

Section I
Total Marks (75)

Part A
Total marks (15)
Attempt Questions 1-15
Allow about 30 minutes for this part

Use the multiple choice answer sheet.
Select the alternative A, B, C or D that best answers the question. Fill in the response circle 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

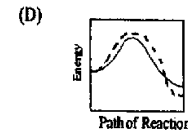
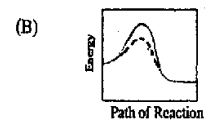
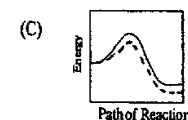
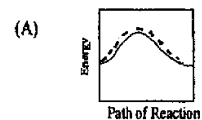
If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

A B ^{correct} C D

1. The role of trace metals in enzyme functions in humans and other organisms has been better understood since the invention of one particular instrument. What is the name of this instrument?

- (A) gas chromatograph
- (B) atomic absorption spectrophotometer
- (C) atomic emission spectrograph
- (D) x-ray diffractometer

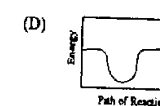
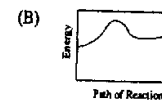
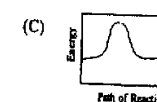
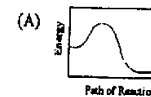
2. Which of the diagrams below correctly depicts the role of catalysts in chemical reactions.



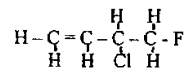
Legend:

Catalysed
Uncatalysed

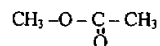
3. Which diagram below correctly depicts the reaction for the production of ammonia from N_2 and H_2 ?



4. What is the IUPAC name for the following compound?

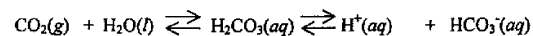


- (A) 1-fluoro-2-chloro-3-butene
 (B) 2-chloro-1-fluoro-3-butene
 (C) 3-chloro-4-fluoro-1-butene
 (D) 4-fluoro-3-chloro-1-butene
5. Which of the following techniques can be used to quantitatively determine the hardness in water?
- (A) titration with sodium EDTA
 (B) colorimetric analysis using ammonium molybdate
 (C) back titration with dilute HCl solution
 (D) titration with dilute sodium carbonate solution
6. Which of the following tests is used to monitor the total dissolved solids in water?
- (A) hardness
 (B) dissolved oxygen and biochemical oxygen demand
 (C) concentration of lead ions
 (D) conductivity
7. What is the IUPAC name for this ester?



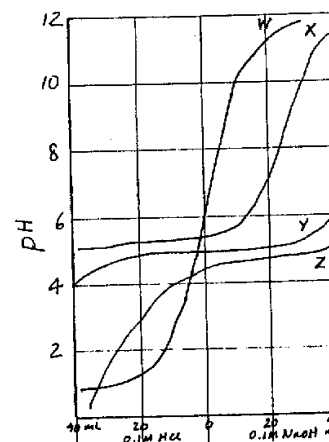
- (A) ethyl methanoate
 (B) ethyl ethanoate
 (C) methyl methanoate
 (D) methyl ethanoate
8. Which of the following species is the strongest base?
- (A) $\text{CH}_3\text{CH}_2\text{OH}$
 (B) NO_3^-
 (C) CH_3COO^-
 (D) HSO_4^-

9. A can of carbonated soft drink contains some interesting equilibria:



Which of the following sets of conditions favours the formation of $\text{H}_2\text{CO}_3(\text{aq})$?

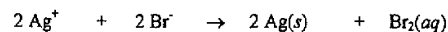
- (A) High pH and low temperature
 (B) High pressure and low pH
 (C) High temperature and low pressure
 (D) High pH and high pressure
10. The graph below shows buffer solutions W, X, Y, and Z reacting with varying amounts of 0.1 mol L^{-1} HCl and 0.1 mol L^{-1} NaOH.



Which solution is the most effective buffer in this situation?

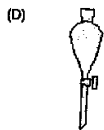
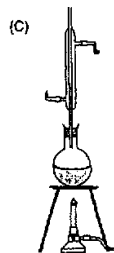
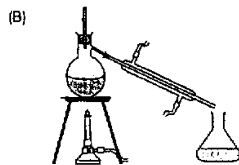
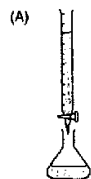
- (A) W
 (B) X
 (C) Y
 (D) Z

11. What is the purpose of the "cracking" process in the refining of petroleum?
- (A) converting natural gas into petrol and other fuels
 (B) increasing the yields of heavy oils and tars
 (C) obtaining a higher yield of petrol and other fuels from crude oil
 (D) lowering the temperature at which crude oil is distilled.
12. The process of black and white photography depends on the following reaction which is initiated by light:



Which of the following species is oxidised in this reaction?

- (A) Ag^+
 (B) Br^-
 (C) $\text{Ag}(s)$
 (D) $\text{Br}_2(aq)$
13. Which of the following apparatus could be used to extract ethanol from a mixture produced by fermentation of glucose solution?



14. Two radioactive decay processes are shown below:



What are X and Y respectively?

- (A) ${}_{89}^{234}\text{Ac}$ and ${}_{82}^{238}\text{Pb}$
 (B) ${}_{90}^{234}\text{Th}$ and ${}_{91}^{234}\text{Pa}$
 (C) ${}_{90}^{242}\text{Th}$ and ${}_{91}^{234}\text{Pa}$
 (D) ${}_{91}^{238}\text{Pa}$ and ${}_{90}^{234}\text{Th}$
15. What is the systematic name of the monomer used to make polyvinyl chloride?
- (A) chloroethene
 (B) 1,2-dichloroethene
 (C) ethene
 (D) 1,1-dichloroethane

Answer Sheet
Section I
Part A

Student Number

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|-----|---|---|---|---|
| 1. | A | B | C | D |
| 2. | A | B | C | D |
| 3. | A | B | C | D |
| 4. | A | B | C | D |
| 5. | A | B | C | D |
| 6. | A | B | C | D |
| 7. | A | B | C | D |
| 8. | A | B | C | D |
| 9. | A | B | C | D |
| 10. | A | B | C | D |
| 11. | A | B | C | D |
| 12. | A | B | C | D |
| 13. | A | B | C | D |
| 14. | A | B | C | D |
| 15. | A | B | C | D |

Student Number.....

Section I

Part B

Total Marks (60)

Attempt Questions 16-37

Allow about 1 hour and 45 minutes for this part

Answer the questions in the spaces provided
Show all relevant working in questions involving calculations

Question 16 (2 marks)

Marks

The presence of ozone in the atmosphere can have an effect on humans. Compare the effect of ozone in the upper atmosphere with its effect in the lower atmosphere

2

Question 17 (2 marks)

(a) Draw a Lewis electron dot diagram for ozone.

1

(b) Indicate the position of the coordinate covalent bond in your diagram above.

1

Question 18 (1 mark)**Mark**

Describe an industrial or domestic use for ammonia.

1

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.....

Question 19 (1 mark)

Explain the need for refluxing during esterification.

1

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Question 20 (1 mark)

Describe the role of concentrated sulfuric acid in the esterification reaction.

1

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Question 21 (3 marks)

Describe three conditions used in the Haber process. Justify the use of each of these conditions.

3

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Question 22 (6 marks)**Marks**

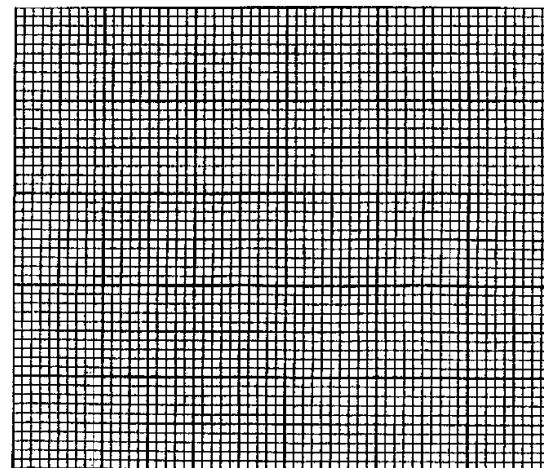
A sample of river water was analysed for copper by atomic absorption spectrophotometry (AAS). A 25.00 mL water sample was diluted to 250.0 mL with demineralised water and directly measured with the AAS instrument. An average absorbance reading of 0.400 was obtained. The standard solutions were prepared by dissolving copper metal in nitric acid and diluting with demineralised water. A series of standards were prepared. The final concentrations of the standards were: 3.48×10^{-6} , 5.24×10^{-6} and 6.97×10^{-6} g mL⁻¹ copper. The average absorbance readings for the standards were 0.313, 0.460 and 0.600 respectively.

- (a) Construct a table of results giving details of the concentrations of the standards and their corresponding readings. Include in your table the unknown and its average reading.

2

- (b) Construct a labelled graph of readings against concentration of the standards.

2



Marks

Question 22 (Continued)

- (c) Using the graph, determine the concentration of copper in the original sample of river water in g mL^{-1} and in p.p.m. 2

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Question 23 (3 marks)

Complete the following table for the testing of ions of interest in environmental studies. 3

Ion	Test Reagent	Ionic Equation for a positive test
chloride		
lead		
barium		

Question 24 (6 marks)

- (a) (i) Name the two lowermost layers of the atmosphere. 1

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- (ii) Name the layer of the atmosphere in which most ozone is formed. 1

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- (b) The composition of the atmosphere is given in the table below:

Gas	Concentration (%v/v)
X	78.09
Y	20.94

- (i) Identify the gases X and Y

X Y 2

- (ii) Calculate the concentration of Y in ppm. Show your working. 2

Question 25 (1 mark)

Marks

(a) Identify one possible source of chlorofluorocarbons in the atmosphere. **1**

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(b) Discuss the problems associated with the use of CFCs with respect to the concentration of ozone in the upper atmosphere. **2**

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Question 26 (3 marks)

Describe the design and composition of microscopic membrane filters and explain how they purify contaminated water supply. **3**

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Question 27 (4 marks)

Marks

Ethene, acrylonitrile and styrene are all monomers used to make polymers:

(a) What name is given to this type of polymerisation? **1**

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(b) Give the name and structural formula of the monomer in this list which could be used to produce the least flexible polymer. **2**

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(c) Explain the reason for the lack of flexibility of the polymer in (b) **1**

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Question 28 (5 marks)

- (a) Write a balanced equation for the reaction which converts a sugar (either glucose or sucrose) into ethanol.

Marks

1

- (b) What name is given to this type of reaction?

1

- (c) Draw a neat labelled diagram of the apparatus used in the school laboratory to prepare ethanol.

2

- (d) Describe one important experimental condition required for this reaction to proceed effectively.

1

Question 29 (2 marks)

- (a) Write a balanced equation to show how ethanol can be made from an alkene.

1

- (b) What name is given to this type of reaction?

1

Question 30 (4 marks)**Marks**

Phosphorus -32 is a radioisotope with a half-life of 14 days.

- (a) Write a nuclear equation for the beta decay of phosphorus-32.

1

- (b) Explain the term "half-life".

1

- (c) Nuclear reactors use high speed neutrons and are used to produce neutron-rich isotopes. A neutron-rich isotope contains more neutrons in its nucleus than most other atoms of the element, such as cobalt-60 or strontium-90. To make neutron deficient radioisotopes, a cyclotron is used. Use the periodic table to complete the table below. Explain your answer.

2

Isotope	Method of production
oxygen-18	

Question 31(4 marks)

Marks

The table below lists the colours and transition range of indicators P – Z. P and W are dual range indicators .

INDICATOR	COLOUR RANGE	pH TRANSITION RANGE
P	red to yellow	1.0 – 2.6
P	yellow to blue-violet	7.6 – 9.2
Q	colourless to pink	1.4 – 3.2
R	yellow to blue-violet	2.8 – 4.6
S	blue to red	3.0 – 5.0
T	yellow to red-violet	4.8 – 6.4
U	orange to deep red-violet	5.0 – 6.0
V	yellow to purple	5.2 – 6.8
W	red to yellow	0.2 – 1.8
W	yellow to purple	7.2 – 8.8
X	yellow to green –violet	9.0 – 13.0
Y	colourless to blue	9.3 – 10.5
Z	yellow to red	10.5 – 12.0

- (a) Indicators R and W are added to a certain solution and the resultant colour in both cases is yellow. Within what range is the pH of the solution? 1
-
- (b) If indicator S is added to this solution what colour will be observed? 1
-
- (c) Two solutions are known to have pH values of 10.0 and 13.0. In order to distinguish them which one indicator could be used? 1
-
- (d) A solution has a pH of 5.8. Which indicator would give a red colour when added to the solution? 1
-

Question 32 (2 marks)

Marks

A solution of ethanoic acid has the same pH (3.0) as a solution of HCl. Equal aliquots of each acid solution are titrated with 0.10 mol L^{-1} NaOH.

- (a) Which acid will require a greater titre (volume) of base for neutralisation? Explain your answer. 1
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-
- (b) Choose a suitable indicator from the table in *Question 31* for the $\text{CH}_3\text{COOH} - \text{NaOH}$ titration and give a reason. 1
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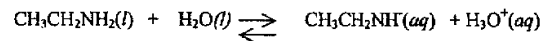
Question 33 (2 marks)

Sodium hydrogen carbonate is a common salt which forms an alkaline aqueous solution.

- (a) Write an equation showing sodium hydrogen carbonate dissolving in water. 1
-
- (b) Write another equation which explains why hydrogen carbonate ions cause the solution to be basic. 1
-

Question 34 (2 marks)

Aminoethane is an amphiprotic liquid which is soluble in water.
The equation below shows aminoethane acting as an acid in water solution.



- (a) Write a balanced equation showing aminoethane acting as a base in water solution

1

- (b) Write the structural formula of the conjugate base of aminoethane.

1

Question 35 (2 marks)

The table below gives the heat energy produced when 100 mL of 1.0 mol L⁻¹ solutions of various acids and bases are mixed.

Solution mixture	Heat energy produced (J)
HCl + NaOH	5700
HNO ₃ + KOH	5690
HBr + KOH	5700
HNO ₃ + LiOH	5710

- (a) Explain why the heat energy produced is very similar in all four reaction mixtures. Include an equation to illustrate your answer

1

- (b) A student predicts that the ΔH produced when 100 mL of 1.0 mol L⁻¹ NaOH is mixed with 100 mL of 1.0 mol L⁻¹ H₂SO₄ is $\approx 11,400$ J. Do you agree with this prediction? Explain your answer.

1

Marks

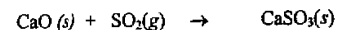
Question 36 (2 marks)

The oxides of sulfur and nitrogen are the main sources of acid rain.

- a) Sulfur dioxide acts as Lewis acid during the formation of acid rain. Define a Lewis acid.

1

- (b) Sulfur dioxide can be removed from industrial exhaust stacks by reaction with lime, CaO:



Calculate the volume (L) of SO₂ gas (at 25°C and 101.3 kPa) which can be removed by 100 kg of CaO.

1

Question 37 (2 marks)

- (a) Define the term eutrophication

1

- (b) List the ions that can be determined to monitor eutrophication in waterways.

1

Marks

Marks

SECTION II

Total marks (25)

Attempt question 38

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 38 (25 marks)	Marks
(a) What is the composition of steel? Explain how the percentage composition of steel can determine its properties	2
(b) Describe the contribution each of the following scientists to our understanding of electrochemistry. (i) Galvani (ii) Davy (iii) Faraday	3
(c) Give two origins of minerals in the oceans.	2
(d) Account for the difference in corrosion of active and passivating metals. Cite one example of active and one example of passivating metals.	2
(e) Explain the process of rusting.	2
(f) Why are iron and steel used as materials for building ships?	1
(g) Differentiate between a galvanic cell and an electrolytic cell.	2
(h) Give the reaction at the cathode and the reaction at the anode for the electrolysis of an aqueous solution of potassium sulfate using carbon electrodes.	2
(i) Give three ways by which the rate of the electrolysis in the previous problem (h) can be increased.	3

Marks

- (j) Devise an experiment which will determine the relationship between the difference in reactivity of three metals and the voltage of the cell that may be constructed from the metal pairs taken in turn. You are given the following materials:

3 pieces of unknown metals of equal shape and size
filter paper
alligator clips and electrical leads
voltmeter
1.0 mole L⁻¹ HCl solution
1.0 mole L⁻¹ aqueous solution of each metal,
saturated potassium nitrate solution

- (i) Give a detailed procedure and an appropriate table of results. 2
(ii) Include diagram(s) of set-ups if applicable and guidelines on how to interpret results. 2
(iii) Prepare a risk assessment study of the procedure you proposed 2

End of Question 38

Answers with

Marking Guidelines

7

Student Number

Answer Sheet
Section I
Part A

Outcomes

1.	A <input type="checkbox"/>	B ●	C <input type="checkbox"/>	D <input type="checkbox"/>	H3, H4, H1
2.	A <input type="checkbox"/>	B ●	C <input type="checkbox"/>	D <input type="checkbox"/>	H7, H8
3.	A ●	B <input type="checkbox"/>	C <input type="checkbox"/>	D <input type="checkbox"/>	H7
4.	A <input type="checkbox"/>	B <input type="checkbox"/>	C ●	D <input type="checkbox"/>	H13
5.	A ●	B <input type="checkbox"/>	C <input type="checkbox"/>	D <input type="checkbox"/>	H11
6.	A <input type="checkbox"/>	B <input type="checkbox"/>	C <input type="checkbox"/>	D ●	H11
7.	A <input type="checkbox"/>	B <input type="checkbox"/>	C <input type="checkbox"/>	D ●	H13
8.	A <input type="checkbox"/>	B <input type="checkbox"/>	C ●	D <input type="checkbox"/>	H8
9.	A <input type="checkbox"/>	B ●	C <input type="checkbox"/>	D <input type="checkbox"/>	H8
10.	A <input type="checkbox"/>	B <input type="checkbox"/>	C ●	D <input type="checkbox"/>	H8
11.	A <input type="checkbox"/>	B <input type="checkbox"/>	C ●	D <input type="checkbox"/>	H9
12.	A <input type="checkbox"/>	B ●	C <input type="checkbox"/>	D <input type="checkbox"/>	H10
13.	A <input type="checkbox"/>	B ●	C <input type="checkbox"/>	D <input type="checkbox"/>	H11
14.	A <input type="checkbox"/>	B ●	C <input type="checkbox"/>	D <input type="checkbox"/>	H6
15.	A ●	B <input type="checkbox"/>	C <input type="checkbox"/>	D <input type="checkbox"/>	H13

James Ruse

2001 Trial
Answers

Student Number.....

Section I**Part B****Total Marks (60)****Attempt Questions 16-37****Allow about 1 hour and 45 minutes for this part**

Answer the questions in the spaces provided

Show all relevant working in questions involving calculations

Question 16 (2 marks) Outcomes: H4, H8. Marks 2
 The presence of ozone in the upper atmosphere can have effect on humans. Compare the effect of ozone in the upper atmosphere with its effect on the lower atmosphere.

Marks	
1	In the upper atmosphere ozone filters off UV radiation protecting humans from its harmful effects
1	In the lower atmosphere, ozone initiates the production of various harmful chemicals and itself can cause lung and other health problems

Question 17 (2 marks) Outcomes: H13

- (a) Draw a Lewis electron dot diagram for ozone. 1
- (b) In your diagram above, indicate the position of the coordinate covalent bond. 1

Marks	
1	Correct Lewis electron dot structure
1	Correct position of coordinate covalent bond

Question 18 (1 mark) Outcome: H4

Describe an industrial or domestic use for ammonia. 1

Marks	
1	As fertilizer, ammonia is applied as $(\text{NH}_4)_2\text{SO}_4$ or directly injected to the ground as NH_3 gas.

Question 19 (1 mark)

Outcome: H11

Marks

Explain the need for refluxing during esterification.

1

Marks	
1	Refluxing prevents the loss of volatile components of the reaction mixture when heat is used to hasten the reaction

Question 20 (1 mark)

Outcome: H11

Describe the role of concentrated sulfuric acid in the esterification reaction.

1

Marks	
1	Dehydrates the mixture and hence shifts equilibrium to the right or catalyses the reaction between the alcohol and the acid

Question 21 (3 marks)

Outcomes: H8, H10, H6, H7

Give three conditions used in the Haber process. Justify the use of each of these conditions.

3

Marks	
1	Moderately high temperature: Allows the attainment of equilibrium rapidly
1	High pressure: Favours the formation of NH_3 (gas/liquid) which occupies less volume than the combined volumes of N_2 and H_2 gases
1	Presence of a catalyst: hastens the attainment of equilibrium so that only a moderately high temperature is required in the reaction

Question 22 (4 marks)

Outcomes: H11, H13, H14

Marks

A sample of river water was analysed for copper by atomic absorption spectrophotometry (AAS). A 25.00 mL water sample was diluted to 250.0 mL with demineralised water and directly aspirated into the AAS instrument. An average reading of 40.0 was obtained. The standard solutions were prepared by dissolving copper metal in nitric acid and diluting with demineralised water. A series of standards were prepared. The final concentrations of the standards were: 3.48×10^{-6} , 5.24×10^{-6} and 6.97×10^{-6} g mL⁻¹ copper. The average readings for the standards were 31.3, 46.0 and 60.0 respectively.

- (a) Construct a table of results giving details of the concentrations of the standards and their corresponding readings. Include in your table the unknown and its average reading.

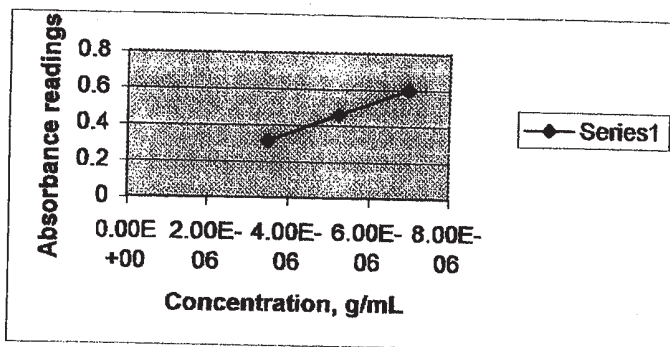
2

Sample	Concentration, g mL ⁻¹	Absorbance reading
1	3.46×10^{-6}	0.313
2	5.24×10^{-6}	0.460
3	6.97×10^{-6}	0.600
Unknown		0.400

Marks	
1	For headings and labels
1	For content

- (b) Construct a labelled graph of readings against concentration of the standards.

2



Marks	
1	For labelling axes
1	For data points

- (c) Using the graph, determine the concentration of copper in the original water in g mL^{-1} and in p.p.m.

2

Marks	
1	From graph: $4.5 \times 10^{-6} \text{ g/mL}$ Original = $4.5 \times 10^{-6} \text{ g/mL} \times 250/25 = 4.5 \times 10^{-5} \text{ g/mL}$
1	In ppm : $4.5 \times 10^{-5} \text{ g/mL} \times 1000 \text{ mL/L} = 45 \text{ mg/g} = 4.5 \text{ ppm}$

Question 23 (3 marks) Outcomes H13, H10, H6

Marks

Complete the following table for the testing of ions of interest in environmental studies. 3

Ion	Test Reagent	Ionic Equation	Marks
chloride	AgNO_3	$\text{Cl}^- + \text{Ag}^+ \rightarrow \text{AgCl} (s)$	1
lead	HCl	$\text{Pb}^{2+} + 2\text{Cl}^- \rightarrow \text{PbCl}_2 (s)$	1
barium	H_2SO_4 or Na_2SO_4	$\text{Ba}^{2+} + \text{SO}_4^{2-} \rightarrow \text{BaSO}_4 (s)$	1

Question 24 (8 marks) Outcomes H13, H10

- (a) (i) Name the two lowermost layers of the atmosphere.

1

Marks	
1	Troposphere
1	Stratosphere

- (ii) Name the layer of the atmosphere in which most ozone is found.

1

Mark	
1	Stratosphere

- (b) The composition of the atmosphere is given in the table below:

Gas	Concentration (%v/v)
<i>X</i>	78.09
<i>Y</i>	20.94

- (i) Identify the gases *X* and *Y* 2

X..... *Y*.....

Marks	
1	X: nitrogen
1	Y: oxygen

- (ii) Calculate the concentration of *Y* in ppm. Show your working. 2

$$\begin{aligned} \text{ppm} &= (20.94 \text{ mL}/100\text{mL}) \times 10000 \\ &= 209,400 \approx 200000 \text{ ppm} \end{aligned}$$

Marks	
1	Correct calculation and units
1	Correct answer

Question 25 (1 mark) Outcome: H4, H13 Marks

- (a) Identify one possible source of chlorofluorocarbons in the atmosphere. 1

Marks	
1	Chlorofluorocarbons that have found their way up through their use as propellants in aerosols

- (b) Discuss the problems associated with the use of CFCs with respect to the concentration of ozone in the upper atmosphere. 1

Question 26 (3 marks) Outcomes H3, H4

Describe the design and composition of microscopic membrane filters and explain how they purify contaminated water supply. 3

A membrane filter is essentially a thin film of a synthetic polymer through which there are small pores (holes) of fairly uniform size. They purify contaminated water by physically eliminating particulates and micro-organisms which are bigger than their pore sizes.

Marks	
1	composition
1	design
1	explanation

Question 27 (4 marks) Outcomes H6, H13

Ethene, acrylonitrile and styrene are all used to make polymers:

- (a) What name is given to this type of polymerisation? 1

Marks	
1	Addition polymerisation

- (b) Give the name and structural formula of the monomer in this list which would be used to produce the least flexible polymer. 2

Marks	
1	styrene
1	structural formula

- (c) Explain the reason for the lack of flexibility. 1

Marks	
1	The benzene side chain of polystyrene restricts the ability of the polymer to 'flop around' ie polymer's rotation is restricted by the bulky side chain

MARKS**Question 28 (5 marks) Outcomes H13, H9, H10, H8, H7, H6**

- (a) Write a balanced equation for the reaction which converts a sugar (either glucose or sucrose) into ethanol. 1

Marks	
1	Balanced equation

- (b) What name is given to this type of reaction? 1

Marks	
1	Fermentation

- (c) Draw a neat labelled diagram of the apparatus used in the school laboratory to carry out this reaction

2

Marks	
1	Correct diagram
1	Correct label

- (d) Describe one important experimental condition required for this reaction to proceed effectively.

1

Marks	
1	The reaction must be initiated at 37°C to activate the yeast or the reaction must be allowed to proceed in the absence of oxygen or pH must be controlled

Question 29(2 marks)

Outcomes: H6, H10, H13

- (a) Write a balanced equation to show how ethanol can be made from an alkene.

1

Marks	
1	Balanced equation

- (b) What name is given to this type of reaction?

1

Marks	
1	Hydration

Question 30 (4 marks) Outcomes: H3, H13

Marks

Phosphorus-32 is a radioisotope with a half life of 14 days.

- (a) Write a nuclear equation for the beta decay of phosphorus-32.

1

Marks	
1	Correct balanced equation

- (b) Explain the term "half-life".

1

Marks	
1	time required for one half of the radioactive material to disintegrate

- (c) Nuclear reactors use high speed neutrons and are used to produce neutron-rich isotopes. A neutron-rich isotope contains more neutrons in its nucleus than most other atoms of the element, such as Cobalt-60 or Strontium-90. To make a neutron deficient radioisotopes, a cyclotron is used. Use the periodic table to complete the table below:
Explain your answer.

2

Isotope	Method of production
oxygen-18	Nuclear reactor

Mark	
1	Oxygen - 18 has 8 protons and 10 neutrons, 2 more neutrons than ordinary oxygen (oxygen - 16) which has 8 protons and 8 neutrons

Question 31(4 marks)**Outcomes: H13, H9**

The table below lists the colours and transition range of indicators P – Z.

P and W are dual range indicators

INDICATOR	COLOUR RANGE	pH TRANSITION RANGE
P	red to yellow	1.0 – 2.6
P	yellow to blue-violet	7.6 – 9.2
Q	colourless to pink	1.4 – 3.2
R	yellow to blue-violet	2.8 – 4.6
S	blue to red	3.0 – 5.0
T	yellow to red-violet	4.8 – 6.4
U	orange to deep red-violet	5.0 – 6.0
V	yellow to purple	5.2 – 6.8
W	red to yellow	0.2 – 1.8
W	yellow to purple	7.2 – 8.8
X	yellow to green – violet	9.0 – 13.0
Y	colourless to blue	9.3 – 10.5
Z	yellow to red	10.5 – 12.0

- (a) Indicators R and W are added to a certain solution and the resultant colour in both cases is yellow. Within what range is the pH of the solution? 1

Marks	
1	1.8 to 2.8

- (b) If indicator S is added to this solution what colour will be observed? 1

Marks	
1	blue

- (c) Two solutions are known to have pH values of 10.0 and 13.0. In order to distinguish them which one indicator could be used? 1

Marks	
1	Z

- (d) A solution has a pH of 5.8. Which indicator would give a red colour when added to the solution? 1

Marks	
1	S

Question 32 (2 marks) Outcomes: H10, H9, H13, H8

Marks

A solution of ethanoic acid has the same pH (3.0) as a solution of HCl. Equal aliquots of each acid solution are titrated with 0.10 mol L^{-1} NaOH.

- (a) Which acid will require a greater titre of base for neutralisation? Explain your answer.

1

Marks	
1	The ethanoic acid will require a greater volume of the base, being a weaker acid than HCl, since it must have a greater concentration than the HCl for its $[\text{H}^+]$ to equal that of the fully ionised HCl

- (b) Choose a suitable indicator from the table in *Question 31*. for the $\text{CH}_3\text{COOH} - \text{NaOH}$ titration and give a reason.

1

Marks	
1	W: It changes colour at the pH at equivalence point of the $\text{CH}_3\text{COOH} - \text{NaOH}$ titration (or X or Y or Z)

Question 33 (2 marks) Outcomes: H10, H8, H13

Sodium hydrogen carbonate is a common salt which forms an alkaline aqueous solution.

- (a) Write an equation showing sodium hydrogen carbonate dissolving in water. 1

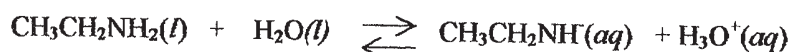
Marks	
1	$\text{NaHCO}_3 (s) \rightarrow \text{Na}^+ + \text{HCO}_3^{1-}$

- (b) Write another equation which explains why hydrogen carbonate ions cause the solution to be basic. 1

Marks	
1	$\text{HCO}_3^- + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3 + \text{OH}^-$

Question 34 (2 marks) Outcomes: H9, H10, H13, H8

Aminoethane is an amphiprotic liquid which is soluble in water. The equation below shows aminoethane acting as an acid in water solution.



- (a) Write a balanced equation showing aminoethane acting as a base in water solution

1

Marks	
1	$\text{CH}_3\text{CH}_2\text{NH}_2(l) + \text{H}_2\text{O}(l) \rightarrow \text{CH}_3\text{CH}_2\text{NH}_3 + \text{OH}^-$

- (b) Write the structural formula of the conjugate base of aminoethane.

1

Marks	
1	$\text{CH}_3\text{CH}_2\text{NH}^-$

Question 35 (2 marks)
Marks

Outcome: H7, H8, H10, H13

The table below gives the heat energy produced when 100 mL of 1.0 mol L⁻¹ solutions of various acids and bases are mixed....

Solution mixture	Heat energy produced (J)
HCl + NaOH	5700
HNO ₃ + KOH	5690
HBr + KOH	5700
HNO ₃ + LiOH	5710

- (a) Explain why the heat energy produced is very similar in all four reaction mixtures. Include an equation to illustrate your answer

1

Marks	
1	The net reaction is the same for all the acid-base reactions: $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}(l)$

- (b) A student predicts that the ΔH produced when 100 mL of 1.0 mol L⁻¹ NaOH is mixed with 100 mL of 1.0 mol L⁻¹ H₂SO₄ is $\approx 11,400$ J. Do you agree with this prediction? Explain your answer.

1

Marks	
1	No, the reaction would release only about 5700 J of energy since only 0.1 mole of OH ⁻ is available for neutralisation.

Question 36(2 marks) Outcomes: H13, H10

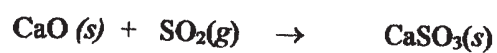
The oxides of sulfur and nitrogen are the main sources of acid rain.

- a) Sulfur dioxide acts as Lewis acid during the formation of acid rain.
Define a Lewis acid.

1

Marks	
1	A Lewis acid is an electron pair acceptor

- (b) Sulfur dioxide can be removed from industrial exhaust stacks by reaction with lime, CaO:



Calculate the volume (L) of SO₂ gas (at 25^oC and 101.3 kPa) which can be removed by 100 kg of CaO.

1

Marks	
1	Correct calculation and units

Question 37 (2 marks) Outcomes: H13, H6

- (a) Define the term eutrophication
- (b) List the ions that can be determined to monitor eutrophication in waterways.

1

1

Marks	
1	(a) An increase in nutrient content of a body of water leading to excessive growth of organisms and depletion of oxygen.
1	NO ₃ ⁻ and PO ₄ ³⁻

SECTION II Outcomes: H1, H2, H3, H7, H6, H8, H10, H11, H12, H13, H14

Total marks (25)

Attempt question 38

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 38 (25 marks)

Marks

- (a) What is the composition of steel? Explain how the percentage composition of steel can determine its properties (H13, H16)

Marks	
1	Steel is an alloy of iron with no more than 2% carbon and often with varying amounts of other metals or silicon
1	The percentage of carbon affects properties quite markedly because of the limited solubility of carbon in iron with the varying properties dependent on the extent of mixing of the carbon with the iron

2

- (b) Describe the contribution each of the following scientists to our understanding of electrochemistry. (H1, H2, H3)

- (i) Galvani
- (ii) Davy
- (iii) Faraday

3

Marks	
1	Galvani: First generated an electric current and observed its effect
1	Davy: Utilised Volta's pile to produce metallic sodium and potassium electrolytically. He recognised that chemical reactions can produce electric current observed in Volta's pile.
1	Faraday related the amount of substance produced electrolytically to the quantity of electricity that passed through the cell

- (c) Give two origins of minerals in the oceans. (H13)

2

Marks	
1	Leaching by rain and ground water that eventually runs off into oceans
1	Dissolution of salts by water passing through hydrothermal vents

- (d) Account for the difference in corrosion of active and passivating metals.
Cite one example of active and one example of passivating metals.

2

Outcome: H13

Marks	
1	An active metal readily combines with oxygen or reacts with dilute acid. A passivating metal is a reactive metal that readily forms an unreactive surface coating with substances such as oxygen or water, this protects the metal from further reaction. An active metal may be a passivating metal
1	An example of an active metal is iron and that of a passivating metal aluminium

- (e) Explain the process of rusting.

2

Outcome: H6, H8

Marks	
1	Rusting occurs when a galvanic cell is set up in a piece of iron. One part of the metal serves as the cathode where dissolved oxygen is reduced to hydroxide
1	Another part serves as the anode where iron is oxidised to iron (II). Combination with oxygen and further oxidation results in rust

- (f) Why are iron and steel used as materials for building ships?

1

Outcome: H6, H8

Marks	
1	Iron and steel are relatively hard, have good mechanical strength, can be rolled pressed and manipulated into various shapes

- (g) Differentiate between a galvanic cell and an electrolytic cell.

2

Outcomes: H7, H13

Marks	
1	In a galvanic cell, electric current is produced as a result of a spontaneous chemical reaction.
1	A non spontaneous reaction is made to occur in an electrolytic cell by passing current through the mixture using inert or active electrodes.

- (h) Give the reaction at the cathode and the reaction at the anode for the electrolysis of an aqueous solution of potassium sulfate.

2

Outcomes: H10

Marks	
1	Anode: $2\text{H}_2\text{O}(l) \rightarrow \text{O}_2(g) + 4\text{H}^+ + 4\text{e}^-$
1	Cathode: $2\text{H}_2\text{O}(l) + 2\text{e}^- \rightarrow \text{H}_2(g) + 2\text{OH}^-$

- (i) Give three ways by which the rate of the electrolysis in the previous problem be increased.

3

Outcomes: H6

Marks	
1 mark each	Any 3 of the following: H Increase the applied voltage H Increase the concentration of the K_2SO_4 dissolved in the solution H Use platinum electrodes with larger surface area H Decrease the distance between the electrodes

- (j) Devise an experiment which will determine the relationship between the difference in reactivity of three metals and the voltage of the cell that may be constructed from the metal pairs taken in turn. You are given the following materials:

three pieces of unknown metals of equal shape and size
 filter paper
 alligator clips and electrical leads
 voltmeter
 1.0 mole L^{-1} HCl solution
 1.0 mole L^{-1} aqueous solution of each metal,
 saturated potassium nitrate solution

Outcomes: H11, H12, H14

- (i) Give a procedure and an appropriate table of results.
 Include diagram(s) of set-up and guideline on how to interpret results

Marks	
1	Appropriate procedure
1	Table of result
1	Diagram
1	How to interpret results

- (ii) Prepare a risk assessment study of the procedure you proposed 2

Marks	
1	Toxicity of the chemicals/electrodes
1	Broken glassware, sharp metal electrodes, hazard from steel wool used to clean electrodes, etc.