SECTION A

Answer ALL questions.

All multiple choice questions must be answered with a cross in the box ☒ for the correct answer from A to D.
If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Select the row of the table that identifies an SI base unit and a derived unit.

		Base unit	Derived unit
☒	**A**	coulomb	ampere
☒	**B**	joule	volt
☒	**C**	newton	kilogram
☒	**D**	second	watt

(Total for Question 1 = 1 mark)

2 A constant current maintained in a copper wire causes the temperature of the wire to increase.

Which of the following does **not** increase?

☒ **A** amplitude of vibration of the lattice ions

☒ **B** number of conduction electrons per unit volume

☒ **C** rate of collision of conduction electrons with lattice ions

☒ **D** rate of energy transfer from conduction electrons to lattice ions

(Total for Question 2 = 1 mark)

3 A car of mass 1.5×10^3 kg is travelling at a speed of 25 m s^{-1}. The driver applies the brakes and the car comes to rest.

Which of the following gives the decrease in kinetic energy, in joules, as the car is brought to rest?

☒ **A** $750 \times (25)^2$

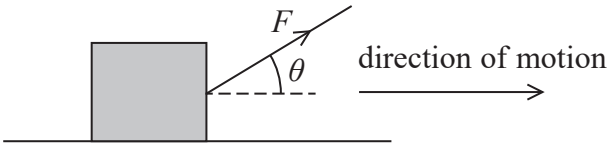
☒ **B** $750 \times \left(\frac{25}{2}\right)^2$

☒ **C** $1500 \times (25)^2$

☒ **D** $1500 \times \left(\frac{25}{2}\right)^2$

(Total for Question 3 = 1 mark)

4 A rope is used to apply a force F to a box as shown. The box is pulled a distance d along a horizontal surface.



Which of the following could be used to determine the work done on the box?

☒ **A** $Fd \sin\theta$

☒ **B** $\dfrac{Fd}{\sin\theta}$

☒ **C** $Fd \cos\theta$

☒ **D** $\dfrac{Fd}{\cos\theta}$

(Total for Question 4 = 1 mark)

5 A torch is switched on for 5 minutes. The current in the torch bulb is 6 mA.

Which of the following gives the charge, in coulombs, that flows in this time?

☒ **A** $6 \times 10^{-3} \times 5$

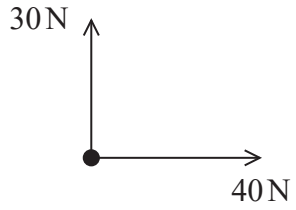
☒ **B** $\dfrac{6 \times 10^{-3}}{5}$

☒ **C** $\dfrac{6}{300}$

☒ **D** $6 \times 10^{-3} \times 300$

(Total for Question 5 = 1 mark)

6 The diagram shows the two forces acting on a point mass.



The mass accelerates.

Which of the following gives the angle between the direction of the acceleration and the 40 N force?

☒ **A** $\cos^{-1}(30/40)$

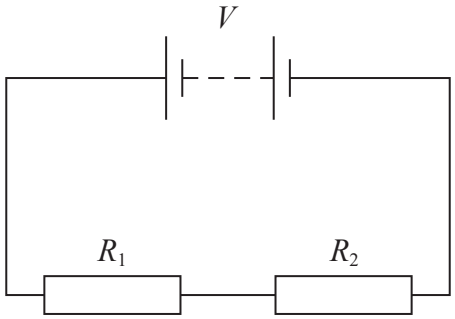
☒ **B** $\sin^{-1}(40/50)$

☒ **C** $\tan^{-1}(30/40)$

☒ **D** $\tan^{-1}(40/50)$

(Total for Question 6 = 1 mark)

7 Two resistors of resistance R_1 and R_2 are connected to a battery as shown.
The terminal potential difference of the battery is V.



Which of the following gives the potential difference across the resistor of resistance R_1?

☒ **A** $\frac{R_1}{R_2} \times V$

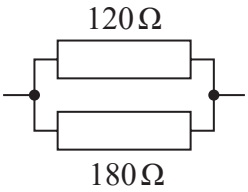
☒ **B** $\frac{R_1}{R_1 + R_2} \times V$

☒ **C** $\frac{R_2}{R_1} \times V$

☒ **D** $\frac{R_2}{R_1 + R_2} \times V$

(Total for Question 7 = 1 mark)

10 Two resistors are connected as shown.



(a) Show that the resistance of the combination is about 70 Ω.

(2)

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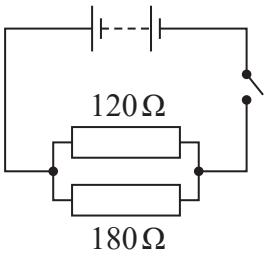
(b) This resistor combination is connected to a battery of e.m.f. ε and internal resistance r.



The switch is closed for 5 minutes.

Calculate the energy dissipated in the resistor combination.

$\varepsilon = 9.0\,\text{V}$
$r = 2.5\,\Omega$

(4)

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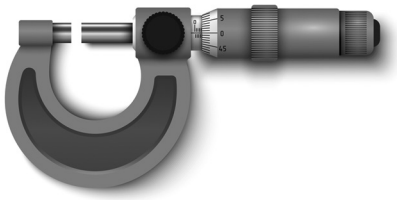
Energy dissipated in resistor combination = ...

(Total for Question 10 = 6 marks)

12 The resistivity of a metal is an important property of wire used in an electric circuit.

(a) A student carried out an experiment to determine the resistivity of a type of wire. He used a micrometer to measure the diameter d of the wire.



(Source: © Viktor Chursin/Shutterstock)

He recorded the following values.

d_1 / mm	d_2 / mm	d_3 / mm	d_4 / mm
1.40	1.44	1.42	1.41

(i) Calculate the percentage uncertainty in the mean diameter of the wire.

(3)

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.....

.....

% uncertainty in mean diameter of wire = ...

(ii) The student used an ohmmeter to measure the resistance R of a 1.65 m length of the wire.

He looked up the resistivity values of some materials.

Material	Titanium	Constantan	Stainless Steel
Resistivity / $10^{-7}\,\Omega\,m$	4.2	4.7	6.9

Identify the material of the wire.

$R = 0.72\,\Omega$

(3)

(b) Nichrome wire is often used in heating elements. Nichrome wire is used to make a coil for a 65 W mains powered heater. The nichrome wire has a resistance per metre of $87.5\,\Omega\,m^{-1}$.

Calculate the length of wire required.

potential difference across the coil = 230 V

(3)

Length of wire required = ...

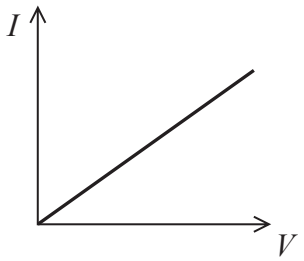
(Total for Question 12 = 9 marks)

SECTION A

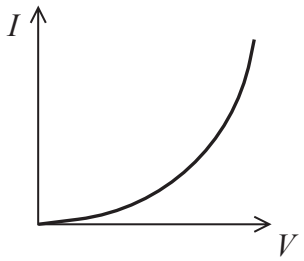
Answer ALL questions.

All multiple choice questions must be answered with a cross in the box ☒ for the correct answer from A to D. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Which of the following graphs shows how the current I through a thermistor varies with the potential difference V across the thermistor?



A



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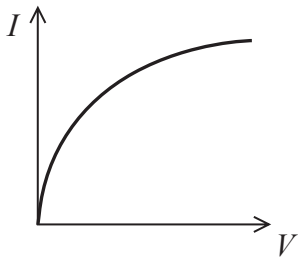
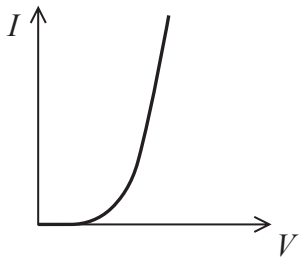


C



D

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 1 = 1 mark)

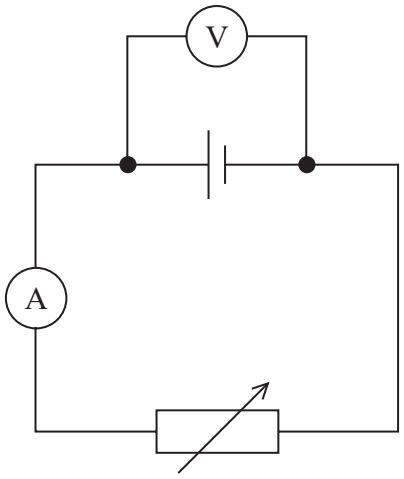
4 A conductor has a resistance R. A constant potential difference is applied across the conductor. The drift velocity of the charge carriers in the conductor is v.

Which of the following is the relationship between R and v?

- ☒ **A** $v \propto R$
- ☒ **B** $v \propto \sqrt{R}$
- ☒ **C** $v \propto \frac{1}{R}$
- ☒ **D** $v \propto \frac{1}{\sqrt{R}}$

(Total for Question 4 = 1 mark)

5 A variable resistor is connected in a circuit as shown. The cell has internal resistance.



The resistance of the variable resistor is increased.

Which row of the table is correct?

	Ammeter reading	Voltmeter reading
☒ **A**	increases	increases
☒ **B**	increases	decreases
☒ **C**	decreases	increases
☒ **D**	decreases	decreases

(Total for Question 5 = 1 mark)

7 A cable is used to pull a mass of 2.5 kg vertically upwards with an acceleration of 4.3 $m\,s^{-2}$.

Which of the following expressions gives the tension in the cable in N?

- ☒ **A** 2.5×4.3
- ☒ **B** $(2.5 \times 4.3) - (2.5 \times 9.81)$
- ☒ **C** $(2.5 \times 4.3) + (2.5 \times 9.81)$
- ☒ **D** 2.5×9.81

(Total for Question 7 = 1 mark)

8 A power station provides electrical power at a mean rate of 3500 MW.

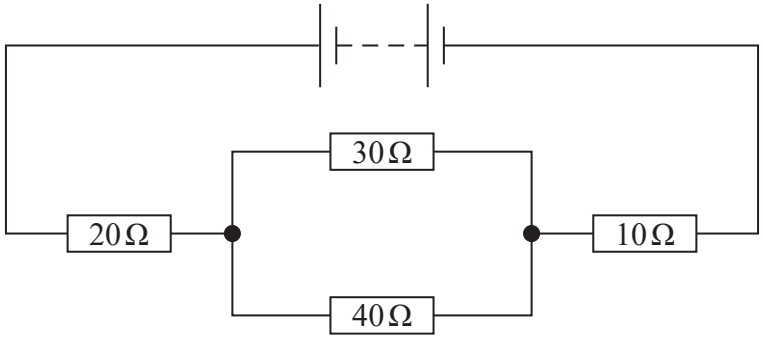
Which of the following gives the best estimate of the energy provided to consumers over a period of a year?

1 year = 3.2×10^7 s

- ☒ **A** 1×10^6 J
- ☒ **B** 1×10^{11} J
- ☒ **C** 1×10^{13} J
- ☒ **D** 1×10^{17} J

(Total for Question 8 = 1 mark)

9 A circuit was constructed as shown.



Calculate the total resistance of the resistors in the circuit.

Total resistance = ...

(Total for Question 9 = 3 marks)

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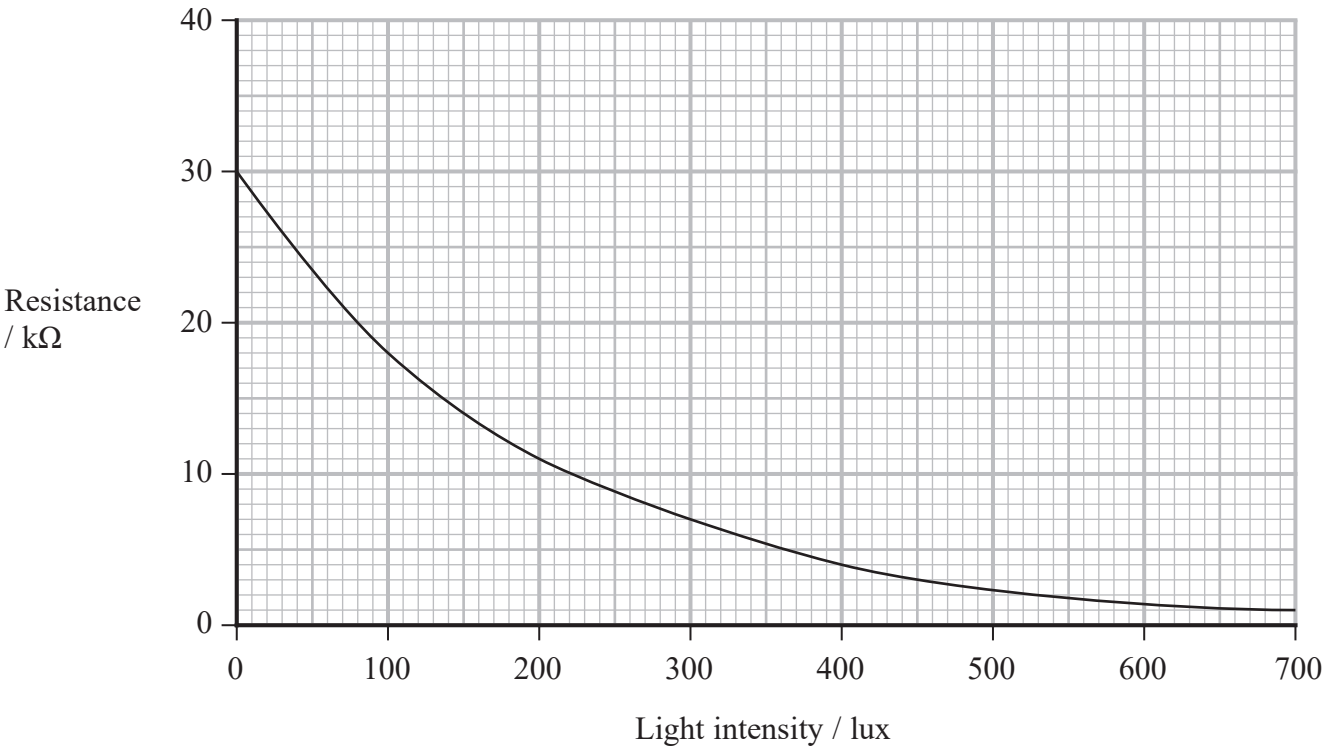
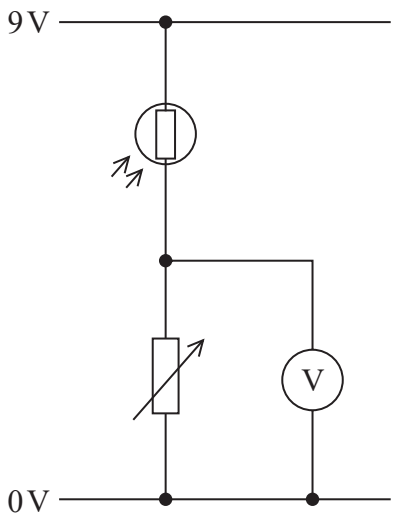
11 The graph shows how the resistance of a light dependent resistor (LDR) varies with the incident light intensity, measured in lux.



A student used the LDR in the light-sensing circuit shown below.



(a) The student increased the resistance of the variable resistor whilst the light intensity was constant. The voltmeter recorded the potential difference across the variable resistor.

Explain what happened to the reading on the voltmeter.

(3)

(b) The variable resistor was set at a resistance of 4.5 kΩ.

Determine the light intensity when the potential difference shown on the voltmeter was 2.5 V.

(3)

Light intensity = ... lux

(Total for Question 11 = 6 marks)

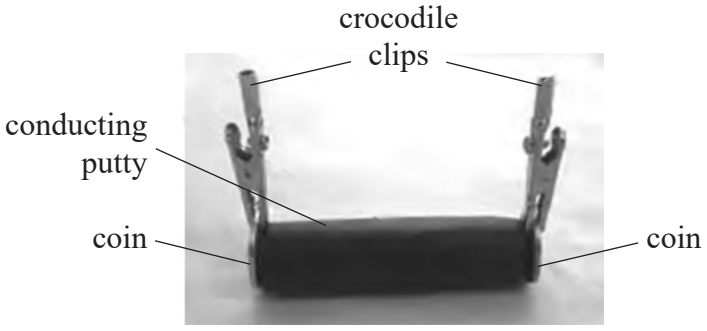
18 A student was given a block of conducting putty of mass 43 g.

(a) (i) Show that the volume of the block of conducting putty was about $8 \times 10^{-6}\,m^3$.

density of conducting putty = $5300\,kg\,m^{-3}$

(2)

(ii) The student formed the putty into a cylinder. Coins were pushed onto the ends of the cylinder as shown. The coins each had a crocodile clip attached and an ohmmeter was connected across the putty.



Determine the resistance of the cylinder of putty.

diameter of cylinder = 12 mm
resistivity of conducting putty = $4.0 \times 10^{-3}\,\Omega\,m$

(3)

Resistance = ...

(b) The student then made a cylinder that had a larger resistance.

Explain how the student used the putty to make a larger resistance.

(2)

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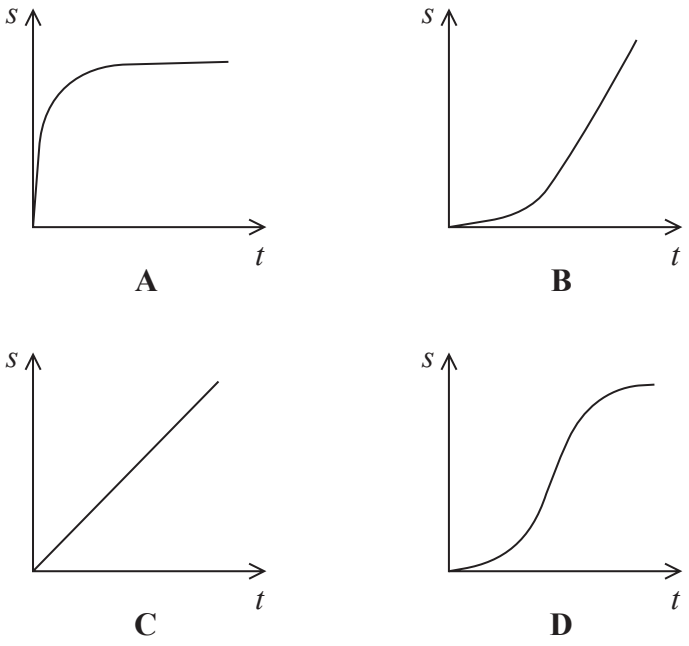
(Total for Question 18 = 7 marks)

TOTAL FOR SECTION B = 21 MARKS
TOTAL FOR PAPER = 80 MARKS

3 A ball falls from rest through glycerine and reaches terminal velocity.

Which of the following graphs shows how displacement s varies with time t for the ball?



☒ **A**

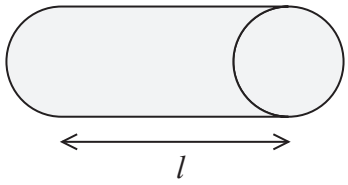
☒ **B**

☒ **C**

☒ **D**

(Total for Question 3 = 1 mark)

4 A piece of conducting putty is shaped into a cylinder of uniform cross-sectional area, as shown. The length of the cylinder is l. The resistance between the two ends is 8.0 Ω.



The piece of putty is then rolled out until the length is $2l$.

Which of the following is now the value of the resistance between the two ends?

☒ **A** 2.0 Ω

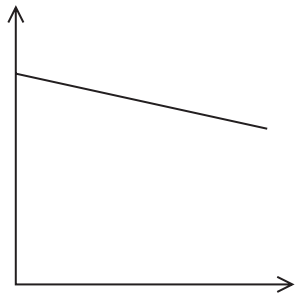
☒ **B** 4.0 Ω

☒ **C** 16.0 Ω

☒ **D** 32.0 Ω

(Total for Question 4 = 1 mark)

7 A student investigated the e.m.f. and internal resistance of a battery. The student produced the following sketch graph.



Which row of the table gives the quantities plotted?

		y-axis	*x*-axis
☒	**A**	e.m.f.	circuit resistance
☒	**B**	e.m.f.	current
☒	**C**	terminal potential difference	circuit resistance
☒	**D**	terminal potential difference	current

(Total for Question 7 = 1 mark)

8 A ball is thrown vertically upwards at a velocity of $6.0\,\text{m}\,\text{s}^{-1}$.

Which of the following gives the maximum height, in m, reached by the ball?

☒ **A** $\dfrac{6.0^2}{2 \times 9.81}$

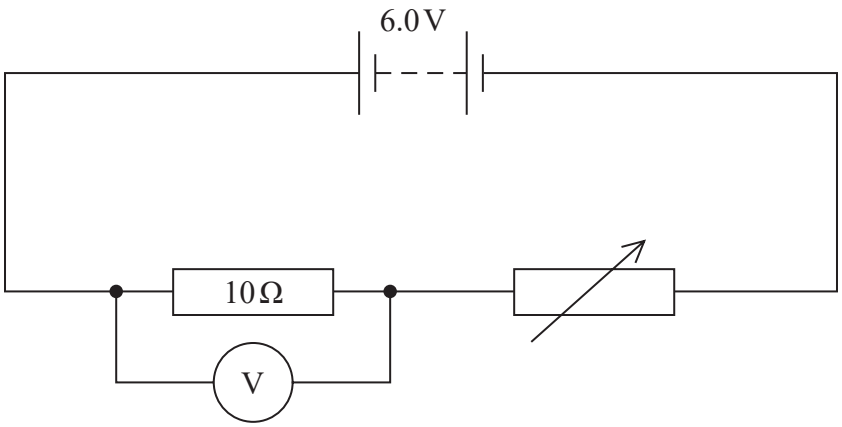
☒ **B** $\dfrac{6.0^2}{2 \times (-9.81)}$

☒ **C** $\dfrac{6.0}{2 \times 9.81}$

☒ **D** $\dfrac{6.0}{2 \times (-9.81)}$

(Total for Question 8 = 1 mark)

9 A student connects the circuit shown. The battery has negligible internal resistance.



The student increases the resistance of the variable resistor from 0 Ω to 40 Ω.

Determine the range of readings on the voltmeter.

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.....

.....

.....

Maximum reading on voltmeter = ...

Minimum reading on voltmeter = ...

(Total for Question 9 = 3 marks)

11 A student investigates how the resistance of a length of nichrome wire changes with temperature.

(a) The student takes measurements to determine the resistance of the wire at different temperatures.

(i) Draw a diagram of the circuit the student could use.

(1)

(ii) The wire has a thin electrically insulating coating so that it can be coiled up without causing a short circuit.

The student places the coil of wire into a water bath so the temperature of the wire can be varied.

Describe how the student could determine the temperature of the wire accurately.

(2)

(b) Explain, in terms of particle behaviour, why the resistance of the nichrome wire changes as temperature increases.

(4)

(Total for Question 11 = 7 marks)

12 A wire-wound resistor consists of a long length of wire wound around an insulating core. A technician finds a wire-wound constantan resistor labelled 80 Ω.

(a) Calculate the length of the constantan wire used to make the resistor.

resistivity of constantan wire at room temperature = $4.9 \times 10^{-7}\,\Omega\,m$
diameter of wire = 0.28 mm

(3)

Length = ...

(b) A potential difference of 9.8 V is applied across the resistor and the current in the resistor is 0.12 A.

Deduce whether the value labelled on the resistor is supported by these data.

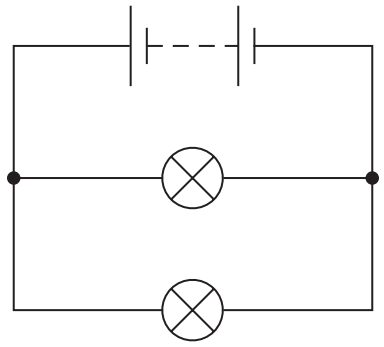
uncertainty in the potential difference = ±0.1 V
uncertainty in the current = ±0.01 A

(4)

(Total for Question 12 = 7 marks)

***14** A student connects a filament bulb to a battery. The battery has internal resistance.

The student connects an identical bulb in parallel with the first bulb, as shown.



He continues to connect identical bulbs in parallel.

The student observes that the bulbs get dimmer as more bulbs are connected. He also observes that the temperature of the battery increases.

Explain these observations.

(Total for Question 14 = 6 marks)