ALEC REED ACADEMY

Mastery Booklet**(Chemistry)**

(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.

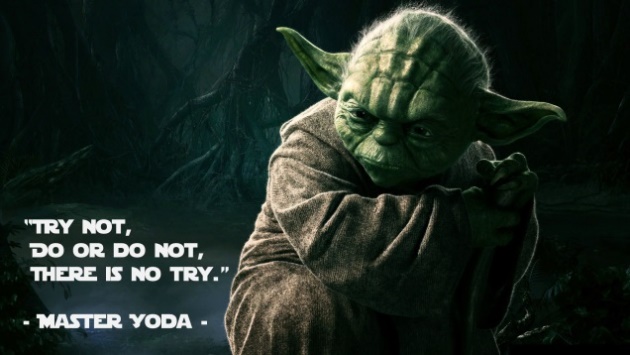
We know you have a lot to revise for and preparing for your exams can be stressful so here is a tool to help you.

**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.

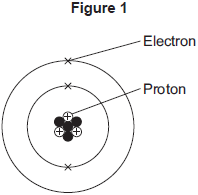
**5. Check out www.getrevising.co.uk.** Free revision planner tool and many free resources. For a small monthly fee you can download other people’s revision materials for AQA science.

**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.** There are eight elements in the second row (lithium to neon) of the periodic table.

(a)     **Figure 1** shows a lithium atom.



(i)      What is the mass number of the lithium atom in **Figure 1**?

|  |  |
| --- | --- |
| Tick (✔) **one** box. |  |
| 3 |  |
| 4 |  |
| 7 |  |

**(1)**

(ii)     What is the charge of an electron?

|  |  |
| --- | --- |
| Tick (✔) **one** box. |  |
| –1 |  |
| 0 |  |
| +1 |  |

**(1)**

(iii)    Protons are in the nucleus. Which other sub-atomic particles are in the nucleus?

|  |  |
| --- | --- |
| Tick (✔) **one** box. |  |
| ions |  |
| molecules |  |
| neutrons |  |

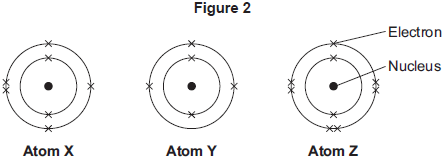
**(1)**

(b)     What is **always** different for atoms of different elements?

|  |  |
| --- | --- |
| Tick (✔) **one** box. |  |
| number of neutrons |  |
| number of protons |  |
| number of shells |  |

**(1)**

(c)     **Figure 2** shows the electron arrangements of three different atoms, **X**, **Y** and **Z**. These atoms are from elements in the second row (lithium to neon) of the periodic table.

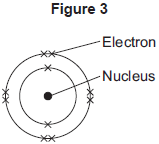


Which atom is from an element in Group 3 of the periodic table?

|  |  |
| --- | --- |
| Tick (✔) **one** box. |  |
| **Atom X** |  |
| **Atom Y** |  |
| **Atom Z** |  |

**(1)**

(d)     **Figure 3** shows the electron arrangement of a different atom from an element in the second row of the periodic table.



(i)      Give the chemical symbol of this element.

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

**(1)**

(ii)     Why is this element unreactive?

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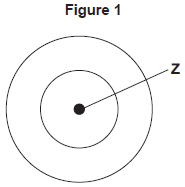
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**(1)**

**(Total 7 marks)**

**Q2.** There are eight elements in the second row (lithium to neon) of the periodic table.

(a)     **Figure 1** shows an atom with two energy levels (shells).



(i)      Complete **Figure 1** to show the electronic structure of a boron atom.

**(1)**

(ii)     What does the central part labelled **Z** represent in **Figure 1**?

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

**(1)**

(iii)    Name the sub-atomic particles in part **Z** of a boron atom.

Give the relative charges of these sub-atomic particles.

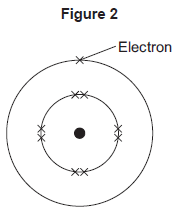
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**(3)**

(b)     The electronic structure of a neon atom shown in **Figure 2** is **not** correct.



Explain what is wrong with the electronic structure shown in **Figure 2**.

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**(3)**

**(Total 8 marks)**

**Q3.**This question is about atoms.

(a)     What does the number 19 represent in  ?

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**(1)**

(b)     How many atoms are present in one mole of fluorine atoms?

Tick (✔) **one** box.

|  |  |
| --- | --- |
| 2.03 × 1026 |  |
| 2.06 × 1023 |  |
| 6.02 × 1023 |  |
| 6.02 × 1026 |  |

**(1)**

(c)     The plum pudding model of the atom was replaced by the nuclear model.

The nuclear model was developed after the alpha particle scattering experiment.

Compare the plum pudding model with the nuclear model of the atom.

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**(4)**

(d)     An element has three isotopes.

The table shows the mass numbers and percentage of each isotope.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Isotope 1** | **Isotope 2** | **Isotope 3** |
| Mass number | 24 | 25 | 26 |
| Percentage (%) | 78.6 | 10.1 | 11.3 |

Calculate the relative atomic mass (*A*r) of the element.

Give your answer to 3 significant figures.

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Relative atomic mass = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

**(Total 8 marks)**

**Q4.**A student investigated the law of conservation of mass.

The law of conservation of mass states that the mass of the products is equal to the mass of the reactants.

This is the method used.

1. Pour lead nitrate solution into a beaker labelled **A**.

2. Pour potassium chromate solution into a beaker labelled **B**.

3. Measure the mass of both beakers and contents.

4. Pour the solution from beaker **B** into beaker **A**.

5. Measure the mass of both beakers and contents again.

When lead nitrate solution and potassium chromate solution are mixed, a reaction takes place.

This is the equation for the reaction:

Pb(NO3)2(aq) + K2CrO4(aq) ⟶ PbCrO4(s) + 2KNO3(aq)

(a)     What would the student see when the reaction takes place?

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

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**(1)**

(b)     The table shows the student’s results.

|  |  |
| --- | --- |
|  | **Mass in g** |
| Beaker **A** and contents before mixing | 128.71 |
| Beaker **B** and contents before mixing | 128.97 |
| Beaker **A** and contents after mixing | 154.10 |
| Beaker **B** after mixing | 103.58 |

Show that the law of conservation of mass is true.

Use the data from the table above.

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

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**(2)**

(c)     What is the resolution of the balance used to obtain the results in the table?

Tick (✔) **one** box.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0.01 g |  |  | 0.1 g |  |  | 1 g |  |  | 100 g |  |

**(1)**

(d)     Calculate the relative formula mass (*M*r) of lead nitrate Pb(NO3)2

Relative atomic masses (*A*r): N = 14 O = 16 Pb = 207

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Relative formula mass = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(e)     The formula of potassium chromate is K2CrO4. The charge on the potassium ion is +1.What is the formula of the chromate ion?

Tick (✔) **one** box.

|  |  |
| --- | --- |
| CrO4+ |  |
| CrO42+ |  |
| CrO4− |  |
| CrO42− |  |

**(1)**

(f)      Another student also tests the law of conservation of mass using the same method.

The student uses a different reaction.This is the equation for the reaction.

Na2CO3(aq) + 2HCI(aq) ⟶ 2NaCl(aq) + CO2(g) + H2O(I)

Explain why this student’s results would **not** appear to support the law of conservation of mass.

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

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**(3)**

**(Total 10 marks)**

**Q5.**The periodic table on the Data Sheet may help you answer these questions.

(a)     Many chemists have contributed to the development of the periodic table.

|  |
| --- |
|  |
| John Newlands was one of the first chemists who attempted to classify elements in a systematic way based on atomic weight. In 1866 he suggested that there was a repeating pattern of elements with similar properties every eighth element. Part of Newlands’ periodic table is shown below. |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | H | Li | Be | B | C | N | O | | F | Na | Mg | Al | Si | P | S | | Cl | K | Ca | Cr | Ti | Mn | Fe | | Co, Ni | Cu | Zn | Y | In | As | Se | | Br | Rb | Sr | Ce, La | Zr | Di, Mo | Ro, Ru | |
| Many chemists in 1866 did not accept Newland’s; periodic table. |

(i)      Give **one** piece of evidence which supports Newlands’ ideas.

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**(1)**

(ii)     Suggest **two** reasons why many chemists in 1866 did not accept Newlands’ ideas.

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

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

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

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

**(2)**

(b)     Chlorine, bromine and iodine are Group 7 elements.

A student investigated the reactivity of these elements. The student added:

•        aqueous chlorine to potassium bromide and potassium iodide solutions

•        aqueous bromine to potassium chloride and potassium iodide solutions

•        aqueous iodine to potassium chloride and potassium bromide solutions.

The student’s results are shown below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Solution** | **Potassium chloride** | **Potassium bromide** | **Potassium iodide** |
| **Chlorine** |  | Solution turned orange-brown | Solution turned brown |
| **Bromine** | No reaction |  | Solution turned brown |
| **Iodine** | No reaction | No reaction |  |

(i)      Use these results to state **and** explain the trend in reactivity of these Group 7 elements.

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**(2)**

(ii)     Complete the equation below, which represents the reaction between chlorine and potassium bromide.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Cl2 | + | 2KBr |  | \_\_\_\_ | + | 2KCl |

**(1)**

(iii)    In terms of electronic structure, state why chlorine, bromine and iodine are in Group 7.

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**(1)**

(c)     Lithium, sodium and potassium are Group 1 elements.

Group 1 elements become **more** reactive down the group.

Explain why in terms of electronic structure.

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**(3)**

**(Total 10 marks)**

**Q6.** In 1866 John Newlands produced an early version of the periodic table.

Part of Newlands’ periodic table is shown below.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Column** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|  | H | Li | Be | B | C | N | O |
|  | F | Na | Mg | Al | Si | P | S |
|  | Cl | K | Ca | Cr | Ti | Mn | Fe |

Newlands’ periodic table arranged all the known elements into columns in order of their atomic weight. Newlands was trying to show a pattern by putting the elements into columns.

(a)     Iron (Fe) does **not** fit the pattern in column 7.

Give a reason why.

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**(1)**

(b)     In 1869 Dmitri Mendeleev produced his version of the periodic table.

Why did Mendeleev leave gaps for undiscovered elements in his periodic table?

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

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**(1)**

(c)     Newlands and Mendeleev placed the elements in order of atomic weight.

Complete the sentence.

The modern periodic table places the elements in order of

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(d)     Lithium, sodium and potassium are all in Group 1 of the modern periodic table.

Explain why.

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

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**(2)**

**(Total 5 marks)**

**Q7.** This question is about the halogens (Group 7).

(a)     How do the boiling points of the halogens change down the group from fluorine to iodine?

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

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**(1)**

(b)     Sodium bromide is produced by reacting sodium with bromine. Sodium bromide is an ionic compound.

(i)      Write down the symbols of the **two** ions in sodium bromide.

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

**(1)**

(ii)     Chlorine reacts with sodium bromide solution to produce bromine and one other product. Complete the word equation for the reaction.

chlorine   +   sodium bromide      bromine   +   \_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(iii)    Why does chlorine displace bromine from sodium bromide?

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

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

**(1)**

(iv)    Use the Chemistry Data Sheet to help you to answer this question.

Suggest which halogen could react with sodium chloride solution to produce chlorine.

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

**(1)**

**(Total 5 marks)**

**Q8.** This question is about atomic structure and elements.

(a)     Complete the sentences.

(i)      The atomic number of an atom is the number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(ii)     The mass number of an atom is the number of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(b)     Explain why an atom has no overall charge.

Use the relative electrical charges of sub-atomic particles in your explanation.

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

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**(2)**

(c)     Explain why fluorine and chlorine are in the same group of the periodic table.

Give the electronic structures of fluorine and chlorine in your explanation.

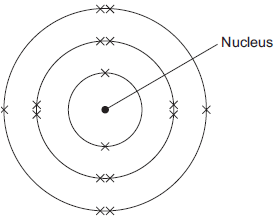
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**(2)**

(d)     The diagram shows the electronic structure of an atom of a non-metal.



What is the chemical symbol of this non-metal?

Tick () **one** box.

|  |  |
| --- | --- |
| Ar |  |
| O |  |
| S |  |
| Si |  |

**(1)**

(e)     When elements react, their atoms join with other atoms to form compounds.

Complete the sentences.

(i)      Compounds formed when non-metals react with metals consist of

particles called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(ii)     Compounds formed from only non-metals consist of

particles called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

**(Total 9 marks)**

**Q9.** Cells contain chemicals which react to produce electricity.

(a)     Why can a rechargeable cell be recharged?

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

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**(1)**

(b)     Give **two** factors that affect the voltage produced by a cell.

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

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

**(2)**

(c)     Balance the half-equation for the reaction occurring at an electrode in one type of hydrogen fuel cell.

H2   +  OH−  ⟶  H2O   +  e−

**(1)**

(d)     Why is the fuel cell in Question (c) described as an alkaline fuel cell?

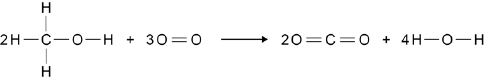
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**(1)**

(e)     Another type of fuel cell uses methanol instead of hydrogen.

The diagram represents the reaction in this fuel cell.



The table shows the bond energies for the reaction.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **C–H** | **C–O** | **O–H** | **O=O** | **C=O** |
| Bond energy in kJ / mol | 412 | 360 | 464 | 498 | 805 |

Calculate the overall energy change for the reaction.

Use the diagram and the table above.

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

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Overall energy change = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kJ / mol

**(3)**

**(Total 8 marks)**

**Q10.** An atom of aluminium has the symbol  

(a)     Give the number of protons, neutrons and electrons in this atom of aluminium.

Number of protons       \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Number of neutrons     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Number of electrons    \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(3)**

(b)     Why is aluminium positioned in Group 3 of the periodic table?

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

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**(1)**

(c)     In the periodic table, the transition elements and Group 1 elements are metals. Some of the properties of two transition elements and two Group 1 elements are shown in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Transition elements** | | **Group 1 elements** | |
| Chromium | Iron | Sodium | Caesium |
| **Melting point in °C** | 1857 | 1535 | 98 | 29 |
| **Formula of oxides** | CrO | FeO | Na2O | Cs2O |
| Cr2O3 | Fe2O3 |  |  |
| CrO2 | Fe3O4 |  |  |
| CrO3 |  |  |  |

Use your own knowledge **and** the data in the table above to compare the chemical and physical properties of transition elements and Group 1 elements.

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

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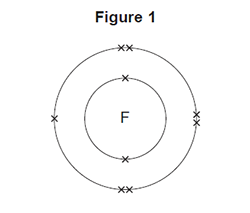
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**(6)**

**(Total 10 marks)**

**Q1.**This question is about fluorine.

(a)     **Figure 1** shows the arrangement of electrons in a fluorine atom.



(i)      In which group of the periodic table is fluorine?

Group \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(ii)     Complete the table below to show the particles in an atom and their relative masses.

|  |  |
| --- | --- |
| **Name of particle** | **Relative mass** |
| Proton |  |
| Neutron | 1 |
|  | Very small |

**(2)**

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

|  |  |  |
| --- | --- | --- |
| **alkalis** | **alloys** | **isotopes** |

Atoms of fluorine with different numbers of neutrons are

called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(b)     Sodium reacts with fluorine to produce sodium fluoride.

(i)      Complete the word equation for this reaction.

sodium     +     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_     →     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(ii)     Complete the sentence.

Substances in which atoms of two or more different elements are chemically

combined are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(iii)    The relative formula mass (*M*r) of sodium fluoride is 42. Use the correct answer from the box to complete the sentence.

|  |  |  |
| --- | --- | --- |
| **ion** | **mole** | **molecule** |

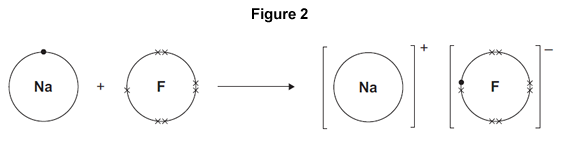
The relative formula mass (*M*r), in grams, of sodium fluoride is one

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the substance.

**(1)**

(iv)     **Figure 2** shows what happens to the electrons in the outer shells when a sodium atom reacts with a fluorine atom.

The dots (•) and crosses (×) represent electrons.



Use **Figure 2** to help you answer this question. Describe, as fully as you can, what happens when sodium reacts with fluorine to produce sodium fluoride.

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

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**(4)**

(v)     Sodium fluoride is an ionic substance. What are **two** properties of ionic substances?

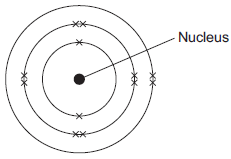
|  |  |
| --- | --- |
| Tick (✔) **two** boxes. |  |
| Dissolve in water |  |
| Gas at room temperature |  |
| High melting point |  |
| Low boiling point |  |

**(2)**

**(Total 13 marks)**

**Q2.**This question is about magnesium.

(a)     (i)      The electronic structure of a magnesium atom is shown below.



Use the correct answer from the box to complete each sentence.

|  |  |  |  |
| --- | --- | --- | --- |
| **electrons** | **neutrons** | **protons** | **shells** |

The nucleus contains protons and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

The particles with the smallest relative mass that move around the nucleus are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

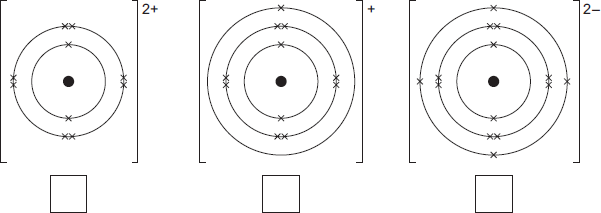
Atoms of magnesium are neutral because they contain the same number of

electrons and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(3)**

(ii)     A magnesium atom reacts to produce a magnesium ion. Which diagram shows a magnesium ion?

Tick () **one** box.



**(1)**

(b)     Magnesium and dilute hydrochloric acid react to produce magnesium chloride solution and hydrogen.

        Mg(s) + 2 HCl(aq)  MgCl2(aq) + H2(g)

(i)      State **two** observations that could be made during the reaction.

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

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

**(2)**

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

Describe a method for making pure crystals of magnesium chloride from magnesium and dilute hydrochloric acid.

In your method you should name the apparatus you will use.

You do **not** need to mention safety.

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

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**(6)**

**(Total 12 marks)**

**Q3.** Distress flares are used to attract attention in an emergency.



Flares often contain magnesium. Magnesium burns to form magnesium oxide.

(a)     The distress flare burns with a bright flame because the reaction is very *exothermic*.

Complete the following sentence using the correct words from the box.

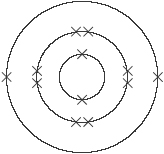
|  |
| --- |
| **gives out heat**                **stores heat**                  **takes in heat** |

An *exothermic* reaction is one which \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(b)     The diagram shows the electronic structure of a magnesium atom.

The atomic (proton) number of magnesium is 12.

  
**Magnesium atom**

The atomic (proton) number of oxygen is 8. Which diagram, **A**, **B**, **C** or **D**, shows the electronic structure of an oxygen atom?

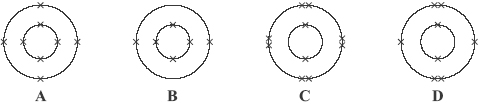
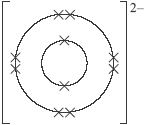


Diagram \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(c)     Magnesium ions and oxide ions are formed when magnesium reacts with oxygen. The diagram shows the electronic structure of an oxide ion.

  
**Oxide ion**

Which diagram, **J**, **K**, **L** or **M**, shows the electronic structure of a magnesium ion?

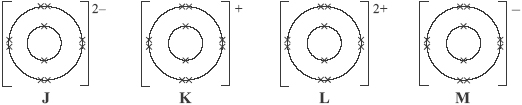


Diagram \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

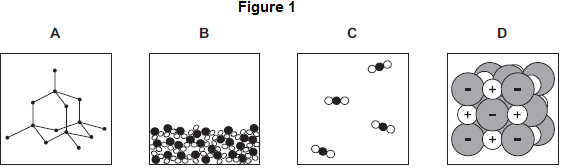
(d)     Indigestion tablets can be made from magnesium oxide. The magnesium oxide neutralises some of the hydrochloric acid in the stomach.Draw a ring around the name of the salt formed when magnesium oxide reacts with hydrochloric acid.

**magnesium chloride**        **magnesium hydroxide**            **magnesium sulfate**

**(1)**

**(Total 4 marks)**

**Q4.** The structures of four substances, **A**, **B**, **C** and **D**, are represented in **Figure 1**.



(a)     Use the correct letter, **A**, **B**, **C** or **D**, to answer each question.

|  |  |  |
| --- | --- | --- |
| (i) | Which substance is a gas? |  |

**(1)**

|  |  |  |
| --- | --- | --- |
| (ii) | Which substance is a liquid? |  |

**(1)**

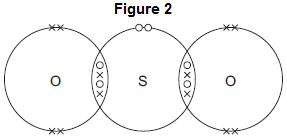
|  |  |  |
| --- | --- | --- |
| (iii) | Which substance is an element? |  |

**(1)**

|  |  |  |
| --- | --- | --- |
| (iv) | Which substance is made of ions? |  |

**(1)**

(b)     **Figure 2** shows the bonding in substance **C**.



(i)      What is the formula of substance **C**? Draw a ring around the correct answer.

|  |  |  |
| --- | --- | --- |
| **SO2** | **SO2** | **S2O** |

**(1)**

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

|  |  |  |
| --- | --- | --- |
| **delocalised** | **shared** | **transferred** |

When a sulfur atom and an oxygen atom bond to produce substance **C**,

electrons are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(iii)    What is the type of bonding in substance **C**?

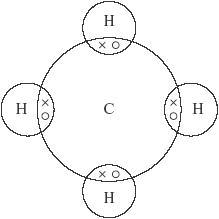
Draw a ring around the correct answer.

|  |  |  |
| --- | --- | --- |
| **covalent** | **ionic** | **metallic** |

**(1)**

**(Total 7 marks)**

**Q5.** The diagram represents a particle of methane.



(a)     What is the formula of methane? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(b)     Choose a word from the box to answer the question.

|  |
| --- |
| **atom**                   **ion**                   **molecule** |

Which of the words best describes the methane particle shown in the diagram?

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

**(1)**

(c)     Choose a word from the box to answer the question.

|  |
| --- |
| **covalent**             **ionic**                 **metallic** |

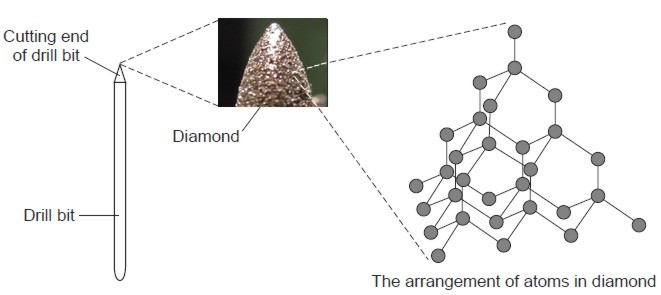
What is the type of bonding shown in the diagram?

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

**(1)**

**(Total 3 marks)**

**Q6.** A drill bit is used to cut holes through materials. The cutting end of this drill bit is covered with very small diamonds.



Draw a ring around the correct word in each box.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | carbon |  |
| (a) | Diamond is made from | nitrogen | atoms. |
|  |  | oxygen |  |

**(1)**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | none |  |
| (b) | Diamond has a giant structure in which | some | of the atoms are joined together. |
|  |  | all |  |

**(1)**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | covalent |  |
| (c) | The atoms in diamond are joined together by | ionic | bonds. |
|  |  | metallic |  |

**(1)**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | two |  |
| (d) | In diamond each atom is joinedto | three | other atoms. |
|  |  | four |  |

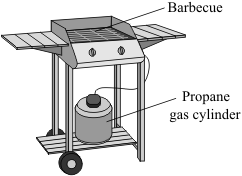
**(1)**

|  |  |  |
| --- | --- | --- |
|  |  | hard. |
| (e) | Diamond is suitable for the cutting end of a drill bit because itis | shiny. |
|  |  | soft |

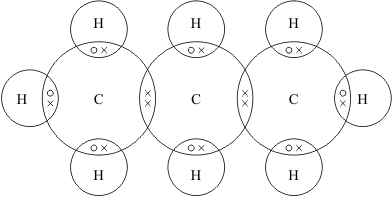
**(1)**

**(Total 5 marks)**

**Q7.** This barbecue burns propane gas.



          The diagram represents a propane molecule.



          (a)     What is the formula of propane?

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

**(1)**

(b)     (i)      Draw a ring around the name of the particle represented by the symbols ○ and × in the diagram.

**electron**               **neutron**                  **proton**

**(1)**

(ii)     Draw a ring around the type of bonding that holds the atoms together in a propane molecule.

**covalent**               **ionic**                       **metallic**

**(1)**

(c)    Under high pressure in the cylinder propane is a liquid.  
Liquid propane evaporates easily to form a gas when the tap on the cylinder is opened.

         Draw a ring around the correct answer in each box to explain why propane evaporates easily.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Propane has a | high  low | boiling point because it consists of | large  small | molecules. |

**(1)**

**(Total 4 marks)**

**Triple Q8.** Read the article and then answer the questions that follow.

|  |
| --- |
| **Nanotennis!**  Tennis balls contain air under pressure, which gives them their bounce. Normal tennis balls are changed at regular intervals during tennis matches because they slowly lose some of the air. This means that a large number of balls are needed for a tennis tournament, using up a lot of materials.    ‘Nanocoated’ tennis balls have a ‘nanosize’ layer of butyl rubber. This layer slows down the escape of air so that the ball does not lose its pressure as quickly. The ‘nanocoated’ tennis balls last much longer and do not need to be replaced as often. |

(a)     How does the ‘nanosize’ layer make the tennis balls last longer?

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

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**(1)**

(b)     Put a tick () next to the best description of a ‘nanosize’ layer.

|  |  |
| --- | --- |
| **Description** | () |
| A layer one atom thick. |  |
| A layer a few hundred atoms thick. |  |
| A layer millions of atoms thick. |  |

**(1)**

(c)     Suggest why using ‘nanocoated’ tennis balls would be good for the environment.

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

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**(2)**

**(Total 4 marks)**

**Q9.** Glass is made from silicon dioxide.



(a)     Silicon dioxide has a very high melting point. Other substances are added to silicon dioxide to make glass. Glass melts at a lower temperature than silicon dioxide. Suggest why.

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

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**(1)**

(b)     Sodium oxide is one of the substances added to silicon dioxide to make glass.

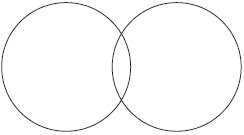
(i)      Sodium oxide contains Na+ ions and O2– ions. Give the formula of sodium oxide.

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

**(1)**

(ii)     Sodium oxide is made by heating sodium metal in oxygen gas.

Complete the diagram to show the outer electrons in an oxygen molecule (O2).



**(2)**

(c)     Glass can be coloured using tiny particles of gold. Gold is a metal. Describe the structure of a metal.

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

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**(3)**

**(Total 7 marks)**

**Q10.** Iron is the main structural metal used in the world.

(a)     The diagram represents the particles in iron, Fe.

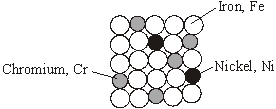


          Draw a ring around the correct word in the box to complete the sentence.

|  |  |  |
| --- | --- | --- |
| Iron is described as an element because all the | atoms  compounds  metals | are the same. |

**(1)**

(b)     Stainless steel is mostly iron. The diagram represents the particles in stainless steel.



Use the correct words from the box to complete the sentences about alloys.

|  |
| --- |
| **metal**       **mixture**     **molecule**      **polymer**       **smart**       **structure** |

Stainless steel is an alloy because it is a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of iron, chromium and nickel.

An alloy is made up of more than one type of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Stainless steel alloys are harder than iron because the different sized atoms added

change the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

An alloy that can return to its original shape after being deformed is called a

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ alloy.

**(4)**

(c)     In the UK, we use about 1.8 billion steel cans every year but only 25% are recycled.  
Used steel cans are worth about £100 per tonne. Recycling saves raw materials and reduces waste that would end up in landfill. Producing steel by recycling used cans saves 75% of the energy that would be needed to produce steel from iron ore. This also reduces carbon dioxide emissions.

(i)      Give **two** reasons, from the information above, to explain why recycling used steel cans is a good idea.

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

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

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

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

**(2)**

(ii)     Suggest how the local council could increase the percentage of used steel cans that are recycled.

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

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**(1)**

**(Total 8 marks)**

**Q11.** The picture shows a wooden bowl. The pieces of wood used for this bowl were dyed different colours.



The artist who made the bowl explained why he dissolved the coloured dyes in methanol.

|  |
| --- |
| I use different coloured dyes dissolved in methanol  I use methanol because with dyes dissolved in water the wood needs to be soaked for a longer time. The bowl dries more quickly if I use methanol instead of water. |

(a)     The artist uses methanol instead of water.Give **two** reasons why.

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

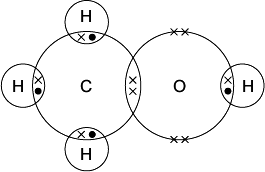
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2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

(b)     The diagram shows how the atoms are bonded in methanol.



Draw a ring around:

(i)      the formula of methanol

|  |  |  |
| --- | --- | --- |
| **CH4O** | **CH4O** | **CHO4** |

**(1)**

(ii)     the type of bonding in methanol.

|  |  |  |
| --- | --- | --- |
| **covalent** | **ionic** | **metallic** |

**(1)**

(c)     Methanol has a low boiling point.

Tick () the reason why.

|  |  |
| --- | --- |
| **Reason why** | **Tick ()** |
| It has a giant covalent structure. |  |
| It is made of small molecules. |  |
| It has a giant metallic structure. |  |

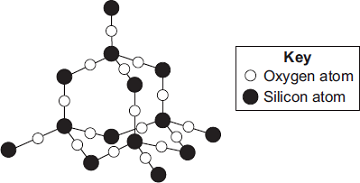
**(1)**

**(Total 5 marks)**

**Q12.** Silicon dioxide is used as a lining for furnaces.Furnaces can be used to melt iron for recycling.



The diagram shows a small part of the structure of silicon dioxide.



Explain why silicon dioxide is a suitable material for lining furnaces.

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

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**(Total 4 marks)**

**Q13.** This question is about the properties and uses of materials.Use your knowledge of structure and bonding to answer the questions.

(a)     Explain how copper conducts electricity.

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

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**(2)**

(b)     Explain why diamond is hard.

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

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**(2)**

(c)     Explain why thermosetting polymers are better than thermosoftening polymers for saucepan handles.

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

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**(2)**

**(Total 6 marks)**

**Q14.** The article gives some information about graphene.

|  |
| --- |
| Nanotunes!    Carbon can be made into nano-thin, strong sheets called graphene.  A graphene sheet is a single layer of graphite.  Graphene conducts electricity and is used in loudspeakers.  The picture shows the structure of graphene. |

(a)     Use the picture and your knowledge of bonding in graphite to:

(i)      explain why graphene is strong;

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

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**(3)**

(ii)     explain why graphene can conduct electricity.

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**(2)**

(b)     Graphite is made up of layers of graphene. Explain why graphite is a lubricant.

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**(2)**

**(Total 7 marks)**

**Q1.**This question is about carbon and gases in the air.

(a)     Carbon atoms have protons, neutrons and electrons.

Complete the table by writing the relative mass of a neutron and an electron.

|  |  |
| --- | --- |
| **Name of particle** | **Relative mass** |
| proton | 1 |
| neutron |  |
| electron |  |

**(2)**

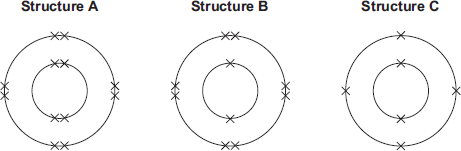
(b)     What is the total number of protons and neutrons in an atom called?

|  |  |
| --- | --- |
| Tick () **one** box. | |
| The atomic number |  |
| The mass number |  |
| One mole of the atom |  |

**(1)**

(c)     An atom of carbon has six electrons.

Which structure, **A, B** or **C**, represents the electronic structure of the carbon atom?



|  |  |
| --- | --- |
| The carbon atom is structure |  |

**(1)**

(d)     Carbon reacts with oxygen to produce carbon dioxide (CO2).

(i)      How many different elements are in one molecule of carbon dioxide?

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

**(1)**

(ii)     What is the total number of atoms in one molecule of carbon dioxide?

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**(1)**

(e)     Sometimes carbon reacts with oxygen to produce carbon monoxide (CO).

(i)      Calculate the relative formula mass (*M*r) of carbon monoxide.

Relative atomic masses (*A*r): C = 12; O = 16

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*Mr* of carbon monoxide = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(ii)     Calculate the percentage by mass of carbon in carbon monoxide.

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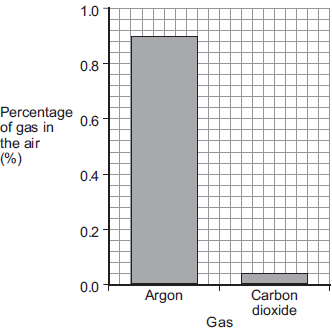
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Percentage by mass of carbon in carbon monoxide = \_\_\_\_\_%

**(1)**

(f)     Carbon dioxide is one of the gases in the air.

(i)      The graph shows the percentage of argon and the percentage of carbon dioxide in the air.



What is the percentage of argon in the air?

Percentage of argon = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ %

**(1)**

(ii)     An instrumental method is used to measure the amount of carbon dioxide in the air. Give **one** reason for using an instrumental method.

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

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**(1)**

**(Total 10 marks)**

**Q2.** Citric acid is a weak acid.

(a)     Explain what is meant by a weak acid.

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**(2)**

A student titrated citric acid with sodium hydroxide solution. This is the method used.

1. Pipette 25.0 cm3 of sodium hydroxide solution into a conical flask.

2. Add a few drops of thymol blue indicator to the sodium hydroxide solution.

    Thymol blue is blue in alkali and yellow in acid.

3. Add citric acid solution from a burette until the end-point was reached.

(b)     Explain what would happen at the end-point of this titration. Refer to the acid, the alkali and the indicator in your answer.

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**(3)**

(c)     Explain why a pipette is used to measure the sodium hydroxide solution but a burette is used to measure the citric acid solution

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**(2)**

(d)     The table shows the student’s results.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Titration 1** | **Titration 2** | **Titration 3** | **Titration 4** | **Titration 5** |
| Volume of citric acid solution in cm3 | 13.50 | 12.10 | 11.10 | 12.15 | 12.15 |

The equation for the reaction is:

C6H8O7 + 3 NaOH ⟶ C6H5O7Na3 + 3 H2O

The concentration of the sodium hydroxide was 0.102 mol / dm 3

Concordant results are those within 0.10 cm 3 of each other. Calculate the concentration of the citric acid in mol / dm 3. Use only the concordant results from the table in your calculation.

You must show your working.

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Concentration = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mol / dm 3

**(5)**

**(Total 12 marks)**

**Q3.**A student investigated the reactions of copper carbonate and copper oxide with dilute hydrochloric acid.

In both reactions one of the products is copper chloride.

(a)     Describe how a sample of copper chloride crystals could be made from copper carbonate and dilute hydrochloric acid.

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**(4)**

(b)     A student wanted to make 11.0 g of copper chloride.

The equation for the reaction is:

                             CuCO3 + 2HCl  →  CuCl2 + H2O + CO2

Relative atomic masses, *A*r: H = 1; C = 12; O = 16; Cl = 35.5; Cu = 63.5

Calculate the mass of copper carbonate the student should react with dilute hydrochloric acid to make 11.0 g of copper chloride.

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Mass of copper carbonate = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(4)**

(c)     The percentage yield of copper chloride was 79.1 %.

Calculate the mass of copper chloride the student actually produced.

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

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Actual mass of copper chloride produced = \_\_\_\_\_\_\_\_\_\_\_\_ g

**(2)**

(d)     Look at the equations for the two reactions:

   Reaction 1        CuCO3(s) + 2HCl(aq)  →  CuCl2(aq) + H2O(l) + CO2(g)

   Reaction 2             CuO(s) + 2HCl(aq)  →  CuCl2(aq) + H2O(l)

Reactive formula masses: CuO = 79.5; HCl = 36.5; CuCl2 = 134.5; H2O = 18

The percentage atom economy for a reaction is calculated using:



Calculate the percentage atom economy for Reaction 2.

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

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Percentage atom economy = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ %

**(3)**

(e)     The atom economy for Reaction 1 is 68.45 %.

Compare the atom economies of the two reactions for making copper chloride. Give a reason for the difference.

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**(1)**

**(Total 14 marks)**

**Q4.** Cobalt forms coloured compounds.

A pink cobalt compound reacts with hydrochloric acid. The reaction can be represented as:

pink cobalt compound + hydrochloric acid ⇌ blue cobalt compound + water

The forward reaction is endothermic. When both cobalt compounds are present in a solution at equilibrium, the equilibrium mixture is purple.

(a)     What is meant by equilibrium?

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

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**(2)**

(b)     The equilibrium mixture is cooled.

Explain what happens to the concentration of the pink cobalt compound.

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**(3)**

(c)     More hydrochloric acid is added.

Explain what happens to the colour of the equilibrium mixture

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**(3)**

(d)     Why does cobalt form different coloured compounds?

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**(1)**

(e)     An oxide of cobalt has the formula Co2O3

Which cobalt ion is present in this oxide?

Tick (✔) **one** box.

|  |  |
| --- | --- |
| Co+ |  |
| Co2+ |  |
| Co3+ |  |
| Co4+ |  |

**(1)**

(f)      Cobalt compounds can act as catalysts.

Which two statements about cobalt compounds are correct?

Tick (✔) **two** boxes.

|  |  |
| --- | --- |
| They allow reactions to reach equilibrium more quickly. |  |
| They are reactants in reactions catalysed by cobalt compounds. |  |
| They are used up when acting as catalysts. |  |
| They increase the equilibrium yield of reactions. |  |
| They provide a different reaction pathway. |  |

**(2)**

(g)     The reaction of hydrogen with carbon monoxide is catalysed by cobalt metal.

Balance the equation for the reaction.

H2  +  CO  ⟶  C6H14  +  H2O

**(1)**

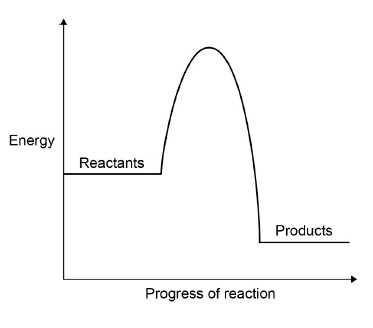
(h)     C6H14 is an alkane.

What is the formula of an alkane containing 18 hydrogen atoms?

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

**(1)**

(i)      The graph shows a reaction profile diagram for a reaction **without** a catalyst.



On the graph:

•   draw the reaction profile diagram for a catalysed reaction

•   draw and label an arrow to show the activation energy for the reaction **without** a catalyst.

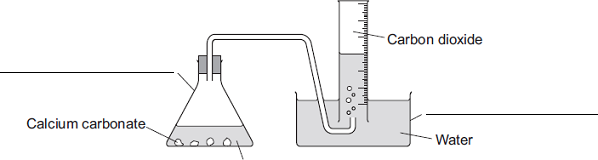
**(2)**

**(Total 16 marks)**

**Q5.** Some students were investigating the rate at which carbon dioxide gas is produced when metal carbonates react with an acid. One student reacted 1.00 g of calcium carbonate with 50 cm3, an excess, of dilute hydrochloric acid.

The apparatus used is shown in **Diagram 1**.

**Diagram 1**

****Dilute hydrochloric acid

(a)     Complete the **two** labels for the apparatus on the diagram.

**(2)**

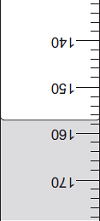
(b)     The student measured the volume of gas collected every 30 seconds.

The table shows the student’s results.

|  |  |
| --- | --- |
| **Time in seconds** | **Volume of carbon dioxide collected in cm3** |
| 30 | 104 |
| 60 |  |
| 90 | 198 |
| 120 | 221 |
| 150 | 232 |
| 180 | 238 |
| 210 | 240 |
| 240 | 240 |

(i)      **Diagram 2** shows what the student saw at 60 seconds.

**Diagram 2**

****

What is the volume of gas collected?

Volume of gas = \_\_\_\_\_\_\_\_\_\_ cm3

**(1)**

(ii)     Why did the volume of gas stop changing after 210 seconds?

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**(1)**

(c)     Another student placed a conical flask containing 1.00 g of a Group 1 carbonate (M2CO3) on a balance. He then added 50 cm3, an excess, of dilute hydrochloric acid to the flask and measured the mass of carbon dioxide given off.The equation for the reaction is:

M2CO3 + 2HCl    2MCl + H2O + CO2

The final mass of carbon dioxide given off was 0.32 g.

(i)      Calculate the amount, in moles, of carbon dioxide in 0.32 g carbon dioxide.

Relative atomic masses (*A*r): C = 12; O = 16

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Moles of carbon dioxide = \_\_\_\_\_\_\_\_\_\_ moles

**(2)**

(ii)     How many moles of the metal carbonate are needed to make this number of moles of carbon dioxide?

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

Moles of metal carbonate = \_\_\_\_\_\_\_\_\_\_ moles

**(1)**

(iii)    The mass of metal carbonate used was 1.00 g.

Use this information, and your answer to part **(c) (ii)**, to calculate the relative formula mass (*M*r) of the metal carbonate.

If you could not answer part **(c) (ii)**, use 0.00943 as the number of moles of metal carbonate. This is **not** the answer to part **(c) (ii)**.

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Relative formula mass (*M*r) of metal carbonate = \_\_\_\_\_\_\_\_\_\_

**(1)**

(iv)    Use your answer to part **(c) (iii)** to calculate the relative atomic mass (*A*r) of the metal in the metal carbonate (M2CO3) and so identify the Group 1 metal in the metal carbonate.

If you could not answer part **(c) (iii)**, use 230 as the relative formula mass of the metal carbonate. This is **not** the answer to part **(c) (iii)**.

To gain full marks, you must show your working.

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Relative atomic mass of metal is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Identity of metal \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(3)**

(d)     Two other students repeated the experiment in part **(c)**.

(i)      When the first student did the experiment some acid sprayed out of the flask as the metal carbonate reacted. Explain the effect this mistake would have on the calculated relative atomic mass of the metal.

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**(3)**

(ii)     The second student used 100 cm3 of dilute hydrochloric acid instead of 50 cm3.

Explain the effect, if any, this mistake would have on the calculated relative atomic mass of the metal.

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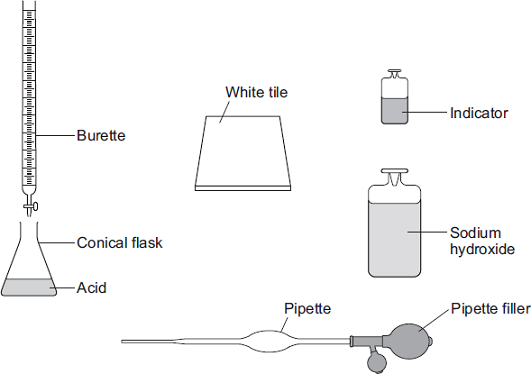
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**(3)**

**(Total 17 marks)**

**Q6.** *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

A student used the equipment shown to do a titration.



Describe how the student should use this equipment to find the volume of sodium hydroxide solution that reacts with a known volume of acid.  
Include any measurements the student should make.

Do **not** describe how to do any calculations.

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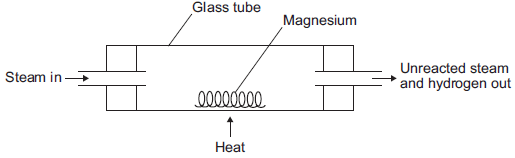
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**(Total 6 marks)**

**Q7.** Magnesium reacts with steam to produce hydrogen gas and magnesium oxide.

A teacher demonstrated the reaction to a class. The figure below shows the apparatus the teacher used.



(a)     (i)      The hydrogen produced was collected. Describe how to test the gas to show that it is hydrogen.

Test \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**(2)**

(ii)     Explain why the magnesium has to be heated to start the reaction.

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**(2)**

(b)     The equation for the reaction is:

Mg(s) + H2O(g)  MgO(s) + H2(g)

(i)      The teacher used 1.00 g of magnesium.

Use the equation to calculate the maximum mass of magnesium oxide produced.

Give your answer to three significant figures.

Relative atomic masses (*A* r): O = 16; Mg = 24

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Maximum mass = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(3)**

(ii)     The teacher’s demonstration produced 1.50 g of magnesium oxide.

Use your answer from part (b)(i) to calculate the percentage yield.

If you could not answer part (b)(i), use 1.82 g as the maximum mass of magnesium oxide. This is **not** the answer to part (b)(i).

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

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

**(2)**

(iii)    Give **one** reason why the percentage yield is less than 100%.

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

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**(1)**

**(Total 10 marks)**

**Q8.** The Haber Process is used to produce ammonia from nitrogen and hydrogen.The equation for the reaction is:

N2  +  3H2  ⇌  2NH3

(a)     An ammonia molecule has the formula NH3, How many atoms are there in one molecule of ammonia?Tick (✔) **one** box.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2 |  |  | 3 |  |  | 4 |  |  | 6 |  |

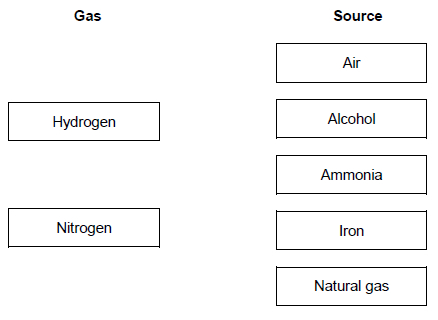
**(1)**

(b)     What does the symbol ⇌ mean?

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

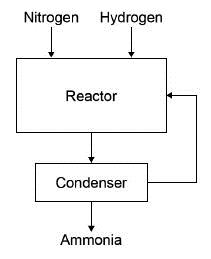
**(1)**

(c)     Draw **one** line from each gas to the source of that gas.



**(2)**

The diagram shows the Haber process.



A mixture of ammonia, hydrogen and nitrogen gases leave the reactor.

**Table 1** shows the boiling points of the gases.

|  |  |
| --- | --- |
| **Table 1** | |
| **Gas** | **Boiling point in °C** |
| Ammonia | – 33 |
| Nitrogen | – 196 |
| Hydrogen | – 253 |

(d)     The mixture is cooled to a temperature at which **only** the ammonia condenses to a liquid.

Which temperature could be used?

Tick (✔) **one** box.

|  |  |
| --- | --- |
| − 20 °C |  |
| − 40 °C |  |
| − 200 °C |  |
| − 260 °C |  |

**(1)**

(e)     What happens to the unreacted nitrogen?

Tick (✔) **one** box.

|  |  |
| --- | --- |
| Collected and sold |  |
| Recycled to the reactor |  |
| Released into the air |  |
| Used as a catalyst |  |

**(1)**

Ammonia from the Haber process can be used to produce fertilisers.

**Table 2** gives information about two compounds used in fertilisers.

|  |  |  |
| --- | --- | --- |
| **Table 2** | | |
| **Fertiliser** | **Compound** | **Cost in £ / kg** |
| A | Potassium chloride | 0.24 |
| B | Diammonium phosphate | 0.35 |

(f)      What type of bonding is present in potassium chloride? Tick (✔) **one** box.

|  |  |
| --- | --- |
| Covalent |  |
| Ionic |  |
| Metallic |  |

**(1)**

(g)     Diammonium phosphate has the chemical formula (NH4)2HPO4. Which **two** elements in (NH4)2HPO4 improve agricultural productivity?

Tick (✔) **two** boxes.

|  |  |
| --- | --- |
| Chlorine |  |
| Hydrogen |  |
| Nitrogen |  |
| Oxygen |  |
| Phosphorus |  |

A farmer uses fertilisers **A** and **B** on a field with an area of 0.05 km2

**(2)**

(h)     50 kg of fertiliser A will cover an area of 0.01 km2

Calculate the cost of fertilising a field with an area of 0.05 km2 with fertiliser **A**.

Use **Table 2**.

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Cost = £ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(i)      Fertiliser **B** is more expensive than fertiliser **A**. Suggest why the farmer uses **both** fertilisers.

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**(1)**

**(Total 12 marks)**

**Q9.** Sodium hydroxide neutralises sulfuric acid.The equation for the reaction is:

                 2NaOH + H2SO4  →  Na2SO4 + 2H2O

(a)     Sulfuric acid is a strong acid. What is meant by a strong acid?

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**(2)**

(b)     Write the ionic equation for this neutralisation reaction. Include state symbols.

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**(2)**

(c)     A student used a pipette to add 25.0 cm3 of sodium hydroxide of unknown concentration to a conical flask. The student carried out a titration to find out the volume of 0.100 mol / dm3 sulfuric acid needed to neutralise the sodium hydroxide. Describe how the student would complete the titration.

You should name a suitable indicator and give the colour change that would be seen.

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**(4)**

(d)     The student carried out five titrations. Her results are shown in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Titration 1 | Titration 2 | Titration 3 | Titration 4 | Titration 5 |
| Volume of 0.100 mol / dm3 sulfuric acid in cm3 | 27.40 | 28.15 | 27.05 | 27.15 | 27.15 |

**Concordant results** are within 0.10 cm3 of each other. Use the student’s concordant results to work out the mean volume of 0.100 mol / dm3 sulfuric acid added.

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

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Mean volume = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cm3

**(2)**

(e)     The equation for the reaction is:

                               2NaOH + H2SO4  →  Na2SO4 + 2H2O

Calculate the concentration of the sodium hydroxide. Give your answer to three significant figures.

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

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Concentration = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mol / dm3

**(4)**

(f)     The student did another experiment using 20 cm3 of sodium hydroxide solution with a concentration of 0.18 mol / dm3.

Relative formula mass (*M*r) of NaOH = 40

Calculate the mass of sodium hydroxide in 20 cm3 of this solution.

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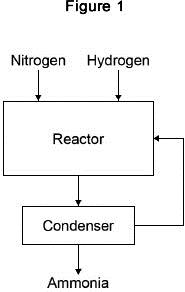
Mass = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(2)**

**(Total 16 marks)**

**Q10.** Nitrogen and hydrogen react to produce ammonia in the Haber process.

**Figure 1** shows the Haber process.



A gaseous mixture of ammonia, hydrogen and nitrogen leaves the reactor. **Table 1** shows the boiling points of the gases.

|  |  |
| --- | --- |
| **Table 1** | |
| **Gas** | **Boiling point in °C** |
| Ammonia | −33 |
| Nitrogen | −196 |
| Hydrogen | −253 |

(a)     Suggest how ammonia is separated from the other gases.

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

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**(2)**

(b)     What happens to the unreacted hydrogen and nitrogen?

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**(1)**

The equation for the reaction is:

N2(g)  +  3H2(g)  ⇌  2NH3(g)

The forward reaction is exothermic.

(c)     Calculate the volume of ammonia produced from the complete reaction of 825 dm 3 of hydrogen.

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Volume of ammonia = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ dm 3

**(2)**

(d)     The Haber process uses a temperature of 450 °C and a pressure of 200 atmospheres. Why are these conditions used? Tick **two** boxes.

|  |  |
| --- | --- |
| A higher pressure is maintained using less energy |  |
| A higher temperature would increase the equilibrium yield |  |
| A lower pressure would decrease the equilibrium yield |  |
| A lower temperature would make the reaction too slow |  |
| There are more product molecules than reactant molecules |  |

**(2)**

Most of the ammonia produced is used to make fertilisers.

**Table 2** shows information about compounds used as fertilisers.

|  |  |  |
| --- | --- | --- |
| **Table 2** | | |
| **Compound** | **Formula** | **Cost in £ / tonne** |
| **A** | NH4NO3 | 220 |
| **B** | (NH4)2HPO4 | 350 |
| **C** | KCl | 235 |

(e)     Which element in compound A improves agricultural productivity?

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

**(1)**

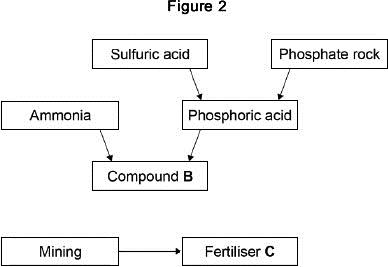
(f)      Which **two** compounds can be mixed to make a fertiliser containing three elements that improve agricultural productivity? Give a reason why you have chosen these compounds.

Compounds \_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_

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

**(2)**

(g)     **Figure 2** shows a flow chart for the production of compounds B and C.



Suggest **two** possible reasons for the difference in cost between compounds **B** and **C**.

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

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

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**(2)**

**(Total 12 marks)**

**Q1.** Lithium carbonate reacts with dilute hydrochloric acid.A group of students investigated the volume of gas produced.This is the method used.

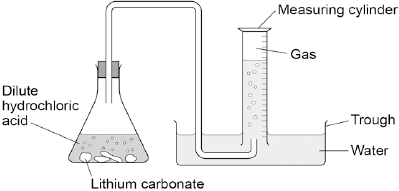
1.       Place a known mass of lithium carbonate in a conical flask.

2.       Measure 10 cm3 of dilute hydrochloric acid using a measuring cylinder.

3.       Pour the acid into the conical flask.

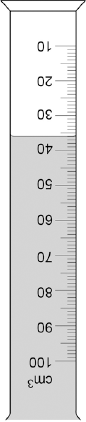
4.       Place a bung in the flask and collect the gas as shown in **Figure 1**.

**Figure 1**

****

(a)     **Figure 2** shows the measuring cylinder.

**Figure 2**

****

What volume of gas has been collected?

Volume = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cm3

**(1)**

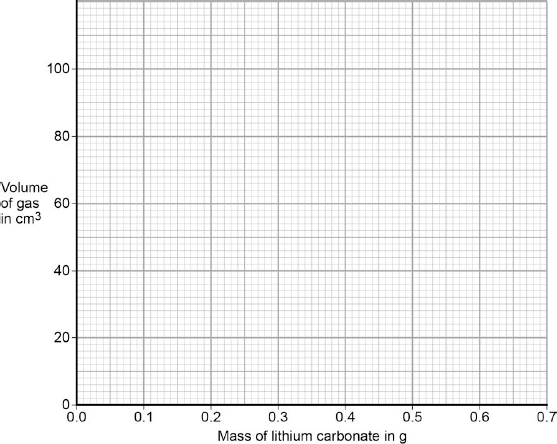
(b)     The table below shows the students’ results.

|  |  |
| --- | --- |
| **Mass of lithium carbonate in g** | **Volume of gas in cm3** |
| 0.0 | 0 |
| 0.1 | 22 |
| 0.2 | 44 |
| 0.3 | 50 |
| 0.4 | 88 |
| 0.5 | 96 |
| 0.6 | 96 |
| 0.7 | 96 |

On **Figure 3**:

•        Plot these results on the grid.

•        Complete the graph by drawing **two** straight lines of best fit.

****

**(4)**

(c)     What are **two** possible reasons for the anomalous result?

|  |  |
| --- | --- |
| Tick **two** boxes. |  |
| Too much lithium carbonate was added. |  |
| The bung was not pushed in firmly enough. |  |
| There was too much water in the trough. |  |
| The measuring cylinder was not completely over the delivery |  |
| The conical flask was too small. |  |

**(2)**

(d)     Describe the pattern the graph shows up to 0.4 g of lithium carbonate added.

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**(2)**

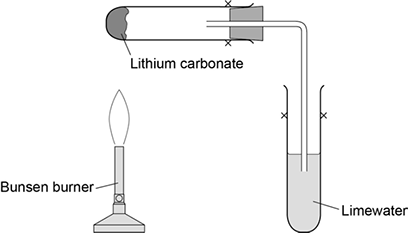
(e)     Lithium carbonate decomposes when heated.

The equation shows the decomposition of lithium carbonate.

Li2CO3 (s)   →   Li2O (s)   +   CO2 (g)

**Figure 4** shows the apparatus a student used to decompose lithium carbonate.

**Figure 4**

****

Why does the limewater bubble?

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

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**(1)**

(f)     The student repeated the experiment with potassium carbonate.

The limewater did not bubble.

Suggest why there were **no** bubbles in the limewater.

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**(1)**

**(Total 11 marks)**

**Q2.** This question is about metal oxides.

When sodium is heated in oxygen, sodium oxide is produced.

(a)     Balance the equation for the reaction.

\_\_\_\_\_\_\_  Na  +  O2  ⟶  2  Na2O

**(1)**

(b)     Why is this an oxidation reaction?

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

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**(1)**

(c)     Sodium oxide is added to water and shaken. Universal indicator is added.

The pH of the solution is 14. What is the colour of the universal indicator?

Tick (✔) **one** box.

|  |  |
| --- | --- |
| Green |  |
| Purple |  |
| Red |  |
| Yellow |  |

**(1)**

(d)     Aluminium oxide reacts with hydrochloric acid to produce a salt. What is the name of the salt produced?

Tick (✔) **one** box.

|  |  |
| --- | --- |
| Aluminium chloride |  |
| Aluminium nitrate |  |
| Aluminium sulfate |  |
| Aluminium sulfide |  |

**(1)**

A student investigates the solubility of four metal oxides and four non-metal oxides in water. The student tests the pH of the solutions formed. The table shows the student’s results.

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of oxide** | **Oxide** | **Solubility in water** | **pH of solution** |
| Metal oxides | Sodium oxide | Soluble | 14 |
| Calcium oxide | Soluble | 10 |
| Magnesium oxide | Slightly soluble | 9 |
| Zinc oxide | Insoluble | No solution formed |
| Non-metal oxides | Carbon dioxide | Soluble | 5 |
| Sulfur dioxide | Soluble | 2 |
| Phosphorus oxide | Soluble | 1 |
| Silicon dioxide | Insoluble | No solution formed |

The student makes two conclusions.

**Conclusion 1:** ‘All metal oxides produce alkaline solutions.’

**Conclusion 2:** ‘All non-metal oxides produce acidic solutions.’

(e)     Explain why the student’s conclusions are only partly correct. Use information from the table above.

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**(4)**

(f)      Give an improved conclusion for metal oxides. Use the table above.

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**(2)**

**(Total 9 marks)**

**Q3.** A scientist produces zinc iodide (ZnI2).This is the method used.

1. Weigh 0.500 g of iodine.

2. Dissolve the iodine in ethanol.

3. Add an excess of zinc.

4. Stir the mixture until there is no further change.

5. Filter off the excess zinc.

6. Evaporate off the ethanol.

(a)     Ethanol is flammable.Suggest how the scientist could carry out **Step 6** safely.

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**(1)**

(b)     Explain why the scientist adds excess zinc rather than excess iodine.

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**(3)**

(c)     Calculate the minimum mass of zinc that needs to be added to 0.500 g of iodine so that the iodine fully reacts. The equation for the reaction is:

Zn + I2 ⟶ ZnI2

Relative atomic masses (*M*r): Zn = 65  I = 127

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Minimum mass of zinc = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(3)**

A different scientist makes zinc iodide by the same method. The scientist obtains 12.5 g of zinc iodide.The percentage yield in this reaction is 92.0%.

(d)     What is the maximum theoretical mass of zinc iodide produced in this reaction?

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Maximum theoretical mass = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(3)**

(e)     Suggest **one** reason why the percentage yield in this reaction is **not** 100%.

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**(1)**

(f)      The scientist makes a solution of zinc iodide with a concentration of 0.100 mol / dm3

Calculate the mass of zinc iodide (ZnI2) required to make 250 cm3 of this solution.

Relative atomic masses (*A*r): Zn = 65 I = 127

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Mass = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(3)**

**(Total 14 marks)**

**Q4.** This question is about compounds.

(a)    The table gives information about the solubility of some compounds.

|  |
| --- |
| **Soluble compounds** |
| All potassium and sodium salts |
| All nitrates |
| Chlorides, bromides and iodides, except those of silver and lead |

Use information from the table to answer these questions.

(i)      Name a soluble compound that contains silver ions.

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

**(1)**

(ii)     Name a soluble compound that contains carbonate ions.

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

**(1)**

(b)     Metal oxides react with acids to make salts. What type of compound is a metal oxide?

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**(1)**

(c)     Lead nitrate solution is produced by reacting lead oxide with nitric acid.

(i)      State how solid lead nitrate can be obtained from lead nitrate solution.

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

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**(1)**

(ii)     Balance the equation for the reaction.

         PbO       +       HNO3             Pb(NO3)2      +       H2O

**(1)**

(iii)    Give the total number of atoms in the formula Pb(NO3)2

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

**(1)**

(d)     An oxide of lead that does **not** have the formula PbO contains 6.21 g of lead and 0.72 g of oxygen.

Calculate the empirical formula of this lead oxide.

Relative atomic masses (*A*r): O = 16; Pb = 207

You must show your working to gain full marks.

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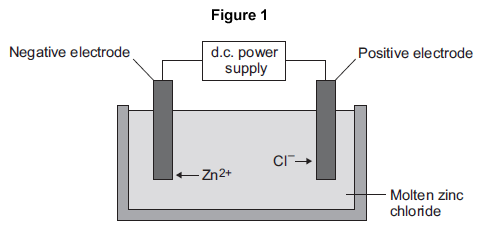
Empirical formula = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(4)**

**(Total 10 marks)**

**Q5.** This question is about zinc.

**Figure 1** shows the electrolysis of molten zinc chloride.



(a)     Zinc chloride is an ionic substance. Complete the sentence.

When zinc chloride is molten, it will conduct \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .

**(1)**

(b)     Zinc ions move towards the negative electrode where they gain electrons to produce zinc.

(i)      Name the product formed at the positive electrode.

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

**(1)**

(ii)     Explain why zinc ions move towards the negative electrode.

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**(2)**

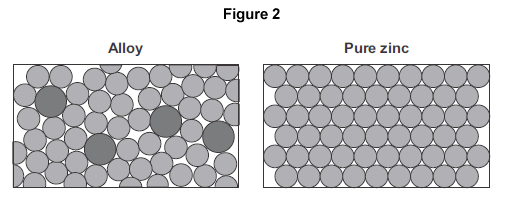
(iii)    What type of reaction occurs when the zinc ions gain electrons?

|  |  |
| --- | --- |
| Tick (✔) **one** box. |  |
| Neutralisation |  |
| Oxidation |  |
| Reduction |  |

**(1)**

(c)     Zinc is mixed with copper to make an alloy.

(i)      **Figure 2** shows the particles in the alloy and in pure zinc.



Use **Figure 2** to explain why the alloy is harder than pure zinc.

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**(2)**

(ii)     Alloys can be bent. Some alloys return to their original shape when heated.

What name is used for these alloys?

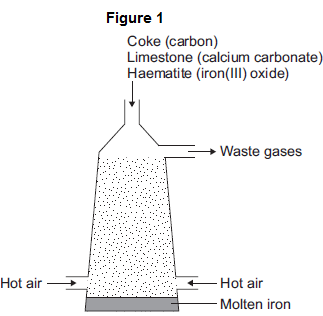
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**(1)**

**(Total 8 marks)**

**Q6.**This question is about iron and aluminium.

(a)     Iron is extracted in a blast furnace. **Figure 1** is a diagram of a blast furnace.



(i)      Calcium carbonate decomposes at high temperatures.

Complete the word equation for the decomposition of calcium carbonate.

calcium carbonate  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ +

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

**(2)**

(ii)     Carbon burns to produce carbon dioxide. The carbon dioxide produced reacts with more carbon to produce carbon monoxide. Balance the equation.

C(s)     +     CO2(g)          \_\_\_\_\_ CO(g)

**(1)**

(iii)    Carbon monoxide reduces iron(III) oxide:

Fe2O3(s) + 3 CO(g)  2 Fe(s) + 3 CO2(g)

Calculate the maximum mass of iron that can be produced from 300 tonnes of iron(III) oxide.

Relative atomic masses (*A*r): O = 16; Fe = 56

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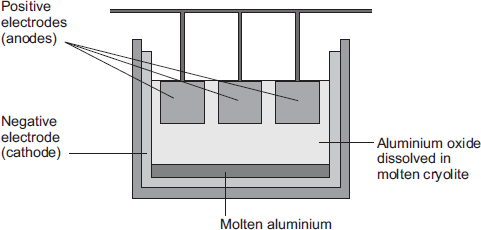
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Maximum mass = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ tonnes

**(3)**

(b)     Aluminium is extracted by electrolysis, as shown in **Figure 2**.

**Figure 2**

****

(i)      Why can aluminium **not** be extracted by heating aluminium oxide with carbon?

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**(1)**

(ii)     Explain why aluminium forms at the negative electrode during electrolysis.

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**(3)**

(iii)    Explain how carbon dioxide forms at the positive electrodes during electrolysis.

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**(3)**

**(Total 13 marks)**

**Q7.** Sodium carbonate reacts with dilute hydrochloric acid:

                   Na2CO3 + 2HCl  →  2NaCl + H2O + CO2

A student investigated the volume of carbon dioxide produced when different masses of sodium carbonate were reacted with dilute hydrochloric acid. This is the method used.

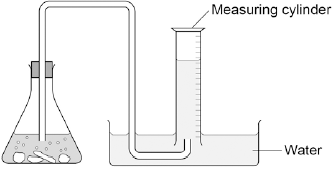
1.        Place a known mass of sodium carbonate in a conical flask.

2.        Measure 10 cm3 of dilute hydrochloric acid using a measuring cylinder.

3.        Pour the acid into the conical flask.

4.        Place a bung in the flask and collect the gas until the reaction is complete.

(a)     The student set up the apparatus as shown in the figure below.



Identify the error in the way the student set up the apparatus.

Describe what would happen if the student used the apparatus shown.

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**(2)**

(b)     The student corrected the error. The student’s results are shown in the table below.

|  |  |
| --- | --- |
| **Mass of sodium carbonate in g** | **Volume of carbon dioxide gas  in cm3** |
| 0.07 | 16.0 |
| 0.12 | 27.5 |
| 0.23 | 52.0 |
| 0.29 | 12.5 |
| 0.34 | 77.0 |
| 0.54 | 95.0 |
| 0.59 | 95.0 |
| 0.65 | 95.0 |

The result for 0.29 g of sodium carbonate is anomalous. Suggest what may have happened to cause this anomalous result.

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**(1)**

(c)     Why does the volume of carbon dioxide collected stop increasing at 95.0 cm3?

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**(1)**

(d)     What further work could the student do to be more certain about the minimum mass of sodium carbonate needed to produce 95.0 cm3 of carbon dioxide?

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**(1)**

(e)     The carbon dioxide was collected at room temperature and pressure.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm3. How many moles of carbon dioxide is 95.0 cm3? Give your answer in three significant figures.

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\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ mol

**(2)**

(f)     Suggest **one** improvement that could be made to the apparatus used that would give more accurate results. Give a reason for your answer.

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**(2)**

(g)     One student said that the results of the experiment were wrong because the first few bubbles of gas collected were air.

A second student said this would make no difference to the results.

Explain why the second student was correct.

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**(2)**

**(Total 11 marks)**

**Q8.** This question is about magnesium and magnesium chloride.

(a)     Magnesium chloride contains magnesium ions (Mg2+) and chloride ions (Cl⁻).

Describe, in terms of electrons, what happens when a magnesium atom reacts with chlorine atoms to produce magnesium chloride.

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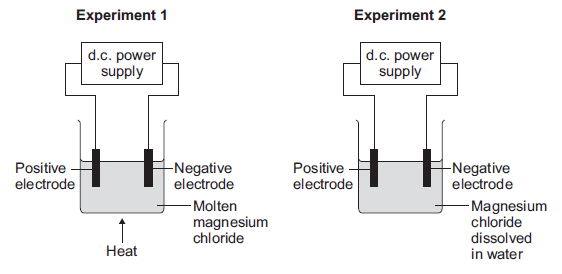
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**(4)**

(b)     Magnesium chloride can be electrolysed.

The diagram below shows two experiments for electrolysing magnesium chloride.



(i)      Explain why magnesium chloride must be molten or dissolved in water to be electrolysed.

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**(2)**

(ii)     Explain how magnesium is produced at the negative electrode in **Experiment 1**.

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**(3)**

(iii)    In **Experiment 2** a gas is produced at the negative electrode.

Name the gas produced at the negative electrode.

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**(1)**

(iv)     Suggest why magnesium is **not** produced at the negative electrode in **Experiment 2**.

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**(1)**

(v)     Complete and balance the half equation for the reaction at the positive electrode.

\_\_\_\_\_ Cl⁻       →       Cl2       +       \_\_\_\_\_

**(1)**

(c)     Magnesium is a metal. Explain why metals can be bent and shaped.

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**(2)**

**(Total 14 marks)**

**Q9.**Rock salt is a mixture of sand and salt. Salt dissolves in water. Sand does **not** dissolve in water.

Some students separated rock salt. This is the method used.

1.      Place the rock salt in a beaker.

2.      Add 100 cm3 of cold water.

3.      Allow the sand to settle to the bottom of the beaker.

4.      Carefully pour the salty water into an evaporating dish.

5.      Heat the contents of the evaporating dish with a Bunsen burner until salt crystals start to form.

(a)     Suggest **one** improvement to step 2 to make sure all the salt is dissolved in the water.

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**(1)**

(b)     The salty water in step 4 still contained very small grains of sand.

Suggest **one** improvement to step 4 to remove all the sand.

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**(1)**

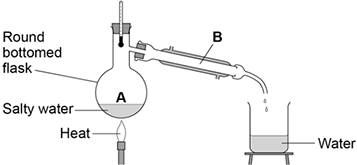
(c)     Suggest **one** safety precaution the students should take in step 5.

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**(1)**

(d)     Another student removed water from salty water using the apparatus in the figure below.



Describe how this technique works by referring to the processes at **A** and **B**.

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**(2)**

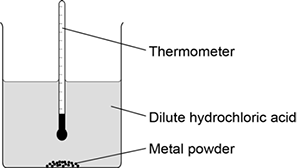
(e)     What is the reading on the thermometer during this process?

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

**(1)**

**(Total 6 marks)**

**Q10.** A student investigated the reactivity of different metals.The student used the apparatus shown in the figure below.



The student used four different metals. The student measured the temperature rise for each metal three times. The student’s results are shown in the table below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Metal** | **Temperature rise in °C** | | | **Mean temperature rise in °C** |
| Test 1 | Test 2 | Test 3 |
| **Calcium** | 17.8 | 16.9 | 17.5 |  |
| **Iron** | 6.2 | 6.0 | 6.1 | 6.1 |
| **Magnesium** | 12.5 | 4.2 | 12.3 | 12.4 |
| **Zinc** | 7.8 | 8.0 | 7.6 | 7.8 |

(a)     Give **two** variables the student should control so that the investigation is a fair test.

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

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

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**(2)**

(b)     One of the results for magnesium is anomalous. Which result is anomalous? Suggest **one** reason why this anomalous result was obtained.

Result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

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**(2)**

(c)     Calculate the mean temperature rise for calcium.

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Mean temperature rise = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ °C

**(1)**

(d)     The temperature rose when the metals were added to sulfuric acid.

Give **one** other observation that might be made when the metal was added to sulfuric acid.

How would this observation be different for the different metals?

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**(2)**

(e)     Aluminium is more reactive than iron and zinc but less reactive than calcium and magnesium. Predict the temperature rise when aluminium is reacted with dilute hydrochloric acid.

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

Temperature rise = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ °C

**(1)**

**(Total 8 marks)**

**Q11.**A student makes a hypothesis:

‘When different salt solutions are electrolysed with inert electrodes, the product at the negative electrode is always a metal’.

(a)     Describe how you would test this hypothesis in the laboratory. You should:

•   draw a labelled diagram of the apparatus

•   give the independent variable

•   describe what you would see at the negative electrode if the hypothesis is true.

Diagram

Independent variable

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

Observation

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

**(5)**

(b)     The student’s hypothesis is only partially correct.Explain why the product at the negative electrode is not always a metal.

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

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

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

**(2)**

(c)     Predict the product at the positive electrode in the electrolysis of:

•   sodium chloride solution

•   copper sulfate solution.

Sodium chloride solution \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Copper sulfate solution \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

**(Total 9 marks)**

**Q12.** A student investigated the reactivity of three different metals.

This is the method used.

1.       Place 1 g of metal powder in a test tube.

2.       Add 10 cm3 of metal sulfate.

3.       Wait 1 minute and observe.

4.       Repeat using the other metals and metal sulfates.

The student placed a tick in the table below if there was a reaction and a cross if there was no reaction.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Zinc** | **Copper** | **Magnesium** |
| **Copper sulfate** |  |  |  |
| **Magnesium sulfate** |  |  |  |
| **Zinc sulfate** |  |  |  |

(a)     What is the dependent variable in the investigation?

|  |  |
| --- | --- |
| Tick **one** box. |  |
| Time taken |  |
| Type of metal |  |
| Volume of metal sulfate |  |
| Whether there was a reaction or not |  |

**(1)**

(b)     Give **one** observation the student could make that shows there is a reaction between zinc and copper sulfate.

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

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

**(1)**

(c)     The student used measuring instruments to measure some of the variables.

Draw **one** line from each variable to the measuring instrument used to measure the variable.

|  |  |  |
| --- | --- | --- |
| **Variable** |  | **Measuring instrument** |
|  |  | Balance |
|  |  |  |
|  |  | Measuring cylinder |
| Mass of metal powder |  |  |
|  |  | Ruler |
|  |  |  |
|  |  | Burette |
| Volume of metal sulfate |  |  |
|  |  | Theromometer |
|  |  |  |
|  |  | Test tube |

**(2)**

(d)     Use the results shown in table above to place zinc, copper and magnesium in order of reactivity.

Most reactive         \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

Least reactive        \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(e)     Suggest **one** reason why the student should **not** use sodium in this investigation.

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

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

**(1)**

(f)     Which metal is found in the Earth as the metal itself?

|  |  |
| --- | --- |
| Tick **one** box. |  |
| Calcium |  |
| Gold |  |
| Lithium |  |
| Potassium |  |

**(1)**

(g)     Iron is found in the Earth as iron oxide (Fe2O3).

Iron oxide is reduced to produce iron.

Balance the equation for the reaction.

\_\_\_Fe2O3      +     \_\_\_C      →     \_\_\_Fe      +      \_\_\_CO2

**(1)**

(h)     Name the element used to reduce iron oxide.

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

**(1)**

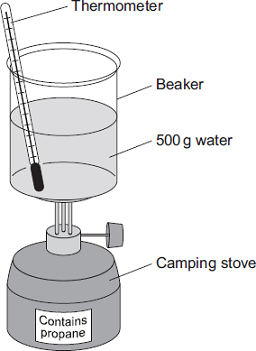
(i)     What is meant by reduction?

|  |  |
| --- | --- |
| Tick **one** box. |  |
| Gain of iron |  |
| Gain of oxide |  |
| Loss of iron |  |
| Loss of oxygen |  |

**(1)**

**(Total 10 marks)**

**Q1.** A camping stove uses propane gas.



(a)     A student did an experiment to find the energy released when propane is burned.

The student:

•        put 500 g water into a beaker

•        measured the temperature of the water

•        heated the water by burning propane for 1 minute

•        measured the temperature of the water again.

The student found the temperature change was 20 °C. The student can calculate the energy released, in joules (J), using the equation:

energy released (J) = mass of water (g) × 4.2 × temperature change (°C)

(i)      Use the student’s result to calculate the energy released in joules (J).

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

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

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

**(2)**

(ii)     State **two** safety precautions that the student should take during the experiment.

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

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

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

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

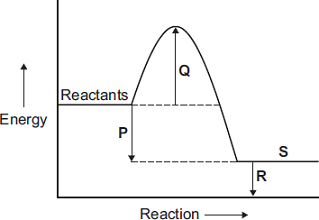
**(2)**

(iii)    Tick () **two** boxes which describe how the student could make his result more accurate.

|  |  |
| --- | --- |
|  | **Tick ()** |
| Stir the water before measuring the temperature. |  |
| Heat the water until it boils. |  |
| Place a lid on the beaker. |  |
| Use a larger beaker for the water. |  |

**(2)**

(b)     The change in energy when propane is burned can be shown in an energy level diagram.



Draw **one** line from each description to the correct letter.

|  |  |  |
| --- | --- | --- |
| **Description** |  | **Letter** |
|  |  | **P** |
| products |  |  |
|  |  | **Q** |
| activation energy |  |  |
|  |  | **R** |
| energy released by the reaction |  |  |
|  |  | **S** |

**(3)**

(c)     Propane and hydrogen are both used as fuels. Some information about propane and hydrogen is given in the table.

|  |  |  |
| --- | --- | --- |
| **Fuel** | **Resource** | **Products formed when fuel burned** |
| propane | crude oil | carbon dioxide and water |
| hydrogen | water | water |

Use the information in the table to suggest **two** disadvantages that propane has as a fuel compared to hydrogen.

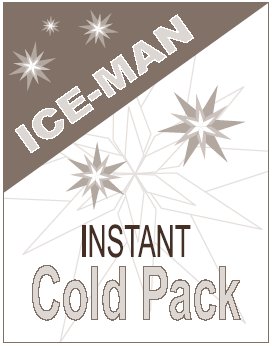
1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**(2)**

**(Total 11 marks)**

**Q2.** Instant cold packs are used to treat sports injuries.



One type of cold pack has a plastic bag containing water.

Inside this bag is a smaller bag containing ammonium nitrate. The outer bag is squeezed so that the inner bag bursts. The pack is shaken and quickly gets very cold as the ammonium nitrate dissolves in the water.

(a)     **One** of the statements in the table is correct.

Put a tick () next to the correct statement.

|  |  |
| --- | --- |
| **Statement** | () |
| The bag gets cold because heat energy is given out to the surroundings. |  |
| The bag gets cold because heat energy is taken in from the surroundings. |  |
| The bag gets cold because plastic is a good insulator. |  |

**(1)**

(b)     Draw a ring around the word that best describes the change when ammonium nitrate dissolves in water.

**electrolysis**         **endothermic**          **exothermic**

**(1)**

(c)     Suggest and explain why the pack is shaken after the inner bag has burst.

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

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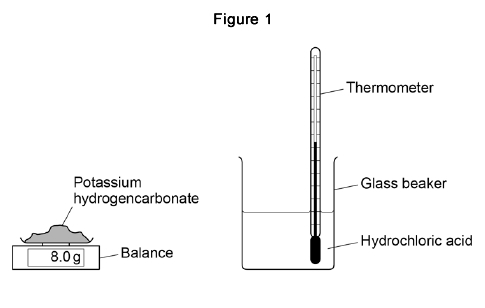
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**(2)**

**(Total 4 marks)**

**Q3.** A student investigated the energy change occurring in the endothermic reaction between potassium hydrogencarbonate and hydrochloric acid.

**Figure 1** shows the apparatus used.



This is the method used.

1. Measure 50 cm3 hydrochloric acid into a glass beaker.

2. Measure 1.0 g of potassium hydrogencarbonate.

3. Add the potassium hydrogencarbonate to the hydrochloric acid.

4. Stir until all the potassium hydrogencarbonate has reacted.

5. Record the lowest temperature reached.

6. Repeat steps 1‒5 two more times.

7. Repeat steps 1‒6 with different masses of potassium hydrogencarbonate.

(a)     Which is the most suitable apparatus to use to measure 50 cm3 of hydrochloric acid?

Tick (✔) **one** box.

|  |  |
| --- | --- |
| Balance |  |
| Conical flask |  |
| Gas syringe |  |
| Measuring cylinder |  |

**(1)**

(b)     The student used a glass beaker for the reaction. Suggest **one** change to the apparatus that would improve the accuracy of the results. Give a reason for your answer.

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

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

**(2)**

(c)     Which **two** variables should the student keep the same to make this a fair test?

Tick **two** boxes.

|  |  |
| --- | --- |
| Mass of potassium hydrogencarbonate |  |
| Same balance |  |
| Same thermometer |  |
| Starting temperature of hydrochloric acid |  |
| Volume of hydrochloric acid |  |

**(2)**

(d)     **Figure 2** shows part of the thermometer used to measure the temperature.



What is the temperature reading on the thermometer?

Temperature = \_\_\_\_\_\_\_\_\_\_\_ °C

**(1)**

The table shows a set of results.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Test 1** | **Test 2** | **Test 3** |
| **Lowest temperature in °C** | 16.1 | 15.8 | 15.9 |

(e)     What is the range of the lowest temperature?

From \_\_\_\_\_\_\_\_\_ °C to \_\_\_\_\_\_\_\_\_ °C

**(1)**

(f)      Calculate the mean lowest temperature. Use the table above.

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

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

Mean lowest temperature = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ °C

**(2)**

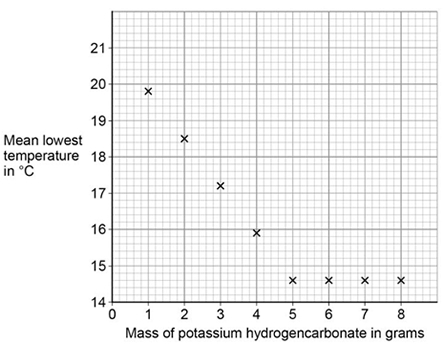
(g)     How do the results show that the reaction is endothermic?

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

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

**(1)**

The graph shows the student’s results.



(h)     Draw **two** straight lines of best fit on the graph above.

**(2)**

(i)      Describe how the lowest temperature changes as the mass of potassium hydrogencarbonate added increases.

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

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**(3)**

**(Total 15 marks)**

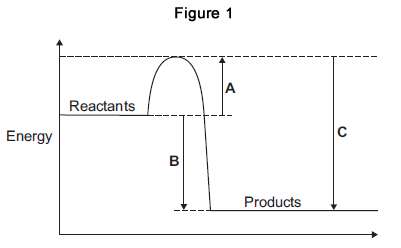
**Q4.** This question is about energy changes in chemical reactions.

(a)     Complete the word equation for the combustion of hydrogen.

hydrogen          +          oxygen          →          \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(b)     **Figure 1** shows a simple energy level diagram.



(i)      Which arrow, **A**, **B** or **C**, shows the activation energy?

|  |  |
| --- | --- |
| Tick (✔) **one** box. |  |
| **A** |  |
| **B** |  |
| **C** |  |

**(1)**

(ii)     What type of reaction is shown by the energy level diagram in **Figure 1**?

Give a reason for your answer.

Type of reaction \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

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

**(2)**

(iii)    For a reaction, the value of **A** is 1370 kJ and **C** is 3230 kJ.

Calculate the value of **B**.

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

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

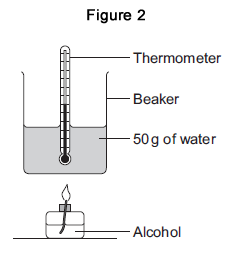
**B** = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kJ

**(1)**

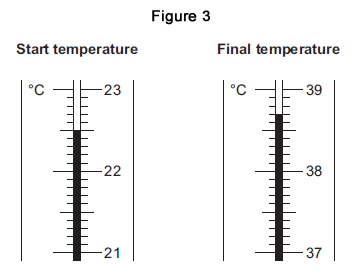
(c)     Alcohols are used as fuels.

A group of students investigated the amount of energy released when different alcohols are burned.

The students used the apparatus shown in **Figure 2**.



(i)      **Figure 3** shows the start temperature and the final temperature of the water.



Write the start temperature and the final temperature of the water in **Table 1**.

Work out the increase in temperature to complete **Table 1**.

|  |  |
| --- | --- |
| **Table 1** | |
| Start temperature of the water in °C |  |
| Final temperature of the water in °C |  |
| Increase in temperature in °C |  |

**(3)**

(ii)     The students worked out the heat energy released by burning 1 g of each alcohol.

The students used the equation:

                Heat energy released = m × 4.2 × increase in temperature

Look at **Figure 2**. What is the value of m?

m = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ g

**(1)**

(iii)     **Table 2** shows the students’ results.

|  |  |  |
| --- | --- | --- |
| **Table 2** | | |
| **Name of alcohol** | **Number of carbon atoms in one molecule of alcohol** | **Heat energy released when 1 g of alcohol is burned in kJ** |
| Methanol | 1 | 11.4 |
| Ethanol | 2 | 13.5 |
| Propanol | 3 | 20.1 |
| Butanol | 4 | 16.8 |
| Pentanol | 5 | 17.2 |

Which value of heat energy released is anomalous?

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

**(1)**

(iv)     Look at **Table 2**. What is the relationship between the number of carbon atoms in one molecule of alcohol and the heat energy released when 1 g of the alcohol is burned?

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

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

**(1)**

(v)     The value in a data book for the amount of heat energy released when 1 g of butanol is burned completely is 36.2 kJ. Suggest two reasons why the students’ result for butanol is lower than the data book value.

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

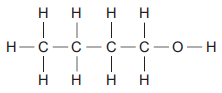
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

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

**(2)**

(vi)     The displayed structure of butanol is:



What is the functional group of the alcohol?

|  |  |
| --- | --- |
| Tick (✔) **one** box. |  |
| –– C –– C |  |
| –– C –– H |  |
| –– O –– H |  |

**(1)**

**(Total 14 marks)**

**Q5.**Cells contain chemicals which react to produce electricity.

(a)     Why can a rechargeable cell be recharged?

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

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

**(1)**

(b)     Give **two** factors that affect the voltage produced by a cell.

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

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

**(2)**

(c)     Balance the half-equation for the reaction occurring at an electrode in one type of hydrogen fuel cell.

H2   +  OH−  ⟶  H2O   +  e−

**(1)**

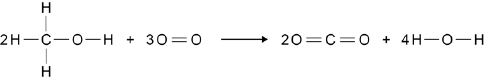
(d)     Why is the fuel cell in Question (c) described as an alkaline fuel cell?

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**(1)**

(e)     Another type of fuel cell uses methanol instead of hydrogen. The diagram represents the reaction in this fuel cell.



The table shows the bond energies for the reaction.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **C–H** | **C–O** | **O–H** | **O=O** | **C=O** |
| Bond energy in kJ / mol | 412 | 360 | 464 | 498 | 805 |

Calculate the overall energy change for the reaction. Use the diagram and the table above.

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

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Overall energy change = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kJ / mol

**(3)**

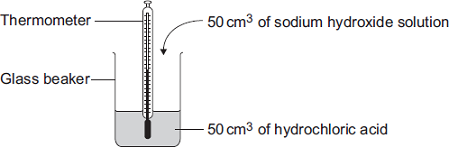
**(Total 8 marks)**

**Q6.** Read the information about energy changes and then answer the questions.

A student did an experiment to find the energy change when hydrochloric acid reacts with sodium hydroxide. The equation which represents the reaction is:

HCl   +   NaOH  →  NaCl +   H2O

The student used the apparatus shown in the diagram.



The student placed 50 cm3 of hydrochloric acid in a glass beaker and measured the initial temperature. The student then quickly added 50 cm3 of sodium hydroxide solution and stirred the mixture with the thermometer. The highest temperature was recorded.

The student repeated the experiment, and calculated the temperature change each time.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Experiment 1** | **Experiment 2** | **Experiment 3** | **Experiment 4** |
| Initial temperature  in °C | 19.0 | 22.0 | 19.2 | 19.0 |
| Highest temperature in °C | 26.2 | 29.0 | 26.0 | 23.5 |
| Temperature change in °C | 7.2 | 7.0 | 6.8 | 4.5 |

(a)     The biggest error in this experiment is heat loss. Suggest how the apparatus could be modified to reduce heat loss.

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

**(1)**

(b)     Suggest why it is important to mix the chemicals thoroughly.

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**(1)**

(c)     Which **one** of these experiments was probably done on a different day to the others? Give a reason for your answer.

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

**(1)**

(d)     Suggest why experiment **4** should **not** be used to calculate the average temperature change.

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

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**(1)**

(e)     Calculate the average temperature change from the first three experiments.

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

Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ °C

**(1)**

(f)     Use the following equation to calculate the energy change for this reaction.

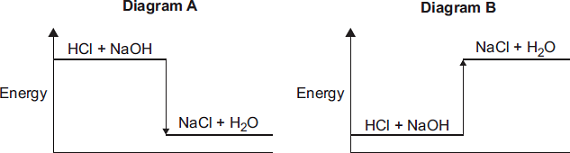
Energy change in joules = 100 × 4.2 × average temperature change

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

Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(1)**

(g)     Which **one** of these energy level diagrams represents the energy change for this reaction? Give a reason for your answer.



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

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**(1)**

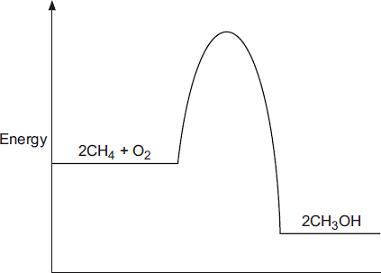
**(Total 7 marks)**

**Q7.** Methanol (CH3OH) can be made by reacting methane (CH4) and oxygen (O2).  
The reaction is exothermic.

The equation for the reaction is:



(a)     The energy level diagram for this reaction is given below.



(i)      How does the diagram show that this reaction is exothermic?

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

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

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**(1)**

(ii)     A platinum catalyst can be used to increase the rate of this reaction.

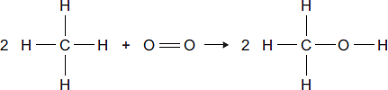
What effect does adding a catalyst have on the energy level diagram?

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

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**(1)**

(b)     The equation can also be written showing the structural formulae of the reactants and the product.



(i)      Use the bond energies given in the table to help you to calculate the energy change for this reaction.

|  |  |
| --- | --- |
| **Bond** | **Bond energy in kJ** |
|  | 435 |
|  | 497 |
|  | 336 |
|  | 464 |

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

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Energy change = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kJ

**(3)**

(iii)    In terms of the bond energies, why is this an exothermic reaction?

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

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**(1)**

**(Total 6 marks)**

**Q8.** Some cars are powered by hydrogen fuel cells.

**Figure 1**

****

© Robert Couse-Baker (CC BY-SA 2.0) via Flickr

(a)     What type of energy is released by hydrogen fuel cells?

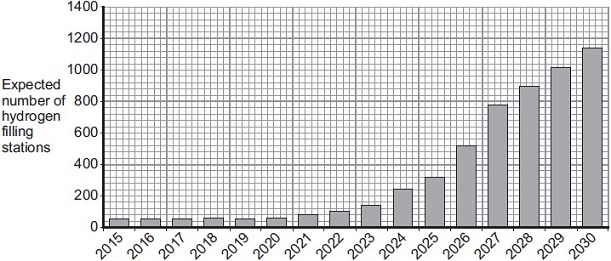
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**(1)**

(b)     Owners of cars powered by fuel cells buy hydrogen from hydrogen filling stations.

**Figure 2** shows how the number of hydrogen filling stations in the UK is expected to increase up to the year 2030.

**Figure 2**

****   
                        Year

Use the information in **Figure 2** and your own knowledge to answer this question.

Suggest **two** reasons why the UK government might encourage the building of more hydrogen filling stations.

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

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**(2)**

(c)     The equation for the reaction of hydrogen with oxygen is:

2 H2    +    O2        2 H2O

During the reaction, energy is used to break the bonds of the reactants.

Energy is released when new bonds are made to form the product.

Bond energies for the reaction are given in the table below.

|  |  |
| --- | --- |
| **Bond** | **Bond energy in kJ** |
|  | 436 |
|  | 498 |
|  | 464 |

The structures of the reactants and product are shown in **Figure 3**.

**Figure 3**

****

|  |  |  |
| --- | --- | --- |
| hydrogen | oxygen | water |

(i)      Calculate the energy change for the reaction:

2 H2    +    O2        2 H2O

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

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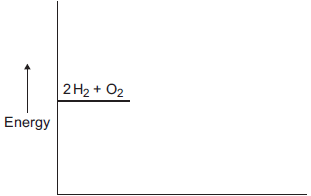
\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Energy change = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ kJ

**(3)**

(ii)     The reaction of hydrogen with oxygen is exothermic. Complete the energy level diagram for this reaction on **Figure 4**. Clearly label the activation energy.

**Figure 4**

****

**(3)**

**(Total 9 marks)**

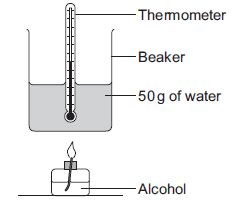
**Q9.**This question is about energy changes in chemical reactions.

(a)     Balance the chemical equation for the combustion of methane.

CH4          +          O2          →          CO2          +          H2O

**(1)**

(b)     Alcohols are used as fuels. A group of students investigated the amount of energy released when an alcohol was burned. The students used the apparatus shown in the diagram below.



In one experiment the temperature of 50 g of water increased from 22.0 °C to 38.4 °C.The mass of alcohol burned was 0.8 g. Calculate the heat energy (Q) in joules, released by burning 0.8 g of the alcohol.

Use the equation:

Q = m × c × ΔT

Specific heat capacity (c) = 4.2 J / g / °C

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

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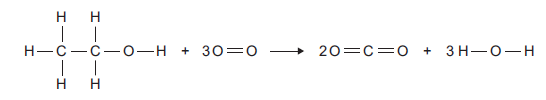
Heat energy (Q) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ J

**(3)**

(c)     The chemical equation for the combustion of ethanol is:

C2H5OH     +     3O2     →     2CO2     +     3H2O

(i)      The equation for the reaction can be shown as:



|  |  |
| --- | --- |
| **Bond** | **Bond energy in kJ per mole** |
| C –– H | 413 |
| C –– C | 347 |
| C –– O | 358 |
| C  O | 799 |
| O –– H | 467 |
| O  O | 495 |

Use the bond energies to calculate the overall energy change for this reaction.

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

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Overall energy change = \_\_\_\_\_\_\_\_\_\_\_ kJ per mole

**(3)**

(ii)     The reaction is exothermic. Explain why, in terms of bonds broken and bonds formed.

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

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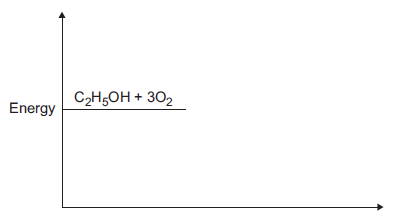
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**(2)**

(iii)     Complete the energy level diagram for the combustion of ethanol. On the completed diagram, label:

•        activation energy

•        overall energy change.



**(3)**

**(Total 12 marks)**

**Q10.** Methane (CH4) is used as a fuel.

(a)     The displayed structure of methane is:



Draw a ring around a part of the displayed structure that represents a covalent bond.

**(1)**

(b)     Why is methane a compound? Tick () **one** box.

|  |  |
| --- | --- |
| Methane contains atoms of two elements, combined chemically. |  |
| Methane is not in the periodic table. |  |
| Methane is a mixture of two different elements. |  |

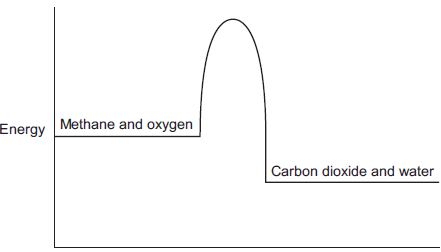
**(1)**

(c)     Methane burns in oxygen.

(i)      The diagram below shows the energy level diagram for the complete combustion of methane. Draw and label arrows on the diagram to show:

•        the activation energy

•        the enthalpy change, *ΔH*.



**(2)**

(ii)     Complete and balance the symbol equation for the complete combustion of methane.

                    CH4     +     \_\_\_\_\_  CO2       +     \_\_\_\_\_

**(2)**

(iii)    Explain why the **incomplete** combustion of methane is dangerous.

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

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**(2)**

(iv)    Explain why, in terms of the energy involved in bond breaking and bond making, the combustion of methane is exothermic.

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

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**(3)**

(d)     Methane reacts with chlorine in the presence of sunlight.

The equation for this reaction is:



Some bond dissociation energies are given in the table.

|  |  |
| --- | --- |
| **Bond** | **Bond dissociation energy  in kJ per mole** |
| C−H | 413 |
| C−Cl | 327 |
| Cl−Cl | 243 |
| H−Cl | 432 |

(i)      Show that the enthalpy change, *ΔH*, for this reaction is −103 kJ per mole.

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

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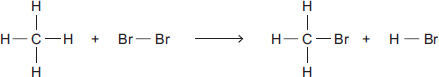
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**(3)**

(ii)     Methane also reacts with bromine in the presence of sunlight.



This reaction is less exothermic than the reaction between methane and chlorine.

The enthalpy change, *ΔH*, is −45 kJ per mole.

What is a possible reason for this?

Tick () **one** box.

|  |  |
| --- | --- |
| CH3Br has a lower boiling point than CH3Cl |  |
| The C−Br bond is weaker than the C−Cl bond. |  |
| The H−Cl bond is weaker than the H−Br bond. |  |
| Chlorine is more reactive than bromine. |  |

**(1)**

**(Total 15 marks)**

**Q11.** The equation for the reaction of ethene and bromine is:

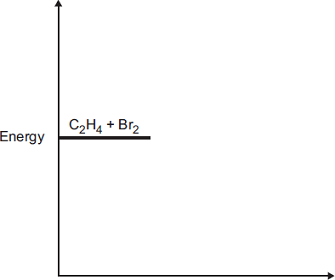
C2H4(g)  +  Br2(l)    C2H4Br2(l)

The reaction is exothermic.

(a)     Complete the energy level diagram.

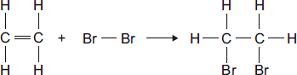
You should label

* the activation energy
* the enthalpy change (∆*H*).



**(3)**

(b)     (i)      The equation for the reaction can be represented as:



|  |  |
| --- | --- |
| **Bond** | **Bond dissociation energy in kJ per mole** |
| C—H | 413 |
| C ═ C | 614 |
| Br—Br | 193 |
| C—C | 348 |
| C—Br | 276 |

Use the bond dissociation energies in the table to calculate the enthalpy change (∆*H*) for this reaction.

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

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Enthalpy change (∆*H*) = \_\_\_\_\_\_\_\_ kJ per mole

**(3)**

(ii)     The reaction is exothermic.

Explain why, in terms of bonds broken and bonds formed.

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

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**(2)**

**(Total 8 marks)**

**Mark schemes**

**Q1.**

(a)     (i)      7

**1**

(ii)     –1

**1**

(iii)     neutrons

**1**

(b)    number of protons

**1**

(c)    atom **Y**

**1**

(d)     (i)      Ne *allow neon*

**1**

(ii)     has a full outer shell *allow in Group 0* *allow a noble gas*

**or**

full outer energy level *allow the shells are full*

**or**

has 8 electrons in its outer shell *ignore in Group 8*

**1**

**[7]**

**Q2.** (a)     (i)      electronic structure 2,3 drawn

*allow any representation of electrons, such as, dots, crosses, or numbers (2,3)*

**1**

(ii)     nucleus

**1**

(iii)     protons and neutrons *do* ***not*** *allow electrons in nucleus*

**1**

(relative charge of proton) +1 *allow positive*

**1**

(relative charge of neutron) 0 *allow no charge/neutral*

**1**

*ignore number of particles*

(b)     too many electrons in the first energy level or inner shell

*allow inner shell can only have a maximum of 2 electrons*

**1**

too few electrons in the second energy level or outer shell

*allow neon has 8 electrons in its outer shell* ***or*** *neon does not have 1 electron in its outer shell / allow neon has a stable arrangement of electrons or a full outer shell*

**1**

neon does not have 9 electrons **or** neon has 10 electrons

*allow one electron missing / allow fluorine has 9 electrons*

**1**

*ignore second shell can hold (maximum) 8 electrons or 2,8,8 rule or is a noble gas or in Group 0*

*max 2 marks if the wrong particle, such as atoms instead of electrons*

*if no other mark awarded allow 1 mark for the electronic structure of neon is 2,8*

**[8]**

**Q3.** (a)     mass number *allow the number of protons + neutrons*

**1**

(b)     6.02 × 1023

**1**

(c)     **Level 2 (3-4 marks):**

Scientifically relevant features are identified; the ways in which they are similar / different is made clear.

**Level 1 (1-2 marks):**

Relevant features are identified and differences noted.

**Level 0**

No relevant content.

**Indicative content**

**similarities**

•   both have positive charges

•   both have (negative) electrons

•   neither has neutrons

**differences**

|  |  |
| --- | --- |
| **plum pudding model** | **nuclear model** |
| ball of positive charge (spread throughout) | positive charge concentrated at the centre |
| electrons spread throughout (embedded in the ball of positive charge) | electrons outside the nucleus |
| no empty space in the atom | most of the atom is empty space |
| mass spread throughout | mass concentrated at the centre |

**4**

(d)     

**or**

(24 × 0.786) + (25 × 0.101) +

(26 × 0.113)

**1**

= 24.3

**1**

*an answer of 24.3 scores* ***2*** *marks*

**[8]**

**Q4.** (a)     precipitate / solid formed

*allow colour change*

**1**

(b)     total mass before = 257.68 g

total mass after = 257.68 g

**1**

so the mass of products equals

the mass of the reactants

**1**

(c)     0.01 g

**1**

(d)     207 + (2 × 14) + (6 × 16)

**or**

207 + 2 × [14 + (3 × 16)]

**1**

= 331

**1**

*an answer of 331 scores* ***2*** *marks*

(e)     CrO42−

**1**

(f)      carbon dioxide is a gas

*allow a gas is produced*

**1**

the gas escapes during the reaction

**1**

(so) the mass at the end is less than expected

**1**

**[10]**

**Q5.** (a)      (i)     a correct link between any two named elements eg same group / column  
same properties / number of outer electrons

*allow some link between any two elements in the same group (in both Newlands and or the modern periodic table)*

**1**

(ii)     any **two** from: *ignore statements about lack of evidence / proof*

•        elements still being discovered

**or**no gaps for undiscovered elements

•        some boxes have 2 elements in them

•        metals and non-metals in same column / mixed up

*accept some elements in same column have different properties.*

*allow any sensible suggestion about misplaced elements eg*

*copper in group 1 elements*

•        pattern for first 16 or so elements only

*allow did not work for all elements*

**2**

(b)     (i)      Cl > Br > I

*accept reactivity / it decreases down the group*

**or**

I < Br < Cl

**1**

Cl has 2 reactions, Br has 1 reaction, I doesn’t react

*owtte*

*allow Cl has most / more reactions and I has least / less reactions (must be clear about where Br fits in)*

**1**

(ii)     Br2

*allow multiples / fractions if correctly completed and balanced*

**1**

(iii)    (they) have 7 outer electrons

*allow (they) have 7 electrons in highest occupied (energy) level / shells / rings*

**1**

(c)                        *outer / last / final must be mentioned once in correct context,  
                   otherwise max* ***2*** *marks comparative required on all three points  
                   accept converse ie less reactive up group*

down group (atom / elements) bigger

**or**

outer electrons (level / shell /ring) further from nucleus / centre *ignore more electrons*

**or**

more shells / level / rings

*do* ***not*** *accept more outer shells for this mark*

**1**

force(s) / attraction(s) are weaker

*allow electron(s) attracted less easily*

*allow electron(s) less under influence (of nucleus)*

**or**

more shielding

**or**

**1**

attracts less

*do* ***not*** *accept magnetic / gravitational / intermolecular forces*

electron(s) lost more easily

*allow electron(s) more likely to be lost*

*allow easier to give away*

**1**

**[10]**

**Q6.** (a)     (iron) is a metal*accept transition element*

*allow (iron) had different properties (to oxygen and sulfur) ignore electrons*

**1**

(b)     so that elements with similar properties could be placed together

*allow to make the pattern fit*

*ignore undiscovered elements*

**1**

(c)     atomic number(s) *allow proton number(s)*

**1**

(d)     all have one electron in the outer shell (highest energy level)

*allow same number of electrons in the outer shell (highest energy level)*

**1**

(so they) have similar properties

**or**

react in the same way *allow specific reactions e.g. with water*

**1**

**[5]**

**Q7.** (a)     increase

**1**

(b)     (i)      Na+ **and** Br−  *both required*

**1**

(ii)     sodium chloride *allow NaCl*

*do* ***not*** *allow sodium chlorine*

**1**

(iii)    chlorine is more reactive than bromine

*allow converse argument*

*allow symbols Cl, Cl2, Br and Br2*

*allow chlorine / it is more reactive*

*do* ***not*** *allow chloride* ***or*** *bromide*

**1**

(iv)    fluorine

*allow F / F2.  do* ***not*** *allow fluoride.*

**1**

**[5]**

**Q8.** (a)     (i)      protons

*allow “protons or electrons”, but do not allow “protons and electrons”*

**1**

(ii)     protons plus / and neutrons

**1**

(b)     (because the relative electrical charges are) −(1) for an electron and +(1) for a proton

*allow electrons are negative and protons are positive*

**1**

and the number of electrons is equal to the number of protons

*if no other mark awarded, allow 1 mark for the charges cancel out*

**1**

(c)     (the electronic structure of) fluorine is 2,7 and chlorine is 2,8,7

*allow diagrams for the first marking point*

**1**

(so fluorine and chlorine are in the same group) because they have the same number of or 7 electrons in their highest energy level or outer shell

*if no other mark awarded, allow 1 mark for have the same / similar properties*

**1**

(d)     S

**1**

(e)     (i)      ions

**1**

(ii)     molecules

**1**

**[9]**

**Q9.** (a)     the chemical reaction is reversible

**1**

(b)     any **two** from:

•   type of electrode

•   electrolyte

•   concentration of electrolyte

•   temperature

**2**

(c)     H2 + **2**OH− → **2**H2O + **2** e−  *allow multiples*

**1**

(d)     contains OH− ions

**1**

(e)     (bonds broken)

((6 × 412) + (2 × 360) + (2 × 464) + (3 × 498)) = 5614

**1**

(bonds made)

((4 × 805) + (8 × 464)) = 6932

**1**

(overall energy change)

(6932 − 5614) = −1318 (kJ / mol)

*allow ecf from marking point 1 and / or marking point 2*

**1**

*an answer of 1318 (kJ / mol) scores* ***3*** *marks*

**[8]**

**Q10.** (a)     13 (protons)

*The answers must be in the correct order.*

*if no other marks awarded, award* ***1*** *mark if number of protons and electrons are equal*

**1**

14 (neutrons)

**1**

13 (electrons)

**1**

(b)     has three electrons in outer energy level / shell

*allow electronic structure is 2.8.3*

**1**

(c)     **Level 3 (5–6 marks):**

A detailed and coherent comparison is given, which demonstrates a broad knowledge and understanding of the key scientific ideas. The response makes logical links between the points raised and uses sufficient examples to support these links.

**Level 2 (3–4 marks):**

A description is given which demonstrates a reasonable knowledge and understanding of the key scientific ideas. Comparisons are made but may not be fully articulated and / or precise.

**Level 1 (1–2 marks):**

Simple statements are made which demonstrate a basic knowledge of some of the relevant ideas. The response may fail to make comparisons between the points raised.

**0 marks:**

No relevant content.

**Indicative content**

Physical

Transition elements

•        high melting points

•        high densities

•        strong

•        hard

Group 1

•        low melting points

•        low densities

•        soft

Chemical

Transition elements

•        low reactivity / react slowly (with water or oxygen)

•        used as catalysts

•        ions with different charges

•        coloured compounds

Group 1

•        very reactive / react (quickly) with water / non-metals

•        not used as catalysts

•        white / colourless compounds

•        only forms a +1 ion

**6**

**[10]**

**Mark schemes**

**Q1.**

(a)     (i)      7 / seven

**1**

(ii)     1 *do* ***not*** *accept –1*

**1**

Electron

**1**

(iii)     isotopes

**1**

(b)     (i)      (sodium + ) fluorine → sodium fluoride

**1**

(ii)     compounds

**1**

(iii)     mole

**1**

(iv)     sodium (atom) loses

**1**

fluorine (atom) gains

**1**

one electron

**1**

ions formed

**1**

*allow sodium forms positive (ion)* ***or*** *fluorine forms negative (ion)*

*allow form ionic bond allow to gain a full outer shell of electrons*

*allow forms noble gas structure*

***max 3*** *if reference to incorrect particle / bonding*

(v)     Dissolve in water

**1**

High melting point

**1**

**[13]**

**Q2.** (a)     (i)      neutrons *this order only*

**1**

electrons

**1**

protons

**1**

(ii)     box on the left ticked

**1**

(b)     (i)      effervescence / bubbling / fizzing / bubbles of gas

*do* ***not*** *accept just gas alone*

**1**

magnesium gets smaller / disappears

*allow magnesium dissolves*

*allow gets hotter* ***or*** *steam produced*

*ignore references to magnesium moving and floating / sinking and incorrectly named gases.*

**1**

(ii)     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 refer to the information in the Marking Guidance and apply a ‘best–fit’ approach to the marking.

**0 marks**No relevant content

**Level 1 (1−2 marks)**There are simple statements of some of the steps in a procedure for obtaining magnesium chloride.

**Level 2 (3−4 marks)**There is a description of a laboratory procedure for obtaining magnesium chloride from dilute hydrochloric acid and magnesium.

The answer must include a way of ensuring the hydrochloric acid is fully reacted **or** a method of obtaining magnesium chloride crystals.

**Level 3 (5−6 marks)**There is a well organised description of a laboratory procedure for obtaining magnesium chloride that can be followed by another person.

The answer must include a way of ensuring the hydrochloric acid is fully reacted **and** a method of obtaining magnesium chloride crystals.

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

•        hydrochloric acid in beaker (or similar)

•        add small pieces of magnesium ribbon

•        until magnesium is in excess or until no more effervescence occurs \*

•        filter using filter paper and funnel

•        filter excess magnesium

•        pour solution into evaporating basin / dish

•        heat using Bunsen burner

•        leave to crystallise / leave for water to evaporate / boil off water

•        decant solution

•        pat dry (using filter paper).

\*Student may choose to use a named indicator until it turns a neutral colour, record the number of pieces of magnesium added then repeat without the indicator.

**6**

**[12]**

**Q3.** (a)     gives out (heat)

**1**

(b)     D

**1**

(c)     L

**1**

(d)     magnesium chloride

**1**

**[4]**

**Q4.**

(a)     (i)      C

**1**

(ii)     B

**1**

(iii)    A

**1**

(iv)    D

**1**

(b)     (i)      SO2

**1**

(ii)     shared

**1**

(iii)    covalent

**1**

**[7]**

**Q5.** (a)     CH4*4 should be below halfway up H / tail of 4 below the dotted line*

**1**

(b)     molecule

**1**

(c)     covalent

**1**

**[3]**

**Q6.** (a)     carbon

**1**

(b)     all

**1**

(c)     covalent

**1**

(d)     four

**1**

(e)     hard

**1**

**[5]**

**Q7.** (a)     C3H8

*capital letters for symbols numbers must be halfway or lower down the element symbol allow H8C3 do* ***not*** *allow 3:8* ***or*** *C3 and H8*

**1**

(b)     (i)      electron

**1**

(ii)     covalent

**1**

(c)     low **and** small *both for* ***1*** *mark*

**1**

**[4]**

**Q8** (a)     Stops / reduces air from escaping (owtte)

*allow keeping shape* ***or*** *keeping it hard*

**1**

(b)     a layer a few hundred atoms thick

**1**

(c)     any **two** from:

•        last longer

•        use fewer balls

•        less materials **or** save resources

•        less manufactured

*accept less factories*

•        less energy

•        less fuel

•        less pollution / greenhouse effect / global warming

•        less waste

*ignore references to cost / recycling*

*any* ***two*** *ideas*

**2**

**[4]**

**Q9.** (a)     *weaker bonds*

*allow (other substances) react with the silicon dioxide*

***or***

*fewer bonds ignore weaker / fewer forces*

***or***

*disruption to lattice*

*do* ***not*** *accept reference to intermolecular forces / bonds*

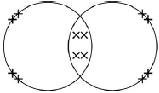
**1**

(b)     (i)      Na2O

*do* ***not*** *accept brackets or charges in the formula*

**1**

(ii)



*electrons can be shown as dots, crosses, e or any combination*

2 bonding pairs

*accept 4 electrons within the overlap*

**1**

2 lone pairs on each oxygen

*accept 4 non-bonding electrons on each oxygen*

**1**

(c)     *lattice / regular pattern / layers / giant structure / close-packed arrangement*

**1**

(of) positive ions **or** (of) atoms

**1**

(with) delocalised / free electrons

*reference to incorrect particles* ***or*** *incorrect bonding* ***or*** *incorrect structure = max* ***2***

**1**

**[7]**

**Q10.** (a)     atoms

**1**

(b)     mixture

**1**

          metal

**1**

          structure

**1**

          smart

**1**

(c)     (i)      any **two** from:

•        saves raw materials / iron ore

•        saves energy / fuels

*accept cheaper / saves money*

•        make new / useful items

•        make money / it is economic

•        reduces pollution

*allow less harmful for the environment*

•        decreases cost of steel cans

•        reduces carbon dioxide emissions

•        decreases waste materials / use of landfill

**2**

(ii)     any **one** from:

•        provide information / education of the need to recycle

•        legislate against / charge for waste

•        reward / pay people to recycle

*accept fine people for not recycling*

•        put labels on the cans

•        provide recycling bags / bins / areas

**1**

**[8]**

**Q11.** (a)     any **two** from

*assume it = methanol*

*allow converse for water*

•        shorter / quicker soaking time

*allow it is quicker*

•        takes less time / quicker to dry

**or** faster evaporation

•        dissolves quicker / better in methanol

**2**

(b)     (i)      CH4O

**1**

(ii)     covalent

**1**

(c)     it is made of small molecules

**1**

**[5]**

**Q12.** high melting point

*reference to incorrect bonding* ***or*** *incorrect particles* ***or*** *incorrect structure = max* ***3***

*accept will not melt (at high temperatures)   
ignore withstand high temperatures*

**1**

because a lot of energy needed to break bonds

**1**

because it is covalent **or** has strong bonds

*accept bonds are hard to break*

**1**

and because it is a giant structure **or** a macromolecule **or** a lattice

*ignore many bonds*

**1**

**[4]**

**Q13.** (a)     has delocalised electrons

*accept free (moving) electrons*

**1**

(so electrons) can move through the structure/metal

*accept (so electrons) can carry charge through the structure/metal*

*accept (so electrons) can form a current*

**1**

*reference to incorrect particles* ***or*** *incorrect bonding* ***or*** *incorrect structure =* ***max 1***

(b)     giant structure

*accept lattice*

*accept each atom forms four bonds (with other carbon atoms)*

*ignore macromolecular*

**1**

strong bonds

*accept covalent do* ***not*** *accept ionic*

**1**

*reference to intermolecular forces/bonds* ***or*** *incorrect particles =* ***max 1***

(c)     thermosetting polymers do not melt (when heated)

*accept thermosetting polymers do not change shape (when heated)*

*accept thermosetting polymers have high(er) melting points*

*ignore thermosetting polymers do not soften (when heated)*

**1**

due to cross-links (between chains)

*accept due to bonds between chains*

**1**

*reference to smart polymers =* ***max 1***

*accept converse argument*

**[6]**

**Q14.** (a)     (i)      giant lattice

*allow each carbon atom is joined to three others*

**1**

atoms in graphene are covalently bonded

*max.* ***2*** *marks if any reference to wrong type of bonding*

**1**

and covalent bonds are strong **or** need a lot of energy to be broken

*allow difficult to break*

**1**

(ii)     because graphene has delocalised electrons

*allow each carbon atom has one free electron*

**1**

which can move throughout the structure

*do* ***not*** *accept just electrons can move.*

**1**

(b)     because there are weak forces between molecules

*allow no bonds between the layers*

**1**

so layers / molecules can slip / slide.

**1**

**[7]**

**Mark schemes**

**Q1.** (a)     1

*must be in this order*

**1**

very small

*accept negligible, 1 / 2000*

*allow zero*

**1**

(b)     The mass number

**1**

(c)     C

**1**

(d)     (i)      2

**1**

(ii)     3

**1**

(e)     (i)      28

**1**

(ii)     42.9 *accept ecf from (e)(i)* *accept 42 - 43*

**1**

(f)    (i)      0.9

**1**

(ii)     any **one** from:

•        accurate

•        sensitive

•        rapid

•        small sample.

**1**

**[10]**

**Q2.** (a)     produces H+ / hydrogen ions in aqueous solution

**1**

(but is) only partially / slightly ionised

**1**

(b)     indicator changes colour

**1**

from blue to yellow *allow from blue to green*

**1**

(when) the acid and alkali are (exactly) neutralised

**or**

(when) no excess of either acid or alkali

**1**

(c)     pipette measures one fixed volume (accurately)

**1**

(but) burette measures variable volumes (accurately)

**1**

(d)     

**1**

(mean titre =) 12.13(3) (cm 3)

**1**

(moles NaOH = conc × vol) = 0.00255

**1**

(moles citric acid =  moles NaOH) = 0.00085

**1**

(conc acid = moles / vol) = 0.0701 (mol / dm 3)

*allow ecf from steps 1, 2, 3 and / or 4*

*allow an answer of 0.0701 (mol / dm 3) without working for* ***1*** *mark only*

**1**

**[12]**

**Q3.** (a)     add excess copper carbonate (to dilute hydrochloric acid)

*accept alternatives to excess, such as ‘until no more reacts’*

**1**

filter (to remove excess copper carbonate)

*reject heat until dry*

**1**

heat filtrate to evaporate some water **or** heat to point of crystallisation

*accept leave to evaporate or leave in evaporating basin*

**1**

leave to cool (so crystals form) *until crystals form*

**1**

*must be in correct order to gain* ***4*** *marks*

(b)     *M*r CuCl2 = 134.5 *correct answer scores* ***4*** *marks*

**1**

moles copper chloride = (mass / *M*r = 11 / 134.5) = 0.0817843866

**1**

*M*r CuCO3= 123.5

**1**

Mass CuCO3 (=moles × M2= 0.08178 × 123.5) = 10.1(00)

**1**

*accept 10.1 with no working shown for* ***4*** *marks*

(c)    

**or**

11.0 × 0.791

**1**

8.70 (g)

**1**

*accept 8.70(g) with no working shown for* ***2*** *marks*

(d)     Total mass of reactants = 152.5

**1**

134.5

152.5 *allow ecf from step 1*

**1**

88.20 (%)

**1**

*allow 88.20 with no working shown for* ***3*** *marks*

(e)     atom economy using carbonate lower because an additional product is made **or** carbon dioxide is made as well *allow ecf*

**1**

**[14]**

**Q4.** (a)     in a closed system

**1**

the rate of the forward and backward reactions are equal

**1**

(b)     concentration increases

**1**

(because) reaction / equilibrium moves to the left / reactant side

**1**

(since the) reverse reaction is exothermic

*allow (so that) temperature increases*

**1**

(c)     becomes blue

**1**

(because) reaction / equilibrium moves to the right / product side

**1**

(so) concentration of blue cobalt compound increases

*allow (so that) concentration of hydrochloric acid decreases*

**1**

(d)     (cobalt has) ions with different charges

*allow (cobalt is a) transition metal*

**1**

(e)     Co3+

**1**

(f)      they allow reactions to reach equilibrium more quickly

**1**

they provide a different reaction pathway

**1**

(g)     **13**H2 + **6**CO → C6H14 + **6**H2O

*allow multiples*

**1**

(h)     C8H18

**1**

(i)      curve below printed curve

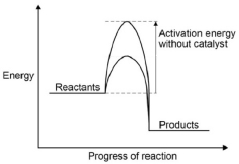
*do* ***not*** *accept different reactant or product levels*

**1**

vertical arrow from reactant level to peak of **printed** curve

**1**

an answer of:



scores **2** marks

**[16]**

**Q5.** (a)     left hand: (conical) flask

*do* ***not*** *accept round bottomed  
flask or container which is not a flask*

**1**

right hand: beaker / trough *accept plastic box*

**1**

(b)     (i)      157

**1**

(ii)     all calcium carbonate used up **or** reaction stopped

*do* ***not*** *accept all acid used up*

**1**

(c)     (i)      0.007(272727…)

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

*if answer incorrect, allow (0.32 / 44) for* ***1*** *mark*

**2**

(ii)     0.007(272727…)

*allow ecf from* ***(c)(i)***

**1**

(iii)    (Mr = mass / moles = 1 / 0.00727…) = 137.5 or 138

*allow ecf from* ***(c)(ii)*** *if use 0.00943 moles then = 106*

*if use 0.007 allow 143 (142.857)*

**1**

(iv)    (138) – 60 (= 78)

*23 / 85*

**1**

(78 / 2) = 39

**1**

potassium

*sodium / rubidium*

*identity of metal ecf on Ar, but* ***must*** *be Group 1*

*If no working max* ***1*** *mark*

**1**

(d)     (i)      (relative atomic mass) would decrease

**1**

because the mass lost greater

**1**

so moles carbon dioxide larger **or** moles metal carbonate greater

**1**

(ii)     no change

**1**

because the acid (already) in excess

**1**

so the amount carbon dioxide lost is the same

**1**

**[17]**

**Q6.** Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.

**0 marks**No relevant content.

**Level 1 (1-2 marks)**There is a simple description of using some of the equipment.

**Level 2 (3-4 marks)**There is a description of an experimental method involving a measurement, **or** including addition of alkali to acid (or vice versa).

**Level 3 (5-6 marks)**There is a description of a titration that would allow a successful result to be obtained.

**Examples of chemistry points made in the response could include:**

•         acid in (conical) flask

•         volume of acid measured using pipette

•         indicator in (conical) flask **and s**odium hydroxide in burette

•         white tile under flask

•         slow addition

•         swirling

•         colour change

•         volume of sodium hydroxide added

**Extra information**

•        allow acid in the burette to be added to sodium hydroxide in the (conical) flask

•        allow any specified indicator colour change need not be specified

**[6]**

**Q7.** (a)     (i)      lit splint **or** ignite the gas

**1**

(squeaky) pop / explosion

**1**

(ii)     because it provides energy (for the reaction)

**1**

to break bonds (in the reactants) **or** so the particles collide successfully

*ignore reference to frequency or rate of collisions*

*because it provides the activation energy gains* ***2*** *marks*

**1**

(b)     (i)      1.67(g) *allow 1.66-1.68*

*correct answer (to 3 significant figures) with or without working gains* ***3*** *marks*

*if answer incorrect allow up to* ***2*** *marks for the following steps:*

*24  →  40*

*1.00  →  40 / 24*

***or***

*moles magnesium = 1 / 24* ***or*** *0.04(17)*

*multiply by 40*

*allow ecf from incorrect ratio* ***or*** *incorrect number of moles*

**3**

(ii)     **if correct answer from part (b)(i) used**

*allow ecf from part (b)(i)*

89.8 or 90

**if 1.82 g used**

82.4 or 82

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

*if answer incorrect, allow the following for* ***1*** *mark:*

*1.50 / 1.67 (or their answer from part (b)(i))*

*if 1.82 g used: 1.50 / 1.82*

**2**

(iii)    any **one** from:

*ignore measurement errors*

•        not all the magnesium reacted

*allow the reaction may be reversible*

•        some of the magnesium oxide / product may have been left in the tube **or** may have been lost

*ignore magnesium lost*

•        different / unexpected reaction

•        magnesium not pure

**1**

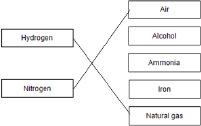
**[10]**

**Q8.** (a)     4

**1**

(b)     reversible (reaction)

**1**

(c)     

**1**

**1**

(d)     −40 °C

**1**

(e)     recycled to the reactor

**1**

(f)      ionic

**1**

(g)     nitrogen

**1**

phosphorus

**1**

(h)     0.24 × 50 × 5

*allow £87.50*

**1**

= £60

**1**

*an answer of £60 scores* ***2*** *marks*

(i)      may need to use nitrogen, phosphorus and potassium

*allow neither fertiliser has all the elements / nutrients needed.*

**[12]**

**Q9.** (a)     (sulfuric acid is) completely / fully ionised

**1**

In aqueous solution **or** when dissolved in water

**1**

(b)     H+(aq) + OH−(aq) → H2O(l)

*allow multiples* ***1*** *mark for equation* ***1*** *mark for state symbols*

**2**

(c)     adds indicator, eg phenolpthalein / methyl orange / litmus added to the sodium hydroxide  
(in the conical flask)

*do* ***not*** *accept universal indicator*

**1**

(adds the acid from a) burette

**1**

with swirling **or** dropwise towards the end point **or** until the indicator just changes colour

**1**

until the indicator changes from pink to colourless (for phenolphthalein) or yellow to red  
(for methyl orange) or blue to red (for litmus)

**1**

(d)     titrations 3, 4 and 5

**or**

****

**1**

27.12 cm3

*accept 27.12 with no working shown for* ***2*** *marks*

**1**

*allow 27.1166 with no working shown for* ***2*** *marks*

(e)     Moles H2SO4 = conc × vol = 0.00271 *allow ecf from 8.4*

**1**

Ratio H2SO4:NaOH is 1:2

**or**

Moles NaOH = Moles H2SO4 × 2 = 0.00542

**1**

Concentration NaOH = mol / vol = 0.00542 / 0.025 = 0.2168

**1**

0.217 (mol / dm3)

*accept 0.217 with no working for* ***4*** *marks*

**1**

*accept 0.2168 with no working for* ***3*** *marks*

(f)           ×   0.18 = no of moles

**or**

0.15 × 40 g

**1**

0.144 (g)

**1**

*accept 0.144g with no working for* ***2*** *marks*

**[16]**

**Q10.** (a)     cool

**1**

to −34 °C *allow temperatures below −34 °C but above −196  °C*

**1**

(b)     recycled (to the reactor)

**1**

(c)     

**1**

= 550 (dm 3)

**1**

*an answer of 550 (dm 3) scores* ***2*** *marks*

(d)     a lower pressure would decrease the equilibrium yield

**1**

a lower temperature would make the reaction too slow

**1**

(e)     nitrogen / N

**1**

(f)      **B** and **C**

**1**

contain nitrogen, phosphorus and potassium

**1**

(g)     (**B**)

any **two** from:

•   more stages

•   uses more energy

•   uses more raw materials

•   takes longer *allow converse for* ***C***

**2**

**[12]**

**Mark schemes**

**Q1.** (a)     36 cm3

**1**

(b)     all points correct *± ½ small square*

**2**

*allow* ***1*** *mark if 6 or 7 of the points are correct*

2 best fit lines drawn

*must not deviate towards anomalous point*

**2**

*allow* ***1*** *mark if 1 line correct*

(c)     The bung was not pushed in firmly enough.

**1**

The measuring cylinder was not completely over the delivery tube.

**1**

(d)     as mass of lithium carbonate increases volume of gas produced increases

**1**

linear / (directly) proportional

**1**

(e)     A gas / carbon dioxide is produced.

*allow because the air in the tube expands*

**1**

(f)     any **one** from:

•        Potassium carbonate does not decompose to produce carbon dioxide / a gas.

•        Potassium carbonate does not decompose at the temperature of the Bunsen  
burner **or** the Bunsen burner is not hot enough to decompose potassium carbonate.

•        When potassium carbonate decomposes a gas is not formed.

**1**

**[11]**

**Q2.** (a)     4 Na + O2 ⟶ 2Na2O*allow multiples*

**1**

(b)     (sodium) gains oxygen

**1**

(c)     purple

**1**

(d)     aluminium chloride

**1**

(e)     **Level 2 (3-4 marks):**

Relevant reasons are identified, given in detail and logically linked to form a clear account.

**Level 1 (1-2 marks):**

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

**Level 0**

No relevant content

**Indicative content**

**conclusion 1**

•   pH values above 7 are alkaline

•   sodium oxide, calcium oxide and magnesium oxide do form alkaline solutions (so correct for those)

•   not all metal oxides form solutions (so incorrect for zinc oxide)

**conclusion 2**

•   pH values below 7 are acidic

•   carbon dioxide, sulfur dioxide and phosphorus oxide do form acidic solutions (so correct for those)

•   not all non-metal oxides form solutions (so incorrect for silicon oxide)]

**4**

(f)      metal oxides produce alkaline solutions if they dissolve in water

*allow* ***1*** *mark for most metal oxides produce alkaline solutions*

**2**

**[10]**

**Q3.** (a)     heat with a water bath

**or**

heat with an electric heater

**or**

allow to evaporate / crystallise at room temperature

**1**

(b)     to make sure that all the iodine reacts

*allow so can see the reaction is complete*

**1**

(as) excess iodine would remain in solution

**1**

(so) iodine could not be filtered off

*allow (whereas) excess zinc could be filtered off*

**or**

(so) the zinc iodide would not be pure

*allow (so) would have to separate iodine from zinc iodide*

**1**

(c)     

*allow moles I2 = 0.00197*

*allow 65 g Zn: 254 g I2*

**1**

mass Zn = 0.00197 × 65 (g)

**1**

mass = 0.128 (g)

**1**

*allow an expression  (g) for the first* ***2*** *marks*

(d)     

**1**

****

**1**

= 13.6 (g)

*allow 13.5869... (g)*

**1**

(e)     some product lost on separation *allow incomplete reaction*

**1**

(f)      *M*r ZnI2 = 319

**1**

moles needed



**or**

mass per dm 3 = 31.9 (g)

**1**

(mass) = 7.98 (g)

*allow 7.975 / 8.0 (g)*

**1**

*an answer of 7.975, 7.98 or 8.0 (g) scores* ***3*** *marks*

**[14]**

**Q4.** (a)     (i)      silver nitrate

*allow AgNO3*

**1**

(ii)     potassium carbonate **or**

*allow K2CO3*

sodium carbonate

*allow Na2CO3*

**1**

(b)     base *allow ionic*

*ignore insoluble or soluble*

*ignore alkali*

**1**

(c)     (i)      evaporate

**or**

crystallise

*allow heat or boil or leave (to evaporate) allow cool*

*ignore filtration unless given as an alternative*

*do* ***not*** *accept freeze or solidify*

**1**

(ii)     2 (HNO3)

*accept multiples*

**1**

(iii)    9

*accept nine*

**1**

(d)     6.21 / 207        0.72 / 16

***1*** *mark for dividing mass by Ar*

**1**

= 0.03              = 0.045

***1*** *mark for correct proportions (allow multiples)*

**1**

2                      3

***1*** *mark for correct whole number ratio (allow multiples). Can be awarded from formula.*

**1**

Pb2O3

*allow O3Pb2*

***ecf*** *allowed throughout if sensible attempt at step 1*

*correct formula with no working gains* ***1*** *mark*

**1**

**[10]**

**Q5.** (a)     electricity

*allow an electric current*

**1**

(b)     (i)      chlorine/Cl2

*do* ***not*** *accept chloride*

**1**

(ii)     (zinc ions are) positive

*ignore to gain electrons*

**1**

and (opposite charges) attract

**1**

(iii)     reduction

**1**

(c)     (i)      in alloy:

*accept converse*

different sized atoms/particles

**or**

no layers/rows

*accept layers distorted*

**1**

so cannot slide

**1**

(ii)      shape memory (alloys)

*accept smart*

**1**

**[8]**

**Q6.** (a)     (i)      calcium oxide

*in either order*

**1**

carbon dioxide *accept correct formulae*

**1**

(ii)     C(s) + CO2(g) → **2**CO(g) *allow multiples*

**1**

(iii)    210 (tonnes)

*award* ***3*** *marks for the correct answer with or without working*

*allow ecf for arithmetical errors*

*if answer incorrect allow up to* ***2*** *marks for any of the steps below:*

*160 → 112*

*300 → 112 / 160 × 300*

***or***

*moles Fe2O3 = 1.875 (× 106) or 300 / 160*

*moles of Fe = 3.75 (× 106) or 2 × moles Fe2O3*

*mass Fe = moles Fe × 56*

*105 (tonnes) scores 2 (missing 1:2 ratio)*

*420 (tonnes) scores 2 − taken Mr of iron as 112*

**3**

(b)     (i)      aluminium is more reactive than carbon **or** carbon is less reactive than aluminium

*must have a comparison of reactivity of carbon and aluminium*

*accept comparison of position in reactivity series.*

**1**

(ii)     (because) aluminium ions are positive

*ignore aluminium is positive*

**1**

and are attracted / move / go to the negative electrode / cathode

**1**

where they gain electrons / are reduced / Al3+ + 3e− → Al

*accept equation or statements involving the wrong number of electrons.*

**1**

(iii)    (because) the anodes **or** (positive) electrodes are made of carbon / graphite

**1**

oxygen is produced (at anode)

**1**

which reacts with the electrodes / anodes

*do* ***not*** *accept any reference to the anodes reacting with oxygen from the air*

*equation C + O2  CO2 gains* ***1*** *mark (M3)*

**1**

**[13]**

**Q7.** (a)     (delivery) tube sticks into the acid

**1**

the acid would go into the water **or** the acid would leave the flask or go up the delivery  
tube

*ignore no gas collected*

**1**

(b)     any **one** from:

•        bung not put in firmly / properly

•        gas lost before bung put in

•        leak from tube

**1**

(c)     all of the acid has reacted

**1**

(d)     take more readings in range 0.34 g to 0.54 g

**1**

*take more readings is insufficient ignore repeat*

(e)        95

24000

**1**

0.00396

**or**

3.96 × 10−3

**1**

*accept 0.00396 or 3.96 × 10−3 with no working shown for* ***2*** *marks*

(f)     use a pipette / burette to measure the acid

**1**

because it is more accurate volume than a measuring cylinder

**or**

greater precision than a measuring cylinder

**or**

use a gas syringe to collect the gas

so it will not dissolve in water

**or**

use a flask with a divider

*accept description of tube suspended inside flask*

so no gas escapes when bung removed

**1**

(g)     they should be collected because carbon dioxide is left in flask at end

**1**

and it has the same volume as the air collected / displaced

**1**

**[11]**

**Q8.** (a)     magnesium loses two electrons **and** chlorine gains one electron

*accept magnesium loses electrons* ***and*** *chlorine gains electrons for 1 mark*

*ignore oxidation and reduction*

**2**

one magnesium and two chlorines *accept MgCl2*

**1**

noble gas structure

**or**

eight electrons in the outer shell

*accept full outer shell (of electrons)*

**or**

(electrostatic) attraction between ions

**or**

forms ionic bonds

*do* ***not*** *accept covalent bonds*

**1**

*reference to incorrect particles* ***or*** *incorrect bonding* ***or*** *incorrect structure =* ***max 3***

(b)     (i)      because ions can move *ignore ions attracted*

*do* ***not*** *accept molecules / atoms moving*

*do* ***not*** *accept incorrect reference to electrons moving*

**1**

(and ions move) to the electrodes

**or**

(and ions) carry charge

**1**

*accept converse for solid*

(ii)     magnesium (ions) attracted (to the electrode)

**1**

so magnesium ions gain electrons

*accept magnesium ions are reduced*

*ignore oxidised*

**1**

2 electrons

*accept a correct half equation for 2nd* ***and*** *3rd marking points*

**1**

(iii)     hydrogen *allow H2*

**1**

(iv)     magnesium is more reactive than hydrogen

*accept converse*

*allow magnesium is high in the reactivity series* ***or*** *magnesium is very/too reactive.*

*do* ***not*** *accept magnesium ions are more reactive than hydrogen ions*

**1**

(v)     **2** Cl- → Cl2 + **2e-**  *must be completely correct*

**1**

(c)     layers (of particles/atoms/ions)

**1**

(particles/atoms/ions/layers) can slide

**1**

*any mention of intermolecular / weak bonds/forces =* ***max 1***

**[14]**

**Q9.** (a)     any **one** from:

•        heat

•        stir

**1**

(b)     filter *accept use a centrifuge* *accept leave longer (to settle)*

**1**

(c)     any **one** from:

•        wear safety spectacles

•        wear an apron

**1**

(d)     evaporation at **A**

**1**

condensation at **B**

**1**

(e)     100

**1**

**[6]**

**Q10.** (a)     any **two** from:

•        concentration / volume of dilute hydrochloric acid

•        mass of metal powder

•        surface area of metal powder

•        stirring (of any) / rate of stirring

*allow reacted for the same length of time*

**2**

(b)     4.2 °C *allow Magnesium Test 2*

**1**

and any **one** from:

•        lower mass of magnesium added

•        surface area of magnesium too low

•        magnesium coated in magnesium oxide (so took a while to start reacting)

•        not stirred

•        not stirred as quickly as the other metals

•        not reacted for as long a time as the other metals

*allow reason for break in circuit*

**1**

(c)     17.4(°C)

**1**

(d)     bubbles of gas

**1**

more (bubbles) seen with calcium than other metals

*allow any correct comparison between two metals*

**1**

(e)     any value between 7.9 °C and 12.3 °C

**1**

**[8]**

**Q11.** (a)     **(diagram)** complete circuit with power supply

**1**

test solution in beaker or other appropriate apparatus

**1**

Electrodes *allow carbon, platinum or inert electrodes*

**1**

**(independent variable)**

salt solutions (with different metal ions)

**1**

**(observation)**

solid / metal deposit on the negative electrode

**1**

(b)     (sometimes) hydrogen is produced

**1**

(because) the metal is more reactive than hydrogen

**1**

(c)     chlorine

**1**

oxygen

**1**

**[9]**

**Q12.** (a)     Whether there was a reaction or not

**1**

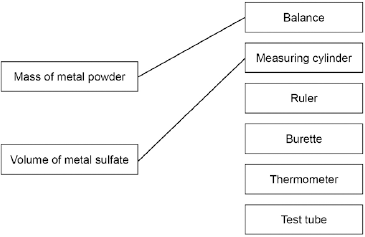
(b)     brown / orange / dark deposit on zinc

**or**

blue solution turns colourless / paler

**1**

(c)               **Variable**                                   **Measuring instrument**



more than one line drawn from a variable negates the mark

**2**

(d)     (Most reactive)        **Magnesium**

**Zinc**

(Least reactive)       **Copper**

*must all be correct*

**1**

(e)     would not be safe **or**

too reactive *allow too dangerous*

**1**

(f)     Gold

**1**

(g)     2Fe2O3   +   3C   →   4Fe   +   3CO2  *allow multiples*

**1**

(h)     carbon

**1**

(i)     Loss of oxygen

**1**

**[10]**

**Mark schemes**

**Q1.** (a)     (i)      42 000

*correct answer gains* ***2*** *marks with or without working  
allow 42 kJ*

*if answer incorrect : correct substitution 500 x 4.2 x 20 gains* ***1****mark*

**2**

(ii)     any **two** from:

•        eye protection

•        lab coat

•        heat-proof mat

•        (heat-proof) gloves

•        (long) hair tied back

•        stand up

•        secure the beaker

**2**

(iii)    Stir the water before measuring the temperature.

**1**

Place a lid on the beaker.

**1**

(b)     the products → S

**1**

the activation energy → Q

**1**

the energy released by the reaction → P

**1**

(c)     carbon dioxide produced

*it = propane allow converse arguments*

*allow greenhouse gas / global warming / atmospheric pollution*

(crude oil / propane) non-renewable

**1**

*allow crude oil running out*

**1**

**[11]**

**Q2.** (a)     the bag gets cold because heat energy is taken in from the surroundings

**1**

(b)     endothermic

**1**

(c)     any **two** from:

•        mix / spread (the ammonium nitrate and water)

•        dissolve faster(\*)

•        get cold faster **or** so the whole bag gets cold(\*)

*(\*)allow increase rate* ***or*** *quicker reaction*

•        particles collide more **or** more collisions

**2**

**[4]**

**Q3.** (a)     measuring cylinder

**1**

(b)     use a polystyrene cup *allow insulate the beaker and / or use a lid*

**1**

better insulator

**or**

reduces energy transfer from the surroundings

**1**

(c)     starting temperature of hydrochloric acid

**1**

volume of hydrochloric acid

**1**

(d)     21.4 (°C)

**1**

(e)     15.8 (°C) to 16.1 (°C) *allow 16.1 (°C) to 15.8 (°C)*

**1**

(f)      

=15.9 (°C) *an answer of 15.9(333..) (°C) scores* ***2*** *marks*

**1**

*allow 15.9(333..) (°C)*

**1**

(g)      temperature decreases

**1**

(h)      straight line from (1.0, 19.8) to (5.0, 14.6)

*ignore continuation of line in either direction*

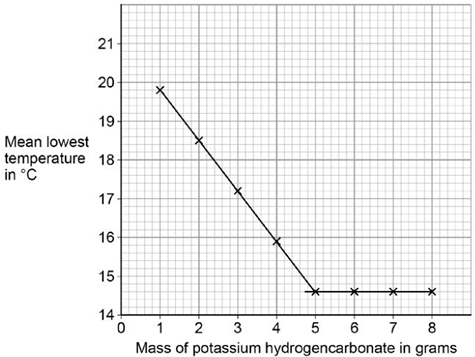
**1**

horizontal straight line from (5.0, 14.6 to 8.0, 14.6)

*ignore continuation of line in either direction*

**1**

the answer below scores **2** marks



(i)       (lowest) temperature decreases

**1**

to 14.6 °C

**or**

until 5 g added

**1**

then no change to temperature (after 5 g solid added)

**or**

then temperature remains at 14.6 °C (after 5 g solid added)

**1**

**[15]**

**Q4.** (a)     water / H2O*allow steam or hydrogen oxide*

**1**

(b)     (i)      A

**1**

(ii)     exothermic

**1**

products (energy) lower than reactants (energy)

**1**

(iii)     1860 (kJ)

**1**

(c)     (i)      22.5

**1**

38.7

**1**

16.2

*allow ecf for correct subtraction*

**1**

(ii)     50 (g)

**1**

(iii)    20.1 (kJ) *allow propanol* *ignore 3*

**1**

(iv)    as the number of carbon atoms (in one molecule of alcohol) increases the heat energy given out increases (when the alcohol is burned)

**1**

(v)     any **two** from:

•        no lid

•        no insulation

•        no draught shield

*Allow heat / energy loss to surroundings for any one of these marks*

•        incomplete combustion

•        inaccurate measurement

•        no repeats (to calculate a mean)

**2**

(iv)    -O-H

**1**

**[14]**

**Q5.** (a)     the chemical reaction is reversible

**1**

(b)     any **two** from:

•   type of electrode

•   electrolyte

•   concentration of electrolyte

•   temperature

**2**

(c)     H2 + **2**OH− → **2**H2O + **2** e−

*allow multiples*

**1**

(d)     contains OH− ions

**1**

(e)     (bonds broken)

((6 × 412) + (2 × 360) + (2 × 464) + (3 × 498)) = 5614

**1**

(bonds made)

((4 × 805) + (8 × 464)) = 6932

**1**

(overall energy change)

(6932 − 5614) = −1318 (kJ / mol)

*allow ecf from marking point 1 and / or marking point 2*

**1**

*an answer of 1318 (kJ / mol) scores* ***3*** *marks*

**[8]**

**Q6.** (a)    eg plastic (beaker) / insulation / lid / cover **or** any mention of enclosed

*any sensible modification to reduce heat loss*

*ignore prevent draughts*

*ignore references to gas loss*

*ignore bomb calorimeter*

**1**

(b)     all the substances react **or** all (the substances) react fully / completely **or** heat evolved quickly **or** distribute heat

*‘so they react’ is insufficient for the mark*

*accept increase chances of (successful) collisions / collision rate increase*

*do* ***not*** *accept rate of reaction increase / make reaction faster*

**1**

(c)     experiment 2 **and**   
different / higher / initial / starting temperature

*accept experiment 2* ***and*** *the room is hotter / at higher temperature*

*do* ***not*** *accept temperature change / results higher*

**1**

(d)     temperature change does not fit pattern

*accept anomalous / odd* ***or*** *it is the lowest* ***or*** *it is lower than the others* ***or*** *it is different to the others*

*‘results are different’ is insufficient*

**1**

(e)     7 / 7.0

**1**

(f)     (100 × 4.2 × 7) = 2940 *ecf from (e)*

**1**

(g)     diagram A **and**   
reaction exothermic / heat evolved / Δ H is negative / temperature rises

*accept energy is lost (to the surroundings)*

*accept energy of products lower than reactants*

*allow arrow goes downwards*

**1**

**[7]**

**Q7.** (a)     (i)      energy / heat of products less than energy of reactants

*allow converse*

*allow products are lower than reactants*

*allow more energy / heat given out than taken in*

*allow methanol is lower*

*allow energy / heat is given out / lost*

*allow ΔH is negative*

**1**

(ii)     lowers / less activation energy *allow lowers energy needed for reaction****or*** *it lowers the peak/ maximum*

*do* ***not*** *allow just ‘lowers the energy’*

**1**

(b)     (i)      (8 × 435) + 497 = 3977

*accept: bonds broken: (2 × 435) + 497 = 1367*

**1**

(6 × 435) + (2 × 336) + (2 × 464) = 4210

*bonds made: (2 × 336) + (2 × 464) = 1600*

**1**

3977 – 4210 = (–) 233

*energy change:*

*1367 – 1600 = (–) 233*

*ignore sign*

*allow ecf*

*correct answer (233) =* ***3*** *marks with or without working*

**1**

(ii)     energy released forming (new) bonds is greater than energy needed to break (existing) bonds *allow converse*

*do* ***not*** *accept energy needed to form (new) bonds greater than energy needed to break (existing) bonds*

**1**

**[6]**

**Q8.** (a)     electrical

**1**

(b)     using hydrogen saves petrol / diesel / *crude oil*

*allow crude oil is non-renewable*

*ignore hydrogen is renewable*

**1**

*using hydrogen (in fuel cells) does not cause pollution*

*accept no carbon dioxide produced*

*allow less carbon dioxide produced allow hydrogen produces only water*

**1**

(c)     (i)      (–)486

*correct answer with or without working gains* ***3*** *marks*

*if answer is incorrect:*

*(2 × 436) + 498* ***or*** *1370 gains* ***1*** *mark*

*4 × 464* ***or*** *1856 gains* ***1*** *mark*

*correct subtraction of ecf gains* ***1*** *mark*

**3**

(ii)     products lower than reactants

**1**

*reaction curve correctly drawn*

**1**

activation energy labelled

**1**

**[9]**

**Q9.** (a)     CH4     +     2O2     →     CO2     +     2H2O*allow multiples*

**1**

(b)     3444 J

*if answer incorrect:*

*one mark for temperature increase = 16.4 °C*

*one mark for mass of water = 50 g*

*ecf for one incorrect value gains two marks for correct calculation*

*no ecf for two incorrect values*

**3**

(c)     (i)      1276 (kJ per mole)

*ignore + or -*

*if answer incorrect:*

*[(5 × 413) + 347 + 358 + 467] + [(3 × 495)] = 4722 (1 mark)*

*[(4 × 799) + (6 × 467)] = 5998 (1 mark)*

*correct subtraction of calculated energy values (1 mark)*

**3**

(ii)     because energy released when bonds form is greater than energy used when bonds broken

*allow converse*

*if no mark awarded allow one mark for energy is used to break bonds*

*or*

*one mark for energy is released when bonds form*

**2**

(iii)    products line lower than reactants

**1**

activation energy labelled

**1**

overall energy change labelled

**1**

**[12]**

**Q10.** (a)     circle round any one (or more) of the covalent bonds

*any correct indication of the bond − the line between letters*

**1**

(b)     Methane contains atoms of two elements, combined chemically

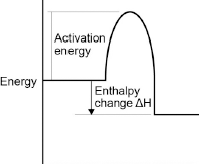
**1**

(c)     (i)      activation energy labelled from level of reagents to highest point of curve

*ignore arrowheads*

**1**

enthalpy change labelled from reagents to products



*arrowhead* ***must*** *go from reagents to products only*

**1**

(ii)     2 O2

**1**

2 H2O

*if not fully correct, award* ***1*** *mark for all formulae correct.*

*ignore state symbols*

**1**

(iii)    carbon monoxide is made

**1**

this combines with the blood / haemoglobin **or** prevents oxygen being carried in the blood / round body **or** kills you **or** is toxic **or** poisonous

*dependent on first marking point*

**1**

(iv)    energy is taken in / required to break bonds

*accept bond breaking is endothermic*

**1**

energy is given out when bonds are made

*accept bond making is exothermic*

**1**

the energy given out is greater than the energy taken in

*this mark only awarded if both of previous marks awarded*

**1**

(d)     (i)      energy to break bonds = 1895

*calculation with no explanation max = 2*

**1**

energy from making bonds = 1998

**1**

1895 − 1998 (= −103)

**or**

energy to break bonds = 656

energy from making bonds = 759

656 − 759 (= −103)

*allow: bonds broken − bonds made =*

*413 + 243 − 327 − 432 = -103 for 3 marks.*

**1**

(ii)     The C — Br bond is weaker than the C — Cl bond

**1**

**[15]**

**Q11.** (a)     products are at a lower energy level than reactants

*if candidate has drawn a profile for an endothermic reaction penalise first marking point only*

**1**

activation energy correctly drawn and labelled

**1**

ΔH correctly labelled

**1**

(b)     (i)      –93 (kJ per mole)

*correct answer with or without working gains* ***3*** *marks*

*allow* ***2*** *marks for +93 kJ per mole*

*if any other answer is seen award up to* ***2*** *marks for any two of the steps below:*

*bonds broken (614 + 193) = 807 (kJ)* ***or*** *(614 + 193 + (4 × 413)) = 2459(kJ)*

*bonds formed (348 + 276 + 276) = 900(kJ)* ***or*** *348 + (2 × 276) + (4 × 413) = 2552(kJ)*

*bonds broken – bonds formed*

*allow ecf for arithmetical errors*

**3**

(ii)     more energy is released when the bonds (in the products) are formed

**1**

than is needed to break the bonds (in the reactants)

*if no other marks gained, allow* ***1*** *mark for energy released for bond making* ***and*** *energy used for bond breaking*

**1**

**[8]**