**Q1.** (a)   A student used the apparatus drawn below to investigate the heating effect of an electric heater.
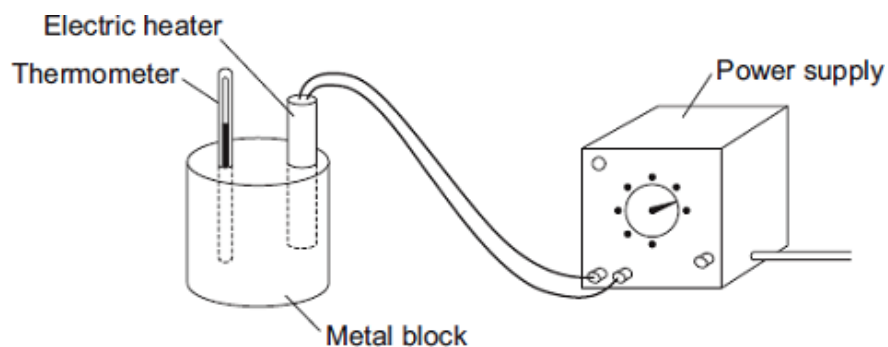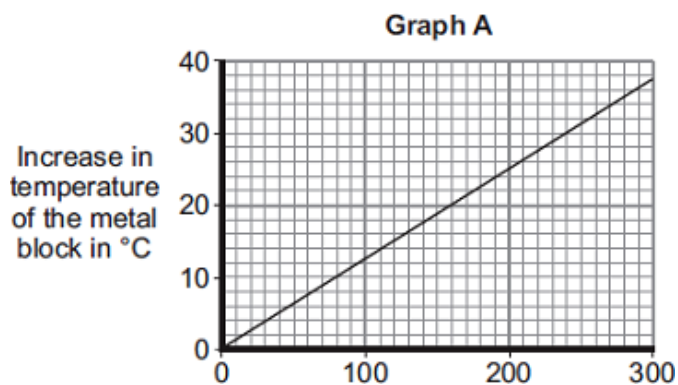
Electric heater

Thermometer

Power supply

Metal block

(i)   Before starting the experiment, the student drew **Graph A**.

**Graph A** shows how the student expected the temperature of the metal block to change after the heater was switched on.

**Graph A**

Increase in temperature of the metal block in °C

Describe the pattern shown in **Graph A**.

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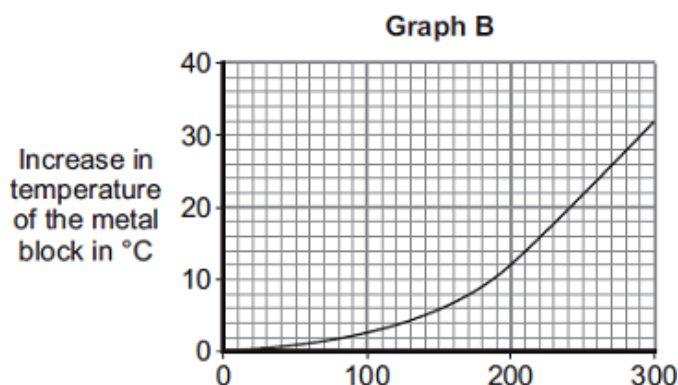.............................................................................................................

**(2)**

(ii) The student measured the room temperature. He then switched the heater on and measured the temperature of the metal block every 50 seconds.

The student calculated the increase in temperature of the metal block and plotted **Graph B**.

**Graph B**



After 300 seconds, **Graph B** shows the increase in temperature of the metal block is lower than the increase in temperature expected from **Graph A**.

Suggest **one** reason why.

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**(1)**

(iii) The power of the electric heater is 50 watts.

Calculate the energy transferred to the heater from the electricity supply in 300 seconds.

Use the correct equation from the Physics Equations Sheet.

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Energy transferred = ........................................... J

**(2)**

(b)   The student uses the same heater to heat blocks of different metals. Each time the heater is switched on for 300 seconds.

Each block of metal has the same mass but a different specific heat capacity.

| Metal | Specific heat capacity in J/kg°C |
|---|---|
| Aluminium | 900 |
| Iron | 450 |
| Lead | 130 |

Which **one** of the metals will heat up the most?

Draw a ring around the correct answer.

**aluminium**               **iron**               **lead**

Give, in terms of the amount of energy needed to heat the metal blocks, a reason for your answer.

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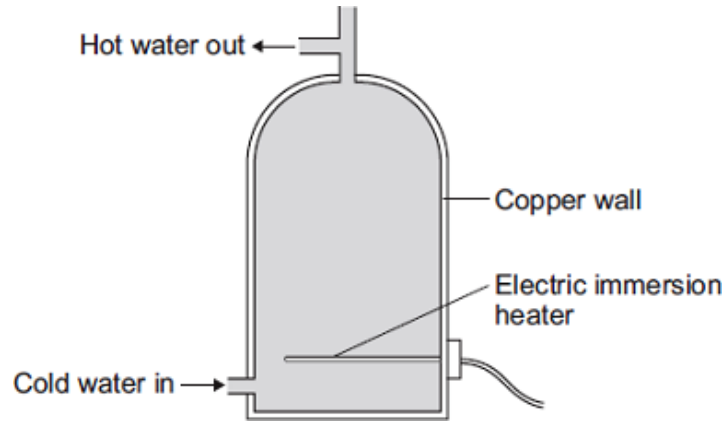...........................................................................................................

**(2)**

(c)     A homeowner uses an electric immersion heater to heat the water in his hot water tank.
        The hot water tank has no insulation.



(i)     Draw a ring around the correct answer to complete each sentence.

Energy is transferred through the water by

| conduction. |
| convection. |
| evaporation. |

Energy is transferred through the copper wall of the hot water tank by

| conduction. |
| convection. |
| evaporation. |

**(2)**

(ii)    To keep the water in the tank hot for longer, the homeowner fits an insulating jacket
        around the tank. The insulating jacket costs £12 to buy.

        The homeowner expects to save £16 each year from reduced energy bills.

        Calculate the pay-back time for the insulating jacket.

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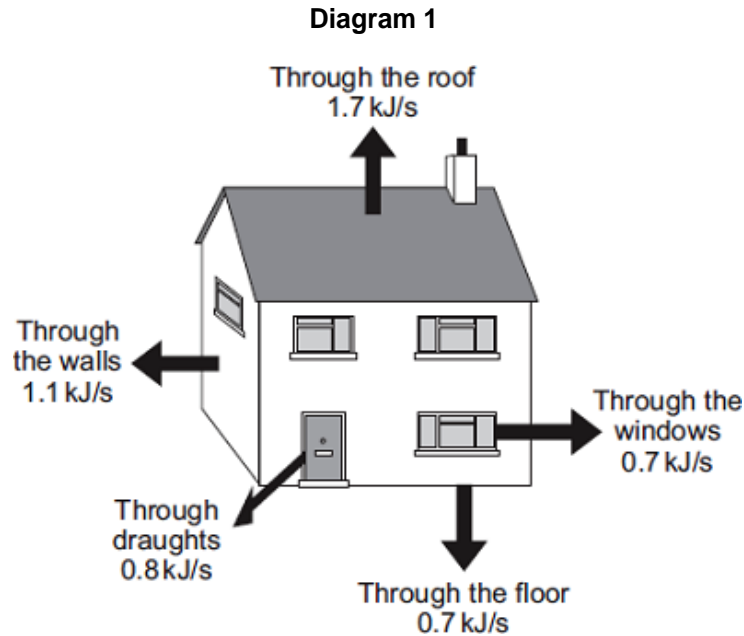                        Pay-back time = .......................................... years

**(2)**
**(Total 11 marks)**

**Q2.**    **Diagram 1** shows the energy transferred per second from a badly insulated house on a cold day in winter.

**Diagram 1**



Through the roof
1.7 kJ/s

Through
the walls
1.1 kJ/s

Through the
windows
0.7 kJ/s

Through
draughts
0.8 kJ/s

Through the floor
0.7 kJ/s

(a)    (i)    When the inside of the house is at a constant temperature, the energy transferred from the heating system to the inside of the house equals the energy transferred from the house to the outside.

Calculate, in kilowatts, the power of the heating system used to keep the inside of the house in **Diagram 1** at a constant temperature.

1 kilowatt (kW) = 1 kilojoule per second (kJ/s)

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Power of the heating system = ...................................................... kW

**(1)**

(ii)    In the winter, the heating system is switched on for a total of 7 hours each day.

Calculate, in kilowatt-hours, the energy transferred each day from the heating system to the inside of the house.

Use the correct equation from the Physics Equations Sheet.

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Energy transferred each day = ...................................................... kWh

**(2)**

(iii)    Energy costs 15 p per kilowatt-hour.

Calculate the cost of heating the house for one day.

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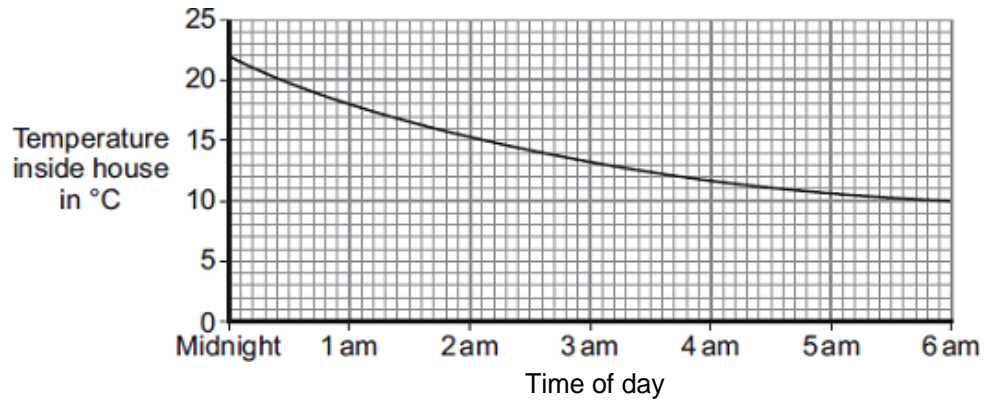
Cost = ..............................

**(1)**

(iv)    The heating system is switched off at midnight.

The graph shows how the temperature inside the house changes after the heating system has been switched off.



Draw a ring around the correct answer in the box to complete the sentence.

Between midnight and 6 am the rate of energy transfer from

the house

decreases.

decreases then stays constant.

increases.

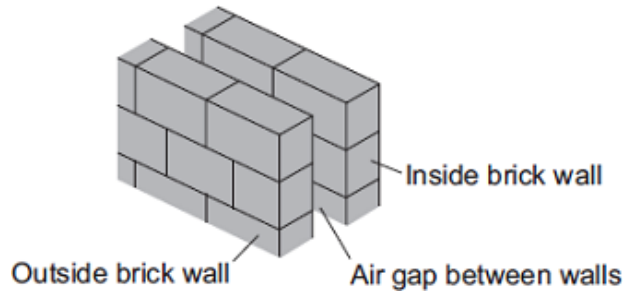Give the reason for your answer.

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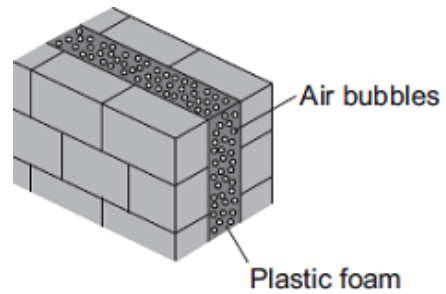
(2)

(b) **Diagram 2** shows how the walls of the house are constructed.
**Diagram 3** shows how the insulation of the house could be improved by filling the air gap between the two brick walls with plastic foam.

**Diagram 2**

**Diagram 3**



Inside brick wall

Outside brick wall        Air gap between walls

Air bubbles

Plastic foam

U-value of the wall = 0.7                    U-value of the wall = 0.3

(i)   The plastic foam reduces energy transfer by convection.

Explain why.

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**(2)**

(ii)  Filling the air gap with plastic foam reduces the U-value of the wall.

What is meant by the term *U-value*?

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**(1)**

(c) A homeowner has part of the outside wall of her house removed and replaced with double-glazed glass doors.

U-value of the wall = 0.3

U-value of glass doors = 1.8

Explain the effect of replacing part of the outside wall with glass doors on the rate of energy transfer from the house.

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**(2)**
**(Total 11 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.

Use the correct equation from the Physics Equations Sheet.

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.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Efficiency = ......................................................

**(1)**

(b)     Sketch and label a Sankey diagram for the CFL.

**(2)**

(c)     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 8 marks)**