Questions are for both separate science and combined science students

Q1.

Figure 1 shows a student putting a coin into a vending machine that sells food.

Figure 1

(a) The vending machine is connected to the mains electricity supply.

What is the frequency and the potential difference of the mains electricity supply in the UK?

Frequency = 50 Hz

Potential difference = 230 V

(2)

The vending machine identifies the value of the coin by measuring the resistance of the coin.

(b) The power dissipated by the coin is 340 mW when the current in the coin is 0.75 A.

Calculate the resistance of the coin.

Use the Physics Equations Sheet.

power = (current)^2 × resistance	$P = I^2 R$

$P = 340\ mW = 340 \times 10^{-3}\ W = 0.34\ W$

$P = I^2 R$

$R = \frac{P}{I^2} = \frac{0.34}{(0.75)^2} = 0.60\ \Omega$

Resistance = 0·60 Ω

(4)

(c) Coins that are dirty are **not** recognised by the vending machine.

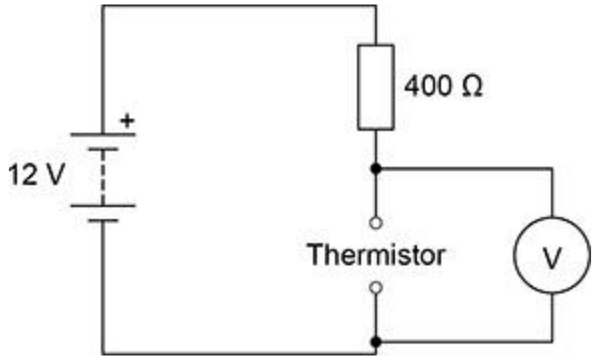
Suggest **one** reason why.

The dirt changes the measured resistance of the coin.

(1)

Figure 2 shows part of a different circuit that is used to monitor the temperature inside the vending machine.

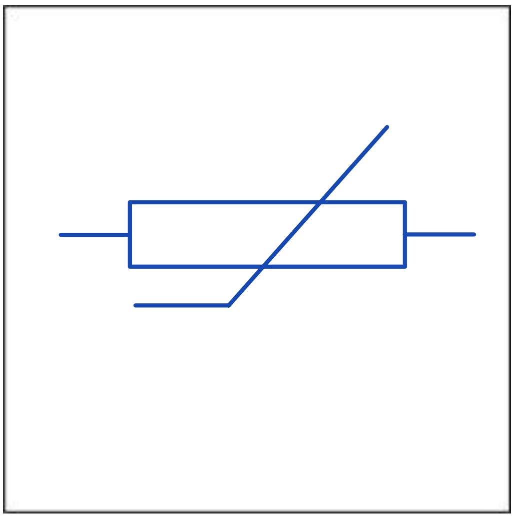
Figure 2



Thermistor and resistor in 'series'

(d) The circuit symbol for a thermistor has not been included.

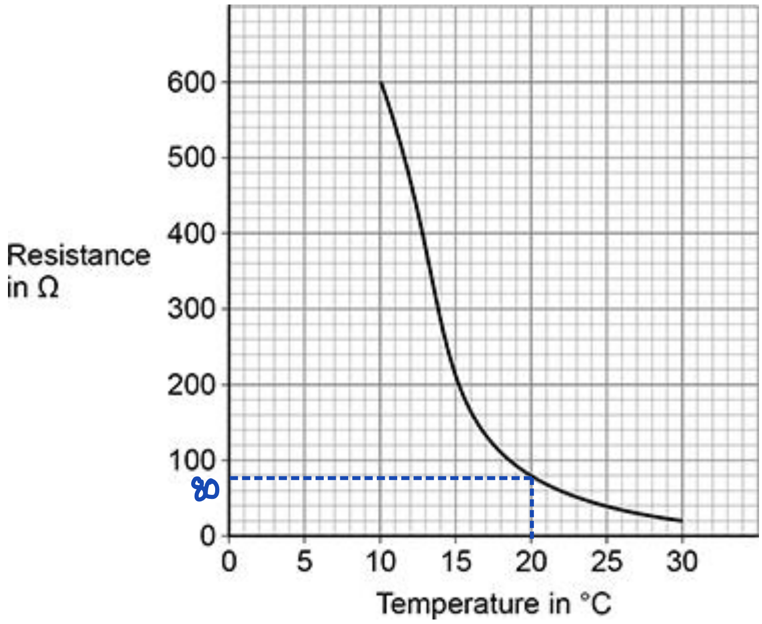
Draw the circuit symbol for a thermistor in the box below.



(1)

Figure 3 shows how the resistance of the thermistor varies with temperature.

Figure 3



(e) The cooling system inside the vending machine turns on when the temperature of the thermistor is above 20 °C.

Determine the potential difference across the thermistor when the temperature is 20 °C.

Use the Physics Equations Sheet.

When T = 20°C, thermistor = 80 Ω

Resistors in series, ∴ R_{TOT} = 400 + 80 = 480 Ω

1) Use cell V to calculate circuit current:

$V = IR$, $I = \frac{V}{R} = \frac{12\ V}{480\ \Omega} = 0.025\ A$

2) Series, so now calculate P.D. across thermistor:

$V = IR$

$V = 0.025A \times 80\Omega = 2.0V$

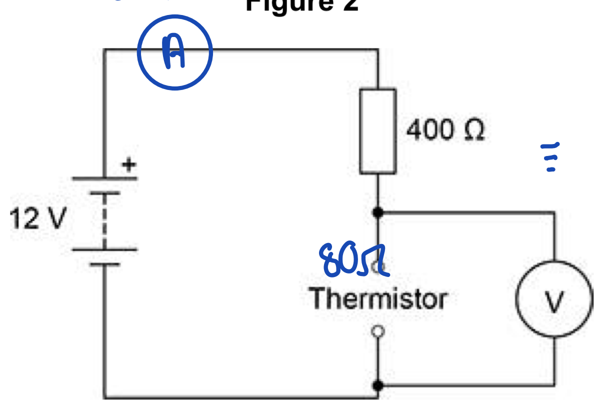
Potential difference = 2.0 V

(5)

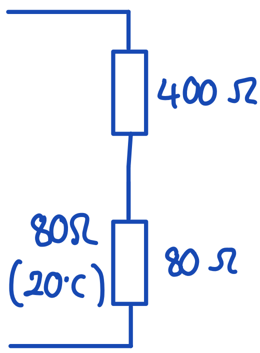
(Total 13 marks)

I = 0.025 A

Figure 2



≡



In series, so:

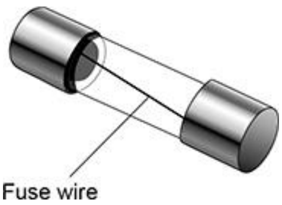
R_{TOTAL} = 400 + 80 = 480

Q2.

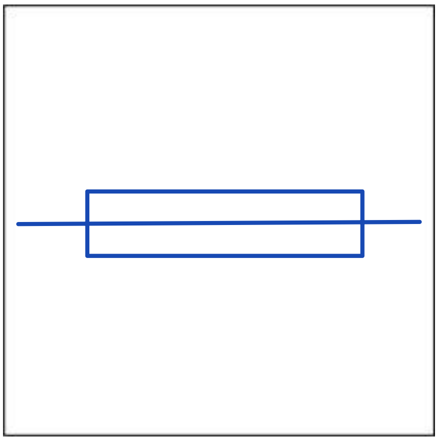
The live wire in a three-core cable is connected to a fuse inside a plug.

A fuse contains a wire that is designed to melt when the current gets too great.

The figure below shows a fuse.



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



(1)

(b) The fuse wire melts when there is a charge flow of 2.0 C for 400 ms.

Calculate the current in the fuse wire.

Use the Physics Equations Sheet.

$t = 400\ ms = 400 \times 10^{-3}\ s = 0.4\ s$

charge flow = current × time	$Q = I\,t$

$Q = 2.0\ C$ $\quad Q = It$

$I = ?$ $\quad I = \frac{Q}{t} = \frac{2.0\ C}{0.4\ s}$

$t = 0.4\ s$

$I = 5A$

Current = 5 A

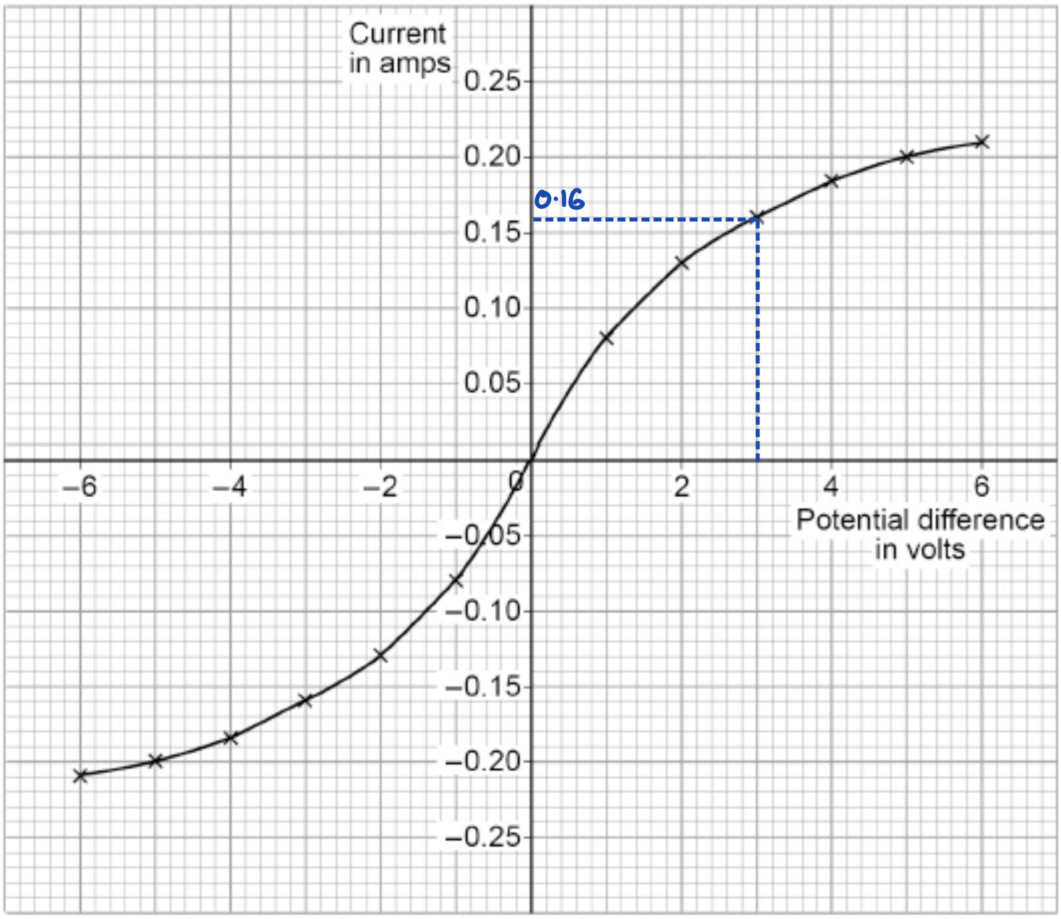
(4)

(Total 5 marks)

Q3.

A student investigated how the current in a filament lamp varies with the potential difference across the filament lamp.

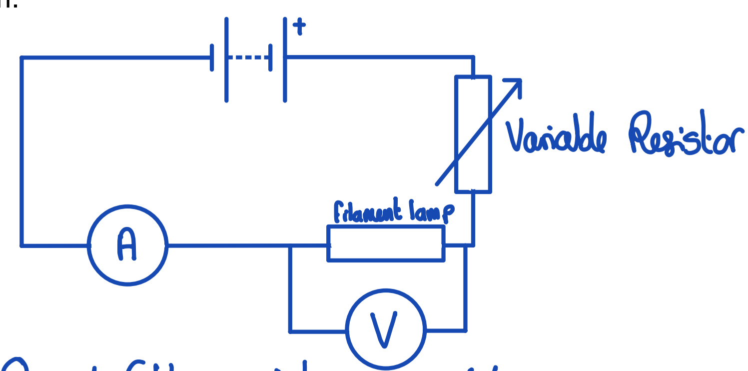
The figure below shows the results.



(a) Describe a method the student could use to obtain these results.

You should include a circuit diagram.

Variable number of cells or Variable resistor used to vary current in and p.d. across filament lamp
p.d. = 0 to 6V



Vary cell voltage between 0 and 6V in intervals of 1V
Reverse connections to power supply to obtain negative values
Take repeat readings and calculate a mean.
Discard anomalies and plot measured current vs V

(6)

(b) Determine the resistance of the filament lamp when the potential difference across it is +3.0 V.

Use the Physics Equations Sheet.

Use the figure above.

From graph, at V = +3.0, I = 0.16 A

potential difference = current × resistance	$V = I\,R$

$V = IR$

$R = \frac{V}{I} = \frac{3.0\,V}{0.16\,A} = 18.75\,\Omega$

Resistance = 18.75 Ω

(3)

(c) The current in the lamp is 0.21 A when the potential difference across the lamp is 6.0 V.

Calculate the energy transferred by the filament lamp in 30 minutes.

Use the Physics Equations Sheet.

I = 0·21 A   E transferred in 30 min

V = 6·0 V

t = 30 × 60 = 1800 s

charge flow = current × time	$Q = I\,t$

Q = It = 0·21 A × 1800 s = 378 C

energy transferred = charge flow × potential difference	$E = Q\,V$

E = Q V

= 378 C × 6·0 V

= 2268 J

Energy transferred = 2268 J

(5)

(d) The power output of the lamp is 1.0 W when the potential difference across the lamp is 5.0 V.

1W → 4W = ×4

A student predicts that the power output would be 4.0 W if the potential difference was doubled.

V 5·0 → ×2

Explain why the student is **not** correct.

power = potential difference × current	$P = V\,I$

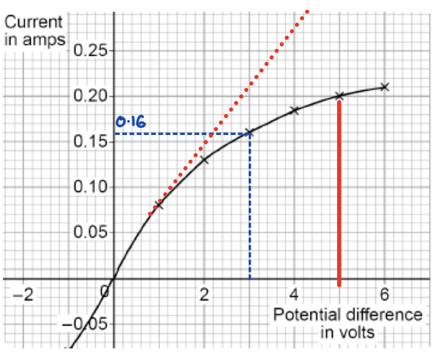
P = V I

4P = 2V . 2I

For the Power to quadruple both the current and the voltage would need to double BUT the current does not double because the resistance of the filament increases.

(2)

(Total 16 marks)



Q4.

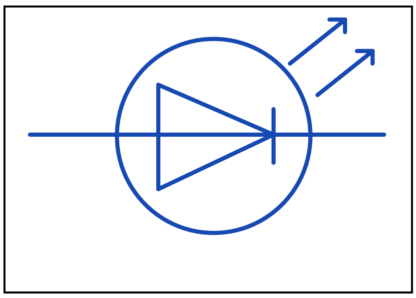
Figure 1 shows some hair straighteners.

Hair straighteners contain heating elements.

Figure 1

(a) When the hair straighteners reach normal operating temperature, an LED turns on.

Draw the circuit symbol for an LED in the box.



(1)

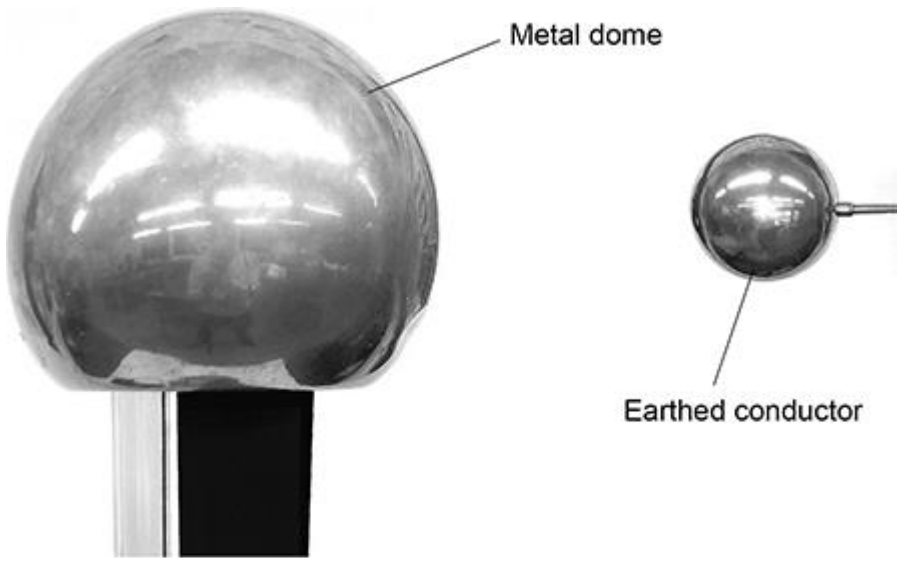
(Total 1 marks)

Questions are for both separate science and combined science students

Q1.

Figure 3 shows the negatively charged metal dome and an earthed conductor.

Figure 3



When the earthed conductor is moved towards the metal dome, there is a spark between the dome and the earthed conductor.

(a) The spark transfers 0.60 J of energy, and 2.0 μC of charge is transferred from the dome to the earthed conductor.

Calculate the potential difference between the metal dome and the earthed conductor.

Use the Physics Equations Sheet.

$Q = 2.0\,\mu C = 2.0 \times 10^{-6}\,C$

$E = 0.60\,J$

energy transferred = charge flow × potential difference	$E = Q\,V$

$E = QV, \quad V = \frac{E}{Q} = \frac{0.60\,J}{2.0 \times 10^{-6}\,C}$

$V = 300\,000\,V$

Potential difference = 300 000 V

(4)

(Total 4 marks)

Q4.

(a) The town of Hornsdale in Australia has electricity supplied by a huge battery.

On one day the battery transferred 3.24×10^{11} J of energy to the town.

The potential difference of the town s electricity supply is 230 V.

Calculate the charge flow to the town on this day.

Use the Physics Equations Sheet.

Give your answer to **3** significant figures.

energy transferred = charge flow × potential difference	$E = Q V$

$E = 3.24 \times 10^{11}$ J $E = QV$

$Q = ?$ $Q = \frac{E}{V} = \frac{3.24 \times 10^{11} \text{ J}}{230 \text{ V}}$

$V = 230$ V

$Q = 1408695652$ C

Charge flow (3 significant figures) = 1.41×10^{9} C

1410 000 000 C

(4)

(Total 4 marks)

Q5.

Figure 1 shows some hair straighteners.

Hair straighteners contain heating elements.

Figure 1

(a) The hair straighteners have a maximum power output of 120 W. (P)

The energy transferred to the hair straighteners to reach normal operating temperature is 3.6 kJ. (E)

Calculate the time (t) taken for the hair straighteners to reach normal operating temperature when operating at maximum power.

Use the Physics Equations Sheet.

$E = 3.6\ kJ = 3.6 \times 10^3\ J = 3600\ J$

$P = 120\ W$

$t = ?$

energy transferred = power × time	$E = P\,t$

$E = Pt$

$t = \frac{E}{P} = \frac{3600\ J}{120\ W} = 30\ s$

Time = 30 seconds

(4)

(Total 4 marks)

Questions are for both separate science and combined science students

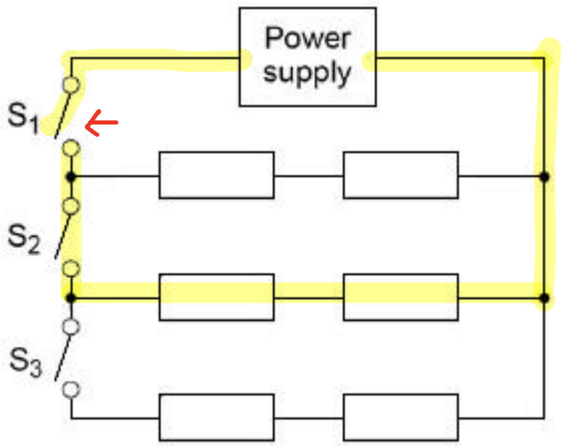
Q1.

Figure 2 shows the circuit diagram for the hair straighteners.

Each resistor represents a heating element.

The power output of the hair straighteners can be changed by closing different switches.

Figure 2



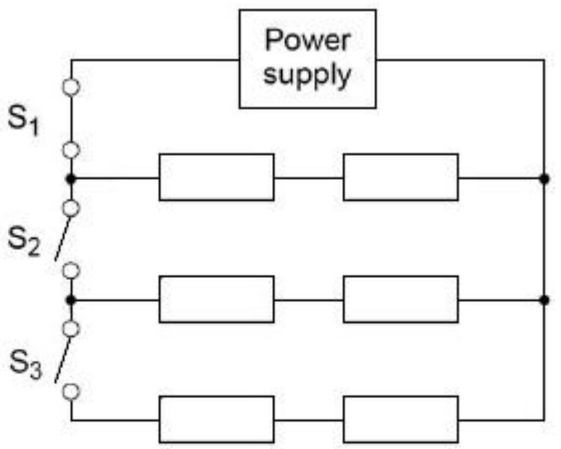
(a) Why do the hair straighteners **not** turn on when only switch S_2 is closed?

S_1 needs to be closed to complete the circuit.

(1)

(b) **Figure 3** shows the hair straighteners circuit with switch S_1 closed.

Figure 3



Switch S_2 and switch S_3 are then closed at the same time.

Explain what happens to the power output of the power supply.

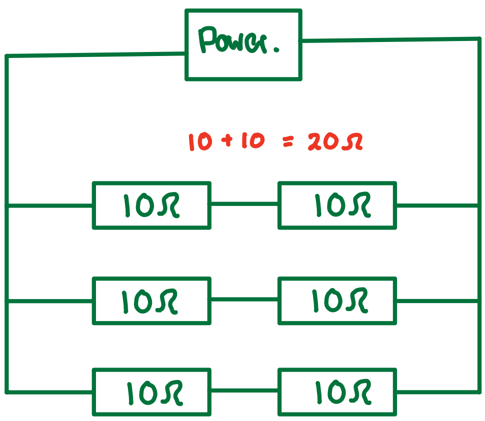
The total resistance of the circuit decreases.
So the current increases
Which increases the power output.

Resistance decreases because in parallel $\frac{1}{R_{TOT}} = \frac{1}{R_1} + \frac{1}{R_2} \ldots$
$V = IR$, V is constant, so if $R\downarrow$ $I\uparrow$

power = potential difference × current	$P = V I$

$P = VI$, $P \propto I$ so if $I\uparrow$, $P\uparrow$

(3)
(Total 4 marks)



$\frac{1}{R_{TOT}} = \frac{1}{20}$ $R_{TOT} = 20\Omega$

$\frac{1}{R_{TOT}} = \frac{1}{20} + \frac{1}{20} = \frac{2}{20} = \frac{1}{10}$ $R_{TOT} = 10\Omega$

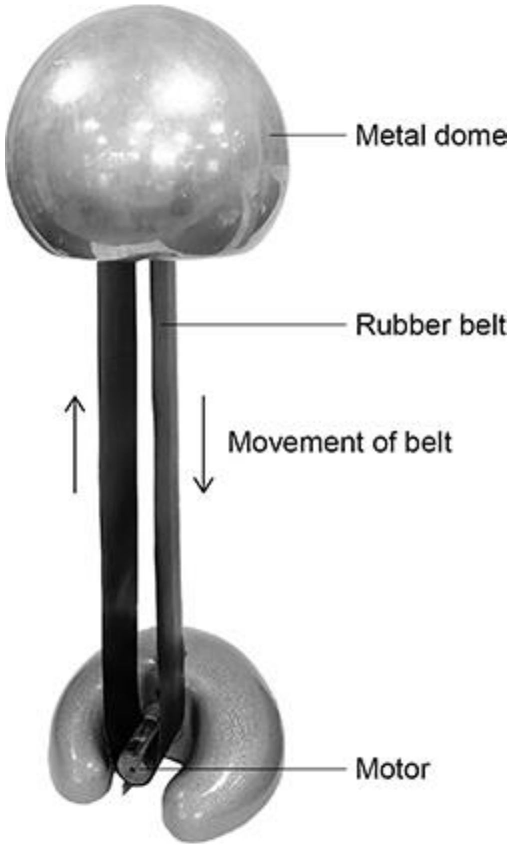
$\frac{1}{R_{TOT}} = \frac{1}{20} + \frac{1}{20} + \frac{1}{20} = \frac{3}{20}$ $R_{TOT} = \frac{20}{3} = 6.\dot{6}\Omega$

Questions are for separate science students only

Q1.

Figure 1 shows a static electricity generator. **(Physics only)**

Figure 1



The rubber belt is turned by a motor.

As the rubber belt moves, charge is transferred from the rubber belt to the metal dome.

(a) **Figure 2** shows a student touching the metal dome of the static electricity generator.

The dome is negatively charged.

Figure 2

Explain why the student s hair stands up on end.

Electrons (e^-) are transferred to the student, so her hair is negatively charged. Like charges repel each other So individual hairs repel and her hair 'stands up on end'.

(3)

The charged metal dome creates an electric field.

(b) What is an electric field?

The region around a charged object where another charged object experiences a force.

(1)

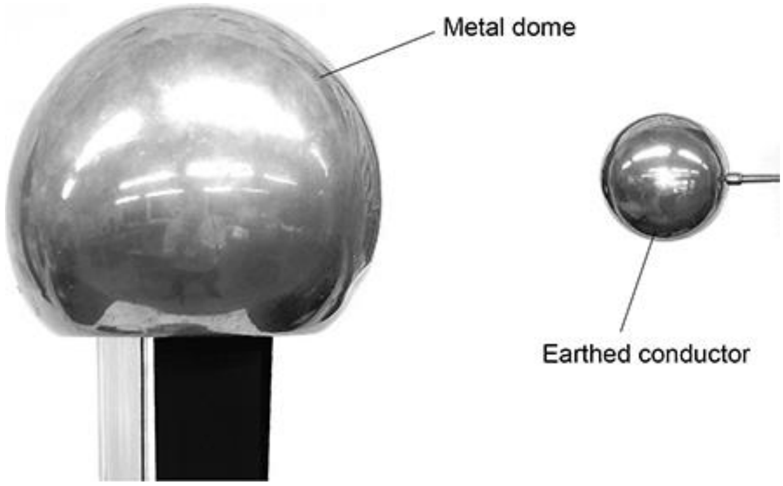
(c) How does the electric field strength vary as the distance from the charged metal dome increases?

Electric field strength decreases

(1)

Figure 3 shows the negatively charged metal dome and an earthed conductor.

Figure 3



When the earthed conductor is moved towards the metal dome, there is a spark between the dome and the earthed conductor.

(d) The spark transfers 0.60 J of energy, and 2.0 μC of charge is transferred from the dome to the earthed conductor.

Calculate the potential difference between the metal dome and the earthed conductor.

Use the Physics Equations Sheet.

$Q = 2.0\,\mu C = 2.0 \times 10^{-6}\,C$

$E = 0.60\,J$

energy transferred = charge flow × potential difference	$E = Q\,V$

$E = QV, \quad V = \frac{E}{Q} = \frac{0.60\,J}{2.0 \times 10^{-6}\,C}$

$V = 300\,000\,V$

Potential difference = 300 000 V

(4)

(e) Which of the following changes would increase the distance a spark can jump between the dome and the earthed conductor?

Tick (✓) **one** box.

Decreased charge on the metal dome	☐
Decreased electric field strength	☐
Decreased electrical resistance of air	✓
Decreased potential difference	☐

(1)
(Total 10 marks)

Q2.

A student rubbed a plastic rod with a cloth. **(Physics only)**

The rod became negatively charged and the cloth became positively charged.

(a) Explain why the cloth became positively charged.

Electrons are transferred from the cloth to the rod.
Electrons are negatively charged.
So there are more positive charges than
negative charges on the cloth.

(3)

Figure 1 shows the negatively charged rod on a balance.

Figure 1

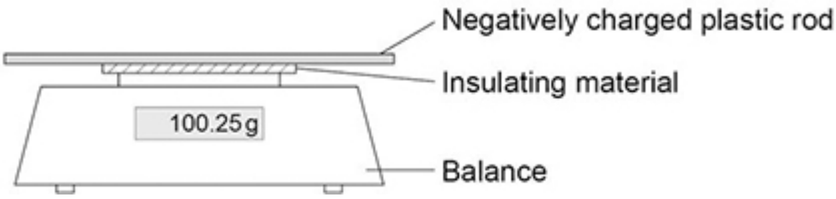
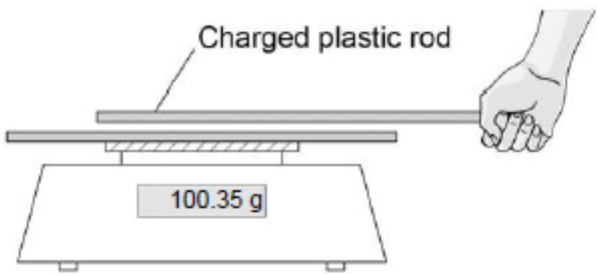


Figure 2 shows another charged rod being held stationary above the rod on the balance.

The rods do not touch each other.

Figure 2



(b) Explain why the reading on the balance increases.

There is an additional downwards force on the balance
which increases the mass reading. Because the held rod
is negatively charged and rods with like charges
repel each other.

(3)

(c) The balance had a zero error.

The zero error is not important in this experiment.

Give the reason why.

Only the change in reading/mass is being observed.

(1)

(d) A negatively charged rod is held near an earthed conductor.

Explain why a spark jumps between the negatively charged rod and the earthed conductor.

The large potential difference between the two objects causes negative electrons/charges to move through the air, from the rod to the conductor.

(3)

(Total 10 marks)