used as heating elements in the rear windows of cars.

The diagram shows two possible designs.



X **Y**

(i) Complete the table by placing a tick (✓) in the correct boxes.

(1)

Design	Series	Parallel
X	✓	
Y		✓

(ii) Describe the advantages and disadvantages of design **X** when used as a heater in a car window.

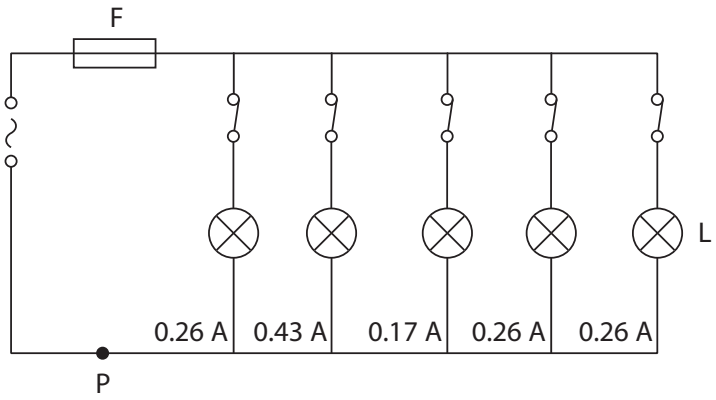
(3)

disadvantage: if one breaks they all stop working.
disadvantage: can't be controlled independently
advantage: fewer wires
advantage: can use lower resistance values

(Total for Question 1 = 14 marks)

2 The diagram shows part of a lighting circuit in a house.

The circuit is protected by fuse F.



(a) Give two reasons why the lamps are wired in parallel.

(2)

1 So they can be switched on and off individually

2 If one of the bulbs blows the rest will still work

(b) What is the current at P?

(1)

☒ **A** 0.17 A

☒ **B** 0.26 A

☒ **C** 0.43 A

☑ **D** 1.38 A

(c) Explain how the fuse protects the circuit.

(3)

If the current through the fuse becomes too large the fuse heats up and melts breaking the circuit and preventing further damage to other components in the socket

(d) (i) State the equation linking power, current and voltage.

(1)

$P = IV$

(ii) Calculate the power of lamp L.
[assume the mains voltage is 230 V]

(2)

$P = IV = 0.26 \times 230$

$= 59.8$

power = 60 W

(iii) Calculate the amount of energy transferred by lamp L in 3 minutes.

Give the unit.

(3)

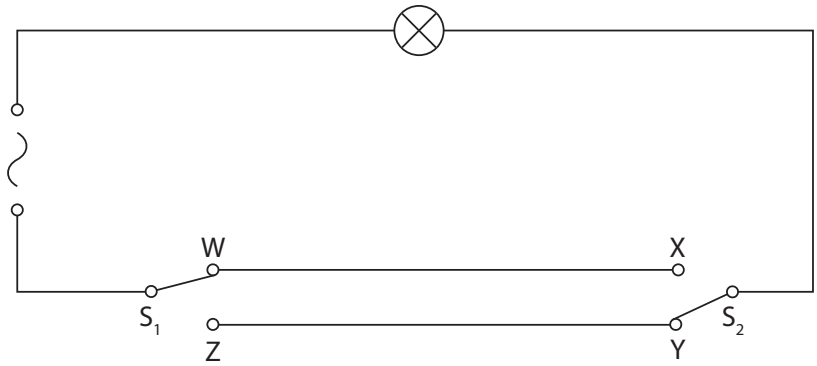
$E = Pt$

$= 60 \times (3 \times 60)$

$= 10,800$

energy transferred = 11,000 unit Joules

(e) This diagram shows another lighting circuit.



(i) Complete the table by putting a tick (✓) in the box if the lamp is lit and a cross (✗) in the box if the lamp is not lit.

(2)

S_1 position	S_2 position	lamp lit (✓ or ✗)
W	X	✓
W	Y	✗
Z	X	✗
Z	Y	✓

(ii) Suggest where this circuit would be useful in a house.

(1)

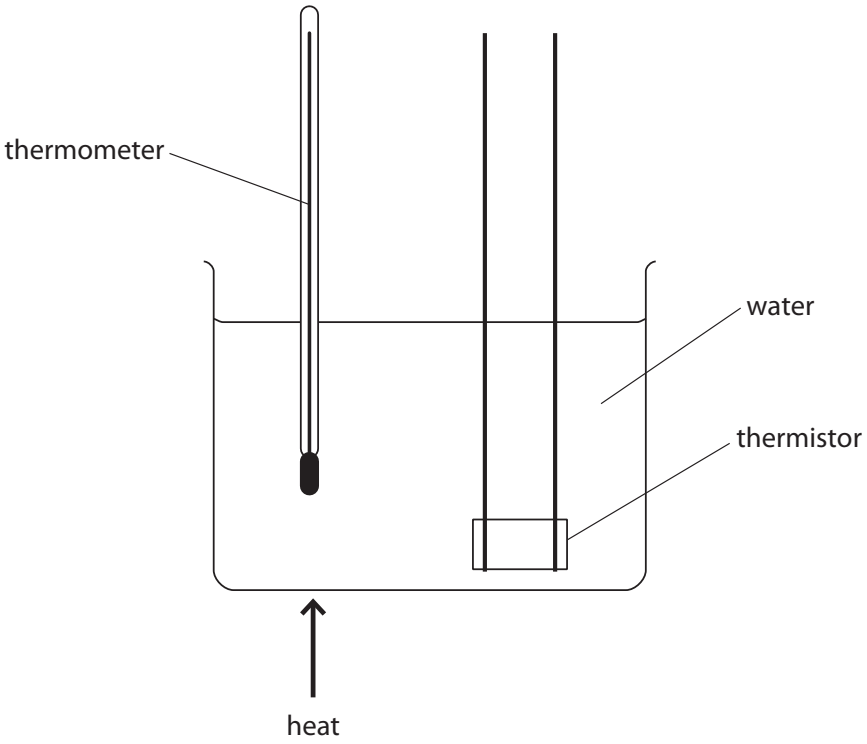
Have the switches at the top and bottom of a flight of stairs

(Total for Question 2 = 15 marks)

3 A student investigates how the voltage across a thermistor varies with temperature.

The student keeps the current in the thermistor constant, but varies the temperatures between 20 °C and 100 °C.

(a) The diagram shows how the student sets up his apparatus.



Suggest three changes to this set up that would improve the accuracy of the measurement of the thermistor temperature.

(3)

1 **Move the thermometer next to the thermistor**

2 **Stir the water to make sure it's the same temperature throughout.**

3 **heat the centre of the beaker**

(b) What instrument should the student use to measure the current in the thermistor?

(1)

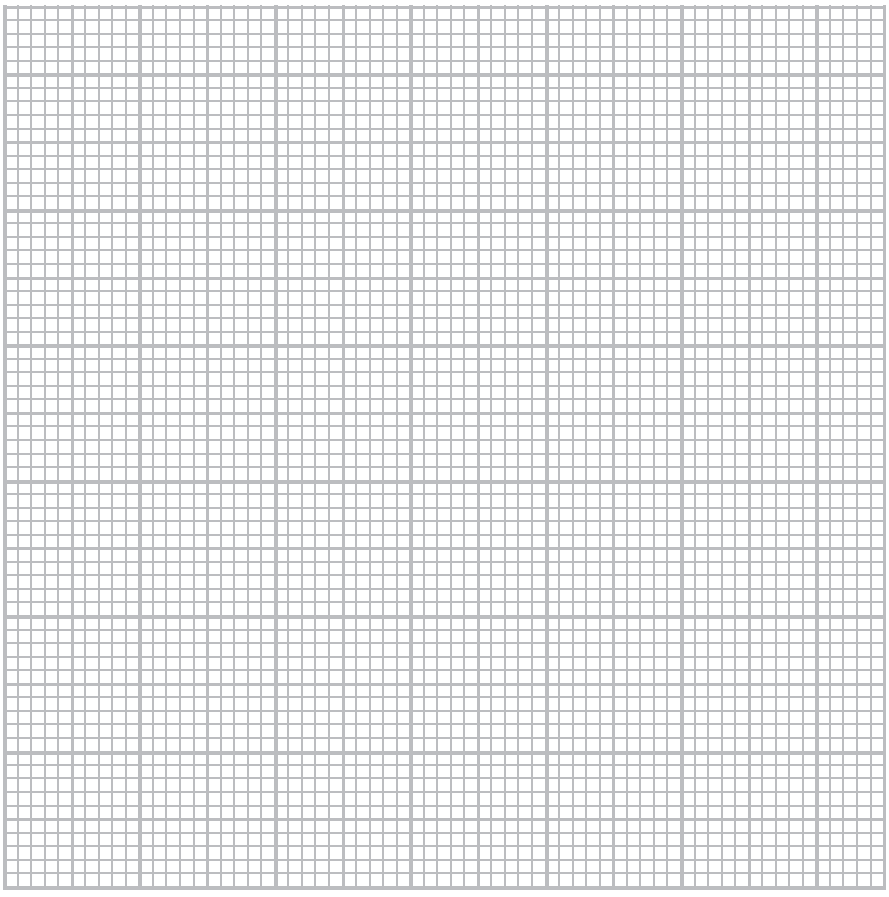
ammeter

(c) The table shows the student's results.

Temperature in °C	Voltage in V
20	6.0
40	2.2
60	1.1
80	0.2
100	0.4

(i) Plot a graph of voltage against temperature and draw the line of best fit.

(5)



(ii) Circle the anomalous point on your graph.

(1)

(d) (i) State the equation linking voltage, current and resistance.

(1)

V=IR

(ii) At room temperature the thermistor has a resistance of 680 Ω.

The voltage across it is 5.9 V.

Show that the current in the thermistor is about 8.5 mA.

(3)

V = IR
I = V/R
I = 5.9/680
I = 0.0087 A
I = 8.7mA

(Total for Question 3 = 14 marks)