* Test papers must be withdrawn after use and stored securely in the school until Friday 15th June 2018.





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

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# TIME ALLOWED FOR THIS PAPER

## Reading time before commencing work: ten minutes

Working time for the paper: two and a half 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 (aprox) |
| --- | --- | --- | --- | --- | --- |
| Section One:  Multiple-choice | 20 | 20 | 30 | /40 | /25 |
| Section Two:  Short answer | 8 | 8 | 60 | /68 | /35 |
| Section Three:  Extended answer | 5 | 5 | 60 | /72 | /40 |
|  | | | | | /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% (40 marks)**

This section has **20** 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: 35 minutes.

1. What is the identity of this species?



1. Helium atom
2. Lithium atom
3. Helium ion
4. Lithium ion
5. Covalent substances are generally not able to conduct electricity because
6. their electrons are localised.
7. their electrons are delocalised.
8. their electrons are transferred.
9. their electrons are shared.
10. Which of the following formulas represents a substance that contains twice as much hydrogen as oxygen, and half as much carbon as oxygen?
11. C4H8O6
12. C2H6O3
13. C3H12O6
14. C5H10O3
15. Which of the following is not a pure substance?
16. Ammonia
17. Cobalt chloride
18. Salt water
19. Sulfur trioxide

A beaker contained a mixture of copper(II) sulfate, water and oil, as shown in the diagram below. It was separated in a series of steps, as indicated in the diagram.



1. What are the names of the processes, X and Y, used to perform these separation steps?

**X Y**

(a) filtration evaporation

(b) filtration decantation

(c) decantation filtration

(d) decantation evaporation

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

1. Tin
2. Antimony
3. Polonium
4. Bismuth
5. How many electrons are in the valence shell of the following species?

**Mg Al3+ O2- P**

1. 2 3 6 5
2. 2 13 8 5
3. 1 6 4 8
4. 2 0 8 5
5. Which of the following isotopes is likely to be the least commonly occurring?
6. carbon-12
7. sulfur-32
8. iron-55
9. nitrogen-16

1. Which of the formulas below is incorrect?

(a) Ba2F

(b) CaS

(c) Na3P

(d) AlCl3

1. 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
5. Which of the following substances is not able to conduct electricity?
6. NaCl(aq)
7. Au(s)
8. KF(s)
9. Hg(l)
10. Element X is in group 16 of the periodic table. Which of the following compounds is least likely to form?
11. H2X
12. NaX
13. MgX
14. F2X
15. The best explanation for why ionic substances are brittle is:
16. electrons have been transferred between species.
17. electrons are shared between species.
18. they are solids at room temperature.
19. movement causes similar charges to align.
20. What is the name given to the elements in group 17?
21. Halogens
22. Alkali metals
23. Alkaline earth metals
24. Noble gases

The boiling points of the first three Group 15 hydrides are shown in the table below.

|  | Boiling point (°C) |
| --- | --- |
| NH3 | -33 |
| PH3 | -88 |
| AsH3 | -63 |

1. Which of the following statements are correct?
2. NH3 has the strongest dispersion forces
3. All the molecules have dipole-dipole forces
4. NH3 has the strongest intermolecular forces
5. NH3 is the only molecule to have hydrogen bonding
6. AsH3 is the most polar molecule
7. (ii) and (iv) only
8. (i), (ii) and (iv) only
9. (i), (iii) and (iv) only
10. (ii), (iii) and (iv) only
11. Approximately 80 g of solid copper sulfate is added to water in a beaker and stirred. Some time after the mixture settles, there is a clear blue liquid with some blue crystals at the bottom of the beaker. Which of the following statements is true?
    1. The clear liquid is a saturated solution.
    2. Adding more copper sulfate crystals will make the blue colour deeper.
    3. The beaker contains a homogeneous mixture.
    4. Adding more water will increase the concentration of the solution as more solid will dissolve.
12. Which of the following are covalent compounds?
13. Hydrogen peroxide
14. Carbon monoxide
15. Potassium hydroxide
16. Copper(II) phosphate
17. Ammonia
18. (i), (ii) and (v) only
19. (ii) and (v) only
20. (i) and (ii) only
21. (ii), (iii) and (v) only

**Questions 18, 19 and 20 relate to three common allotropes of carbon; diamond, graphite and fullerenes.**

Consider the list of physical properties given below.

1. Conductor of electricity
2. High melting point
3. Hard substance
4. Inert (unreactive) substance
5. Atoms form a three dimensional network shape
6. Which of these properties correspond to diamond?

(a) (i), (ii) and (iv) only

(b) (ii), (iii) (iv) and (v) only

(c) (i), (iii) and (v) only

(d) (ii), (iii) and (v) only

1. Which of these properties correspond to graphite?
2. (i) and (iv) only
3. (ii) and (v) only
4. (i), (ii) and (iv) only
5. (i), (iii) and (v) only
6. The most significant property that distinguishes fullerenes from both diamond and graphite is their
7. electrical conductivity.
8. size.
9. elemental composition.
10. strength.

End of Section One

**Section Two: Short answer 35% (68 marks)**

This section has **8** 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 21 (12 marks)**

Write ionic equations for any reactions that would occur when the following pairs of solutions are mixed. Write “**no reaction**” if the pair of solutions would not react. For each of the example write the observations that you would make. Write “**no visible reaction**” if nothing would be observed on mixing the solutions.

1. Sodium sulfate and lead nitrate (4 marks)

Equation

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Observation

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1. Potassium iodide and lead nitrate (4 marks)

Equation

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Observation

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1. Copper II chloride and silver nitrate (4 marks)

Equation

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Observation

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**Question 22 (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) What do elements A and E in group 1have in common (1 mark)

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(b) What do elements B, C and D in period 2 have in common (1 mark)

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(c) Why would atoms of C and E chemically combine? Name the type of bond formed and describe the nature of the chemical bonds formed. (3 marks)

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(d) Why would atoms of C and D chemically combine? Name the type of bond formed and describe the nature of the chemical bonds formed. (3 marks)

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**Question 23 (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 24 (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 25 (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 meant by relative atomic mass? Why is the Ar of potassium not a whole number? (2 marks)

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**Question 26 (8 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? (1 mark)

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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) What are the potential risks of using products containing nanomaterials? (2 marks)

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The properties of nanoparticles differ from those of the bulk in many ways. It is believed that the antibacterial properties of nanosilver occur when silver ions (Ag+) are released at the corners of silver crystals. Chemical reactivity is also dependent on surface effects particularly at the edges of crystals. Nano particles of gold may react where bulk gold may be inert. The colour of the nano particles is determined by their size. Small sizes are more efficient at absorbing small wavelengths of light such as blue or green making a solution of the particles appear red. Larger particles absorb longer (red) wavelengths so the solution appears more blue.

(c) Why is nanosilver so much more effective as an antibiotic than bulk silver. (2 marks)

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1. During the formation of nanogold the solution was seen to change from a blue to a red colour. Does this indicates nanoparticles growing or being reduced in size. (2 marks

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1. Name one property where gold differs in its bulk form to that of its nanoparticles

(1 mark)

**Question 27 (11 marks)**

For each of the following pairs of molecules;

1. Circle the one that you would expect to have the highest boiling point, and
2. Give a brief explanation for your choice.
3. hydrogen fluoride OR hydrogen chloride (2 marks)

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1. carbon dioxide OR sulfur dioxide (3 marks)

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1. bromine OR iodine (3 marks)

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1. CH3OH or CH2O (3 marks)

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**Question 28 [7 marks]**

1. Write the electronic configuration of a sodium atom and a magnesium atom. (2 mark)

Sodium Magnesium

The first five ionisation energies of sodium and magnesium in MJ mol-1 are shown below:

| Ionisation | 1st | 2nd | 3rd | 4th | 5th |
| --- | --- | --- | --- | --- | --- |
| Sodium | 0.502 | 4.569 | 6.919 | 9.550 | 13.356 |
| Magnesium | 0.744 | 1.457 | 7.739 | 10.547 | 13.636 |

1. Account for the difference in the 1st ionisation energies of sodium and magnesium? (2 marks)

1. Account for the difference in the 2nd ionisation energies of sodium and magnesium? (2 marks)

1. Explain the progressive increase in ionisation energy of the sodium as we go from 1st to 5th ionisation. (1 mark)

**End of Section Two**

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**Section Three: Extended answer 40% (72 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 29 (14 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.



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 30 (14 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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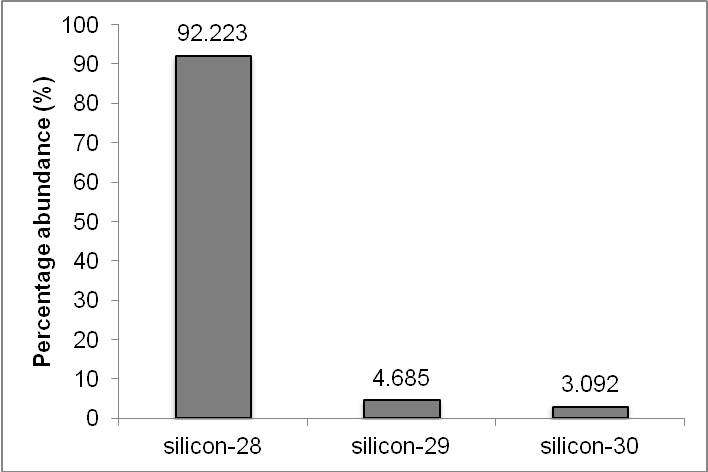
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AAS determined that there was some silicon present in the extra-terrestrial water. Some of the silicon sample was isolated and sent for analysis by mass spectrometry, to determine if the isotopic forms of this silicon were the same as those found on 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. (4 marks)

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**Question 31 (17 marks)**

This question is about the properties of water

(a) In cold climates, bodies of water such as ponds and lakes can freeze. The ice floats on the top of water because it is less dense than the liquid water. This allows the aquatic life in the water to survive during the colder months.

Describe, using a diagram, intermolecular bonding in solid ice and explain why the volume of the water increases (and the density reduces) when it changes from liquid water to solid ice. (5 marks)

(b) Many insects and spiders are able to walk on the surface of water but they are unable to walk on the surface of volatile liquids such as acetone (CH3COCH3) and petrol (C8H10).

i) Use a suitable diagram to show how the intermolecular forces present allow this to occur in water but not the other liquids. (6 marks)

ii) If salt was added to the water explain whether this would increase or decrease the insects ability to walk on water. (2 marks)

(c) Water is the most commonly used solvent, but it cannot dissolve non polar hydrocarbons such as oil, petrol and grease.

Explain, using your knowledge of intermolecular bonding why water is **unable** to dissolve these types of substances.

(4 marks)

**Question 32 [16 marks]**

Complete the following table showing the Lewis structure (electron dot diagram), shape, name the shape and show the molecular polarity if any for the four species listed.

| **Cl2CO** | **F2CH2** | **ammonia** | **SO2** |
| --- | --- | --- | --- |
| Lewis structure | Lewis structure | Lewis structure | Lewis structure |
| Sketch shape | Sketch shape | Sketch shape | Sketch shape |
| Name shape | Name shape | Name shape | Name shape |
| Polarity (yes or no) | Polarity (yes or no) | Polarity (yes or no) | Polarity (yes or no) |

**Question 33 (11 marks)**























Above is the detector read-out from a high performance gas chromatography apparatus analysing

the organic residues inside a chemical reaction tank using a polar stationary phase in the column.

The mobile phase used was helium, which had a column retention time of 0.6 minutes, as seen from the graph.

(a) Which compound in the tank was present in the greatest concentration? (1 mark)

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The Retention Factor can be calculated by comparing the Retention Time of a substance to the Retention Time of the mobile phase, in this case Helium, using the formula below;

Rf = THe

Tx

(b) Which compound had a Retention Factor of 0.34? Show calculations. (3 marks)

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(c) Which compound being tested is the least polar? Explain. (3 marks)

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(d) By considering the bonding types, explain why the Retention Time for methanamine (CH3NH2) would be the greatest. (2 marks)

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1. There are several different types of chromatography each with their own advantages and disadvantages. Give an example of a situation where gas chromatography would not be a suitable but High Performance Liquid Chromatography may work. (2 marks)

Spare answer page

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