Electricity 3

Name: _____

Class: _____

Date: _____

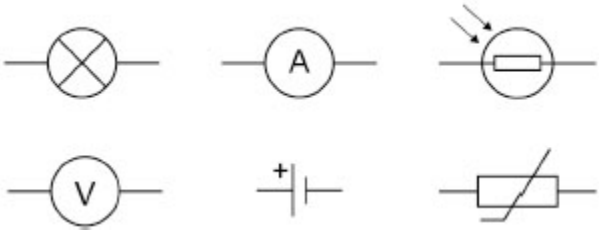
Time: **73 minutes**

Marks: **68 marks**

Comments:

1. **Figure 1** shows circuit symbols for some electrical components.

Figure 1



A student connects a circuit to measure the current in a filament lamp.

The student uses:

- an ammeter
- a cell
- a filament lamp.

(a) Draw a circuit diagram for a circuit the student could use to measure the current in a filament lamp.

You should use **three** of the circuit symbols from **Figure 1**.

(3)

(b) Which component is the source of energy for the circuit?

Tick (✓) **one** box.

Ammeter ☐

Cell ☐

Filament lamp ☐

(1)

(c) There is a current of 1.5 A in the filament lamp for a time of 30 s.

Calculate the charge flow in the filament lamp.

Use the equation:

charge flow = current × time

_____

_____

_____

Charge flow = _____ C

(2)

(d) The current in the filament lamp is 1.5 A when the potential difference across the filament lamp is 12 V.

Calculate the resistance of the filament lamp.

Use the equation:

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

Choose the unit from the box.

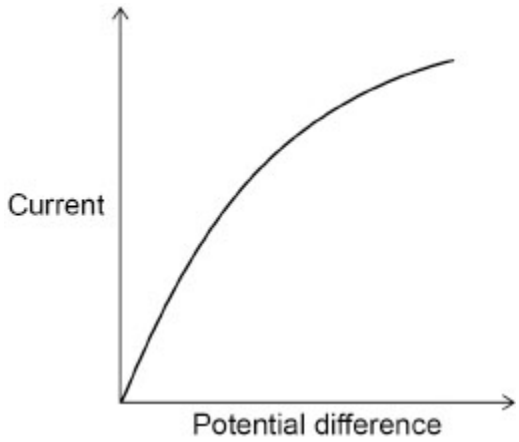
Ω	°C	W

Resistance = _____ Unit _____

(3)

Figure 2 shows how the current varies with potential difference for the filament lamp.

Figure 2



(e) Describe the relationship between potential difference and current for the filament lamp.

(2)

(f) As the current in the filament lamp increases, the temperature of the filament lamp increases.

What happens to the resistance of the filament lamp as the temperature increases?

(1)

(g) In most homes, filament lamps have been replaced with LED bulbs.

The table below shows information about a filament lamp and an LED bulb.

	Input power in watts	**Brightness in arbitrary units**
Filament lamp	40	800
LED bulb	8	800

Explain the advantages of using LED bulbs instead of filament lamps.

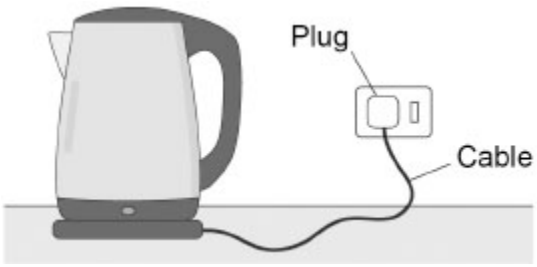
You should include a calculation in your answer.

(4)

(Total 16 marks)

2. The figure below shows a plastic kettle.

The kettle is connected to the mains electricity supply.



(a) What is the frequency of the UK mains electricity supply?

Tick (✓) **one** box.

25 Hz ☐

50 Hz ☐

75 Hz ☐

100 Hz ☐

(1)

(b) The cable that connects the kettle to the plug contains two insulated wires.

Draw **one** line from each wire to the colour of the insulation on the wire.

Wire	**Colour of insulation**
Live	Blue
	Brown
Neutral	Green and yellow stripes

(2)

Use the Physics Equations Sheet to answer parts (c) and (d).

(c) Write down the equation that links current (I), potential difference (V) and power (P).

_____

_____

(1)

(d) The power of the heating element in the kettle is 2100 W.

The potential difference across the heating element is 230 V.

Calculate the current in the heating element.

Give your answer to 2 significant figures.

Current (2 significant figures) = _____ A

(4)

(e) The kettle is designed to switch off when the water reaches boiling point.

Before the kettle switches off, 0.0080 kg of water changes state.

The energy transferred to change the state of the water is 18 000 J.

Calculate the specific latent heat of vaporisation of the water.

Use the Physics Equations Sheet.

Specific latent heat of vaporisation = _____ J/kg

(3)

(f) A different kettle is used to heat some water.

The useful output energy transferred to the water is 75 600 J.

The total input energy transferred by the kettle is 84 000 J.

Calculate the efficiency of the kettle.

Use the equation:

$$\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$$

Efficiency = _____

(2)

(g) Explain **one** advantage of electrical appliances having a high efficiency.

(2)

(Total 15 marks)

3. A student investigated the resistance of a resistor.

(a) The student used:

- the resistor
- a cell
- a switch
- an ammeter
- a voltmeter.

Draw a circuit diagram for a circuit the student could use to measure the resistance of the resistor.

(3)

The student:

- added a variable resistor to the circuit
- used the variable resistor to change the readings on the ammeter and the voltmeter
- recorded several different pairs of readings from the ammeter and the voltmeter.

(b) When the reading on the ammeter was 450 mA, the reading on the voltmeter was 2.7 V.

Calculate the resistance of the resistor.

Use the Physics Equations Sheet.

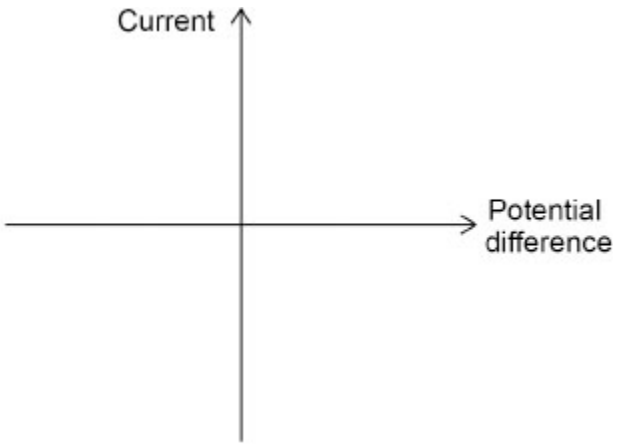
Resistance = _____ Ω

(4)

(c) The student plotted a graph of current against potential difference for the fixed resistor.

Complete **Figure 1** to show a sketch graph for a fixed resistor at a constant temperature.

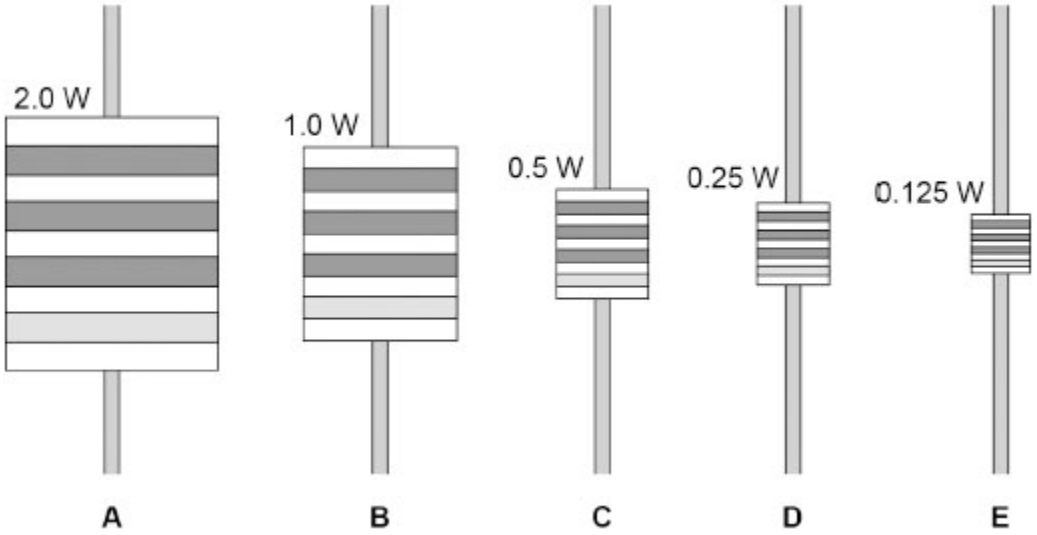
Figure 1



(1)

(d) **Figure 2** shows five resistors with the same resistance but different power ratings.

Figure 2



The power rating of a resistor is the maximum energy the resistor can transfer each second without overheating.

Each resistor has a resistance of 2.2 kΩ.

Determine which resistors in **Figure 2** are suitable to be used in a circuit that has a maximum current of 0.012 A.

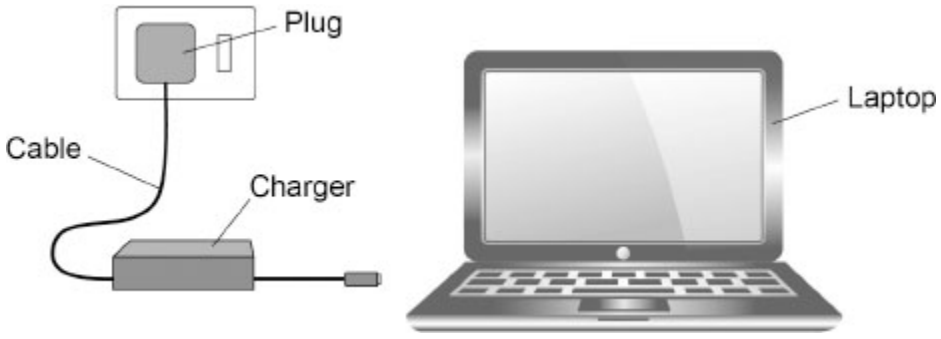
Use the Physics Equations Sheet.

Suitable resistors _____

(4)

(Total 12 marks)

4. The figure below shows a laptop computer, and a charger plugged into the mains supply.



(a) Give the potential difference and frequency of the UK mains electricity supply.

Potential difference _____ V

Frequency _____ Hz

(2)

(b) The cable that connects the charger to the plug contains **two** wires that have coloured insulation.

The cable does **not** contain an earth wire.

Name each wire in the cable.

Give the colour of the insulation covering each wire.

Name of wire _____ Colour of insulation _____

Name of wire _____ Colour of insulation _____

(2)

(c) The input to the charger is an alternating potential difference.

The output from the charger is a direct potential difference.

Describe the difference between an alternating potential difference and a direct potential difference.

_____

_____

_____

_____

(2)

A student is using the laptop computer.

The student notices that the battery has no stored energy.

The student quickly plugs the charger into the laptop and continues to use the laptop.

(d) The laptop charger provides a constant power to the laptop.

The laptop takes longer to charge when the student uses the laptop than when the laptop is not used.

Explain why.

_____

_____

_____

_____

(2)

(e) The potential difference across the laptop circuit is 15 V.

The average current in the laptop circuit when it is being used is 4.8 A.

The laptop charger provides a constant power of 97 W.

The maximum energy that the battery can store is 225 kJ.

Calculate the time taken to fully charge the battery from zero when the laptop is used continuously.

Use the Physics Equations Sheet.

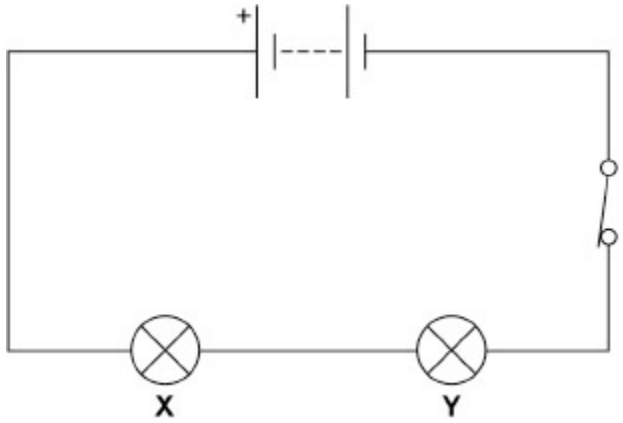
Give your answer in hours.

Time = _____ hours

(6)

(Total 14 marks)

5. The figure below shows a circuit diagram. The circuit contains a battery and two lamps, **X** and **Y**.



(a) How does the current in lamp **X** compare with the current in lamp **Y**?

Tick (✓) **one** box.

The current in lamp **X** is smaller. ☐

The current in both lamps is the same. ☐

The current in lamp **X** is greater. ☐

(1)

(b) Lamp **X** and lamp **Y** are **not** identical.

The potential difference across the battery is 4.5 V.

The potential difference across lamp **X** is 1.5 V.

Calculate the potential difference across lamp **Y**.

_____

_____

Potential difference across lamp **Y** = _____ V

(1)

The current in lamp **X** is 1.2 A.

The potential difference across lamp **X** is 1.5 V.

(c) Calculate the power of lamp **X**.

Use the equation:

power = potential difference × current

Power = _____ W

(2)

(d) Calculate the resistance of lamp **X**.

Use the equation:

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

Resistance = _____ Ω

(2)

(e) The current in lamp **X** is 1.2 A.

Calculate the charge flow through lamp **X** in 40 seconds.

Use the equation:

charge flow = current × time

Charge flow = _____ C

(2)

(f) The switch can be used to turn the lamps on and off.

Immediately after the lamps are switched on, the resistance of each lamp increases.

Why does the resistance of each lamp increase?

Tick (✓) **one** box.

The current in the battery decreases. ☐

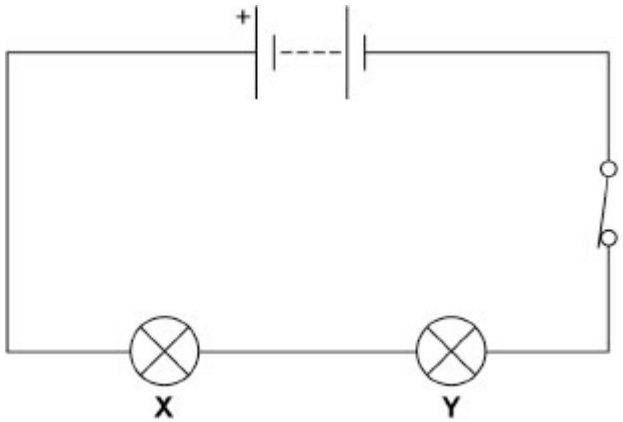
The potential difference across each lamp decreases. ☐

The power of the battery increases. ☐

The temperature of each lamp increases. ☐

(1)

The figure above is repeated below.



(g) Lamp **Y** breaks.

What happens to lamp **X**?

Give a reason for your answer.

Tick (✓) **one** box.

Lamp **X** gets brighter. ☐

Lamp **X** stays the same brightness. ☐

Lamp **X** no longer emits light. ☐

Reason _____

_____

(2)

(Total 11 marks)

Mark schemes

1.

(a) symbols for filament lamp, ammeter and cell used

*allow **1** mark for 2 correct circuit symbols*

2

a simple complete series circuit

*MP3 dependent on scoring at least **1** other mark*

1

(b) cell

1

(c) $Q = 1.5 \times 30$

1

$Q = 45$ (C)

1

(d)

$$R = \frac{12}{1.5}$$

1

$R = 8$

allow 8.0

1

Ω

allow ohms

1

(e) as potential difference increases, the current increases

1

non-linear relationship

allow at a decreasing rate

1

(f) (resistance) increases

1

(g) **Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

3-4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1-2

No relevant content

0

Indicative content

- both types of bulb have equal brightness
- the same number of bulbs are needed
- LED bulbs do not need to be replaced as often

power comparison

- the input power of filament lamp is greater
- the input power of the filament lamp is 32 W greater
- the input power of filament lamp is 5 times greater
- the brightness per watt for the LED bulb is 100 arbitrary units
- the brightness per watt for the filament lamp is 20 arbitrary units

consequence

- LED bulb transfers less energy
- (number of units of) electricity used is lower for LED bulb
- LED bulb wastes less energy
- LED bulb running costs are lower
- the LED bulb is more efficient
- the LED bulb is 5 times more efficient

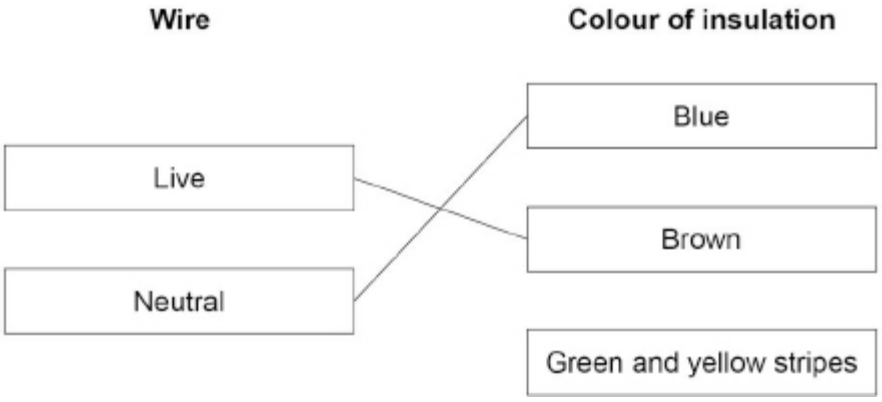
for **Level 2** answers must include a valid calculation

[16]

2. (a) 50 Hz

1

(b)



do **not** accept more than one line from a box on the left

2

(c) power = potential difference × current

or

$P = VI$

1

(d) $2100 = 230 \times I$

1

$I = \frac{2100}{230}$

1

$I = 9.13\ldots$

1

$I = 9.1$ (A)

allow an answer calculated using the numbers from the question given to two significant figures

1

(e) $18\,000 = 0.0080 \times L$

1

$L = \frac{18\,000}{0.0080}$

1

$L = 2\,250\,000$ (J/kg)

allow 2 300 000

1

(f)

$\text{efficiency} = \frac{75\,600}{84\,000}$

1

efficiency = 0.9

OR

$\text{efficiency} = \frac{75\,600}{84\,000} \times 100$ (1)

efficiency = 90% (1)

1

(g) less energy is wasted

allow power for energy throughout

1

(so) costs less to run

or

(so) uses less electricity / energy

allow so the appliance is used for less time

1

[15]

3.

(a) circuit with a cell, (switch) and resistor in series

allow battery for cell

1

ammeter in series (with the resistor and the cell)

1

voltmeter in parallel with resistor

1

(b) $I = 0.45$ (A)

subsequent marks may be awarded if an incorrectly / not converted value of I is used

1

$2.7 = 0.45 \times R$

1

$$R = \frac{2.7}{0.45}$$

1

$R = 6$ (Ω)

allow 6.0 (Ω)

1

(c) straight line through the origin in **both** 1st and 3rd quadrant

1

(d) R = 2200 (Ω)

subsequent marks may be awarded if an incorrectly / not converted value of R is used

1

$P = 0.012^2 \times 2200$

1

P = 0.3168 (W)

allow P = 0.32

allow P = 0.317

1

resistors **A**, **B** and **C**

*dependent on MP1 **and** MP3*

OR

the first three marks may be awarded for calculating I_{max} for any of the resistors

R = 2200 (Ω) (1)

subsequent marks may be awarded if an incorrectly / not converted value of R is used

2.0 = $I^2 \times 2200$ (1)

$I = 0.030\ldots$(1)

resistors **A**, **B** and **C** (1)

*dependent on MP1 **and** MP3*

1

[12]

4. (a) 230 (V)

allow about 230 (V)

1

50 (Hz)

1

(b) live – brown

1

neutral – blue

1

(c) alternating (potential difference) continuously changes direction

1

direct (potential difference) is always in the same direction

1

(d) energy / power is transferred by the laptop (when being used)

1

(so) the power delivered to the battery is reduced

allow (so) the rate at which energy is transferred to the battery is lower

1

(e) $P = 15 \times 4.8$

1

$P = 72$ (W)

1

$\Delta P = 97 - 72 = 25$ (W)

1

$$25 = \frac{225\,000}{t}$$

subsequent marks may be awarded if an incorrect / not converted value of E is used.

1

$t = 9000$ (s)

1

$t = 2.5$ (hours)

1

[14]

5. (a) the current in both lamps is the same

1

(b) (4.5 - 1.5 =) 3 (V)

allow (4.5 - 1.5 =) 3.0 (V)

1

(c) $P = 1.5 \times 1.2$

1

1.8 (W)

1

(d)

$$R = \frac{1.5}{1.2}$$

1

1.25 (Ω)

allow 1.3 (Ω)

1

(e) $Q = 1.2 \times 40$

1

48 (C)

1

(f) the temperature of each lamp increases

1

(g) lamp **X** no longer emits light

1

because the circuit is no longer complete

dependent on MP1

allow because there is no current

1

[11]