5 The photograph shows a statue of Buddha in Sri Lanka, which is protected by a lightning conductor.

(a) During a storm, a potential difference of 2.7 MV was generated between a cloud and the top of the lightning conductor on the statue. A flash of lightning passed between the cloud and the lightning conductor, producing a current of 25 kA for a time of 7.5 ms.

Calculate the energy transferred by the lightning strike.

(3)

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.....

Energy transferred = ...

(b) The lightning conductor is a length of copper wire with a diameter of 1.2×10^{-2} m and a resistance of 4.3×10^{-3} Ω. It runs along the back of the statue from the base to a height of 1.5 m above the top of the statue.

A guidebook claims that the statue is over 30 m high.

Assess the validity of this claim.

resistivity of copper = 1.7×10^{-8} Ω m

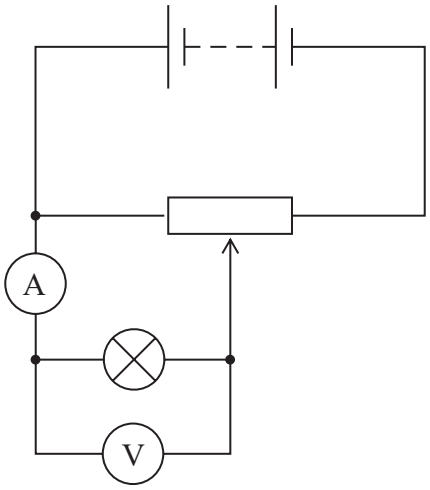
(4)

(c) Give a reason why the lightning conductor should be taller than the statue.

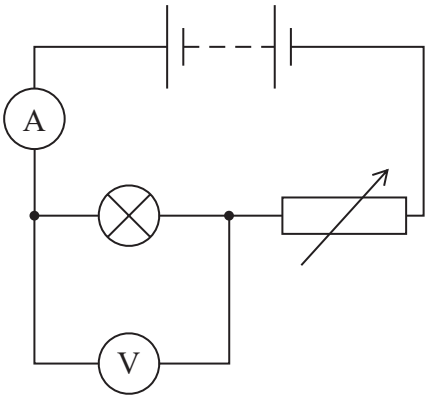
(1)

(Total for Question 5 = 8 marks)

9 A student is planning to collect data to produce a current-potential difference graph for a filament lamp. Her teacher suggests two circuits that she could use.



Circuit 1



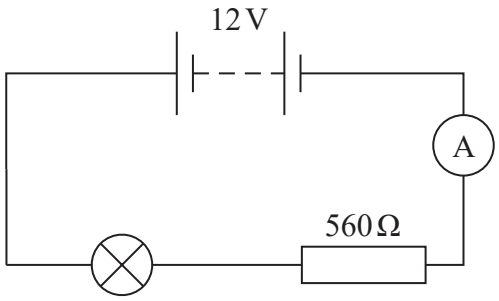
Circuit 2

Circuit 1 uses a potential divider and circuit 2 uses a variable resistor to vary the potential difference across the filament lamp.

*(a) Discuss the suitability of each circuit to collect the data.

(6)

(b) The student sets up the following circuit with the filament lamp. The battery has negligible internal resistance.



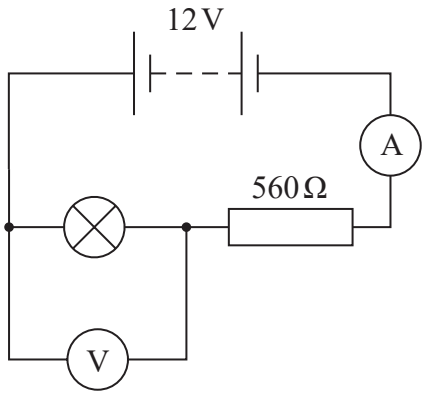
(i) The reading on the ammeter is 17.5 mA.

Calculate the value of the potential difference (p.d.) across the filament lamp.

(2)

p.d. across filament lamp = ...

(ii) When a voltmeter with a resistance of 1.5 kΩ is connected as shown, the p.d. across the filament lamp decreases.

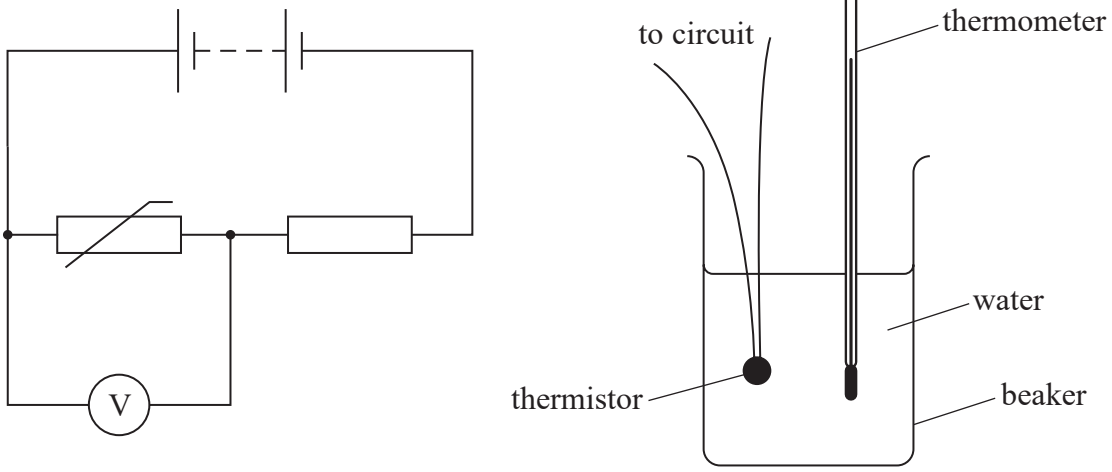


Explain why the p.d. across the filament lamp decreases.

(3)

(Total for Question 9 = 11 marks)

11 A student carried out an experiment to calibrate a thermistor. She connected the thermistor in series with a resistor and a power supply as shown. Then she placed the thermistor in a beaker of hot water and used a thermometer to record the temperature θ of the water.



The student recorded θ and corresponding values of the reading V on the voltmeter as the water cooled.

(a) Explain, making reference to charge carriers, why V increased as the water cooled.

(3)

(b) Over a limited temperature range V varies with θ according to the expression

$$V = V_0 e^{-b\theta}$$

where b and V_0 are constants.

(i) Explain why a graph of $\ln V$ against θ would give a straight line.

(2)

(ii) The student's data is shown in the table below.

θ/°C	V/V	
89.0	1.9	
74.0	2.9	
53.5	4.9	
32.5	9.1	
18.5	12.6	
3.5	18.7	

Plot a graph of $\ln V$ against θ on the grid opposite. Use the column provided to show any processed data.

(5)

(iii) Determine values for b and V_0.

(4)

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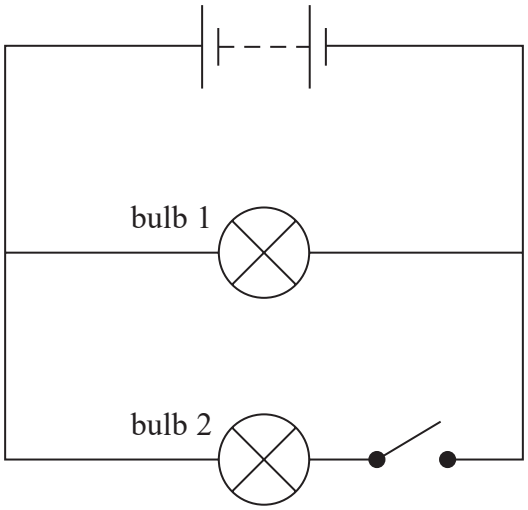
$b =$ .....

$V_0 =$ .....

(Total for Question 11 = 14 marks)

2 A battery has an e.m.f. of 12 V and an internal resistance of 0.50 Ω. The battery is connected into a circuit, as shown.



Each bulb has a normal working power of 40 W when a potential difference (p.d.) of 12 V is applied.

(a) Initially the switch is open.

Calculate the terminal p.d. of the battery when bulb 1 is lit. Assume that the resistance of the bulb has its normal working value.

(4)

Terminal p.d. of battery = ...

(b) Explain how the brightness of bulb 1 changes when the switch is closed. No further calculations are necessary.

(3)

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(Total for Question 2 = 7 marks)