**Q1.**

(a)     A resistor is a component that is used in an electric circuit.

 

(i)      Describe how a student would use the circuit to take the readings necessary to determine the resistance of resistor **R**.

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**(6)**

(ii)     Explain why the student should open the switch after each reading.

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**(2)**

(iii)    In an experiment using this circuit, an ammeter reading was 0.75 A.
The calculated value of the resistance of resistor **R** was 16 Ω.

What is the voltmeter reading?

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Voltmeter reading = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V

**(2)**

(iv)    The student told his teacher that the resistance of resistor **R** was 16 Ω.

The teacher explained that the resistors used could only have one of the following values of resistance.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **10 Ω** | **12 Ω** | **15 Ω** | **18 Ω** | **22 Ω** |

Suggest which of these resistors the student had used in his experiment.

Give a reason for your answer.

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**(2)**

(b)     The diagram shows a fuse.

 

Describe the action of the fuse in a circuit.

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**(3)**

**(Total 15 marks)**

**Q2.**

Most electric kettles use the ac mains electricity supply.

(a)     Complete the sentence.

The ac mains supply has a potential difference that continuously

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ polarity

**(1)**

**Figure 1** gives the power output of three electric kettles.

**Figure 1**

****

A student investigated how the power output of a kettle affected the time taken to boil a fixed volume of water.

The water in all three kettles had an initial temperature of 25 °C.

(b)     What type of variable was the time?

Tick **one** box.

|  |  |
| --- | --- |
| Control |  |
| Dependent |  |
| Independent |  |

**(1)**

(c)     Which kettle will boil the water in the shortest time?

Give a reason for your answer.

Kettle \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Reason \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(d)     **Figure 2** shows how the amount of energy transferred by a kettle varies with time.

**Figure 2**

****

The power output of the kettle is given by the gradient of the graph.

Calculate the power output of the kettle.

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Power output = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W

**(2)**

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

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**(1)**

(f)      Calculate the current through the kettle when 2400 coulombs of charge flows in 250 seconds.

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Current = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A

**(3)**

**(Total 10 marks)**

**Q3.**

(a)    The diagram shows the inside of an incorrectly wired three-pin plug.



(i)      What **two** changes need to be made so that the plug is wired correctly?

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**(2)**

(ii)     The fuse inside a plug is a safety device.

Explain what happens when too much current passes through a fuse.

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**(2)**

(b)     Each of these pictures shows an electrical appliance being used in a bathroom.



Using the hairdryer in picture **A** is dangerous. However, it is safe to use the battery-operated radio in picture **B**.

Explain why.

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**(2)**

**(Total 6 marks)**

**Q4.**

(a)     A washing machine is connected to the mains electricity supply using a cable and three-pin plug.

**Figure 1** shows a three-pin plug.

**Figure 1**

****

Name the materials used in the structure of a plug. Give the reason why each material is used.

Pin \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Outer case \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(1)**

(b)     The three-pin plug contains a fuse. The fuse is connected to one of the wires inside the cable.

(i)      Which **one** of the wires inside the cable is the fuse connected to?

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**(1)**

(ii)     The fuse is a thin wire inside a closed glass tube. The wire acts as a resistor.

What effect does a current through a wire have on the wire?

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**(1)**

(iii)     The power of the washing machine varies between 0.7 kW and 2 kW depending on which part of the wash cycle is operating.

Calculate the maximum current drawn from the mains electricity supply by the washing machine.

The mains electricity supply is at a potential difference of 230 V.

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Current = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A

**(2)**

(c)     **Figure 2** shows how the mains electricity cable is connected to the washing machine.

The earth wire is connected to the metal case of the washing machine.

**Figure 2**

****

If a fault makes the metal case live, the earth wire and fuse inside the plug prevent the mains cable from overheating and causing a fire.

Explain how.

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**(2)**

(d)     New research has shown that many people underestimate the hazards of using mains electricity.

It is important that people do understand the hazards of using mains electricity.

Suggest why.

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**(1)**

**(Total 9 marks)**

**Q5.**

A student finds some information about energy-saving light bulbs.

(a)     A 30W light bulb uses 600J of electrical energy in a certain period of time. In that time, it produces 450 J of light energy. The rest of the energy is wasted.

(i)      Calculate the energy wasted by the light bulb in this period of time.

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Wasted energy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(1)**

(ii)     What happens to the energy wasted by the light bulb?

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**(1)**

(iii)    Calculate the efficiency of this light bulb.

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Efficiency = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(iv)    Calculate the period of time, in seconds, during which the 600 J is provided to the 30 W light bulb.

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Time = \_\_\_\_\_\_\_\_\_\_\_\_\_ s

**(2)**

(b)     A company that makes light bulbs provides information about some of their products.

The table shows some of this information.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Power in watts** | **Lifetime in hours** | **Cost of bulb in £** |
| **Filament bulb** | 60 |   1250 |   2.00 |
| **LED bulb** | 12 | 50 000 | 16.00 |

(i)      Suggest why it is important to confirm this information independently.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(ii)     A homeowner is thinking about replacing his filament bulbs with LED bulbs.

A 12 W LED bulb gives the same light output as a 60 W filament bulb.

Suggest reasons why the homeowner is likely to choose LED bulbs.

Use the information given in the table.

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**(2)**

(iii)    State **one** factor, other than efficiency, that is important when considering the choice of a bulb for lighting in the home.

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**(1)**

**(Total 10 marks)**

**Q6.**

(a)    Describe the difference between an alternating current (a.c.) and a direct current (d.c.).

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**(2)**

(b)     The diagram shows how the electric supply cable is connected to an electric kettle.
The earth wire is connected to the metal case of the kettle.



If a fault makes the metal case live, the earth wire and the fuse inside the plug protect anyone using the kettle from an electric shock.

Explain how.

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**(2)**

**(Total 4 marks)**

**Q7.**

An electrician is replacing an old electric shower with a new one.

The inside of the old shower is shown in **Figure 1**.

**Figure 1**

****

                                                              © Michael Priest

(a)     If the electrician touches the live wire he will receive an electric shock.

Explain why.

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**(4)**

(b)     Different electrical wires need to have a cross-sectional area that is suitable for the power output.

**Figure 2** shows the recommended maximum power input to wires of different cross-sectional areas.

**Figure 2**

****

The new electric shower has a power input of 13.8 kW.

Determine the minimum **diameter** of wire that should be used for the new shower.

The diameter, d, can be calculated using the equation:



A is the cross-sectional area of the wire.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Minimum diameter = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mm

**(2)**

(c)     The charge that flows through the new shower in 300 seconds is 18 000 C.

The new electric shower has a power of 13.8 kW.

Calculate the resistance of the heating element in the new shower.

Write down any equations you use.

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Resistance = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Ω

**(5)**

**(Total 11 marks)**

Mark schemes

**Q1.**

(a)     (i)      any **six** from:

•        switch on

•        read both ammeter and voltmeter

*allow read the meters*

•        adjust variable resistor to change the current

•        take further readings

•        draw graph

•        (of) V against I

*allow take mean*

•        R = V / I

*allow take the gradient of the graph*

**6**

(ii)     resistor would get hot if current left on

**1**

so its resistance would increase

**1**

(iii)    12 (V)

*0.75 × 16 gains* ***1*** *mark*

**2**

(iv)    15 (Ω)

**1**

16 is nearer to that value than any other

**1**

(b)     if current is above 5 A / value of fuse

**1**

fuse melts

*allow blows / breaks*

*do* ***not*** *accept exploded*

**1**

breaks circuit

**1**

**[15]**

**Q2.**

(a)     changes

*allow reverses*

**1**

(b)     dependent

**1**

(c)     kettle **C**

**or**

2.8 kW

**1**

highest power (output)

*allow higher power (output)*

**1**

(d)     values for gradient calculation shown on graph or on answer lines

**1**

power input = 2200 (W)

*accept an answer that rounds to 2200 (W) for* ***2*** *marks*

**1**

(e)     charge flow = current × time

*allow Q = It*

**1**

(f)      2400 = I × 250

**1**

****

**1**

I = 9.6 (A)

*an answer of 9.6 (A) scores 3 marks*

**1**

**[10]**

**Q3.**

(a)     (i)       connect the earth wire (to pin)

*answers must be in terms of correcting the faults*

**1**

screw cable grip (across cable)

*accept tighten the cable grip*

**1**

(ii)     any **two** from:

•         fuse gets (very) hot
•         fuse melts

*accept blows for melts*

*do* ***not*** *accept break / snap fuse / blow up*

•         circuit breaks / switches off

*accept stops current flowing*

**2**

(b)     any **two** from:

•         hairdryer is plugged into mains (electricity socket)

*it refers to hairdryer
hairdryer works from the mains*

**or**hairdryer is using 230 V

*accept 240 for 230*

•         water conducts electricity

*do* ***not*** *accept water and electricity don’t mix*

•         radio is low power / current / pd / voltage

*accept radio not connected to the mains
do* ***not*** *accept radio is waterproof*

•         (the current in / pd across) hairdryer more likely to give a (fatal) electric shock

*accept the idea of electrocution if hairdryer is wet
accept the idea of radio not causing electrocution if wet*

**2**

**[6]**

**Q4.**

(a)     pin

made from brass because it is (hard and) a (good electrical) conductor

*accept copper for brass*

*metal is insufficient*

*heat conductor on its own negates*

**1**

outer case

plastic/rubber because it is a (good electrical) insulator

*heat insulator on its own negates*

**1**

(b)     (i)      live

**1**

(ii)     makes it hot/warm

*melts is insufficient*

**1**

(iii)     8.7

*accept an answer that rounds to 8.7*

*allow* ***1*** *mark for correct substitution ie 2000 = 230 × I*

*an answer of 0.0087* ***or*** *0.009* ***or*** *3.0(4)* ***or*** *5.65* ***or*** *5.7 gains* ***1*** *mark*

**2**

(c)     a (large) current goes from the live wire to the earth wire

*accept metal case for live wire*

*accept a current goes from live to earth*

*do not accept electricity for current*

**1**

(which causes) the fuse to (overheat and) melt

*accept blow for melt*

*break is insufficient*

*do not accept snap / blow up for melt*

**1**

(d)     reduce chance of an electric shock

*accept to reduce the risk of an accident*

*accept prevent electric shock*

*accept prevent electrocution*

*accept prevent or reduce the risk of an (electrical) fire*

*accept an electric shock can kill you*

*accept it can kill you*

*accept so you can use it safely*

**1**

**[9]**

**Q5.**

(a)     (i)      150

**1**

(ii)     transferred to the surroundings by heating

*reference to sound negates mark*

**1**

(iii)    0.75

*450 / 600 gains* ***1*** *mark*

*accept 75% for* ***2*** *marks*

*maximum of* ***1*** *mark awarded if a unit is given*

**2**

(iv)    20 (s)

*correct answer with or without working gains* ***2*** *marks*

*correct substitution of 600 / 30 gains* ***1*** *mark*

**2**

(b)     (i)      to avoid bias

**1**

(ii)     use less power and last longer

**1**

1 LED costs £16, 40 filament bulbs cost £80

**or**

filament costs (5 times) more in energy consumption

**1**

(iii)    any **one** from:

•        availability of bulbs

•        colour output

•        temperature of bulb surface

**1**

**[10]**

**Q6.**

(a)    d.c. flows in (only) one direction

**1**

a.c. changes direction (twice every cycle)

*accept a.c. constantly changing direction*

*ignore references to frequency*

**1**

(b)     a current flows through from the live wire / metal case to the earth wire

*accept a current flows from live to earth*

*do* ***not*** *accept on its own if the current is too high*

**1**

this current causes the fuse to melt

*accept blow for melt*

*do* ***not*** *accept break / snap / blow up for melt*

**1**

**[4]**

**Q7.**

(a)     (because the) potential of the live wire is 230 V

**1**

(and the) potential of the electrician is 0 V

**1**

(so there is a) large potential difference between live wire and electrician

**1**

charge / current passes through his body

*allow voltage for potential difference*

**1**

(b)     diameter between 3.50 and 3.55 (mm)

*allow correct use of value of cross-sectional area of 9.5 to 9.9 (mm2) with no final answer given for* ***1*** *mark*

**2**

(c)     18000 = I × 300

**1**

I = 18000 / 300   = 60

**1**

13 800 = (602) × R

**1**

R = 13 800 / 602

**1**

3.83 (Ω)

**1**

*allow 3.83(Ω) with no working shown for* ***5*** *marks*

*answer may also be correctly calculated using P = IV and V = IR if 230 V is used.*

**[11]**