



## Tertiary Entrance Examination, 2007

### Question/Answer Booklet

# CHEMISTRY

Please place your student identification label in this box

Student Number: In figures

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In words

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### ***Time allowed for this paper***

Reading time before commencing work: Ten minutes

Working time for paper: Three hours

### ***Materials required/recommended for this paper***

#### **To be provided by the supervisor**

This Question/Answer Booklet

Multiple-Choice Answer Sheet

Chemistry Data Sheet (inside the front cover of this Question/Answer Booklet)

Question Sheet for Part 4 (inside the front cover of this Question/Answer Booklet)

#### **To be provided by the candidate**

Standard items: Pens, pencils, eraser or correction fluid, ruler, highlighter

Special items: A blue or black pen or a B or 2B pencil for the separate Multiple-Choice Answer Sheet, and calculators satisfying the conditions set by the Curriculum Council for this subject.

### ***Important note to candidates***

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

**Structure of this paper**

Part	Number of questions available	Number of questions to be attempted	Suggested working time (minutes)	Marks available
1 Multiple-Choice	30	30	55	60
2 Short Answers	13	13	60	70
3 Calculations	5	5	45	50
4 Extended Answers	1	1	20	20
<b>Total marks</b>				<b>200</b>

**Instructions to candidates**

- The rules for the conduct of Western Australian external examinations are detailed in the *TEEWACE Handbook*. Sitting this examination implies that you agree to abide by these rules.

- Answer the questions according to the following instructions:

**Part 1** Answer **all** questions on the separate Multiple-Choice Answer Sheet. Use a blue or black pen or a B or 2B pencil.

If you consider that two or more of the alternative responses are correct, choose the one you think is best. If you think you know an answer, mark it even if you are not certain you are correct. Marks will not be deducted for incorrect answers.

**Parts 2, 3 and 4** Write your answers in the spaces provided in this Question/Answer Booklet. A blue or black ballpoint or ink pen should be used.

Questions for Part 4 have been repeated on a removable sheet which is inserted into the front of this booklet so that you can refer to it more easily while answering the questions. Do not write your answers on the Question Sheet. The removable Question Sheet is **not** to be handed in with your answers.

Questions containing specific instructions to show working should be answered with a complete, logical, clear sequence of reasoning showing how the final answer was arrived at; correct answers for such questions which do not show working will not be awarded full marks.

- The examiners recommend that you spend your reading time mainly reading the instructions to candidates and Parts 2, 3 and 4.
- Chemical equations**  
For full marks, chemical equations should refer only to those species consumed in the reaction and the new species produced. These species may be **ions** [for example  $\text{Ag}^+(\text{aq})$ ], **molecules** [for example  $\text{NH}_3(\text{g})$ ,  $\text{NH}_3(\text{aq})$ ,  $\text{CH}_3\text{COOH}(\ell)$ ,  $\text{CH}_3\text{COOH}(\text{aq})$ ] or **solids** [for example  $\text{BaSO}_4(\text{s})$ ,  $\text{Cu}(\text{s})$ ,  $\text{Na}_2\text{CO}_3(\text{s})$ ].

**PART 1 (60 Marks)**

Answer ALL questions in Part 1 on the separate Multiple-Choice Answer Sheet provided, using a blue or black pen or B or 2B pencil. Each question in this part is worth 2 marks.

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1. Which of the following statements concerning intermolecular forces is/are correct?

- I Dispersion forces exist in all molecular solids.
- II All molecules that contain polar bonds are polar molecules.
- III Hydrogen bonding only occurs for molecules containing O-H bonds.

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

2. Which one of the following will show hydrogen bonding between neighbouring molecules?

- (a) Ethane
- (b) Ethanol
- (c) Ethene
- (d) Ethanal

3. Why is the bond between a sulfur atom and an oxygen atom polar?

- (a) The O atom is more electronegative than the S atom.
- (b) The S atom has a higher positive charge in the nucleus than the O atom.
- (c) The S atom is larger than the O atom.
- (d) The S atom has more electrons than the O atom, so will be negative relative to the O atom.



6. An element "X" has the following successive ionisation energies, in MJ mol<sup>-1</sup>.

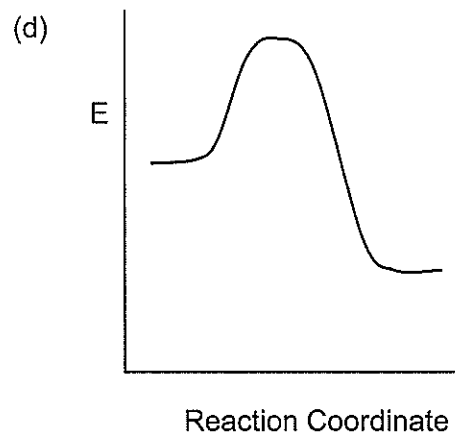
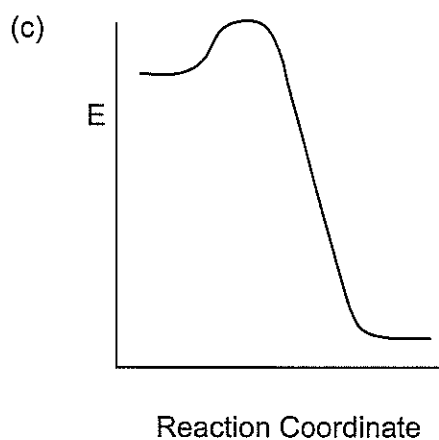
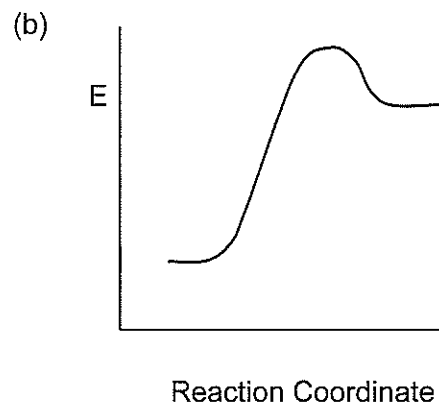
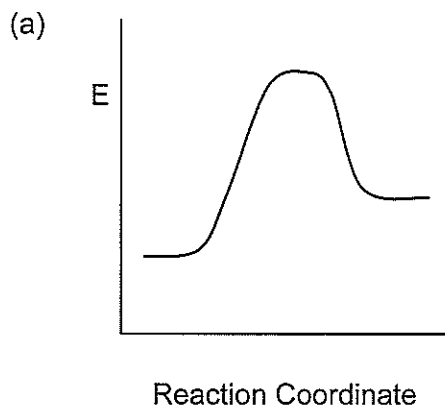
First	Second	Third	Fourth	Fifth
0.7	1.5	7.7	10.5	13.6

Which one of the following statements concerning this element is correct?

- (a) The element can only belong to period 2 of the Periodic Table.
- (b) The element will form a stable divalent cation X<sup>2+</sup>.
- (c) The element will form an oxide of formula X<sub>2</sub>O.
- (d) The element will have 5 valence electrons.
7. Which of the following species does **NOT** have the same electronic configuration as the chloride ion, Cl<sup>-</sup>?
- (a) sulfide ion S<sup>2-</sup>
- (b) potassium ion K<sup>+</sup>
- (c) oxide ion O<sup>2-</sup>
- (d) argon atom
8. Which one of the following is an endothermic process?
- (a) The combustion of petrol
- (b) CH<sub>3</sub>CH<sub>2</sub>OH(*ℓ*) → CH<sub>3</sub>CH<sub>2</sub>OH(*g*)
- (c) Na<sup>+</sup>(*g*) + e<sup>-</sup> → Na(*g*)
- (d) 2 H<sub>2</sub>(*g*) + O<sub>2</sub>(*g*) → 2 H<sub>2</sub>O(*g*)

9. Nitroglycerine is a highly dangerous explosive substance. Simply dropping a container of nitroglycerine provides enough kinetic energy on impact with the floor to cause it to explode, releasing a very large amount of energy.

Which of the following energy profile diagrams would BEST represent this reaction?



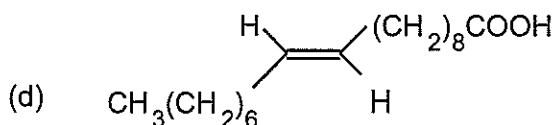
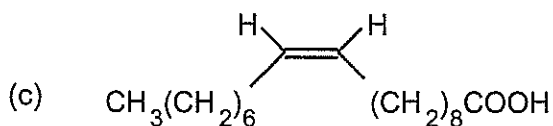
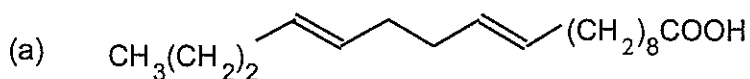
10. Consider the following acid-base reaction



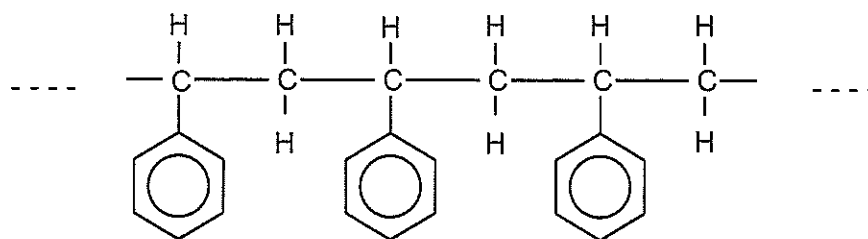
Which one of the following correctly identifies the acid-base conjugate pairs in this system?

	Acid	Conjugate Base	Base	Conjugate acid
(a)	$\text{HSO}_4^-$	$\text{HS}^-$	$\text{SO}_4^{2-}$	$\text{H}_2\text{S}$
(b)	$\text{HSO}_4^-$	$\text{SO}_4^{2-}$	$\text{HS}^-$	$\text{H}_2\text{S}$
(c)	$\text{HSO}_4^-$	$\text{H}_2\text{S}$	$\text{HS}^-$	$\text{SO}_4^{2-}$
(d)	$\text{HS}^-$	$\text{HSO}_4^-$	$\text{H}_2\text{S}$	$\text{SO}_4^{2-}$

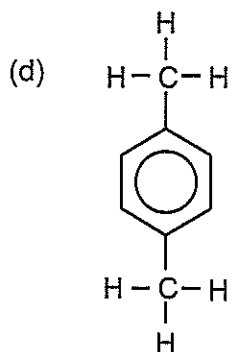
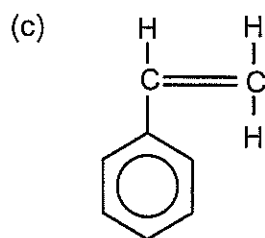
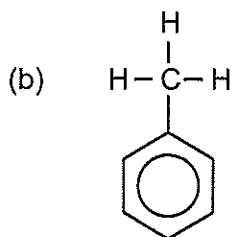
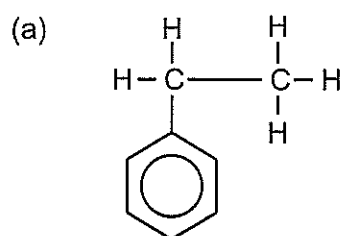
11. Which one of the following solutions would have a pH of 10?
- $1 \times 10^{-10} \text{ mol L}^{-1}$  sodium hydroxide
  - $5 \times 10^{-5} \text{ mol L}^{-1}$  barium hydroxide
  - $1 \times 10^{-4} \text{ mol L}^{-1}$  calcium hydroxide
  - $1 \times 10^{-10} \text{ mol L}^{-1}$  nitric acid
12. Which one of the following statements is true?
- Only organic acids are weak.
  - $\text{H}_2\text{O}$  and  $\text{OH}^-$  are a conjugate acid-base pair.
  - Weak acid solutions do not contain  $\text{H}_3\text{O}^+$ .
  - Diluting a strong acid produces a weak acid.
13. Fatty acids are important in our diet and can be saturated or unsaturated. The unsaturated fatty acids can have *cis* or *trans* forms. Which one of the following representations of various fatty acids **best** shows the structure of a *cis* type unsaturated fatty acid?



14. Below is a section of the structure of an addition polymer:



Which one of the following compounds could polymerise to form this chain?

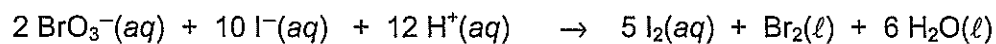


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15. How many primary alcohols have the molecular formula  $C_4H_9OH$ ?
- (a) 1  
(b) 2  
(c) 3  
(d) 4
16. Which one of the following will react readily with acidified dichromate ( $Cr_2O_7^{2-}$ ) solution?
- (a)  $CH_3COCH_3$   
(b)  $CH_3CH_2CHO$   
(c) 
$$\begin{array}{c} OH \\ | \\ H_3C - C - CH_3 \\ | \\ CH_3 \end{array}$$
  
(d)  $CH_3CH_2CH_3$

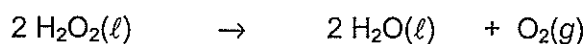
17. Consider the following equation:



For this reaction, which one of the following is true?

- (a)  $BrO_3^-$  is the reducing agent.  
(b)  $H^+$  is reduced.  
(c)  $I^-$  is the oxidising agent.  
(d)  $BrO_3^-$  is reduced.

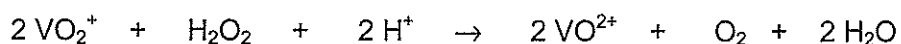
18. Consider the statements about the following reaction:



- I  $\text{H}_2\text{O}_2$  is reduced.
- II  $\text{H}_2\text{O}_2$  is oxidised.
- III  $\text{H}_2\text{O}_2$  acts as a reducing agent.
- IV This is not a redox reaction.

Which of the above statements are true?

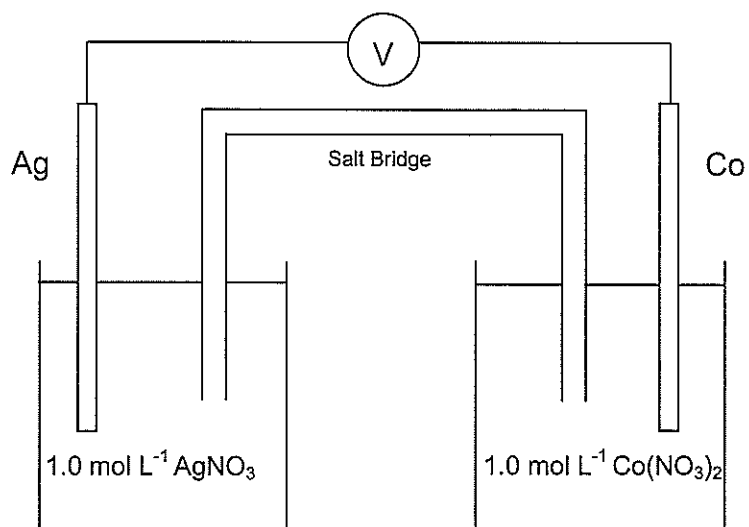
- (a) IV only
  - (b) II and III only
  - (c) I only
  - (d) I, II and III only
19. Consider the following reaction:



Which one of the following statements is true for this reaction?

- (a) The  $\text{VO}_2^+$  is reduced and the  $\text{H}^+$  is oxidised.
  - (b) The  $\text{H}^+$  is reduced and the  $\text{H}_2\text{O}_2$  is oxidised.
  - (c) The  $\text{VO}_2^+$  is the oxidising agent and the  $\text{H}^+$  is the reducing agent.
  - (d) The  $\text{VO}_2^+$  is reduced and the  $\text{H}_2\text{O}_2$  is oxidised.
20. An electrolytic cell consists of steel electrodes immersed in  $1.00 \text{ mol L}^{-1}$  nickel(II) chloride solution. Which of the following reactions is most likely to occur at the cathode?
- (a)  $\text{Ni}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Ni}(\text{s})$
  - (b)  $2 \text{H}_2\text{O}(\ell) + 2 \text{e}^- \rightarrow \text{H}_2(\text{g}) + 2 \text{OH}^-(\text{aq})$
  - (c)  $\text{Fe}(\text{s}) \rightarrow \text{Fe}^{2+}(\text{aq}) + 2 \text{e}^-$
  - (d)  $2 \text{Cl}^-(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + 2 \text{e}^-$

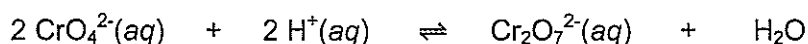
21. An electrochemical cell consists of an  $\text{Ag}/\text{Ag}^+(\text{aq})$  half-cell coupled with a  $\text{Co}/\text{Co}^{2+}(\text{aq})$  half-cell as shown in the diagram below:



Under standard conditions, what voltage would be generated by this cell?

- (a) 1.88 V
  - (b) 1.32 V
  - (c) 1.08 V
  - (d) 0.52 V
22. Which one of the following statements is correct?
- (a) The corrosion of iron is a redox reaction in which iron is oxidised.
  - (b) A sacrificial anode is more easily reduced than iron.
  - (c) Cathodic protection prevents rusting by excluding oxygen.
  - (d) Painting of iron prevents corrosion because the paint is more readily oxidised than the iron.

23. A common reaction that illustrates chemical equilibrium is the chromate-dichromate reaction:



What is the equilibrium constant expression for this reaction?

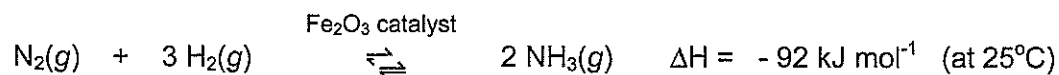
- (a)  $K = \frac{[\text{Cr}_2\text{O}_7^{2-}][\text{H}_2\text{O}]^2}{[\text{CrO}_4^{2-}]^2[\text{H}^+]^2}$
- (b)  $K = \frac{[\text{Cr}_2\text{O}_7^{2-}][2\text{H}_2\text{O}]}{[2\text{CrO}_4^{2-}][2\text{H}^+]}$
- (c)  $K = \frac{[\text{Cr}_2\text{O}_7^{2-}]}{[\text{CrO}_4^{2-}]^2[\text{H}^+]^2}$
- (d)  $K = \frac{[\text{Cr}_2\text{O}_7^{2-}]}{2[\text{CrO}_4^{2-}] + 2[\text{H}^+]}$
24. Which one of the following is characteristic of a system at equilibrium?
- (a) The rate of the forward reaction equals the rate of the reverse reaction.
- (b) The concentration of reactants equals the concentration of products.
- (c) The forward and reverse reactions have stopped.
- (d) Changing the temperature of a system in equilibrium has no effect on the equilibrium constant.
25. If solid calcium carbonate is heated in a sealed container, the following equilibrium is established at 500°C and 600 kPa pressure:



Which one of the following statements about this equilibrium is correct?

- (a) Adding more  $\text{CO}_2$  to the system will reduce the amount of  $\text{CaO}$  present.
- (b) Reducing the temperature of the system will increase the amount of  $\text{CaO}$  present.
- (c) Increasing the pressure of the system to 1000 kPa by adding inert nitrogen gas will decrease the amount of  $\text{CaCO}_3$  present.
- (d) Adding more  $\text{CaCO}_3$  to the system will cause an increase in  $\text{CaO}$  and  $\text{CO}_2$  present.

26. The equilibrium utilised in the Haber process can be represented as:



What will happen if the quantity of catalyst is halved?

- (a) The temperature drops to half the original value.
  - (b) The rate drops to half the original value.
  - (c) The yield of product drops to half the original value.
  - (d) None of the above will occur.
27. Which one of the following statements about soap is true?
- (a) Soap is an ester of glycerol.
  - (b) Soap is a carboxylic acid.
  - (c) Soap is a carbohydrate.
  - (d) Soap is a salt.
28. Which one of the following shows the atoms in increasing order of first ionisation energy?
- (a) Rb    K    Na    S    Cl
  - (b) Ca    K    Na    P    Br
  - (c) I      Br    Cl    Mg    Na
  - (d) Br    Cl    F    S    Mg
29. Which one of the following gives rise to the properties of transition metals?
- (a) The existence of a range of oxidation states
  - (b) The formation of coloured compounds
  - (c) The elements have valence electrons in d orbitals
  - (d) The existence of complex ions

30. Unlike structures made of iron, structures made of aluminium often do not need to be protected from corrosion. Why is aluminium more resistant to corrosion than iron?
- (a) Aluminium is unreactive.
  - (b) Aluminium has a high reduction potential.
  - (c) Aluminium forms a protective oxide layer.
  - (d) Iron can be alloyed with other elements.

**END OF PART 1**

**SEE NEXT PAGE**

**PART 2 (70 Marks)**

Answer ALL questions in Part 2 in the spaces provided.

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1. Write the equation for the reaction that occurs in each of the following procedures. If no reaction occurs write "no reaction".

Following this, describe **in full** what you would observe in each case, including any

- colours
- odours
- precipitates (give the colour)
- gases evolved (give the colour or describe as colourless).

If no change is observed, you should state this.

- (a) Ammonia gas is mixed with hydrogen chloride gas.

**Equation** \_\_\_\_\_

**Observation** \_\_\_\_\_

\_\_\_\_\_ [3 marks]

- (b) Zinc dust is added to a solution of gold(III) chloride.

**Equation** \_\_\_\_\_

**Observation** \_\_\_\_\_

\_\_\_\_\_ [3 marks]

- (c) Concentrated ammonia solution is added to a suspension of silver oxide.

**Equation** \_\_\_\_\_

**Observation** \_\_\_\_\_

\_\_\_\_\_ [3 marks]

- (d) Dilute sulfuric acid is added to a copper(II) nitrate solution.

**Equation** \_\_\_\_\_

**Observation** \_\_\_\_\_

\_\_\_\_\_ [3 marks]

2. For each species listed in the table below, draw the structural formula, representing all valence shell electron pairs either as : or as —

[for example, water  $\text{H}:\ddot{\text{O}}:\text{H}$  or  $\text{H}-\ddot{\text{O}}-\text{H}$  or  $\text{H}-\bar{\text{O}}-\text{H}$  and so on]

Species	Electron dot diagram
Ethanol	
Potassium hydroxide	

[4 marks]



3. On Earth, nitrogen exists as a gas. On Triton, the largest moon orbiting the planet Neptune, nitrogen can exist as a solid. The surface temperature of Triton is around  $-235^{\circ}\text{C}$ .

Name the force of attraction that exists between nitrogen molecules.

\_\_\_\_\_

Explain how these forces arise and why the temperature needs to be so low for nitrogen to be a solid.

[4 marks]

4. Name and draw the structural formula for each of the following:

An amine containing three carbon atoms per molecule.

Structure:

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

A tertiary alcohol containing four carbon atoms per molecule.

Structure:

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

An aromatic hydrocarbon containing seven carbon atoms per molecule.

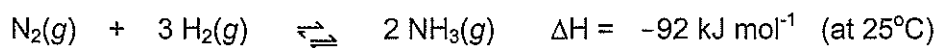
Structure:

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

[6 marks]

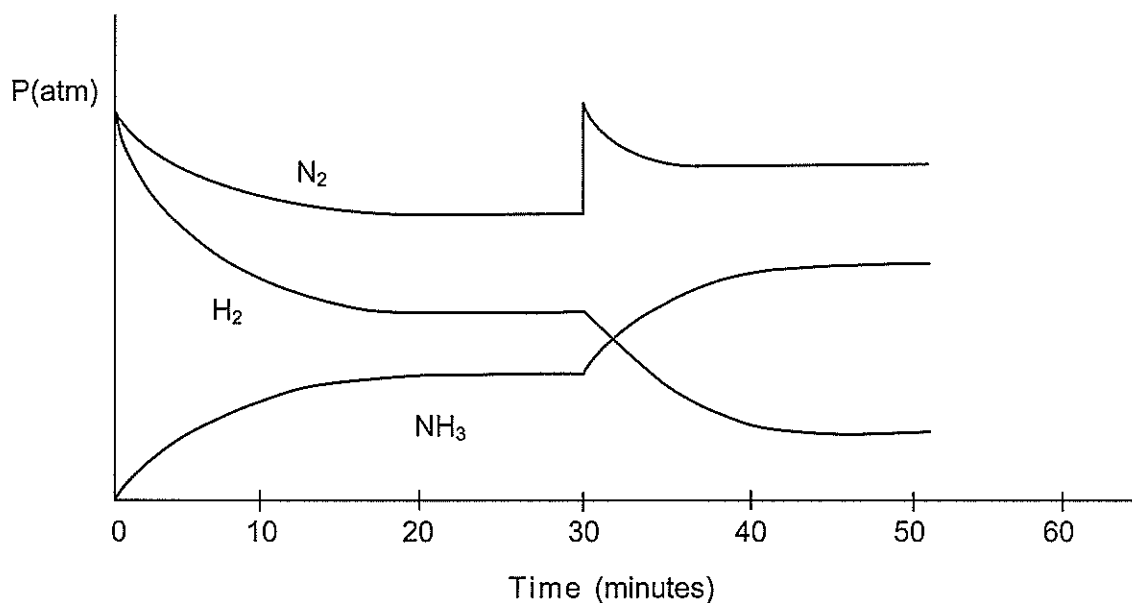
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5. Ammonia is an industrially important gas produced by the Haber process, as illustrated by the reaction below:



The reaction is catalysed by iron(III) oxide,  $\text{Fe}_2\text{O}_3$ .

The following graph shows the partial pressures of the three species involved in the reaction:



Answer the following questions about the above graph:

Why does the partial pressure of the  $\text{H}_2$  decrease more rapidly than that of the  $\text{N}_2$ ?

\_\_\_\_\_ [1 mark]

Why do the partial pressures of each of the three species stabilise between 20 and 30 minutes?

\_\_\_\_\_ [1 mark]

What has occurred at the 30-minute mark to cause the changes shown in the graph?

\_\_\_\_\_ [1 mark]

By the 40-minute mark, what difference will the change imposed at the 30-minute mark have made to the rate of:

the forward reaction? \_\_\_\_\_

the reverse reaction? \_\_\_\_\_

[2 marks]

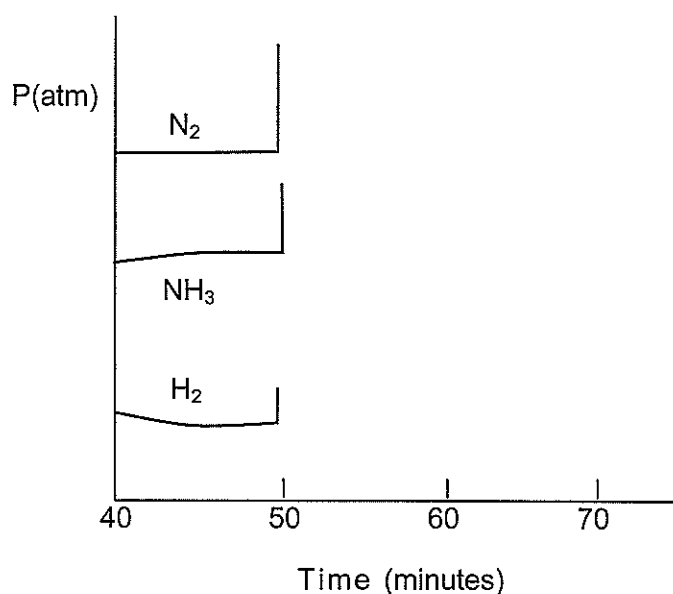
Using the Collision Theory, explain why the rate of forward reaction is affected by the imposed change at the 30-minute mark.

\_\_\_\_\_

\_\_\_\_\_

[2 marks]

At 50 minutes, the contents of the reaction vessel are rapidly compressed by reducing the volume. The changes in the partial pressures of the species are shown on the following graph, starting at 40 minutes.



Complete the above graph up to 70 minutes by showing how the partial pressures of each of the species change as a new equilibrium is achieved.

[3 marks]

6. An equilibrium is set up in a test tube by suspending some finely powdered copper sulfide in a dilute solution of hydrochloric acid. The equation for the equilibrium is:

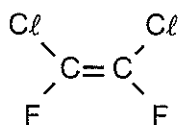


Complete the following table, giving your answers as "increases", "decreases" or "no change":

Change made to the equilibrium system	Effect on rate of forward reaction	Effect on equilibrium yield of $\text{Cu}^{2+}(aq)$
HCl(g) is passed into the solution		
CuSO <sub>4</sub> solution is added		
More finely powdered CuS is added		

[6 marks]

7. Below is the structural formula of a chlorofluorocarbon:



Draw and name the structures of TWO other isomers of this compound:

Structure:

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

Structure:

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

[4 marks]

8. Potassium peroxymonosulfate ( $\text{KHSO}_5$ ) is a powerful oxidising agent used as "Spa Shock" to oxidise organic wastes in spa baths and small swimming pools. The  $\text{HSO}_5^-$  ion is reduced to  $\text{HSO}_4^-$ .

Write a balanced half-equation for the reduction of  $\text{HSO}_5^-$  to  $\text{HSO}_4^-$ .

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[1 mark]

$\text{KHSO}_5$  can be used to oxidise propanol. Write the half-equation for the oxidation of propanol to propanoic acid:

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[2 marks]

Write the final overall redox equation for this reaction:

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[2 marks]

9. Some transition elements exhibit a range of oxidation states.

Give two examples of transition elements that do **not** normally show more than one oxidation state in their compounds:

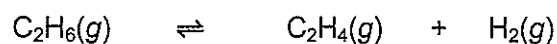
\_\_\_\_\_

Give two examples of elements that are not transition metals, but which do have more than one oxidation state in their compounds:

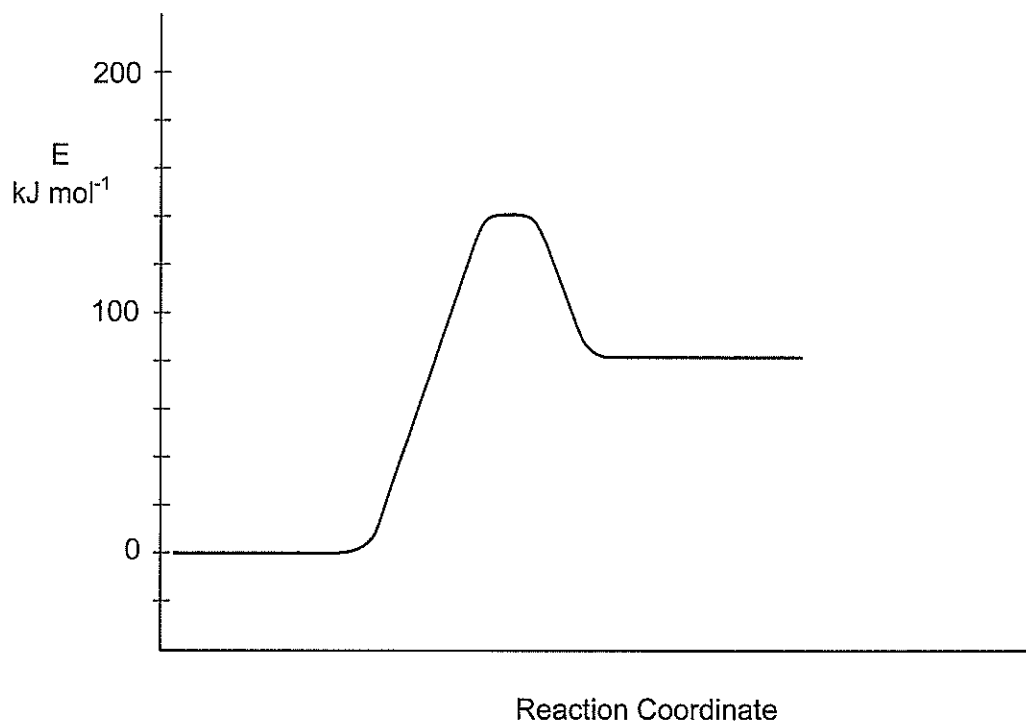
\_\_\_\_\_

[4 marks]

10. Ethene can be produced by heating ethane:



A potential energy diagram for the uncatalysed reaction is shown below:



Determine from this graph the value for the reaction of:

Activation energy: \_\_\_\_\_

$\Delta\text{H}$ : \_\_\_\_\_

[2 marks]

Using a dotted line, **draw on the above diagram** a possible potential energy diagram for the same reaction but in the presence of a catalyst.

[2 marks]

11. The first step in the manufacture of hydrochloric acid is the production of hydrogen chloride gas.

Write an equation for the industrial manufacture of hydrogen chloride gas.

\_\_\_\_\_ [1 mark]

The gas is mixed with water droplets to give hydrochloric acid. Explain why the gas is reacted with water droplets rather than bubbled through water.

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

[2 marks]

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Name two uses of hydrochloric acid.

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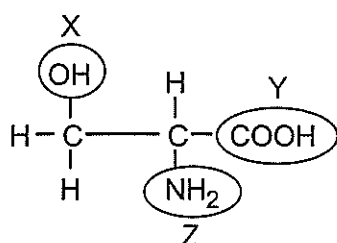
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[2 marks]

12. Serine, whose structure is shown below, is required for production of antibodies. It contains three functional groups labelled X, Y and Z in the structural formula below. Name the class of compounds associated with each of these functional groups



X \_\_\_\_\_

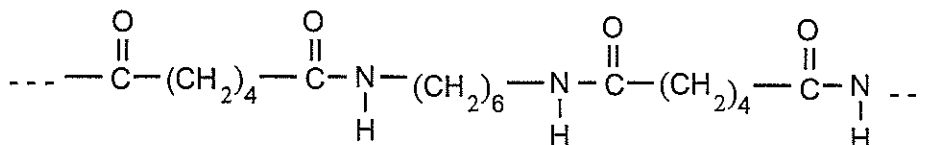
Y \_\_\_\_\_

Z \_\_\_\_\_

[3 marks]

13. The structure below shows part of the chain of a polymer:

In the boxes below, show the structures for each of the monomers used to form the polymer.



[2 marks]

To which class of polymer does this belong?

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[1 mark]

END OF SECTION 2

SEE NEXT PAGE











3. Ascorbic acid,  $C_6H_8O_6$ , is known as vitamin C. The vitamin C content in vitamin C tablets can be determined by adding a known excess volume of iodine solution to an aqueous solution of the vitamin C tablet. The remaining iodine can then be titrated with sodium thiosulfate ( $Na_2S_2O_3$ ).

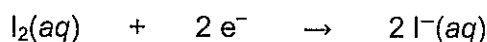
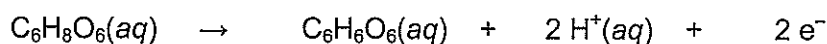
A researcher analysing the vitamin C in a particular brand of tablets carried out the following steps:

- (a) A 250 mg ( $2.50 \times 10^{-1}$  g) tablet was dissolved in 50.0 mL of water, and 100.0 mL of  $0.0521 \text{ mol L}^{-1}$   $I_2$  solution was added. This mixture was then made up to 250.0 mL with water in a volumetric flask.
- (b) 20.0 mL aliquots of the resulting solution were titrated with  $0.0493 \text{ mol L}^{-1}$  sodium thiosulfate solution ( $Na_2S_2O_3$ )

The following results were obtained:

Titration Results	Trials (mL)			
	1	2	3	4
Final Volume	15.27	15.92	14.28	15.67
Initial volume	0.42	1.96	0.50	1.75
Titre				

The relevant half-equations are:



- (a) Write and balance the equation for the reaction between iodine and thiosulfate ions.
- (b) Write a balanced equation for the reaction between ascorbic acid (vitamin C) and iodine.
- (c) Calculate the mass of vitamin C in the 250 mg tablet.
- (d) Calculate the percentage by mass of vitamin C in the tablet.

[11 marks]

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4. The mineral jarosite occurs widely in nature, and has recently been discovered on Mars. It is known to contain potassium, iron, sulfate and hydroxide ions.

A 3.00 g sample was dissolved with the aid of hydrochloric acid and made up to 250 mL with de-ionised water. The solution was labelled "stock solution". It was analysed for potassium and found to have a concentration of  $6.22 \times 10^{-2} \text{ mol L}^{-1}$ .

A 100 mL portion of the stock solution was treated with aluminium filings to ensure all iron was in the form of  $\text{Fe}^{2+}$ . Aliquots of 25.0 mL were titrated with  $0.0108 \text{ mol L}^{-1}$   $\text{KMnO}_4$ . The average titre was found to be 28.8 mL.

Another 100 mL portion of the stock solution was neutralised and treated with excess barium chloride. This produced 0.967 g of a white precipitate.

Calculate the empirical formula of jarosite.

[12 marks]

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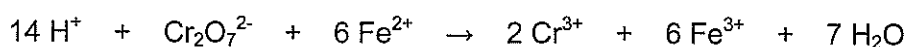
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5. Some soil was suspected to be contaminated with chromium. It was necessary to test whether the chromium level was below the maximum allowable limit of 0.300 ppm. As the soil was sandy and contained no appreciable amounts of elements which give insoluble hydroxides, other than chromium, the chromium could be dissolved under acidic conditions and then precipitated for gravimetric analysis as  $\text{Cr}(\text{OH})_3$ .

Before precipitation of  $\text{Cr}(\text{OH})_3$ , however, any chromium(VI) present must be reduced to chromium(III) using iron(II).

A 21.6 kg soil sample was agitated with an excess of  $0.00122 \text{ mol L}^{-1}$  iron(II) nitrate solution. A total of 2.00 L of iron(II) nitrate solution was used. The chromium(III) dissolves as  $\text{Cr}^{3+}$  and the chromium(VI), present as  $\text{Cr}_2\text{O}_7^{2-}$ , is converted to Cr(III) according to the equation:



- (a) How many moles of iron(II) were added to the soil?

The soil was filtered off, the resulting solution acidified, and air bubbled through so that oxygen from the air would convert the remaining iron(II) to iron(III).

- (b) How many moles of iron(III) will be in the solution after bubbling air?

Sodium hydroxide was added to bring the pH into the range 5.8 to 9.2. In this range all Cr(III) is precipitated as  $\text{Cr}(\text{OH})_3$ , and all iron(III) as  $\text{Fe}(\text{OH})_3$ . The precipitate was dried and the total mass was found to be 2.67 g.

- (c) How many moles of  $\text{Fe}(\text{OH})_3$  were precipitated?
- (d) What mass of  $\text{Fe}(\text{OH})_3$  was included in the dried precipitate?
- (e) What was the mass of  $\text{Cr}(\text{OH})_3$  in the precipitate?
- (f) What mass of Cr was in the 21.6 kg of soil?
- (g) What was the concentration, in ppm, of chromium in the soil?

[9 marks]

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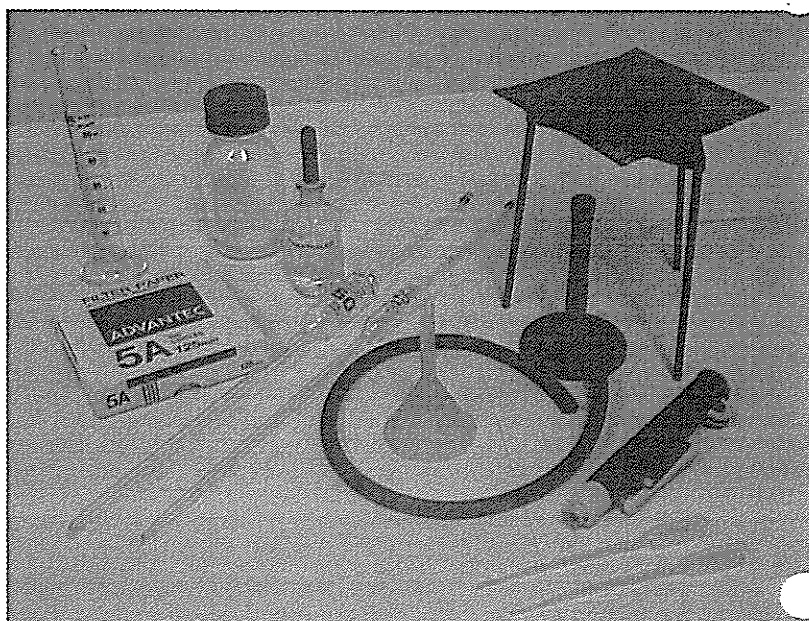
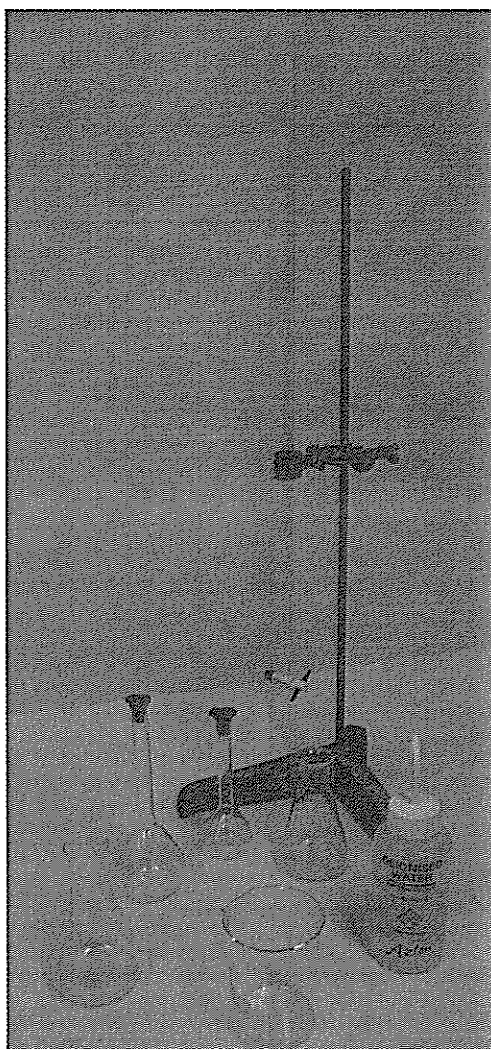


**PART 4 (20 Marks)**

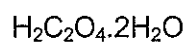
Answer the following question. Marks are awarded for the relevant chemical content of your answer, and also for coherence and clarity of expression. Where applicable, use equations, diagrams and illustrative examples of the chemistry you are describing.

Your answers should be presented in about 1½–2 pages. Begin your essay on the lined page following the end of the questions.

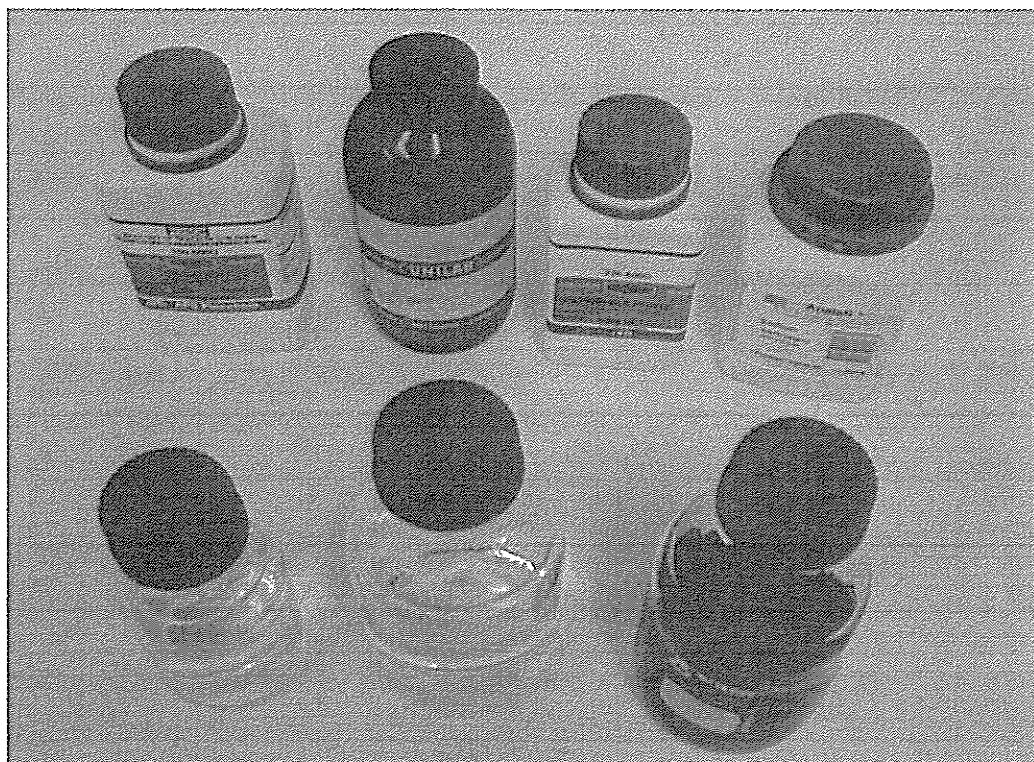
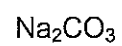
An engineer wishes to find the percentage of iron in a mild steel sample. Your laboratory has the equipment and chemicals shown in the photographs (and an analytical balance which is not shown). In your answer you may select whichever of these items you consider necessary. Describe in detail the procedure you would use to find the percentage of iron, briefly explaining your reasoning for each step. You should include in your answer any relevant chemical equations. Discuss sources of error in the measurement, and describe how you would minimise these errors. You are NOT required to give an example of the calculations involved in this analysis.



Oxalic Acid Dihydrate

 $\text{KMnO}_4$  $\text{FeSO}_4$ 

Anhydrous

2 M  $\text{H}_2\text{SO}_4$ approx. 0.05 M  $\text{FeSO}_4$ approx. 0.02 M  $\text{KMnO}_4$ **END OF QUESTIONS**

*Check that you have written your Student Number on the front cover of this booklet*



Lined paper for notes, consisting of 20 horizontal lines.

Lined writing area consisting of 20 horizontal lines.













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