Duncraig Senior High School
Semester Two Examination, 2018

Question/Answer Booklet

CHEMISTRY 11

Student Name: _____

Teacher's Name: _____

Time allowed for this paper
Reading time before commencing work: ten minutes
Working time: 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: non-programmable calculators approved for use in this examination

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 examination
Section One Multiple-choice	25	25	50	/50	/25
Section Two Short answer	8	8	60	/70	/35
Section Three Extended answer	5	5	70	/80	/40
			Total	/200	/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 **not** handed in with your Question/Answer Booklet.

See next page

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.

Questions 1 and 2 relate to the information given in the following table.

	Atom	Number of protons	Number of neutrons	Electron configuration
I	sodium-22	11	**W**	2, 8, 1
II	argon-40	**X**	20	2, 8, 8
III	aluminium-27	13	14	**Y**
IV	**Z**	16	17	2, 8, 6

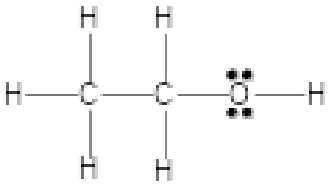
1. Which of the following correctly completes the table above?

	W	**X**	**Y**	**Z**
(a)	11	18	2, 8, 3	sulfur-33
(b)	12	20	2, 3	sulfur-33
(c)	11	18	2, 8, 15, 2	oxygen-16
(d)	12	8	2, 8, 3	sulfur-32

2. Which of these elements would have the highest electronegativity?

(a) I
(b) II
(c) III
(d) IV

3. Consider the structural drawing of an ethanol molecule shown below.



Which of the following statements regarding this molecule is **not** correct?

(a) It has 7 polar bonds.
(b) It has 1 non-polar bond.
(c) It is a polar molecule.
(d) It is a symmetrical molecule.

See next page

4. Which of the following statements regarding the energy changes occurring in an endothermic reaction is **correct**?

   (a) The system gains energy.
   (b) The surroundings gain energy.
   (c) The total energy in the system remains constant.
   (d) The temperature of the surroundings increases.

5. Ethanol has a boiling point of 78.4 ˚C. Therefore, if a sample of ethanol was compared to a sample of water at 25 ˚C, it must be **true** that

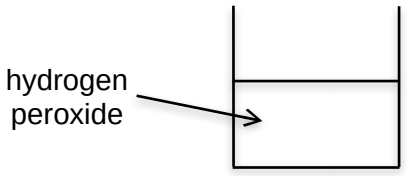
   (a) the vapour pressure of ethanol is greater than that of water.
   (b) the intermolecular forces in ethanol are stronger than those in water.
   (c) the density of ethanol is greater than that of water.
   (d) the boiling point of ethanol is higher than that of water.

6. A sample of 0.75 mol L^{-1} nitric acid solution was poured over a small amount of solid copper(II) oxide powder. Which of the following most accurately describes the observations that would be noted for the reaction that takes place?

   (a) Blue solid dissolves, producing a clear blue solution.
   (b) Blue solid dissolves, producing a colourless, odourless gas.
   (c) Black solid dissolves, producing a clear blue solution.
   (d) Black solid dissolves, producing a colourless, odourless gas.

Questions 7 and 8 refer to the reaction described below.

The spontaneous decomposition of hydrogen peroxide solution into oxygen gas and water can be catalysed by the addition of solid manganese(IV) oxide. A beaker was set up as shown in the diagram below.



$$2\ H_2O_2(aq) \rightarrow O_2(g) + 2\ H_2O(l)$$

7. Which of the following would **not** increase the rate of this reaction?

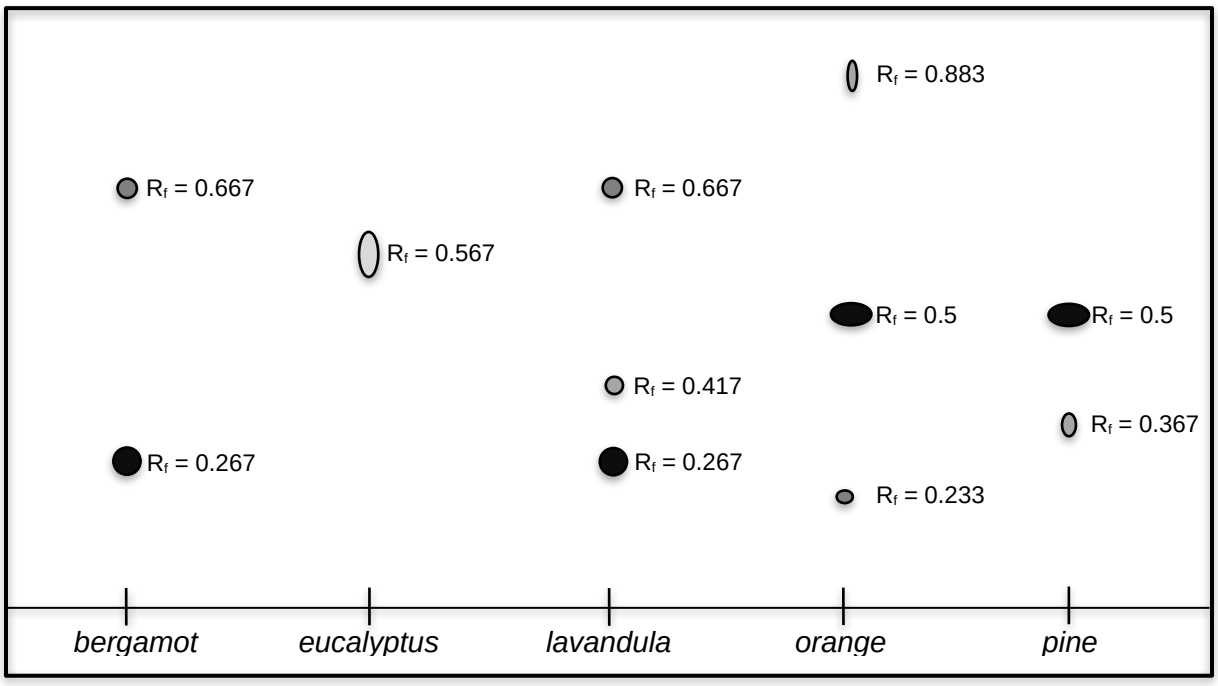
   (a) increasing the pressure surrounding the beaker
   (b) addition of manganese(IV) oxide chips
   (c) addition of powdered manganese(IV) oxide
   (d) increasing the concentration of hydrogen peroxide solution

8. An additional way to increase the rate of this reaction is by gently warming the solution of hydrogen peroxide. Which statement below does **not** contribute to an explanation for the increased reaction rate observed in this case?

   (a) The particles would have greater kinetic energy.
   (b) The particles would collide more frequently.
   (c) The particles would collide with greater force.
   (d) The particles would collide with the desired orientation.

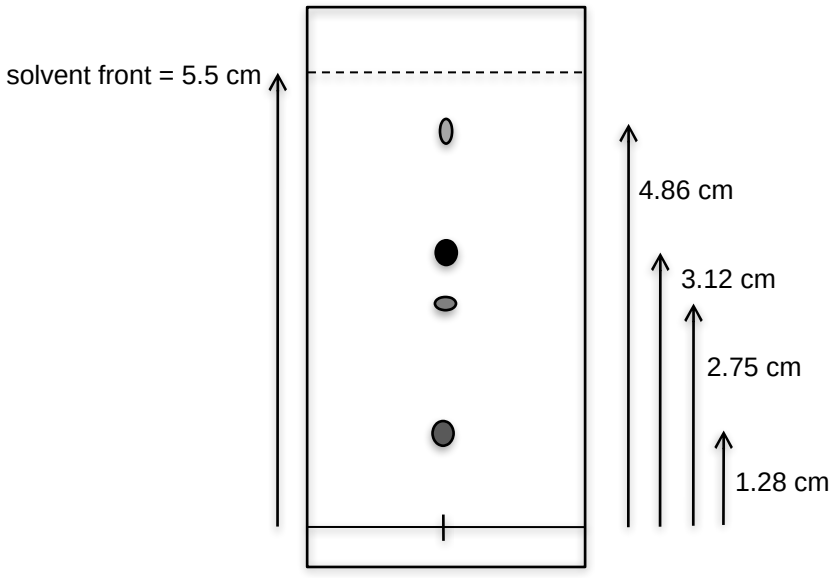
See next page

9. Thin layer chromatography (TLC) was performed on five (5) different essential oils; bergamot, eucalyptus, lavandula, orange and pine. The TLC plate is shown below, along with the corresponding R_f value for each resolved component.



$$R_f = \frac{\text{distance travelled by component}}{\text{distance travelled by solvent}}$$

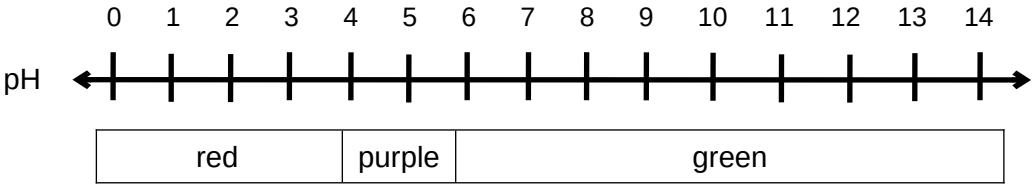
A small amount of an unknown essential oil, labelled as 'Sample X', was then analysed by TLC using identical running conditions. This plate is shown below. Use the data provided to determine which **two** essential oils have been mixed to produce 'Sample X'.



(a) bergamot and pine
(b) eucalyptus and lavandula
(c) orange and eucalyptus
(d) lavandula and pine

See next page

10. The juice of blueberries can be used as an acid-base indicator. The diagram below shows the colour displayed by blueberry juice at various pH levels.



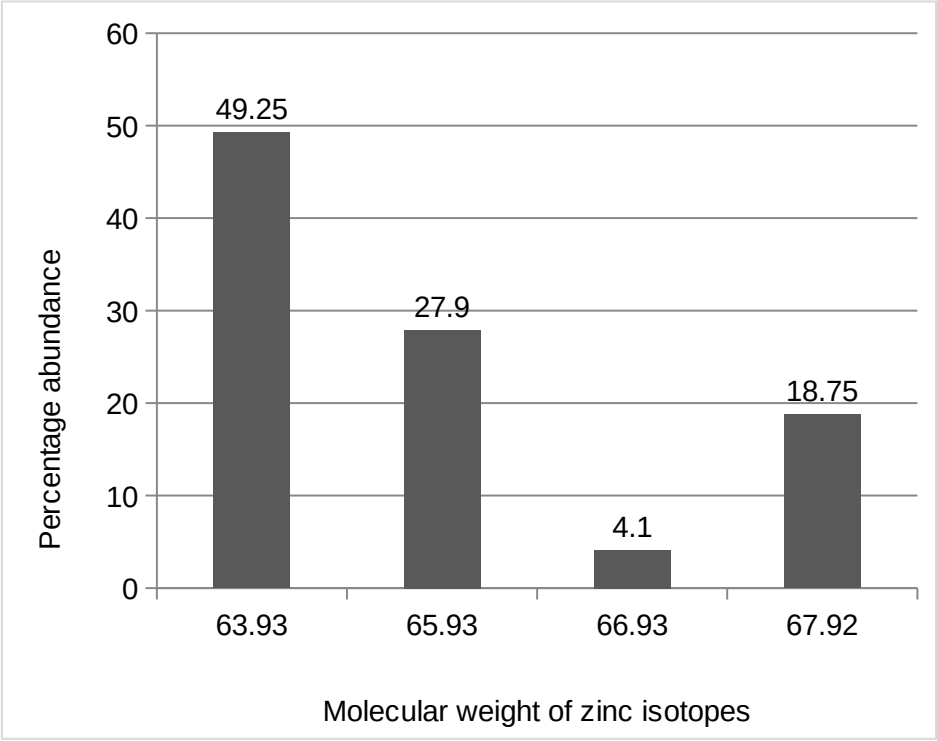
Which pair of substances could be distinguished using the blueberry juice indicator?

(a) HCl(aq) and H_2O(l)
(b) HCl(aq) and HNO_3(aq)
(c) NH_3(aq) and $Ba(OH)_2$(aq)
(d) KOH(aq) and H_2O(l)

11. Which statement regarding ions is **correct**?

(a) Cations have a negative charge.
(b) Negative ions have lost protons.
(c) Positive ions have lost electrons.
(d) An example of an anion is NH_4^+.

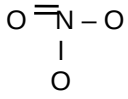
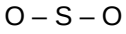
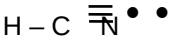
12. Use the following mass spectrometry data to calculate the relative atomic mass of zinc.



(a) 65.34
(b) 65.36
(c) 65.38
(d) 65.40

See next page

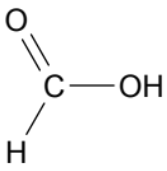
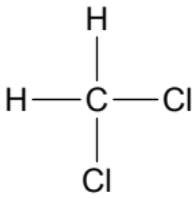
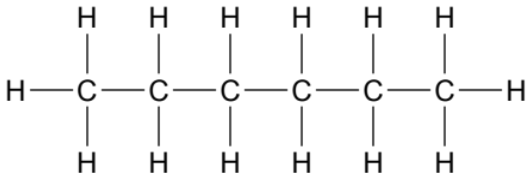
13. Which of the following structural formulas has been drawn **correctly** for the species named?

(a) nitrate ion 	(b) sodium chloride 
(c) sulfur dioxide 	(d) hydrogen cyanide 

14. A catalyst, in the form of metal nanoparticles, was found to be successful in increasing the rate of a particular reaction. Which statement regarding this catalyst is **not** correct?

(a) The catalyst particles would be in the size range 1-100 nm.
(b) The catalyst would have all the same properties as the metal in bulk material form.
(c) The catalyst would provide a very high surface area.
(d) The catalyst would provide an alternate reaction pathway.

15. Consider the three (3) solvents shown below.

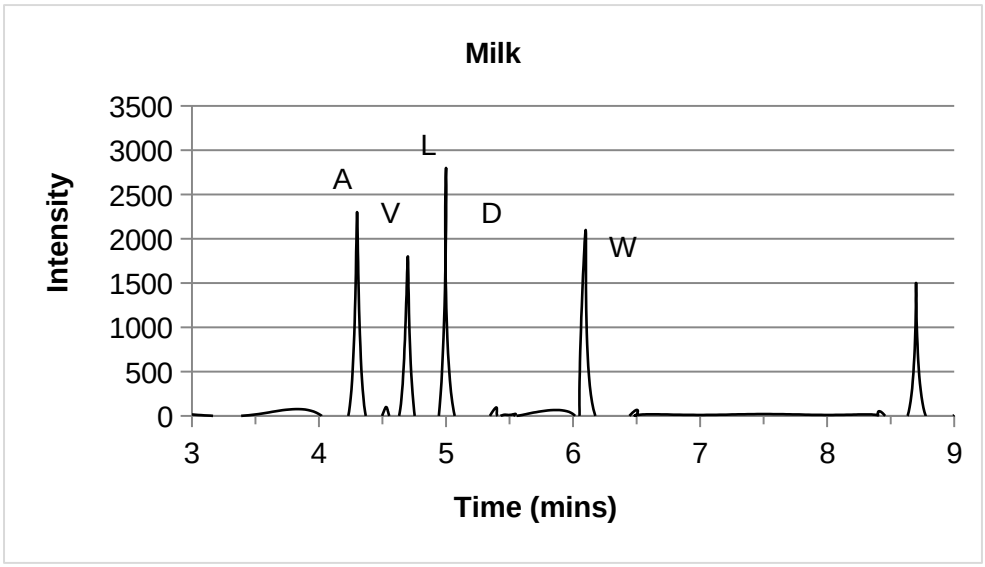
Methanoic acid	Dichloromethane	Hexane
$HCOOH(l)$	$CH_2Cl_2(l)$	$C_6H_{14}(l)$
		

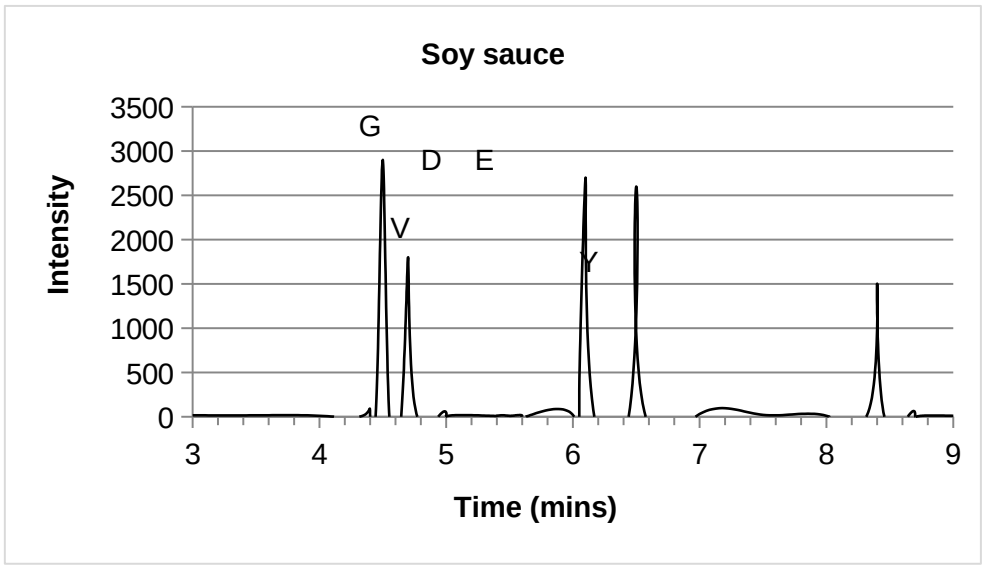
Ammonia (NH_3) will be soluble in

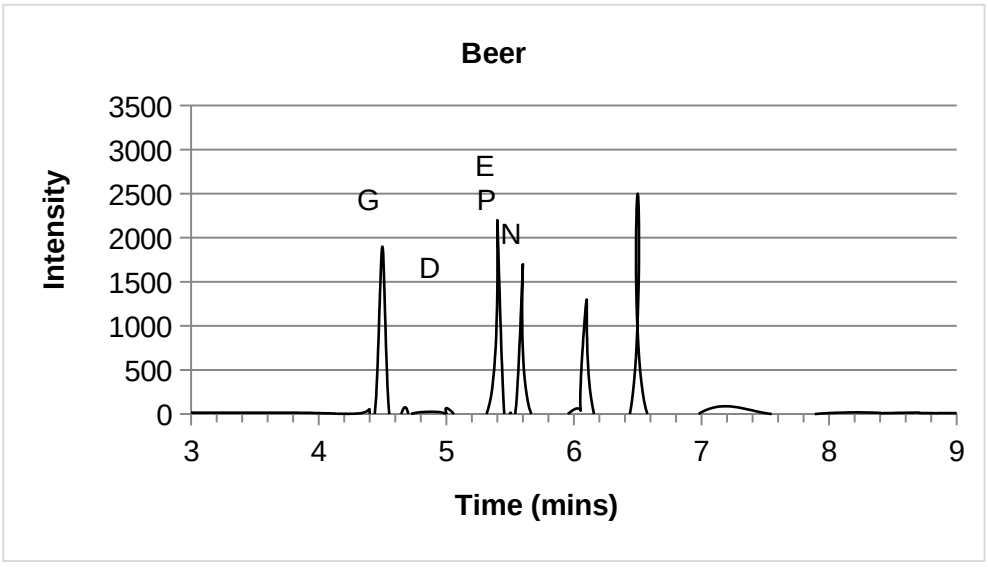
(a) methanoic acid only.
(b) dichloromethane only.
(c) hexane only.
(d) methanoic acid and dichloromethane only.

See next page

16. Gas chromatography can be used for analysing the presence and type of amino acids in food and drink. The gas chromatographs for milk, soy sauce and beer are shown below, each indicating the five (5) most common amino acids present (labelled with capital letters). Each sample was run under identical conditions.







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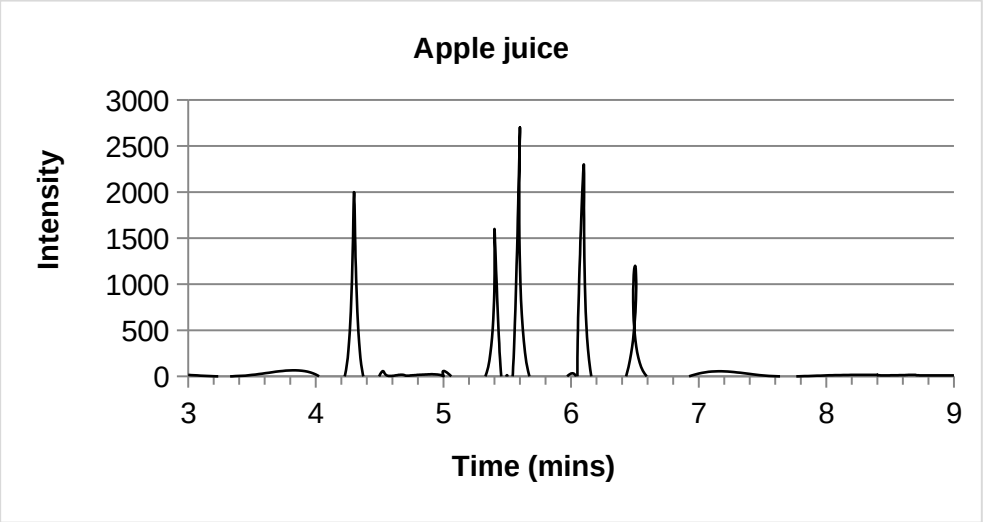
A sample of apple juice was analysed by gas chromatography, using the same conditions as on the previous page, and the chromatograph is shown below.



What is the amino acid composition of apple juice?

(a) A, P, N, D, E
(b) G, V, P, D, E
(c) A, P, N, E, Y
(d) G, P, N, D, W

17. Which of the following is **correct** for a 1.0 mol L^{-1} solution of ethanoic acid?

(a) $c(H^+) > c(CH_3COOH)$
(b) $c(H^+) < c(CH_3COO^-)$
(c) $c(CH_3COOH) > c(CH_3COO^-)$
(d) $c(CH_3COOH) = c(H^+)$

18. A sample of gas is stored in a sealed container at 20 ˚C. If this gas was an **ideal** gas, then according to the kinetic theory, which of the following statements is **not** correct?

(a) If the container was cooled to absolute zero, the gas volume would be zero.
(b) If the container was heated to 100 ˚C the pressure would increase.
(c) If the volume of the container was halved the gas particles would move faster.
(d) If more gas was added to the container the pressure would increase.

19. When 5 mL of potassium carbonate solution (K_2CO_3) was mixed with 10 mL of ethanoic acid solution (CH_3COOH) a chemical reaction took place. Which of the following gives the balanced ionic equation for this reaction?

(a) $CO_3^{2-}(aq) + 2\ CH_3COOH(aq) \rightarrow 2\ CH_3COO^-(aq) + CO_2(g) + H_2O(l)$
(b) $K_2CO_3(s) + 2\ CH_3COOH(aq) \rightarrow 2\ K^+(aq) + 2\ CH_3COO^-(aq) + CO_2(g) + H_2O(l)$
(c) $CO_3^{2-}(aq) + 2\ H^+(aq) \rightarrow CO_2(g) + H_2O(l)$
(d) $K_2CO_3(aq) + 2\ H^+(aq) \rightarrow 2\ K^+(aq) + CO_2(g) + H_2O(l)$

See next page

Questions 20, 21, 22, and 23 relate to the five substances in the table below.

	Name of substance
I	sulfurous acid
II	calcium phosphate
III	nickel bromide
IV	dinitrogen tetroxide
V	air

20. Which of the following lists the correct formulas for each substance?

	I	**II**	**III**	**IV**
(a)	H_2S	$CaPO_4$	NiBr	N_2O_3
(b)	H_2SO_3	Ca_3PO_4	$NiBr_3$	N^2O^4
(c)	H_2SO_4	$Ca_2(PO_4)_3$	$NiBr_2$	N_2O_4
(d)	H_2SO_3	$Ca_3(PO_4)_2$	$NiBr_2$	N_2O_4

21. Which of the following statements does **not** help to explain why substance V has no formula?

(a) Air is not a pure substance.
(b) Air has a variable molecular weight.
(c) Air is composed of many different substances.
(d) Air has a variable composition.

22. Which substance(s) would conduct electricity when mixed with water?

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

23. Which substance is likely to have the highest melting point?

(a) I
(b) II
(c) IV
(d) V

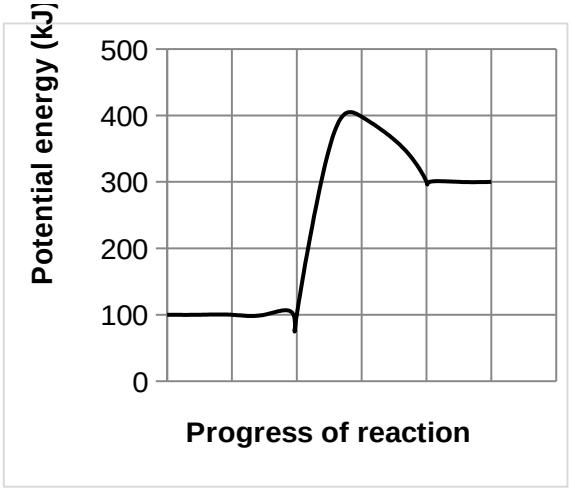
24. Which of the following statements **cannot** be explained by the presence of hydrogen bonding?

(a) Solid water is less dense than liquid water.
(b) Water is a highly polar molecule.
(c) Water has a high surface tension.
(d) Water has a high melting point for a molecule of its molecular weight.

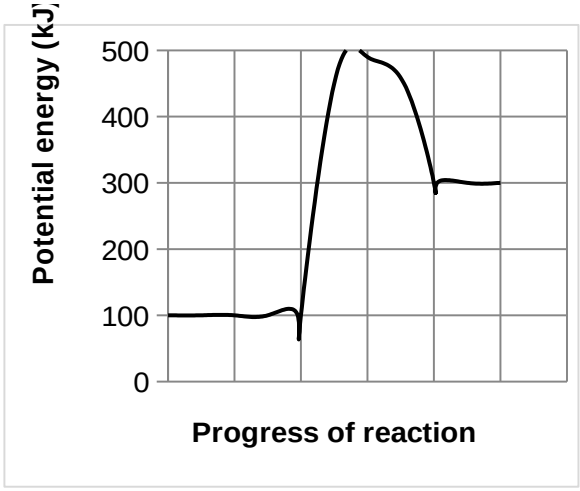
See next page

25. Consider the energy profile diagrams shown below, for Reaction A and Reaction B.

Reaction A



Reaction B



Which of the following would be **correct** regarding reactions A and B?

(a) Reaction B is likely to proceed at a faster rate.
(b) Reactant particles in A likely contain stronger bonds than those in B.
(c) Reactant particles in B need less energy than those in A, in order to react.
(d) The temperature change measured for Reaction A and B would be the same.

End of Section One

See next page

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

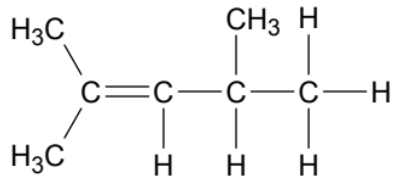
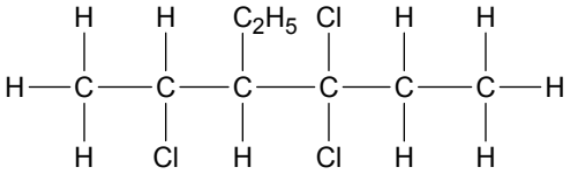
This section has **8** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for the use of planning/continuing your answer to a question have been provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 60 minutes.

Question 26 **(6 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. (3 marks)

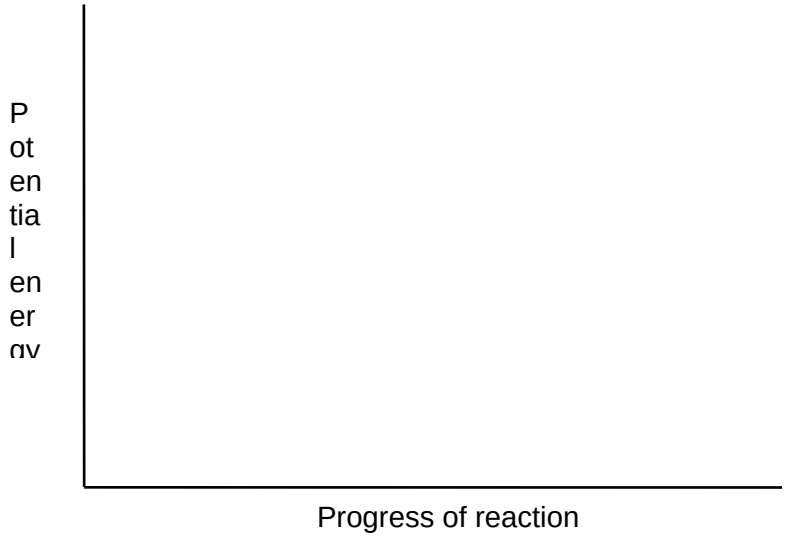
See next page

Question 27 **(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.

$$\text{luciferin} + \text{ATP} + \text{oxygen gas} \xrightarrow{\textit{luciferase}} \text{oxyluciferin} + \text{AMP} + \text{light}$$

(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)



(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)

_____

_____

See next page

Question 28 **(11 marks)**

Seawater contains many different dissolved ions, such as sodium (Na^+), magnesium (Mg^{2+}), chloride (Cl^-), hydrogencarbonate (HCO_3^-) and barium (Ba^{2+}).

(a) The concentration of barium ions (Ba^{2+}) 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 Ba^{2+} and Cl^- ions would interact with the water molecules in the ocean. (3 marks)

The solubility of barium chloride ($BaCl_2$) is 35.8 g per 1.00×10^2 mL water at 20.0 ˚C.

(c) How would you produce a saturated solution of barium chloride if you had **250 mL** of water at 20 ˚C? (2 marks)

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)

See next page

Question 29 **(8 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. (4 marks)

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

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

See next page

Question 30 **(10 marks)**

Some chemistry students were investigating the pH of various compounds. In particular, they were investigating sodium hydroxide (NaOH) and ammonia (NH_3). 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} NH_3(aq). The students added a few drops of universal indicator to each solution.

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

(b) Explain why the NaOH(aq) would have a higher pH than the NH_3(aq). (4 marks)

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 measured?"

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

See next page

The students then investigated a chemical reaction involving both sodium hydroxide and ammonium chloride. 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 chemical equation for this reaction. (2 marks)

_____

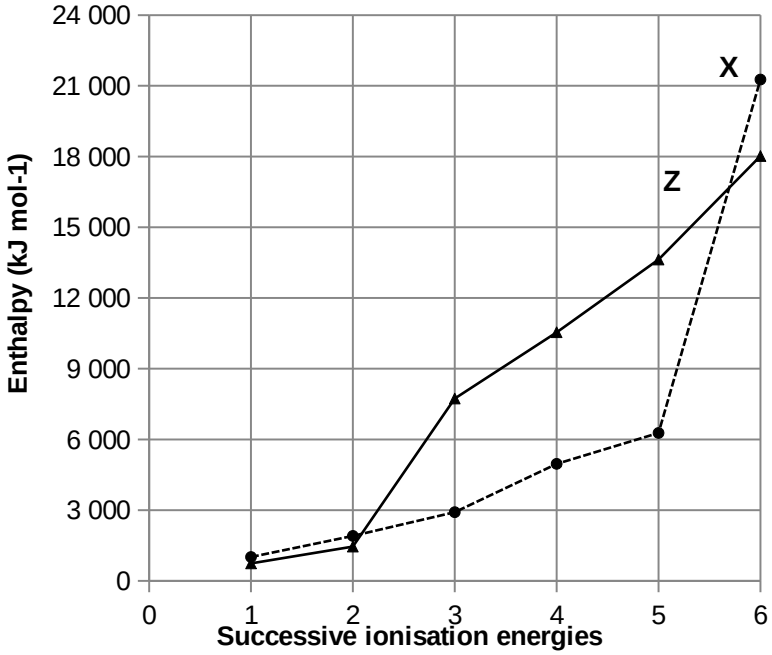
_____

_____

_____

Question 31 **(9 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		

See next page

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

(c) Describe how X and Z could combine by forming chemical bonds. Give the formula of the most likely compound that would form. (3 marks)

Question 32 **(8 marks)**

Azurite, $Cu_3(CO_3)_2(OH)_2$, is a common copper-containing compound found in some copper ores.

(a) Calculate the percentage by mass of copper in azurite, $Cu_3(CO_3)_2(OH)_2$. (2 marks)

See next page

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

$$2\ Cu_3(CO_3)_2(OH)_2(s)\ +\ 3\ C(s)\ \rightarrow\ 6\ Cu(s)\ +\ 7\ CO_2(g)\ +\ 2\ H_2O(g)$$

If 2.98 tonnes of pure copper were produced

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

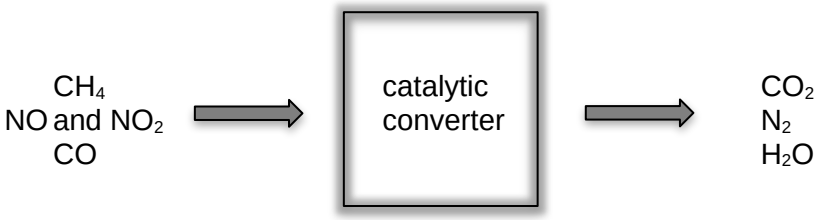
(c) Calculate the mass of azurite, $Cu_3(CO_3)_2(OH)_2$, that was smelted. (2 marks)

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

See next page

Question 33 **(10 marks)**

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



(a) What is the function of a catalytic converter? (1 mark)

_____

_____

(b) Choose **three (3)** of the gases shown in the diagram above and 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.

Each of your chosen gases must have a <u>different</u> molecular shape. (9 marks)

Electron dot diagram	Shape	Intermolecular forces

End of Section Two

See next page

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.

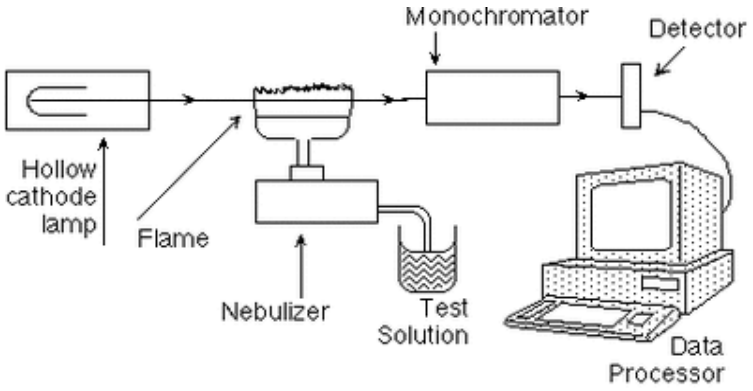
Final answers to calculations should be expressed to the appropriate number of significant figures.

Supplementary pages for the use of planning/continuing your answer to a question have been provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 70 minutes.

Question 34 **(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.

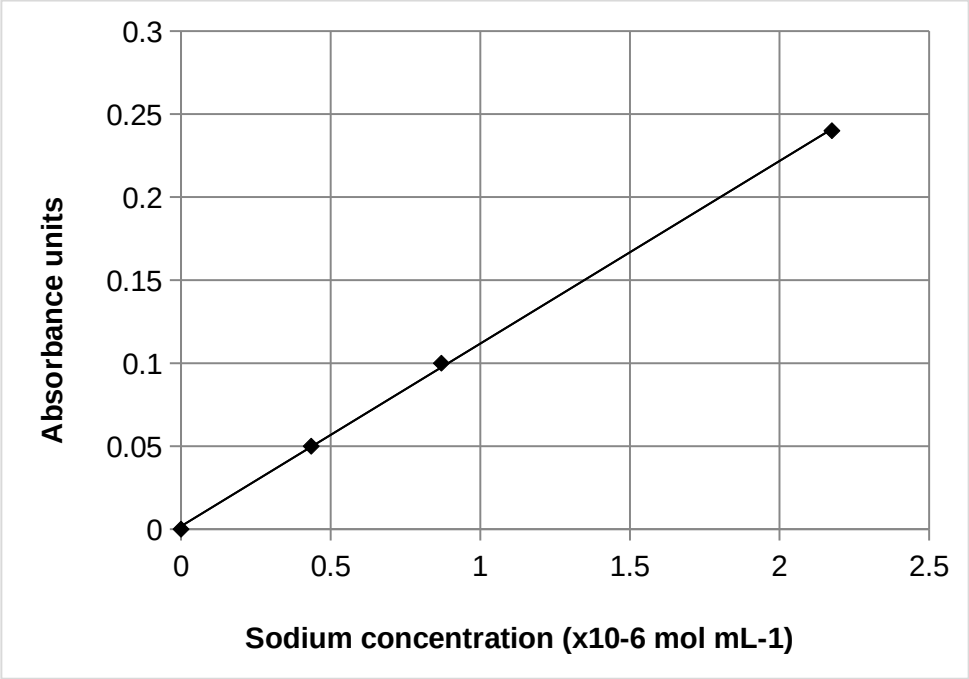


In this analysis, the element in the hollow cathode lamp contained sodium (Na). When the lamp is turned on, the atoms of sodium produce an emission spectrum that is unique to the sodium element.

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

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

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.



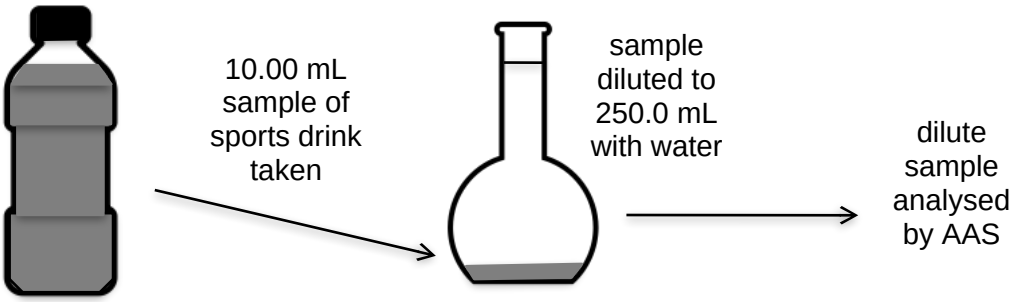
(c) Describe how this calibration curve would have been obtained. (3 marks)

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

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

See next page

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.



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 600.0 mL bottle.

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

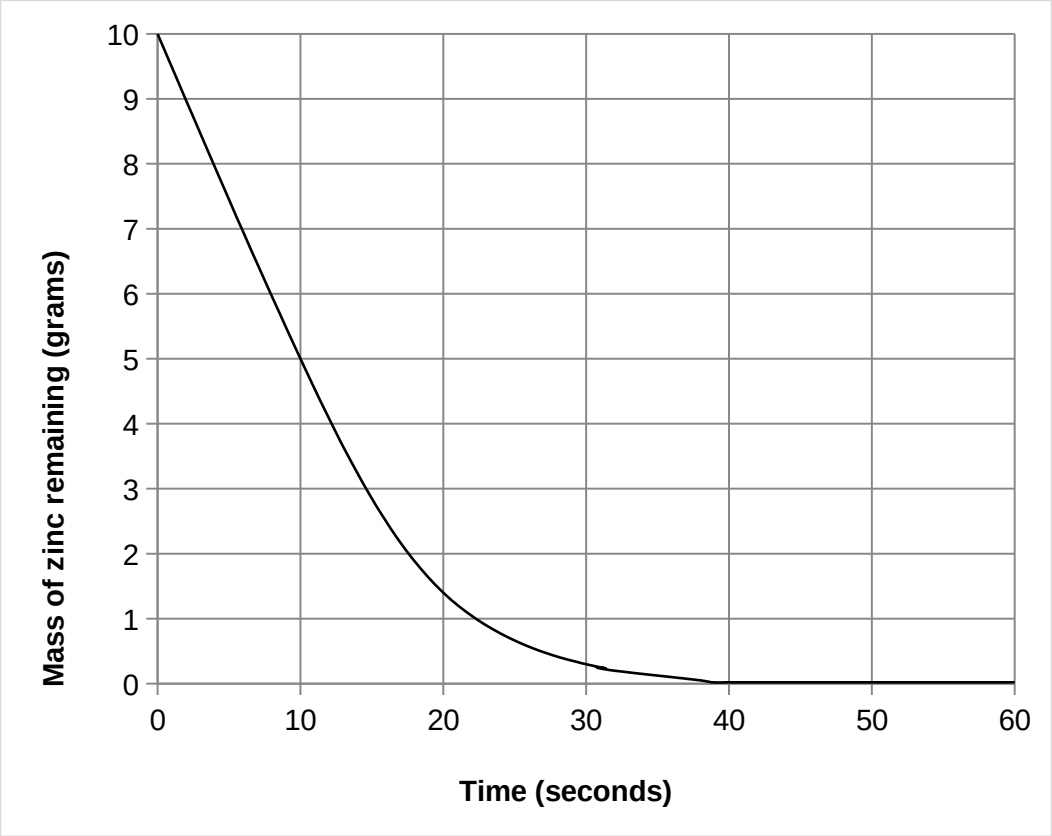
See next page

Question 35 **(15 marks)**

A chemistry class was investigating the topic of reaction rates. 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	

See next page

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

(i) half of the zinc had reacted? _____

(ii) the rate of the reaction became zero? _____

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

_____

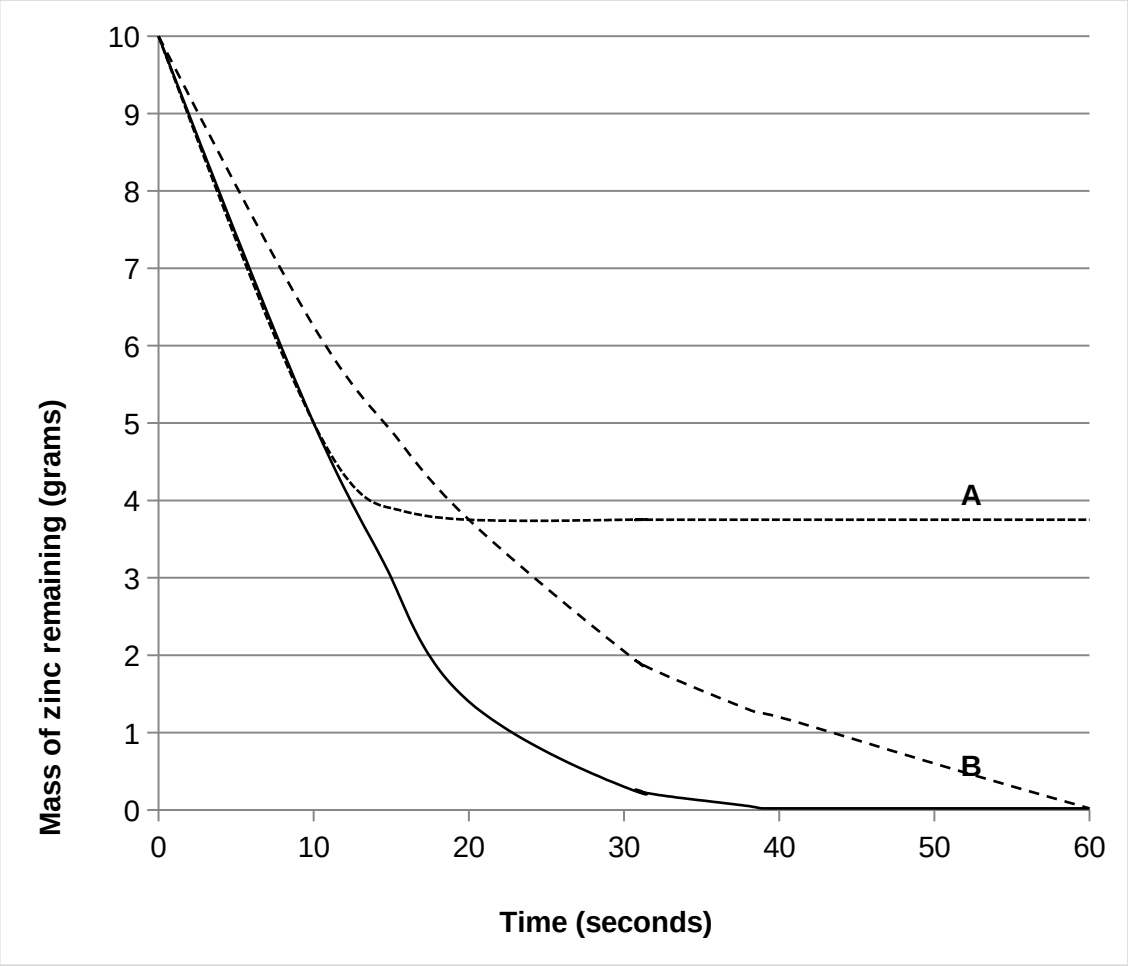
_____

_____

_____

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).



See next page

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,
- and 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)

Change made	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)

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)

See next page

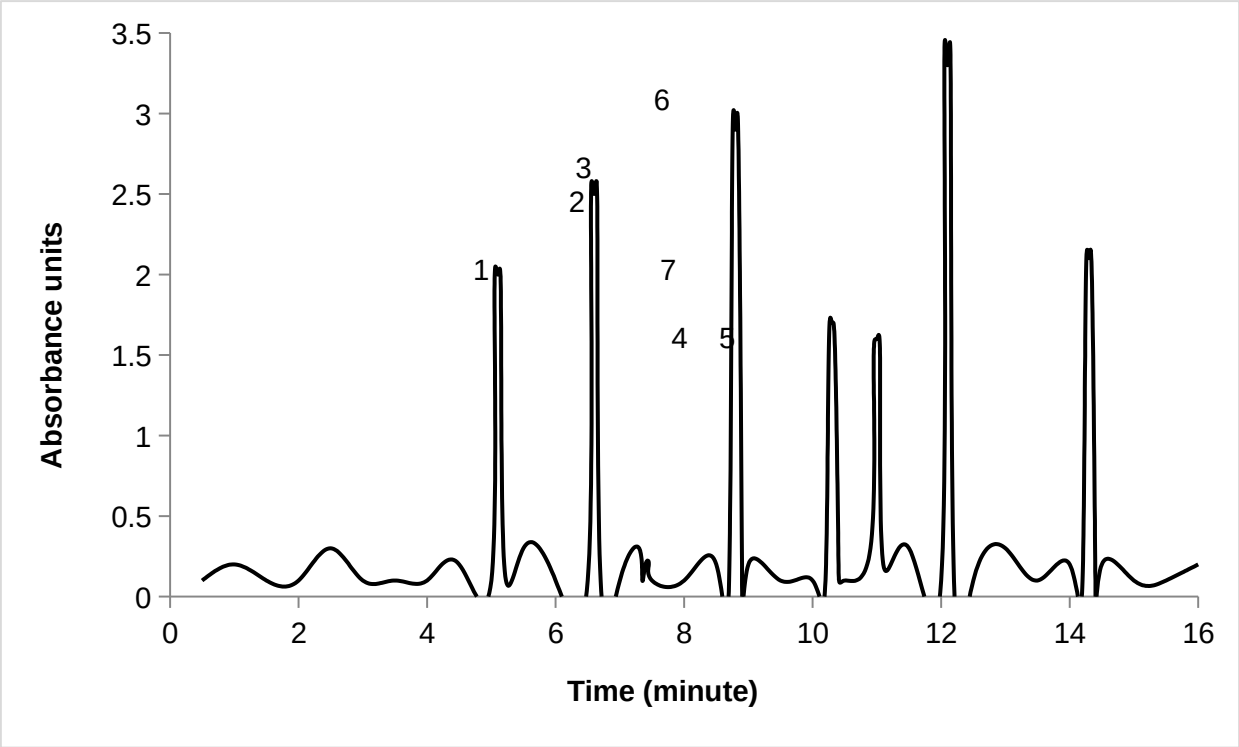
Question 36 **(16 marks)**

High performance liquid chromatography (HPLC) is often used to test water for potential contamination. One particular analysis determines the levels of a range of polycyclic aromatic hydrocarbons (PAHs) in water. These pollutants are naturally occurring, but can be damaging when consumed in high levels.

The table below provides information about seven (7) different PAHs that commonly appear in water samples.

	PAH	MF	Source of PAH
1	naphthalene	$C_{10}H_8$	coal tar, petroleum
2	fluorene	$C_{13}H_{10}$	coal tar
3	anthracene	$C_{14}H_{10}$	coal tar
4	pyrene	$C_{16}H_{10}$	crude oil, fossil fuels
5	chrysene	$C_{18}H_{12}$	coal tar
6	benzofluoranthene	$C_{20}H_{12}$	crude oil, petrol exhaust
7	indenopyrene	$C_{22}H_{12}$	coal tar, diesel exhaust

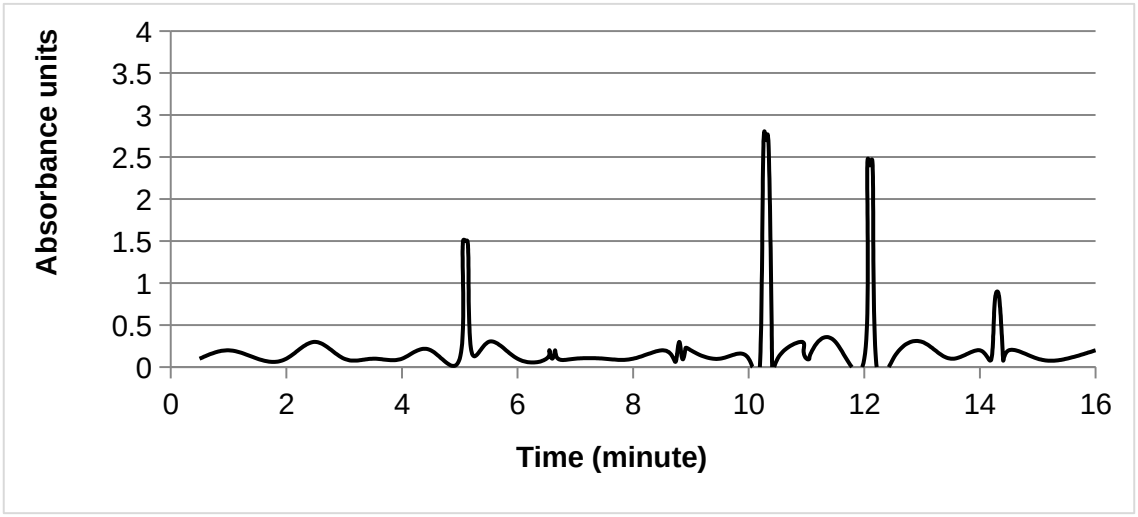
HPLC analysis can determine both the presence and concentration of these PAHs in a water sample. The chromatogram below is a control, showing each of the seven PAHs and their corresponding retention times. The absorbance readings were recorded at 254 nm.



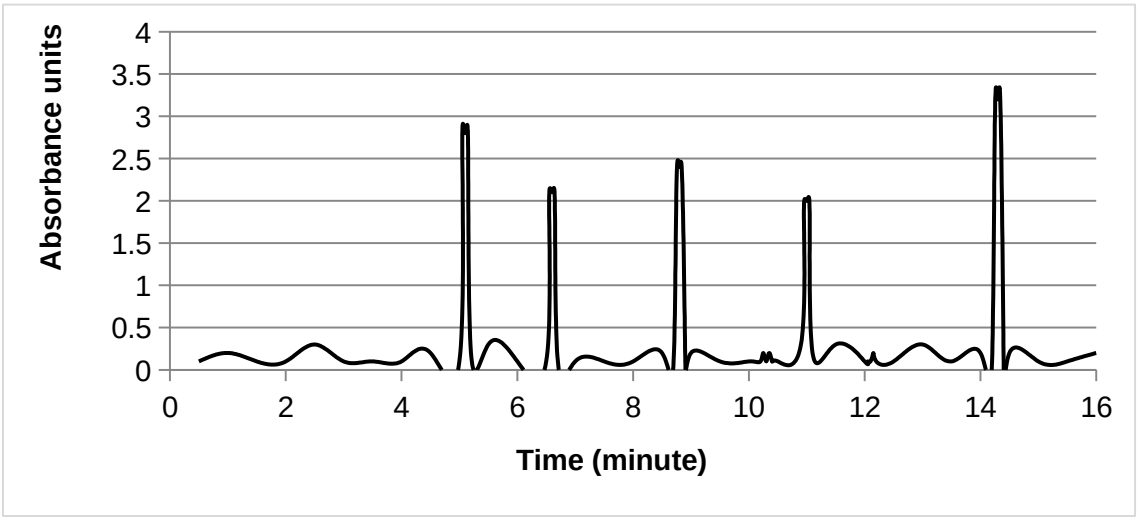
See next page

Three water samples (A, B and C) were collected from various locations and analysed for the presence of these seven PAHs. The HPLC conditions used were identical to those used in the control chromatogram. The results of the three analyses are shown in the chromatograms below.

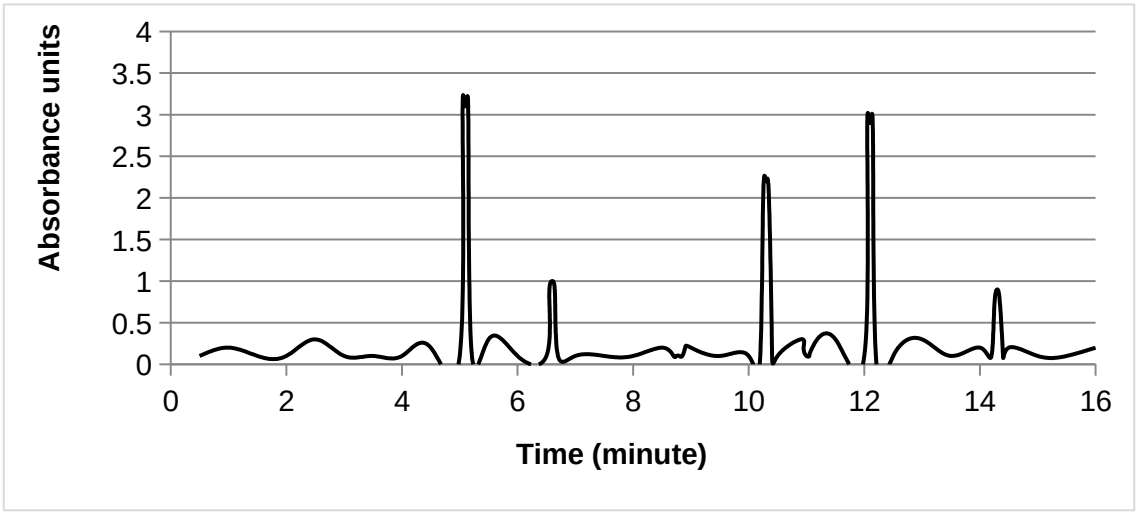
SAMPLE A



SAMPLE B



SAMPLE C



See next page

(a) State **two (2)** controlled variables that would need to be considered to keep the HPLC conditions identical. (2 marks)

(b) Name the **two (2)** significant contaminants common to **all** of the water samples. (1 mark)

(c) Which water sample has the highest concentration of pyrene? (1 mark)

This particular HPLC analysis utilises a non-polar stationary phase with a mixture of water and acetonitrile as the polar mobile phase.

(d) Briefly explain the principles of HPLC and how the various components of a mixture are separated in this process. (4 marks)

(e) Since all the PAHs are non-polar substances, what characteristic has allowed them to be separated in this case? Explain. (2 marks)

See next page

(f) If a polar compound was identified by this HPLC analysis, what retention time would you predict it to have? Justify your answer. (2 marks)

(g) Which water sample is most likely to be contaminated by coal tar? Justify your answer. (2 marks)

It is important that the quality of potable water (clean drinking water) is monitored and maintained to a high standard, to ensure the water does not pose any health risks.

(h) Briefly describe **one (1)** process by which water may be purified or treated before it joins the main water supply? (2 marks)

Question 37 **(18 marks)**

Propane (C_3H_8) 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

$$C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(g) + 2220\ kJ$$

If 455 kg of propane was combusted in air, calculate

(a) the volume of gaseous products that would form at 25°C and 101.3 kPa. (6 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.

See next page

(c) List **two (2)** advantages of using biopropane as a 'greener' alternative to propane. (2 marks)

Propene (C_3H_6) 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.

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

Excess amounts of propane and propene gases were bubbled through separate solutions of bromine water, $Br_2(aq)$. A visible reaction took place in one case, but no change was observed in the other.

(e) 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)

See next page

Question 38 **(17 marks)**

A chemistry student has a solution of silver nitrate, $AgNO_3(aq)$, with a labelled concentration of 0.0425 g mL^{-1}. The student measured out 75.0 mL of the $AgNO_3(aq)$ and placed it in a beaker.

(a) Calculate the concentration of the $AgNO_3(aq)$ solution in moles per litre. (2 marks)

The student then added 100.0 mL of 0.12 mol L^{-1} sodium carbonate solution, $Na_2CO_3(aq)$. They ensured there was excess $Na_2CO_3(aq)$ present in order to precipitate all the silver ions from solution.

The equation for the reaction that took place is;

$$2\ AgNO_3(aq) + Na_2CO_3(aq) \rightarrow Ag_2CO_3(s) + 2\ NaNO_3(aq)$$

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

_____

_____

_____

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

See next page

The student then filtered the mixture to collect the $Ag_2CO_3(s)$ 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 $Ag_2CO_3(s)$ 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 in the evaporating dish. (1 mark)

_____

_____

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

_____

_____

End of questions

Supplementary page

Question number: _____

Supplementary page

Question number: _____

Acknowledgements

Question 34
Author Dean Meagher, http://chemicalinstrumentation.weebly.com/flame-aas.html