

2008

**TRIAL HSC
EXAMINATION**

Chemistry

Student Number	
Mark / 100	

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Write your Student Number at the top of this page and on pages 7,9,11,13,15,17 and 19.
- Board-approved calculators may be used
- A data sheet and a Periodic Table are provided at the back of this paper. This may be removed for your convenience.

Total Marks – 100

Section I Pages 3-19

75 marks

This section has two parts, Part A and Part B

Part A – 15 marks

- Attempt Questions 1-15
- Allow about 30 minutes for this part

Part B – 60 marks

- Attempt Questions 16-28
- Allow about 1 hour and 45 minutes for this part

Section II Pages 20 – 21

25 marks

- Attempt Question 29
- Allow about 45 minutes for this section

Section I

75 marks

Part A – 15 marks

Attempt Questions 1-15

Allow about 30 minutes for this part

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows.

A B C D
correct
↙

Mark your answers on the ANSWER sheet on page 7.

1. Which is the most common catalyst for the manufacture of ethanol from ethene and water?
- (A) Yeast
 - (B) Iron
 - (C) Hydrochloric acid
 - (D) Sulfuric acid

The information below relates to questions 2 and 3.

Students measured the mass change in a flask containing glucose solution and yeast. The initial mass of the flask and contents was 428.1 g and the mass of the flask and contents after a week was 390.1 g.

2. What volume of gas was released at 25°C and 100 kPa.?
- (A) 0.86 L
 - (B) 19.61 L
 - (C) 21.40L
 - (D) 38.0 L
3. What method could be used to separate the other product from the reaction mixture?
- (A) Refluxing
 - (B) Fractional distillation
 - (C) The use of a separating funnel
 - (D) Filtration.
4. The heat of combustion of 1-butanol is 36,100 J g⁻¹.
What is the value of the heat of combustion in kJ mol⁻¹ ?
- (A) 488
 - (B) 1661
 - (C) 2022
 - (D) 2676

5. The results of tests involving metals L,M,N,P and solutions of their ions were as follows:

<i>Ions</i>	<i>Metals</i>			
	<i>L</i>	<i>M</i>	<i>N</i>	<i>P</i>
L²⁺	N/R	Solid deposit	Solid deposit	Solid Deposit
M²⁺	N/R	N/R	Solid Deposit	Solid Deposit
N²⁺	N/R	N/R	N/R	Solid Deposit
P²⁺	N/R	N/R	N/R	N/R

N/R= no reaction

Which metal is the most active?

- (A) L
 - (B) M
 - (C) N
 - (D) P
6. Which acid is considered a general component of acid rain?

- (A) Acetic acid
- (B) Nitric acid
- (C) Phosphoric acid
- (D) Sodium hydroxide

7. Bromine gas may be formed from the decomposition of bromine pentafluoride as shown in the equation.



What will happen to the concentration of bromine if the pressure is increased (temperature kept constant) after the reaction has attained equilibrium?

- (A) remain the same because only the reaction rate will change
- (B) decrease because there are fewer gaseous reactant molecules than products
- (C) increase since the reaction acquires energy from the pressure
- (D) decrease because there are more gaseous reactant molecules than products

8. Common oxides include CaO, CO₂, Na₂O and SO₂. Which of these oxides would give a solution with a pH less than 7, and which oxides would give a solution with a pH greater than 7?

	<i>pH</i> < 7	<i>pH</i> > 7
(A)	CO ₂ , SO ₂	Na ₂ O, CaO
(B)	SO ₂ , CaO	CO ₂ , Na ₂ O
(C)	Na ₂ O, CaO	CO ₂ , SO ₂
(D)	CO ₂ , Na ₂ O	CaO, SO ₂

9. The condensed structural formula of an ester that gives a *rum*-smell is provided.



What two organic compounds would be used to form the *rum*-smelling ester?

- (A) 1-propanol and butanoic acid
(B) 1-butanol and ethanoic acid
(C) propanol and pentanoic acid
(D) 1-butanol and propanoic acid
10. Which organic compound would have the highest boiling point?
- (A) hexanoic acid
(B) 1-hexanol
(C) hexane
(D) hexene
11. Which of the following cannot be a Brønsted – Lowry acid?
- (A) HCO₃⁻
(B) CO₂
(C) H₂CO₃
(D) H₂O

12. What is the common name of 2 – hydroxypropane – 1,2,3 – tricarboxylic acid?

- (A) citric acid
- (B) hydrochloric acid
- (C) acetic acid
- (D) propanoic acid

13. The water supply is often treated with the following substances:

- (i) chlorine
- (ii) fluorine,
- (iii) iron (III) chloride
- (iv) sodium fluoride.

Which of the substances is/are added to sanitize the water supply?

- (A) all of the additives
- (B) (i) only
- (C) (i) and (ii) only
- (D) (i) and (iii) only

14. Which of the following *ozones* is vital to the survival of all living things on Earth?

- (A) atmospheric ozone
- (B) stratospheric ozone
- (C) tropospheric ozone
- (D) mesospheric ozone

15. The colourless aqueous solution of a white solid sample formed a precipitate with an acidified aqueous solution of lead (II) nitrate. What is the possible identity of the original solution of this sample?

- (A) copper (II) sulfate
- (B) barium chloride
- (C) sodium sulfate
- (D) silver chloride

Section I**Mark** -----/15**Part A****Multiple Choice ANSWER sheet**

- | | | | | |
|-----|-------------------------|-------------------------|-------------------------|-------------------------|
| 1. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 2. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 3. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 4. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 5. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 6. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 7. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 8. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 9. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
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| 11. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 12. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 13. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 14. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 15. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |

Part B. 60 marks

Attempt questions 16 to 28

Allow about 1 hour and 45 minutes for this part

▶ Show all relevant working in questions involving calculations

MARKS

Question 16 (8 marks)

Draw a diagram to show the construction of a galvanic cell that could measure the difference in potential between silver and zinc.

On the diagram label:

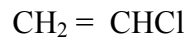
- the anode
- the cathode
- nature of the electrolyte solutions
- the direction and location of electron flow
- the direction and location of positive ion flow

Below the diagram :

- Write half equations and a balanced net ionic equation for the reaction.
- Calculate the potential E° using the table of standard potentials

Question 17 (3 marks)

The condensed structural formula of a monomer is shown.



- (a) Identify the systematic name of this monomer. **1**

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- (b) Draw the structure of the polymer made from this monomer (showing 4 monomer units). **1**

- (c) What is the molecular weight of this polymer made from 4 monomers.? **1**

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Question 18 (5 marks)

- (a) The value for the heat of combustion of 1-propanol is 2021 kJ mol^{-1} . Calculate the theoretical volume of water that could be heated from 31°C to 55°C if 5g of 1-propanol was used.

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- (b) If 1-pentanol was used instead of 1-propanol would you expect that a greater or lesser quantity of fuel could be used to heat the same volume of water by the same amount? Explain your answer.

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Question 19 (4 marks)

- (a) What is a transuranic element? **1**

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- (b) Give one example of a transuranic element and describe where and how it is produced. **3**

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Question 20 (4 marks)

One hazardous compound is sulfur dioxide.

- (a) State one industrial source of sulfur dioxide. **1**

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- (b) Write a balanced formulae equation to describe how sulfur dioxide may be formed **1**

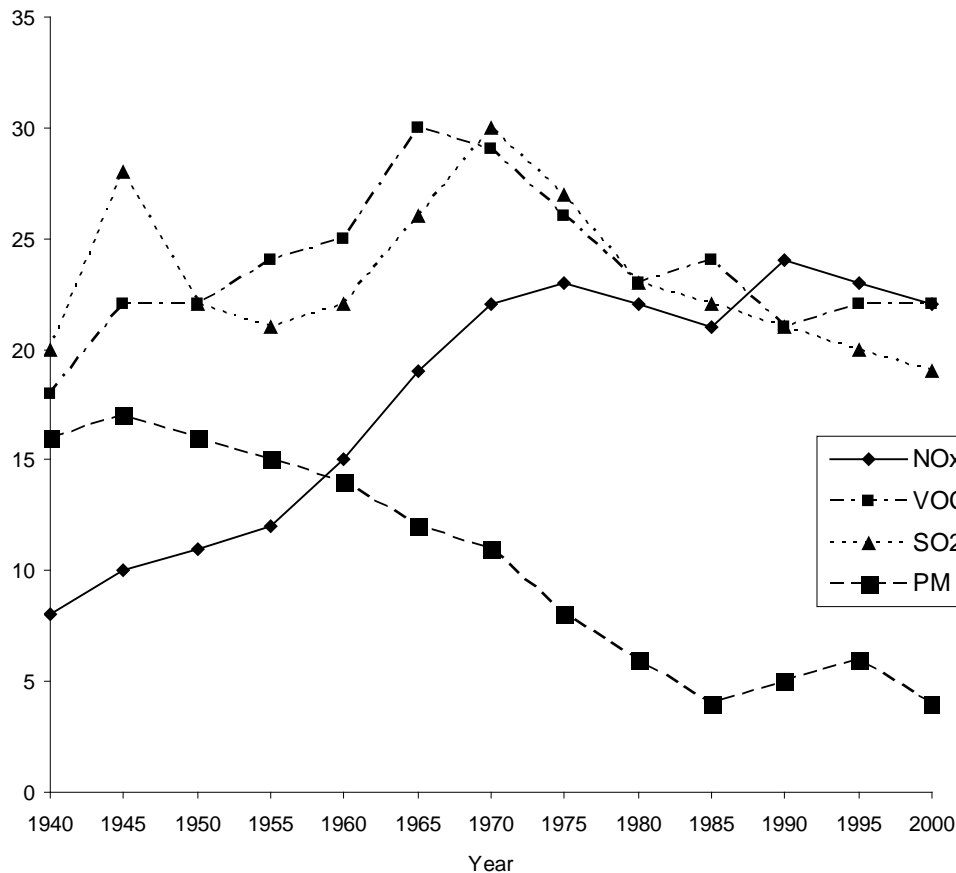
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- (c) Give two reasons why sulfur dioxide may be considered a pollutant. **2**

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Question 21 (5 marks)

The graph shows the national trends in emissions of nitrogen oxides, volatile organic compounds (VOC), sulfur dioxide and particulate matter (PM) in the United States over an approximately 50-year time frame.



(a) Write the formula for one type of nitrogen oxide. 1

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(b) Explain the trend observed for the emission of nitrogen oxides over the 50-year period. 2

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Question 21 continues next page...

Question 21 continued

- (c) Describe how you would assess the validity and reliability of the above evidence for the emission of nitrogen oxides.

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Question 22 (5 marks)

When *Alka-Seltzer* tablets are placed in water, a series of chemical reactions results in the formation of carbon dioxide and water. The results of an investigation that examined the effects of temperature on the solubility of carbon dioxide in water are displayed in the table.

	<i>Beaker 1</i>	<i>Beaker 2</i>	<i>Beaker 3</i>	<i>Beaker 4</i>
Volume of distilled water (mL)	150	150	150	150
Mass of Alka-Seltzer tablets (g)	-	2	2	-
Volume of NaOH(aq) added (mL)	0.5	0.5	0.5	0.5
Temperature of water (°C)	6	6	70	70
Amount of Bromothymol blue indicator added (mL)	2	2	2	2
Colour of solution	light blue	yellow	colourless to light green	light blue

Information regarding the colours of bromothymol blue in acidic, neutral and alkaline solutions is given in the table below.

<i>Indicator</i>	<i>Colour change</i>				
	Highly acidic	Slightly acidic	neutral	Slightly alkaline	Highly alkaline
<i>Bromothymol blue</i>	Yellow	Yellow	Colourless to light green	Blue	blue

Question 22 continues next page....

Question 22 continued..

Explain how the results demonstrate the effect of temperature on the solubility of carbon dioxide in water?

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Question 23 (4 marks)

A 0.126 mol L^{-1} solution of a triprotic acid, H_3A , has a pH of 4.56.

(a) Is H_3A a weak or a strong acid? Justify your answer.

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(b) Calculate the volume of a 0.432 mol L^{-1} NaOH which will react completely with 20.0 mL of the acid. Show your working.

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Question 24 (3 marks)

Despite extreme care, Anne Koh, a top Chemistry student, spilled some concentrated sulfuric acid on a school wooden bench. What chemical substance should Anne use to minimise the damage to the table and lessen the associated hazard of the spilled concentrated acid? Justify your choice by citing appropriate desirable characteristics of the chemical of your choice. Include in your answer a balanced chemical equation.

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Question 25 (2 marks)

Manny Tor is an industrial chemist employed by Hubba Industries to oversee the production of ammonia by the Haber process. Two other chemists work with Manny to keep Hubba Industries running. Justify the collaboration between chemists in this industry.

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Question 26 (4 marks)

Several drinking water samples were to be analysed by AAS for their copper ion content. The absorbance of each of the solutions were determined as well as the absorbance readings of 4 standard solutions. The result of the analysis is given in the table below:

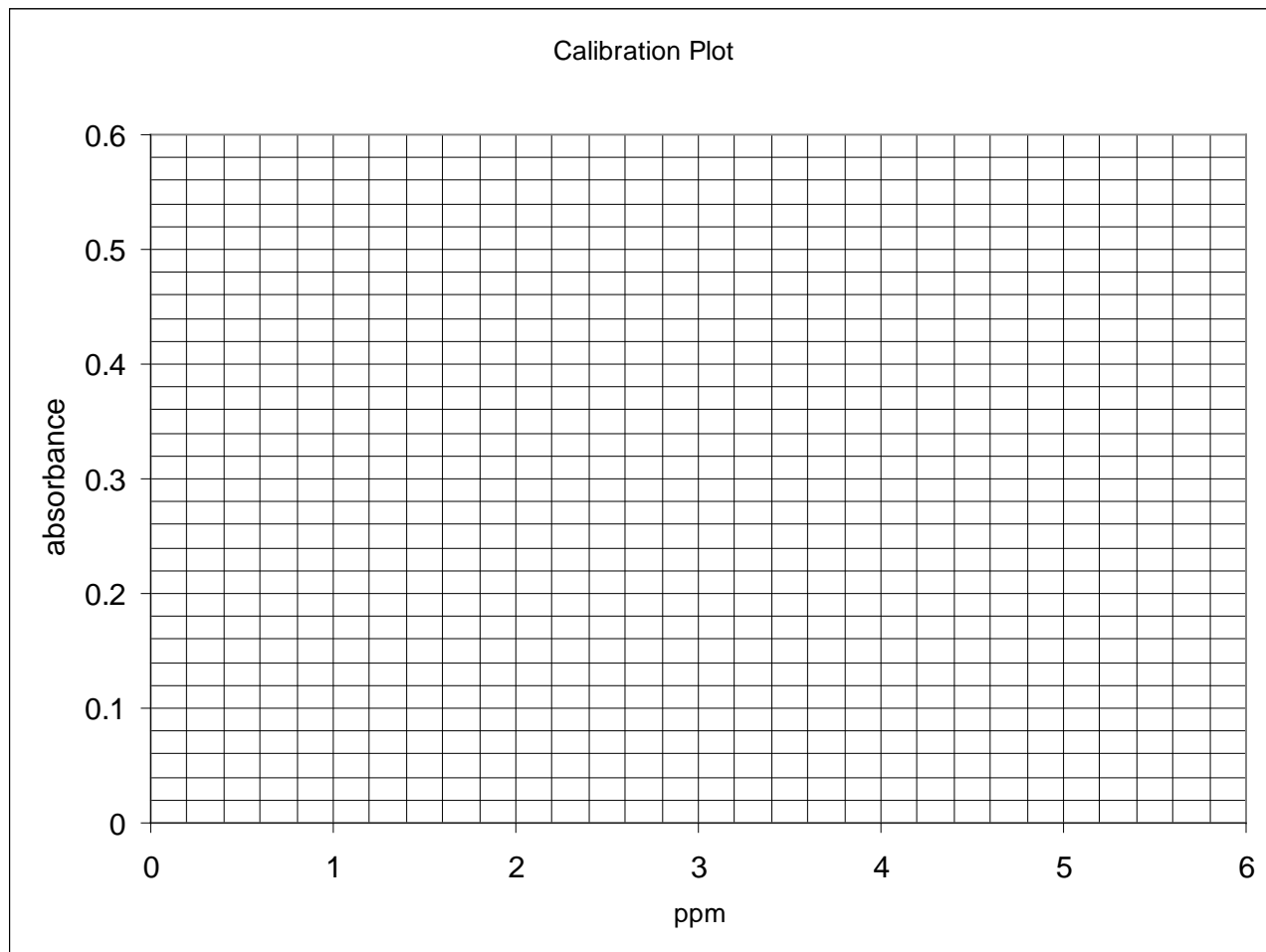
<i>Concentration of the standard (ppm)</i>	<i>Absorbance</i>
1.00	0.240
2.00	0.319
3.00	0.402
4.00	0.478
Water Samples	Absorbance
X	0.257
Z	0.456
M	0.579

Question 26 continues next page..

Question 26 continued..

(a) Use the grid below to construct a calibration curve for this analysis

2



(b) Use the graph to determine the concentration of samples X, Z, and M.

1

Sample X Sample Z Sample M

(c) Which of the results had the least validity? Explain your answer.

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Question 27 (6 marks)

Discuss the problems associated with the use of CFCs and evaluate the effectiveness of the use of the replacement chemicals to CFCs.

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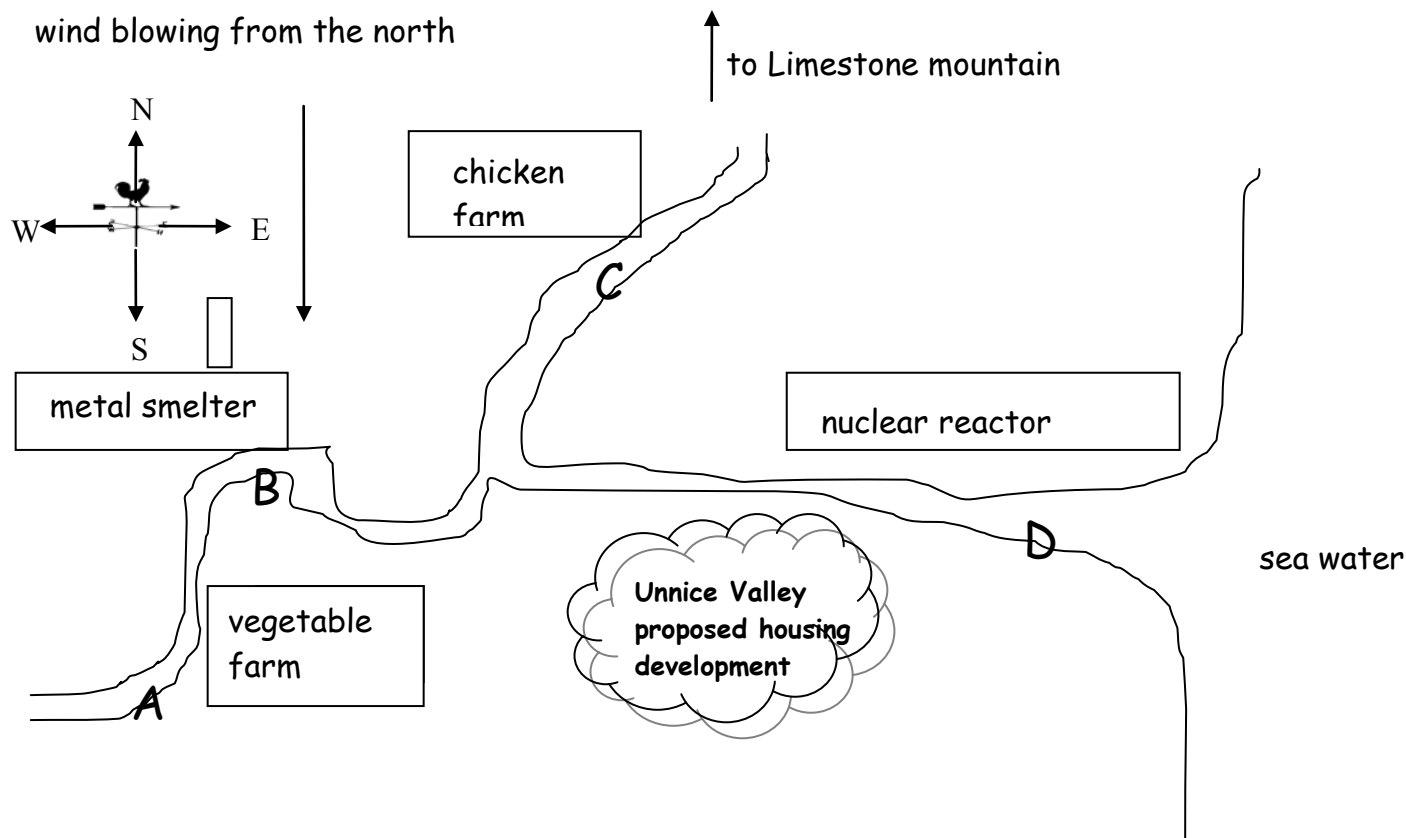
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Question 28 (7 marks)

The diagram shows an outback region, Unnice valley, located just at the foot of a limestone mountain. The region centres around a meandering river that goes out to sea at D. Water analysis was done at points A, B, C and D as part of an environmental assessment of the feasibility of erecting a housing development for the workers in the already existing industries in the area. Since the town is rather remote, no town water supply is yet available. It is proposed that the residents obtain their drinking water from bores, rainfall tanks and from the river. It is also envisaged that the river would provide food (fish) and recreational facilities for the residents.



Shown below is the experimental results of analysis of water samples at A,B,C and D

<i>Substance/Area</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
<i>Dissolved Oxygen (mg L⁻¹)</i>	8.0	8.0	3.0	2.0
<i>Temperature (° C)</i>	15	17	18	20
<i>pH</i>	3.0	4.0	7.5	7.0
<i>Cl⁻ (mol L⁻¹)</i>	10 ⁻⁴	10 ⁻⁴	10 ⁻³	0.3
<i>Ca²⁺ (mg L⁻¹)</i>	10	10	200	250
<i>BOD</i>	3	3	200	300

Question 28 continues next page

Question 28 continued..

MARKS

- (a) What is the possible cause of the observed river water pH in area A and B? Justify your answer with an equation.

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- (b) Explain the effect of high calcium ion concentration in the water obtained in area C if this water is used for household purposes.

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- (c) Assess the capacity of the river system to provide food and recreational facilities (such as boating or swimming) for the residents of this proposed housing development.

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Section II

25 marks

Attempt question 29

Allow about 45 minutes for this section

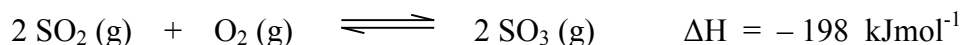
Answer the question in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

Question 29

MARKS

- (a) During your practical work you performed a first hand investigation to observe the reaction of sulfuric acid acting as an oxidizing agent.
- (i) Identify a risk associated with this procedure. **1**
- (ii) Outline the procedure used and the results you obtained. **2**
- (b) Sulfur dioxide is converted to sulfur trioxide by the *contact* process. Consider the following information.



	Reactant Concentrations (mol L^{-1})		Product Concentrations (mol L^{-1})
550 °C	SO ₂	O ₂	SO ₃
Initial	1.13	1.78	0
Final	0.950	x	0.180

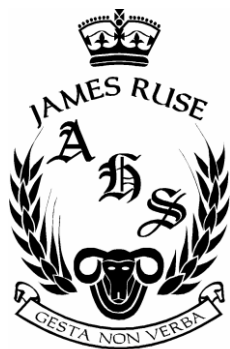
- (i) Write the equilibrium constant expression for this reaction. **1**
- (ii) Determine the value of x and hence calculate the equilibrium constant. **3**
- (iii) Does the reaction favour the reactants or the products at 550 °C?
Explain your answer. **1**
- (iv) Why is a temperature range of 500–600 °C used in the *contact* process? **2**

Question 29 continues next page

Question 29 continued..

- (c) Sodium hydroxide is manufactured from sodium chloride by electrolysis.
Describe the advantages and disadvantages associated with using a mercury cell to produce sodium hydroxide. **4**
- (d) Soaps and detergents act as emulsifying agents when removing stains from materials, however, they have different structures.
- (i) Explain how soaps OR detergents act as emulsifying agents. **4**
- (ii) Distinguish between soaps and detergents in terms of their effect in hard water. **2**
- (e) The Solvay process is a series of reactions in the production of sodium carbonate.
- (i) Identify one use of sodium carbonate. **1**
- (ii) Write an overall equation for the production of sodium carbonate from sodium chloride and calcium carbonate. **1**
- (iii) Calculate the mass and volume of carbon dioxide produced at 25 °C and 100 kPa when 1000 kg of calcium carbonate is heated.. **3**

End of Test 🔔



2008

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EXAMINATION**

Chemistry

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- Working time – 3 hours
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Student Number	
Mark / 100	

ANSWERS

Total Marks – 100

Section I Pages....

75 marks

This section has two parts, Part A and Part B

Part A – 15 marks

- Attempt Questions 1-15
- Allow about 30 minutes for this part

Part B – 60 marks

- Attempt Questions
- Allow about 1 hour and 45 minutes for this part

Section II Pages

25 marks

- Attempt Question.29
- Allow about 45 minutes for this section

Section I

75 marks

Part A – 15 marks

Attempt Questions 1-15

Allow about 30 minutes for this part

Use the multiple choice answer sheet on page

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows.

A B C D
correct
↙

Mark your answers on the ANSWER grid on page.....

1. Which is the most common catalyst for the manufacture of ethanol from ethene and water?

Outcome: H8

- (A) Yeast
- (B) Iron
- (C) Hydrochloric acid
- (D) Sulfuric acid**

The information below relates to questions 2 and 3.

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2. What volume of gas was released at 25°C and 100 kPa.?

Outcome H10

- (A) 0.86 L
- (B) 19.61 L
- (C) 21.40L**
- (D) 38.0 L

3. What method could be used to separate the other product from the reaction mixture?

Outcome H11

- (A) Refluxing
- (B) Fractional distillation**
- (C) The use of a separating funnel
- (D) Filtration.

4. The heat of combustion of butan-1-ol is 36,100 J g⁻¹.
What is the value of the heat of combustion in kJ mol⁻¹ ?

Outcome H13

- (A) 488
- (B) 1661
- (C) 2022
- (D) 2676**

5. The results of tests involving metals L,M,N,P and solutions of their ions were as follows:

<i>Ions</i>	<i>Metals</i>			
	<i>L</i>	<i>M</i>	<i>N</i>	<i>P</i>
L ²⁺	N/R	Solid deposit	Solid deposit	Solid Deposit
M ²⁺	N/R	N/R	Solid Deposit	Solid Deposit
N ²⁺	N/R	N/R	N/R	Solid Deposit
P ²⁺	N/R	N/R	N/R	N/R

N/R= no reaction

Which metal is the most active?

- (A) L
- (B) M
- (C) N
- (D) P**

Outcome H14

6. Which acid is considered a general component of acid rain?

- (A) Acetic acid
- (B) Nitric acid**
- (C) Phosphoric acid
- (D) Sodium hydroxide

7. Bromine gas may be formed from the decomposition of bromine pentafluoride as shown in the equation.



What will happen to the concentration of bromine if the pressure is increased (temperature kept constant) after the reaction has attained equilibrium?

- (A) remain the same because only the reaction rate will change
- (B) decrease because there are fewer gaseous reactant molecules than products**
- (C) increase since the reaction acquires energy from the pressure
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8. Common oxides include CaO, CO₂, Na₂O and SO₂. Which of these oxides would give a solution with a pH less than 7, and which oxides would give a solution with a pH greater than 7?

	<i>pH</i> < 7	<i>pH</i> > 7
(A)	CO ₂ , SO ₂	Na ₂ O, CaO
(B)	SO ₂ , CaO	CO ₂ , Na ₂ O
(C)	Na ₂ O, CaO	CO ₂ , SO ₂
(D)	CO ₂ , Na ₂ O	CaO, SO ₂

9. The condensed structural formula of an ester that gives a *rum*-smell is provided.



What two organic compounds would be used to form the *rum*-smelling ester?

- (A) **1-propanol and butanoic acid**
(B) 1-butanol and ethanoic acid
(C) propanol and pentanoic acid
(D) 1-butanol and propanoic acid
10. Which organic compound would have the highest boiling point?
(A) **hexanoic acid**
(B) 1-hexanol
(C) hexane
(D) hexene
11. Which of the following cannot be a Brønsted – Lowry acid?

- (A) HCO₃⁻
(B) **CO₂**
(C) H₂CO₃
(D) H₂O

Outcome: H13

12. What is the common name of 2 – hydroxypropane – 1,2,3 – tricarboxylic acid acid?

- (A) **citric acid**
- (B) hydrochloric acid
- (C) acetic acid
- (D) propanoic acid

Outcome: H13

13. The water supply is often treated with the following substances:

- (i) chlorine
- (ii) fluorine,
- (iii) iron (III) chloride
- (iv) sodium fluoride.

Which of the substances is/are added to sanitize the water supply?

- (A) all of the additives
- (B) **(i) only**
- (C) (i) and (ii) only
- (D) (i) and (iii) only

Outcome: H9

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- (A) atmospheric ozone
- (B) **stratospheric ozone**
- (C) tropospheric ozone
- (D) mesospheric ozone

Outcome:H4

15. The colourless aqueous solution of a white solid sample formed a precipitate with an acidified aqueous solution of lead (II) nitrate. What is the possible identity of the original solution of this sample?

- (A) copper (II) sulfate
- (B) barium chloride
- (C) **sodium sulfate**
- (D) silver chloride

Outcome: H13

Section I
Part A
Multiple Choice Answer Sheet

Mark -----/15

- | | | | | |
|-----|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| 1. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input checked="" type="radio"/> |
| 2. | A <input type="radio"/> | B <input type="radio"/> | C <input checked="" type="radio"/> | D <input type="radio"/> |
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| 8. | A <input checked="" type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 9. | A <input checked="" type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 10. | A <input checked="" type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 11. | A <input type="radio"/> | B <input checked="" type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 12. | A <input checked="" type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 13. | A <input type="radio"/> | B <input checked="" type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 14. | A <input type="radio"/> | B <input checked="" type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 15. | A <input type="radio"/> | B <input type="radio"/> | C <input checked="" type="radio"/> | D <input type="radio"/> |

Part B. 60 marks**Attempt questions 16 to 28****Allow about 1 hour and 45 minutes for this part****▶ Show all relevant working in questions involving calculations****MARKS****Question 16 (8 marks)**

Draw a diagram to show the construction of a galvanic cell that could measure the difference in potential between silver and zinc.

On the diagram label:

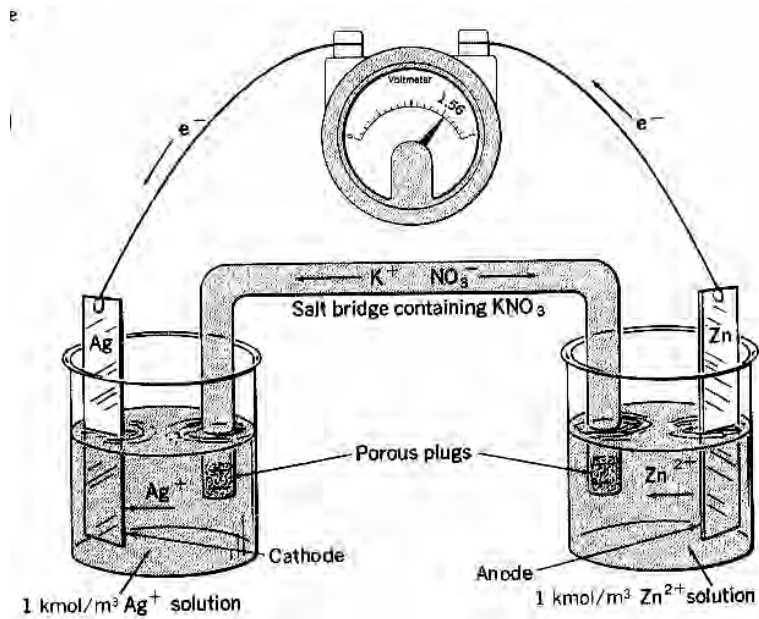
- the anode
- the cathode
- nature of the electrolyte solutions
- the direction and location of electron flow
- the direction and location of positive ion flow

Below the diagram :

- Write half equations and a balanced net ionic equation for the reaction.
- Calculate the potential E° using the table of standard potentials

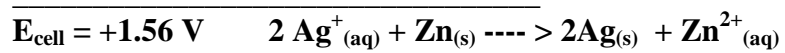
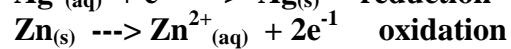
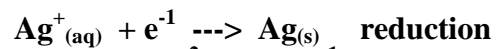
Outcome: H7

<i>Criteria</i>	<i>Marks</i>
Anode labeled correctly- zinc Cathode labeled correctly-silver	1
Zinc nitrate labeled correctly Silver nitrate labeled correctly	1
Electron flow from zinc to silver through wire labeled correctly	1
Positive ion flow from zinc to silver half cell through salt bridge labeled correctly	1
Both half equations correct Balanced net ionic equation correct	3
Correct E° value (1.56V)	1



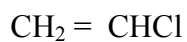
$$E^{\circ} = +0.80 \text{ V}$$

$$E^{\circ} = +0.76 \text{ V}$$



Question 17 (3 marks)

The condensed structural formula of a monomer is shown.



- (a) Identify the systematic name of this monomer. **1**

.....

- (b) Draw the structure of the polymer made from this monomer (showing 4 monomer units) **1**

- (c) What is the molecular weight of this polymer made from 4 monomers.? **1**

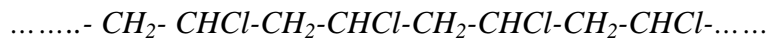
.....

Outcome H9

Sample Answer

(a) *chloroethene*

(b)



(c) *249.8*

<i>Criteria</i>	<i>Marks</i>
<ul style="list-style-type: none"> • Correctly names the monomer • Correctly draws the structure for PVC showing 4 monomer units only • Correctly calculates the molecular weight for the polymer drawn 	3
Two of above	2
One of above	1

Question 18 (5 marks)

- (a) The value for the heat of combustion of 1-propanol is 2021 kJ mol^{-1} .
 Calculate the theoretical volume of water that could be heated from 31°C to 55°C
 if 5g of 1-propanol was used. **2**

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- (b) If 1-pentanol was used instead of 1-propanol would you expect that a greater or lesser
 quantity of fuel could be used to heat the same volume of water by the same amount?
 Explain your answer. **3**

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Outcome: H9

Sample answer

- (a) *Molar mass of 1-propanol = 60.094g*
60.094g ethanol releases 2021kJ

Therefore 5g releases $2021 \times 5/60.094 \text{ kJ} = 168.15\text{kJ} = 168,153 \text{ J}$ (1 mark)

$168153 = \text{mass of water} \times 4.18 \times (55-31)$

$\text{Mass of water} = 168153/100.32 = 1676\text{g}$

Therefore the theoretical volume of water that could be heated is **1676 ml**

(a)

Criteria	Marks
<ul style="list-style-type: none">Correctly calculates the number of J or kJ released by 5g of 1-propanolCorrectly calculates the volume of water that could be heated	2
<ul style="list-style-type: none">Correctly calculates the number of J or kJ released by 5g of 1-propanol	1

(b) *A lesser quantity (No. of moles) of fuel could be used if 1-pentanol was used because it would be expected that 1-pentanol would have a greater heat of combustion per mole as it has more chemical energy stored in the greater number of chemical bonds (longer chain length) which could be released when the compound is combusted and new products are formed.*

(b)

Criteria	Marks
<ul style="list-style-type: none">Identifies that a lesser quantity of 1-pentanol could be usedCorrectly identifies that 1-pentanol has a greater heat of combustion per mole than 1-propanolGives a correct explanation for higher heat of combustion	3
Two of above	2
One of above	1

Question 19 (4 marks)

(a) What is a transuranic element? **1**

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(b) Give one example of a transuranic element and describe where and how it is produced. **3**

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Outcome: H3, H13

Sample Answer

- (a) *Transuranic elements have an atomic number greater than 92.*
(b) *Neptunium is made in a nuclear reactor. U-238 is bombarded with neutrons which produce U-239 which then decays by beta emission to neptunium-239*

<i>Criteria</i>	<i>Marks</i>
<ul style="list-style-type: none">• Defines a transuranic element• Identifies an example of a transuranic element• Correctly identifies where it is produced• Correctly identifies how it is produced	4
3 of the above	3
2 of the above	2
1 of the above	1

Question 20 (4 marks)

One hazardous compound is sulfur dioxide.

- (a) State one industrial source of sulfur dioxide.

1

Answer:

Combustion of coal to produce electricity. Metal smelters. Combustion of diesel.

<i>Outcome criteria</i>	<i>Marks</i>
Stating one industrial source of SO ₂ .	1

- (b) Write a balanced formulae equation to describe how sulfur dioxide may be formed

1

Answer: $S(s) + O_2(g) \rightarrow SO_2(g)$

<i>Outcome criteria</i>	<i>Marks</i>
Writing a balanced equation (including states).	1

(c) Give two reasons why sulfur dioxide may be considered a pollutant.

2

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SO₂(g) is a poisonous gas that may trigger asthma.

SO₂(g) may react with water to form acid rain.

<i>Outcome criteria</i>	<i>Marks</i>
Provides two examples of SO ₂ acting as a pollutant.	2
Provides one example of SO ₂ acting as a pollutant.	1

Question 21 (5 marks)

The graph shows the national trends in emissions of nitrogen oxides, volatile organic compounds, sulfur dioxide and particulate matter in the United States over an approximately 50-year time frame.

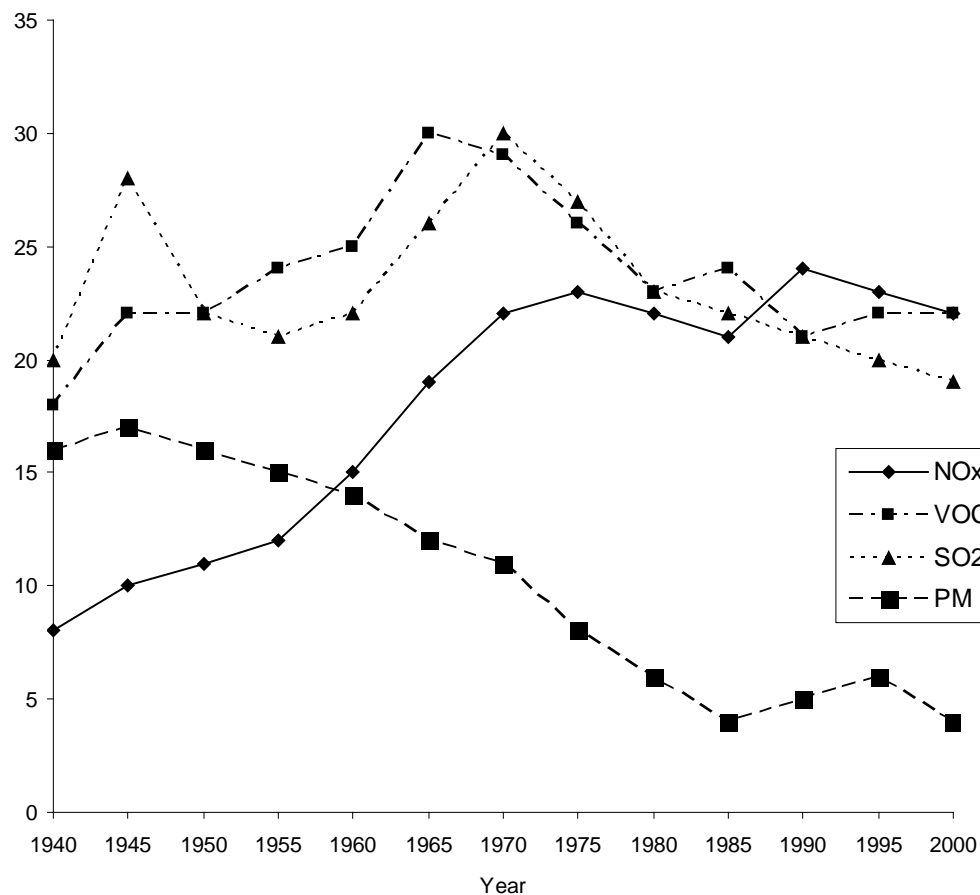


Figure USA national trends in emissions of nitrogen oxides, volatile organic compounds (VOC), sulfur dioxide, and particulate matter (PM).

(a) Write the formula for one type of nitrogen oxide.

1

Answer:

NO_2 , NO , N_2O_4

<i>Outcome criteria</i>	<i>Marks</i>
Provides one formula for a nitrogen oxide	1

- (b) Explain the trend observed for the emission of nitrogen oxides over the 50-year period. 2

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Sample Answer:

There has been a gradual increase in the amount of nitrogen oxides emitted into the atmosphere over the past fifty years. This increase could be due to an increase in the use of motor vehicles and power stations; both of these are sources of nitrogen oxides as a result of the combustion of fuel using air. Air is predominately nitrogen, which reacts with oxygen in the combustion chambers of engines under high temperature and pressure to form nitrogen oxides

<i>Outcome criteria</i>	<i>Marks</i>
Identifies the graphical trend for nitrogen oxides + provides one reason for the trend.	2
Identifies the graphical trend for nitrogen oxides.	1

- (c) Describe how you would assess the validity and reliability of above evidence for the emission of nitrogen oxides. 2

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Sample Answer

The sources of information provided for the graph would be investigated for their credibility. If the sources were university-based researchers using scientific means of obtaining data then the data would be valid (accurate). If other creditable sources of nitrogen oxide data reflect the same type of trend, then the information would be assessed as reliable (precise or reproducible). If the data from other sources differs, then the data would be treated as skeptical and treated with caution.

<i>Outcome criteria</i>	<i>Marks</i>
States one way of assessing information obtained from secondary sources in terms of validity and reliability. Students must distinguish between validity and reliability.	2
States one way of assessing information obtained from secondary sources in terms of validity or reliability.	1

V = validity mark

R = reliability mark

“**no link**” = has not differentiated between validity and reliability.

“**defined**” = has not outlined how to assess; the student, rather, has provided a definition of validity or reliability.

Secondary sources thread

Validity: creditable source? Up-to-date?

Reliability: do other resources report similar results? “cross-reference with other sources”; “comparing...”; “**cross check...**”; “checking with other sources”.

Experimental thread

Validity: assess the method used to obtain the results. “examine the...”; researching the method...”.

Reliability: examine the consistency of repeat results: “how close repeats are” “judge the consistency of repeats”.

Question 22 (5 marks)

When *Alka-Seltzer* tablets are placed in water, a series of chemical reactions results in the formation of carbon dioxide and water. The results of an investigation that examined the effects of temperature on the solubility of carbon dioxide in water are displayed in the table.

	<i>Beaker 1</i>	<i>Beaker 2</i>	<i>Beaker 3</i>	<i>Beaker 4</i>
Volume of distilled water (mL)	150	150	150	150
Mass of Alka-Seltzer tablets (g)	-	2	2	-
Volume of NaOH(aq) added (mL)	0.5	0.5	0.5	0.5
Temperature of water (°C)	6	6	70	70
Amount of Bromothymol blue indicator added (mL)	2	2	2	2
Colour of solution	light blue	yellow	colourless to light green	light blue

Information regarding the colours of bromothymol blue in acidic, neutral and alkaline solutions is given in the table below.

	<i>Colour change</i>				
Indicator	Highly acidic	Slightly acidic	neutral	Slightly alkaline	Highly alkaline
Bromothymol blue	Yellow	Yellow	Colourless to light green	Blue	blue

Explain how the results demonstrate the effect of temperature on the solubility of carbon dioxide in water?

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Sample Answer

Beakers 1 and 4 are light blue to the alkaline nature of the solution they contain; this means that temperature does not affect the acidity of the NaOH(aq)/indicator/water solutions. These beakers are controls for Beakers 2 and 3 respectively. The solutions are alkaline due to the NaOH(aq) added. Beaker 2 is acidic due to the CO₂ formed from the Alka Seltzer tablet reaction with water reacting with water to form carbonic acid. The neutral status of the solution in Beaker 3 is a result of the high temperature of the solution causing less CO₂ to dissolve, compared to Beaker 2, and thus there is less CO₂ to react with water to form carbonic acid.

<i>Outcome criteria</i>	<i>Marks</i>
<i>(L): recognises that the solubility of CO₂ in water decreases with increasing temperature of solution. (Inverse relationship.)</i>	1
<i>(T): Compares results of Beakers 2 and 3 in order to derive the impact of temperature on solubility of CO₂ in water.</i>	1
<i>(A): explains acidity of solutions with CO₂: identifies carbonic acid as a product of CO₂ reacting with water (NOT dissolving with water).</i>	1
<i>(I): Correct interpretation of indicator colours to acidity level of solutions.</i>	1
<i>(C) Identifying the alkaline nature of the solutions in Beakers 1 and 4 (controls) as a baseline measure. Or, variables controlled when comparing Beakers 2 and 3. (V)</i>	1

Question 23 (4 marks)

A 0.126 mol L⁻¹ solution of a triprotic acid, H₃A, has a pH of 4.56.

- (a) Is H₃A a weak or a strong acid? Justify your answer.

1

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Outcomes: H10, H13**Sample Answer:**

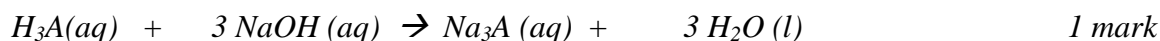
H₃A is a weak acid. A stronger acid should record a pH of approximately 1 for this acid concentration, i.e., less than (-log₁₀ [0.126])

Criteria	Mark(s)
<i>correct answer + justification</i>	<i>1</i>

- (b) Calculate the volume of a 0.432 mol L⁻¹ NaOH which will react completely with 20.0 mL of the acid.. Show your working.

3

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Outcome: H10**Sample Answer:**

$$\text{moles NaOH} = 3 \times \text{moles } H_3A = 3 \times 0.0200 \times 0.126 = 7.56 \times 10^{-3} \text{ mol} \quad 1 \text{ mark}$$

$$\text{Volume NaOH} = \frac{\text{moles NaOH}}{[NaOH]} = \frac{7.56 \times 10^{-3}}{0.432} = 0.0175 \text{ L} = 17.5 \text{ mL} \quad 1 \text{ mark}$$

Criteria	Mark(s)
<i>correct calculations + equation</i>	<i>3</i>

Question 24 (3 marks)

Despite extreme care, Anne Koh, a top Chemistry student, spilled some concentrated sulfuric acid on a school wooden bench. What chemical substance should Anne use to minimise the damage to the table and lessen the associated hazard of the spilled concentrated acid? Justify your choice by citing an appropriate desirable characteristics of the chemical of your choice. Include in your answer a balanced chemical equation.

3

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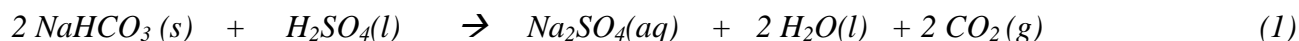
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Outcome: H11

Sample Answer:

Anne should sprinkle **solid** sodium hydrogen carbonate on the spilled acid until the effervescence stops. (1)



It is important to use solid NaHCO₃ so as not to dilute the sulfuric acid. NaHCO₃ is a good acid neutraliser to use because of its weakly basic nature It is able to neutralise the concentrated acid effectively without being corrosive, an excess of the sodium hydrogen carbonate can be used without harm to the surrounding and the experimenter.

(1)

Criteria	Mark(s)
<i>correct choice of solid sodium hydrogen carbonate (also sodium carbonate)</i>	<i>1</i>
<i>correct chemical equation (subscript not marked)</i>	<i>1</i>
<i>any correct chemical property of sodium hydrogen carbonate</i>	<i>1</i>

Question 25 (2 marks)

Manny Tor is an industrial chemist employed by Hubba Industries to oversee the production of ammonia by the Haber process. Two other chemists work with Manny to keep Hubba Industries running.

Justify the collaboration between chemists in this industry.

2

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Outcomes: H15

Collaboration between chemists is important in this industry because of the specialisation of most chemists and the variety of expertise required (for rate vs. equilibrium adjustment, – physical chemists, catalysts experts, analytical chemist to analyse raw materials (N_2 and H_2 for contamination and the purity of the ammonia produced).

Criteria	Mark(s)
2 or more valid reasons for collaboration in the Haber process industry	2
2 or more valid reasons for collaboration but not specifically for this industry	1

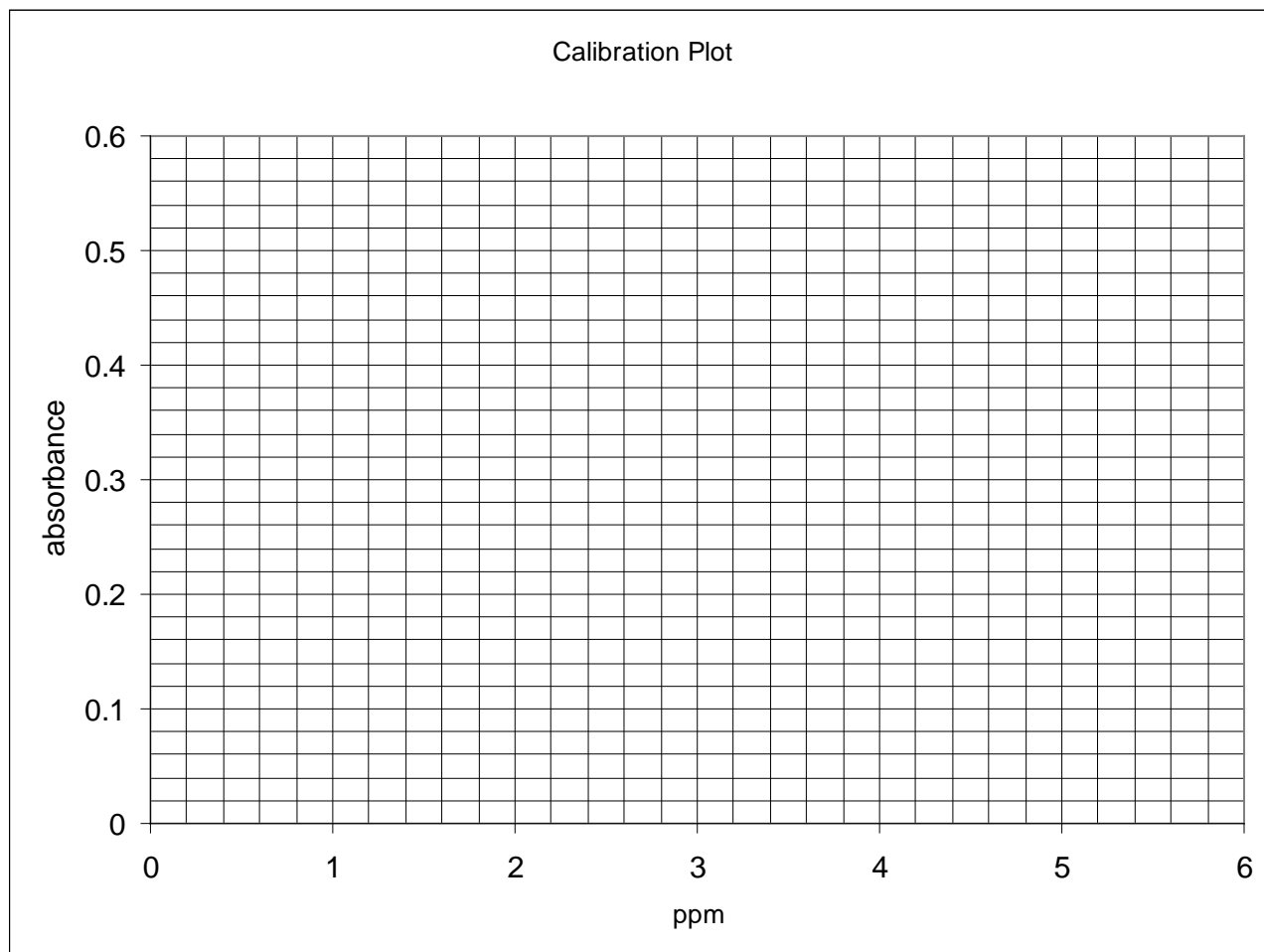
Question 26 (5 marks)

Several drinking water samples were to be analysed by AAS for their copper ion content. The absorbance of each of the solutions were determined as well as the absorbance readings of 4 standard solutions. The result of the analysis is given in the table below:

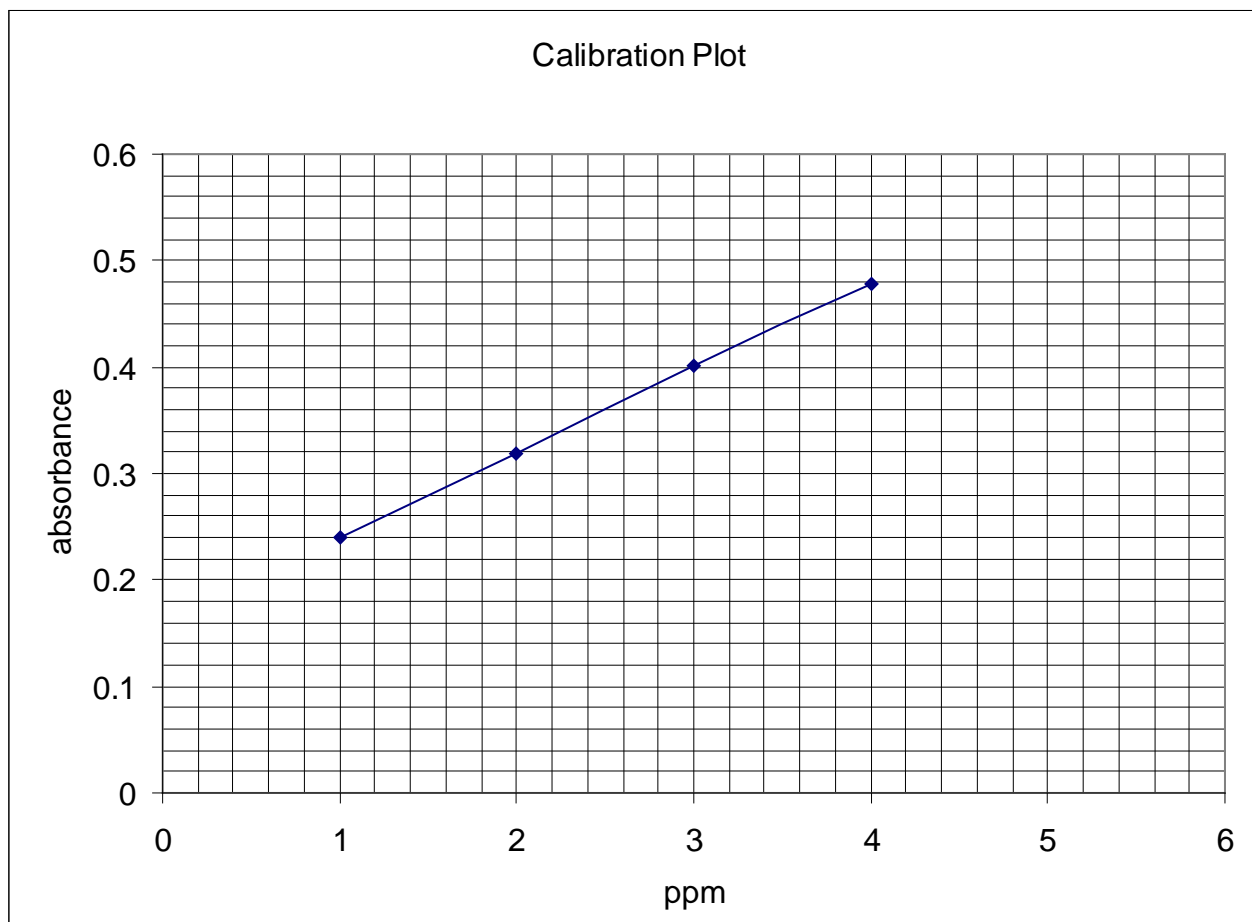
<i>Concentration of the standard (ppm)</i>	<i>Absorbance</i>
1.00	0.240
2.00	0.319
3.00	0.402
4.00	0.478
Water Samples	Absorbance
X	0.257
Z	0.456
M	0.579

(a) Use the grid below to construct a calibration curve for this analysis

2



Outcomes: H13
Sample Answer:



Marking Guidelines

Criteria	Mark(s)
Correct data plotting	1
Line of best fit	1

(b) Use the graph to determine the concentration of sample X, Z, and M.

1

Outcome:H13

Answer:

Sample X 1.20 ppm..... Sample Z3.7 ppm Sample M5.2 ppm

(c) Which of the results had the least validity? Explain your answer.

1

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Outcome:H14

Answer:

Sample M had the least validity because it is an extrapolated value whereas samples X and Y were interpolated values.

<i>Criteria</i>	<i>Mark(s)</i>
<i>choice of M and reason for the choice</i>	<i>1</i>

Question 27 (6 marks)

Discuss the problems associated with the use of CFCs and evaluate the effectiveness of the use of the replacement chemicals to CFCs.

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Outcomes: H4, H11, H12, H13, H14, H16

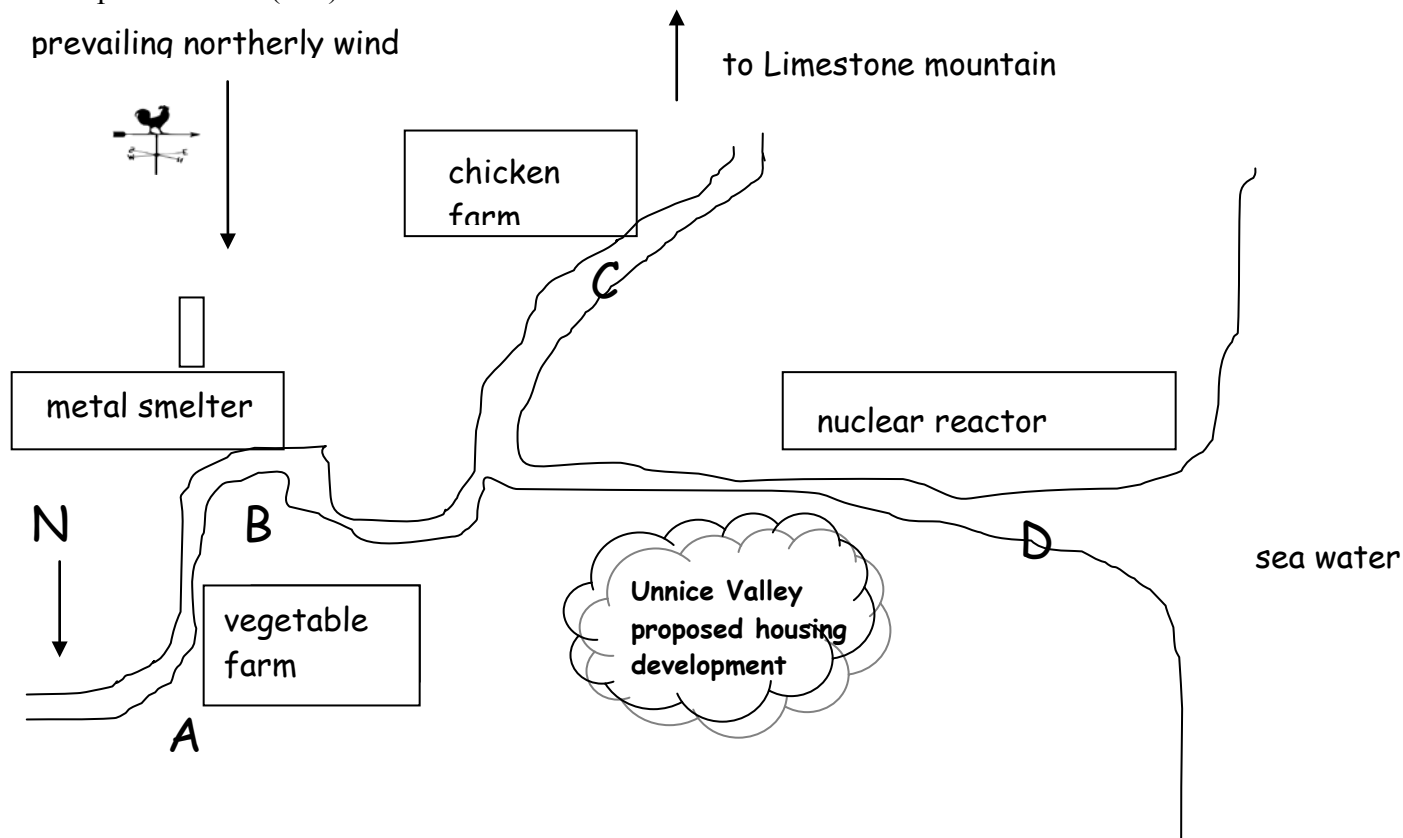
Sample Answer:

- *CFCs are non-reactive carbon compounds containing carbon, chlorine and fluorine.*
- *These compounds have favourable energy of vapourisation and liquefaction that makes them ideal as refrigerants and unreactivity that makes them ideal as propellants*
- *Through diffusion, these compounds have reached the stratosphere where high energy radiation breaks them down releasing atomic chlorine*
- *atomic chlorine catalyses the destruction of stratospheric ozone*
- *reduced ozone layer results in increased UV penetrating the Earth's atmosphere with adverse consequences to life on Earth, (higher incidence of skin cancer, cataracts, etc)*
- *useful as they are, they are being replaced with HCFC (still capable of destroying ozone) and HFC (non-ozone destroying but a greenhouse gas)*
- *HCFCs and HFCs are more expensive but are less efficient than the CFCs*
- **Verdict:** *Replacements are less effective but are less harmful to the environment, hence are very much acceptable as an alternative.*

Criteria	Mark(s)
statement of what CFCs are and their use(s) (W)	<i>1</i>
statement of how they destroy the ozone layer (H)	<i>1</i>
statement of effect of such destruction on UV B penetration of the Earth's atmosphere (E₁)	<i>1</i>
statement of the effect of such penetration on the life on Earth (E₂)	<i>1</i>
description of replacements to CFCs (R)	<i>1</i>
an evaluation statement on the effectiveness of these replacements (J)	<i>1</i>

Question 28 (7 marks)

The diagram shows an outback region, Unnice valley, located just at the foot of a limestone mountain. The region centres around a meandering river that goes out to sea at D. Water analysis was done at points A, B, C and D as part of an environmental assessment of the feasibility of erecting a housing development for the workers in the already existing industries in the area. Since the town is rather remote, no town water supply is yet available. It is proposed that the residents obtain their drinking water from bores, rainfall tanks and from the river. It is also envisaged that the river would provide food (fish) and recreational facilities for the residents.



Outcomes: H16, H4, H13, H16

Shown below is the experimental results of analysis of water samples at A, B, C and D

Substance/Area	A	B	C	D
Dissolved Oxygen (mg L^{-1})	8.0	8.0	3.0	2.0
Temperature ($^{\circ}\text{C}$)	15	17	18	20
pH	3.0	4.0	7.5	7.0
Cl^{-} (mol L^{-1})	10^{-4}	10^{-4}	10^{-3}	0.3
Ca^{2+} (mg L^{-1})	10	10	200	250
BOD	3	3	200	300

(a) What is the possible cause of the observed river water pH in area A and B? Justify your

answer with an equation.

2

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Sample answer:

The low pH could be due to the smelter emitting sulfur dioxide which forms acid rain that falls into the river. (1 mark)

The possible reaction is : $SO_2 + H_2O \rightleftharpoons H_2SO_3 \rightleftharpoons H^+ + HSO_3^-$ (1 mark)

Criteria	Mark
choice of the smelter as the cause of low pH and accompanying explanation	1
equation	1

(b) Explain the effect of high calcium ion concentration in the water sample obtained from C if this water is used in the home.

2

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Sample Answer:

High Ca^{2+} ion concentration in water constitutes hardness in water. This results in the development of scum on equipment (deposition of calcium carbonate on the equipment) and the non-lathering of soap due to the precipitation of calcium ion with the soap.

Criteria	Mark
Effect of high calcium ion concentration	1
Explanation of this effect	1

- (c) Assess the capacity of the river system to provide food and recreational facilities (such as boating or swimming) for the residents of this proposed housing development. 4

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Sample Answer:

- *support of fish population depends on the dissolved oxygen in the river. The presence of the nuclear reactor dumping its cooling water on the river (shown by the elevated temperature in C and D lowers the oxygen solubility and hence the dissolved oxygen.*
- ◇ *the type of fish that can survive will be limited.*
- *the very high BOD due to the waste generated by the chicken farm makes the water unsafe for swimming*
- *the low water pH in some parts discourages life and life diversity in the river, since most fish survive better at a pH of 6-8.*

The verdict: *the river is an unsatisfactory source of food. It is also unsuitable as a venue for recreation, especially swimming, for residents of this development.*

Criteria	Mark
2 valid reasons on the capacity of the river to provide food and to be a recreational facility for the residents	2
Judgment	1

Outcomes: H16, H4, H13, H16

Section II

25 marks

Attempt question 29

Allow about 45 minutes for this section

Answer the question in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

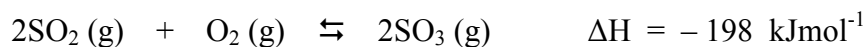
Question 29

(a) During your practical work you performed a first hand investigation to observe the reaction of sulfuric acid acting as an oxidizing agent.

(i) Identify a risk associated with this procedure. 1

(ii) Outline the procedure used and the results you obtained. 2

(b) Sulfur dioxide is converted to sulfur trioxide by the contact process.
Consider the following information.



	<i>Reactant Concentrations (mol L⁻¹)</i>		<i>Product Concentrations (mol L⁻¹)</i>
550 °C	SO ₂	O ₂	SO ₃
Initial	1.13	1.78	0
Final	0.950	<i>x</i>	0.180

(i) Write the equilibrium constant expression for this reaction. 1

(ii) Determine the value of *x* and hence calculate the equilibrium constant. 3

(iii) Does the reaction favour the reactants or the products at 550 °C?
Explain your answer. 1

(iv) Why is a temperature range of 500–600 °C used in the contact process? 2

- (c) Sodium hydroxide is manufactured from sodium chloride by electrolysis.
Describe the advantages and disadvantages associated with using a mercury cell to produce sodium hydroxide. 4
- (d) Soaps and detergents act as emulsifying agents when removing stains from materials, however, they have different structures.
(i) Explain how soaps OR detergents act as emulsifying agents. 4
(ii) Distinguish between soaps and detergents in terms of their effect in hard water. 2
- (e) The Solvay process is a series of reactions in the production of sodium carbonate.
(i) Identify one use of sodium carbonate. 1
(ii) Write an overall equation for the production of sodium carbonate from sodium chloride and calcium carbonate. 1
(iii) Calculate the mass and volume of carbon dioxide produced at 25 °C and 100 kPa when 1000 kg of calcium carbonate is heated.. 3

Sample Answers and marking guidelines

- (a) During your practical work you performed a first hand investigation to observe the reaction of sulfuric acid acting as an oxidizing agent.
(i) Identify a risk associated with this procedure.

Sample answer

Sulfuric acid is very corrosive and protective gloves should be worn

Marking criteria	Marks
<ul style="list-style-type: none"> • Correctly identifies a risk associated with this procedure 	1

Outcomes H11

- (ii) Outline the procedure used and the results you obtained.

Sample Answer

React zinc metal with concentrated sulfuric acid in a test tube in a fume cupboard. The results show the zinc disappearing and gas bubbles being liberated.

Marking criteria	Marks
<ul style="list-style-type: none"> Sketches in general terms the procedure used and results obtained 	2
<ul style="list-style-type: none"> Sketches in general terms EITHER the procedure OR results 	1

Outcomes H11, H13

- (b) Sulfur dioxide is converted to sulfur trioxide by the *contact process*. Consider the following information.



	Reactant Concentrations mol^{-1}		Product Concentrations mol L^{-1}
550 °C	SO ₂	O ₂	SO ₃
Initial	1.13	1.78	0
Final	0.950	x	0.180

- (i) Write the equilibrium constant expression for this reaction.

1

Sample Answer

$$K = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]}$$

Marking criteria	Marks
<ul style="list-style-type: none"> Correctly writes the equilibrium constant expression 	1

Outcomes H10, H13

- (ii) Determine the value of x and hence calculate the equilibrium constant.

Sample Answer

$$x = 1.78 - \frac{1}{2}(0.180) = 1.69$$

$$K = \frac{[SO_3]^2}{[SO_2]^2 [O_2]}$$

$$= \frac{0.180^2}{0.950^2 \times 1.69}$$

$$= 0.0212$$

Marking criteria	Marks
<ul style="list-style-type: none"> Gives the correct answer for the equilibrium constant showing the value for x and relevant working. 	3
<ul style="list-style-type: none"> Correct working based on incorrect value for x Correct working based on correct x and incorrect gas concentrations 	2
<ul style="list-style-type: none"> Correct value for x OR Gives the correct answer for the equilibrium constant 	1

Outcomes H10, H13

- (iii) Does the reaction favour the reactants or the products at 550 °C?
Explain your answer. 1

Sample Answer

K is less than one which means the numerator is less than the denominator or concentration of products is less than concentration of reactants. This means that the reactants are favoured.

Marking criteria	Marks
<ul style="list-style-type: none"> Explains that reactants are favoured when $K < 1$ 	1

- (iv) Why is a temperature range of 500 – 600 °C used in the contact process? 2

Sample answer

Even though low temperatures would favour the forward reaction as it is exothermic, it is very slow, so a compromise temperature of 500 – 600 °C is used to increase the rate of reaction so that equilibrium is reached faster.

Marking criteria	Marks
<ul style="list-style-type: none"> Links compromise temperatures with reaction rate and equilibrium 	2
<ul style="list-style-type: none"> Identifies 500 – 600 °C temperature will increase reaction rate 	1

(c) Sodium hydroxide is manufactured from sodium chloride by electrolysis.

Outline the advantages and disadvantages associated with using a mercury cell to produce sodium hydroxide.

Sample answer

Disadvantages : Some mercury is lost to the environment which has a negative impact as mercury is bioaccumulative and toxic. The process is expensive and requires a lot of energy

Advantages : The mercury process produces a high quality product and all the products of electrolysis are used.

4

Marking criteria	Marks
<ul style="list-style-type: none"> Outlines two advantages and two disadvantages 	4
<ul style="list-style-type: none"> Outlines two advantages and one disadvantage OR Outlines one advantage and two disadvantages 	3
<ul style="list-style-type: none"> Outlines two advantages OR two disadvantages Outlines one advantage AND one disadvantage Identifies advantages and disadvantages 	2
<ul style="list-style-type: none"> Outlines one advantage OR one disadvantage 	1

Outcomes H3, H4. H13

(d) Soaps and detergents act as emulsifying agents when removing stains from materials, however, they have different structures.

(i) Explain how soaps OR detergents act as emulsifying agents. 4

Sample answer

Emulsifiers allow immiscible materials to mix. Once the oil or grease is removed from the material the soap acts as an emulsifying agent by keeping the droplets of oil in the water where they can be carried away. The non-polar alkyl tail of the soap molecule forms dispersion forces with the oil molecule. The tails bury themselves in the oil and the polar heads on the

outside of the droplet prevent the droplets from joining together (they repel each other). Thus the oil droplets are suspended in the water.

Marking criteria	Marks
<ul style="list-style-type: none"> Identifies polar and non polar ends of the soap/detergent molecule and explains their function in maintaining droplets suspended in the emulsion including hydrogen bonding and dispersion forces. 	4
<ul style="list-style-type: none"> Outlines the action of soap/detergent as an emulsifying agent 	3
<ul style="list-style-type: none"> Briefly outlines the action of soap/detergent as an emulsifying agent without key terms. 	2
<ul style="list-style-type: none"> Identifies that emulsifiers allow immiscible materials to mix. Identifies polar and non polar ends of the soap/detergent molecule. 	1

Outcomes H4, H9

(ii) Distinguish between soaps and detergents in terms of their effect in hard water.

Sample answer

Soaps react with Ca and Mg ions in hard water to form precipitates that form a grey scum and prevent the soap from lathering. Detergents do not form a scum with hard water as the salts of these detergents are soluble.

Marking criteria	Marks
<ul style="list-style-type: none"> Describes the effect of soaps AND detergents in hard water 	2
<ul style="list-style-type: none"> Describes the effect of soaps OR detergents in hard water 	1

Outcomes H3, H4, H9

(e) The Solvay process is a series of reactions in the production of sodium carbonate.

(i) Identify one use of sodium carbonate. 1

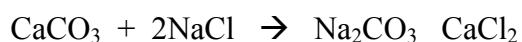
Sample answers

Glass making, Making detergents and soaps, manufacturing paper, making other chemicals, preparing textiles, washing soda

Marking criteria	Marks
• Identifies one use of sodium carbonate	1

Outcomes H4

(ii) Write an overall equation for the production of sodium carbonate from sodium chloride and calcium carbonate.



Marking criteria	Marks
• Correct balanced equation, no subscripts required	1

Outcomes H10

(iii) Calculate the mass and volume of carbon dioxide produced at 25⁰C and 100kPa when 1000kg of calcium carbonate is heated.

Sample answer

$$\text{mol CaCO}_3 = \text{mass/fw} = 1000 \times 10^3 / 100 = 10000 \text{ mol}$$

$$\text{mass CO}_2 = \text{mol} \times \text{fw} = 10000 \times 44 = 440,000\text{g} = 440\text{kg}$$

$$V \text{ CO}_2 = \text{mol} \times 24.79 = 247.9 \times 10^3 \text{ L}$$

Marking criteria	Marks
<ul style="list-style-type: none">• Correct mass and volume with relevant working	3
<ul style="list-style-type: none">• Correct mass or volume with relevant working OR• Correct mass and volume with incorrect mol CaCO_3	2
<ul style="list-style-type: none">• Correct mass OR• Correct volume OR• Correct mol CaCO_3	1

Outcomes H9, H10

End of Test 🛎