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**CHEMISTRY**

**UNIT 1**

**2018**

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

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

# TIME ALLOWED FOR THIS PAPER

## Reading time before commencing work: ten minutes

Working time for the paper: three hours

# MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER

**To be provided by the supervisor:**

This Question/Answer Booklet

Multiple-choice Answer Sheet

Chemistry Data Book

**To be provided by the candidate:**

Standard items: pens (blue/black preferred), pencils (including coloured), sharpener,

eraser, correction tape/fluid, ruler, highlighters

Special items: up to three non-programmable calculators approved for use in the WACE examinations

# IMPORTANT NOTE TO CANDIDATES

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

**Structure of this paper**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Section | Number of questions available | Number of questions to be answered | Suggested working time  (minutes) | Marks available | Percentage of exam |
| Section One:  Multiple-choice | 25 | 25 | 50 | /50 | /30 |
| Section Two:  Short answer | 9 | 9 | 60 | /60 | /35 |
| Section Three:  Extended answer | 4 | 4 | 70 | /60 | /35 |
|  | | | | | /100 |

**Instructions to candidates**

1. Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice Answer Sheet provided. For each questions shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Sections Two and Three: Write your answers in this Question/Answer Booklet.

2. When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

3. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

4. Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

* + Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
  + Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

5. The Chemistry Data Book is **not** handed in with your Question/Answer Booklet.

**Section One: Multiple-choice 25% (50 marks)**

This section has **25** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 50 minutes.

1. What is the identity of this species?

+

+

n

+

n

n

n

e

e

+

n

e

proton

neutron

electron

1. Helium atom
2. Lithium atom
3. Helium ion
4. Lithium ion

2. Covalent substances are generally not able to conduct electricity because

1. their electrons are localised.
2. their electrons are delocalised.
3. their electrons are transferred.
4. their electrons are shared.

3. Which of the following is **not** an example of how a nanomaterial differs from its bulk material form?

(a) Nanoparticles of gold may appear pink in colour.

(b) Nanoparticles of gold may be used to treat cancer.

(c) Nanoparticles of gold are soluble in water.

(d) Nanoparticles of gold are highly reactive.

4. Which of the following formulas represents a substance that contains twice as much hydrogen as oxygen, and half as much carbon as oxygen?

1. C4H8O6
2. C2H6O3
3. C3H12O6
4. C5H10O3

5. Which of the following is a mixture of more than one kind of molecule?

1. Ammonia
2. Cobalt chloride
3. Salt water
4. Sulfur trioxide

6. Which one of the following has the same electron configuration as a calcium ion?

(a) magnesium

(b) potassium

(c) titanium

(d) argon

7. Which element is found in group 15, period 5?

1. Tin
2. Antimony
3. Polonium
4. Bismuth

8. How many electrons are in the valence shell of the following species?

**Mg Al3+ O2- P**

1. 2 3 6 5
2. 2 8 8 5
3. 1 6 4 8
4. 2 0 8 8

9. Which of the following isotopes is likely to be the **least** commonly occurring?

1. carbon-12
2. sulfur-32
3. iron-55
4. nitrogen-16

10. Which of the formulas below is **incorrect**?

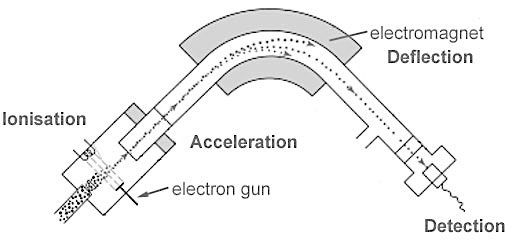
(a) Ba2F

(b) CaS

(c) Na3P

(d) AlCl3

11. The following is a simplified diagram showing how a mass spectrometer works. When a sample is analysed by mass spectrometry, it undergoes a series of four (4) steps.



For which of the four steps is the electromagnet responsible?

1. Ionisation
2. Acceleration
3. Deflection
4. Detection

12. Which of the following substances is **not** able to conduct electricity?

1. NaCl(aq)
2. Au(s)
3. KF(s)
4. Hg(l)

13. Which of these chemical equations represents an exothermic reaction?

(i) CO + H2O → H2 + CO2 + 41 kJ

(ii) CH4 + H2O → CO + 3 H2 ΔH = +206 kJ

(iii) N2O3 + 40 kJ → NO + NO2

1. (i) only
2. (ii) only
3. (iii) only
4. (ii) and (iii) only

14. Which of these organic compounds has a different molecular formula to the others?

1. oct-3-ene
2. 2,3,3-trimethylpent-1-ene
3. 3-ethylhept-2-ene
4. 3,4-dimethylhex-3-ene

15. Element X is in group 16 of the periodic table. Which of the following compounds is **least** likely to form?

1. H2X
2. NaX
3. MgX
4. F2X

16. Ionic substances are brittle because

1. electrons have been transferred between species.
2. electrons are shared between species.
3. they are solids at room temperature.
4. the charged species are arranged in a rigid lattice.

17. Which of these is **not** a correct IUPAC name?

1. 2,2-dichloropent-3-ene
2. 2-methylbut-1-ene
3. methylpropane
4. 1,2,2-tribromohexane

18. What are the coefficients in this equation once correctly balanced?

\_\_\_ NH3(g) + \_\_\_ O2(g) → \_\_\_ NO(g) + \_\_\_ H2O(l)

1. 2, 2, 2, 3
2. 1, 3, 1, 2
3. 4, 2, 3, 5
4. 4, 5, 4, 6

19. What is the name given to the elements in group 17?

1. Halogens
2. Alkali metals
3. Alkaline earth metals
4. Noble gases

20. Which of the following could **not** result in a substitution reaction?

1. propane mixed with chlorine water
2. benzene mixed with aqueous iodine
3. pent-1-ene mixed with bromine water
4. chloromethane mixed with aqueous chlorine

21. Which of the following contains the greatest number of **atoms**?

1. 3.0 g of Pb
2. 0.01 mol of Ca
3. 0.005 mol of NaCl
4. 0.28 g NO2

22. Which of the following are covalent compounds?

1. Hydrogen peroxide
2. Carbon monoxide
3. Potassium hydroxide
4. Copper(II) phosphate
5. Sulfurous acid
6. (i), (ii) and (v) only
7. (ii) and (v) only
8. (i) and (ii) only
9. (ii), (iii) and (v) only

23. Which of the following atoms will have the smallest atomic radius?

* 1. F
  2. Cℓ
  3. S
  4. O

24. The total number of hydrogen atoms in 2 moles of ethanoic acid (CH3COOH) is approximately equal to

(a) 6.

(b) 8.

(c) 3.6 x 1024.

(d) 4.8 x 1024.

25. Which of these is closest to the molar mass of zinc hydrogen sulfate?

(a) 162.5 g

(b) 194.5 g

(c) 227.8 g

(d) 259.5 g

End of Section One

**Section Two: Short answer 35% (70 marks)**

This section has **10** questions. Answer **all** questions. Write your answers in the spaces provided.

When calculating numerical answers, show your working or reasoning clearly. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

* Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
* Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 60 minutes.

**Question 26 (6 marks)**

Two sulfur-containing compounds that have very different properties are aluminium sulfate (Al2(SO4)3) and sulfuric acid (H2SO4). Explain, in terms of structure and bonding, why aluminium sulfate is a solid at room temperature, whereas pure sulfuric acid is an oily liquid.

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**Question 27 (8 marks)**

(a) Complete the table below by; (6 marks)

* drawing structural formulas showing **all bonds and atoms**, and
* writing the molecular formula for each organic molecule.

|  |  |  |
| --- | --- | --- |
|  | Structural diagram | Molecular formula |
| 2,2,3-trimethylbutane |  |  |
| 3-ethylpent-2-ene |  |  |
| methylbenzene |  |  |

(b) Which of the organic compounds above contains the highest percentage of carbon by mass? Calculate this value. (2 marks)

**Question 28 (8 marks)**

Consider the elements labelled A-E on the diagram below, which shows the first four periods of the periodic table.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | B |  |  |  |  |  |  |  |  |  |  |  |  |  | C | D |  |
| E |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

(a) Why are A and E both in group 1? (1 mark)

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(b) Why are B, C and D all in period 2? (1 mark)

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(c) Why would atoms of element C and E form chemical bonds? State the type of compound formed and describe how the chemical bonds form. (3 marks)

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(d) Why would atoms of element C and D form chemical bonds? State the type of compound formed and describe how the chemical bonds form. (3 marks)

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**Question 29 (6 marks)**

Consider the diagram below.

melting boiling

H2O(s) H2O(l) H2O(g)

solidification condensation

(a) Name one (1) of the labelled phase changes that is **endothermic**. Justify your choice. (3 marks)

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Bioluminescent Bay in Puerto Rico is a popular tourist attraction because of the microorganisms that live in the water. These types of organisms glow in the dark because they produce light by a special chemical reaction.

(b) Explain why this reaction is exothermic. (3 marks)

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**Question 30 (8 marks)**

All matter can be classified as either pure substances or mixtures.

(a) Complete the table below by writing the name or formula of the compound, as well as classifying the compound as having consistent properties with either an ionic or covalent substance. (6 marks)

|  |  |  |
| --- | --- | --- |
| Name | Formula | Covalent or ionic properties |
| Ammonium carbonate |  |  |
|  | Fe(NO3)3 |  |
| Ethanoic acid |  |  |

The table above refers only to pure substances.

(b) State two (2) ways a mixture differs from a pure substance. (2 marks)

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**Question 31 (7 marks)**

Complete the table below, showing the subatomic particle arrangement of the four different species.

|  |  |  |  |
| --- | --- | --- | --- |
| Symbol | Number of protons | Number of neutrons | Electron configuration |
| 19F |  |  |  |
|  | 11 | 12 | 2, 8 |
| 32S2- |  | 16 |  |
|  | 6 | 8 | 2, 4 |

**Question 32 (7 marks)**

Salts containing the metal potassium (K) have a characteristic lilac (purple) colour in a flame test. A chemistry student was planning on performing flame tests on a series of different salt samples, trying to find one that contained a rare isotope of potassium. However, the student decided that the flame test would not be reliable as the isotope flame colour would be different from usual.

(a) What is an isotope? (2 marks)

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(b) Was the student correct? Explain. (3 marks)

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The relative atomic mass (Ar) of potassium is 39.10.

(c) What is the Ar of an element? What does it indicate that the Ar of potassium is close to the whole number of 39? (2 marks)

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**Question 33 (9 marks)**

Nanosilver is an example of a nanomaterial and refers to an extremely finely divided form of silver. Nanosilver is used widely due to its ability to function as an antibiotic and disinfectant.

(a) What is a nanomaterial? (2 marks)

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Despite its beneficial qualities, there may be potential negative side effects from the use of nanosilver. Some people who have been exposed to high levels of silver, for example in certain medications, have developed a condition where their skin turns blue.

(b) Why should products containing nanomaterials be carefully monitored? (2 marks)

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It is thought that the antibacterial properties of nanosilver occur when silver ions (Ag+) are released by the silver nanoparticles.

(c) What is an ion? Explain how a silver ion forms. (3 marks)

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A nurse used a bandage coated with 0.0837 g of nanosilver to cover a serious burn on a patient’s arm and prevent it becoming infected.

(d) Calculate the number of atoms of silver present on the bandage. (2 marks)

**Question 34 (5 marks)**

Complete the reactions below by drawing structural formulas or naming the substances as required.

(a)

Name:

+ Br2 →



Name:

Structural formula:

(b)

Name:

Formula:

+ I2 → +



**Section Three: Extended answer 40% (80 marks)**

This section contains **five (5)** questions. You must answer **all** questions. Write your answers in the spaces provided below.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures.

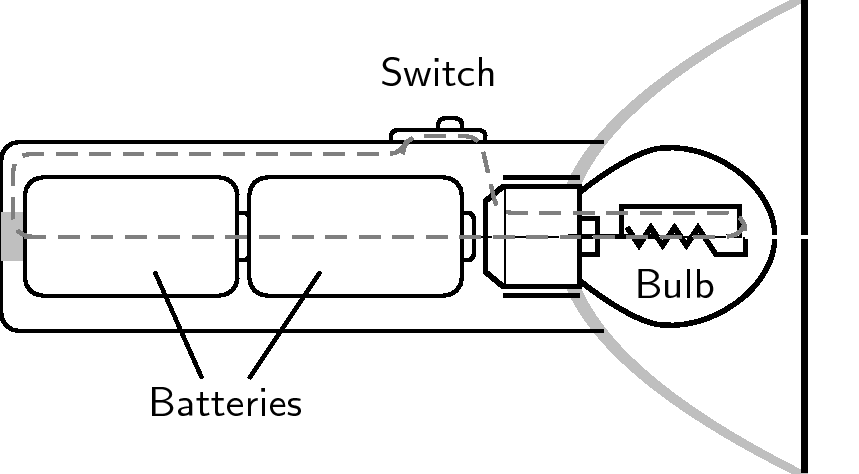
Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

* Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
* Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 70 minutes.

**Question 35 (10 marks)**

Study the following diagram of a torch (flashlight). Several components have been labelled and some information about the properties of these materials has also been included.



Ammonium chloride (NH4Cl) paste

- used as a component in batteries because it **conducts electricity.**

Glass / Silicon dioxide (SiO2)

- used to protect the bulb because it is **hard** and **strong.**

Plastic ((C2H4)x)

- used to make the body of the torch because it is a **soft substance** that can be **shaped easily.**

Copper (Cu)

- used for the wiring because it is **malleable** and **conducts electricity.**

Explain why each of the labelled materials has been used in this torch. Your answer should focus on the type of bonding present in each of the four (4) labelled components, as well as an explanation of their main properties (shown in **bold**), in terms of the structure and bonding present.

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**Question 36 (18 marks)**

Three groups of chemistry students (A, B and C) were investigating endothermic and exothermic reactions. Each group was given one reaction to study, as shown in the table below.

|  |  |
| --- | --- |
| **Group A** | HCl(aq) + NaHCO3(aq) → NaCl(aq) + CO2(g) + H2O(l) |
| **Group B** | CuSO4(aq) + Mg(s) → MgSO4(aq) + Cu(s) |
| **Group C** | Ba(OH)2(s) + 2 NH4SCN(s) → Ba(SCN)2(aq) + 2 H2O(l) + 2 NH3(g) |

Each group planned their experiment, with the aim to investigate whether their reaction was endothermic or exothermic. They mixed their reagents together in test tubes and recorded the initial temperature of the system, as well as the final temperature once the reaction was finished.

The incomplete results of each group are shown in the tables below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Group A** | **Trial 1** | **Trial 2** | **Trial 3** |
| Initial temp (°C) | 20.5 | 20.0 | 21.5 |
| Final temp (°C) | 17.0 | 16.0 | 18.0 |
| Temperature change (°C) | - 3.5 |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Group B** | **Trial 1** | **Trial 2** | **Trial 3** |
| Initial temp (°C) | 22.5 | 21.5 | 23.0 |
| Final temp (°C) | 25.0 | 26.5 | 26.5 |
| Temperature change (°C) | + 2.5 |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Group C** | **Trial 1** | **Trial 2** | **Trial 3** |
| Initial temp (°C) | 18.5 | 19.0 | 19.5 |
| Final temp (°C) | 4.0 | 5.5 |  |
| Temperature change (°C) | -14.5 |  |  |

The final temperature reading of group C is shown on the thermometer to the right.

15

10

5

0

-5

-10

-15

(a) Complete the tables on the previous page, by reading the final result for group C and recording it in the correct table. Then fill in any other values that are missing, by calculating the change in temperature (i.e. final – initial). (4 marks)

The following diagrams represent the energy changes that can occur during a reaction, as well as illustrate whether a reaction is endothermic or exothermic.

**Diagram X Diagram Y**

Reactants

Products

H

Progress of reaction

Reactants

Products

H

Progress of reaction

Choose **one** of the reactions investigated (A, B or C) that corresponds to Diagram X.

(b) State the reaction (A, B or C) and explain what information this diagram provides in terms of the bond breaking and bond making that has occurred in your chosen reaction. (3 marks)

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Choose **one** of the reactions investigated (A, B or C) that corresponds to Diagram Y.

(c) State the reaction (A, B or C) and explain why this diagram represents your chosen reaction. Include a description of how the Law of Conservation of Energy relates to this diagram. (4 marks)

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(d) Explain why the groups would have chosen to carry out three trials. (2 marks)

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(e) Which group had the lowest random error? Justify your answer. (2 marks)

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Group B realised that they had forgotten to ‘tare’ (reset to zero) the balance they used to weigh out the magnesium metal. This resulted in them using **less** Mg(s) than intended in each trial.

(f) Is this a random or systematic error? Justify your choice and state the likely effect that this error would have had on the final temperatures that group B measured (i.e. higher, lower or unchanged)? (3 marks)

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**Question 37 (14 marks)**

Diesel is a fuel that can be obtained from crude oil. It is used in most forms of transport, from trucks, cars and tractors to aircraft and rail cars. Biodiesel is most commonly produced from vegetable oil in a chemical reaction called transesterification. It can be used in pure form, in many of the same vehicles as regular diesel, however it is often used as a biodiesel-diesel mix.

(a) Briefly describe two (2) advantages of using biofuels instead of fossil fuels as an energy source. (2 marks)

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(b) State two (2) reasons it is not always possible for people to use biofuels. (2 marks)

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(c) Ethanol is an example of a biofuel that is described as being ‘carbon neutral'. Explain what is meant by the expression ‘carbon neutral’ (2 marks)

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(d) Ethanol is an example of a biofuel that is described as being ‘carbon neutral'. Explain what is meant by the expression ‘carbon neutral’ (2 marks)

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(e) Suggest two reasons why most people have not switched to using ethanol powered cars. (2 marks)

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(f) Biodiesel produces much less sulfur dioxide when it is burned than normal diesel does. Explain why this is an advantage. (2 marks)

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(g) Explain one positive and one negative social impact of producing and using biodiesel. (2 marks)

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**Question 38 (13 marks)**

Meteorites that hit the Earth’s surface can provide scientists with information about the chemical composition of objects in different parts of our solar system or galaxy. A sample of ice was taken from a meteorite that landed in the Australian outback, and the extra-terrestrial water was analysed to determine the presence of various elements.

Atomic absorption spectroscopy (AAS) was used to determine the presence and concentration of various elements in the extra-terrestrial water, including silicon. AAS is an effective technique because each element has it’s own characteristic absorption / emission spectrum.

(a) Explain how electron absorption / emission spectra are related to the electron shells (levels) of an element. (4 marks)

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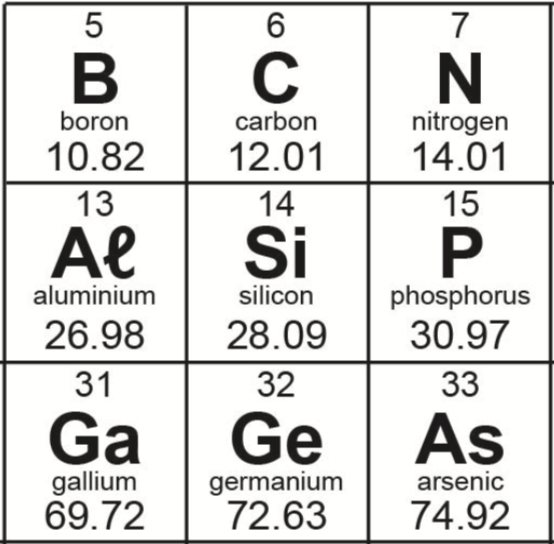
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AAS determined that there was some silicon present in the extra-terrestrial water. Some of the silicon sample was isolated and sent for analysis by mass spectrometry, to determine if the isotopic forms of this silicon were the same as those found on Earth.

The results of the mass spectrometry are shown below.

(b) Calculate the relative atomic mass (Ar) of this extra-terrestrial silicon, and comment on its similarity to the silicon found on Earth. (3 marks)

A portion of the periodic table, showing the elements surrounding silicon, is given below. Consider the five elements in the diagram.



(c) Of these elements, germanium has the largest atomic radius and the smallest first ionisation energy. Explain why. (3 marks)

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(d) Define electronegativity, and state and explain the trend in electronegativity as you move left to right from aluminium to phosphorus. (3 marks)

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End of questions

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**Acknowledgements**

**Question 11** *Source: http://scienceaid.co.uk/chemistry/fundamental/particles.html*

**Question 36** *Source:  OpenStax, Physics - grade 10 [caps 2011]. OpenStax CNX. Jun 14, 2011 Download for free at*[*http://cnx.org/content/col11298/1.3*](http://cnx.org/content/col11298/1.3)