****

**YEAR 11 ATAR CHEMISTRY**

**UNITS 1 & 2**

**2018**

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

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

# TIME ALLOWED FOR THIS PAPER

## Reading time before commencing work: ten minutes

Working time for the paper: three hours

|  |  |
| --- | --- |
| **Section** | **Marks** |
| 1 | /20 |
| **/40** |
| 2 | **/60** |
| 3 | **/65** |
| total | **/165** |
| **%** |

# MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER

**To be provided by the supervisor:**

This Question/Answer Booklet

Multiple-choice Question Booklet

Chemistry Data Sheet

**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 | 20 | 20 | 35 | /40 | /25 |
| Section Two:  Short answer | 8 | 8 | 55 | /60 | /35 |
| Section Three:  Extended answer | 4 | 4 | 60 | /65 | /40 |
|  |  |  |  | /165 | /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 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.

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 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, do not erase or use correction fluid, and shade your new answer. 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.

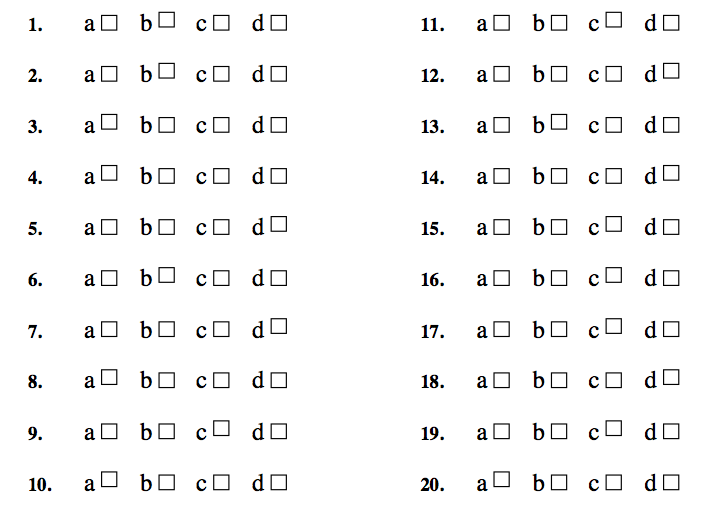
For each question, **shade the box to indicate your answer**. Use only a blue or black pen to shade the boxes.

For example, if b is your answer: a b c d

If you make a mistake, place a cross through that square, do not erase or use correction fluid.

Shade your new answer.

For example, if b is a mistake and d is your correct answer: a b c d



|  |  |
| --- | --- |
| total / 20 |  |
| total / 40 |  |

**End of Section One**

**Section Two: Short answer 35% (60 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: 55 minutes.

**Question 21 (5 marks)**

(a) Complete the following table by either giving the correct IUPAC name of the substance or drawing a structural diagram for the organic molecule named. (3 marks)

|  |  |
| --- | --- |
| Structural diagram | IUPAC name |
|  |  |
|  |  |
|  | 4-bromo-1,2-difluorobut-1-ene |

(b) Write the equation for the reaction that would take place between methylbenzene and liquid bromine in the presence of an aluminium bromide catalyst. (2 marks)

|  |
| --- |
|  |

**Question 22 (8 marks)**

Fireflies ‘glow’ due to a special chemical reaction that produces light. Fireflies have a substance in their bodies called ‘luciferin’. The compound luciferin is oxidised to oxyluciferin by the enzyme *luciferase*. ATP is an organic compound that provides energy for the reaction to take place. The word equation for the ‘glow’ reaction in fireflies is shown below.

*luciferase*

luciferin + ATP + oxygen gas oxyluciferin + AMP + diphosphate + light

(a) Sketch an energy profile diagram for this reaction, in the absence of the *luciferase* enzyme. Label the change in enthalpy and the activation energy. (3 marks)

Progress of reaction

Potential energy (kJ)

(b) Add to the energy profile diagram above, the effect of the *luciferase* enzyme on this reaction. (1 mark)

(c) Define an ‘enzyme’ and explain, in terms of the collision theory, how enzymes increase the rate of a reaction. (3 marks)

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(d) State the role of ATP in this reaction, in terms of the collision theory. (1 mark)

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**Question 23 (9 marks)**

Seawater contains many different dissolved ions, such as sodium (Na+), magnesium (Mg2+), chloride (Cl-), hydrogencarbonate (HCO3-) and barium (Ba2+).

(a) The concentration of barium ions (Ba2+) in seawater is 0.025 ppm. If you had a 250 mL sample of seawater, how many barium ions would be present? Assume the density of seawater is 1.00 kg L-1. (4 marks)

(b) Draw a **labelled** diagram showing how dissolved Ba2+ and Cl- ions would interact with the water molecules in the ocean. (2 marks)

|  |
| --- |
|  |

The solubility of barium chloride (BaCl2) is 35.8 g per 100 mL water at 20 °C.

(c) Calculate the mass of barium chloride required to produce a saturated solution if you had **250 mL** of water at 20 °C? (1 mark)

The sea surface temperature at Cottesloe beach in summer can reach 23 °C.

(d) If your saturated solution from (c) was heated to 23 °C, would the solution now likely be saturated, unsaturated or supersaturated? Justify your answer. (2 marks)

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**Question 24 (7 marks)**

Consider the information in the table, regarding the conductivity of substances W, X, Y and Z.

|  |  |  |
| --- | --- | --- |
| Substance | Conductivity (l) | Conductivity (aq) |
| W | no | yes |
| X | yes | yes |
| Y | no | no (not soluble in water) |
| Z | yes | no (not soluble in water) |

(a) Which of these substances is **most likely** to be malleable? Justify your answer in terms of the **structure and bonding** present. (3 marks)

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(b) Name or give the formula for **one** possible identityof substance W. (1 mark)

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(c) Which of these substances is **most likely** to be diamond? Briefly describe the structure and bonding within diamond. (3 marks)

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**Question 25 (9 marks)**

Some chemistry students were investigating the pH of various compounds. In particular, they were investigating sodium hydroxide (NaOH) and ammonia (NH3). The students knew that both of these compounds were classified as bases because they produce hydroxide ions (OH-) in solution.

They were given a sample of 0.5 mol L-1 NaOH(aq) and 0.5 mol L-1 NH3(aq). The students added a few drops of universal indicator to each solution.

(a) What is an indicator? (1 mark)

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(b) Explain why the NaOH(aq) would have a higher pH than the NH3(aq). (3 marks)

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The students’ teacher was explaining that the pH scale is a measure of the **concentration of hydrogen ions (H+) in a solution**. One of the students asked, “According to the Arrhenius theory, if bases are substances that produce **hydroxide ions** in solution, how can their pH be calculated?”

(c) Briefly answer the student’s question. (3 marks)

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The student then investigated a chemical reaction involving both sodium hydroxide and ammonia. They noted the following observations in their laboratory book;

*“A clear colourless solution with a highly basic pH was added to a white powder. A pungent smelling odour was detected and the white powder dissolved forming a clear, colourless solution. This solution was later determined to be aqueous sodium chloride.”*

(d) Write the balanced molecular equation for this reaction including phase symbols. (2 marks)

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**Question 26 (8 marks)**

Consider the graph below, which shows the first six (6) ionisation energies of magnesium and phosphorus.

(a) Complete the table below, by writing the electron configuration for magnesium and phosphorus, as well as identifying which line on the graph (X or Z) corresponds to each element. (3 marks)

|  |  |  |
| --- | --- | --- |
|  | Electron configuration | Line X or Z? |
| Magnesium |  |  |
| Phosphorus |  |  |

(b) Why is the first ionisation energy of X higher than that of Z? (3 marks)

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(c) Describe how Magnesium and Phosphorus could combine by forming chemical bonds. Give the formula of the most likely compound that would form. (2 marks)

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**Question 27 (8 marks)**

Azurite, Cu3(CO3)2(OH)2, is a common copper-containing compound found in some copper ores.

(a) Calculate the percentage by mass of copper in azurite, Cu3(CO3)2(OH)2. (2 marks)

Some copper ore, containing 61.5% azurite, was processed to extract the copper according to the equation below.

2 Cu3(CO3)2(OH)2(s) + 3 C(s) → 6 Cu(s) + 7 CO2(g) + 2 H2O(g)

If 2.98 tonnes of copper was produced;

(b) Calculate the volume of carbon dioxide (at STP) that would have been released. (3 marks)

(c) Calculate the mass of azurite, Cu3(CO3)2(OH)2, that was smelted. (2 marks)

(d) Calculate the mass of ore that would have been required as the starting material. (1 mark)

**Question 28 (6 marks)**

Complete the following table by;

* drawing the structural formula for each molecule, representing all valence shell electron pairs either as : or –,
* naming the shape of the molecule, and
* stating the most significant intermolecular forces present in a pure sample.

(6 marks)

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Electron dot diagram | Shape | Intermolecular forces |
| Carbon monoxide |  |  |  |
| Water |  |  |  |
| Dichloromethane |  |  |  |

End of Section Two

**Section Three: Extended answer 40% (65 marks)**

This section contains **four (4)** 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.

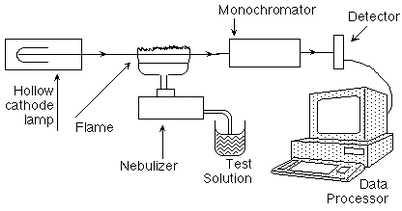
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Suggested working time: 60 minutes.

**Question 29 (14 marks)**

Several different brands of sports drinks were analysed by atomic absorption spectroscopy (AAS) to determine their sodium content. Sports drinks contain sodium in the form of sodium ions, Na+. A diagram of the equipment used in AAS is shown below.



In this analysis, the hollow cathode lamp contained the element sodium (Na). When the lamp is turned on, the atoms of sodium produce an emission spectrum that is unique to the sodium element.

(a) Explain how sodium atoms are able to produce this unique emission spectrum. (3 marks)

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(b) Why does the emission spectrum of the hollow cathode lamp need to match the metal being analysed by AAS? (2 marks)

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Samples of each sports drink were diluted with water and then run through the spectrometer. Absorbance values for each were collected. The data was then compared to an existing calibration curve for sodium, which is shown below.

(c) Describe how this calibration curve would have been obtained. (3 marks)

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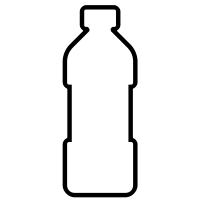
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Using the calibration curve above, the concentration for a particular diluted sports drink was determined to be 1.11 x 10-6 mol mL-1.

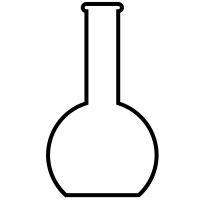
(d) What absorbance would this correspond to? (1 mark)

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A 10.00 mL sample of a sports drink was taken and diluted to a final volume of 250.0 mL by the addition of water. A portion of the dilute sample was analysed by AAS.



sample diluted to 250.0 mL with water



10.00 mL sample of sports drink taken

dilute sample analysed by AAS

The absorbance obtained was compared to the calibration curve and the concentration was determined to be 1.11 x 10-6 mol mL-1 as previously stated.

(e) Calculate the concentration of sodium (in mol L-1) in the **undiluted** sports drink. (3 marks)

The sports drink was sold in a 600 mL bottle.

(f) Calculate the total mass of sodium present in the drink. (2 marks)

**Question 30 (15 marks)**

A chemistry class was investigating the topic of reaction rate. The students decided to use the reaction between solid zinc granules and hydrochloric acid, because they would be able to time how long it took for the zinc to completely dissolve. The students wanted to see how the rate of a reaction changes over time. They wrote the following hypothesis;

*“The rate of reaction will decrease over time and this will be observed by a uniform (linear) decrease in the mass of zinc present in the beaker.”*

The data collected by the students is represented in the graph below.

(a) Write a balanced **ionic** equation for the reaction that is occurring in this investigation. State the corresponding observations. (4 marks)

|  |  |
| --- | --- |
| Ionic equation |  |
| Observations |  |

(b) How long did it take before; (2 marks)

1. half of the zinc had reacted? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. all of the zinc had reacted? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(c) Was the students’ hypothesis completely supported? Justify your answer by referring to the graph. (2 marks)

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The students then performed three (3) variations of the investigation described above. They altered one particular aspect of the experiment each time, to determine the effect of the various factors on the rate of reaction.

The results of two (2) of the variations, labelled A and B, are shown in the graph below (dotted lines). The original data is also displayed for comparison (solid line).

Consider lines A and B on the graph on page 24. In each of these experiments, **only** **one** variable was changed in comparison with the original experiment (solid line). The changes made were;

* the concentration of acid was halved
* the volume of acid was halved

(d) Complete the table below by stating which line on the graph corresponds to the changes made to the original experiment. (2 marks)

|  |  |
| --- | --- |
|  | A or B? |
| **The concentration of acid was halved.** |  |
| **The volume of acid was halved.** |  |

(e) Justify your choices in part (d) by referring to the graph. (4 marks)

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The third variation of the experiment that the students investigated was increasing the temperature of the hydrochloric acid before pouring it over the zinc granules.

(f) Sketch a fourth line, labelled C, on the graph on page 24, displaying the results you would expect the students to have obtained. (1 mark)

**Question 31 (19 marks)**

Propane (C3H8) can be obtained from the processing of natural gas or petroleum refining. It is a gas at room temperature, but can be liquefied by pressure, which makes it easy to transport and store. For this reason, propane is a commonly used fuel in barbeques, portables stoves and heating devices.

The combustion equation for propane is;

C3H8(g) + 5 O2(g) → 3 CO2(g) + 4 H2O(g) + 2220 kJ

If 455 kg of propane was combusted in air, calculate;

(a) the volume of gaseous products that would form at STP. (5 marks)

(b) the energy released. (1 mark)

Biopropane is a biofuel and refers to propane that has been produced from renewable resources using biological processes. It is referred to as a ‘drop in’ fuel, because it has exactly the same molecular structure as propane, and can therefore be used for the same purposes. Biopropane can be produced by hydrogenating vegetable or animal fats and oils.

Propene (C3H6) is obtained by much the same processes as propane. It is a volatile, flammable substance that can be used as a fuel in welding and cutting torches.

(c) Predict whether propane or propene would have the higher boiling point. Justify your answer using relevant chemical understanding. (4 marks)

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Excess amounts of propane and propene gases were bubbled through separate solutions of bromine water, Br2(aq). A visible reaction took place in one case, but no change was observed in the other.

(d) Explain these observations. Name the type of reaction occurring and include a chemical equation in your answer. State the observations that would have been made. (5 marks)

**Propane**

Type of reaction:

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

Chemical equation:

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

Observations:

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

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**Propene**

Type of reaction:

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Chemical equation:

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

Observations:

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

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The diagram below shows some of the gases that enter a catalytic converter.

CH4 catalytic

NOx converter

CO

(e) What is the function of a catalytic converter and where are they used? (2 marks)

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(f) Name the metallic substances that are used as the catalysts in the converter. (1 mark)

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(g) What substances are produced by the catalytic converter. (1 mark)

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**Question 32 (17 marks)**

A chemistry student has a solution of silver nitrate, AgNO3(aq), with a labelled concentration of 0.0425 g mL-1. The student measured out 75.0 mL of the AgNO3(aq) and placed it in a beaker.

(a) Calculate the concentration of the AgNO3(aq) solution in moles per litre. (2 marks)

The student then added 100.0 mL of 0.12 mol L-1 sodium carbonate solution, Na2CO3(aq). They ensured there was excess Na2CO3(aq) present in order to precipitate all the silver ions from solution.

The equation for the reaction that took place is;

2 AgNO3(aq) + Na2CO3(aq) → Ag2CO3(s) + 2 NaNO3(aq)

(b) State the observations that would have been made as the reaction took place. (2 marks)

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(c) Calculate the concentration in moles per litre of sodium ions, Na+(aq), that would be present after the two solutions were mixed. (4 marks)

The student then filtered the mixture to collect the Ag2CO3(s) precipitate.

(d) Draw a labelled diagram of the equipment the student would use. Indicate where the products of the reaction would finish and use the labels ‘filtrate’ and ‘residue’ in your answer. (4 marks)

(e) Calculate the mass of Ag2CO3(s) precipitate, once dried, that would have been separated from this mixture. (3 marks)

The student then poured the remaining filtered solution into an evaporating dish and heated it gently over a Bunsen burner until no liquid remained.

(f) Name the two (2) solids that would have been present on the evaporating dish. (1 mark)

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(g) Briefly explain why these solids could not be isolated by filtration. (1 mark)

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**End of questions**

Spare answer page

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**References**

**Question 39**

Author Dean Meagher, http://chemicalinstrumentation.weebly.com/flame-aas.html