Semester One Examination 2016
Question/Answer Booklet

CHEMISTRY
UNIT 1

Student Name: _____

Teacher's Name: _____

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	/25
Section Two: Short answer	10	10	60	/70	/35
Section Three: Extended answer	9	9	70	/80	/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** to be handed in with your Question/Answer Booklet.

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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.

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1. What is the total number atoms in the formula $Ca_3(PO_4)_2$?

(a) 3
(b) 12
(c) 13
(d) 14

2. Alkanes have the general formula of:

(a) C_XH_{2X+2}
(b) C_XH_{2X-2}
(c) $C_{2X}H_{2X+2}$
(d) $C_{2X}H_{2X-2}$

3. What is the correct sequence for obtaining salt from a mixture of salt and sand?

(a) Evaporation, dissolve in water, filtration.
(b) Filtration, dissolve in water evaporation.
(c) Dissolve in water, filtration, evaporation.
(d) Filtration, evaporation, dissolve in water.

4. Which of the following has been incorrectly balanced?

(a) $Fe_3O_4 + 3H_2 \rightarrow 3Fe + 3H_2O$
(b) $Mg + 2HCl \rightarrow MgCl_2 + H_2$
(c) $2AgNO_3 + CaCO_3 \rightarrow Ca(NO_3)_2 + Ag_2CO_3$
(d) $CuCO_3 \rightarrow CuO + CO_2$

5. The chemical properties of hydrocarbons differ due to the nature of their bonding. Identify which correctly lists the following types of hydrocarbons from least reactive to most reactive.

(a) Alkanes, alkenes, benzene.
(b) Benzene, alkenes, alkanes.
(c) Alkenes, alkanes, benzene.
(d) Alkanes, benzene, alkenes.

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6. Which of the following correctly states the trend for first ionisation energy on the periodic table?

(a) It increases as you move across a period and down a group.
(b) It increases as you move across a period and decreases down a group.
(c) It decreases as you move across a period and down a group.
(d) It decreases as you move across a period and increases down a group.

7. Pure water can be separated from inky water by distillation because:

(a) Pure waters boiling point is just below 100^{o}C.
(b) Water and ink have a very small difference in boiling point.
(c) There will be a visual colour difference at the end of the process.
(d) Water and ink have a large difference in boiling point.

8. Select which of the following is not a property of metals:

(a) They are lustrous.
(b) They have high boiling points.
(c) They are reasonably chemically inactive.
(d) Most are solid a room temperature.

9. Three groups of chemistry students were asked to weigh a standard paperclip with a weight of 0.45g, three times and obtain an average.

Groups	Mass (grams)			Average
1	0.44	0.45	0.44	0.44
2	0.48	0.51	0.50	0.49
3	0.45	0.44	0.46	0.45

Analyse the information and determine (if any) of the groups contain systematic errors.

(a) 1
(b) 2
(c) 1 and 3
(d) None of the three groups contain systematic errors.

10. Select which element has the lowest electronegativity.

(a) N
(b) Li
(c) K
(d) S

11. Which reaction is most likely to produce a white solid?

(a) Silver nitrate reacting with sodium chloride.
(b) Calcium nitrate reacting with potassium hydroxide.
(c) Sodium ethanoate reacting with lithium sulfate.
(d) Hydrochloric acid reacting with magnesium sulfide.

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12. The number of formula units in 5.5 grams of magnesium chloride would be:

(a) $3.5x10^{22}$
(b) $9.6x10^{-26}$
(c) $8.7x10^{-22}$
(d) $1.0x10^{24}$

13. Which of the following correctly names the hydrocarbon below?

$CH_3CH(CH_3)CHBrCHCH_2$

(a) 4-bromo,3-ethyl-1-hexene.
(b) 3-bromo,4-methyl-1-pentene.
(c) 3-bromo,4-methyl-1-pentane.
(d) 4-bromo,3-ethyl-1-pentane.

14. Which of the following correctly states the trends in atomic radii?

(a) As you move across a period the atomic radii increases, and down a group it also increases.
(b) As you move across a period the atomic radii increases, and down a group it decreases.
(c) As you move across a period the atomic radii decreases, and down a group it also decreases.
(d) As you move across a period the atomic radii decreases, and down a group it increases.

15. As the following reaction takes place, the observations that would be seen are;

$H_2SO_4 + CuCO_3 \rightarrow CuSO_4 + H_2O + CO_2$

I. Green solid dissolves
II. Colourless gas formed
III. White solution forms
IV. Blue solution formed
V. Green solid forms

(a) I, II and III
(b) I, II, III and V
(c) I, II and IV
(d) II, V and IV

16. Select the most appropriate explanation why an ionic substance can conduct electricity in aqueous solution but not in the solid form.

(a) In the solid form, the negative ions are fixed within a 3D crystallised lattice that required a large amount of energy to overcome.
(b) In the solid form, the positive ions and delocalised electrons are in a fixed 3D lattice and cannot move.
(c) In the aqueous solution, the delocalised electrons are no longer in a fixed 3D lattice and are free to move and conduct electricity.
(d) In the aqueous solution, the positive and negative ions are no longer in a fixed 3D lattice and are free to move and conduct electricity.

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17. Which of the following is FALSE about valence electrons?

(a) Elements in the same group of the periodic table have the same number of electrons.
(b) Valence electrons are transferred or shared when chemicals react together.
(c) As you move across the period 3, from left to right, the number of valence electrons increases and then decreases.
(d) As you move across the period 3, from left to right, the number of valence electrons increases.

18. As you increase the number of carbon atoms in a hydrocarbon:

(a) It will make it less reactive.
(b) It will turn into the gaseous phase.
(c) The number of electrons increases causing the boiling point to decrease.
(d) The number of electrons increases causing the boiling point to increase.

19. Which of the following would contain discrete molecules?

(a) Bromine gas.
(b) Sodium chloride.
(c) Graphite.
(d) Copper.

20. How many non-bonding pairs of electrons are there in a molecule of nitrogen?

(a) 2
(b) 3
(c) 4
(d) 6

Analyse the information below about the conductivity of three different substances to answer question 21 and 22.

	Conduct electricity		
Substance	**Solid**	**Molten**	**Aqueous**
A	X	X	X
B	X	✓	✓
C	✓	✓	✓

21. From this information is can be concluded that A would most likely contain:

(a) Metallic bonding.
(b) Covalent molecular bonding.
(c) Covalent network bonding.
(d) Ionic bonding.

22. Using the table in question 21 which would have the highest boiling point?

(a) A
(b) B
(c) C
(d) A and B would both have high boiling points.

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23. Which of the following will go through substitution reactions?

I. $CH_3CH_2CH_3$
II. $C_5H_{11}F$
III. $CH_3CH_2CH_2CH(CH_3)CH_3$

(a) I only
(b) I and II
(c) II and III
(d) I, II and III

24. Enthalpy is known as;

(a) The amount of energy required to break bonds.
(b) The difference in energy between reactants and products.
(c) The amount of time it takes for a reaction to occur.
(d) The maximum amount of energy required for the reaction to start.

25. Compared to exothermic reactions, endothermic reactions require:

(a) Less energy to break the existing bonds, than when new bonds are being formed.
(b) More energy to break the existing bonds, than when new bonds are being formed.
(c) The same amount of energy to break the existing bonds, than to form new bonds.
(d) No energy to break the existing bonds, than when new bonds are being formed.

End of Section One

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

This section has **ten (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.

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Suggested working time: 60 minutes.

Question 26 **(4 marks)**

Complete the following by giving the name or formula for the following:

(a) SO_2 _____

(b) Ammonium sulphite _____

(c) $AlPO_4$ _____

(d) Hydrogen carbonate ion _____

(e) CuCl _____

(f) Dinitrogen pentoxide _____

(g) CF_4 _____

(h) Calcium nitrate _____

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Question 27 **(4 marks)**

Draw an atom of lithium. Label the major regions and the sub-atomic particles.

Question 28 **(4 marks)**

State all of the observations that would be seen for the following reactions below. If no observations can be seen, write “no visible reaction”.

(a) An aqueous solution of potassium nitrate is added to a test tube of aqueous barium chloride. (2 marks)

(b) Propene is added into a test tube of of liquid bromine and shaken. (2 marks)

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Question 29 **(4 marks)**

Write balanced ionic equations for the following reactions described below.

(a) An aqueous solution of iron (III) chloride is mixed with an aqueous solution of sodium hydroxide. (2 marks)

(b) A spatula of solid silver carbonate is added to an aqueous solution of magnesium nitrate. (2 marks)

Question 30 **(10 marks)**

(a) Complete the following table. (6 marks)

	Neutrons	**Protons**	**Electron Configuration**	***Gain* or *lose* electrons to form ions?**
Oxygen				
^{23}Na				
Al^{+3}				

(b) Sodium also exists in the form of ^{22}Na. Describe the effects this may have on its physical and chemical properties and give reasons for your answers. (4 marks)

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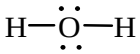
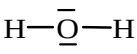
For example, water  or  or )

Question 31 **(8 marks)**

(a) Draw dot diagrams (Lewis structures) for the following. Show all valence shell electron pairs as either : or — (6 marks)

Ne	(2 marks)
NH_4Cl	(2 marks)
$HClO_4$	(2 marks)

(b) Explain why neon does not form compounds like the two other substances in question a. (2 marks)

Question 32 **(11 marks)**

Diamonds, graphite and fullerenes are carbon based substances that have different chemical and physical properties. Using your knowledge and understanding of these substances answer the following questions.

(a) Graphite is an allotrope of carbon. Define what is mean by the word ‘allotrope’. (2 marks)

(b) Diamonds are known for their high degree of hardness and are commonly used for drill bits and saws to cut through surfaces such as; stone, ceramics, glass and gemstones. Explain, based on its chemical structure why diamond is chosen for the purpose of cutting through hard surfaces. (3 marks)

(c) Explain why graphite can conduct electricity whilst diamond cannot. (3 marks)

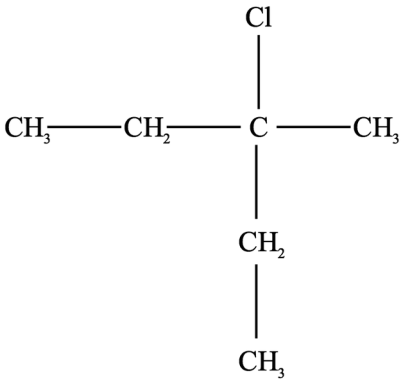
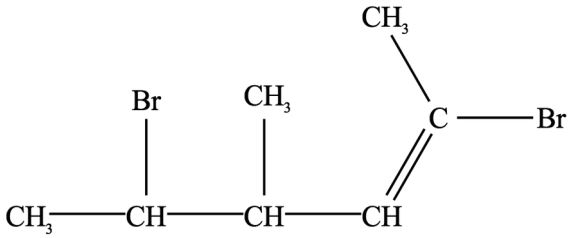
(d) Compare and contrast the arrangement of atoms within graphite with fullerenes. (2 marks)

SEE NEXT PAGE

(e) Fullerenes are currently being studied to help in medical processes. State one potential medical use for fullerenes. (1 mark)

Question 33 **(6 marks)**

Complete the table by drawing or naming the following hydrocarbons using IUPAC nomenclature.

Structure	IUPAC Name
	
	2-methylbutane
	
	2,4-dichloropent-2-ene

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Question 34 **(6 marks)**

Write balanced equations for the following organic reactions. All hydrocarbons must be represented with either full structural or semi structural formulae (not a combination):

(a) The combustion of butane. (2 marks)

(b) Ethene reacting with chlorine. (2 marks)

(c) Pentene reacting with HI in the presence of a platinum catalyst. (2 marks)

Question 35 **(13 marks)**

The properties of metallic, ionic, covalent molecular and covalent network substances can differ dramatically. As a result they are used for different purposes. With reference to chemical structure, account for the following scenarios:

(a) Iron can be bent into shapes while iron (II) chloride cannot. (6 marks)

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(b) The differences in melting points of SO_2 (-72^{o}C) and SiO_2 (1600^{o}C). (4 marks)

(c) Aluminium conducts electricity more efficiently than sodium. (3 marks)

End of Section Two

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

This section contains **nine (9)** 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.

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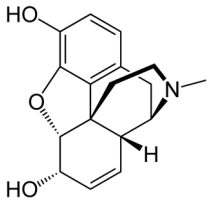
Suggested working time: 70 minutes.

Question 36 **(5 marks)**

Morphine ($C_{17}H_{19}NO_3$) is an opiate type of medication that is used for chronic pain. German pharmacist Freidrich Serturner was the first to derive morphine from the plant, opium poppy, in early 1800's. It is used for serious injuries, after operations and sometimes given during childbirth. It is a highly addictive medication that can cause drowsiness and vomiting.



Calculate the percentage composition of morphine.

Question 37 **(11 marks)**

Magnesium carbonate is added to phosphoric acid to form a colourless odourless gas.

(a) Balance the equation below. (1 mark)

$MgCO_{3(s)}$ + $H_3PO_{4(aq)}$ → $Mg_3(PO_4)_{2(s)}$ + $H_2O_{(l)}$ + $CO_{2(g)}$

If an excess amount of phosphoric acid is added to 2.75 gram of magnesium carbonate calculate:

(b) The amount of phosphoric acid consumed in moles. (3 marks)

(c) The amount of magnesium phosphate in grams. (3 marks)

(d) The total number of molecules of gas produced. (2 marks)

(e) The total number of formula units of magnesium phosphate produced. (2 marks)

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Question 38 **(12 marks)**

Within the human body certain types of reactions known as oxidation reactions produce harmful products that can lead to diseases. It has been suggested that certain chemicals found in foods can prevent these reactions occurring. These beneficial chemicals are therefore called antioxidants and can come in a variety of fruits and vegetables. Common antioxidants include vitamins A, C and E and are found in food such as carrots, blueberries, grapes, cranberries and sweet potato.

To determine the content of antioxidants in a particular food, the Briggs-Rauscher reaction is used. This is an oscillating chemical reaction that produces vivid colour changes. It starts at a dark blue colour and changes to colourless then yellow and back to dark blue. The time taken to complete one cycle of colour changes can determine the concentration of antioxidant in the food. The longer the time it takes for one cycle the more antioxidants the food will contain.

Below is a table of result from a student's investigation:

Food	Trial 1 (seconds)	Trial 2 (seconds)	Trial 3 (seconds)	Average (seconds)
Carrots	73	70	77	
Blueberries	289	296	227	
Grapes	84	93	89	
Cranberries	99	100	96	
Sweet potato	160	159	166	
Kale	205	208	203	

(a) Calculate the average time for each type of food. (3 marks)

(b) Which food would have the highest level of antioxidants? (1 mark)

_____

(c) Identify the independent variable. (1 mark)

_____

(d) Identify the dependent variable. (1 mark)

_____

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(e) Identify one controlled variable. (1 mark)

Claims have been made that the concentration of antioxidants decreases when the food is cooked. This results in less antioxidants been consumed in order to stop oxidation reactions within the body.

The student ran the same investigation again, using the Briggs-Rauscher reaction, but with cooked samples of each type of food. The student's results were collected.

Food	Average (seconds)
Carrots	72
Blueberries	251
Grapes	85
Cranberries	80
Sweet potato	163
Kale	205

(f) Consider the information given and evaluate the claim that, "the concentration of antioxidants decreases when the food is cooked." (5 marks)

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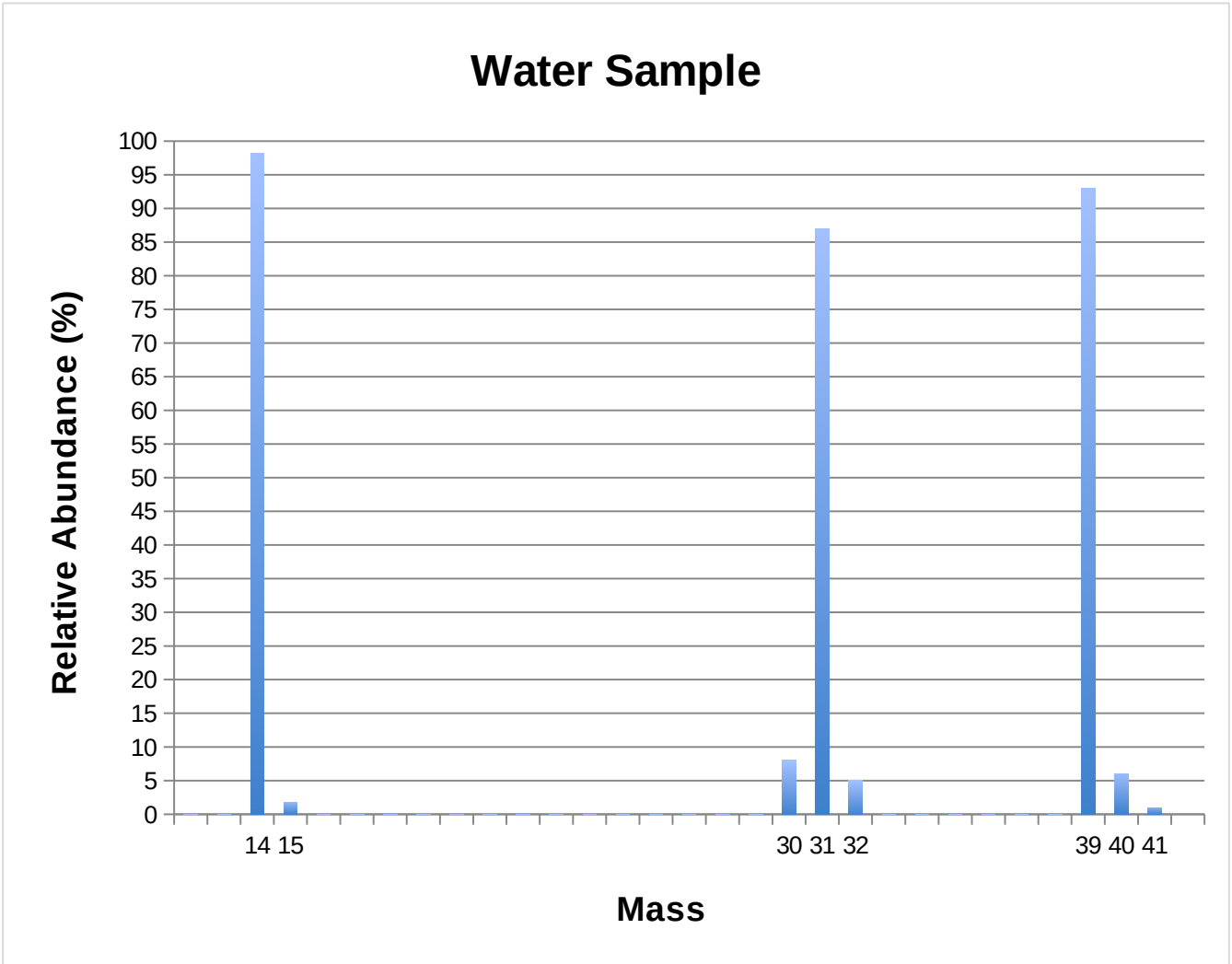
Question 39 **(18 marks)**

Fossil fuels such as coal and oil have played a major role in sustaining our energy needs. However these fuels are starting to become limited in supply and over recent times have been linked to environmental issues such as global warming.

Biofuels are an alternative form of energy that includes bioethanol, biogas and biodiesel. The production of bioethanol has started to occur in Australia. Bioethanol relies on the fermentation of crops (sugarcane, wheat or corn) to enable energy to be obtained.

For the production of bioethanol to occur, large numbers of these food crops need to be planted. Farmers are now using substantial amounts of fertilisers to improve their crops yield. These fertilisers are high in chemical elements that enable plants to grow faster. This has led to problems associated with run-off that causes eutrophication and can result in algal blooms and fish dying.

Scientists from the Environmental Protection Authority collected a sample of water from a river that passes through a farm, which is known to grow corn for biofuels, after reports of fish dying in large numbers. It was tested using mass spectroscopy and the results shown below.



(a) Determine the three elements that have resulted in the fish death, by calculating their relative molecular masses. All working out must be show to obtain marks. (6 marks)

(b) Explain why the relative molecular mass of each element is not identical to those found on the periodic table. (2 marks)

(c) Give two advantages of using biofuels. (2 marks)

(d) Give two disadvantages of biofuels that has not been discussed in this paper. (2 marks)

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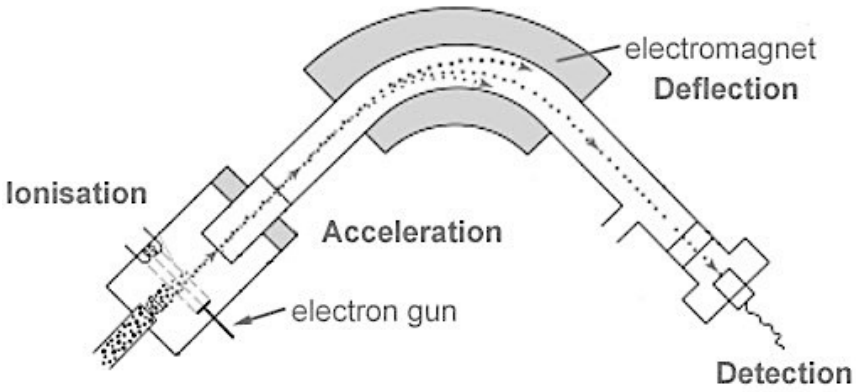
(e) Describe each of the following steps of mass spectrometry.



(i) Ionisation (2 marks)

(ii) Acceleration (1 mark)

(iii) Deflection (3 marks)

Question 40 **(9 marks)**

Nanotechnology is an emerging area of scientific endeavour. Much of the development in the field has been due to advances in high powered microscopy. One such microscope is the scanning tunnelling microscope, which owes its existence to scientists Gerd Binnig and Heinrich Rohrer who made their discovery known in 1981. Some of the more well-known nanomaterials owing their discovery to Binning and Rhorer's work are buckminsterfullerene (bucky ball) and carbon nanotubes.

(a) Define the term nanoparticle. (1 mark)

(b) How do nanoparticles differ from their bulk material? (2 marks)

(c) With the use of a diagram, explain how nanoparticles have helped with UV protection in sunscreens. (4 marks)

Sunscreen **without** nanoparticles:	Sunscreen **with** nanoparticles:

SEE NEXT PAGE

(d) Describe one concern that people may have with the use of nanoparticles in sunscreens. (1 mark)

(e) Give another example, which has not already been discussed in this paper, where nanoparticles are being used to benefit society in some way. (1 mark)

This space has been left intentionally.

Question 41 **(11 marks)**

Sodium's eleven ionisation energies are listed below.

Number of electrons	Ionisation energy / kJ molL^{-1}
1	496
2	4,562
3	6,910
4	9,543
5	13,354
6	16,613
7	20,117
8	25,496
9	28,932
10	141,362
11	159,075

(a) Graph these results. (5 marks)

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(b) Describe the trends that occur in the graph. (2 marks)

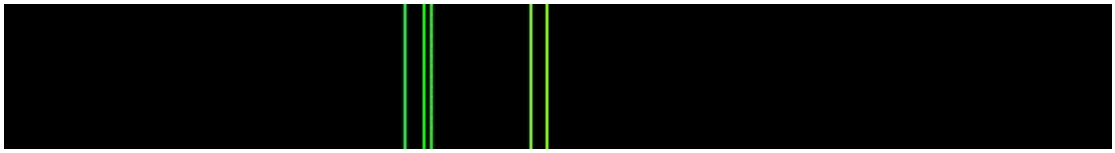
(c) Explain why these trends are occurring. (4 marks)

Question 42 **(6 marks)**

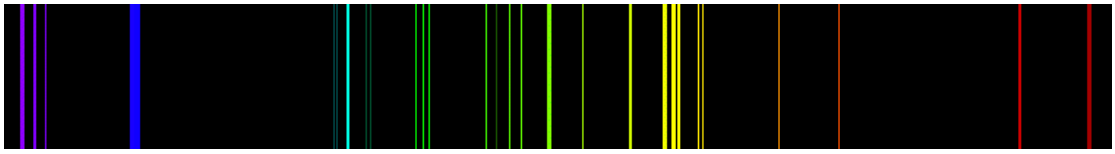
Good Friday has a common tradition where people will eat seafood during the festive period. Gary, a local fishmonger, has had complaints from his customers after they became ill from eating the swordfish he sold to them. With his reputation being questioned, Gary decides to get the batch of swordfish tested using atomic absorption spectroscopy (AAS).

Analytical chemists compared the swordfish sample against known spectra. Analyse the information below and answer the associated questions.

Arsenic:

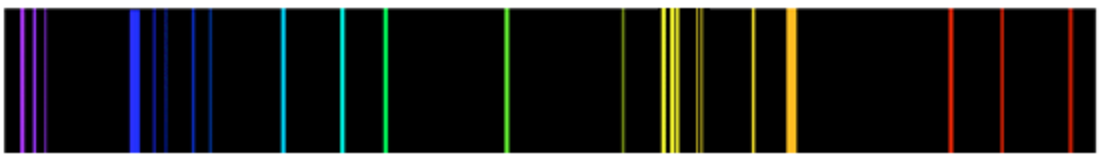


Mercury:



Lead:

Swordfish Sample:



(a) Was the swordfish to blame for the customers' illness? Give a reason for your answer.

(2 marks)

(b) Explain how a flame test works. (4 marks)

Question 43 **(4 marks)**

The thermite reaction is a highly exothermic reaction that produces large amounts of energy in the form of heat and light. The reaction occurs between aluminium and iron (III) oxide to form iron and aluminium oxide as per the equation:

$$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3.$$

As temperature can exceed 2200^{o}C many safety risks need to be taken into account.

Conduct a risk assessment of this experiment, by suggesting two potential risks and outline ways to reduce the identified hazards.

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Question 44 **(4 marks)**

Findings from a range of scientific experiments have contributed to the understanding of the atom.

Some of the most well-known scientists that have contributed to the Atomic Theory have been Joseph John Thomson in the late 1890's and his successor Ernest Rutherford in the early 1900's.

For one of these scientists:
(a) Describe the experiments they conducted that lead to their discovery. (1 mark)
(b) The conclusions they made about the atomic structure as a result of their findings. (3 marks)

SEE NEXT PAGE

End of examination.

Spare answer page

Question number: _____

Acknowledgements

Question 39e - http://scienceaid.co.uk/chemistry/fundamental/particles.html

Question 41 - Arsenic image: http://chemistry.bd.psu.edu/jircitano/As.gif
Mercury image: http://chemistry.bd.psu.edu/jircitano/Hg.gif
Lead image: http://chemistry.bd.psu.edu/jircitano/Pb.gif

Question 43 - http://www.rsc.org/Education/EiC/issues/2011January/ExhibitionChemistry.asp?e=1