Electricity part 3 AQA Triple Physics

Name: _____

Class: _____

Date: _____

Time: **71 minutes**

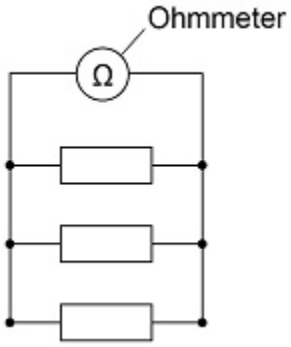
Marks: **67 marks**

Comments:

1. A student investigated how the total resistance of identical resistors connected in parallel varied with the number of resistors.

The student used an ohmmeter to measure the total resistance of the resistors.

The diagram below shows the student's circuit with 3 resistors.



The student repeated each reading of resistance three times.

The table below shows some of the results for 3 resistors in parallel.

Number of resistors	Total resistance in ohms			
	Reading 1	Reading 2	Reading 3	Mean
3	15.8	15.3	**X**	15.7

(a) Calculate value **X** in the table above.

_____

_____

_____

X = _____ Ω

(2)

(b) The student thought that taking a fourth reading would improve the precision of the results.

The fourth reading was 16.2 Ω.

Explain why the student was wrong.

_____

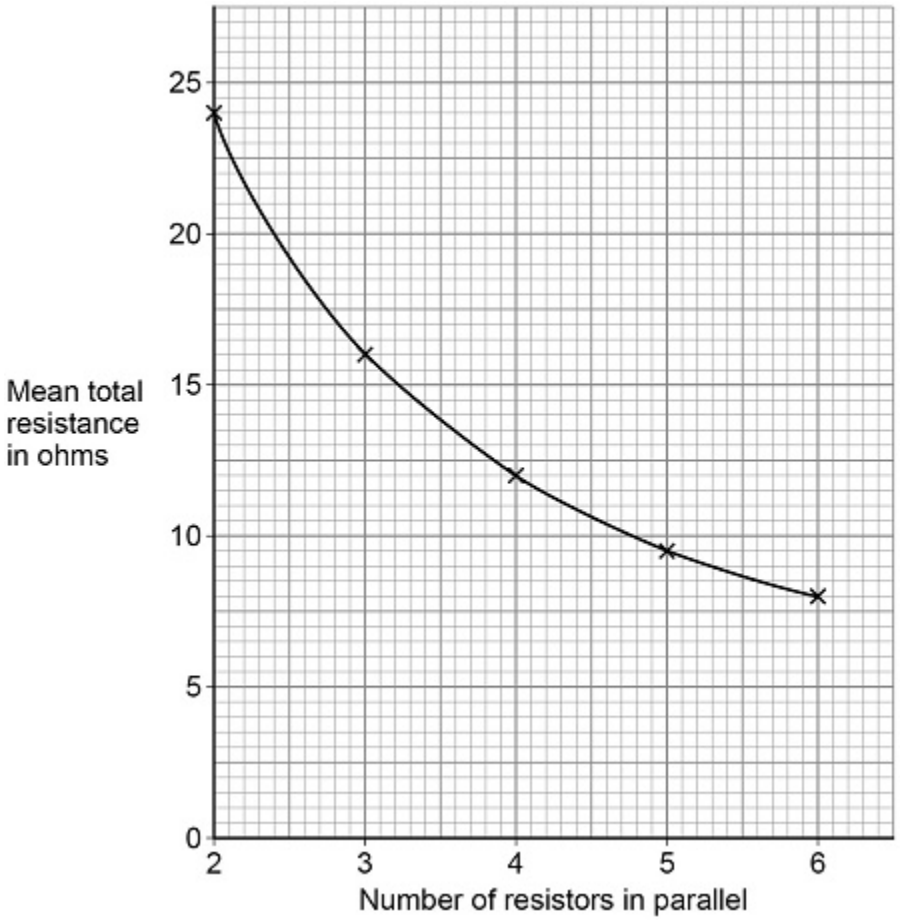
_____

_____

_____

(2)

The graph below shows the results from the investigation.



(c) The student concluded that the number of resistors in parallel was inversely proportional to the mean total resistance.

Explain why the student was correct.

Use data from the graph in your answer.

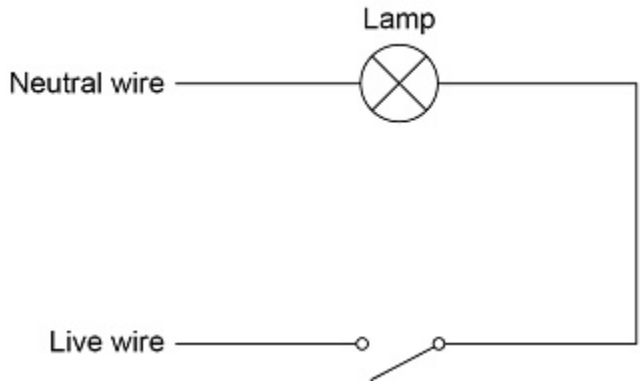
(3)

(d) Explain why adding resistors in parallel decreases the total resistance.

(2)

(Total 9 marks)

2. The diagram below shows part of a mains electricity lighting circuit in a house.



(a) A fault in the switch caused a householder to receive a mild electric shock before a safety device switched the circuit off.

The mean power transfer to the person was 5.75 W.

The potential difference across the person was 230 V.

Calculate the resistance of the person.

Resistance = _____Ω

(5)

(b) An electrician replaced the switch.

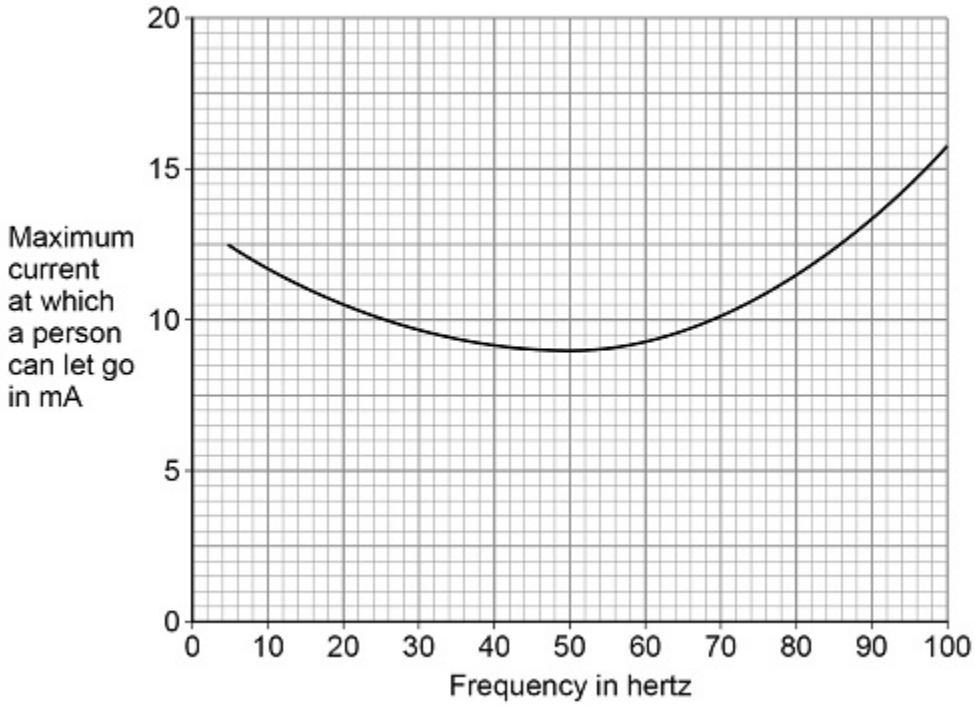
The electrician would have received an electric shock unless the circuit was disconnected from the mains supply.

Explain why.

(3)

(c) The current from an electric shock causes a person's muscles to contract. The person cannot let go of the electrical circuit if the current is too high.

The graph below shows how the maximum current at which a person can let go depends on the frequency of the electricity supply.



The UK mains frequency is 50 Hz.

Explain why it would be safer if the UK mains frequency was **not** 50 Hz.

_____

_____

_____

_____

_____

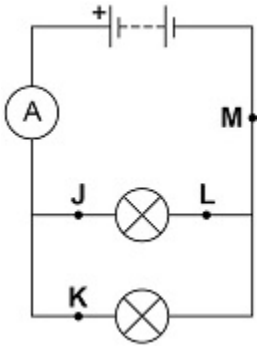
_____

(2)

(Total 10 marks)

3. **Figure 1** shows a circuit diagram.

Figure 1



(a) In which position could a switch be placed so that both lamps can be switched on or off at the same time?

Tick (✓) **one** box.

J ☐ **K** ☐ **L** ☐ **M** ☐

(1)

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

(1)

(c) In 30 seconds, 24 coulombs of charge flow through the battery.

Calculate the current in the battery.

Use the equation:

$$\text{current} = \frac{\text{charge flow}}{\text{time}}$$

Current = _____ A

(2)

(d) There is a potential difference of 3.6 V across the battery.

Calculate the energy transferred by the battery when 60 coulombs of charge flows through the battery.

Use the equation:

energy transferred = charge flow × potential difference

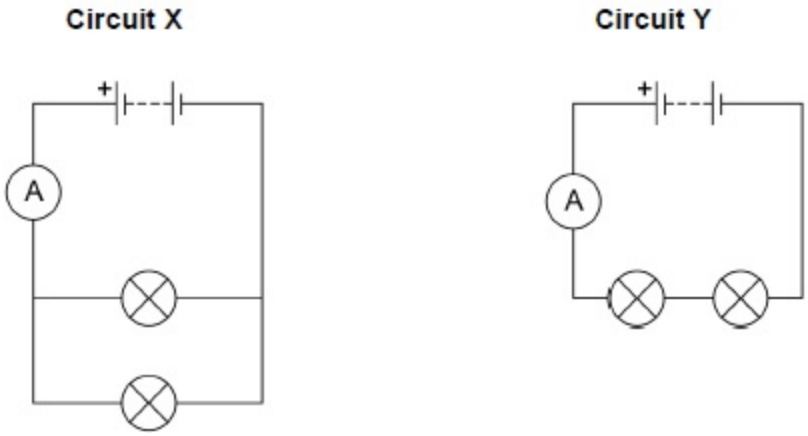
Energy transferred = _____ J

(2)

A student built **Circuit X** and **Circuit Y** shown in **Figure 2**.

The components used in each circuit were identical.

Figure 2



(e) How would the reading on the ammeter in **Circuit Y** compare to the reading on the ammeter in Circuit X?

Tick (✓) **one** box.

The reading in **Y** would be higher. ☐

The reading in **Y** would be lower. ☐

The readings would be the same. ☐

(1)

(f) How does the total resistance of **Circuit Y** compare with the total resistance of **Circuit X**?

Tick (✓) **one** box.

The total resistance of **Y** is greater. ☐

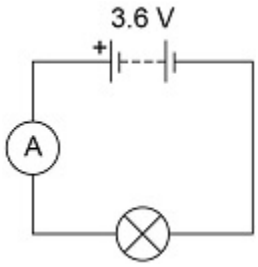
The total resistance of **Y** is less. ☐

The total resistance is the same. ☐

(1)

The student built another circuit which is shown in **Figure 3**.

Figure 3



(g) Write down the equation which links current, potential difference and resistance.

_____

(1)

(h) There is a potential difference of 3.6 V across the lamp in **Figure 3**.

The current through the lamp is 0.80 A

Calculate the resistance of the lamp.

_____

_____

_____

Resistance = _____ Ω

(3)

(Total 12 marks)

4. **Figure 1** shows a person using an electric lawn mower.

Figure 1

(a) The lawn mower is connected to the mains electricity supply.

What is the frequency of the mains electricity supply in the UK?

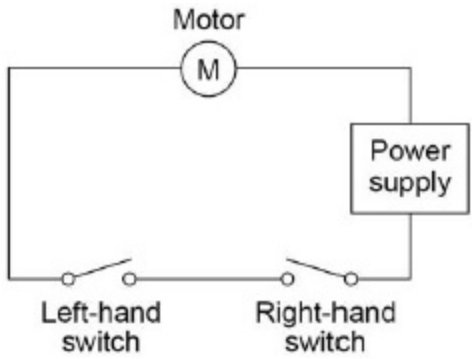
Frequency = _____ Unit _____

(2)

The lawn mower has a switch on each side of the handle.

Figure 2 shows the circuit diagram for the lawn mower.

Figure 2



(b) The motor in the lawn mower can only be turned on when the person using it holds the handle of the lawn mower with both hands.

Explain why.

_____

_____

_____

_____

(2)

(c) The power input to the motor is 1.8 kW

The resistance of the motor is 32 Ω

Calculate the current in the motor.

_____

_____

_____

_____

Current = _____ A

(3)

(d) The useful power output from the motor is 1.5 kW

Calculate the time it takes for the motor to transfer 450 000 J of useful energy.

Time = _____ seconds

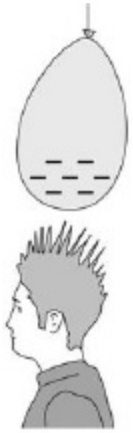
(3)

(Total 10 marks)

5. **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)

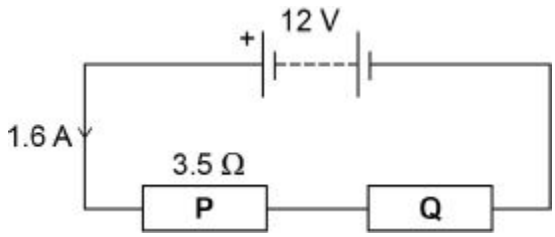
(Total 10 marks)

6. (a) Draw a diagram to show how 1.5 V cells should be connected together to give a potential difference of 4.5 V.

Use the correct circuit symbol for a cell.

(2)

A student built the circuit shown in the diagram below.



(b) Calculate the total resistance of the circuit in the diagram above.

Use the equation:

$$\text{resistance} = \frac{\text{potential difference}}{\text{current}}$$

Total resistance = _____ Ω

(2)

(c) The resistance of **P** is 3.5 Ω.

Calculate the resistance of **Q**.

Resistance of **Q** = _____ Ω

(1)

(d) The student connects the two resistors in the diagram above in parallel.

What happens to the total resistance of the circuit?

Tick **one** box.

It decreases ☐

It increases ☐

It does not change ☐

(1)

Give a reason for your answer.

_____

_____

_____

_____

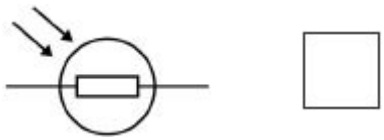
(1)

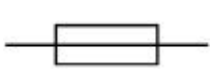
(Total 7 marks)

7. The plug of an electrical appliance contains a fuse.

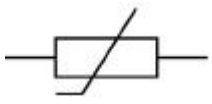
(a) What is the correct circuit symbol for a fuse?

Tick **one** box.

 ☐

 ☐

 ☐

 ☐

(1)

(b) The appliance is connected to the mains electrical supply. The mains potential difference is 230 V.

Calculate the energy transferred when 13 C of charge flows through the appliance.

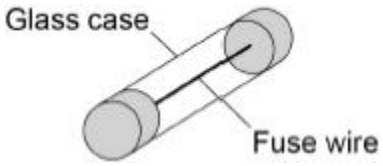
Use the equation:

energy transferred = charge flow × potential difference

Energy transferred = _____ J

(2)

The diagram below shows the structure of a fuse.



(c) Write down the equation that links charge flow, current and time.

(1)

(d) The fuse wire melts when 1.52 coulombs of charge flows through the fuse in 0.40 seconds.

Calculate the current at which the fuse wire melts.

Current = _____ A

(3)

(e) The mass of the fuse wire is 0.00175 kg. The specific latent heat of fusion of the fuse wire is 205 000 J/kg.

Calculate the energy needed to melt the fuse wire.

Use the Physics Equations Sheet.

_____

_____

_____

_____

Energy = _____ J

(2)

(Total 9 marks)

1. (a) $15.7 = \frac{15.8 + 15.3 + \mathbf{X}}{3}$

1

X = 16.0 (Ω)

1

(b) precise results show little variation

1

the 4th result was further away from the mean than the other values

allow the range of values has increased

ignore the 4th result was an anomaly

1

(c) two pairs of values of n and R showing that $n \times R$ = constant

e.g. 2 × 24 = 48, 3 × 16 = 48
4 × 12 = 48, 5 × 9.5 = 47.5
6 × 8 =48

1

third pair of values of n and R showing that $n \times R$ = constant

1

(so) $n \times R$ = constant (showing the student was correct)

allow 1 mark each for two statements relating the change in number of resistors to the change in (mean total) resistance

allow 1 mark for use of data from graph to confirm at least one statement

1

(d) multiple paths for charge / electrons to flow

allow current for charge

1

total current is greater (for the same potential difference when more resistors are added)

1

[9]

2. (a) $5.75 = I \times 230$

1

$I = \frac{5.75}{230}$

1

$I = 0.025$ (A)

1

$230 = 0.025 \times R$

or

$R = \frac{230}{0.025}$

allow a correct substitution using an incorrect value of I

or

allow a correct rearrangement using incorrect value of I

1

$R = 9200$ (Ω)

allow a correct calculation of resistance using an incorrect value of I

alternative approach for 4th and 5th marks:

$5.75 = 0.025^2 \times R$ (1)

or

$R = \frac{5.75}{0.025^2}$

R = 9200 (Ω) (1)

alternative approach:

$5.75 = \frac{230^2}{R}$ (3)

$R = \frac{230^2}{5.75}$ (1)

R = 9200 (Ω) (1)

1

(b) one wire in the switch is live

allow the switch / circuit is live allow one wire is at a potential of 230 V

1

the electrician is earthed

or

the electrician is at earth potential

1

(so) there will be a (large) potential difference between the live wire and the electrician / earth (if the electrician touched the wire)

1

(c) 50 Hz has the lowest (maximum) let-go current

1

a higher / lower / different frequency would allow people to let go at a greater current

allow a specific numerical example as opposed to a trend

1

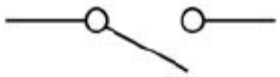
[10]

3. (a) M

1

(b)

or



1

(c)

*an answer of 0.8 (A) scores **2** marks*

$$\text{current} = \frac{24}{30}$$

1

current = 0.80 (A)

1

(d)

*an answer of 216 (J) scores **2** marks*

E = 60 × 3.6

1

E = 216 (J)

1

(e) The reading in **Y** would be lower

1

(f) The total resistance of **Y** is greater

1

(g) potential difference = current × resistance

or

V = *IR*

1

(h)

*an answer of 4.5 (Ω) scores **3** marks*

3.6 = 0.80 × R

1

$R = \frac{3.6}{0.80}$

1

R = 4.5 (Ω)

1

[12]

4. (a) 50

1

Hz / hertz

allow Hertz

1

(b) (both) switches need to be closed / on

1

to complete the <u>series</u> circuit
or
to allow charge to flow
or
so there is a current in the circuit

1

(c)

*an answer of 7.5 (A) scores **3** marks*

*an answer of 0.237(A) scores **2** marks*

$1800 = I^2 \times 32$

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

1

$I^2 = \frac{1800}{32}$

or

$I^2 = 56.25$

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

1

I = 7.5 (A)

this answer only

1

(d)

*an answer of 300 (s) scores **3** marks*

*an answer of 300 000 (s) scores **2** marks*

$1500 = \frac{450\ 000}{t}$

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

1

$t = \frac{450\ 000}{1500}$

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

1

t = 300 (s)

this answer only

1

[10]

5. (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*

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

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

$4800 = 40 \times R$

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]

6. (a) correct circuit symbol

1

3 cells joined in series in correct orientation

e.g.

ignore absence of + symbol

1

(b) $R = \frac{12}{1.6}$

1

R = 7.5 (Ω)

1

*an answer of 7.5 (Ω) scores **2** marks*

(c) 4.0 (Ω)

*allow their answer to part **(b)** − 3.5 correctly calculated*

1

(d) it decreases

1

the current would be higher (for the same p.d.)

reason only scores if correct box is chosen

or

more than one path for charge to flow

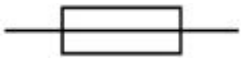
allow current for charge

or

total resistance is always less than the smallest individual resistance

1

[7]

7. (a) 

1

(b) E = 13 × 230

1

E = 2990 (J)

1

*an answer 2990 (J) scores **2** marks*

(c) charge flow = current × time

allow Q = It

1

(d) 1.52 = I × 0.40

1

$$I = \frac{1.52}{0.40}$$

1

I = 3.8 (A)

1

*an answer of 3.8 (A) scores **3** marks*

(e) E = 0.00175 × 205 000

1

E = 359 (J)

*allow an answer that rounds to 360 (J) for **2** marks*

1

*an answer of 359 (J) scores **2** marks*

[9]