Q1. 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



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

Explain why.

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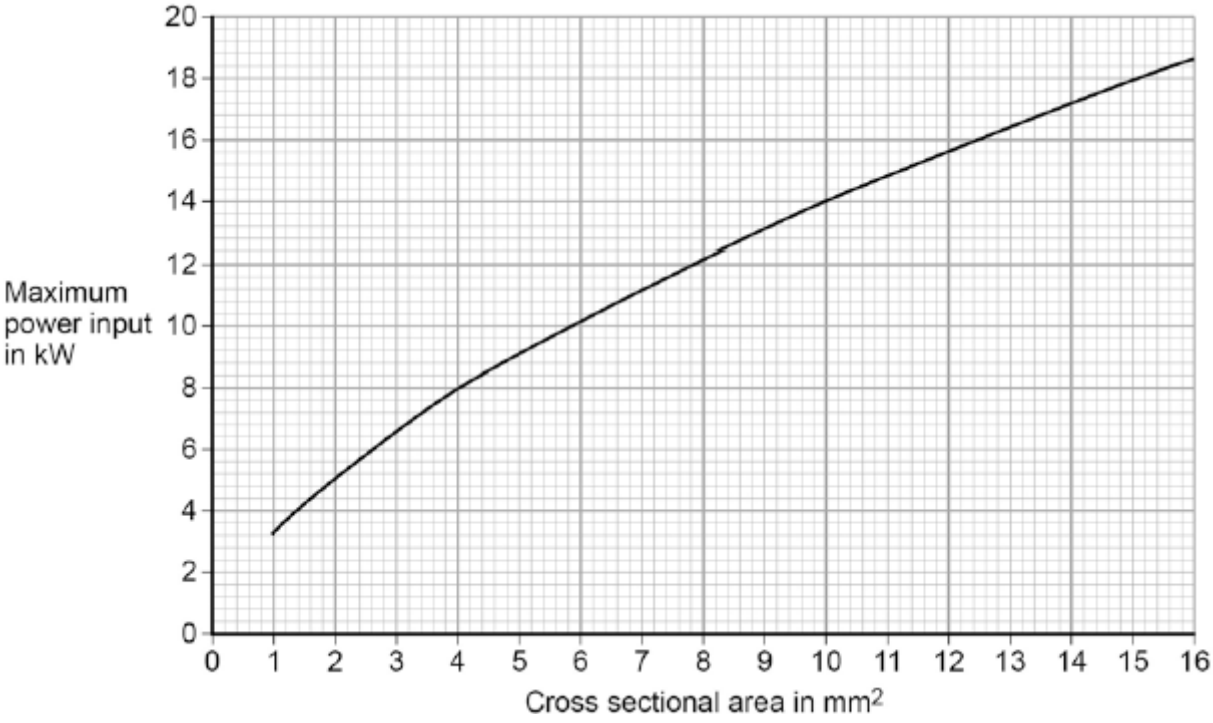
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(4)

(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:

$$d = \sqrt{\frac{4A}{\pi}}$$

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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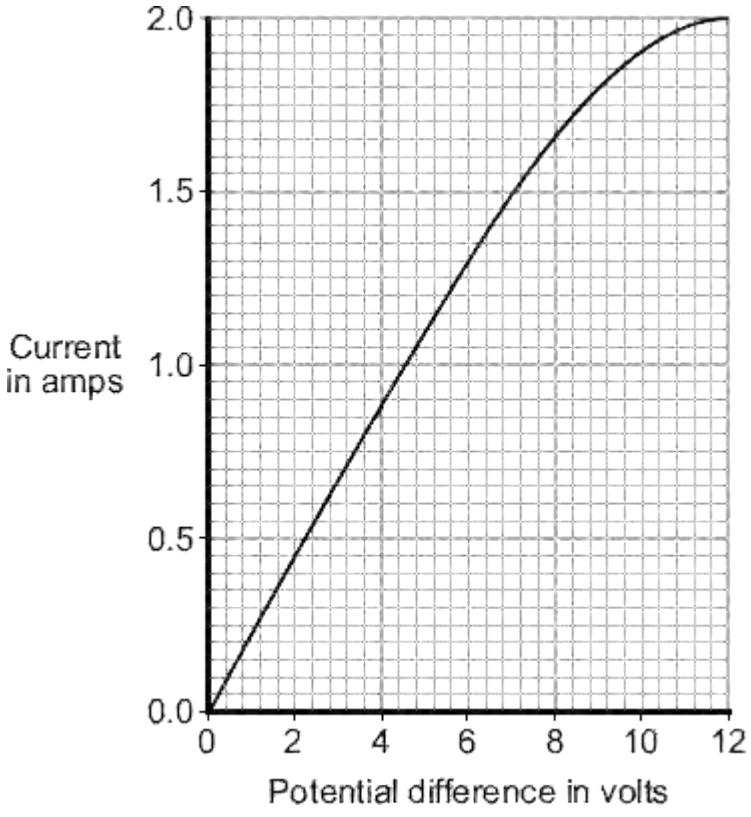
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Resistance = ... Ω

(5)

(Total 11 marks)

Q2. The graph shows how the electric current through a 12 V filament bulb varies with the potential difference across the bulb.



(a) What is the meaning of the following terms?

electric current

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potential difference

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(2)

(b) The resistance of the metal filament inside the bulb increases as the potential difference across the bulb increases.

Explain why.

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(3)

(c) Use data from the graph to calculate the rate at which the filament bulb transfers energy, when the potential difference across the bulb is 6 V.

Show clearly how you work out your answer.

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Rate of energy transfer = ... W

(2)

(Total 7 marks)

Q3. The table gives data about two types of low energy bulb.

Type of bulb	Power input in watts	Efficiency	Lifetime in hours	Cost of one bulb
Compact Fluorescent Lamp (CFL)	8	20%	10 000	£3.10
Light Emitting Diode (LED)	5		50 000	£29.85

(a) Both types of bulb produce the same useful power output.

(i) Calculate the useful power output of the CFL.

Show clearly how you work out your answer.

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Useful power output = ... W

(2)

(ii) Calculate the efficiency of the LED bulb.

Show clearly how you work out your answer.

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Efficiency = ...

(1)

(b) LED bulbs are expensive. This is because of the large number of individual electronic
LED chips needed to produce sufficient light from each bulb.

(i) Use the data in the table to evaluate the cost-effectiveness of an LED bulb compared to a CFL.

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(2)

(ii) Scientists are developing brighter and more efficient LED chips than those currently used in LED bulbs.

Suggest **one** benefit of developing brighter and more efficient LED chips.

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(1)
(Total 6 marks)

Q4. Solar panels are often seen on the roofs of houses.

(a) Describe the action and purpose of a solar panel.

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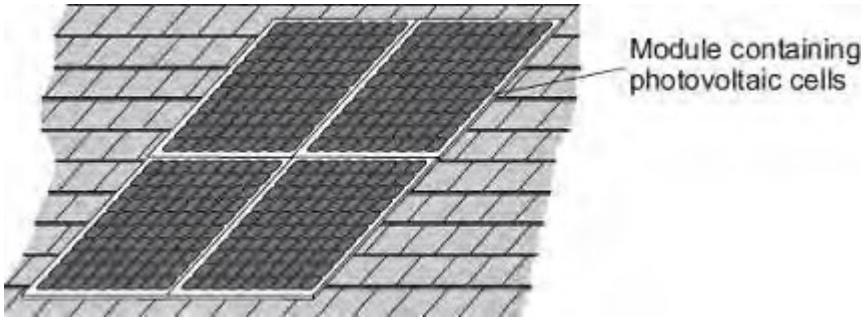
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(2)

(b) Photovoltaic cells transfer light energy to electrical energy.

In the UK, some householders have fitted modules containing photovoltaic cells on the roofs of their houses.

Four modules are shown in the diagram.



The electricity company pays the householder for the energy transferred.

The maximum power available from the photovoltaic cells shown in the diagram is 1.4×10^3 W.

How long, in minutes, does it take to transfer 168 kJ of energy?

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..... Time = ... minutes

(3)

(c) When the modules are fitted on a roof, the householder gets an extra electricity meter to measure the amount of energy transferred by the photovoltaic cells.

(i) The diagram shows two readings of this electricity meter taken three months apart.
The readings are in kilowatt-hours (kWh).

21 November

0	0	0	4	4

21 February

0	0	1	9	4

Calculate the energy transferred by the photovoltaic cells during this time period.

.....

Energy transferred = ... kWh

(1)

(ii) The electricity company pays 40p for each kWh of energy transferred.

Calculate the money the electricity company would pay the householder.

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Money paid = ...

(2)

(iii) The cost of the four modules is £6000.

Calculate the payback time in years for the modules.

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Payback time = ... years

(3)

(iv) State an assumption you have made in your calculation in part **(iii)**.

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(1)

(d) In the northern hemisphere, the modules should always face south for the maximum transfer of energy.

State **one** other factor that would affect the amount of energy transferred during daylight hours.

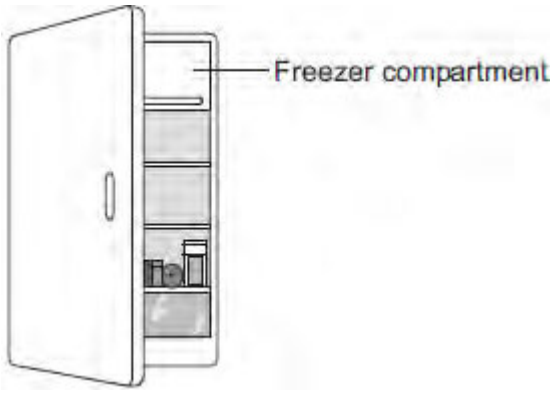
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(1)
(Total 13 marks)

Q5.(a) The figure below shows a fridge with a freezer compartment.

The temperature of the air inside the freezer compartment is –5 °C.



The air inside the fridge forms a convection current when the fridge door is closed.

Explain why.

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(4)

(b) The table below shows information about four fridges.

Fridge	Volume in litres	Energy used in one year in kWh
A	250	300
B	375	480
C	500	630
D	750	750

A householder concludes that the energy used in one year is directly proportional to the volume of the fridge.

Explain why her conclusion is **not** correct.

Use data from the table in your answer.

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(2)

(c) New fridges are more efficient than fridges made twenty years ago.

Give **one** advantage and **one** disadvantage of replacing an old fridge with a new fridge.

Ignore the cost of buying a new fridge.

Advantage .....

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Disadvantage .....

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(2)
(Total 8 marks)

Q6.Table 1 shows information about different light bulbs.

The bulbs all have the same brightness.

Table 1

Type of bulb	Input power in watts	Efficiency
Halogen	40	0.15
Compact fluorescent (CFL)	14	0.42
LED	7	0.85

(a) (i) Calculate the useful power output of the CFL bulb.

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Useful power output = ... watts

(2)

(ii) Use your answer to part **(i)** to calculate the waste energy produced each second by a CFL bulb.

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Waste energy per second = ... joules

(1)

(b) (i) A growth cabinet is used to investigate the effect of light on the rate of growth of plants.

The figure below shows a growth cabinet.



In the cabinet the factors that affect growth can be controlled.

A cooler unit is used to keep the temperature in the cabinet constant. The cooler unit is programmed to operate when the temperature rises above 20 °C.

The growth cabinet is lit using 50 halogen bulbs.

Changing from using halogen bulbs to LED bulbs would reduce the cost of running the growth cabinet.

Explain why.

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(4)

(ii) A scientist measured the rate of growth of plants for different intensities of light.

What type of graph should be drawn to present the results?

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Give a reason for your answer.

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(1)

(c) **Table 2** gives further information about both a halogen bulb and a LED bulb.

Table 2

Type of bulb	Cost to buy	Lifetime in hours	Operating cost over the lifetime of one bulb
Halogen	£1.50	2 000	£16.00
LED	£30.00	48 000	£67.20

A householder needs to replace a broken halogen light bulb.

Compare the cost efficiency of buying and using halogen bulbs rather than a LED bulb over a time span of 48 000 hours of use.

Your comparison must include calculations.

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(4)

(Total 12 marks)