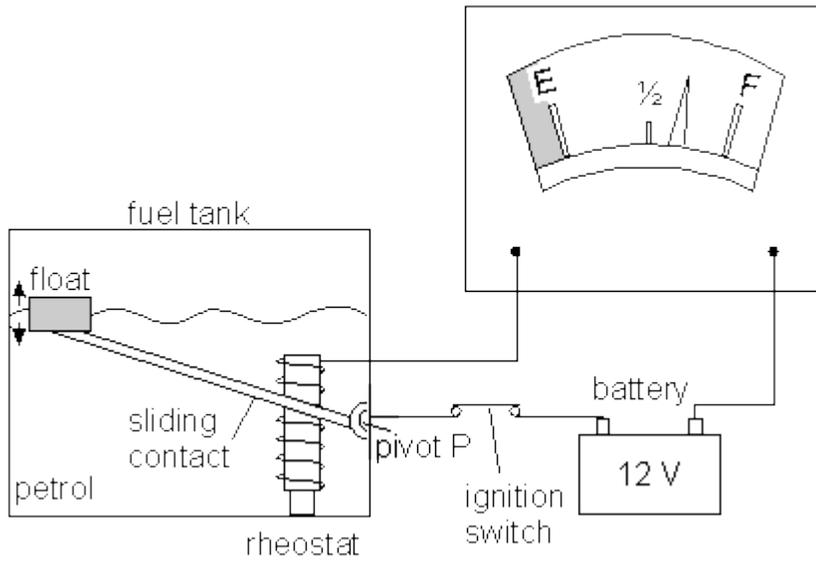**1** The diagram below shows how one type of fuel gauge in a car works. A sliding contact makes contact with a resistance wire wound in a coil (rheostat). It is connected to a float via a pivot P. When the petrol level changes the circuit resistance changes. This causes the pointer in the fuel gauge to move and show how much petrol is in the petrol tank.

The circuit diagram is shown below.
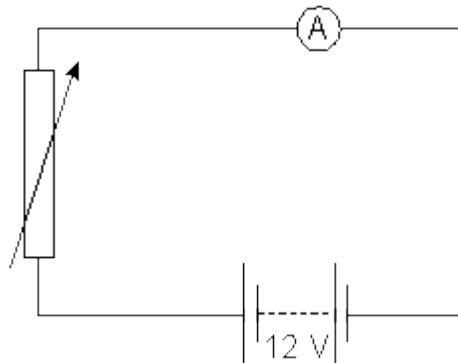
The petrol gauge is an ammeter. Explain why the reading on the ammeter falls as the petrol is used.

_____
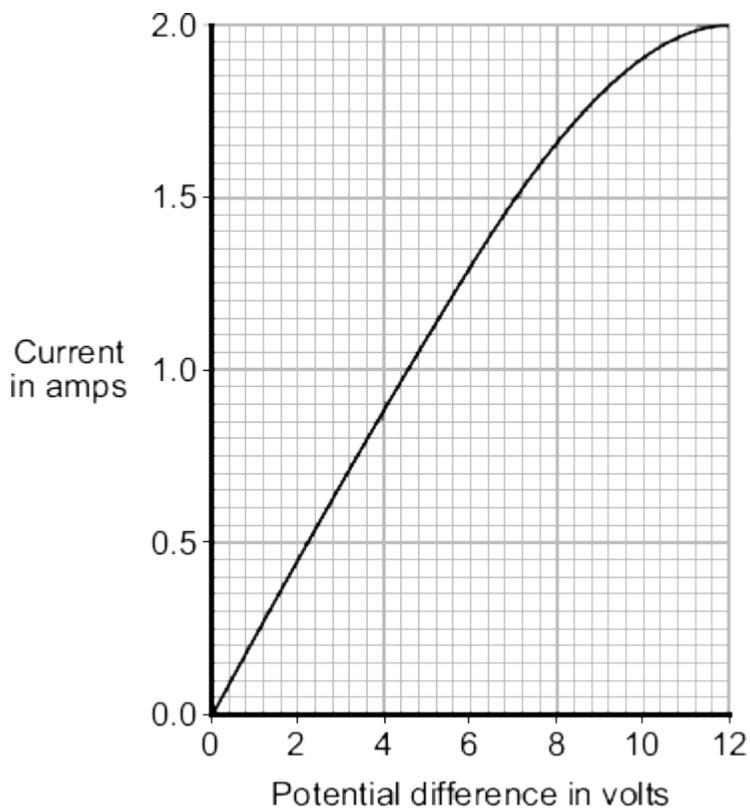
_____

_____

_____

(Total 3 marks)

2 The graph shows how the electric current through a 12 V filament bulb varies with the potential difference across the bulb.

(a) What is the meaning of the following terms?

electric current

_____

_____

potential difference

_____

_____

(2)

(b)   The resistance of the metal filament inside the bulb increases as the potential difference across the bulb increases.

Explain why.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(c)   Use data from the graph to calculate the rate at which the filament bulb transfers energy, when the potential difference across the bulb is 6 V.

Show clearly how you work out your answer.

_____

_____

Rate of energy transfer = _____ W

(2)

(Total 7 marks)

3   (a)   The resistance of a 24 W, 12 V filament lamp depends on the current flowing through the lamp. For currents up to 0.8 A, the resistance has a constant value of 2.5 Ω.

(i)   Use the equation in the box to calculate the potential difference across the lamp when a current of 0.8 A flows through the lamp.

┌───┐
│ potential difference   =   current   ×   resistance   │
└───┘
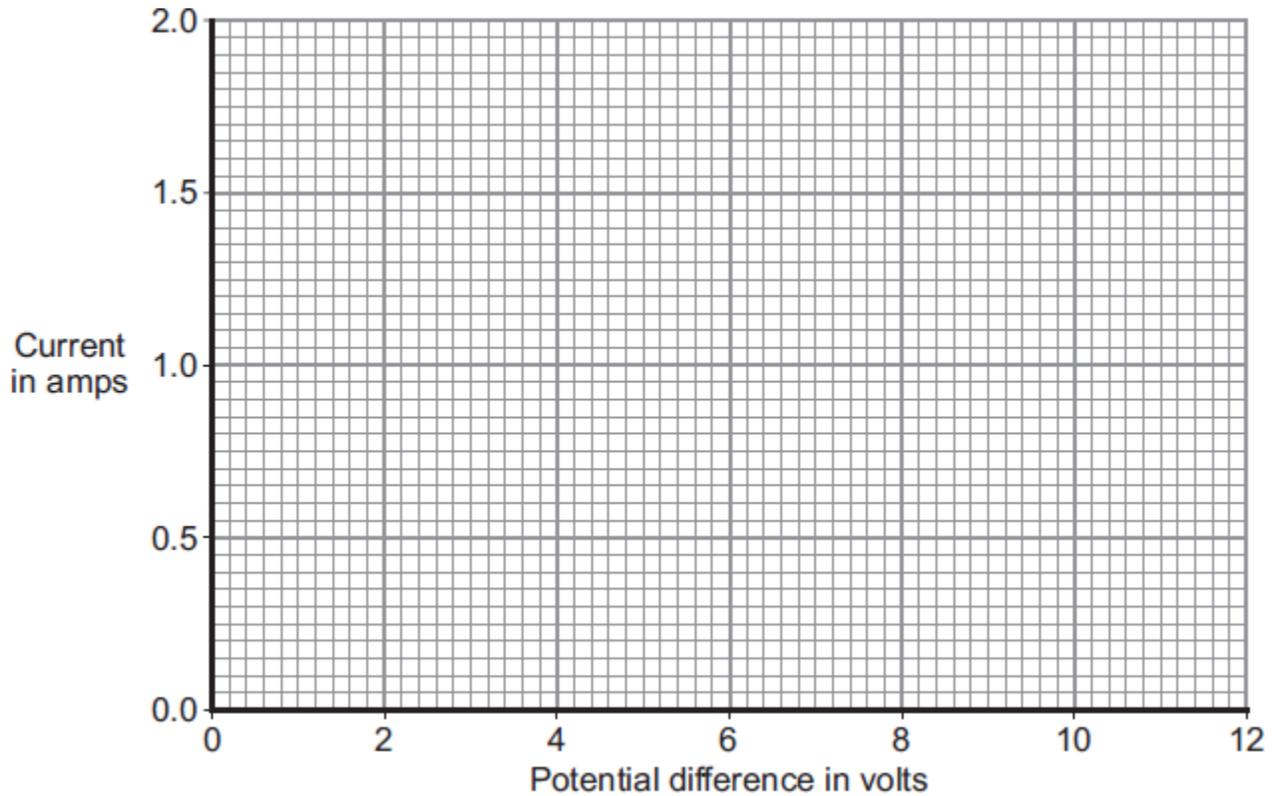
Show clearly how you work out your answer.

_____

_____

Potential difference = _____ V

(2)

(ii)   When the potential difference across the lamp is 12 V, the current through the lamp is 2 A.

On the axes below, draw a current–potential difference graph for the filament lamp over the range of potential difference from 0 to 12 volts.

(2)

(iii)   Why does the resistance of the lamp change when the current through the lamp exceeds 0.8 A?
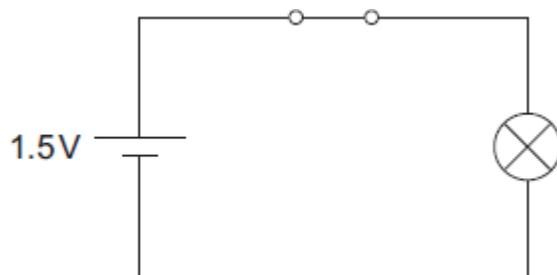
_____

_____

(1)

(b)   The lamp is now included in a circuit. The circuit is switched on for 2 minutes. During this time, 72 coulombs of charge pass through the lamp.

Use the equation in the box to calculate the energy transformed by the lamp while the circuit is switched on.

energy transformed   =   potential difference   ×   charge

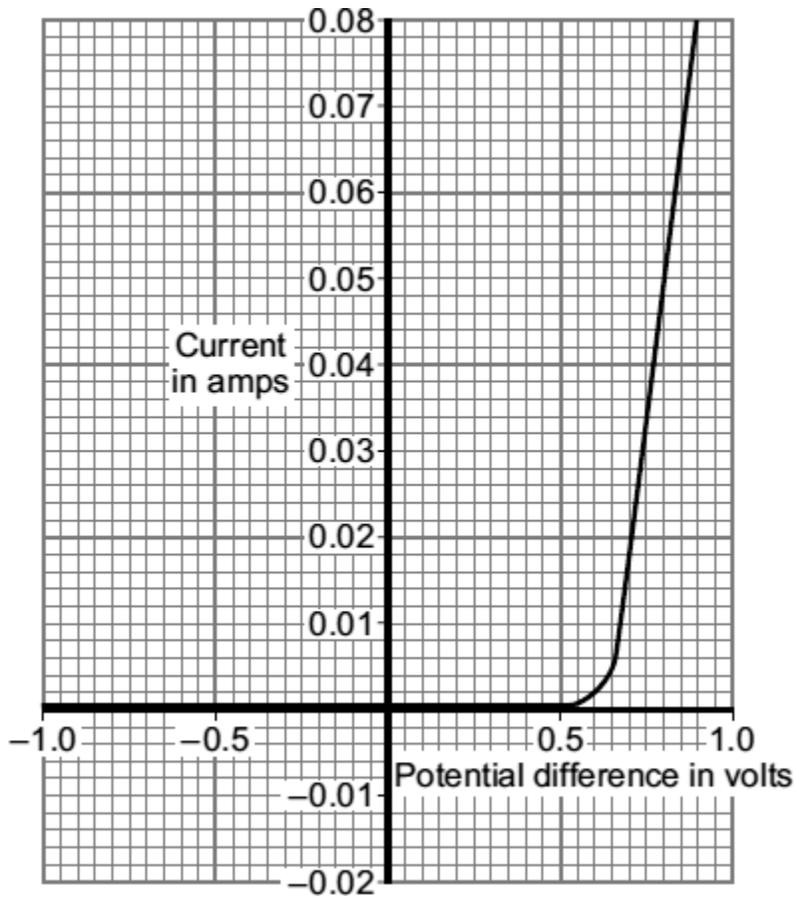Show clearly how you work out your answer.

_____

_____

Energy transformed = _____ J

(2)
(Total 7 marks)

4 The current-potential difference graph for one type of electrical component is drawn below.
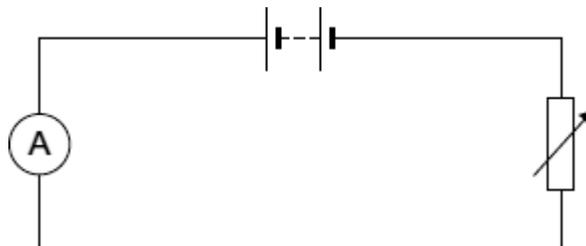

(a)   What is the component?

_____

(1)

(b)   Complete the diagram to show a circuit that can be used to obtain the data needed to plot the graph. Use the correct circuit symbol for each component that you add to the diagram.

(2)

(c)   (i)   What is the current through the component when the potential difference across the component is 0.8 volts?

Current _____ amps

(1)

(ii)   Calculate the resistance of the component when the potential difference across it is 0.8 volts.

Show clearly how you work out your answer.

_____

_____

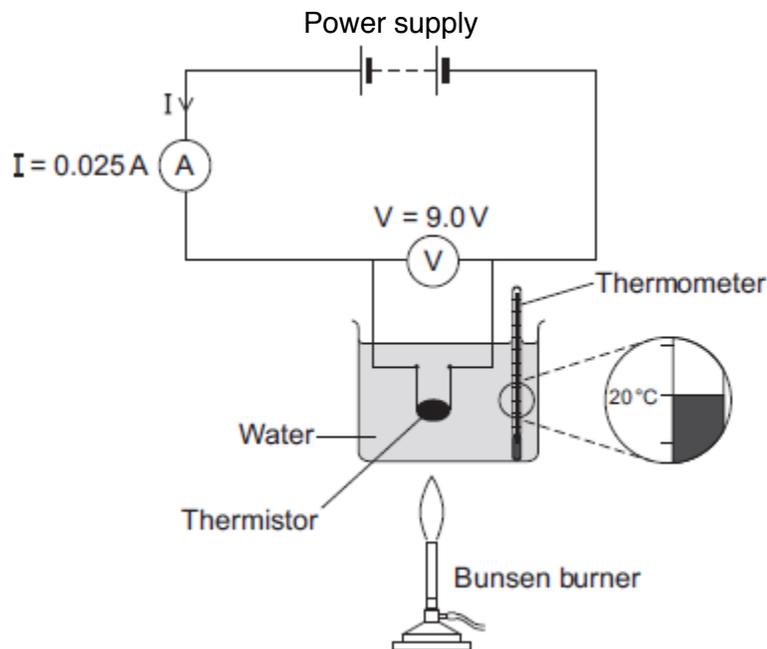Resistance = _____ Ω

(2)

(Total 6 marks)

5   (a)   **Figure 1** shows the apparatus used to obtain the data needed to calculate the resistance of a thermistor at different temperatures.

Figure 1

(i)   In the box below, draw the circuit symbol for a thermistor.

(1)

(ii)   Use the data given in **Figure 1** to calculate the resistance of the thermistor at 20 °C.
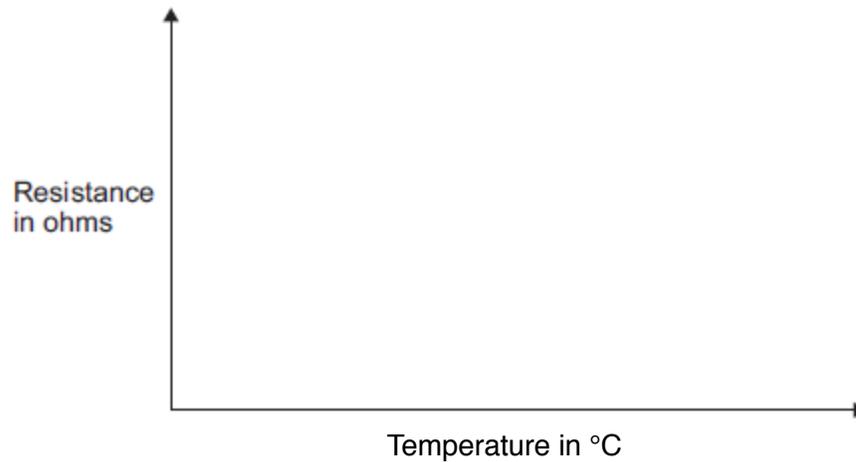
_____

_____

_____

Resistance = _____ ohms

(2)

(iii)   **Figure 2** shows the axes for a sketch graph.

Complete **Figure 2** to show how the resistance of the thermistor will change as the temperature of the thermistor increases from 20 °C to 100 °C.

Figure 2

Resistance in ohms

Temperature in °C

(1)

(iv)   Which **one** of the following is most likely to include a thermistor?

Tick (✓) **one** box.

An automatic circuit to switch a plant watering system on and off. ☐

An automatic circuit to switch an outside light on when it gets dark. ☐

An automatic circuit to switch a heating system on and off. ☐

(1)

(b)   The ammeter used in the circuit has a very low resistance.

Why is it important that ammeters have a very low resistance?

_____

_____

(1)

(c)   The table below gives the temperature of boiling water using three different temperature scales.

Temperature	Scale
100	Celsius (°C)
212	Fahrenheit (°F)
80	Réaumur (°Re)

Scientists in different countries use the same temperature scale to measure temperature.

Suggest **one** advantage of doing this.

_____

_____

_____

(1)

(d)   A student plans to investigate how the resistance of a light-dependent resistor (LDR) changes with light intensity.

The student starts with the apparatus shown in **Figure 2** but makes three changes to the apparatus.

One of the changes the student makes is to replace the thermistor with an LDR.

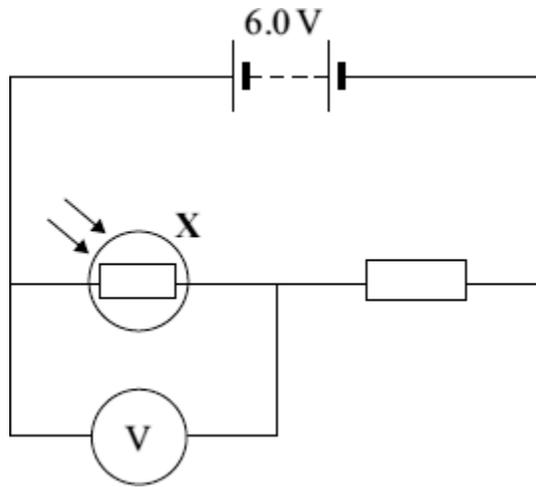Describe what other changes the student should make to the apparatus.

_____

_____

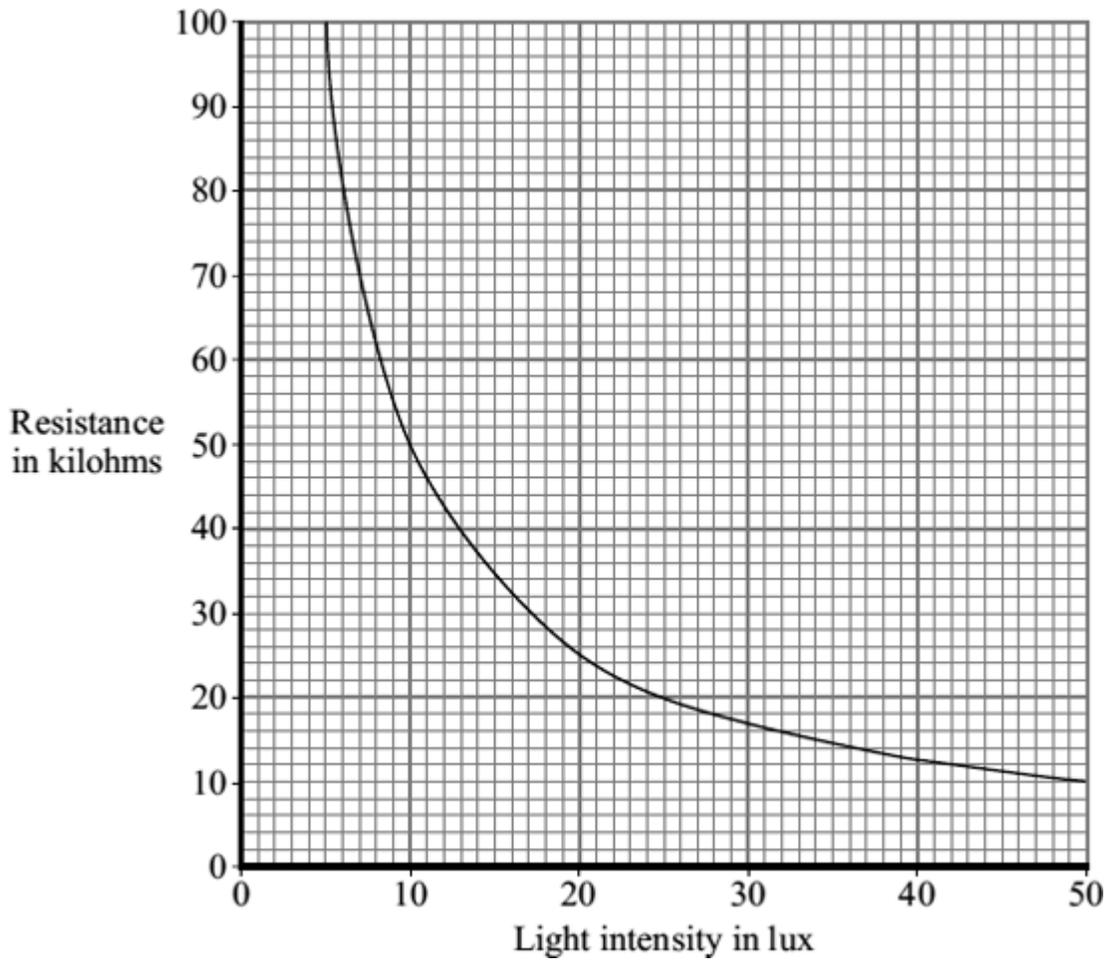_____

_____

(2)

(Total 9 marks)

6 The diagram shows a simple light-sensing circuit.

6.0 V

X

V

(a)   The graph, supplied by the manufacturer, shows how the resistance of the component labelled **X** varies with light intensity.

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

_____

(1)

(ii)   Use the graph to find the resistance of component **X** when the light intensity is 20 lux.

_____

(1)

(iii)   When the light intensity is 20 lux, the current through the circuit is 0.0002 A.

Calculate the reading on the voltmeter when the light intensity is 20 lux.

Show clearly how you work out your answer.
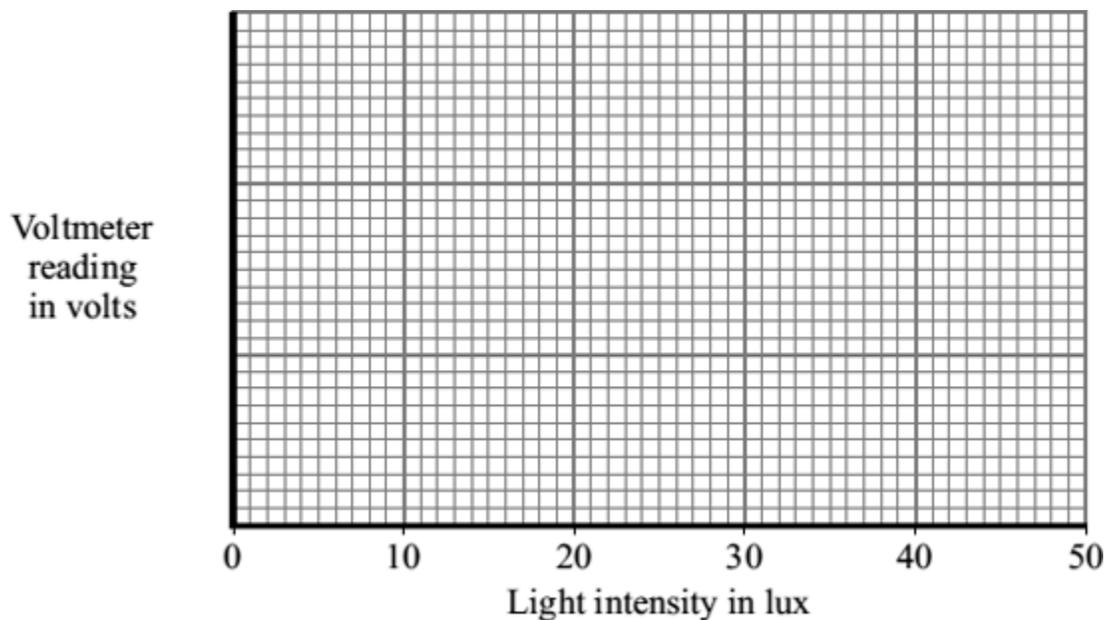
_____

_____

Voltmeter reading =_____ volts

(2)

(b)   Use the grid below to show how the voltmeter reading in the light-sensing circuit varies with light intensity.

(i)   Add a suitable scale to the *y*-axis (vertical axis).

(1)

(ii)   Complete the sketch graph by drawing a line on the grid to show how the voltmeter reading will vary with light intensity.

(2)

(c)   The following passage is taken from the technical data supplied for component **X** by the manufacturer.

> For any given light intensity, the resistance of this component can vary by plus or minus 50% of the value shown on the **graph of light intensity and resistance**.

(i)   Calculate the maximum resistance that component **X** could have at 20 lux light intensity.

_____

Maximum resistance =_____ kilohms

(1)

(ii)   Explain why this light-sensing circuit would **not** be used to measure values of light intensity.

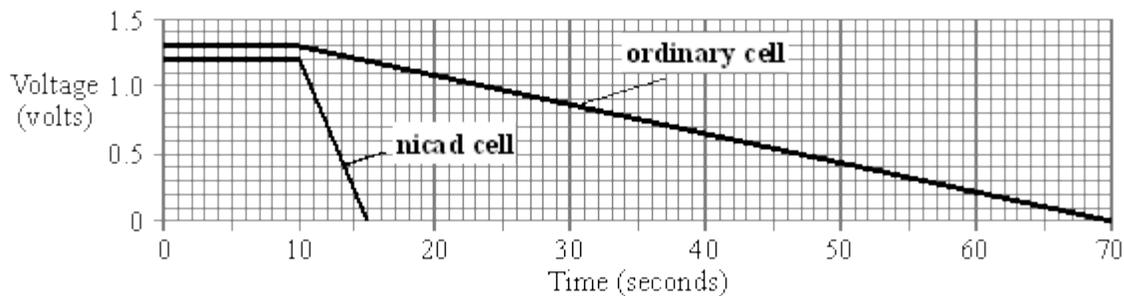_____

_____

_____

(2)

(Total 10 marks)

7   A small torch uses a single cell to make the bulb light up.

(a)   The graphs show the voltage across two different types of cell as they transfer the last bit of their stored energy through the torch bulb.
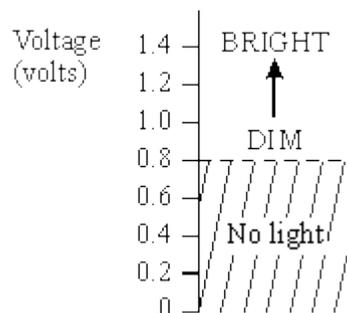

Describe the differences that the graphs show between the two types of cell.

_____

_____

(3)

(b)   The diagram shows how bright the torch bulb is for different voltages.

From the point when the voltage of each cell starts to fall, how long will the bulb stay lit:

(i)   with the ordinary cell?

_____

(ii)   with the nicad cell?

_____

(4)

(c)   When the voltage across the bulb falls to half, the current through the bulb falls by **less than** half. Why is this?

_____

_____
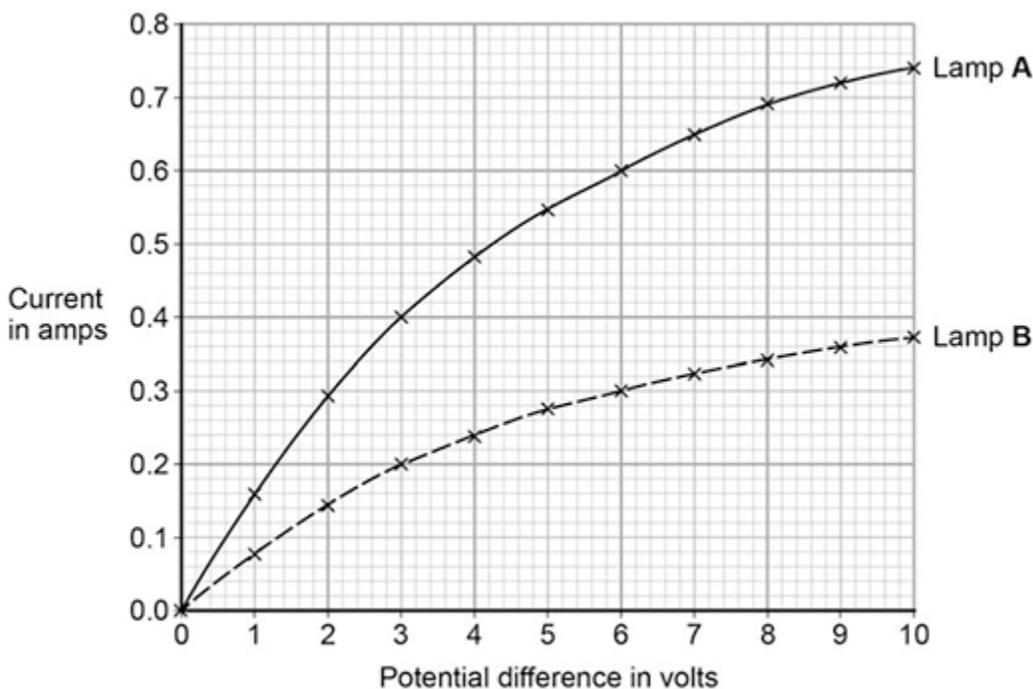
_____

_____

(3)

(Total 10 marks)

8   A student investigated how current varies with potential difference for two different lamps.

Her results are shown in the figure below.

(a)   Complete the circuit diagram for the circuit that the student could have used to obtain the results shown in the figure above.

(3)

(b)   Which lamp will be brighter at any potential difference?

Explain your answer.

Use the figure above to aid your explanation

_____

_____

_____

_____

(2)

(c)   Lamp **B** has the higher resistance at any potential difference.

Explain how the figure above shows this.

_____

_____

_____

_____

(2)

(d)   Both lamps behave like ohmic conductors through a range of values of potential difference.

Use the figure above to determine the range for these lamps.

Explain your answer.
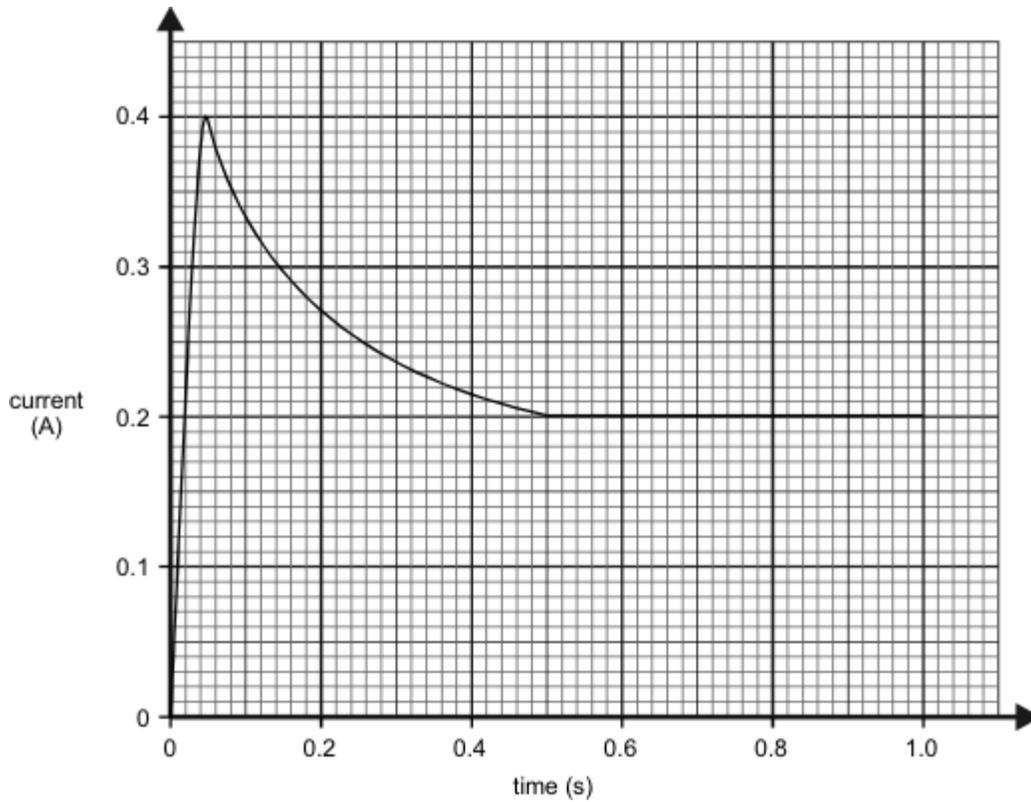
_____

_____

_____

_____

_____

_____

(3)
(Total 10 marks)

9 When a mains lamp is switched on it takes 0.5 seconds for the filament to reach its normal operating temperature. The way in which the current changes during the first second after switching on is shown in the sketch graph below. Mains voltage is 240 V.

(a) Calculate the resistance of the filament whilst the lamp is drawing the **maximum** current.

_____

_____

_____

(3)

(b) Describe how the resistance of the lamp changes after the current has reached its maximum value.

_____

_____

(2)

(c) Calculate the **maximum** power taken by the lamp.

_____

_____

_____

(2)

(d)   Calculate the power of the lamp in normal use.

_____

_____

_____

(2)

(e)   Calculate the energy used by the lamp in six hours of normal use.
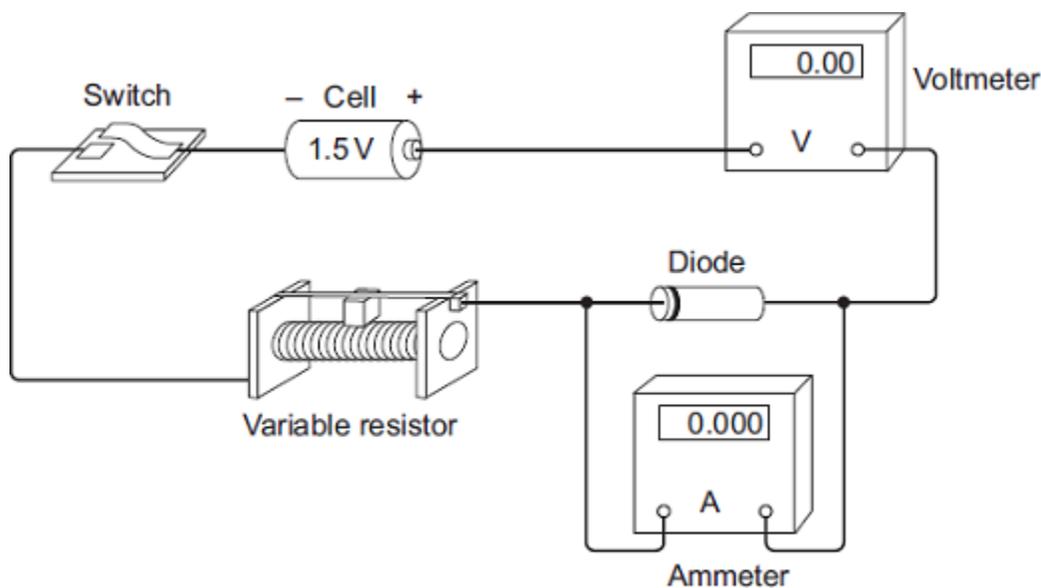
_____

_____

_____

(3)

(Total 12 marks)

10   (a)   A student set up the circuit shown in the diagram. The student uses the circuit to obtain the data needed to plot a current - potential difference graph for a diode.

(i)   Draw, in the boxes, the circuit symbol for a diode and the circuit symbol for a variable resistor.

Diode	**Variable resistor**

(2)

(ii)   The student made two mistakes when setting up the circuit.

What **two** mistakes did the student make?

1. _____

_____

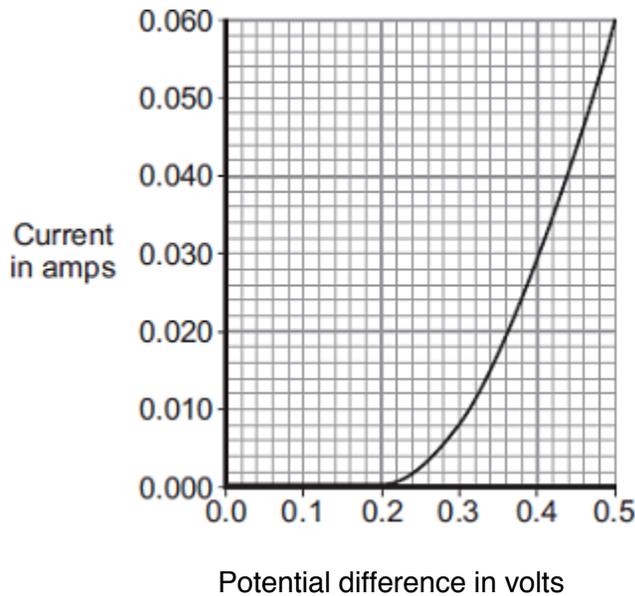2. _____

_____

(2)

(b)   After correcting the circuit, the student obtained a set of data and plotted the graph below.

Potential difference in volts

(i)   At what potential difference did the diode start to conduct an electric current?

_____ V

(1)

(ii)   Use data from the graph to calculate the resistance of the diode when the potential difference across the diode is 0.3 V.

_____
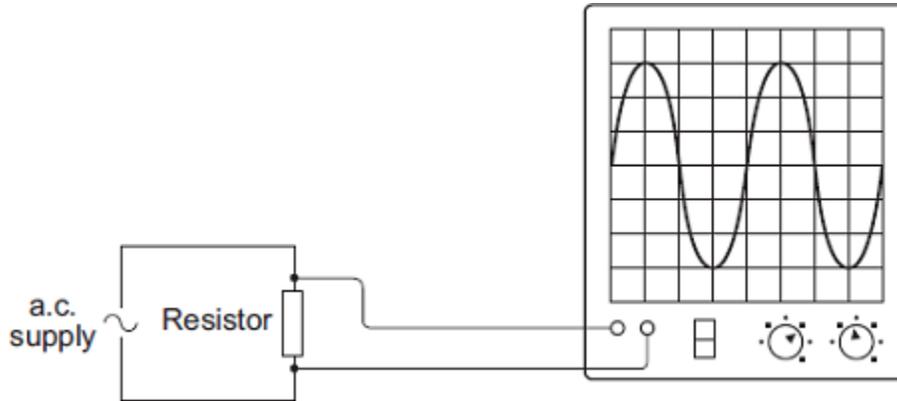
_____

_____

Resistance = _____ ohms

(3)

(c)   The diagram shows the trace produced by an alternating current (a.c.) supply on an oscilloscope.

Each horizontal division on the oscilloscope screen represents a time of 0.01s.
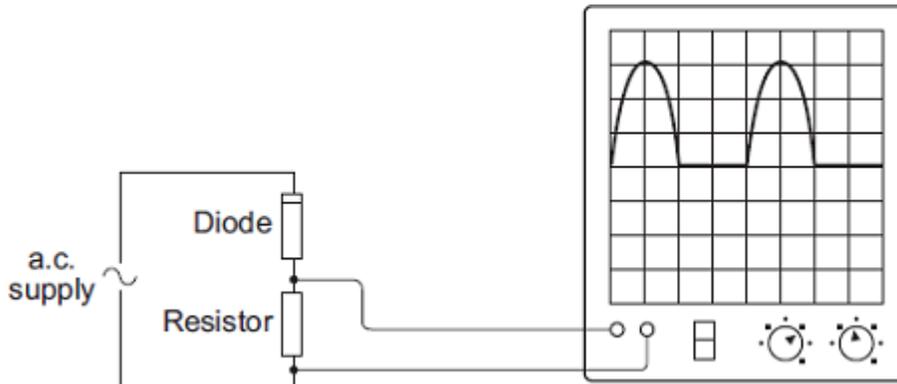
(i)   Calculate the frequency of the a.c. supply.

_____

_____

_____

Frequency = _____ hertz

(2)

(ii)   A diode is now connected in series with the a.c. power supply.

Why does the diode cause the trace on the oscilloscope screen to change?

_____

_____

_____

_____

(2)

(Total 12 marks)