

# Year 11 Chemistry Unit 1 & 2

## Semester 2 2015 Question / Answer Booklet



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

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

### **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.

### **MARKS**

**Section 1** /40

**Section 2** /55

**Section 3** /65

**Total** /160

0/n

**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	30	/40	/25
Section Two: Short answer	8	8	55	/55	/35
Section Three: Extended answer	4	4	65	/65	/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.

**Section One: Multiple-choice****25% (40 marks)**

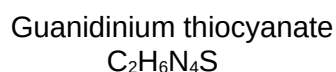
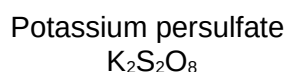
This section has **20** questions. Answer **all** questions on the separate Multiple-choice Answer Sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square then shade your new answer. 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: 30 minutes.

1. Which of the following correctly identifies both a pure substance and a mixture?

	Pure substance	Mixture
(a)	salt water	air
(b)	ethanol	water
(c)	methane	stainless steel
(d)	sulfurous acid	ammonia

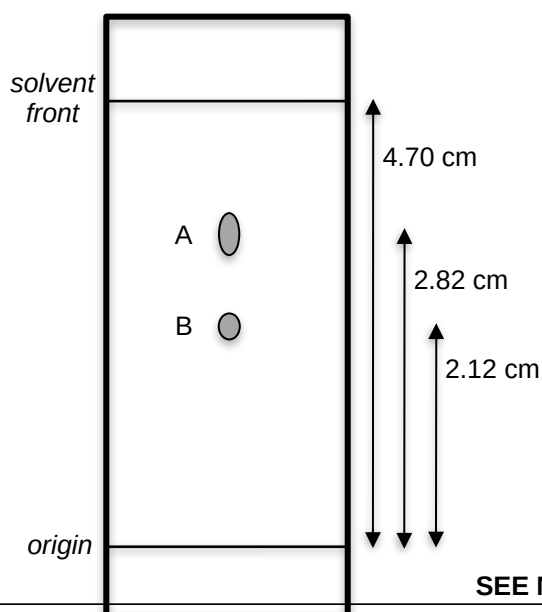
2. Consider the two sulfur-containing compounds below.



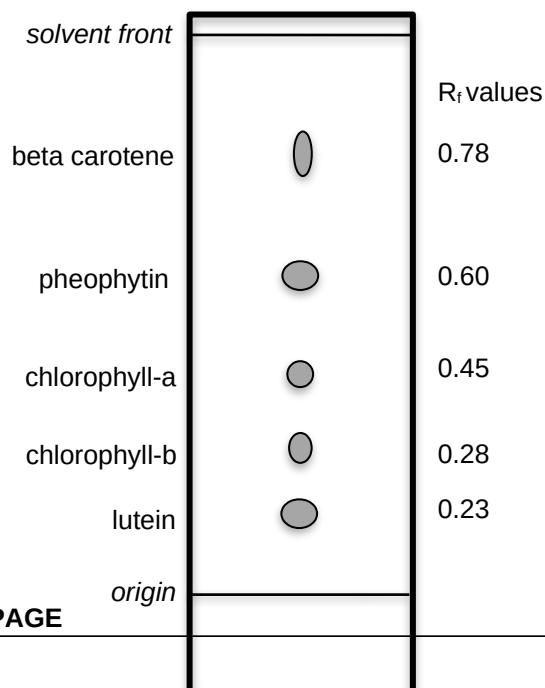
Which of these compounds contains the **highest** percentage of sulfur by mass and what is this value?

- (a) Potassium persulfate, 33.4%  
(b) Guanidinium thiocyanate, 27.1%  
(c) Potassium persulfate, 23.7%  
(d) Guanidinium thiocyanate, 28.6%
3. A group of students were analysing the pigments in a plant leaf sample by thin layer chromatography (TLC). A diagram of their TLC plate is shown (below, left) as well as a standard TLC plate produced from the analysis of the pigments in spinach leaves (below, right).

**Unknown sample**



**Standard – spinach leaves**



SEE NEXT PAGE

The students calculated the retention factor,  $R_f$ , for the unidentified pigments A and B using the following formula;

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

Use the TLC data provided to determine the  $R_f$  value for pigment A and compare this to the standard TLC plate to identify A. You may assume the plates were run under identical conditions.

- |     |                    |                    |
|-----|--------------------|--------------------|
| (a) | $R_f$ value = 0.6  | A is pheophytin    |
| (b) | $R_f$ value = 0.45 | A is chlorophyll-a |
| (c) | $R_f$ value = 0.78 | A is beta carotene |
| (d) | $R_f$ value = 1.7  | A is beta carotene |

4. Which of the following would have dispersion forces as the **only** intermolecular force present in a pure sample?

- |     |                          |
|-----|--------------------------|
| (a) | $\text{SO}_2$            |
| (b) | $\text{CS}_2$            |
| (c) | $\text{CH}_2\text{Cl}_2$ |
| (d) | $\text{CO}$              |

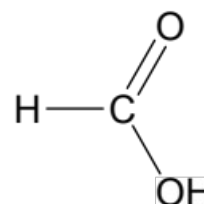
5. In which of the following are the covalent bonds ranked in order of decreasing polarity (i.e. most polar to least polar)?

- |     |  |
|-----|--|
| (a) | $\text{H-O} > \text{H-F} > \text{H-Br} > \text{H-C}$ |
| (b) | $\text{H-C} > \text{H-Br} > \text{H-O} > \text{H-F}$ |
| (c) | $\text{H-F} > \text{H-C} > \text{H-O} > \text{H-Br}$ |
| (d) | $\text{H-F} > \text{H-O} > \text{H-Br} > \text{H-C}$ |

6. Which of these gives the correct shape for each of the covalent molecules?

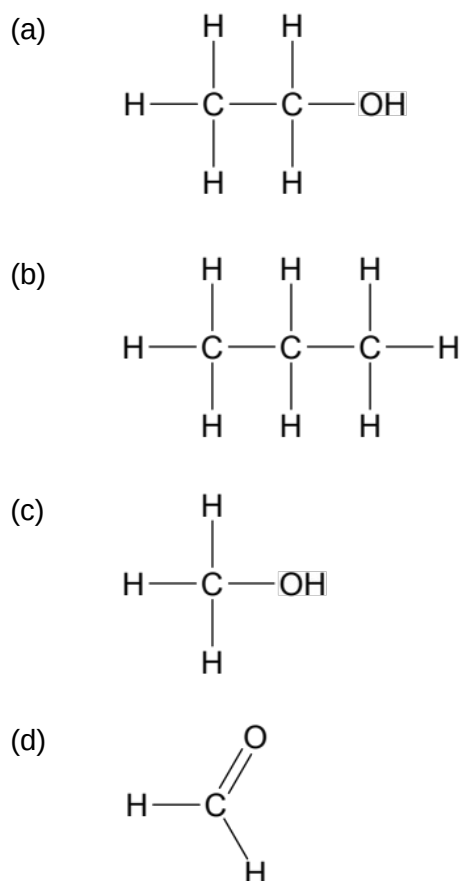
- |     | $\text{SO}_3$   | $\text{HCN}$    | $\text{F}_2\text{O}$ |
|-----|-----------------|-----------------|----------------------|
| (a) | pyramidal       | linear          | bent / v-shaped      |
| (b) | trigonal planar | linear          | bent / v-shaped      |
| (c) | trigonal planar | bent / v-shaped | linear               |
| (d) | pyramidal       | trigonal planar | linear               |

7. Formic acid (methanoic acid) is used as a preservative and antibacterial agent, as well as in various cleaning products. It has boiling point of  $101^\circ\text{C}$  and its structure is shown to the right.



a

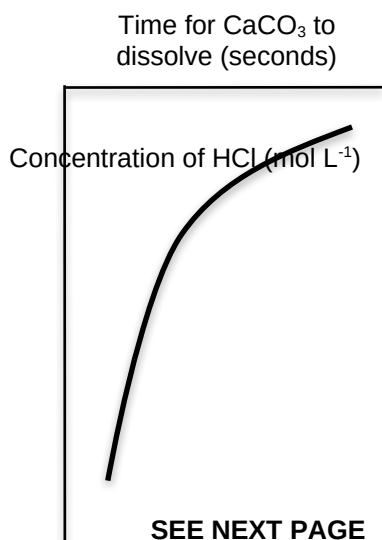
Which of the following substances would be **least** soluble in formic acid?



Questions 8, 9 and 10 relate to the following experiment.

A group of chemistry students set up an experiment to investigate reaction rate. They had 5 beakers, each containing the same mass of calcium carbonate powder. To each beaker they added 50.0 mL of hydrochloric acid. The concentration of the hydrochloric acid in each beaker was 0.25 mol L<sup>-1</sup>, 0.5 mol L<sup>-1</sup>, 0.75 mol L<sup>-1</sup>, 1.0 mol L<sup>-1</sup> and 1.25 mol L<sup>-1</sup> respectively. In each case they measured how long it took, in seconds, for the calcium carbonate powder to dissolve completely.

The equation for the reaction that took place in each beaker is shown below, along with a graph summarising their data.



8. Which of the following correctly states the independent variable, dependent variable and a controlled variable in this experiment?

	<b>Independent</b>	<b>Dependent</b>	<b>Controlled</b>
(a)	time for $\text{CaCO}_3$ to dissolve	concentration of HCl	mass of $\text{CaCO}_3$
(b)	concentration of HCl	time for $\text{CaCO}_3$ to dissolve	volume of HCl
(c)	time for $\text{CaCO}_3$ to dissolve	volume of HCl	temperature of room
(d)	concentration of HCl	mass of $\text{CaCO}_3$	volume of HCl

9. Looking at the students' graph, what trend can be identified from the data collected in this experiment?

- (a) With an increase in HCl concentration, the  $\text{CaCO}_3$  takes longer to dissolve
- (b) With an increase in HCl concentration, there are more collisions occurring between the reactant particles
- (c) With an increase in HCl concentration, less  $\text{CaCO}_3$  is consumed
- (d) With an increase in HCl concentration, there is an increased rate of reaction

10. When evaluating their experiment, the students came up with several things they believed could have contributed to experimental error. Which of these errors would be considered a 'random error'?

- (a) In one of the beakers, the reactants were stirred after being mixed, but no stirring occurred in the other four beakers
- (b) The five beakers were different sizes, which sometimes made it difficult to tell when the  $\text{CaCO}_3$  powder had completely dissolved
- (c) The student recording the results may not have pressed the start button on the stopwatch at exactly the same moment in each trial
- (d) When weighing the  $\text{CaCO}_3$  into each beaker, the students did not zero the balance

11. What physical property of water does the paragraph below describe?

*“Water molecules are strongly attracted to each other through cohesive forces. In liquid water, most molecules are attracted to neighbouring water molecules above, below and on all sides. However, the molecules at the surface of the liquid do not have water molecules above them and are therefore pulled more strongly downwards by the water molecules below them.”*

- (a) Surface tension
- (b) Hydrogen bonding
- (c) Vapour pressure
- (d) Density

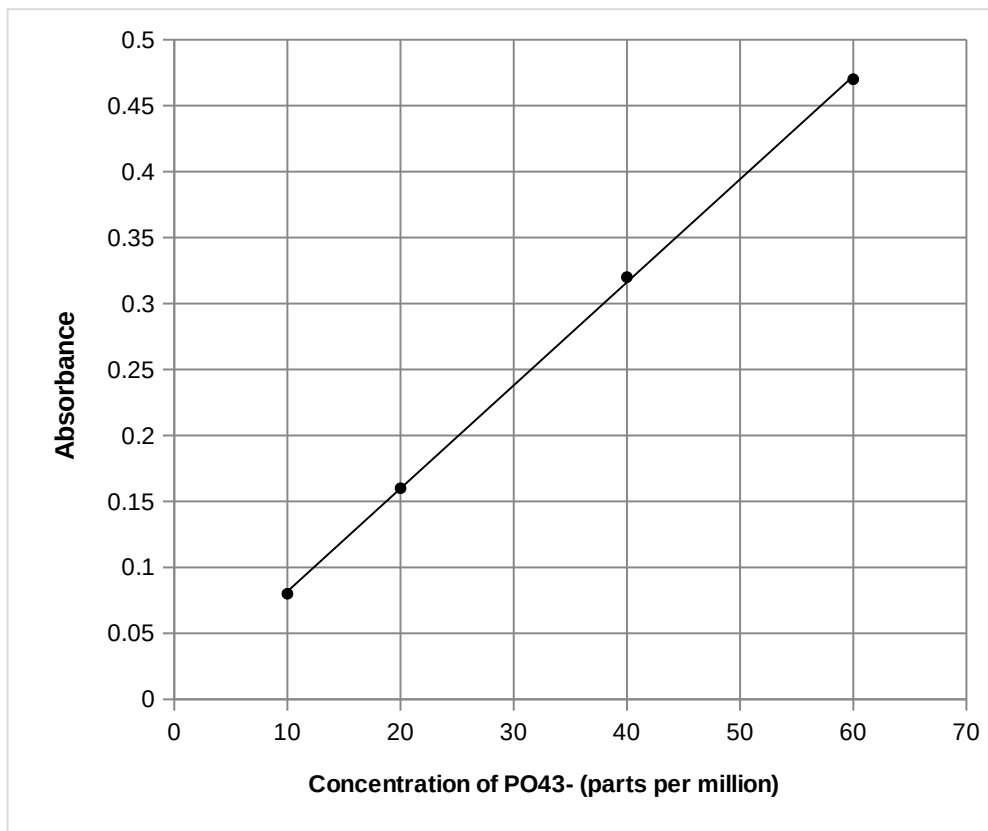
**Questions 12 and 13 relate to the following experiment.**

A chemistry class was given the task of distinguishing between two white powders, sodium hydroxide (NaOH) and sodium sulfate (Na<sub>2</sub>SO<sub>4</sub>). The students began by dissolving each of the powders into separate beakers of water.

12. Which of the solutions below would **not** be useful in distinguishing between the NaOH and Na<sub>2</sub>SO<sub>4</sub> solutions, when a small amount was added to each?
- (a) Zn(NO<sub>3</sub>)<sub>2</sub>(aq)
  - (b) BaCl<sub>2</sub>(aq)
  - (c) Pb(NO<sub>3</sub>)<sub>2</sub>(aq)
  - (d) MgCl<sub>2</sub>(aq)
13. The students suggested a flame test be conducted to distinguish the two aqueous solutions but their teacher said this would not work. What is the main reason a flame test would not help the students?
- (a) Flame tests cannot be done on aqueous solutions
  - (b) Both these ionic compounds have the same cation
  - (c) Only transition metals can be distinguished by flame tests
  - (d) Flame tests are unreliable

14. A phosphate blood test is often done when a patient is suspected of having kidney or gastrointestinal disorders. The concentration of phosphate ( $\text{PO}_4^{3-}$ ) in the blood is measured using high performance liquid chromatography (HPLC). HPLC is used to obtain an absorbance reading for the patient's blood phosphate level, and this then is compared to a set of standards to determine the blood concentration of phosphate.

The standard concentration curve for phosphate is shown in the graph below.



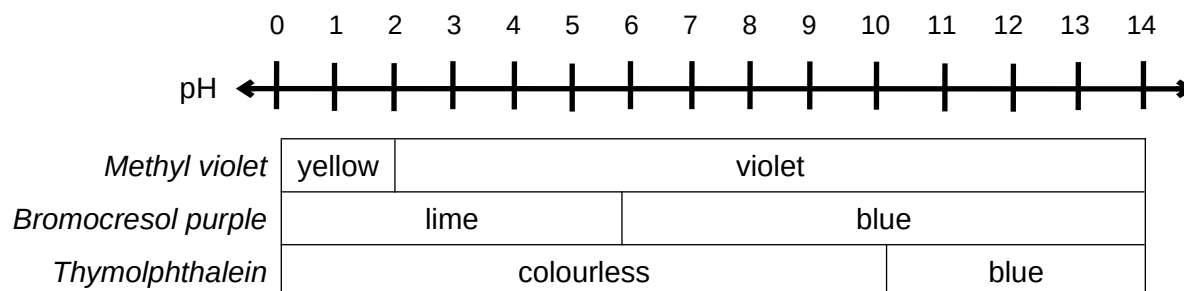
Use the information provided to determine the level of phosphate in a patient's blood if the phosphate absorbance reading obtained from HPLC analysis of their blood was 0.42.

- (a) 0.25 ppm
- (b) 0.34 ppm
- (c) 48 ppm
- (d) 53 ppm



Questions 15 and 16 relate to the following information.

The following diagram shows the colour of three indicators for varying pH values.



15. What colour would you expect a 1.0 mol L<sup>-1</sup> solution of potassium hydroxide (KOH) to turn if a few drops of each of these indicators was added to different samples of potassium hydroxide solution?

	<b>Methyl violet</b>	<b>Bromocresol purple</b>	<b>Thymolphthalein</b>
(a)	violet	blue	blue
(b)	blue	violet	colourless
(c)	yellow	blue	colourless
(d)	blue	violet	blue

16. A mystery solution was tested with each of the above indicators and the results are shown below.

<b>Indicator</b>	<b>Colour</b>
Methyl violet	violet
Bromocresol purple	lime
Thymolphthalein	colourless

What is the narrowest pH range you could assign to this substance based on this data?

- (a) Below 10  
 (b) Between 2 and 6  
 (c) Below 6  
 (d) Between 2 and 10
17. A 99.0 g sample of cobalt(II) chloride was added to 150 mL of water at 20 °C and the solution was stirred until no more solute would dissolve. Some of the CoCl<sub>2</sub> remained undissolved at the bottom of the beaker. The solution was then heated from 20 °C to 40 °C while stirring. If the solubility of cobalt(II) chloride at 40 °C is 69.5 g per 100 mL of water, what observation would have been noted as the solution reached its final temperature?
- (a) No change would be observed  
 (b) More solute crystals would appear  
 (c) Some solute crystals would dissolve  
 (d) All solute crystals would dissolve

Question 18 and 19 relate to the following energy profile diagram.



18. What are the values for the heat of enthalpy ( $\Delta H$ ) and the activation energy ( $E_a$ ) for this reaction?

	$\Delta H$ (kJ)	$E_a$ (kJ)
(a)	-200	+300
(b)	+200	+500
(c)	-200	+500
(d)	+200	+100

19. Which of the following is **not** correct regarding X?

- (a) X represents the transition state
- (b) Particles at X have the highest enthalpy
- (c) X only exists temporarily
- (d) All particles at X will quickly form products

20. A small sample of sodium carbonate solution is mixed with hydrochloric acid. Which of the following correctly shows the balanced ionic equation for the reaction that would take place?

- (a)  $\text{Na}_2\text{CO}_3(\text{aq}) + 2 \text{H}^+(\text{aq}) \rightarrow 2 \text{Na}^+(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- (b)  $\text{CO}_3^{2-}(\text{aq}) + 2 \text{H}^+(\text{aq}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- (c)  $\text{Na}_2\text{CO}_3 + 2 \text{HCl}(\text{aq}) \rightarrow 2 \text{NaCl}(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- (d)  $\text{CO}_3^{2-}(\text{aq}) + 2 \text{H}^+(\text{aq}) \rightarrow \text{H}_2\text{CO}_3(\text{aq})$

End of Section One

SEE NEXT PAGE

**Section Two: Short answer****35% (55 marks)**

This section has **7** 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.

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Suggested working time: 55 minutes.

**Question 21****(13 marks)**

Consider the solubility information given in the table below.

	Solubility in water (g per 100 mL)
Potassium nitrate ( $\text{KNO}_3$ )	32
Ammonium nitrate ( $\text{NH}_4\text{NO}_3$ )	150
Potassium phosphate ( $\text{K}_3\text{PO}_4$ )	90

- (a) Classify the solutions below as 'saturated', 'unsaturated' or 'supersaturated'. Explain your reasoning. (5 marks)

- (i) 216 g of  $\text{K}_3\text{PO}_4$  was dissolved in 240 mL of water.

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- (ii) 0.375 mol of  $\text{KNO}_3$  was dissolved in 170 mL of water.

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- (b) A saturated solution of  $\text{NH}_4\text{NO}_3$  was prepared. Describe how this could be used to form a supersaturated solution. (3 marks)

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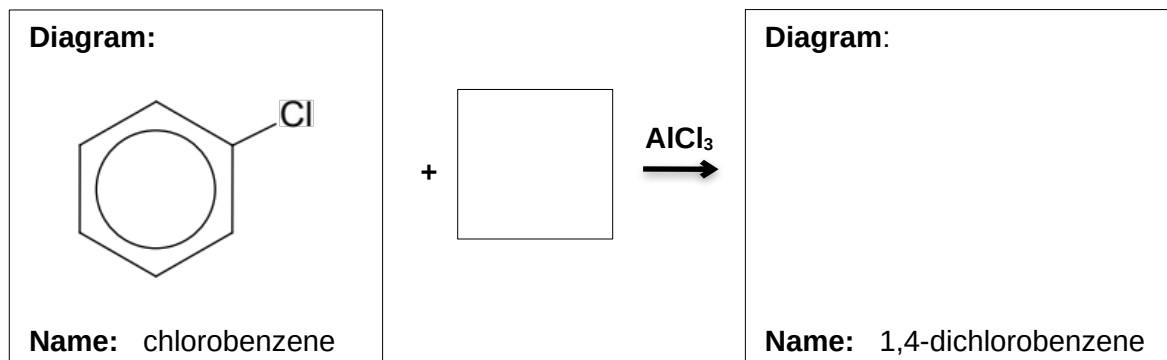
The two solutions described in part (a) were mixed together.

- (c) Calculate the final concentration (in  $\text{mol L}^{-1}$ ) of potassium ions ( $\text{K}^+$ ) in the resulting solution. (5 marks)

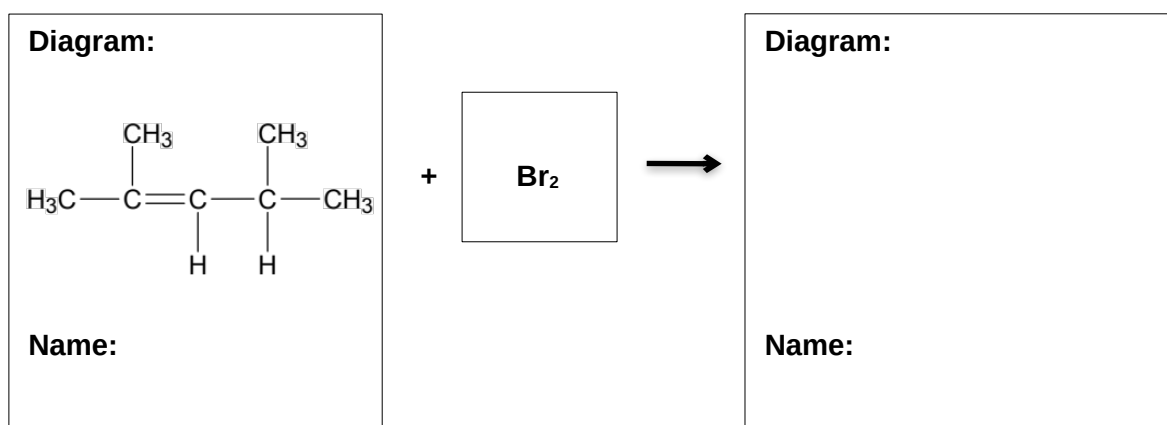
**Question 22****(7 marks)**

Organic compounds can undergo many different types of reactions.

- (a) Complete the reaction below by adding the inorganic reactant and drawing the structural diagram for the organic product formed. (2 marks)



- (b) Complete the reaction below by giving the IUPAC name for the organic reactant and the structural diagram and IUPAC name for the organic product formed. (3 marks)



- (c) Name the type of reaction occurring in; (2 marks)

- (a) \_\_\_\_\_
- (b) \_\_\_\_\_

### Question 23

**(6 marks)**

Most modern cars are powered by an engine with a 4-stroke combustion cycle. The purpose of each stroke is described below.

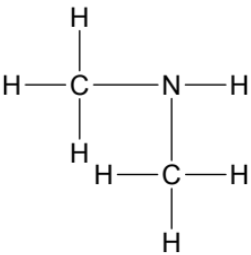
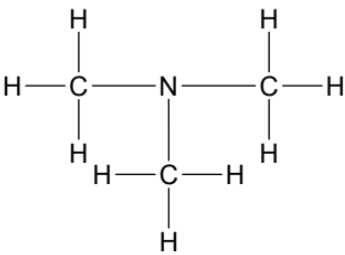
1. Intake stroke - the fuel is injected in as a fine mist, where it mixes with air
2. Compression stroke - the fuel/air mixture is compressed into a small volume
3. Combustion stroke - a spark plug ignites the fuel/air mixture, which explodes
4. Exhaust stroke - exhaust fumes leave through the valve

Explain, in terms of the collision theory, how each of the conditions described in **stroke 1, 2 and 3** affect the rate of reaction between the fuel and the air.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

**Question 24****(7 marks)**

Consider the information given in the table below.

Dimethylamine	Trimethylamine
	
Boiling point 8 °C	Boiling point -3 °C

- (a) Dimethylamine has the ability to form hydrogen bonds. Explain in detail how hydrogen bonds form and draw a diagram showing these bonds in dimethylamine. (4 marks)

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- (b) Explain why trimethylamine has the stronger dispersion forces, but dimethylamine has the higher boiling point. (3 marks)

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**Question 25****(8 marks)**

When scientists are looking for other planets that might support life, they search for those that may have liquid water. Water is one of the main reasons that life can exist on planet Earth.

One of the special properties of water is that its solid form (ice) is less dense than its liquid form.

- (a) Explain this property in terms of the structure and bonding present in water, and give an example of how this property of water is essential to the survival of many aquatic life forms found on Earth. (4 marks)

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Water that can be used for drinking is known as 'potable' water. In Perth, most of the potable water comes from groundwater or the ocean.

- (b) Briefly describe 2 of the processes that may be required to treat these sources of water before they are of suitable quality to join our water supply. (4 marks)

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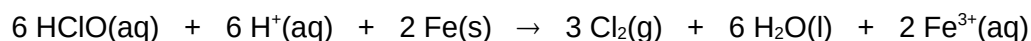
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**Question 26****(5 marks)**

The equation below represents the reaction between solid iron (Fe) and hypochlorous acid (HClO).



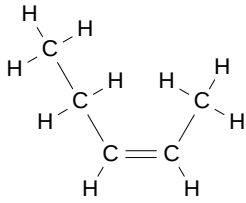
A piece of iron was placed in a solution of  $1.53 \text{ mol L}^{-1}$  hypochlorous acid. The reaction was allowed to go to completion and at the end all of the solid iron had reacted. If  $1.48 \text{ L}$  of  $\text{Cl}_2$  was produced at STP;

- (a) Calculate the volume of HClO that would have been required for the reaction to take place. (3 marks)

- (b) Calculate the mass of iron that must have been present. (2 marks)

**Question 27****(4 marks)**

Complete the following table showing the structure and names of four hydrocarbons.

Structure	IUPAC Name
	Butane
	
$  \begin{array}{ccccccc}  & & & \text{CH}_3 & & & \\  & & &   & & & \\  \text{CH}_3 & - & \text{CH}_2 & - & \text{CH}_2 & - & \text{C} & - & \text{CH} & - & \text{CH}_3 \\  & & & & & &   & &   & & \\  & & & & & & \text{CH}_3 & & \text{CH}_3 & &   \end{array}  $	
	ethylpentane

**Question 28****(5 marks)****SEE NEXT PAGE**

Write ionic equations, including state symbols, and observations for any reactions that occur in the following situations.

- (a) Dilute sulfuric acid solution is added to aluminium metal. (3 marks)

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- (b) Solid magnesium oxide is added to dilute nitric acid. (2 marks)

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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.

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.

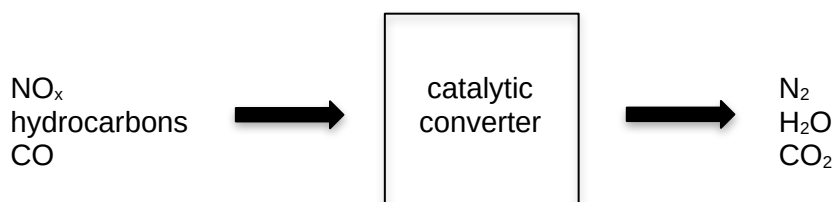
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Suggested working time: 65 minutes.

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**Question 29****(16 marks)**

The catalytic converter in a car takes in the undesirable gases produced by the combustion of petrol, such as carbon monoxide and various nitrogen oxides, and converts them into less harmful gases such as carbon dioxide, nitrogen gas and water. The less harmful gases are released into the atmosphere as we drive.



Metals such as platinum, palladium and rhodium are used as the catalyst in a catalytic converter.

- (a) Explain what a catalyst is and describe its effect on the rate of a reaction. (3 marks)

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The table below shows the major gaseous products to exit a catalytic converter.

- (b) Complete this table by drawing the structural formula for each of the three gases, representing all valence shell electron pairs either as : or –. In addition, state the shape of the molecule, and indicate whether or not the molecule contains polar bonds or is a polar molecule. (6 marks)

	Structural diagram	Shape	Polar bonds (‘yes’ or ‘no’)	Polar molecule (‘yes’ or ‘no’)
N <sub>2</sub>				
CO <sub>2</sub>				
H <sub>2</sub> O				

A sample of exhaust fumes from a car was analysed by gas chromatography (GC) to determine the composition of the fumes and assess the effectiveness of the catalytic converter.

- (c) Briefly describe the principles of gas chromatography and state one reason why GC may have been chosen over other forms of chromatography to perform the analysis in this situation. (4 marks)

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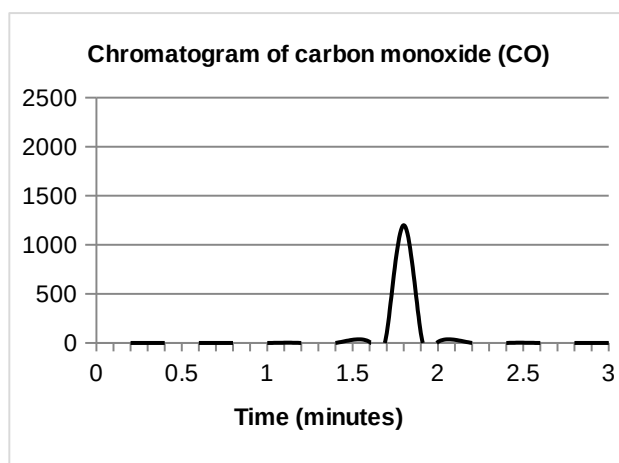
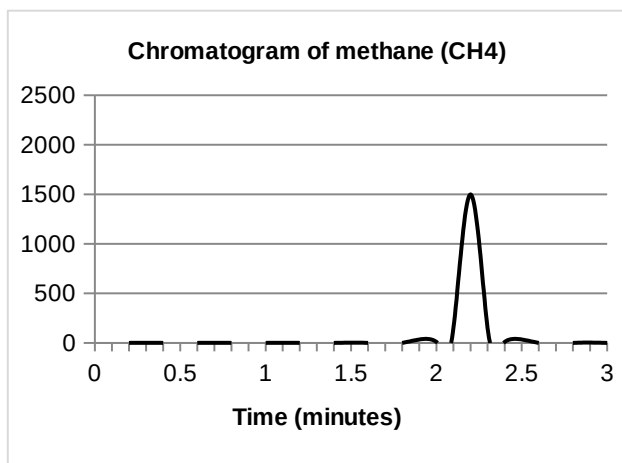
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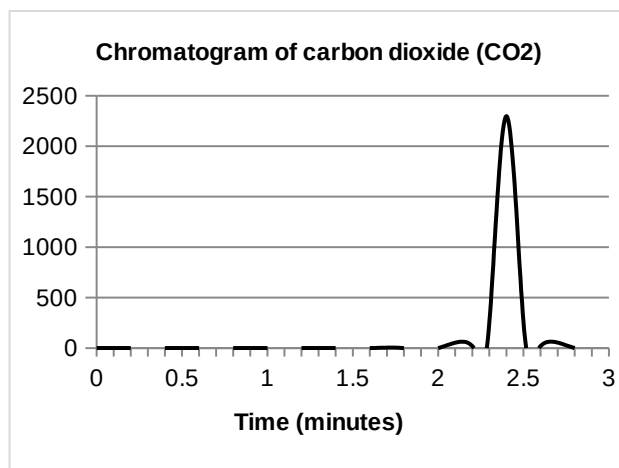
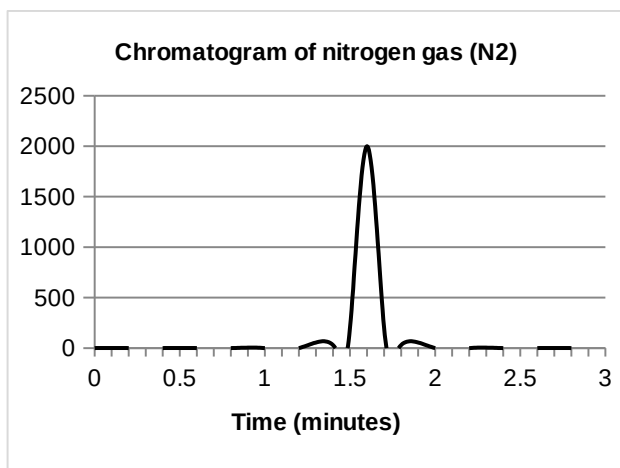
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The data below shows GC standards for four of the relevant gases, as well as the chromatogram obtained from analysis of the car exhaust fumes.

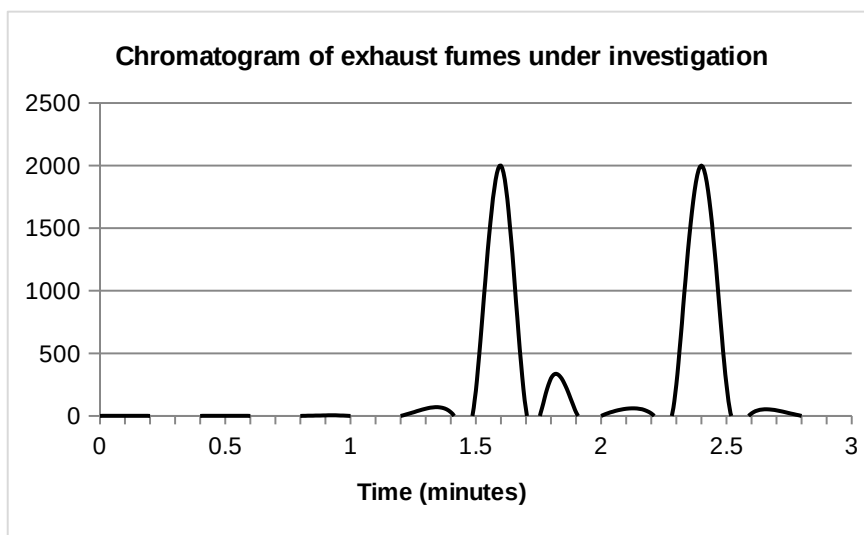
The two chromatograms below, for methane and carbon monoxide, were obtained from the analysis of car exhaust fumes that **do not pass** through a catalytic converter.



The two chromatograms below, for nitrogen and carbon dioxide, were obtained from the analysis of exhaust fumes released from an **efficiently functioning** catalytic converter.



The chromatogram for the sample of exhaust fumes being analysed is shown below.



SEE NEXT PAGE

- (d) Elaborate on the information provided by this data, in terms of the composition of the car exhaust fumes and the effectiveness of the catalytic converter. (3 marks)

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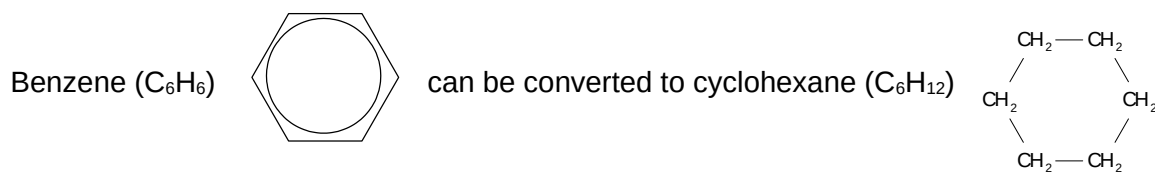
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**Question 30****(18 marks)**

by the addition of hydrogen. The reaction can be catalysed using metallic nanoparticles.

- (a) Using collision theory, explain why the metal catalyst is more effective in the form of nanoparticles than in the bulk form (larger pieces) of the metal. (2 marks)

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- (b) Using the collision theory, and including an appropriate diagram, explain how temperature affects the rate of a chemical reaction. (4 marks)

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- (c) Write a balanced chemical equation for this reaction. (1 mark)

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- (d) Calculate the mass of cyclohexane that can be produced from 750 g of benzene. (3 marks)

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- (e) Calculate the volume of this amount of hydrogen gas at standard temperature and pressure (STP). (2 marks)

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(f) During this process, the chemical engineer was concerned that cyclohexene ( $C_6H_{10}$ ) might be formed in place of the cyclohexane.

- (i) Describe a chemical test, including expected observations, that would detect the presence of cyclohexene in the products of this reaction. (2 marks)

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- (ii) With reference to the equation in part (c), suggest how the chemical engineer can reduce the risk of cyclohexene being formed in the reaction. (1 mark)

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(g) The percentage by mass of carbon in cyclohexane is 85.8%

- (i) Calculate the percentage by mass of carbon in benzene (1 mark)

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- (ii) Use your answer to (g) (i) to suggest why aromatic substances such as benzene burn with a more smoky flame than aliphatic compounds such as cyclohexane. (2 marks)

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## Question 31

(14 marks)

A chemist was preparing for his next experiment by organising and labelling all his bottles of solutions. He had five bottles to go when the fire alarm went off for a practice safety drill. When he got back to his bench later he found five bottles, each containing a clear colourless liquid. Next to these bottles were the remaining five labels;

Barium hydroxide $\text{Ba}(\text{OH})_2$ 0.25 mol L <sup>-1</sup>	Sodium chloride NaCl 0.25 mol L <sup>-1</sup>	Ethanoic acid $\text{CH}_3\text{COOH}$ 0.25 mol L <sup>-1</sup>
Hydrochloric acid HCl 0.25 mol L <sup>-1</sup>	Sodium hydroxide NaOH 0.25 mol L <sup>-1</sup>	

He set about identifying each solution so that he could finish labelling them. He began by adding a few drops of sulfuric acid to a small sample of each. This test allowed him to identify the  $\text{Ba}(\text{OH})_2$  solution straight away.

- (a) What observation would he have made to allow this identification? Write the ionic equation for the reaction that could have taken place in the test tube containing  $\text{Ba}(\text{OH})_2$ . (2 marks)

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He then added some powdered ammonium chloride ( $\text{NH}_4\text{Cl}$ ) to a new sample of the remaining four unidentified solutions. Bubbles were observed to form with **one** of the unknown solutions and an unpleasant, pungent smelling gas was produced.

- (b) Identify this solution and write the ionic equation for the reaction that was occurring. (2 marks)

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The gas produced by the reaction in part (b) was collected and dissolved in a sample of distilled water.

- (c) Describe the expected observations if litmus indicator was added to the water sample once the gas had dissolved and write an equation that supports these observations. (2 marks)

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Universal indicator was then added to new samples of the remaining three unidentified solutions.

- (d) Explain how an indicator works and describe how this test would allow **clear** identification of **one** of the substances. (3 marks)

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A piece of zinc metal was added to the final two solutions. In one solution, a fast reaction was seen, with much effervescence (bubbles). The other test tube also showed some effervescence but at a much slower rate.

- (e) Explain in detail why a difference in reaction rate was observed between these two solutions and how this observation allowed the chemist to identify and distinguish these two solutions from one another. (5 marks)

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**Question 32****(17 marks)**

Bioethanol is the same compound as ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ) but refers to ethanol that has been produced from 'biomass', which is a renewable resource. Ethanol is a useful fuel and combusts according to the following equation;



- (a) Explain briefly how bioethanol is produced. (2 marks)

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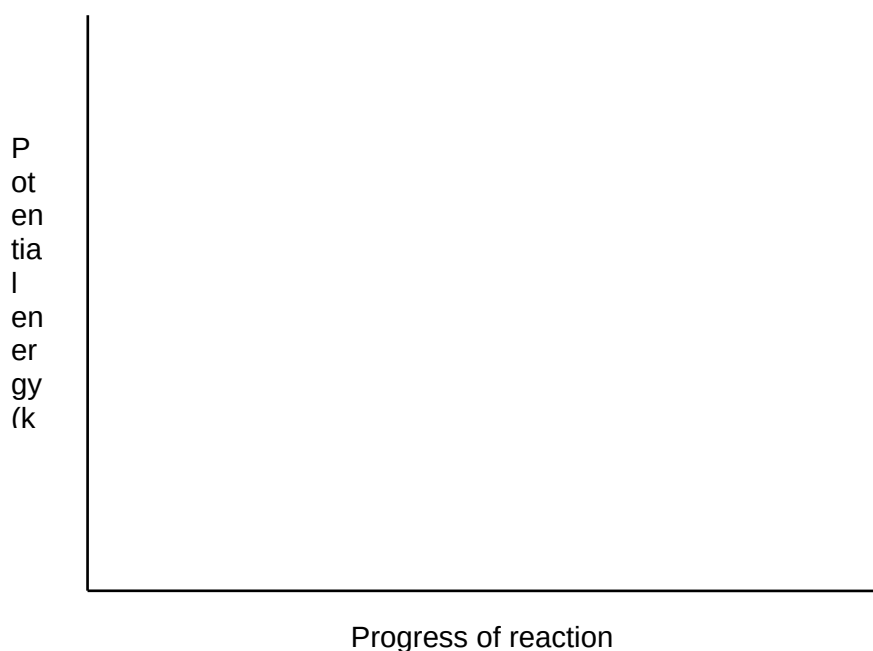
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If the activation energy for the combustion reaction above is 387 kJ;

- (b) Draw a fully labelled energy profile diagram, to scale, for the combustion of ethanol. (4 marks)



- (c) Explain how the Law of Conservation of Energy applies to your energy profile diagram. (2 marks)

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**SEE NEXT PAGE**

Octane ( $\text{C}_8\text{H}_{18}$ ) is a hydrocarbon fuel, which is obtained from the fractional distillation of crude oil. Unlike bioethanol it is a non-renewable resource. Octane and its many structural isomers can be found as components of the petrol we use to power our cars.

- (d) Briefly describe the composition of petrol. (2 marks)

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The activation energy for the combustion of octane is substantially higher than the activation energy for the combustion of ethanol.

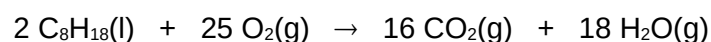
- (e) What information does this give you about ethanol and octane? (2 marks)

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The equation representing the combustion of octane is shown below. The enthalpy change for the combustion is  $-5470 \text{ kJ mol}^{-1}$  of octane.



- (f) If 1.55 kg of octane was burnt, calculate the amount of heat energy released **and** the volume of carbon dioxide produced at STP. (5 marks)

End of questions

Spare answer page

Question number: \_\_\_\_\_

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