ALEC REED ACADEMY

Mastery Booklet**(Physics)**

(Paper 1)

Name : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Teacher : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date Given : \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

These booklets are a consolidation of your learning. They should be used in the following way – You should attempt the questions WITHOUT looking at the answers. Then mark your questions with **Green pen** and add any missing marks you missed.

*THIS WILL IMPROVE YOUR GRADES…!!*

**Year 11 GCSE Intervention Support 2019-20**



**These are your science exam dates for your**

**Paper 1**

**Biology 1…. …12th May 2020**

**Chemistry 1….. 14th May 2020**

**Physics 1…… 20th May 2020**

**These are your science exams for your**

**Paper 2**

**Biology2 1stJune 2020**

**Chemistry 2 10th June 2020**

**Physics 2 12th June 2020**

**IMPORTANT:** This is not instead of revision at home. You should still do your own revision. This is just to help you with the toughest parts.

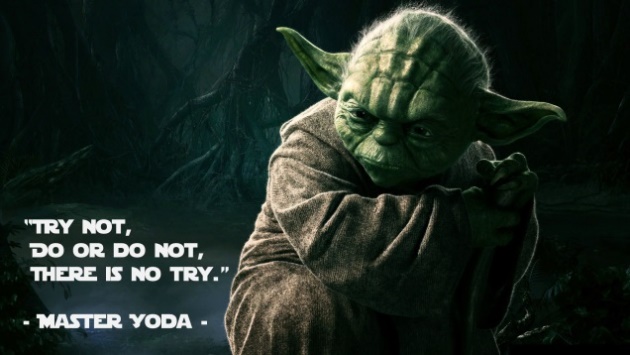
We know you have a lot to revise for and preparing for your exams can be stressful so here is a tool to help you.

**STEP 1: You have finished your (B1, C1, and P1) year 9-11 learning so you can target all the areas you want support with.**

**HOW TO USE THIS BOOKLET**

You know best. What your strengths and target areas are so please can you pick the topics you want most help with.

**Tips:**



**Revision Tips**

**1. Plan to revise. Don’t sit down without knowing what to do, it feels awful.**

Try this…. “Right I am going to do 30 minutes on radioactivity. I will list 10 key facts, one idea I find tough and try 1 past paper question.”

So plan your tasks and topics. It really helps. Ask for help with making a revision plan.

2. **Avoid distractions.** Revise with a friend so you don’t think about what they are doing. Avoid revising when really tired or hungry.

3. **Reward yourself.** “If I do an hour or two this morning then I can go out this afternoon”.

4. **Make stuff.** Put up posters, make flash cards or revision cards. Post-it your room with key ideas. Keep what you’ve made to help you realise you are working well.

5. **Practice past paper questions**. You have been provided with a free book of these and they are one of the best things you can do. Remember to B.U.G. (**B**ox the keyword, **U**nderline important info, **G**o through it twice).

**Revision tools**

**1.** Use Sam Learning. The centre code is TA6CT1 **https://www.samlearning.com/ Use your revision guide to help with the tasks/tests.**

**2. Don’t just read your revision guide.** Make lists of keywords then test yourself to see if you can describe the keywords. Practice drawing key diagrams from memory. Use the question pages in the revision guides.

**3.** Google **“AQA Science A past papers”** for year 10 topics. Google **“AQA science past papers”** for year 11 stuff.Lots to choose from.

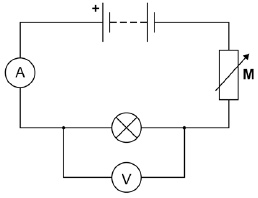
**4. GCSE Bitesize** has recently been given a makeover and now has lots of helpful videos linked to the tests and tasks.

**5. Check out www.getrevising.co.uk.** Free revision planner tool and many free resources. For a small monthly fee you can download other people’s revision materials for AQA science.

**6. Phone apps.** App store search cgp revision guides, they are fairly cheap if you want an on the go revision guide.

7. YOUTUBE The “mygcse science” youtube channel has really lovely walkthrough commentaries with pictures for all your B/C/P topics. Have a look.

**Q1.**The diagram shows the circuit used to obtain the data needed to plot the current-potential difference graph for a filament lamp.



(a)     Why is component **M** included in the circuit?

Tick **one** box.

|  |  |
| --- | --- |
| To keep the current constant. |  |
| To keep the potential difference constant. |  |
| To vary the current. |  |

**(1)**

(b) Why does the resistance of the lamp increase as the potential difference across the lamp increases?

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**(1)**

(c) The potential difference across the lamp is 12.0 V. Calculate the energy transferred by the lamp when 8.5 C of charge flows through the lamp.Use the equation:

energy transferred = charge flow × potential difference

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

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Energy transferred = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(2)**

(d)   The table gives data about two types of lamp that householders may use in their homes.

|  |  |  |
| --- | --- | --- |
| **Type of lamp** | **Energy efficiency** | **Mean lifetime in hours** |
| Halogen | 10% | 2000 |
| LED | 90% | 36000 |

Both types of lamp produce the same amount of light.

Describe the environmental advantages of using the LED lamp compared with the halogen lamp.

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**(2)**

**(Total 6 marks)**

**Q2.**The image shows a battery-powered drone.



(a)     Complete the sentences.

Choose the answers from the box.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **chemical** | **elastic potential** | |
| **gravitational potential** | | **kinetic** | **nuclear** |

As the drone accelerates upwards

its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy increases

and its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy increases.

The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy store

of the battery decreases.

**(3)**

(b)     In the USA, drones are not allowed to be flown too high above the ground.

Suggest **one** possible risk of flying a drone too high above the ground.

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**(2)**

(c)     Write down the equation that links energy transferred, power and time.

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**(1)**

(d)     The drone can fly for 25 minutes before the battery needs recharging.

The power output of the battery is 65.0 W

Calculate the maximum energy stored by the battery.

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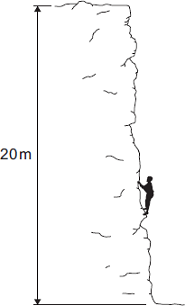
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Maximum energy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ joules

**(3)**

**(Total 8 marks)**

**Q3.**The diagram shows a climber part way up a cliff.



(a)     Complete the sentence.

When the climber moves up the cliff, the climber

gains gravitational \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy.

**(1)**

(b)     The climber weighs 660 N.

(i)      Calculate the work the climber must do against gravity, to climb to the top of the cliff.

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Work done = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(2)**

(ii)     It takes the climber 800 seconds to climb to the top of the cliff.  
During this time the energy transferred to the climber equals the work done by the climber.

Calculate the power of the climber during the climb.

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

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

**(2)**

**(Total 5 marks)**

**Q4.**The specific heat capacity of aluminium can be determined by experiment.

(a)     Draw a labelled diagram showing how the apparatus used to determine the specific heat capacity of aluminium should be arranged.

**(3)**

(b)     Describe how you could use the apparatus you drew in part (a) to determine the specific heat capacity of aluminium.

**(6)**

(c)     Methods used to determine the specific heat capacity of aluminium may give a value greater than the actual value. Explain why.

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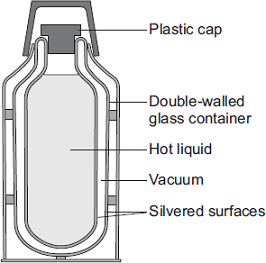
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**(2)**

**(Total 11 marks)**

**Q5.** (a)     *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The diagram shows the structure of a vacuum flask.



A vacuum flask is designed to reduce the rate of energy transfer by heating processes.

Describe how the design of a vacuum flask keeps the liquid inside hot.

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**(6)**

(b)     Arctic foxes live in a very cold environment.



Arctic foxes have small ears. How does the size of the ears help to keep the fox warm in a cold environment?

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

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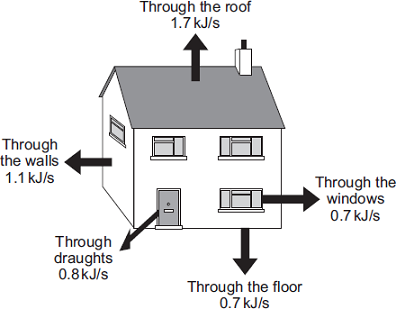
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**(2)**

**(Total 8 marks)**

**Q6. Diagram 1** shows the energy transferred per second from a badly insulated house on a cold day in winter.

**Diagram 1**

****

(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)

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

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.

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

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Energy transferred each day = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kWh

**(2)**

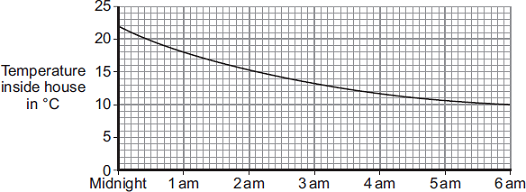
(iii)    Energy costs 15 p per kilowatt-hour. Calculate the cost of heating the house for one day.

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

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.



Time of day

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

|  |  |
| --- | --- |
|  | decreases. |
| the house | 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** |
|  |  |
| U-value of the wall = 0.7 | U-value of the wall = 0.3 |

The plastic foam reduces energy transfer by convection. Explain why.

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

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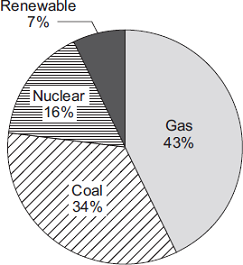
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**(2)**

**(Total 8 marks)**

**Q7.** (a) The pie chart shows the proportions of electricity generated in the UK from different energy sources in 2010.



(i)      Calculate the percentage of electricity generated using fossil fuels.

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

Percentage = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ %

**(1)**

(ii)     The pie chart shows that 7% of electricity was generated using renewable energy sources. Which **one** of the following is **not** a renewable energy source?

Tick () **one** box.

|  |  |
| --- | --- |
| Oil |  |
| Solar |  |
| Wind |  |

**(1)**

(b)     Complete the following sentence.

In some types of power station, fossil fuels are burned to heat \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to produce steam.

**(1)**

(c)     Burning fossil fuels releases carbon dioxide into the atmosphere. Why do many scientists think adding carbon dioxide to the atmosphere is harmful to the environment?

Tick () **one** box.

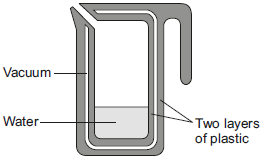
|  |  |
| --- | --- |
| Carbon dioxide is the main cause of acid rain. |  |
| Carbon dioxide causes global warming. |  |
| Carbon dioxide causes visual pollution. |  |

**(1)**

**(Total 4 marks)**

**Q8.** A new design for a kettle is made from two layers of plastic separated by a vacuum.

After the water in the kettle has boiled, the water stays hot for at least 2 hours.The new kettle is shown below.



(a)     The energy transferred from the water in the kettle to the surroundings in 2 hours is   
46 200 J. The mass of water in the kettle is 0.50 kg.

The specific heat capacity of water is 4200 J/kg °C.

The initial temperature of the water is 100 °C.

Calculate the temperature of the water in the kettle after 2 hours.

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

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Temperature after 2 hours = \_\_\_\_\_\_\_\_\_\_\_ °C

**(3)**

(b)     Calculate the average power output from the water in the kettle to the surroundings in 2 hours.

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

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Average power output = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ W

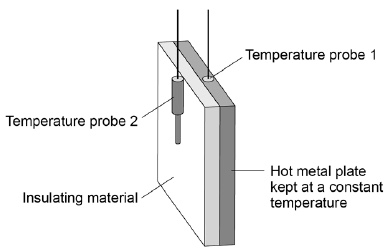
**(2)**

**(Total 5 marks)**

**Q9.** A student investigated the properties of three types of insulation.

**Figure 1** shows the apparatus the student used.

**Figure 1**

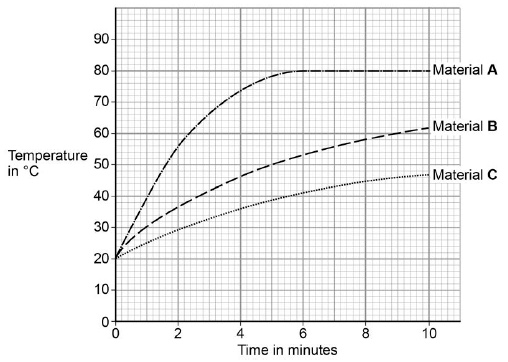
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In the investigation different insulating materials were placed in contact with the hot metal plate. Temperature probes measured the temperature on each side of the material.

The temperature probes were connected to a data logger.

**Figure 2** shows how the temperature measured by temperature probe 2 changed over 10 minutes for each of the materials.

**Figure 2**

****

(a)     What was the temperature of the hot metal plate?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ °C

**(1)**

(b)     Which material is the best insulator?

Tick **one** box.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **A** |  | **B** |  | **C** |  |

Give the reason for your answer.

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

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**(2)**

(c)     Another student repeated the investigation but doubled the thickness for all three insulating materials.Suggest how using thicker insulation would affect the results of the second student's investigation compared with the first student's results.

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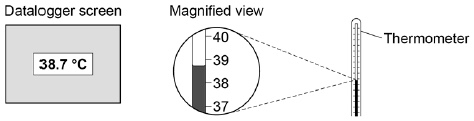
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**(2)**

(d)     The students could have used a thermometer instead of temperature probes and a datalogger.

**Figure 3** shows the datalogger screen and a thermometer.

**Figure 3**

****

Give two advantages of using the datalogger and temperature probes compared to a thermometer.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(e)     The table gives information about four types of insulation that could be used for insulating the cavity walls of houses.

|  |  |
| --- | --- |
| **Type of insulation** | **Thermal conductivity in W/m °C** |
| Felt wool | 0.070 |
| Mineral wool | 0.040 |
| Polyurethane foam | 0.030 |
| Rock wool | 0.045 |

Explain which one of the types of insulation in the table would be the best to use for cavity wall insulation.

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**(2)**

**(Total 9 marks)**

**Q10.** Electricity can be generated using various energy sources.

(a)     Give **one** advantage and **one** disadvantage of using nuclear power stations rather than gas-fired power stations to generate electricity.

Advantage \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

Disadvantage \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(b)     (i)      A single wind turbine has a maximum power output of 2 000 000 W.

The wind turbine operated continuously at maximum power for 6 hours.

Calculate the energy output in kilowatt-hours of the wind turbine.

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

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Energy output = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kWh

**(2)**

(ii)     Why, on average, do wind turbines operate at maximum power output for only 30% of the time?

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

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**(1)**

(c)     An on-shore wind farm is made up of many individual wind turbines.

They are connected to the National Grid using underground power cables.

Give **one** advantage of using underground power cables rather than overhead power cables.

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

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**(1)**

**(Total 6 marks)**

**Q11.** Iceland is a country that generates most of its electricity using geothermal power stations and hydroelectric power stations.

(a)  (i)  Complete the following sentences to describe how some geothermal power stations work. In regions where volcanoes are active, the ground is hot.

Cold \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is pumped down into the ground

and is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ by hot rocks.

It returns to the surface as steam. The steam is used to turn a turbine.

The turbine drives a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to produce electricity.

**(3)**

(ii)     Which **one** of the following statements about geothermal power stations is true?

Tick () **one** box.

|  |  |
| --- | --- |
| Geothermal power stations use fossil fuels. |  |
| Geothermal power stations produce carbon dioxide. |  |
| Geothermal power stations provide a reliable source of electricity. |  |

**(1)**

(b)     What is needed for a hydroelectric power station to be able to generate electricity?

Tick () **one** box.

|  |  |
| --- | --- |
| Falling water |  |
| A long coastline |  |
| Lots of sunny days |  |

**(1)**

**(Total 5 marks)**

**Q12.** (a)     **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

A householder wants to reduce her energy bills. She collected information about a number of ways of reducing energy used. The information is shown in the table.

|  |  |  |
| --- | --- | --- |
| **Ways of reducing energy used** | **Cost to buy and install in £** | **Money saved per year in £** |
| Install an energy-efficient boiler | 2 000 | 320 |
| Insulate the loft | 400 | 200 |
| Install double-glazed windows | 12 000 | 120 |
| Install cavity wall insulation | 415 | 145 |

Use the information in the table to compare the different ways of reducing the energy used. Your answer should include some calculations.

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**(6)**

(b)     Increasing the amount of insulation in a house affects the total U-value of the house.

(i)      What is meant by the term ‘U-value’?

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

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**(1)**

(ii)     How is the U-value affected by increasing the amount of insulation?

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

**(1)**

**(Total 8 marks)**

**Q13.** Energy resources can be renewable or non-renewable.

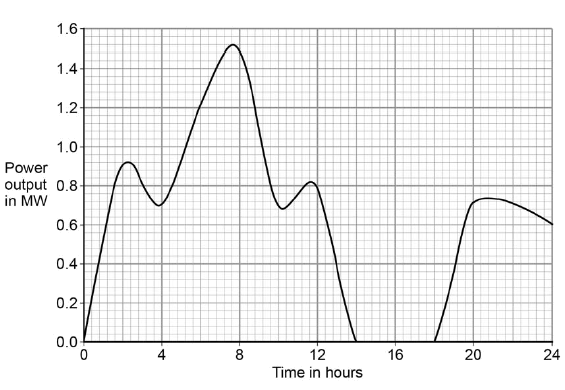
(a)     Coal is a non-renewable energy resource. Name **two** other non-renewable energy resources.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(b)     Wind turbines are used to generate electricity. The graph below shows how the power output of a wind turbine changes over one day.



A wind turbine does not generate electricity constantly. For how many hours did the wind turbine generate no electricity?

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

Time = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ hours

**(1)**

(c)     Electrical power is transferred from power stations to the National Grid.

What is the National Grid?

|  |  |
| --- | --- |
| Tick **one** box. |  |
| a system of cables and pylons |  |
| a system of cables and transformers |  |
| a system of cables, transformers and power stations |  |

**(1)**

(d)     An island has a large number of wind turbines and a coal-fired power station. The island needs to use the electricity generated by the coal-fired power station at certain times.

Choose **one** reason why.

|  |  |
| --- | --- |
| Tick **one** box. |  |
| Wind is a renewable energy resource. |  |
| Wind turbine power output is constant. |  |
| The power output of wind turbines is unpredictable. |  |
| The fuel cost for wind turbines is very high. |  |

**(1)**

(e)     A wind turbine has an average power output of 0.60 MW.

A coal-fired power station has a continuous power output of 1500 MW.

Calculate how many wind turbines would be needed to generate the same power output as one coal-fired power station.

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Number of wind turbines = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(f)      It is important that scientists develop new energy resources. Choose **one** reason why.

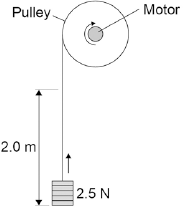
|  |  |
| --- | --- |
| Tick **one** box. |  |
| All energy resources are running out. |  |
| All energy resources are used to generate electricity. |  |
| Most energy resources have negative environmental effects. |  |

**(1)**

**(Total 8 marks)**

**Q14.**A student investigated the efficiency of a motor using the equipment in **Figure 1**.

**Figure 1**

****

He used the motor to lift a weight of 2.5 N a height of 2.0 m.

He measured the speed at which the weight was lifted and calculated the efficiency of the energy transfer. He repeated the experiment to gain two sets of data.

(a)     Give **one** variable that the student controlled in his investigation.

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**(1)**

(b)     Give **two** reasons for taking repeat readings in an investigation.

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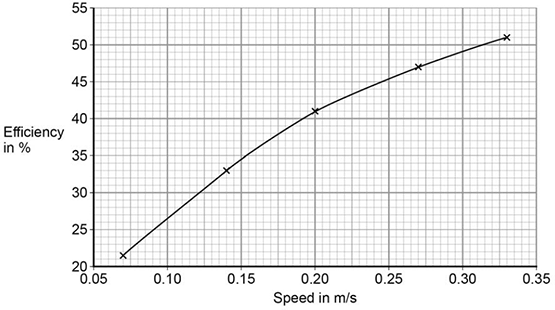
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**(2)**

(c)     **Figure 2** shows a graph of the student’s results.

**Figure 2**

****

Give **two** conclusions that could be made from the data in **Figure 2**.

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

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**(2)**

(d)     Give the main way that the motor is likely to waste energy.

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**(1)**

(e)     When the total power input to the motor was 5 W the motor could not lift the 2.5 N weight. State the efficiency of the motor.

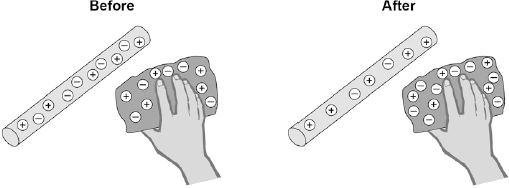
Efficiency = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ %

**(1)**

**(Total 7 marks)**

**Q1.** A student rubs an acetate rod with a cloth. **Figure 1** shows the charges on the acetate rod and cloth before and after rubbing.

**Figure 1**

****

(a)     Explain how rubbing an acetate rod with a cloth causes the rod and cloth to become charged.

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**(4)**

(b)     After charging them, the student moves the acetate rod and the cloth closer together.

Which statement is correct?

|  |  |
| --- | --- |
| Tick **one** box. |  |
| There is no force between the acetate rod and the cloth. |  |
| There is a force of attraction between the acetate rod and the cloth. |  |
| There is a force of repulsion between the acetate rod and the cloth. |  |

Give a reason for your answer.

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

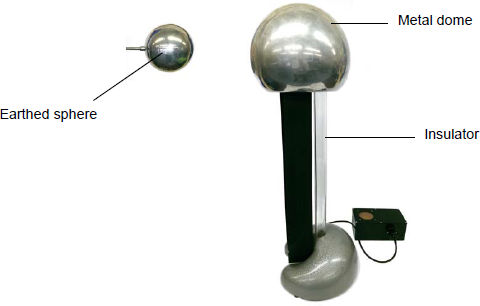
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**(2)**

(c)     **Figure 2** shows a Van de Graaff generator, which is used to generate static electricity.

**Figure 2**

****

The longer the Van de Graaff generator is switched on, the more charge is stored on the metal dome. Use an answer from the box to complete the sentence.

|  |
| --- |
| **decrease**                         **increase**                         **stay the same** |

The amount of charge on the metal dome is increased, which causes the potential

difference between the metal dome and the earthed sphere to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(d)     When the potential difference between the Van de Graaff generator and the earthed sphere is 60 kV, a spark jumps between the metal dome and the earthed sphere.

The spark transfers 0.000025 coulombs of charge to the earthed sphere.

The equation which links charge, energy and potential difference is:

energy transferred = charge × potential difference

Calculate the energy transferred by the spark.

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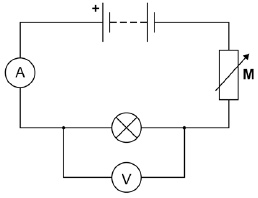
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Energy transferred = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(2)**

**(Total 9 marks)**

**Q2.** The diagram shows the circuit used to obtain the data needed to plot the current-potential difference graph for a filament lamp.



(a)     Why is component **M** included in the circuit? Tick **one** box.

|  |  |
| --- | --- |
| To keep the current constant. |  |
| To keep the potential difference constant. |  |
| To vary the current. |  |

**(1)**

(b)     Why does the resistance of the lamp increase as the potential difference across the lamp increases?

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

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**(1)**

(c)     The potential difference across the lamp is 12.0 V. Calculate the energy transferred by the lamp when 8.5 C of charge flows through the lamp. Use the equation:

energy transferred = charge flow × potential difference

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

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Energy transferred = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(2)**

(d)     The table gives data about two types of lamp that householders may use in their homes.

|  |  |  |
| --- | --- | --- |
| **Type of lamp** | **Energy efficiency** | **Mean lifetime in hours** |
| Halogen | 10% | 2000 |
| LED | 90% | 36000 |

Both types of lamp produce the same amount of light. Describe the environmental advantages of using the LED lamp compared with the halogen lamp.

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

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**(2)**

**(Total 6 marks)**

**Q3.** An electrician is replacing an old electric shower with a new one.The inside of the old shower is shown in the figure below.



(a) The electrician should **not** change the shower unless he switches off the mains electricity supply. Explain why.

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

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**(2)**

(b)     The new shower has a power output of 10 690 W when it is connected to the 230 V mains electricity supply. The equation which links current, potential difference and power is:

current= 

Calculate the current passing through the new shower. Give your answer to two significant figures.

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

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

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

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

**(4)**

(c)     The new shower has a higher power rating than the old shower. How does the power of the new shower affect the cost of using the shower? Give a reason for your answer.

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

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**(2)**

**(Total 8 marks)**

**Q4.** Solar cells produce electricity using light from the Sun.

The symbol for a solar cell is:  

A householder has three solar cells.

Each solar cell has an output potential difference of 0.70 V

(a)     Which arrangement of three solar cells will give a potential difference of 2.10 V? Tick **one** box.

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |

**(1)**

(b)     A solar cell has a resistance of 2.5 Ω when the output potential difference is 0.70 V

Calculate the current through the solar cell. Use the equation:



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

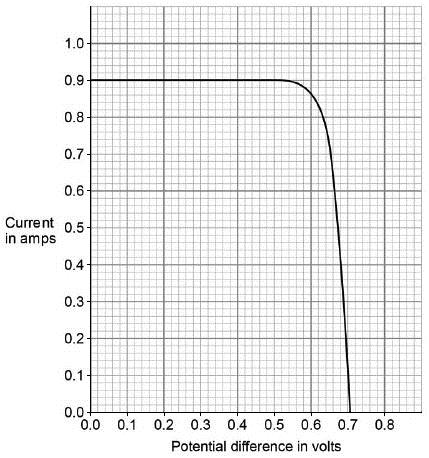
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Current = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A

**(2)**

The graph below shows a graph of current against P.D.for a different type of solar cell.



(c)     The power output of the solar cell is calculated using the equation.

power = current × potential difference

Which value of potential difference on the graph above gives the maximum power output of the solar cell? Tick **one** box.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0.1 V |  | 0.3 V |  | 0.6 V |  | 0.7 V |  |

Give the reason for your answer.

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

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**(2)**

(d)     Write down the equation that links efficiency, total power input and useful power output.

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

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**(1)**

(e)     The total power input to the solar cell is 2.4 W when the efficiency is 0.20

Calculate the useful power output of the solar cell.

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

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Useful power output = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W

**(3)**

**(Total 9 marks)**

**Q5.** Many electrical appliances are connected to the mains supply using a three-core cable and a three-pin plug.

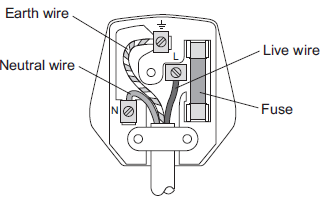
(a)     Use the correct answer from the box to complete the sentence.

|  |  |  |
| --- | --- | --- |
| **charge** | **energy** | **power** |

Electric current is the rate of flow of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(b)     The diagram shows a three-pin plug connected to a three-core cable.



(i)      The three wires of the three-core cable have different coloured coverings.

State the colour of the covering of the neutral wire.

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

**(1)**

(ii)     Which **two** parts of the plug shown above protect the wiring of a circuit?

Tick () **two** boxes.

|  |  |
| --- | --- |
|  | **Tick ()** |
| Earth wire |  |
| Fuse |  |
| Live wire |  |
| Neutral wire |  |

**(2)**

(c)     Some electrical appliances are connected to the mains supply using a two-core cable and a three-pin plug. Appliances that are double insulated do not require all three wires.

(i)      What does ‘double insulated’ mean?

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

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

**(1)**

(ii)     State which of the three wires is **not** required.

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

**(1)**

(d)     (i)      An electrical appliance is connected to a 20 V supply.

The current in the appliance is 3 A.

Calculate the power of the appliance.

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

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

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

**(2)**

(ii)     Another electrical appliance is connected to a 20 V supply.The appliance transfers 300 J of energy. Calculate the charge. Give the unit.

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

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

Charge = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Unit \_\_\_\_\_\_\_\_\_\_\_\_\_

**(3)**

**(Total 11 marks)**

**Q6.** 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.

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

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

**(1)**

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

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

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

**(1)**

(iii)    Calculate the efficiency of this light bulb.

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

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

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

**(2)**

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

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

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

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.

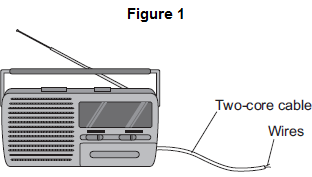
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**(1)**

**(Total 10 marks)**

**Q7. Figure 1** shows a radio. The radio can be powered by connecting the two-core cable to the mains electricity supply.



(a)     (i)      What must be fitted to the cable before it can be connected to the mains electricity supply?

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

**(1)**

(ii)     There are only two wires inside the cable. What are the names of the two wires inside the cable? Tick () **one** box.

|  |  |
| --- | --- |
| Earth and live |  |
| Earth and neutral |  |
| Live and neutral |  |

**(1)**

(iii)    Use the correct answer from the box to complete the sentence.

|  |  |  |
| --- | --- | --- |
| **double** | **extra** | **fully** |

It is safe to connect the radio to the mains electricity supply using a two-core

cable because the radio is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ insulated.

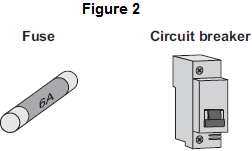
**(1)**

(b)     The radio can also be powered by a battery. What type of current does a battery supply? Tick () **one** box.

|  |  |
| --- | --- |
| Alternating current (a.c.) only |  |
| Direct current (d.c.) only |  |
| Both a.c. and d.c. |  |

**(1)**

(c)     **Figure 2** shows a fuse and a circuit breaker. Fuses and circuit breakers are able to disconnect and switch off circuits.



(i)      Use the correct answer from the box to complete the sentence.

|  |  |  |
| --- | --- | --- |
| **earth** | **live** | **neutral** |

A fuse or a circuit breaker is connected to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ wire in a circuit.

**(1)**

(ii)     What happens to cause a fuse or circuit breaker to disconnect a circuit?

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

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

**(1)**

(iii)    Suggest **two** advantages of using a circuit breaker to disconnect a circuit compared with using a fuse.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

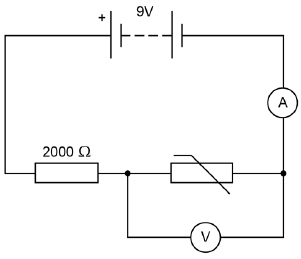
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**(2)**

**(Total 8 marks)**

**Q8.**The diagram shows a temperature sensing circuit used to control a heating system in a house.



(a)     What quantity does the ammeter measure?

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

**(1)**

(b)     The current in the circuit is 3.5 mA when the potential difference across the thermistor is 4.2 V. Calculate the resistance of the thermistor.

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

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

**(3)**

(c)     Calculate the charge that flows through the thermistor in 5 minutes when the current is 3.5 mA.

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

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Charge = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ C

**(3)**

(d)     Explain why the potential difference across the thermistor changes as the temperature in the house decreases.

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**(2)**

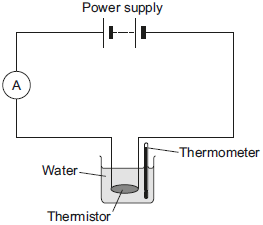
(e)     The circuit shown in the diagram can be modified to turn lights on and off by replacing the thermistor with a Light Dependent Resistor (LDR). Draw the circuit symbol for an LDR in the space below.

**(1)**

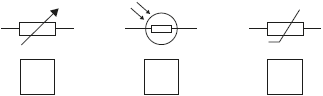
**(Total 10 marks)**

**Q9.Figure 1** shows the apparatus used to investigate how the current through a thermistor depends on the temperature of the thermistor.

**Figure 1**

****

(a) Which **one** of the following is the correct circuit symbol for a thermistor? Tick (✔) **one** box.

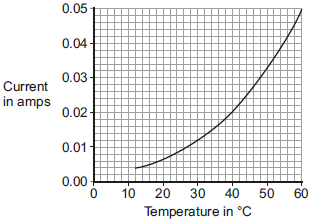


**(1)**

(b)To get a range of results, hot water at 60 °C was poured into the beaker.

The temperature of the water and current through the thermistor were then recorded as the water cooled. The results of the investigation are shown in **Figure 2**.

**Figure 2**

****

(i)      Suggest **one** way the investigation could have been changed to give a wider range of temperatures.

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

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**(1)**

(ii) Describe how the current through the thermistor depends on the temperature of the thermistor.

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

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**(1)**

(iii)     Use **Figure 2** to determine the current through the thermistor at 40 °C.

Current at 40 °C = \_\_\_\_\_\_\_\_\_\_\_ A

**(1)**

(iv)     At 40 °C the thermistor has a resistance of 250 Ω.

Use your answer to part **(iii)** and the resistance of the thermistor to calculate the potential difference across the thermistor.

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Potential difference = \_\_\_\_\_\_\_\_\_\_\_ V

**(2)**

(v)     The potential difference across the thermistor stays the same all through the investigation.

What conclusion can be made from the results in **Figure 2** about the resistance of the thermistor as the temperature of the thermistor **decreases?**

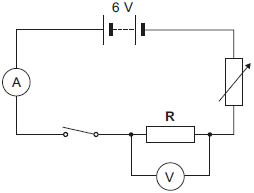
Tick (✔) **one** box.

|  |  |
| --- | --- |
| the resistance increases |  |
| the resistance does not change |  |
| the resistance decreases |  |

**(1)**

**(Total 7 marks)**

**Q10.**The diagram shows an electrical circuit.



(a)     The 6 V battery shown in the diagram is made up of a number of identical 1.5 V cells.

Calculate the minimum number of cells needed to make the battery.

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

Number of cells =\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(b)     The switch in the diagram is shown in the open position. Closing the switch completes the circuit. Charge flows through the completed circuit and a reading is shown on both the ammeter and the voltmeter.

(i)      In 10 seconds, 20 coulombs of charge flows through the circuit.

Calculate the current reading shown on the ammeter.

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

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

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

**(2)**

(ii)     For 20 coulombs of charge to flow through the resistor R, 100 joules of work must be done.

Calculate the potential difference reading given by the voltmeter.

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

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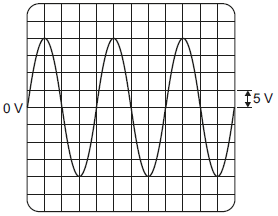
Potential difference = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V

**(2)**

**(Total 5 marks)**

**Q11.** (a)     **Figure 1** shows the oscilloscope trace an alternating current (a.c.) electricity supply produces.

**Figure 1**

****

One vertical division on the oscilloscope screen represents 5 volts.

Calculate the peak potential difference of the electricity supply.

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

Peak potential difference = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V

**(1)**

(b)     Use the correct answer from the box to complete the sentence.

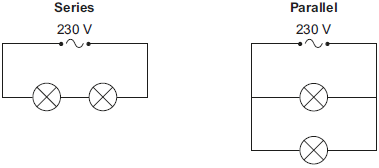
|  |  |  |
| --- | --- | --- |
| **40** | **50** | **60** |

In the UK, the frequency of the a.c. mains electricity supply is \_\_\_\_\_\_ hertz.

**(1)**

(c)     **Figure 2** shows how two lamps may be connected in series or in parallel to the 230 volt mains electricity supply.

**Figure 2**

****

(i)      Calculate the potential difference across each lamp when the lamps are connected in **series**. The lamps are identical.

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

Potential difference when in series = \_\_\_\_\_\_\_\_\_\_\_ V

**(1)**

(ii)     What is the potential difference across each lamp when the lamps are connected in **parallel**?

Tick (✔) **one** box.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 115 V |  | 230 V |  | 460 V |  |

**(1)**

(iii)     Give **one** advantage of connecting the lamps in parallel instead of in series.

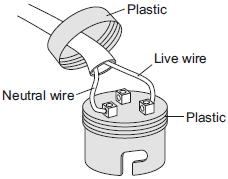
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**(1)**

(d)     **Figure 3** shows the light fitting used to connect a filament light bulb to the mains electricity supply.

**Figure 3**

****

The light fitting does **not** have an earth wire connected.

Explain why the light fitting is safe to use.

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

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**(2)**

(e)     A fuse can be used to protect an electrical circuit.

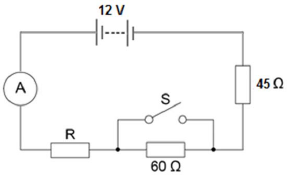
Name a different device that can also be used to protect an electrical circuit.

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

**(1)**

**(Total 8 marks)**

**Q12.** A student set up the electrical circuit shown in the figure below.



(a)     The ammeter displays a reading of 0.10 A.

Calculate the potential difference across the 45 Ω resistor.

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

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Potential difference = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V

**(2)**

(b)     Calculate the resistance of the resistor labelled **R**.

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

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

**(3)**

(c)     State what happens to the total resistance of the circuit and the current through the circuit when switch **S** is closed.

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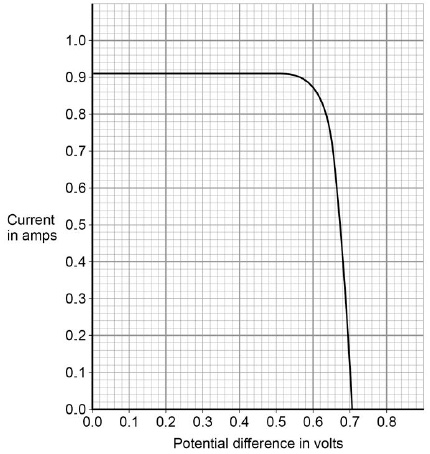
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**(2)**

**(Total 7 marks)**

**Q13. Figure 1** shows a graph of current against potential difference for a solar cell when light of intensity 450 W/m2 is incident on it.

**Figure 1**

****

(a)     Determine the power output of the solar cell when the potential difference is 0.5 V

Use data from **Figure 1**.

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

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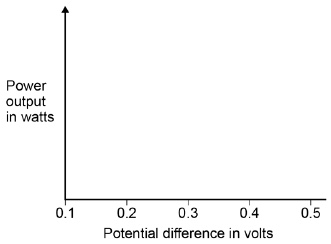
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Power = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W

**(3)**

(b)  Draw a sketch graph on **Figure 2** to show how the power output of the solar cell varies with potential difference between 0.1 V and 0.5 V. **No values** need to be included on the vertical axis.

**Figure 2**

****

**(2)**

(c)     The maximum power output of this solar cell is 0.52 W. When the light intensity is 450 W/m2 the cell has an efficiency of 0.15 at the maximum power output. Calculate the area of the solar cell.

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

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Area = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ m2

**(4)**

(d)     A householder has four solar cells. Each of the solar cells has a resistance of 0.78 Ω

Explain how the solar cells should be connected so that the total resistance is as low as possible.

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

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**(2)**

**(Total 11 marks)**

**Q14.** A student wants to investigate how the current through a filament lamp affects its resistance.

(a)     Use the circuit symbols in the boxes to draw a circuit diagram that she could use.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **12 V battery** | **variable resistor** | **filament lamp** | **voltmeter** | **ammeter** |
|  |  |  |  |  |

**(2)**

(b)     Describe how the student could use her circuit to investigate how the current through a filament lamp affects its resistance.

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

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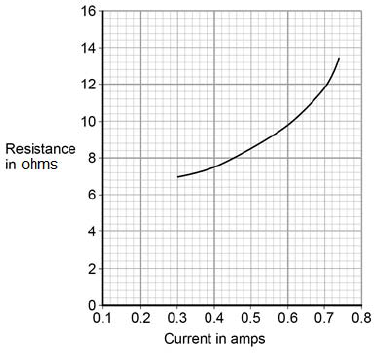
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**(4)**

(c)     The student’s results are shown in **Figure 1**.

**Figure 1**

****

Describe how the resistance of the filament lamp changes as the current through it increases.

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

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**(1)**

(d)     Use **Figure 1** to estimate the resistance of the filament lamp when a current of 0.10 A passes through the lamp.

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

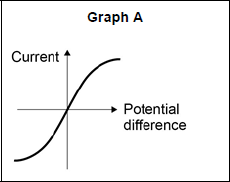
**(1)**

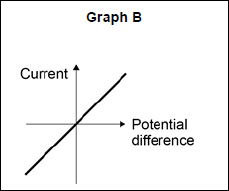
(e)     The current‑potential difference graphs of three components are shown in **Figure 2**.

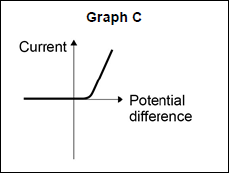
Use answers from the box to identify each component.

|  |  |  |
| --- | --- | --- |
| **diode** | **filament lamp** | **light dependent resistor** |
| **resistor at constant temperature** | | **thermistor** |

**Figure 2**

****             \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

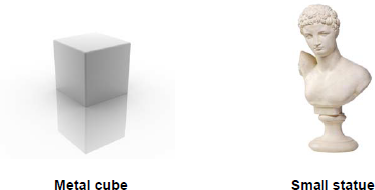
             \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**(3)**

**(Total 11 marks)**

**Q1.** A student wants to calculate the density of the two objects shown in the figure below.



Describe the methods that the student should use to calculate the densities of the two objects.

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

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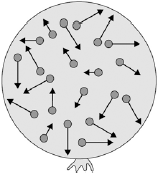
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**(Total 6 marks)**

**Q2.**The figure below shows a balloon filled with helium gas.



(a)     Describe the movement of the particles of helium gas inside the balloon.

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**(2)**

(b)     What name is given to the total kinetic energy and potential energy of all the particles of helium gas in the balloon?

|  |  |
| --- | --- |
| Tick **one** box. |  |
| External energy |  |
| Internal energy |  |
| Movement energy |  |

**(1)**

(c)     Write down the equation which links density, mass and volume.

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**(1)**

(d)     The helium in the balloon has a mass of 0.00254 kg. The balloon has a volume of 0.0141 m3. Calculate the density of helium. Choose the correct unit from the box.

|  |
| --- |
| **m3 / kg**                              **kg / m3**                              **kg m3** |

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

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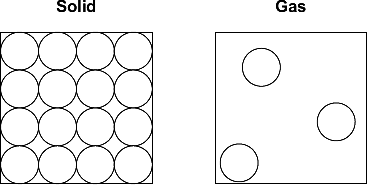
Density = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Unit \_\_\_\_\_\_\_\_\_

**(3)**

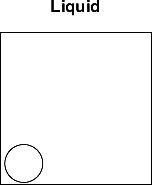
**(Total 7 marks)**

**Q3.** (a) The diagrams show the arrangement of the particles in a solid and in a gas.

Each circle represents one particle.



(i)      Complete the diagram below to show the arrangement of the particles in a liquid.



**(2)**

(ii)     Explain, in terms of the particles, why gases are easy to compress.

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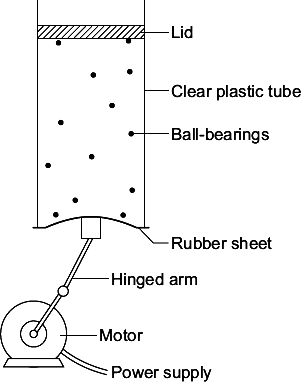
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**(2)**

(b)     The diagram below shows the model that a science teacher used to show her students that there is a link between the temperature of a gas and the speed of the gas particles.

The ball-bearings represent the gas particles. Switching the motor on makes the ball-bearings move around in all directions.



(i)      How is the motion of the ball-bearings similar to the motion of the gas particles?

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**(1)**

(ii)     The faster the motor runs, the faster the ball-bearings move. Increasing the speed of the motor is like increasing the temperature of a gas.

Use the model to predict what happens to the speed of the gas particles when the temperature of a gas is increased.

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**(1)**

**(Total 6 marks)**

**Q4.** (a)     A company is developing a system which can heat up and melt ice on roads in the winter. This system is called ‘energy storage’.

During the summer, the black surface of the road will heat up in the sunshine.

This energy will be stored in a large amount of soil deep under the road surface.   
Pipes will run through the soil. In winter, cold water entering the pipes will be warmed and brought to the surface to melt ice.

The system could work well because the road surface is black.

Suggest why.

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**(1)**

(b)     (i)      What is meant by specific latent heat of fusion?

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**(2)**

(ii)     Calculate the amount of energy required to melt 15 kg of ice at 0 °C.

Specific latent heat of fusion of ice = 3.4 × 105 J/kg.

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

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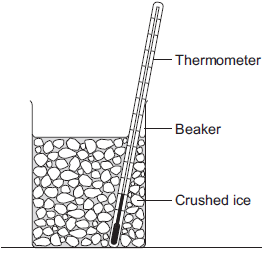
Energy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(2)**

(c)     Another way to keep roads clear of ice is to spread salt on them.   
When salt is added to ice, the melting point of the ice changes.

A student investigated how the melting point of ice varies with the mass of salt added.

The figure below shows the equipment that she used.



The student added salt to crushed ice and measured the temperature at which the ice melted.

(i)      State **one** variable that the student should have controlled.

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**(1)**

(ii)     During the investigation the student stirred the crushed ice.

Suggest **two** reasons why.

Tick () **two** boxes.

|  |  |
| --- | --- |
|  | **Tick ()** |
| To raise the melting point of the ice |  |
| To lower the melting point of the ice |  |
| To distribute the salt throughout the ice |  |
| To keep all the ice at the same temperature |  |
| To reduce energy transfer from the surroundings to the ice |  |

**(2)**

(iii)    The table below shows the data that the student obtained.

|  |  |  |  |
| --- | --- | --- | --- |
| **Mass of salt added in grams** | 0 | 10 | 20 |
| **Melting point of ice in °C** | 0 | -6 | -16 |

Describe the pattern shown in the table.

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**(1)**

(d)     Undersoil electrical heating systems are used in greenhouses. This system could also be used under a road.

A cable just below the ground carries an electric current. One greenhouse system has a power output of 0.50 kW.

Calculate the energy transferred in 2 minutes.

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Energy transferred = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(3)**

(e)     **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

A local council wants to keep a particular section of a road clear of ice in the winter.

Describe the advantages and disadvantages of keeping the road clear of ice using:

•        energy storage

•        salt

•        undersoil electrical heating.

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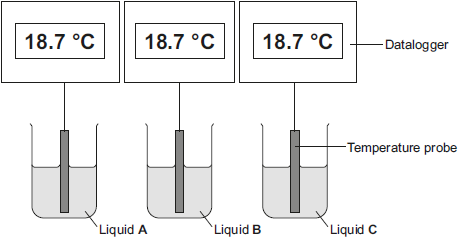
**(6)**

**(Total 18 marks)**

**Q5.** A student investigated the cooling effect of evaporation.

She used the equipment in **Figure 1** to measure how the temperature of three different liquids changed as the liquids evaporated.

**Figure 1**

****

(a)     The temperature and volume of each liquid was the same at the start of the investigation. State **one** further control variable in this investigation.

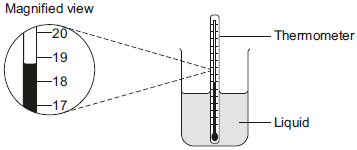
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**(1)**

(b)     Give **two** advantages of using dataloggers and temperature probes compared to using the thermometer shown in **Figure 2**.

**Figure 2**

****

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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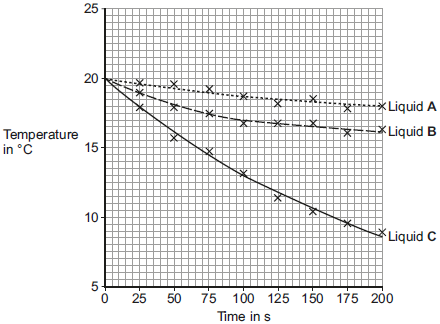
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(c)     The student’s results are shown in **Figure 3**.

**Figure 3**

****

(i)      Calculate the average rate of temperature decrease of liquid **C** between 0 and 100 seconds.

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

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Average rate of temperature decrease = \_\_\_\_\_\_\_\_\_\_ °C / s

**(2)**

(ii)     Give **one** conclusion that can be made about the rate of temperature decrease of **all three** liquids from the results in **Figure 3**.

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

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**(1)**

(iii)     Which liquid had the lowest rate of evaporation? Give a reason for your answer.

Liquid \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

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**(1)**

(iv)     A second student did the same investigation but using a smaller volume of liquid than the first student. All other variables were kept the same.

What effect would this have on the results of the second student’s investigation?

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**(1)**

(d)     Explain how the evaporation of a liquid causes the temperature of the remaining liquid to decrease.

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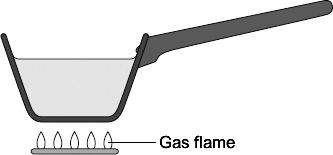
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**(3)**

**(Total 11 marks)**

**Q6.** The diagram shows a metal pan being used to heat water.



Energy from the gas flame is transferred through the metal pan by conduction. Explain the process of conduction through metals.

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**(Total 4 marks)**

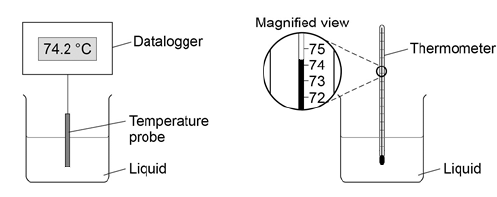
**Q7.** Two students investigated the change of state of stearic acid from liquid to solid.

They measured how the temperature of stearic acid changed over 5 minutes as it changed from liquid to solid.

**Figure 1** shows the different apparatus the two students used.

**Figure 1**

**Student A’s apparatus**                  **Student B’s apparatus**

****

(a)     Choose **two** advantages of using student **A**’s apparatus.

|  |  |
| --- | --- |
| Tick **two** boxes. |  |
| Student **A**’s apparatus made sure the test was fair. |  |
| Student **B**’s apparatus only measured categoric variables. |  |
| Student **A**’s measurements had a higher resolution. |  |
| Student **B** was more likely to misread the temperature. |  |

**(2)**

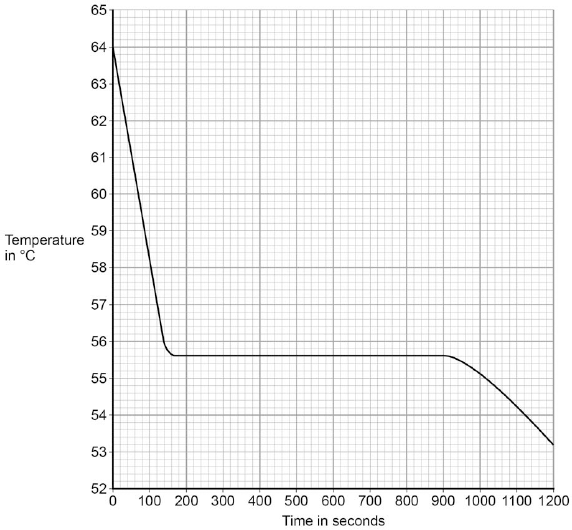
(b)     Student **B** removed the thermometer from the liquid each time he took a temperature reading. What type of error would this cause?

|  |  |
| --- | --- |
| Tick **one** box. |  |
| A systematic error |  |
| A random error |  |
| A zero error |  |

**(1)**

(c)     Student **A**’s results are shown in **Figure 2**.

**Figure 2**

****

What was the decrease in temperature between 0 and 160 seconds?

|  |  |
| --- | --- |
| Tick **one** box. |  |
| 8.2 °C |  |
| 8.4 °C |  |
| 53.2 °C |  |
| 55.6 °C |  |

**(1)**

(d)     Use **Figure 2** to determine the time taken for the stearic acid to change from a liquid to a solid.

Time = \_\_\_\_\_\_\_\_\_\_\_\_ seconds

**(1)**

(e)     Calculate the energy transferred to the surroundings as 0.40 kg of stearic acid changed state from liquid to solid.

The specific latent heat of fusion of stearic acid is 199 000 J / kg.

Use the correct equation from the Physics Equations Sheet.

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Energy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(2)**

(f)     After 1200 seconds the temperature of the stearic acid continued to decrease. Explain why.

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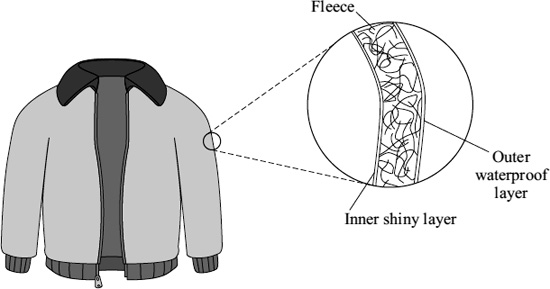
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**(2)**

**(Total 9 marks)**

**Q8.** (a)    The diagram shows a ski jacket that has been designed to keep a skier warm.  
The jacket is made from layers of different materials.



(i)      The inner layer is shiny to reduce heat transfer. Which process of heat transfer will it reduce?

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**(1)**

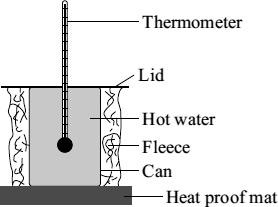
(ii)     Why is the layer of fleece good at reducing the transfer of heat from a skier’s body?

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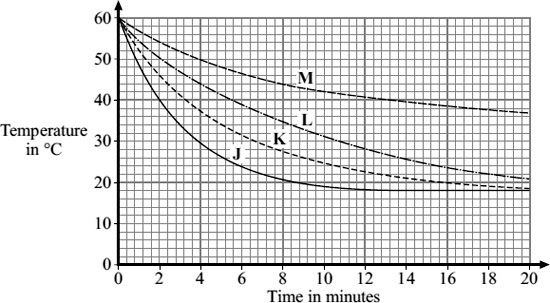
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**(1)**

(b)     A student tested four different types of fleece, **J**, **K**, **L** and **M**, to find which would make the warmest jacket. Each type of fleece was wrapped around a can which was then filled with hot water. The temperature of the water was taken every two minutes for 20 minutes.



The graph shows the student’s results.



(i)      In each test, the water cooled faster during the first five minutes than during the last five minutes. Why?

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**(1)**

(ii)    To be able to compare the results, it was important to use the same volume of water in each test. Give **one** other quantity that was the same in each test.

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

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**(1)**

(iii)    Look at the graph line for fleece **K**. Estimate what the temperature of the water in the can wrapped in fleece **K** would be after 40 minutes.

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

**(1)**

(iv) Which type of fleece, **J**, **K**, **L** or **M**, should the student recommend to be used in the ski jacket?

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Give a reason for your answer.

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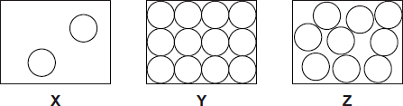
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**(2)**

**(Total 7 marks)**

**Q9.** (a)The diagrams, **X**, **Y** and **Z**, show how the particles are arranged in the three states of matter.



(i)      Which **one** of the diagrams, **X**, **Y** or **Z**, shows the arrangement of particles in a liquid?

Write the correct answer in the box.              

**(1)**

(ii)     Which **one** of the diagrams, **X**, **Y** or **Z**, shows the arrangement of particles in a gas?

Write the correct answer in the box.             

**(1)**

(b)     Draw a ring around the correct answer in each box to complete each sentence.

|  |  |  |
| --- | --- | --- |
|  |  | vibrating in fixed positions. |
| (i) | In a gas, the particles are | moving randomly. |
|  |  | not moving. |

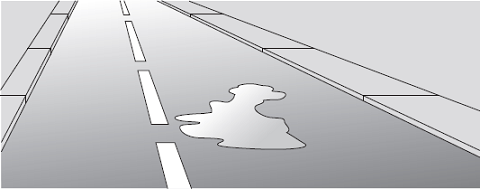
**(1)**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | stronger than |  |
| (ii) | In a solid, the forces between the particles are | equal to | the |
|  |  | weaker than |  |

forces between the particles in a liquid.

**(1)**

(c)     The picture shows a puddle of water in a road, after a rain shower.



(i)      During the day, the puddle of water dries up and disappears. This happens because the water particles move from the puddle into the air. What process causes water particles to move from the puddle into the air? **Draw a ring around the correct answer.**

|  |  |  |
| --- | --- | --- |
| **condensation** | **evaporation** | **radiation** |

**(1)**

(ii)     Describe **one** change in the weather which would cause the puddle of water to dry up faster.

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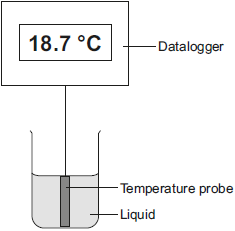
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**(1)**

**(Total 6 marks)**

**Q10.** A student investigated the cooling effect of evaporation.She used the equipment (datalogger and probe) shown in **Figure 1** to measure how the temperature of a liquid changed as the liquid evaporated.

**Figure 1**

****

(a)     Which type of variable was the temperature in this investigation?

Tick (✔) **one** box.

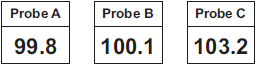
|  |  |
| --- | --- |
|  | **Tick** (✔) |
| control |  |
| dependent |  |
| independent |  |

**(1)**

(b)     Before the investigation started, the student checked the accuracy of three different temperature probes. The student put the probes in a beaker of boiling water that had a temperature of 100.0 °C.

The readings from the three temperature probes are shown in **Figure 2**.

**Figure 2**

****

Which **one** of the temperature probes, **A**, **B** or **C**, was **least** accurate?

Write the correct answer in the box.



Give a reason for your answer.

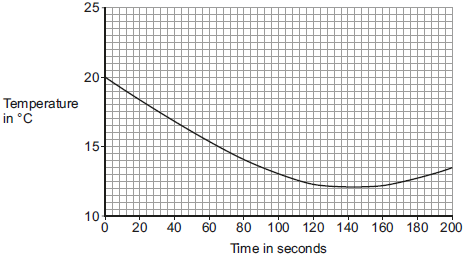
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**(2)**

(c)     **Figure 3** shows how the temperature recorded changed during the investigation.

**Figure 3**

****

(i)       Use **Figure 3** to determine the lowest temperature recorded as the liquid evaporated.

Temperature = \_\_\_\_\_\_ °C

**(1)**

(ii)      Use **Figure 3** to determine how long it took for all the liquid to evaporate.

Give a reason for your answer.

Time = \_\_\_\_\_\_\_\_ seconds

Reason: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(iii)    How would increasing the starting temperature of the liquid above 20 °C affect the rate of evaporation of the liquid?

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**(1)**

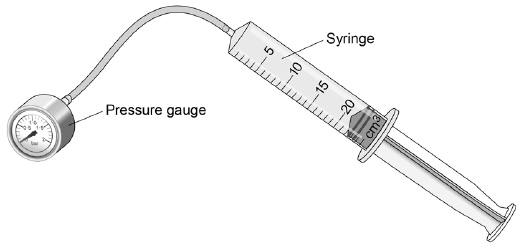
**(Total 7 marks)**

**Q11.**A student investigated how the pressure of a gas varied with the volume of the gas.

The mass and temperature of the gas were constant.

**Figure 1** shows the equipment the student used.

**Figure 1**

****

(a)     What is the resolution of the syringe?

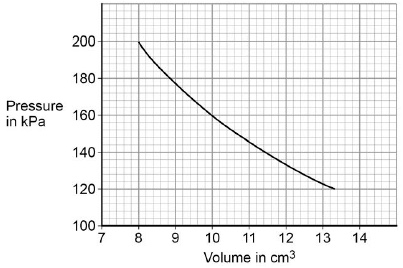
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cm3

**(1)**

The student compressed the gas in the syringe and read the pressure from the pressure gauge.

**Figure 2** shows the student's results.

**Figure 2**

****

(b)     What conclusion can the student make from the data in **Figure 2**? Use data from **Figure 2** in your answer. Give the reason for your answer.

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

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**(3)**

(c)     Explain why the pressure in the gas increases as the gas is compressed.

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**(4)**

**(Total 8 marks)**

**Q12.** Solid, liquid and gas are three different states of matter.

(a)     Describe the difference between the solid and gas states, in terms of the arrangement and movement of their particles.

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**(4)**

(b)     What is meant by ‘specific latent heat of vaporisation’?

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**(2)**

(c)     While a kettle boils, 0.018 kg of water changes to steam.

Calculate the amount of energy required for this change.

Specific latent heat of vaporisation of water = 2.3 × 106 J / kg.

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

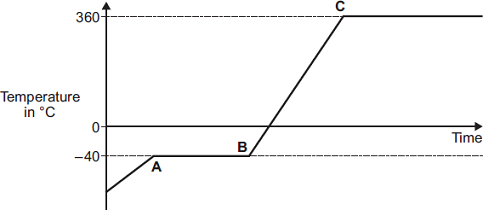
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Energy required = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(2)**

(d)     The graph shows how temperature varies with time for a substance as it is heated. The graph is **not** drawn to scale.



Explain what is happening to the substance in sections **AB** and **BC** of the graph.

Section **AB** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Section **BC** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(4)**

**(Total 12 marks)**

**Q1.** Sources of background radiation are either natural or man-made.

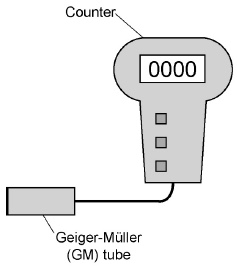
(a)     Which **two** of the sources listed in the table are natural sources of background radiation? Tick **two** boxes.

|  |  |
| --- | --- |
| Cosmic rays |  |
| Medical X-rays |  |
| Nuclear power stations |  |
| Nuclear weapons testing |  |
| Radon gas |  |

**(2)**

A teacher used a Geiger-Müller (GM) tube and counter to measure the background radiation in his laboratory. **Figure 1** shows the GM tube and counter.

**Figure 1**

****

(b)     The table gives three readings taken by the teacher at three different times on the same day.

|  |
| --- |
| **Counts in 1 minute** |
| 16 |
| 21 |
| 18 |

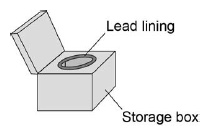
What is the most likely reason for the readings being different? Tick **one** box.

|  |  |
| --- | --- |
| Radioactive decay is a random process. |  |
| The air pressure in the laboratory increased. |  |
| The background radiation increased during the day. |  |
| The temperature in the laboratory decreased. |  |

**(1)**

(c)     The teacher takes a radioactive source from a storage box. **Figure 2** shows the box.

**Figure 2**

****

Why does storing the radioactive source in the box reduce the risk of radiation exposure to the teacher?

Tick **one** box.

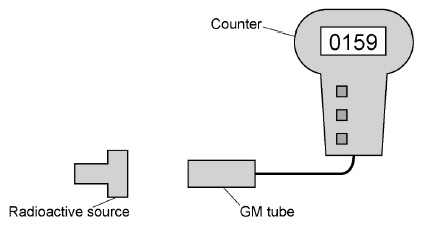
|  |  |
| --- | --- |
| The lead lining absorbs the emitted radiation. |  |
| The lead lining reflects the emitted radiation. |  |
| The lead lining transmits the emitted radiation. |  |

**(1)**

(d)     **Figure 3** shows how the teacher used the GM tube and counter to measure the radiation emitted from the radioactive source. The counter was reset to zero.

The count after one minute was 159.

**Figure 3**

****

How should the teacher calculate the counts from the radioactive source? Tick **one** box.

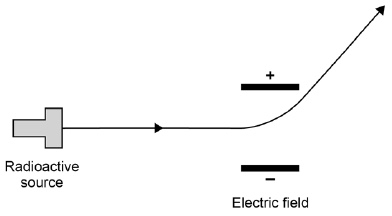
|  |  |
| --- | --- |
| Add the background count to 159 |  |
| Divide the background count by 159 |  |
| Multiply the background count by 159 |  |
| Subtract the background count from 159 |  |

**(1)**

(e)     The teacher passed the radiation through an electric field.

**Figure 4** shows the path that the radiation took through the electric field.

**Figure 4**

****

What type of radiation was being emitted by the radioactive source?

Tick **one** box.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Alpha |  | Beta |  | Gamma |  | Neutron |  |

Explain the reason for your answer.

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

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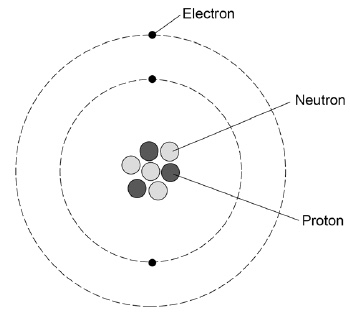
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**(3)**

**(Total 8 marks)**

**Q2.** The diagram shows a lithium atom.



(a)     What is the mass number of this lithium atom? Tick **one** box.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 3 |  | 4 |  | 7 |  | 10 |  |

**(1)**

(b)     What is the atomic number of a lithium atom? Tick **one** box.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 3 |  | 4 |  | 7 |  | 10 |  |

Give a reason for your answer.

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

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**(2)**

(c)     Complete the sentence. Choose the answer from the box.

|  |  |  |
| --- | --- | --- |
| **circles** | **levels** | **rings** |

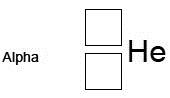
The electrons in an atom orbit in different energy \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

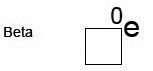
**(1)**

(d)     Some atomic nuclei are unstable and decay by emitting an alpha particle or a beta particle. Complete the symbols for an alpha particle and a beta particle.

Use answers from the box.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **–1** | **0** | **1** | **2** | **4** |

****



**(3)**

(e)     Doctors may use nuclear radiation to diagnose certain types of illness. The table below gives data about three radiation sources used. Each source emits beta radiation.

|  |  |
| --- | --- |
| **Radiation source** | **Half-life in minutes** |
| Carbon-11 | 20 |
| Nitrogen-13 | 10 |
| Oxygen-15 | 2 |

Explain why oxygen-15 is likely to pose the least risk to a patient.

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**(2)**

**(Total 9 marks)**

**Q3.**Nuclear fission and nuclear fusion are two processes that release energy.

(a)     The following nuclear equation represents the fission of uranium-235 (U-235).



Chemical symbols:

•        Ba = barium

•        Kr = krypton

•         = neutron

Describe the process of nuclear fission.

Use the information in the equation.

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**(4)**

(b)     Explain what happens in the process of nuclear fusion.

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**(3)**

(c)     Fission reactors are used in nuclear power stations.

Engineers are developing fusion reactors for use in power stations.

Fusion uses isotopes of hydrogen called deuterium and tritium.

•        Deuterium is naturally occurring and can be easily extracted from seawater.

•        Tritium can be produced from lithium. Lithium is also found in seawater.

The table shows the energy released from 1 kg of fusion fuel and from 1 kg of fission fuel.

|  |  |
| --- | --- |
| **Type of fuel** | **Energy released from 1 kg of fuel in joules** |
| Fusion | 3.4 × 1014 |
| Fission | 8.8 × 1013 |

Suggest **two** advantages of the fuel used in a fusion reactor compared with the fuel used in a fission reactor.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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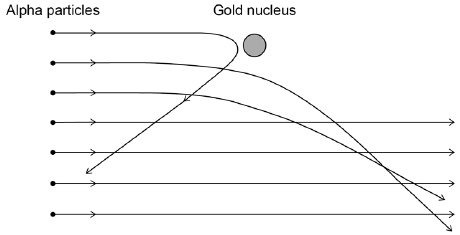
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**(2)**

**(Total 9 marks)**

**Q4.** In the early 20th century, scientists developed an alpha particle scattering experiment using gold foil.

The diagram shows the paths of some of the alpha particles in the alpha particle scattering experiment.



(a)     Explain how the paths of the alpha particles were used to develop the nuclear model of the atom.

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**(4)**

(b)     Niels Bohr adapted the nuclear model by suggesting electrons orbited the nucleus at specific distances.

Explain how the distance at which an electron orbits the nucleus may be changed.

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**(3)**

**(Total 7 marks)**

**Q5.** Many countries use nuclear power stations to generate electricity.

Nuclear power stations use the process of nuclear fission to release energy.

(a)     (i)      What is nuclear fission?

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

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**(1)**

(ii)     Plutonium-239 is one substance used as a fuel in a nuclear reactor. For nuclear fission to happen, the nucleus must absorb a particle.

What type of particle must be absorbed?

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

**(1)**

(b)     Nuclear **fusion** also releases energy. Nuclear fusion happens at very high temperatures. A high temperature is needed to overcome the repulsion force between the nuclei.

(i)      Why is there a repulsion force between the nuclei of atoms?

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**(1)**

(ii)     Where does nuclear fusion happen naturally?

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**(1)**

(c)     In 1991, scientists produced the first controlled release of energy from an experimental nuclear **fusion** reactor. This was achieved by fusing the hydrogen isotopes, deuterium and tritium. Deuterium is naturally occurring and can easily be extracted from seawater. Tritium can be produced from lithium. Lithium is also found in seawater.

The table gives the energy released from 1 kg of fusion fuel and from 1 kg of fission fuel.

|  |  |
| --- | --- |
| **Type of fuel** | **Energy released from 1 kg of fuel in joules** |
| Fusion fuel | 3.4 × 1014 |
| Fission fuel | 8.8 × 1013 |

(i)      Suggest **two** advantages of the fuel used in a fusion reactor compared with plutonium and the other substances used as fuel in a fission reactor.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(ii)     Some scientists think that by the year 2050 a nuclear fusion power station capable of generating electricity on a large scale will have been developed. Suggest **one** important consequence of developing nuclear fusion power stations to generate electricity.

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**(1)**

(d)     Tritium is radioactive. After 36 years, only 10 g of tritium remains from an original sample of 80 g. Calculate the half-life of tritium.

Show clearly how you work out your answer.

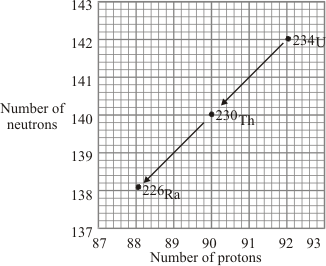
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Half-life = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ years

**(2)**

**Q6.** (a)     Uranium-234 (234U) is a radioactive element. The graph shows the number of protons and neutrons in the nuclei of the elements formed when uranium-234 decays.



(i)      How does the graph show that uranium-234 (234U) and thorium-230 (230Th) emit alpha particles?

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**(1)**

(ii)     What makes uranium and thorium different elements?

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**(1)**

(iii)     Radioactive decay may also produce gamma radiation.

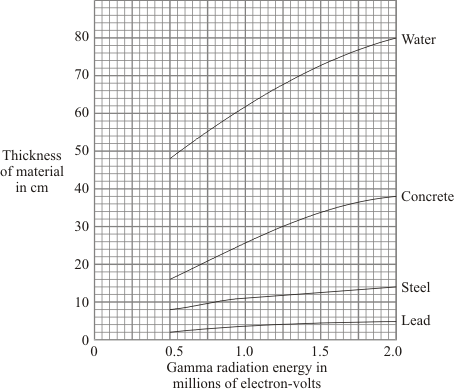
Why does the emission of gamma radiation **not** cause a new element to be formed?

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**(1)**

b)     The graph shows how the thickness of different materials needed to absorb 90% of the gamma radiation emitted by a source depends on the energy of the radiation. The energy of the gamma radiation is given in units called electron-volts.



(i)      Which of the materials shown is least effective at absorbing gamma radiation?   
Use the information in the graph to give a reason for your answer.

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**(1)**

(ii)     For gamma radiation of energy 1.5 million electron-volts, how many times more effective is steel than water at absorbing the radiation? Show clearly how you obtain your answer.

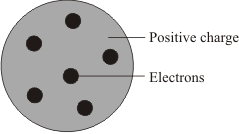
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**(2)**

(c)     Scientists in the early twentieth century thought that atoms were made up of electrons scattered inside a ball of positive charge. This was called the ‘plum-pudding’ model of the atom.



**Plum pudding model**

Rutherford and Marsden did an experiment, in which a beam of alpha particles was aimed at a thin sheet of gold.  
Explain how the results of this experiment led to a new model of the atom.   
You may include one or more diagrams in your answer.

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**(3)**

**(Total 9 marks)**

**Q7.** In 2011 an earthquake caused severe damage to a nuclear power station in Japan.

The damage led to the release of large amounts of radioactive iodine-131  into the atmosphere.

(a)     The table gives some information about an atom of iodine-131 .

Complete the table.

|  |  |
| --- | --- |
| mass number | 131 |
| number of protons | 53 |
| number of neutrons |  |

**(1)**

(b)     Complete the sentence.

The number of protons in an atom is called the proton number or

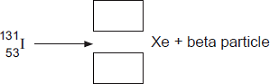
the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ number.

**(1)**

(c)     An atom of iodine-131 decays into an atom of xenon (Xe) by emitting a beta particle.

(i)      The decay of iodine-131 can be represented by the equation below.

Complete the equation by writing the correct number in each of the **two** boxes.



**(2)**

(ii)     A sample of rainwater contaminated with iodine-131 gives a count rate of 1200 counts per second.

Calculate how many days it will take for the count rate from the sample of rainwater to fall to 75 counts per second.

Half-life of iodine-131 = 8 days

Show clearly how you work out your answer.

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

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ days

**(2)**

(iii)    If people drink water contaminated with iodine-131, the iodine-131 builds up in the thyroid gland. This continues until the thyroid is saturated with iodine-131 and cannot absorb any more. The radiation emitted from the iodine-131 could cause cancer of the thyroid. In Japan, people likely to be drinking water contaminated with iodine-131 were advised to take tablets containing a non-radioactive isotope of iodine.

Suggest why this advice was given.

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**(2)**

**(Total 8 marks)**

**Q8.** Different radioactive isotopes have different values of half-life.

(a)     What is meant by the ‘half-life’ of a radioactive isotope?

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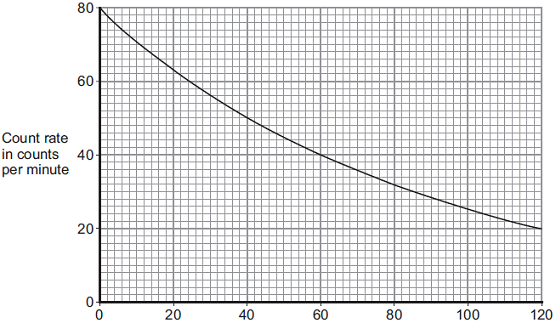
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**(1)**

(b)     **Figure 1** shows how the count rate from a sample of a radioactive isotope varies with time.

**Figure 1**

****   
                    Time in days

Use information from **Figure 1** to calculate the half-life of the radioactive isotope.

Show clearly on **Figure 1** how you obtain your answer.

Half-life = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ days

**(2)**

(c)     The table below shows data for some radioactive isotopes that are used in schools.

|  |  |  |
| --- | --- | --- |
| **Radioactive  isotope** | **Type of radiation  emitted** | **Half-life in  years** |
| Americium-241 | Alpha and gamma | 460 |
| Cobalt-60 | Gamma | 5 |
| Radium-226 | Alpha, beta and gamma | 1600 |
| Strontium-90 | Beta | 28 |
| Thorium-232 | Alpha and beta | 1.4 x 1010 |

(i) State which radioactive isotope in the table above emits only radiation that is **not** deflected by a magnetic field. Give a reason for your choice.

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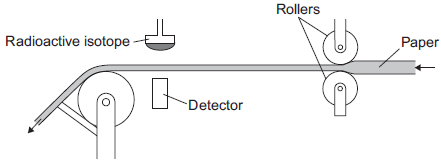
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**(2)**

(ii)     **Figure 2** shows a radioactive isotope being used to monitor the thickness of paper during production.

**Figure 2**

****

State which radioactive isotope in the table should be used to monitor the thickness of the paper. Explain your choice.

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

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**(3)**

All the radioactive isotopes in the table have practical uses. State which source in the table would need replacing most often.

Explain your choice.

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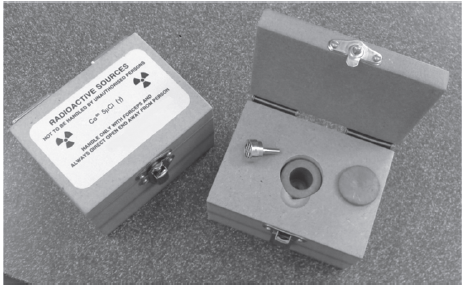
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**(3)**

(iii)    When the radioactive isotopes are not in use, they are stored in lead-lined wooden boxes. The boxes reduce the level of radiation that reaches the surroundings.

**Figure 3** shows two of these boxes.

**Figure 3**

****

State **one** source from the table which emits radiation that could penetrate the box.

Explain your answer.

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

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**(3)**

**(Total 14 marks)**

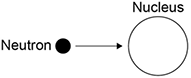
**Q9.** Electricity is generated in a nuclear power station.

Fission is the process by which energy is released in the nuclear reactor.

(a)     **Figure 1** shows the first part of the nuclear fission reaction.

Complete **Figure 1** to show how the fission process starts a chain reaction.

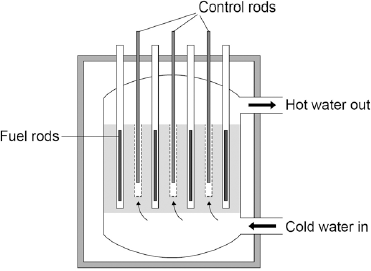
**Figure 1**

****

**(3)**

(b)     **Figure 2** shows the inside of a nuclear reactor in a nuclear power station.

**Figure 2**

****

In a nuclear reactor a chain reaction occurs, which causes neutrons to be released.

The control rods absorb neutrons.

The control rods can be moved up and down.

Explain how the energy released by the chain reaction is affected by moving the control rods.

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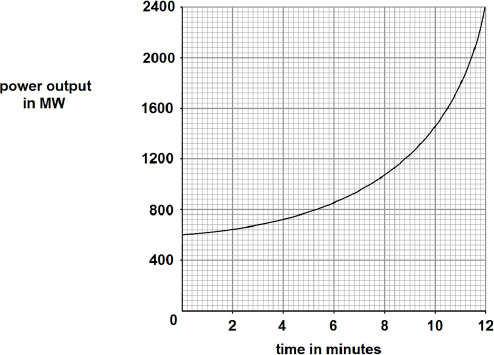
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**(2)**

(c)     **Figure 3** shows how the power output of the nuclear reactor would change if the control rods were removed.

**Figure 3**

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Calculate the rate of increase of power output at 10 minutes.

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

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Rate of increase of power output = \_\_\_\_\_\_\_\_\_ MW / minute

**(2)**

**(Total 7 marks)**

**Q10.** The equation below shows the process by which two atomic nuclei join to form a different nucleus.



2. Tick () **one** box.

|  |  |
| --- | --- |
| Inside the Earth |  |
| Inside a nuclear power station |  |
| Inside the Sun |  |

**(1)**

(b)     Use the correct answer from the box to complete the sentence.

|  |  |  |
| --- | --- | --- |
| **fission** | **force** | **fusion** |

The process of joining two atomic nuclei to form a different nucleus is called

nuclear \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(c)     What is released during this process?

Draw a ring around the correct answer.

|  |  |  |
| --- | --- | --- |
| **charge** | **energy** | **force** |

**(1)**

**(Total 3 marks)**

**Q11.** Atoms are different sizes.

One of the heaviest naturally occurring stable elements is lead.

Two of its isotopes are lead-206 () and lead-208 ().

(a)     (i)      What is meant by ‘isotopes’?

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**(2)**

(ii)     How many protons are in the nucleus of a  atom?

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

**(1)**

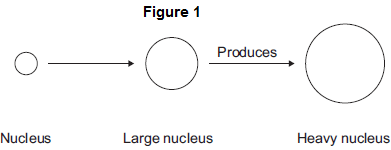
(iii)    How many neutrons are in the nucleus of a  atom?

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

**(1)**

(b)     A nucleus can be accelerated in a particle accelerator and directed at a large nucleus. This produces a heavy nucleus that will decay after a short time.

This is shown in **Figure 1**.



(i)      In 1984, nuclei of iron (Fe) were directed at nuclei of lead (Pb). This produced nuclei of hassium (Hs). Complete the equation for this reaction by writing numbers in the empty boxes.



**(3)**

(ii)     Use the correct answer from the box to complete the sentence.

|  |  |  |
| --- | --- | --- |
| **an electron** | **a proton** | **a neutron** |

The particle **X** in part (b)(i) is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(iii)    After acceleration the iron nuclei travel at a steady speed of one-tenth of the speed of light. The speed of light is 3.00 × 108 m/s. Calculate the time taken for the iron nuclei to travel a distance of 12 000 m.

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

**(2)**

(iv)    Linear accelerators, in which particles are accelerated in a straight line, are **not** used for these experiments. Circular particle accelerators are used. Suggest why.

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

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**(3)**

(c)     Hassium-265 () decays by alpha emission with a half-life of 0.002 seconds.

(i)      What is meant by ‘half-life’?

Tick () **two** boxes.

|  |  |
| --- | --- |
|  | **Tick ()** |
| The average time for the number of nuclei to halve |  |
| The time for count rate to be equal to background count |  |
| The time for background count to halve |  |
| The time for count rate to halve |  |

**(2)**

(ii)     Complete the equation for the decay of Hs-265 by writing numbers in the empty boxes.



**(2)**

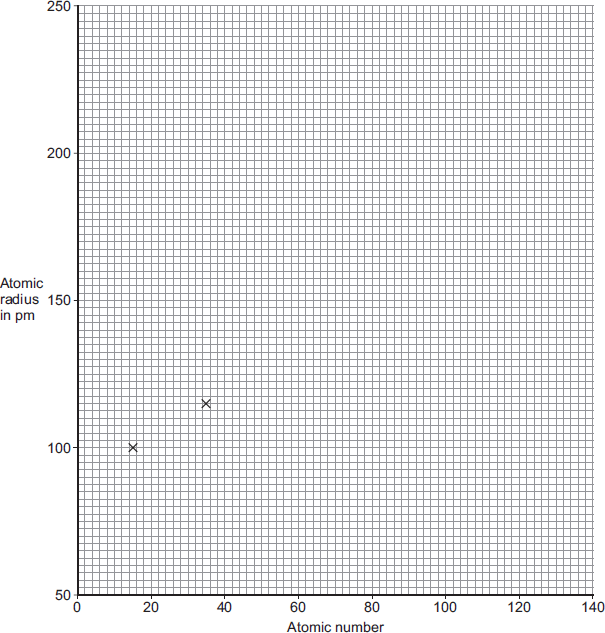
(d)     The table below shows how the atomic radius of some atoms varies with atomic number.

|  |  |
| --- | --- |
| **Atomic number** | **Atomic radius in picometres (pm)** |
| 15 | 100 |
| 35 | 115 |
| 50 | 130 |
| 70 | 150 |
| 95 | 170 |

1 pm = 10–12 m

(i)      On **Figure 2**, use the data from the table above to plot a graph of atomic radius against atomic number and draw a line of best fit. Two points have been plotted for you.

**Figure 2**

****

**(2)**

(ii)     Scientists believe that the element with atomic number 126 can be produced and that it will be stable. Use your graph in **Figure 2** to predict the atomic radius of an atom with atomic number 126.

Atomic radius = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ pm

**(1)**

**(Total 20 marks)**

**Q12.**A student models the random nature of radioactive decay using 100 dice.He rolls the dice and removes any that land with the number 6 facing upwards. He rolls the remaining dice again.The student repeats this process a number of times.The table below shows his results.

|  |  |
| --- | --- |
| **Roll number** | **Number of dice remaining** |
| 0 | 100 |
| 1 | 84 |
| 2 | 70 |
| 3 | 59 |
| 4 | 46 |
| 5 | 40 |
| 6 | 32 |
| 7 | 27 |
| 8 | 23 |

(a)     Give **two** reasons why this is a good model for the random nature of radioactive decay.

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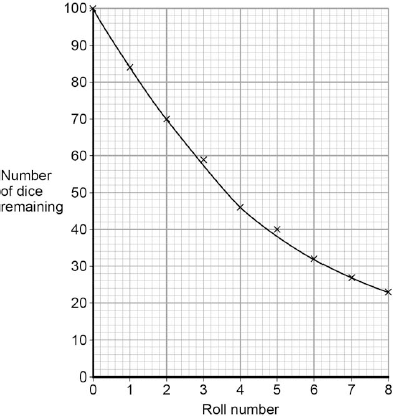
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(b)     The student’s results are shown in **Figure 1**.

**Figure 1**

****

Use **Figure 1** to determine the half-life for these dice using this model. Show on **Figure 1** how you work out your answer.

Half-life = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ rolls

**(2)**

(c)     A teacher uses a protactinium (Pa) generator to produce a sample of radioactive material that has a half-life of 70 seconds. In the first stage in the protactinium generator, uranium (U) decays into thorium (Th) and alpha (α) radiation is emitted.

The decay can be represented by the equation shown in **Figure 2**.

**Figure 2**

****

Determine the atomic number of thorium (Th) 234.

Atomic number = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(d)     When protactinium decays, a new element is formed and radiation is emitted.

The decay can be represented by the equation shown in **Figure 3**.

**Figure 3**

****

When protactinium decays, a new element, **X**, is formed.

Use information from **Figure 2** and **Figure 3** to determine the name of element **X**.

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

**(1)**

(e)     Determine the type of radiation emitted as protactinium decays into a new element.

Give a reason for your answer.

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

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**(2)**

(f)     The teacher wears polythene gloves as a safety precaution when handling radioactive materials.

The polythene gloves do **not** stop the teacher’s hands from being irradiated.

Explain why the teacher wears polythene gloves.

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

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**(2)**

**(Total 10 marks)**

**Mark schemes**

**Q1.**

(a)     to vary the current.

**1**

(b)     the temperature of the filament increases

*allow the filament heats up*

**1**

(c)     E = 12 × 8.5

**1**

E = 102 (J)

*an answer of 102 (J) scores* ***2*** *marks*

**1**

(d)     (LED lamp)

longer lifetime (per lamp)

**1**

wastes less energy

**or**

lower input energy (for same light energy output)

**1**

**[6]**

**Q2.**

(a)     gravitational potential

**1**

kinetic

**1**

chemical

**1**

(b)     flying drones may damage aircraft

**or**

falling drones may injure people

**or**

damage buildings / vehicles

*allow any sensible suggestion of a hazard caused by a flying / falling drone*

**1**

(c)     energy transferred = power × time

*allow E = Pt*

**1**

(d)     t = 25 × 60 = 1500 (s)

**1**

E = 65 × 1500

**1**

E = 97 500 (J)

*an answer of 97 500 (J) scores 3 marks*

*allow 2 marks for an answer of 1625 (J)*

**1**

**[8]**

**Q3.**

(a)    potential

**1**

(b)     (i)      13 200

*allow* ***1*** *mark for correct substitution, ie 660 × 20 provided no subsequent step shown*

**2**

(ii)     16.5

*allow 1 mark for correct*

**or**

 correctly calculated

*substitution, ie * ***or*** **

*provided no subsequent step shown*

**2**

**[5]**

**Q4.**

(a)     apparatus diagram to show:

•        aluminium block (surrounded by insulation)

**1**

•        thermometer and immersion heater inside (or in contact with) aluminium

**1**

•        joulemeter connected to immersion heater

**or**

ammeter and voltmeter connected correctly around immersion heater

*full credit can be given for a correct alternative method*

*ignore position or absence of stopclock*

*ignore position or absence of electric balance*

**1**

(b)

|  |  |
| --- | --- |
| **Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced. | 5-6 |
| **Level 2:** The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced. | 3-4 |
| **Level 1:** The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear. | 1-2 |
| No relevant content | 0 |
| **Indicative content**  **measurements:**  •   energy (transferred) using joulemeter **or** ammeter, voltmeter and stopclock  •   mass using electric balance  •   temperature change using thermometer  **SHC calculation:**  E = mcθ  **or**    **valid results:**  •   repeat practical and calculate a mean  •   plot a graph of temperature against time and use linear section of graph for temperature change  •   small (eg 10 °C) temperature change (so cylinder isn’t significantly hotter than surroundings)  **safety:**  immersion heater gets very hot so avoid touching (heating element) with bare hand |  |

**6**

(c)     immersion heater gets very hot so avoid touching (heating element) with bare hand

*allow not all of the energy (as measured by the joulemeter) is transferred to the block*

**1**

(so) temperature increase not as high as it should be for the total energy transferred

*allow justification using the equation: *

**1**

**[11]**

**Q5.**

(a)     Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the [Marking guidance](file:///\\chchs-fs02.chchs.internal\staff$\Teaching\STAH65\resources\AG_BL\menus\Markingguidance.pdf).

**0 marks**No relevant content.

**Level 1(1-2 marks)**There is a basic explanation of **one** feature  
**or**a simple statement relating reduction in energy transfer to **one** feature.

**Level 2(3-4 marks)**There is a clear explanation of **one** feature  
**or**a simple statement relating reduction in energy transfer to **two** features.

**Level 3(5-6 marks)**There is a detailed explanation of at least **two** features  
**or**a simple statement relating reduction in energy transfer to all **four** features.

**Examples of the points made in response**

***extra information***

*accept throughout:   
heat for energy   
loss for transfer*

plastic cap:

•        plastic is a poor conductor

*accept insulator for poor conductor*

•        stops convection currents forming at the top of the flask so stopping energy transfer by convection

•        molecules / particles evaporating from the (hot) liquid cannot move into the (surrounding) air so stops energy transfer by evaporation

•        plastic cap reduces / stops energy transfer by conduction / convection / evaporation

glass container:

•        glass is a poor conductor so reducing energy transfer by conduction

•        glass reduces / stops energy transfer by conduction

vacuum:

•        both conduction and convection require a medium / particles

•        so stops energy transfer between the two walls by conduction and convection

•        vacuum stops energy transfer by conduction / convection

silvered surfaces:

•        silvered surfaces reflect infrared radiation *accept heat for infrared*

•        silvered surfaces are poor emitters of infrared radiation

•        infrared radiation (partly) reflected back (towards hot liquid)

•        silvered surfaces reduce / stop energy transfer by radiation

**6**

(b)     (the ears have a) small surface area

*ears are small is insufficient*

**1**

so reducing energy radiated / transferred (from the fox)

*accept heat lost for energy radiated*

*do* ***not*** *accept stops heat loss*

**1**

**[8]**

**Q6.** (a)     (i)      5(.0)

**1**

(ii)     35 **or** their (a)(i) × 7 correctly calculated

*allow* ***1*** *mark for correct substitution, ie 5* ***or*** *their (a)(i) × 7 provided no subsequent step shown*

**2**

(iii)     525(p)  
**or**(£) 5.25  
**or**their (a)(ii) × 15 correctly calculated

*if unit p or £ given they must be consistent with the numerical answer*

**1**

(iv)    decreases

**1**

temperature difference (between inside and outside) decreases

*accept gradient (of line) decreases*

*do* ***not*** *accept temperature (inside) decreases*

*do* ***not*** *accept graph goes down*

**1**

(b)     air (bubbles are) trapped (in the foam)

*do* ***not*** *accept air traps heat   
foam has air pockets is insufficient*

**1**

(and so the) air cannot circulate / move / form convection current

*air is a good insulator is insufficient   
no convection current is insufficient*

*answers in terms of warm air from the room being trapped are incorrect and score no marks*

**1**

**[8]**

**Q7.** (a)     (i)       77

**1**

(ii)     Oil

**1**

(b)     water *accept H2O*

**1**

(c)     Carbon dioxide causes global warming

**1**

**[4]**

**Q8.** (a)     78 (°C)

*allow* ***2*** *marks for correct temperature change ie 22 °C*

*allow* ***1*** *mark for correct substitution*

*ie 46 200 = 0.5 × 4200 x θ*

***or***

******

**3**

(b)     6.4 (W) *allow* ***2*** *marks for an answer that rounds to 6.4*

*allow* ***1*** *mark for correct substitution*

*ie 46 200 = P × 7200*

*an answer of 23 000 or 23 100 or 385 gains 1 mark*

**2**

**[5]**

**Q9.** (a)     80 (°C)

**1**

(b)     **C**

**1**

temperature after 10 minutes was lowest

**or**

final temperature was lowest

*reason only scores if material* ***C*** *is chosen*

*allow temperature after 10 minutes was lower*

**1**

(c)     lower total temperature rise (for all materials)

*allow lower final temperature (for all materials)*

**1**

(because) the rate of temperature increase would be lower

*allow lower gradient lines*

**1**

(d)     higher resolution

**1**

reduced risk of misreading instrument

**1**

(e)     polyurethane foam

*no marks if polyurethane foam not chosen*

**1**

(because it has the) lowest rate of energy transfer

**1**

**[9]**

**Q10.** (a)     advantage

any **one** from:

•        produce no / little greenhouse gases / carbon dioxide

*allow produces no / little polluting gases*

*allow doesn’t contribute to global warming / climate change*

*allow produce no acid rain / sulphur dioxide*

*reference to atmospheric pollution is insufficient*

*produce no harmful gases is insufficient*

•        high(er) energy density in fuel

*accept one nuclear power station produces as much power as several gas power stations*

*nuclear power stations can supply a lot of or more energy is insufficient*

•        long(er) operating life

*allow saves using reserves of fossil fuels or gas*

**1**

disadvantage

any **one** from:

•        produce (long term) radioactive waste *accept waste is toxic*

*accept nuclear for radioactive*

•        accidents at nuclear power stations may have far reaching or long term consequences

•        high(er) decommissioning costs *accept high(er) building costs*

•        long(er) start up time

**1**

(b)     (i)      12 000 (kWh)

*allow* ***1*** *mark for correct substitution eg*

*2000  ×  6*

***or****2 000 000  ×  6*

***or*****

*an answer of 12 000 000 scores* ***1*** *mark*

**2**

(ii)     any idea of unreliability, eg

•        wind is unreliable

*reference to weather alone is insufficient*

•        shut down if wind too strong / weak

•        wind is variable

**1**

(c)     any **one** from:

•        cannot be seen

•        no hazard to (low flying) aircraft / helicopters

•        unlikely to be or not damaged / affected by (severe) weather

*unlikely to be damaged is insufficient*

•        (normally) no / reduced shock hazard

*safer is insufficient*

*less maintenance is insufficient*

*installed in urban areas is insufficient*

**1**

**[6]**

**Q11.** (a)     (i)      water

**1**

heated

*accept boiled or turned to steam*

*do* ***not*** *accept evaporated*

**1**

generator

**1**

(ii)     geothermal power stations provide a reliable source of electricity

**1**

(b)     falling water

**1**

**[5]**

**Q12.** (a)     Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a ‘best-fit’ approach to the marking.

**0 marks**No relevant information

**Level 1 (1-2 marks)**There is a relevant statement about an energy saving method

**Level 2 (3-4 marks)**There is at least one clear comparison of energy saving methods and their cost effectiveness with an appropriate calculation

**Level 3 (5-6 marks)**There is a comparison of energy saving methods and their cost effectiveness with appropriate calculations. Comparison to include further detail.

**examples of physics points made in the response**

**examples of relevant statements**

•        energy efficient boiler saves the most (energy / money) per year

•        loft insulation costs the least to install

•        double-glazing costs the most to install

**examples of statements that include cost effectiveness**

•        loft insulation is the most cost effective in the long term

•        double-glazing is the least cost effective

•        loft insulation has the shortest payback time

•        double-glazing has the longest payback time

•        payback time calculated for any method

*payback times:*

*energy efficient boiler: 6.25 years*

*loft insulation: 2 years*

*double glazing: 100 years*

*cavity wall insulation: 2.86 years*

**examples of further detail**

•        for cost effectiveness install in the following order: loft, cavity wall, boiler, double-glazing

•        for reducing energy use install in the following order: boiler, loft, cavity wall, double glazing

•        don’t install double-glazing for insulation purposes

•        double-glazing won’t pay for itself in your lifetime

•        justified choice of best / worst method

**6**

(b)     (i)      how effective a material is as an insulator

*accept ‘heat’ for energy*

*accept how effective a material is at keeping energy in*

*accept the lower the U-value the better the insulator*

*accept the lower the U-value the lower the rate of energy transfer*

**1**

(ii)     (the U-value) decreases

**1**

**[8]**

**Q13.**

(a)     any **two** from:

•        nuclear

•        oil

•        (natural) gas

**2**

(b)     4 (hours)

**1**

(c)     a system of cables and transformers

**1**

(d)     The power output of wind turbines is unpredictable

**1**

(e)     1500 / 0.6

**1**

2500 (wind turbines)

**1**

*allow 2500 with no working shown for* ***2*** *marks*

(f)     Most energy resources have negative environmental effects.

**1**

**[8]**

**Q14.** (a)     weight (lifted)

**or**

height (lifted)

**1**

(b)     any **two** from:

•        calculate a mean

•        spot anomalies

•        reduce the effect of random errors

**2**

(c)     as speed increases, the efficiency increases

**1**

(but) graph tends towards a constant value

**or**

appears to reach a limit *accept efficiency cannot be greater than 100%*

**1**

(d)     heating the surroundings

**1**

(e)     0 (%)

**1**

**[7]**

**Mark schemes**

**Q1.** (a)     **Level 2 (3–4 marks):**

A detailed and coherent explanation is provided. The student makes logical links between clearly identified, relevant points.

**Level 1 (1–2 marks):**

Simple statements are made, but not precisely. The logic is unclear.

**0 marks:**

No relevant content

**Indicative content**

•        friction (between cloth and rod) causes

•        electrons (to) move

•        from the acetate rod **or** to the cloth

•        (net) charge on cloth is now negative

•        (net) charge on rod is now positive

**4**

(b)     there is a force of attraction between the acetate rod and the cloth

(reason)

**1**

unlike charges attract

**or**

negative charges attract positive charges

**1**

(c)     increase

**1**

(d)     0.000025 × 60 000

**1**

1.5 (J)

**1**

*accept 1.5 (J) with no working shown for* ***2*** *marks*

**[9]**

**Q2.** (a)     to vary the current.

**1**

(b)     the temperature of the filament increases

*allow the filament heats up*

**1**

(c)     E = 12 × 8.5

**1**

E = 102 (J)

*an answer of 102 (J) scores* ***2*** *marks*

**1**

(d)     (LED lamp)

longer lifetime (per lamp)

**1**

wastes less energy

**or**

lower input energy (for same light energy output)

**1**

**[6]**

**Q3.** (a)     he may receive an electric shock

**or**

he may be electrocuted

**1**

if he touches the live wire

**1**

(b)     10 690 = I × 230

**1**

I = 10 690 / 230

**1**

46.478(260) (A)

**1**

46

**1**

*allow 46 (A) with no working shown for* ***4*** *marks*

(c)     cost is higher

**1**

more energy is used (per second)

**1**

**[8]**

**Q4.**

(a)     

**1**

(b)     

**1**

current = 0.28 (A)

*an answer of 0.28 (A) scores* ***2*** *marks*

**1**

(c)     0.60 (V)

**1**

product of potential difference and current gives highest value

**1**

(d)     

**1**

(e)     

**1**

useful power output = 0.20 × 2.4

**1**

useful power output = 0.48 (W)

*an answer of 0.48 (W) scores* ***3*** *marks*

**1**

**[9]**

**Q5.** (a)     charge

**1**

(b)     (i)      blue

**1**

(ii)     earth wire

**1**

fuse

**1**

(c)     (i)      case is non-metal / non-conducting / plastic / insulator

*must refer to case / outside of appliance*

*do not accept plastic coating / covering*

**1**

(ii)     earth (wire)

**1**

(d)     (i)      60 (W)

*P = 3 × 20 gains* ***1*** *mark*

*provided no subsequent step shown*

**2**

(ii)     15

*300 = 20 × Q*

***or***

*20 = 300 / Q gains* ***1*** *mark*

**2**

C / coulombs

*must clearly be upper case C accept J / V or As*

**1**

**[11]**

**Q6.** (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]**

**Q7.** (a)     (i)      (3-pin) plug

*do* ***not*** *accept plug socket*

**1**

(ii)     live and neutral

**1**

(iii)    double

**1**

(b)     direct current (d.c.) only

**1**

(c)     (i)      live

**1**

(ii)     too great a current flows

*accept a surge of current   
accept too great a power   
accept an electrical fault*

*do* ***not*** *accept voltage / energy / electricity too high*

**1**

(iii)    can be reset

*accept does not need replacing*

**1**

(disconnects circuit) faster

*cheaper is insufficient   
does not melt is insufficient   
quicker to fix / replace is insufficient*

**1**

**[8]**

**Q8.** (a)     current

**1**

(b)     4.2 = 3.5 × 10–3 × R

**1**

R = 4.2 / 3.5 × 10–3

**1**

R = 1200 (Ω) *an answer of 1200 (Ω) scores* ***3*** *marks*

*an answer of 1.2 scores* ***2*** *marks*

**1**

(c)     conversion from minutes to seconds (300 s)

**1**

Q = 0.0035 × (5 × 60)

**1**

Q = 1.05 C

*an answer of 1.05 (C) scores* ***3*** *marks*

*an answer of 17.5 scores* ***1*** *mark*

*an answer of 1050 or 0.0175 scores* ***2*** *marks*

**1**

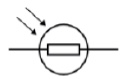
(d)     (potential difference) increases

**1**

(because thermistor) resistance increases

*2nd mark dependent on scoring 1st mark*

**1**

(e)     

**1**

**[10]**

**Q9.** (a)     last box ticked



**1**

(b)     (i)      use hotter water (than 60 °C) *accept use boiling water*

*accept use water at any stated temperature above 60 °C*

**or**

add ice cubes

*accept add water at any stated temperature below 12 °C*

*use different temperatures is insufficient*

**1**

(ii)     the current increases as the temperature increases

**1**

(iii)     0.02 (A)

**1**

(iv)     5 (V)

**or**

their **(b)(iii)** × 250 correctly calculated

*allow* ***1*** *mark for correct substitution ie V = 0.02 × 250*

***or***

*V = their* ***(b)(iii)*** *× 250*

**2**

(v)     the resistance increases

**1**

**[7]**

**Q10.** (a)     4

**1**

(b)     (i)      2 *allow* ***1*** *mark for correct substitution ie*

**

*provided no subsequent step*

**2**

(ii)     5 *allow* ***1*** *mark for correct substitution ie*

**

*provided no subsequent step*

**2**

**[5]**

**Q11.** (a)     20

**1**

(b)     50

**1**

(c)     (i)      115

**1**

(ii)     230

**1**

(iii)     if one goes out the other still works

**or**

brighter

*accept power (output) is greater*

*can be switched on/off independently is insufficient*

**1**

(d)     the outside/casing is plastic

*there is plastic around the wires is insufficient*

*it is plastic is insufficient*

**1**

and plastic is an insulator

*an answer the light fitting is double insulated gains both marks*

**1**

(e)     (residual current) circuit breaker

*accept RCCB*

*accept RCBO*

*accept RCCD*

*accept RCB*

*accept miniature circuit breaker / MCB*

*trip switch is insufficient*

*breaker is insufficient*

*do not accept earth wire*

**1**

**[8]**

**Q12.** (a)     V = 0.10 × 45

**1**

4.5 (V)

**1**

(b)     R = 12 / 0.10

**1**

total resistance = 120 (Ω)

**1**

R = 120 – 105 = 15 (Ω)

**1**

(c)     (total) resistance decreases

**1**

(so) current increases

**1**

**[7]**

**Q13.** (a)     current at 0.5 V = 0.91 (A)

**1**

P = 0.91 × 0.5

**1**

P = 0.455 (W) *an answer of 0.455 (W) scores* ***3*** *marks*

**1**

(b)     straight line with positive gradient

*allow for* ***1*** *mark a straight line that passes through (0.1, 0)*

**1**

positive y-axis intercept *ignore any values on y-axis*

**1**

(c)     

**1**

total P = 3.47 (W)

**1**

****

**1**

area = 7.7 × 10–3 (m2)

*an answer of 7.7 × 10–3 (m2) scores* ***4*** *marks*

*allow use of student’s calculated incorrect total power for last 2 marking points*

**1**

(d)     connect the solar cells in parallel

**1**

(so that) the current has multiple paths it can take

**or**

the total resistance is less than the resistance of one solar cell

**1**

**[11]**

**Q14.** (a)     battery, lamp and ammeter connected in series with variable resistor

**1**

voltmeter in parallel with (filament) lamp

**1**

(b)     **Level 2 (3–4 marks):**

A detailed and coherent description of a plan covering all the major steps is provided.  
The steps are set out in a logical manner that could be followed by another person to  
obtain valid results.

**Level 1 (1–2 marks):**

Simple statements relating to relevant apparatus or steps are made but they may  
not be in a logical order. The plan would not allow another person to obtain valid results.

**0 marks:**

No relevant content

**Indicative content**

•        ammeter used to measure current

•        voltmeter used to measure potential difference

•        resistance of variable resistor altered to change current in circuit **or** change potential difference (across filament lamp)

•        resistance (of filament lamp) calculated **or** R=V / I statement

•        resistance calculated for a large enough range of different currents that would allow a valid conclusion about the relationship to be made

**4**

(c)     (as current increases) resistance increases (at an increasing rate)

**1**

(d)     any value between 6.3 and 6.9 (Ω)

**1**

(e)     **A**: Filament lamp

**1**

**B**: Resistor at constant temperature

**1**

**C**: Diode

**1**

**[11]**

**Mark schemes**

**Q1. Level 3 (5–6 marks):**

Clear and coherent description of both methods including equation needed to calculate density. Steps are logically ordered and could be followed by someone else to obtain valid results.

**Level 2 (3–4 marks):**

Clear description of one method to measure density **or** partial description of both methods. Steps may not be logically ordered.

**Level 1 (1–2 marks):**

Basic description of measurements needed with no indication of how to use them.

**0 marks:**

No relevant content.

**Indicative content**

**For both:**

•        measure mass using a balance

•        calculate density using ρ = m / V

**Metal cube:**

•        measure length of cube’s sides using a ruler

•        calculate volume

**Small statue:**

•        immerse in water

•        measure volume / mass of water displaced

•        volume of water displaced = volume of small statue

**[6]**

**Q2.** (a)     range of speeds

**1**

moving in different directions

*accept random motion*

**1**

(b)     internal energy

**1**

(c)     density = mass / volume

**1**

(d)     0.00254 / 0.0141

**1**

0.18

**1**

*accept 0.18 with no working shown for the* ***2*** *calculation marks*

kg / m3

**1**

**[7]**

**Q3.** (a)      (i)     random distribution of circles in the box with at least 50 % of circles touching

**1**

random distribution of circles occupies more than 50 % of the space

*judged by eye*

**1**

(ii)     (large) gaps between particles

*accept particles do not touch*

*accept particles are spread out*

**1**

(so) easy to push particles closer (together)  
**or**forces between particles are negligible / none

*an answer in terms of number of particles is insufficient*

**1**

(b)    (i)       (both are) random

*accept a correct description of random eg unpredictable or move around freely or in all directions*

*they take up all the space is insufficient*

*they are spread out is insufficient*

*they move in straight lines is insufficient*

**1**

(ii)     (speed also) increases

**1**

**[6]**

**Q4.**

(a)     (black) is a good absorber of (infrared) radiation

**1**

(b)     (i)      amount of energy required to change (the state of a substance) from solid to liquid (with no change in temperature)

*melt is insufficient*

**1**

unit mass / 1kg

**1**

(ii)     5.1 × 106 (J)

*accept 5 x 106*

*allow* ***1*** *mark for correct substitution ie E = 15 × 3.4 × 105*

**2**

(c)     (i)      mass of *ice*

*allow volume / weight / amount / quantity of ice*

**1**

(ii)     to distribute the salt throughout the ice

**1**

to keep all the ice at the same temperature

**1**

(iii)    melting point decreases as the mass of salt is increased

*allow concentration for mass*

*accept negative correlation*

*do* ***not*** *accept inversely proportional*

**1**

(d)     60 000 (J)

*accept 60 KJ*

*allow* ***2*** *marks for correct substitution ie E = 500 × 2.0 × 60*

*allow* ***2*** *marks for an answer of 1000* ***or*** *60*

*allow* ***1*** *mark for correct substitution ie*

*E = 500 × 2.0* ***or*** *0.50 × 2.0 × 60*

*allow* ***1*** *mark for an answer of 1*

**3**

(e)     Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also apply a ‘best-fit’ approach to the marking.

**0 marks**

No relevant content

**Level 1 (1–2 marks)**

There is *an attempt at a description of some advantages or disadvantages.*

**Level 2 (3–4 marks)**

*There is a basic description* of *some advantages* ***and / or*** *disadvantages for some of the methods*

**Level 3 (5–6 marks)**

There is a clear description of the advantages and disadvantages of all the methods.

**examples of the points made in the response**

***extra information***

**energy storage**

advantages:

•        no fuel costs

•        no environmental effects

disadvantages:

•        expensive to set up and maintain

•        need to dig deep under road

•        dependent on (summer) weather

•        digging up earth and disrupting habitats

**salt spreading**

advantages:

•        easily available

•        cheap

disadvantages:

•        can damage trees / plants / drinking water / cars

•        needs to be cleaned away

**undersoil heating**

advantages:

•        not dependent on weather

•        can be switched on and off

disadvantages:

•        costly

•        bad for environment

**6**

**[18]**

**Q5.**

(a)     surface area

**or**

duration of experiment

*accept shape of beaker*

*size of beaker is insufficient*

**1**

(b)     any **two** from:

•        takes readings automatically

*ignore easier* ***or*** *takes readings for you*

•        takes readings more frequently

•        reduces / no instrument reading error

*ignore human error*

•        higher resolution

*allow better resolution*

•        don't need to remove probe to take reading

•        more accurate

**2**

(c)     (i)      0.07 (°C/s)

*allow* ***1*** *mark for obtaining a temperature drop of 7 (°C)*

*allow* ***1*** *mark for an answer between 0.068 and 0.069 (°C/s)*

**2**

(ii)     rate of temperature change is greater at the start

*accept rate of evaporation is greater at the start*

**or**

rate of temperature change decreases

*allow rate of evaporation decreases*

*allow temperature decreases faster at the start*

**1**

(iii)     A

*reason only scores if A is chosen*

lower temperature decrease (over 200 seconds)

*accept lower gradient*

**1**

(iv)     no effect (as rate of evaporation is unchanged)

*allow larger temperature change (per second as mass of liquid is lower)*

**1**

(d)     particles with more energy

*accept particles with higher speeds*

**1**

leave the (surface of the) liquid

**1**

(which) reduces the average (kinetic) energy (of the remaining particles)

*allow reference to the total energy of the liquid reducing*

**1**

**[11]**

**Q6.** *accept atoms / particles for ions throughout*

(a metal has) free electrons

*accept mobile for free*

**1**

(kinetic) energy of (free) electrons increases

*accept energy of ions increases*

*accept ions vibrate with a bigger amplitude*

*accept ions vibrate more*

*do* ***not*** *accept electrons vibrate more*

**1**

(free) electrons move faster

**1**

**or**

electrons move through metal

*accept electrons collide with other electrons / ions*

(so) electrons transfer energy to other electrons / ions

*accept ions transfer energy to neighbouring ions*

**1**

**[4]**

**Q7.**

(a)     Student A’s measurements had a higher resolution

**1**

Student B was more likely to misread the temperature

**1**

(b)     a random error

**1**

(c)     8.4 °C

**1**

(d)     740 (seconds) *allow answers in the range 730 – 780*

**1**

(e)     0.40 × 199 000

**1**

79 600 (J)

**1**

*accept 79 600 (J) with no working shown for* ***2*** *marks*

(f)     stearic acid has a higher temperature than the surroundings

*accept stearic acid is hotter than the surroundings*

**1**

temperature will decrease until stearic acid is the same as the room temperature / surroundings

**1**

**[9]**

**Q8.** (a)      (i)     radiation

**1**

(ii)     traps (small pockets of) air

*do* ***not*** *accept it’s an insulator*

*do* ***not*** *accept reduces conduction and / or convection*

*do* ***not*** *allow it doesn’t allow heat to escape*

**1**

(b)     (i)      bigger temperature difference (between the water and surroundings)  
at the start (than at the end)

*do* ***not*** *accept water is hotter*

**1**

(ii)     starting temperature (of the water)

*accept thickness of fleece*

*do* ***not*** *accept same amount of fleece*

*do* ***not*** *accept thermometer / can*

*do* ***not*** *accept time is the same*

**1**

(iii)    18 (°C)

*correct answer only*

**1**

(iv)     **M**

**1**

smallest temperature drop (after 20 mins)

*cannot score if* ***M*** *is not chosen*

*accept it’s the best insulator*

*accept smallest loss in heat*

*accept keeps heat / warmth in for longer*

**1**

**[7]**

**Q9.**

(a)     (i)      Z

**1**

(ii)     X

**1**

(b)     (i)      moving randomly

**1**

(ii)     stronger than

**1**

(c)     (i)      evaporation

**1**

(ii)     any **one** from:

•         becomes windy

•         temperature increases

*accept (becomes) sunny  
“the sun” alone is insufficient*

•         less humid

**1**

**[6]**

**Q10.**

(a)     dependent

**1**

(b)     (probe) C

*allow 103.2*

**1**

largest difference between reading and actual temperature

*reason only scores if C chosen*

*accept larger*

*it is 3.2 greater is insufficient*

*comparing C with only one other probe is insufficient*

**1**

(c)     (i)      12(°C)

*accept a value between 12.0 and 12.2 inclusive*

**1**

(ii)     140 (seconds)

*accept an answer between 130 and 150 inclusive*

**1**

temperature starts to rise

*only scores if time mark awarded*

*accept the temperature was lowest (at this time)*

**1**

(iii)     increase

*accept faster (rate)*

**1**

**[7]**

**Q11.**

(a)     1 (cm3)

**1**

(b)     pressure is inversely proportional to volume

**1**

data to prove inversely proportional relationship

*eg 8 × 200 = 1600*

*and 10 × 160 = 1600*

*if no other marks score allow for* ***1*** *mark: as volume decreases pressure increases*

**2**

(c)     (as the gas is compressed) the volume of gas decreases

**1**

(so there are) more frequent collisions of gas particles with container walls

**1**

(and) each particle collision with the wall causes a force

**1**

(so there is a) greater force on walls

**1**

**[8]**

**Q12.**

(a)     **solid**particles vibrate about fixed positions

**1**

closely packed

*accept regular*

**1**

**gas**particles move randomly

*accept particles move faster*

*accept freely for randomly*

**1**

far apart

**1**

(b)     amount of energy required to change the state of a substance from liquid to gas (vapour)

**1**

unit mass / 1 kg

*dependent on first marking point*

**1**

(c)     41000 **or** 4.1 × 104 (J)

*accept*

*41400 or 4.14 × 104*

*correct substitution of*

*0.018 × 2.3 × 106 gains* ***1*** *mark*

**2**

(d)     **AB**changing state from solid to liquid / melting

**1**

at steady temperature

*dependent on first* ***AB*** *mark*

**1**

**BC**temperature of liquid rises

**1**

until it reaches boiling point

*dependent on first* ***BC*** *mark*

**1**

**[12]**

**Mark schemes**

**Q1.**

(a)     cosmic rays

**1**

radon gas

**1**

(b)     radioactive decay is a random process

**1**

(c)     the lead lining absorbs the emitted radiation

**1**

(d)     subtract the background count from 159

**1**

(e)     beta

**1**

beta is negatively charged

**1**

(so is) attracted to positive plate

**or**

(so is) repelled by negative plate

**1**

**[8]**

**Q2.**

(a)     7

**1**

(b)     3

**1**

number of protons

*reason only scores if 3 chosen*

**1**

(c)     levels

**1**

(d)     

*correct order only*

**1**

**1**

****

**1**

(e)     shorter half-life (than the other sources)

**1**

exposure time to radiation is shorter

**1**

**[9]**

**Q3.**

(a)     a uranium nucleus

**1**

absorbs a neutron

**1**

(uranium-236 nucleus) splits into two smaller nuclei

**or**

Kr and Ba nuclei

**or**

krypton and barium nuclei

**1**

and releases 3 neutrons and energy

**1**

(b)     light nuclei

**1**

join to form a heavier nucleus

*allow hydrogen nuclei for light nuclei*

*allow helium nucleus for heavier nucleus*

**1**

(some of the) mass of the nuclei is converted to energy

*allow particles for nuclei*

**1**

(c)     any **two** from:

•        easy to obtain / extract

•        available in (very) large amounts

•        releases more energy (per kg)

*do* ***not*** *accept figures* ***only***

*naturally occurring is insufficient*

*seawater is renewable is insufficient*

*less cost is insufficient*

*allow produces little / no radioactive waste*

**2**

**[9]**

**Q4.** (a)     most alpha particles pass straight through the atom

**1**

which shows that the atom is mostly empty space

**1**

very few alpha particles are deflected through a large angle

**1**

which shows the atom contains a nucleus where the mass / charge of the atom is concentrated

**1**

(b)     electron may absorb electromagnetic radiation

*full credit may be scored for a description of an electron emitting electromagnetic radiation*

**1**

(and) move further from the nucleus

**1**

to a higher energy level

**1**

**[7]**

**Q5.** (a)     (i)      splitting of a(n atomic) nucleus*do not accept splitting an atom*

**1**

(ii)     Neutron

**1**

(b)     (i)      nuclei have the same charge  
**or**nuclei are positive *accept protons have the same charge*

**1**

(ii)     (main sequence) star

*accept Sun or any correctly named star*

*accept red (super) giant*

**1**

(c)     (i)      any **two** from:

•        easy to obtain / extract

•        available in (very) large amounts

•        releases more energy (per kg)

*do* ***not*** *accept figures only*

•        produces little / no radioactive waste.

*naturally occurring is insufficient*

*seawater is renewable is insufficient*

*less cost is insufficient*

**2**

(ii)     any **one** from:

•        makes another source of energy available

•        increases supply of electricity

•        able to meet global demand

•        less environmental damage

•        reduces amount of other fuels used.

*accept any sensible suggestion*

*accept a specific example*

*accept a specific example*

**1**

(d)     12

*allow* ***1*** *mark for obtaining 3 half-lives*

**2**

**[9]**

**Q6.**

(a)     (i)      both lose 2 protons and (2) neutrons

*accept changes by 2 protons and 2 neutrons*

**1**

(ii)     different number of protons (in the nucleus)

*accept different atomic number  
do* ***not*** *accept different number of protons and neutrons or different mass number  
ignore electrons*

**1**

(iii)     gamma involves no change in the number of protons (in the nucleus)  
**or** gamma is a wave (not a particle)

*do* ***not*** *accept number of neutrons   
and / or protons  
ignore electrons*

**1**

(b)     (i)      water because

*both material* ***and*** *reason required*

         for all energy values the thickness  
of water needed to absorb (90% of)  
the radiation is more than the other materials

*accept thickness of water required is always more  
than the other materials*

**1**

(ii)     6

*allow* ***1*** *mark for obtaining both correct values 72****and*** *12 from graph  
allow* ***1*** *mark for incorrect values 71 and / or   
11 from graph evaluated correctly*

**2**

(c)     any **three** from:

*may be scored on annotated diagram provided  
not negated elsewhere*

•        most (alpha) particles passed  
undeflected / straight through the gold

•        suggesting most of the atom is empty (space)

•        a few (alpha) particles scattered / deflected through (very) large angles

*accept repelled   
do* ***not*** *accept reflected / rebound /  
bounce back*

•        suggesting a concentrated / small nucleus

•        nucleus is positive because it repels the positive (alpha) particles

*no reference to experiment, maximum* ***1*** *mark*

**3**

**[9]**

**Q7.**

(a)    78

**1**

(b)     atomic

**1**

(c)     (i)      131

*correct order only*

**1**

54

**1**

(ii)     32 (days)

*allow* ***1*** *mark for showing 4 half-lives provided no subsequent step*

**2**

(iii)    limits amount of iodine-131 / radioactive iodine that can be absorbed

*accept increases level of non-radioactive iodine in thyroid*

*do* ***not*** *accept cancels out iodine-131*

**1**

so reducing risk of cancer (of the thyroid)

*accept stops risk of cancer (of the thyroid)*

**1**

**[8]**

**Q8.** (a)     (average) time taken for the amount / number of nuclei / atoms (of the isotope in a sample) to halve  
**or**time taken for the count rate (from a sample containing the isotope) to fall to half

*accept (radio)activity for count rate*

**1**

(b)     *60 ±3* (days)

**1**

indication on graph how value was obtained

**1**

(c)     (i)      cobalt(-60)

**1**

*gamma not* deflected by a magnetic field  
**or***gamma have no charge dependent on first marking point*

*accept (only) emits gamma*

*gamma has no mass is insufficient do* ***not*** *accept any reference to half-life*

**1**

(ii)     strontium(-90)

**1**

any **two** from:

•        *only* has beta

•        alpha would be absorbed

•        gamma unaffected

•        *beta penetration / absorption depends on thickness of paper*

*if thorium(-232) or radium(-226) given, max* ***2*** *marks can be awarded*

**2**

(iii)    cobalt(-60)

**1**

shortest half-life *accept half-life is 5 years*

*dependent on first marking point*

**1**

so activity / count rate will decrease quickest

**1**

(iv)    *americium(-241) / cobalt(-60) / radium(-226)*

**1**

gamma emitter

**1**

(only gamma) can penetrate lead *(of this box) do not allow lead fully absorbs gamma*

**1**

**[14]**

**Q9.**

(a)     Nucleus splitting into two fragments and releasing two or three neutrons

**1**

(at least one) fission neutron shown to be absorbed by additional large nucleus and causing fission

**1**

two or three additional neutrons released from fission reaction

**1**

*This diagram would gain all* ***3*** *marks:*

**

(b)     lowering the control rods increases the number of neutrons absorbed

*accept converse description*

**1**

(so) energy released decreases

**1**

*allow changing the position of the control rods affects the number of neutrons absorbed for* ***1*** *mark*

(c)     rate of increase between 240 and 276 (MW / min)

**2**

*allow* ***1*** *mark for attempt to calculate gradient of line at 10 minutes*

**[7]**

**Q10.**

(a)     inside the Sun

**1**

(b)     fusion

**1**

(c)     energy

**1**

**[3]**

**Q11.** (a)     (i)      (atoms with the) same number of protons

*allow same atomic number*

***or*** *same proton number*

**1**

(atoms with) different number of neutrons

*allow different mass number*

**1**

(ii)     82

**1**

(iii)    124

**1**

(b)     (i)      

***1*** *mark for each correct box*

**3**

(ii)     (a) neutron

**1**

(iii)    4.0 × 10-4 (s)  
**or**0.0004

*3.00 × 108 × 0.1 = 12 000 / t*

*gains* ***1*** *mark*

**2**

(iv)    particles need to travel a large distance

**1**

equipment would have to be very long

**1**

with circular paths long distances can be accommodated in a smaller space

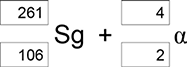
**1**

(c)     (i)      the average time for the number of nuclei to halve

**1**

the time for count rate to halve

**1**

(ii)     

***1*** *mark if top boxes total = 265*

***and*** *bottom boxes total = 108*

***1*** *mark for 4 and 2 for alpha*

**2**

(d)     (i)      3 plotted points

*± ½ small square*

**1**

best line through points

**1**

(ii)     190−205 (pm)

*or correct from student’s line*

**1**

**[20]**

**Q12.**

(a)     cannot predict which dice / atom will ‘decay’

*accept answers given in terms of ‘roll a 6’*

**1**

cannot predict when a dice / atom will ‘decay’

**1**

(b)     3.6 to 3.7 (rolls)

*allow* ***1*** *mark for attempt to read graph when number of dice = 50*

**2**

(c)     90

**1**

(d)     uranium

**1**

(e)     beta

**1**

proton number has gone up (as neutron decays to proton and e–)

**1**

(f)     prevents contamination

**or**

prevents transfer of radioactive material to teacher’s hands

**1**

which would cause damage / irradiation over a longer time period.

**1**

**[10]**