Electricity 1

Name: _____

Class: _____

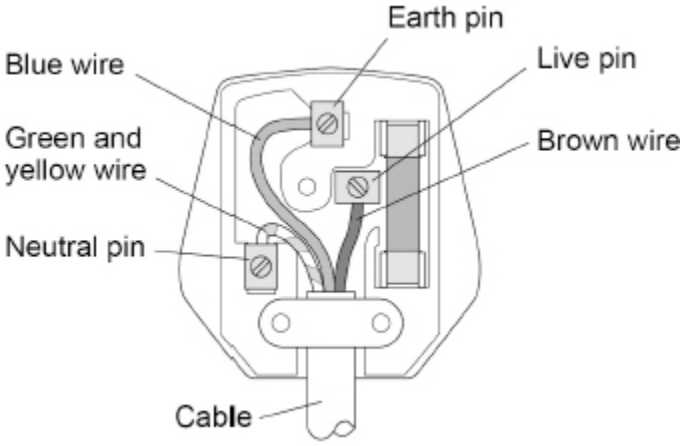
Date: _____

Time: **81 minutes**

Marks: **74 marks**

Comments:

1. The diagram below shows the inside of a plug.



(a) The plug is **not** wired correctly.

What should be done to connect the wires in the plug correctly?

_____

_____

(1)

The correctly wired plug and cable connects a washing machine to the mains electricity supply.

(b) Give the potential difference and frequency of the mains electricity supply in the UK.

The potential difference is _____ V

The frequency is _____ Hz

(2)

(c) The washing machine is switched on.

What is the potential difference between the neutral wire and the earth wire?

Potential difference = _____ V

(1)

(d) The plug has a fuse.

Draw the circuit symbol for a fuse in the space below.

(1)

The washing machine has a metal case.

A fault causes the live wire to make an electrical connection with the metal case of the washing machine.

(e) The earth wire is **not** connected to the metal case of the washing machine.

Explain why it would not be safe for a person to touch the metal case.

_____

_____

_____

_____

_____

_____

(2)

(f) The earth wire is now connected to the metal case of the washing machine.

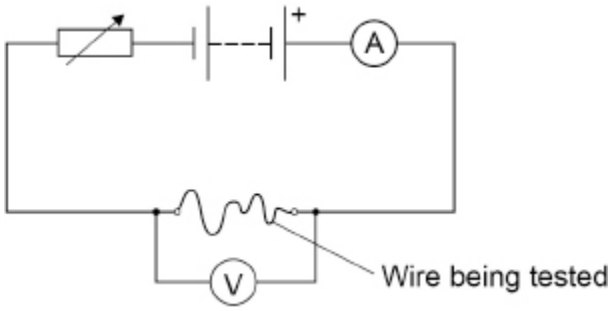
Explain why it would now be safe for a person to touch the metal case, even if the live wire touches the metal case.

(2)

(Total 9 marks)

2. A student investigated how the resistance of a piece of wire varies with its length.

(a) The diagram below shows the circuit used.



Explain why the student needed to adjust the variable resistor each time she changed the length of the wire.

(3)

(b) The student recorded three measurements of the potential difference across a 0.10 m length of wire.

The table below shows the results.

Length in m	**Potential difference in V**			
	1	2	3	Mean
0.10	**X**	0.18	0.15	0.17

Calculate **X** in table above.

_____

_____

_____

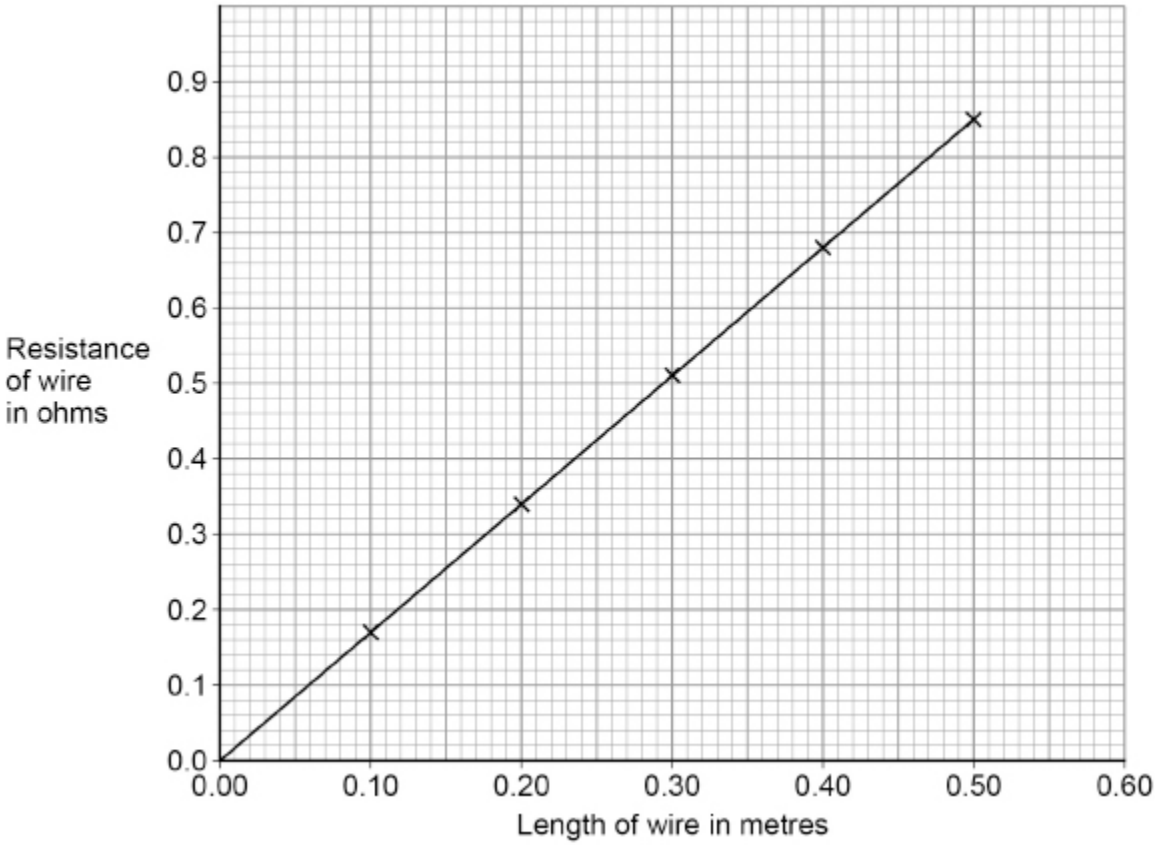
_____

X = _____ V

(2)

(c) **Figure 1** shows the results for five different lengths of the wire.

Figure 1



Describe the relationship between the length of the wire and the resistance of the wire.

_____

_____

_____

_____

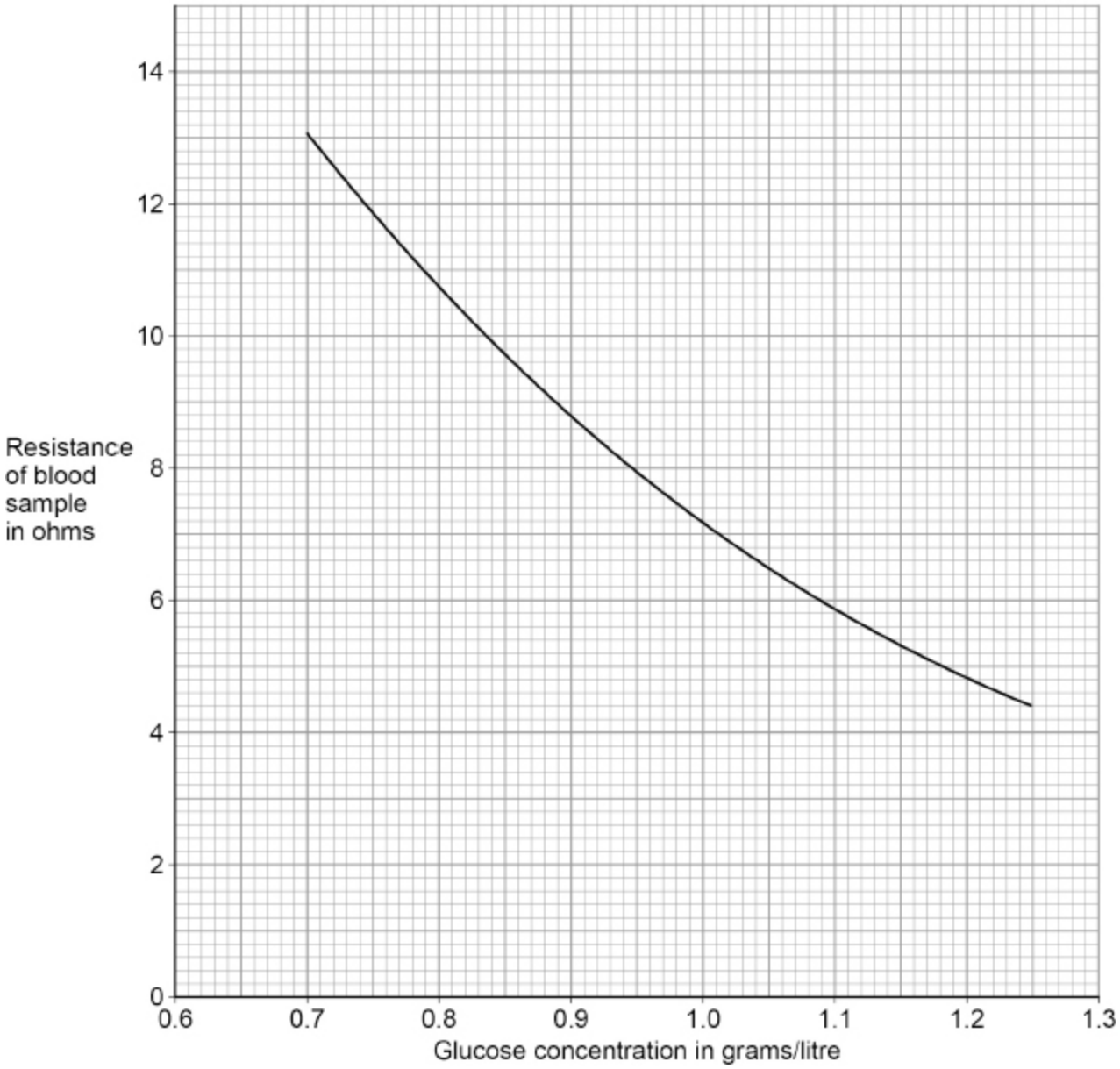
(2)

A glucometer uses the resistance of a blood sample to calculate the glucose concentration in a person's blood.

A blood sample is put into a small tube, which is put inside the glucometer. The blood then acts like a resistance wire.

Figure 2 shows the relationship between the resistance of a blood sample and the glucose concentration.

Figure 2


Resistance of blood sample in ohms
14
12
10
8
6
4
2
0
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
Glucose concentration in grams/litre

(d) The glucometer applies a potential difference of 0.90 volts across a blood sample.

The glucose concentration of the blood sample is 0.98 grams/litre.

Determine the current in the blood sample.

Current = _____ A

(4)

(e) A new tube is used each time a blood sample is tested.

Explain why valid results are only obtained if each tube is identical.

(2)

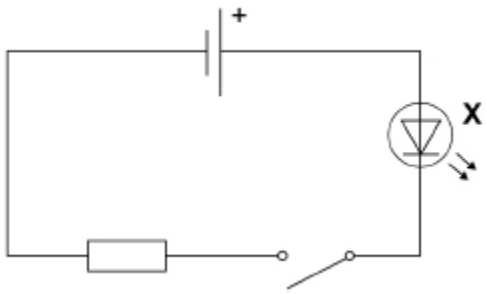
(Total 13 marks)

3. A designer made some shoes that have lights in them.

Each shoe has a switch which closes when a person puts their foot on the floor.

Figure 1 shows the circuit.

Figure 1



(a) What is component **X**?

Tick (✓) **one** box.

Lamp ☐

LDR ☐

LED ☐

(1)

(b) Complete the sentence.

Choose the answer from the box.

greater than	**less than**	**the same as**

When the switch was closed, the current in component **X** was

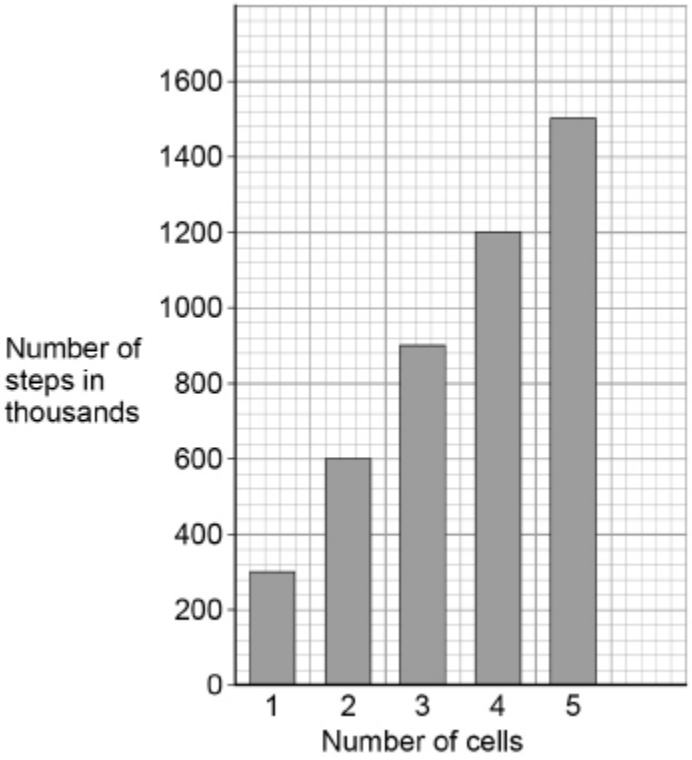
_____ the current in the resistor.

(1)

The designer tested how the number of cells affected the number of steps that could be taken before the lights stopped working.

Figure 2 shows the results.

Figure 2



(c) Determine how many more steps could be taken when the number of cells was increased from 3 to 5

_____

_____

Number of steps = _____ thousand

(2)

(d) How could the designer check the repeatability of the results?

Tick (✓) **one** box.

Repeat the experiment with a different resistor in the circuit. ☐

Repeat the experiment using exactly the same method. ☐

Repeat the experiment with different types of shoe. ☐

(1)

(e) When the potential difference across the resistor was 0.80 V, the current in the resistor was 0.020 A

Calculate the power dissipated by the resistor.

Use the equation:

power = potential difference × current

_____

_____

_____

Power = _____ W

(2)

(f) Which other equation can be used to calculate the power dissipated by a resistor?

Tick (✓) **one** box.

Power = (current)^2 × resistance ☐

Power = $\frac{\text{current}}{(\text{resistance})^2}$ ☐

Power = current × (resistance)^2 ☐

(1)

(g) What happens to the temperature of the resistor when there is a current in it?

_____

_____

(1)

(h) There was a current of 0.020 A in the resistor for 180 seconds.

Calculate the charge flow through the resistor.

Use the equation:

charge flow = current × time

_____

_____

_____

Charge flow = _____ C

(2)

(Total 11 marks)

4. The photograph shows a toaster.

The toaster is connected to the mains supply using a three-core cable.

(a) What is the function of the earth wire inside the cable?

Tick (✓) **one** box.

To carry the current from the supply to the toaster ☐

To complete the circuit in the toaster ☐

To melt if a fault occurs inside the toaster ☐

To stop the metal case of the toaster becoming live if a fault occurs ☐

(1)

(b) Complete the sentences.

Choose answers from the box.

blue	**brown**	**orange**	**white**	**yellow**

The insulation around the earth wire is green and _____ .

The insulation around the live wire is _____ .

The insulation around the neutral wire is _____ .

(3)

(c) The toaster is switched on for 120 seconds.

The power of the toaster is 850 watts.

Calculate the energy transferred by the toaster.

Use the equation:

energy transferred = power × time

_____

_____

_____

Energy transferred = _____ J

(2)

(d) Complete the sentences.

Choose answers from the box.

chemical	**elastic potential**	**kinetic**	**thermal**

When bread is lowered into the toaster, a spring is stretched. The stretched spring stores _____ energy.

After the bread is toasted, the spring makes the toast move upwards. As the speed of the toast increases, the _____ energy of the toast increases.

(2)

(e) Write the equation which links gravitational field strength, gravitational potential energy, height and mass.

_____

_____

(1)

(f) The toast was moved upwards by the spring.

The change in gravitational potential energy of the toast was 0.049 J

The mass of the toast was 0.050 kg

gravitational field strength = 9.8 N/kg

Calculate the change in height of the toast.

_____

_____

_____

_____

_____

_____

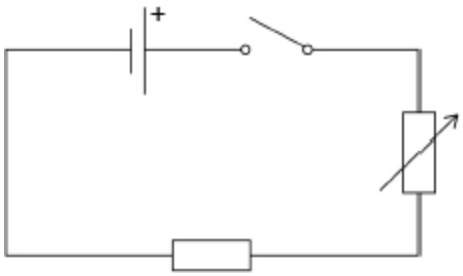
Change in height = _____ m

(3)

(Total 12 marks)

5. A student investigated how the current in a resistor varies with the potential difference across the resistor.

The diagram shows part of the circuit used.



(a) The student connected an ammeter and a voltmeter into the circuit.

What is the correct way to connect the ammeter and the voltmeter into the circuit?

Tick (✓) **one** box.

Ammeter	**Voltmeter**	
In parallel with the resistor	In series with the resistor	☐
In parallel with the cell	In series with the resistor	☐
In series with the resistor	In parallel with the resistor	☐
In series with the resistor	In parallel with the cell	☐

(1)

(b) The student increased the resistance of the variable resistor.

How did increasing the resistance affect the current in the circuit?

_____

_____

(1)

(c) How should the student change the circuit to give negative values for current and potential difference?

_____

_____

(1)

(d) Name the type of relationship between current and potential difference for a resistor at constant temperature.

_____

_____

(1)

(e) Write the equation which links current, potential difference and resistance.

_____

(1)

(f) The current in the resistor was 0.12 A when the potential difference across the resistor was 3.0 V

Calculate the resistance of the resistor.

_____

_____

_____

_____

_____

_____

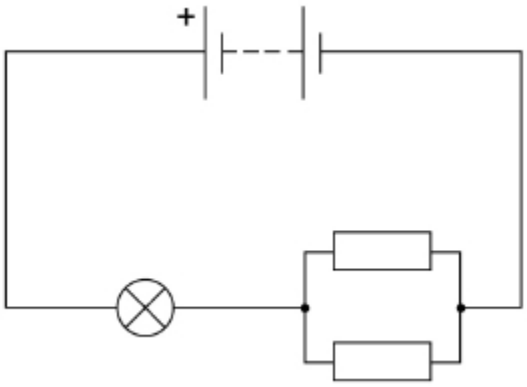
Resistance = _____ Ω

(3)

(Total 8 marks)

6. **Figure 1** shows a circuit that a student built.

Figure 1



(a) The lamp has a resistance of 10 Ω

Each resistor has a resistance of 10 Ω

What is the total resistance of the circuit?

Tick (✓) **one** box.

Between 20 and 30 Ω ☐

Exactly 20 Ω ☐

Exactly 30 Ω ☐

Less than 20 Ω ☐

(1)

(b) Explain your answer to part (a).

_____

_____

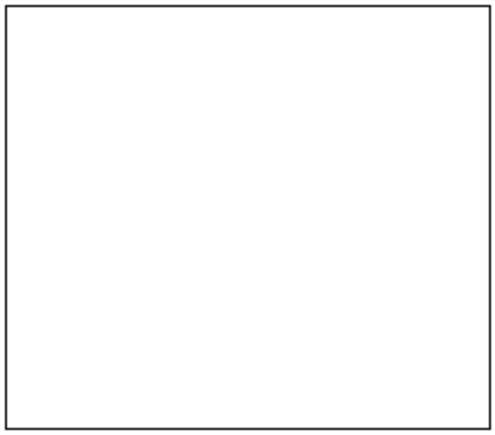
_____

_____

(2)

The student replaced one of the resistors with a thermistor.

(c) Draw the circuit symbol for a thermistor in the box below.



(1)

(d) The student increased the temperature of the thermistor.

Explain how the current in the thermistor changed.

_____

_____

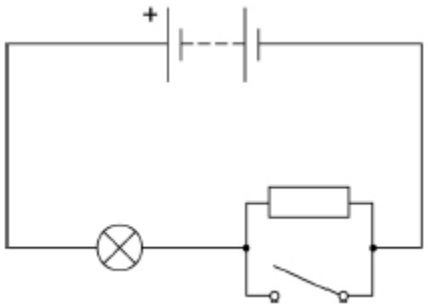
_____

_____

(2)

(e) **Figure 2** shows another circuit the student built.

Figure 2



Explain how the potential difference across the resistor and the lamp will change when the switch is closed.

The resistor _____

_____

_____

_____

The lamp _____

_____

_____

_____

(4)

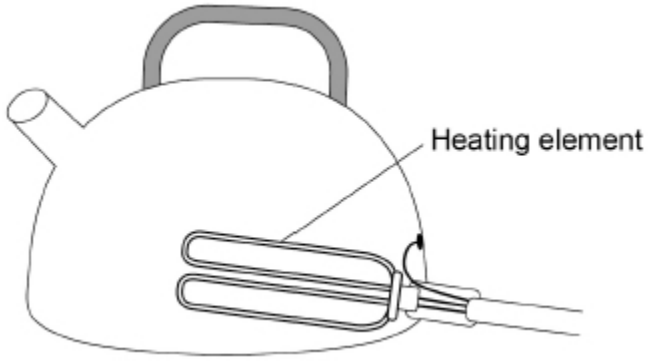
(Total 10 marks)

7. A student investigated how the mass of water in an electric kettle affected the time taken for the water to reach boiling point.

The kettle switched off when the water reached boiling point.

Figure 1 shows the kettle.

Figure 1



(a) The heating element of the kettle was connected to the mains supply.

Explain why the temperature of the heating element increased.

_____

_____

_____

_____

_____

_____

(2)

(b) Give **one** variable that the student should have controlled.

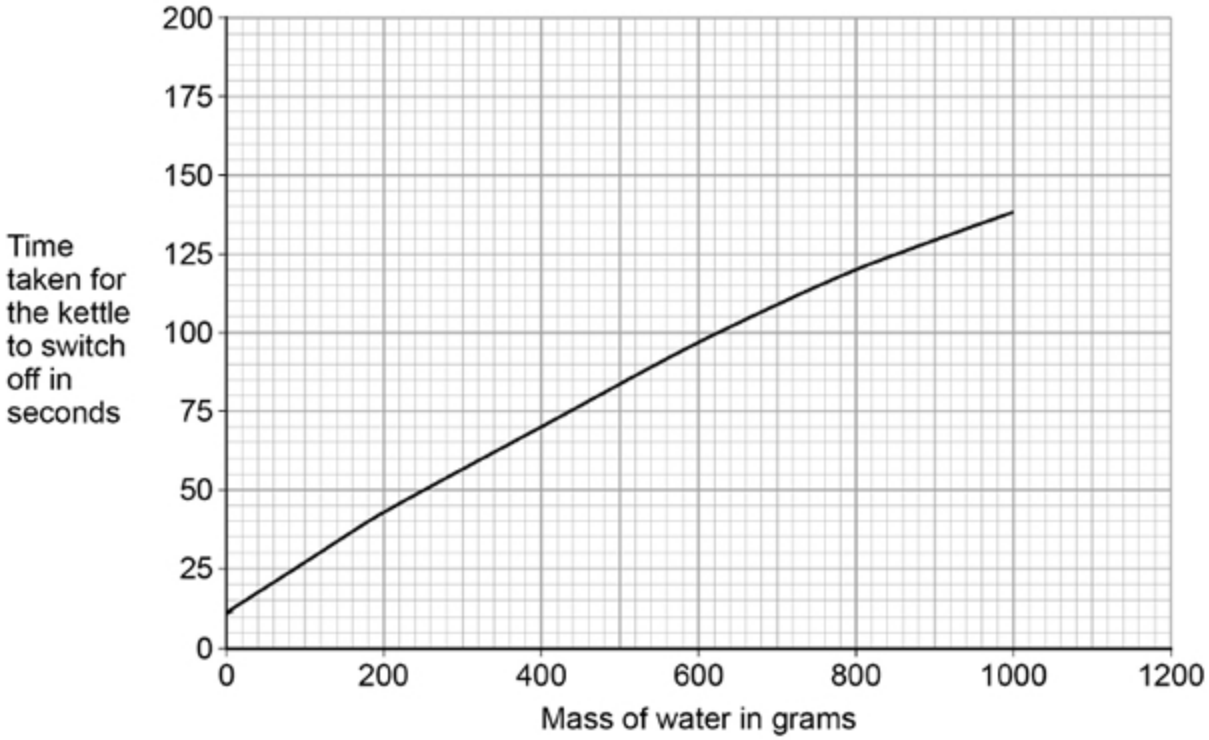
_____

_____

(1)

Figure 2 shows how the mass of water in the kettle affected the time taken for the kettle to switch off.

Figure 2



(c) Suggest why the line on **Figure 2** does **not** go through the origin.

_____

_____

(1)

(d) Suggest why the results give a non-linear pattern.

_____

_____

(1)

(e) The power of the kettle was 2.6 kW

The kettle took 120 seconds to heat 0.80 kg of water from 18 °C to 100 °C

Calculate the specific heat capacity of water using this information.

Give your answer to 2 significant figures.

Specific heat capacity = _____ J/kg °C

(6)

(Total 11 marks)

1. (a) swap the blue wire and the green and yellow wire

allow connect the blue wire to the neutral pin and the yellow and green wire to the earth pin.

allow swap the earth and neutral wires

ignore the earth wire and neutral wire are wrongly connected

1

(b) 230 (V)

1

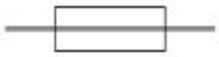
50 (Hz)

1

(c) 0 (V)

1

(d)



1

(e) the person could get an electric shock

allow so the person could be electrocuted

1

because there is a current in the person

allow because the person provides a connection (from the washing machine) to earth
allow because there is a potential difference across the person

1

(f) the charge flows through the earth wire (instead of the person)

1

because the resistance of the earth wire is much less than that of a person

allow so the case does not become live
allow so the fuse will break / melt / blow

1

[9]

2. (a) (the variable resistor) changes the resistance of the circuit

1

to keep the current the same

1

so the temperature of the wire is kept constant

allow to control the temperature of the wire

1

(b) $0.17 = \frac{X+0.18+0.15}{3}$

allow X = 3 × 0.17 – 0.18-0.15

1

X = 0.18 (V)

1

(c) resistance is directly proportional to length

allow length is directly proportional to resistance

allow as length increases resistance increases for 1 mark

allow positive correlation for 1 mark

2

(d) resistance = 7.5 (Ω)

allow a range from 7.4 to 7.6

1

0.90 = I × 7.5

allow their value of R read from the graph correctly substituted

1

$I = \frac{0.90}{7.5}$

allow a correct re-arrangement using their value of R read from the graph

1

I = 0.12 (A)

allow a value consistent with their value of R read from the graph

1

(e) the length/width/volume (of the blood sample) affects the resistance of the blood sample

allow length/width/volume (of the blood sample) should be a control variable

allow shape/size of the tube should be a control variable

ignore amount of blood

1

so only glucose concentration affects resistance

1

[13]

3. (a) LED

1

(b) the same as

1

(c)

*an answer of 600 (thousand) or 600 000 scores **2** marks*

*two correct readings from the graph scores **1** mark*

1500 − 900

allow a range of 1480 to 1520 and a range of 880 to 920

1

600 (thousand)

allow an answer in the range of 560 (thousand) to 640 (thousand) consistent with their allowed readings

1

(d) repeat the experiment using exactly the same method

1

(e) power = 0.80 × 0.020

1

power = 0.016 (W)

1

*an answer of 0.016 (W) scores **2** marks*

(f) power = (current)^2 × resistance

1

(g) temperature increases

1

(h)

*an answer of 3.6 (C) scores **2** marks*

Q = 0.020 × 180

1

Q = 3.6 (C)

1

[11]

4. (a) to stop the metal case of the toaster becoming live if a fault occurs

1

(b) yellow

1

brown

1

blue

1

(c) E = 850 × 120

1

E = 102 000 (J)

1

*an answer of 102 000 (J) scores **2** marks*

(d) elastic potential

1

kinetic

1

(e) gravitational potential energy = mass × gravitational field strength × height

or

$E_p = m\ g\ h$

allow gpe

1

allow any correct re-arrangement

(f) 0.049 = 0.050 × 9.8 × h

1

$$h = \frac{0.049}{0.050 \times 9.8}$$

1

h = 0.10 (m)

1

*an answer of 0.10 (m) scores **3** marks*

[12]

5. (a) ammeter in series with the resistor, voltmeter in parallel with the resistor

1

(b) current decreased

ignore slows down

1

(c) reverse the connections to the cell

allow battery for cell

allow reverse the cell

1

(d) (directly) proportional

do not allow inversely proportional

do not allow indirectly proportional

1

(e) potential difference = current × resistance

allow voltage for potential difference

or

V=IR

allow any correct re-arrangement

1

(f) 3.0 = 0.12 × R

1

$$R = \frac{3.0}{0.12}$$

1

R = 25 (Ω)

1

*an answer of 25 (Ω) scores **3** marks*

[8]

6. (a) less than 20 Ω

1

(b) the resistance of the lamp is added to the total resistance of the resistors in parallel

allow resistors in series add up

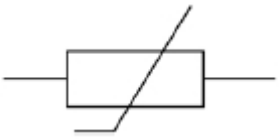
1

the resistors in parallel have a total resistance of less than 10 ohms

allow resistors in parallel have a smaller resistance than the lowest value resistor

1

(c)



1

(d) the current increased

1

(because) the resistance (of the thermistor) decreased

allow because the resistance of the circuit decreased

1

(e) **the resistor**

the potential difference across the resistor becomes 0V

1

because there is a short circuit across the resistor

allow because there is no current in the resistor allow switch has no resistance

1

*If neither of the first two marking points awarded, allow **1** mark for p.d. decreases because there is less current in the resistor*

or

p.d. decreases because components in parallel have less resistance

or

p.d. decreases because there is an alternative route for the current

the lamp

the potential difference across the lamp increases

allow the potential difference across the lamp will be the same as the battery

1

because the current increases

allow because the resistance of the circuit decreases

allow because there is less p.d. across the resistor

1

[10]

7. (a) electrons collide with particles in the heating element

allow there is a current in the heating element

1

which increases the (kinetic) energy of the particles (in the heating element)

allow internal store of energy increases

allow the particles (in the heating element) vibrate more rapidly

1

(b) the starting temperature of the water

allow the starting temperature of the kettle

1

(c) (the heating element of) the kettle took time to heat up

1

(d) the (rate of) energy transfer (per kg of water) to the surroundings decreases as the mass of water increases

allow the efficiency of the kettle changes as the mass of water changes

or

the efficiency of the kettle increases as the mass of water increases

allow the (rate of) energy transfer (per kg of water) to the surroundings changes as the mass of water changes

1

(e)

*an answer of 4800 (J/kg °C) scores **6** marks*

*a correct answer given to more than 2 s.f. scores **5** marks*

E = 2600 × 120

allow a correct substitution of an incorrectly/not converted value of P and/or t.

1

E = 312 000 (J)

this answer only

the equation E = Pt must have been used to score subsequent marks.

1

312 000 = 0.80 × c × (100-18)
or
312 000 = 0.80 × c × (82)

allow use of their value of E calculated using E = Pt for this and subsequent steps

1

$$c = \frac{312\,000}{0.80 \times 82}$$

1

c = 4 756

1

c = 4 800 (J/kg °C) (2 s.f.)

this mark can only be scored for a correct rounding of a value of c calculated using correct equations

1

[11]