Section 2: Electricity 1

Answer Key

1.1	What is current?	The rate of flow of charge. I = Q/t where I is the current, measured in Amps Q is the charge, measured in coulombs t is time, measured in seconds
1.2	What is needed for current to flow?	A potential difference and a closed circuit.
1.3	**What is the unit of charge?**	**C (coulombs)**
1.4	**What is the unit of current**	**A (amps)**
1.5	What is resistance?	The opposition to the flow of current.
1.6	**What is the unit of resistance?**	**Ω (ohms)**
1.7	**What is the unit of potential difference?**	**V (volts)**
1.8	How do we measure current?	With an ammeter in series with the circuit
1.9	How do we measure potential difference?	With a voltmeter in parallel to the component of interest
1.10	**How do we find resistance of a component or circuit?**	**Find the current and potential difference, then use Ohms Law** **V = IR, where** **V is the voltage, measured in volts** **I is the current, measured in amps** **R is the resistance, measured in ohms**

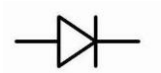
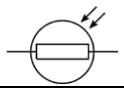
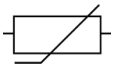
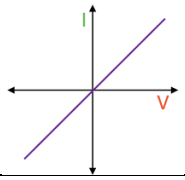
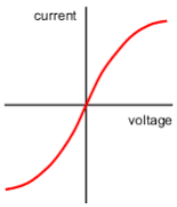
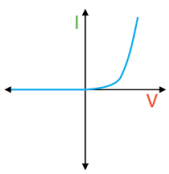
Section 2: Electricity 2

Answer Key

2.1	What is the difference between series and parallel circuits?	Components in series are on the same loop of the circuit; components in parallel are on separate loops
2.2	**What happens to current in series?**	**Stays the same**
2.3	**What happens to current in parallel?**	**Splits up then recombines.**
2.4	What happens to potential difference in series?	Total p.d. is split across the components.
2.5	What happens to potential difference in parallel?	Total p.d. stays the same across each branch.
2.6	What happens to resistance in series?	Total resistance is the sum of the resistances of all the components
2.7	What happens to resistance in parallel?	Total resistance is lower than the resistance of the component with the smallest resistance
2.8	What is the difference between direct current (DC) and alternating current (AC)?	In DC, the charges move continuously in one direction. In AC, charges continuously change direction (p.d. is continuously changed direction)
2.9	**Describe 3 features of UK mains electricity**	**230V, AC, 50Hz**
2.10	**In a 3-core cable, what are the features of the live wire?**	**Alternates to potential difference from maximum +325V to -325V, 50 times per second**
2.11	**In a 3-core cable, what are the features of the neutral wire?**	**Potential difference = 0V – completes the circuit between the appliance and the local substation**
2.12	**In a 3-core cable, what are the features of the earth wire?**	**Potential difference = 0V – only carries current in the event of a fault**

Section 2: Electricity 3

Answer Key

3.1	Why is the live wire dangerous even when the switch in a mains circuit is open?	Because it is at a very high p.d. Compared to earth, so that if a person touched it they would be electrocuted as current flowed through them to earth
3.2	How is electrical power transferred in the National Grid?	At a very high potential difference between power stations and consumers, then stepped down to 230V before use.
3.3	Why is transferring electrical power at a very high potential difference across long distances an efficient method?	Because power lost due to heating is proportional to I, a higher pd means a lower I and therefore less power lost.
3.4	**What is this component and what does it do?** 	**Diode only lets current flow through in one direction (the direction of the arrow)**
3.5	**What is this component and what does it do?** 	**Light Dependent Resistor** **Has a resistance that decreases as light intensity increases**
3.6	**What is this component and what does it do??** 	**Thermistor** **Has a resistance that decreases as temperature increases**
3.7	What component does this graph show? 	Ohmic conductor or Wire
3.8	What component does this graph show? 	Filament lamp
3.9	What component does this graph show? 	Diode

Section 20: Static Electricity (Triple Content)

Answer Key

1.	How is static electricity generated by rubbing surfaces?	**Electrons are transferred** from one surface to the other.
2.	What causes someone to receive an electric shock from a metal object?	There is a potential difference between the person and the metal object, which causes electrons to be transferred to the metal object, which earths the charge.
3.	**What is an electric field?**	**The space around a charged object where another charged object experiences an electrostatic force**
4.	Describe an experiment to show the force between the two objects with opposite charge	Suspend the two charged objects from a string and bring them together: they will move towards each other due to the attractive force between them.
5.	Describe an experiment to show the force between two objects with the same charge.	Suspend the two charged objects from a string and bring them together: they will move away from each other due to the repulsive force between them.
6.	**Why does the electrostatic force between two charged objects get stronger when the distance between them decreases?**	**The field is stronger closer to the object**
7.	Is the electrostatic force contact or non-contact?	Non-contact
8.	Why does the transfer of electrons lead to electrostatic effects?	Electrons have a negative charge, so a build-up of electrons on a surface gives it a negative charge while a loss of electrons from a surface gives it a positive charge

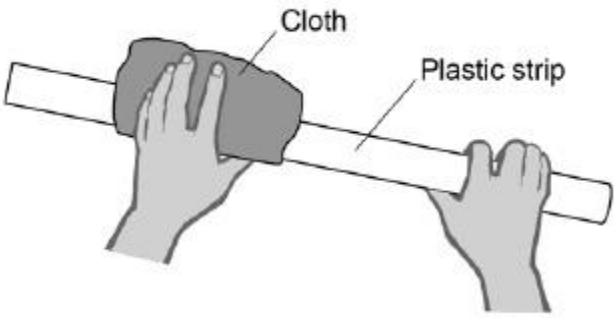
FOUNDATION QUESTIONS

Q1.

A student used some everyday items to investigate static electricity.

Figure 1 shows a flexible plastic strip being rubbed with a cloth.

Figure 1



(a) Complete the sentence.

Choose the answer from the box.

electrons	**neutrons**	**protons**

Rubbing the plastic strip with the cloth causes the strip to become negatively charged because _____ move from the cloth onto the plastic strip.

(1)

(b) Complete the sentence.

Choose the answer from the box.

a negative	**a positive**	**zero**

The cloth is left with _____ charge.

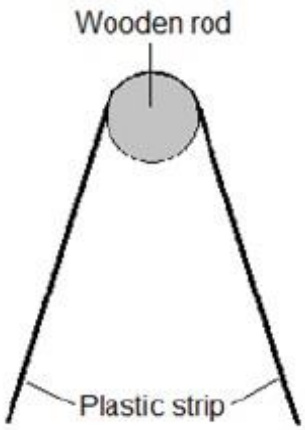
(1)

(c) The student hung the plastic strip over a wooden rod.

The ends of the strip moved away from each other.

Figure 2 shows the position of the plastic strip on the wooden rod.

Figure 2



What **two** conclusions should the student make about the forces acting on the two halves of the plastic strip?

1. _____

_____

2. _____

_____

(2)

(d) Another student repeated the experiment using the same method and found the plastic strip moved in the same way.

Complete the sentence.

Choose the answer from the box.

an anomaly	**repeatable**	**reproducible**

The investigation was _____ .

(1)

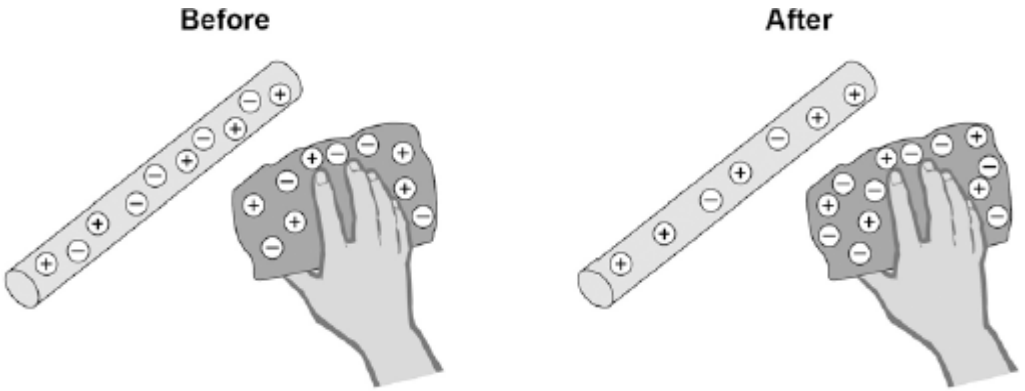
(Total 5 marks)

Q2.

A student rubs an acetate rod with a cloth.

Figure 1 shows the charges on the acetate rod and cloth before and after rubbing.

Figure 1



(a) Explain how rubbing an acetate rod with a cloth causes the rod and cloth to become charged.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) After charging them, the student moves the acetate rod and the cloth closer together.

Which statement is correct?

Tick **one** box.

There is no force between the acetate rod and the cloth. ☐

There is a force of attraction between the acetate rod and the cloth. ☐

There is a force of repulsion between the acetate rod and the cloth. ☐

Give a reason for your answer.

_____

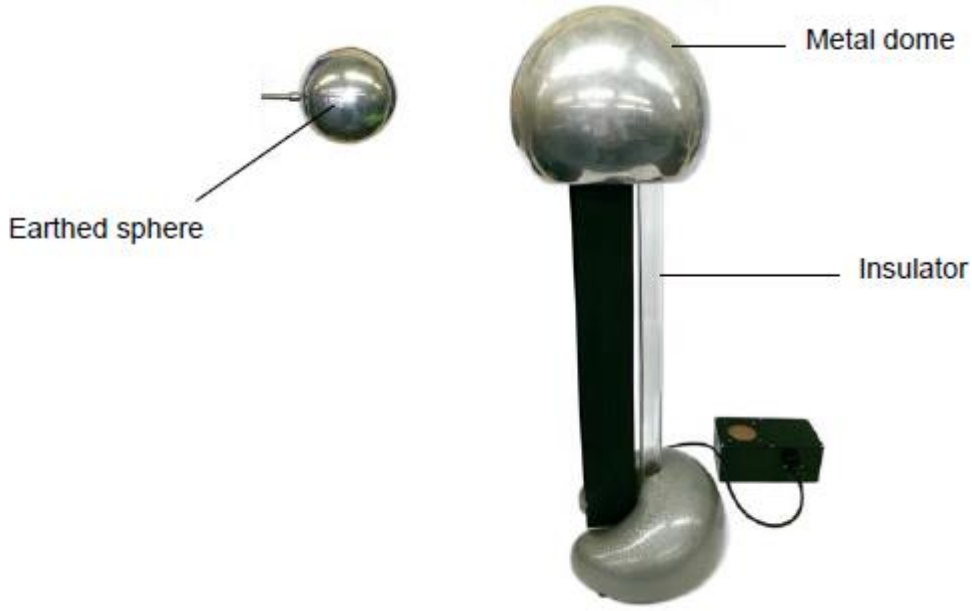
_____

_____

(2)

(c) **Figure 2** shows a Van de Graaff generator, which is used to generate static electricity.

Figure 2



The longer the Van de Graaff generator is switched on, the more charge is stored on the metal dome.

Use an answer from the box to complete the sentence.

decrease	**increase**	**stay the same**

The amount of charge on the metal dome is increased, which causes the potential difference between the metal dome and the earthed sphere to _____ .

(1)

(d) When the potential difference between the Van de Graaff generator and the earthed sphere is 60 kV, a spark jumps between the metal dome and the earthed sphere.

The spark transfers 0.000025 coulombs of charge to the earthed sphere.

The equation which links charge, energy and potential difference is:

energy transferred = charge × potential difference

Calculate the energy transferred by the spark.

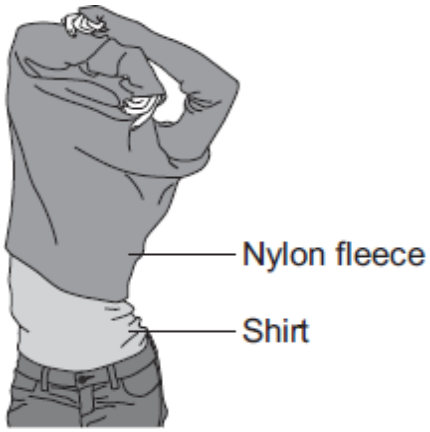
Energy transferred = _____ J

(2)

(Total 9 marks)

Q3.

(a) A student takes off his nylon fleece and feels a small electric shock.
He realises that this happens because his fleece becomes charged.



Explain why the fleece becomes charged.

(2)

(b) Only **two** of the following statements are correct.

Put a tick (✓) in the boxes next to the **two** correct statements.

Positively charged objects repel negatively charged objects. ☐

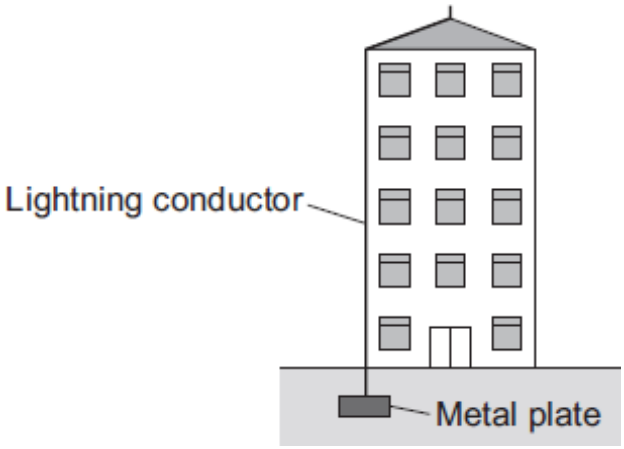
Electrical charges move easily through metals. ☐

Static electricity is safe; it never causes any danger. ☐

An electric current is a flow of electrical charge. ☐

(2)

(c) The diagram shows a lightning conductor attached to the side of a tall building.



If the building is struck by lightning, charge flows to earth through the lightning conductor.

(i) Which of the materials in the list is used to make the lightning conductor?

Draw a ring around your answer.

copper **glass** **plastic**

Give a reason for your answer.

_____

_____

_____

(2)

(ii) Complete the sentence by drawing a ring around the correct line in the box.

The resistance of the lightning conductor is

higher than
the same as
lower than

the resistance of the building.

(1)

(iii) It is almost impossible to test different designs of lightning conductor in controlled experiments during a lightning storm.

Suggest a reason why.

_____

_____

(1)

(Total 8 marks)

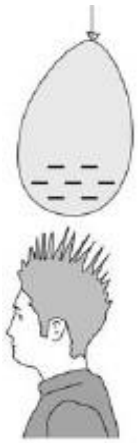
HIGHER QUESTIONS

Q4.

Figure 1 shows a student after rubbing a balloon on his hair.

The balloon and hair have become charged.

Figure 1



(a) Describe the force that acts on the student's hair in **Figure 1**.

_____

_____

_____

_____

(2)

(b) An earthed conductor was brought near the charged student.
A spark jumped between the conductor and the student.

The potential difference between the conductor and the student was 2.5 kV
The energy transferred by the spark was 0.0050 J

Calculate the charge transferred by the spark.

_____

_____

_____

Charge = _____ C

(3)

(c) A defibrillator can transfer a charge to regulate a person's heartbeat.

Figure 2 shows a defibrillator.

Figure 2

When the defibrillator is in use, a potential difference of 4800 V is applied across the person's chest.

A charge of 0.16 coulombs passes through the person's chest in 4.0 ms

Calculate the resistance of the person's chest.

Resistance = _____ Ω

(5)

(Total 10 marks)

Q5.

Figure 1 shows a Van de Graaff generator that is used to investigate static electricity.

Before it is switched on, the metal dome has no net charge.

After it is switched on, the metal dome becomes positively charged.

Figure 1

(a) Explain how an uncharged object may become positively charged.

_____

_____

_____

_____

_____

_____

(3)

(b) **Figure 2** shows a plan view of the positively charged metal dome of a Van de Graaff generator.

Draw the electric field pattern around the metal dome when it is isolated from its surroundings.

Use arrows to show the direction of the electric field.

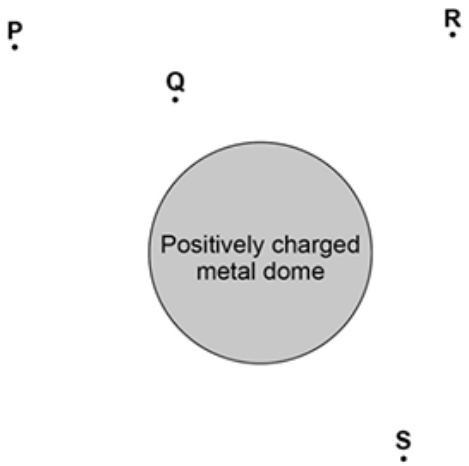
Figure 2

(2)

(c) Another positively charged object is placed in the electric field.

Look at **Figure 3**.

Figure 3



In which position would the object experience the greatest force?

Tick **one** box.

P ☐

Q ☐

R ☐

S ☐

(1)

(Total 6 marks)

Q6.

A student rubbed a plastic rod with a cloth.

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

(a) Explain why the cloth became positively charged.

(3)

Figure 1 shows the negatively charged rod on a balance.

Figure 1

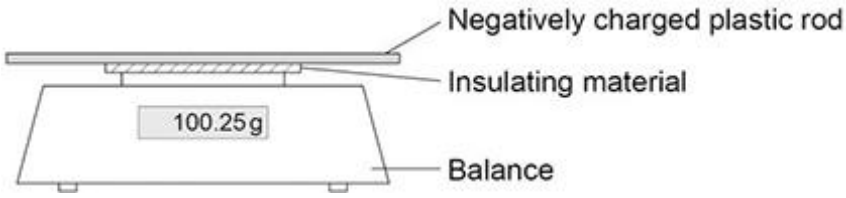
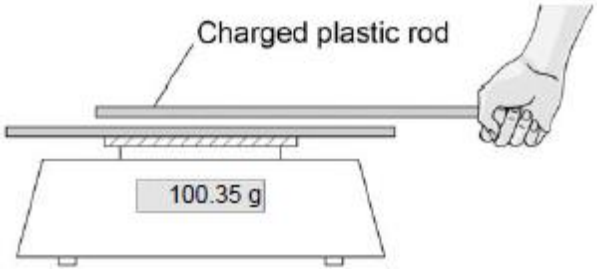


Figure 2 shows another charged rod being held stationary above the rod on the balance.

The rods do not touch each other.

Figure 2



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

(3)

(c) The balance had a zero error.

The zero error is not important in this experiment.

Give the reason why.

_____

_____

(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.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

FOUNDATION MARK SCHEME

Q1.

(a) electrons

1

(b) a positive

1

(c) the forces are repulsive

allow the forces act in opposite directions

1

the forces are equal in size

allow the forces are the same (size)

1

(d) reproducible

1

[5]

Q2.

(a) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The student makes logical links between clearly identified, relevant points.

Level 1 (1–2 marks):
Simple statements are made, but not precisely. The logic is unclear.

0 marks:
No relevant content

Indicative content

- friction (between cloth and rod) causes
- electrons (to) move
- from the acetate rod **or** to the cloth
- (net) charge on cloth is now negative
- (net) charge on rod is now positive

4

(b) there is a force of attraction between the acetate rod and the cloth

(reason)

1

unlike charges attract

or

negative charges attract positive charges

1

(c) increase

1

(d) 0.000025 × 60 000

1

1.5 (J)

1

*accept 1.5 (J) with no working shown for **2** marks*

[9]

Q3.

(a) fleece rubs against shirt

it refers to the fleece

1

or

friction (between fleece and shirt)

(causing) <u>electrons</u> to transfer from one to the other

accept a specific direction of transfer
*do **not** accept charge for electrons*
positive electrons negates this mark
movement of protons negates this mark

1

(b) Electrical charges move easily through metals.

1

An electric current is a flow of electrical charge.

1

(c) (i) copper

reason only scores if copper chosen

1

(good electrical) conductor

accept it is a metal
any mention of heat conduction negates this mark

1

(ii) lower than

1

(iii) accept any sensible suggestion,eg:

- too many variables (to control)
- lightning strikes / storms are random / unpredictable
- do not know which building will be struck
- do not know when a building will be struck
- do not know when lightning will happen
- (very) difficult to create same conditions in a laboratory
- lightning storms are not the same

it is not safe is insufficient
*do **not** accept lightning does not strike the same place twice*

1

[8]

HIGHER MARK SCHEME

Q4.

(a) non-contact (force)

allow electrostatic (force)

1

attraction (between hair and balloon)

allow repulsion between the hairs on the head

1

(b)

*an answer of 2.0 × 10^{-6} (C) scores **3** marks*

*an answer of 2 × 10^{-3} (C) scores **2** marks*

0.0050 = Q × 2500

this mark may be awarded if pd is incorrectly or not converted

1

$$Q = \frac{0.0050}{2500}$$

this mark may be awarded if pd is incorrectly or not converted

1

Q = 2.0 × 10^{-6} (C)
or
Q = 0.0000020 (C)

these answers only

1

(c)

*an answer of 120 (Ω) scores **5** marks*

0.16 = I × 4.0 × 10^{-3}
or

$$I = \frac{0.16}{4.0 \times 10^{-3}}$$

this mark may be awarded if time is incorrectly / not converted

1

I = 40 (A)

this value only

1

4800 = 40 × R

allow 4800 = their calculated I × R

1

$$R = \frac{4800}{40}$$

allow R = 4800 / their calculated I

1

R = 120 (Ω)

allow an answer consistent with their calculated I

1

[10]

Q5.

(a) negatively charged

1

electrons are transferred

1

from the (neutral) object

1

(b) minimum of four lines drawn perpendicular to surface of sphere

judge by eye

1

minimum of one arrow shown pointing away from sphere

*do **not** accept any arrow pointing inwards.*

1

(c) Q

1

[6]

Q6.

(a) electrons transferred from the cloth to the rod

1

(electrons are) negatively charged

this mark only scores if linked to the first marking point

1

(so) there are more positive charges than negative charges on the cloth

1

(b) (there is an additional) downwards force on the balance

1

(because) the rod is negatively charged

1

(and) like charges repel
or
negative charges repel each other

1

(c) difference / change in reading / mass is being measured

1

(d) the large potential difference between the two objects

allow (strong) electric field causes breakdown of air

1

(causes negative) electrons / charge move through the air

1

from the rod to the conductor

1

[10]