Student No. SOLUTIONS

Barker College

2006
YEAR 12
EXAMINATION TERM 1

Chemistry

ANSWER SHEET

Staff Involved:

PM THURSDAY 6 APRIL

- TER* MIC & Q16+17 (p8-10) 12marks
- ASH Q 18-19 (p 11+12) 12marks
- KHW Q 25, 26, 27 (p. 18-22) 17marks
- RZS Q 22, 23, 24 (p 15-17) 12 marks
- RJP Q 20, 21 (P13-14) 12marks.

110 copies

Section I – Multiple Choice

Choose the best response and fill in the response oval completely

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

Barker College

2006
YEAR 12 EXAMINATION TERM 1

Chemistry

PM THURSDAY 6 APRIL

Staff Involved:

- **TER***
- **ASH**
- **KHW**
- **RZS**
- **RJP**

110 copies

General Instructions

- **Reading time – 5 minutes**
- **Working time – 2 hours**
- **Write using blue or black pen**
- **Board-approved calculators may be used**
- **Draw diagrams using pencil**
- **A Data Sheet and Periodic Table are provided at the back of this paper**
- **Write your Barker Student Number at the top of the answer sheet and at the top of ALL answer pages in Section II**
- **ALL working or relevant equation writing must be shown in Questions 16 – 28**

Total marks – 80

Section I Pages 2 – 7

15 marks
- Attempt Questions 1 – 15
- Indicate all answers on the Answer Sheet provided
- Allow about 25 minutes for this part

Section II Pages 8 – 23

65 marks
- Attempt ALL questions
- Indicate all answers in the spaces provided on paper
- Allow about 1 hour 30 minutes for this section

Section I

15 marks

Attempt Questions 1–15
Allow about 25 minutes for this section

Use the multiple-choice answer sheet

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 this by writing the word *correct* and drawing an arrow as follows.

correct ←

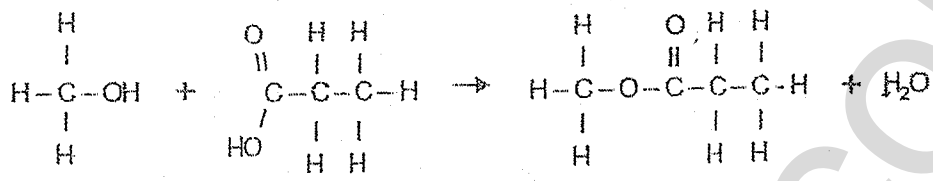
(A) ⊗ (B) ⊗ (C) ○ (D) ○

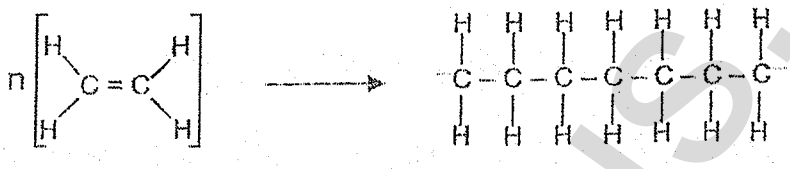
1. Which of the following is a systematic name for styrene?

(A) Ethenylbenzene
(B) Choroethene
(C) Benzylethene
(D) Chlorobenzene

Text book p.16

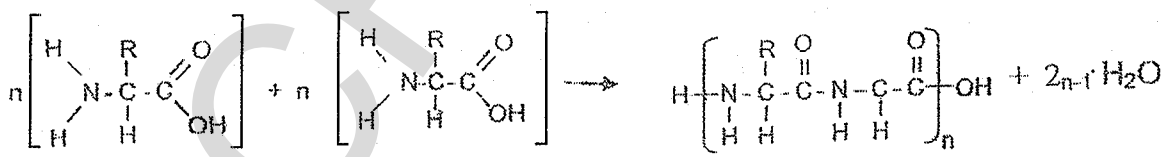
2. Which of the following is a condensation **polymerisation** reaction?

(A) 

(B) 

Text p 18

(C) $2C_6H_{12}O_6 \longrightarrow C_{12}H_{22}O_{11} + H_2O$

(D) 

3. What is the best reason that ethene can be transformed easily into many useful products?

(A) Ethene is a gas composed of non-polar molecules.
(B) Ethene has a highly reactive double bond.
(C) Ethene is 86% carbon by mass.
(D) Ethene can be produced by catalytic cracking.

4. The table gives the heat of combustion in $kJ.g^{-1}$ for a number of different fuels.

Fuel	Heat of combustion ($kJ.g^{-1}$)
Methanol 32	22.7 -726.4
Ethanol 46	29.6 1361.6
Propanol 60	33.6 2016
Petrol (octane) 104	47.8

The heat of combustion in $kJ\ mol^{-1}$ for one of the fuels was calculated as 2016 $kJ\ mol^{-1}$.

What was the fuel?

(A) Methanol

(B) Ethanol

(C) Propanol

(D) Petrol

5. What substance may ethanol be dehydrated to?

(A) Ethylene

(B) Ethanolic acid

(C) Ethyne

(D) Ethyl ethanoate

Text p 25.

6. The boiling points of three compounds are:

Compound A: 78.3°C
Compound B: –88.6°C
Compound C: 117.9°C

Text p 144

The compounds are known to be, in no particular order, ethane, ethanoic acid and ethanol.

Which of the following correctly identifies compounds A, B and C in that order?

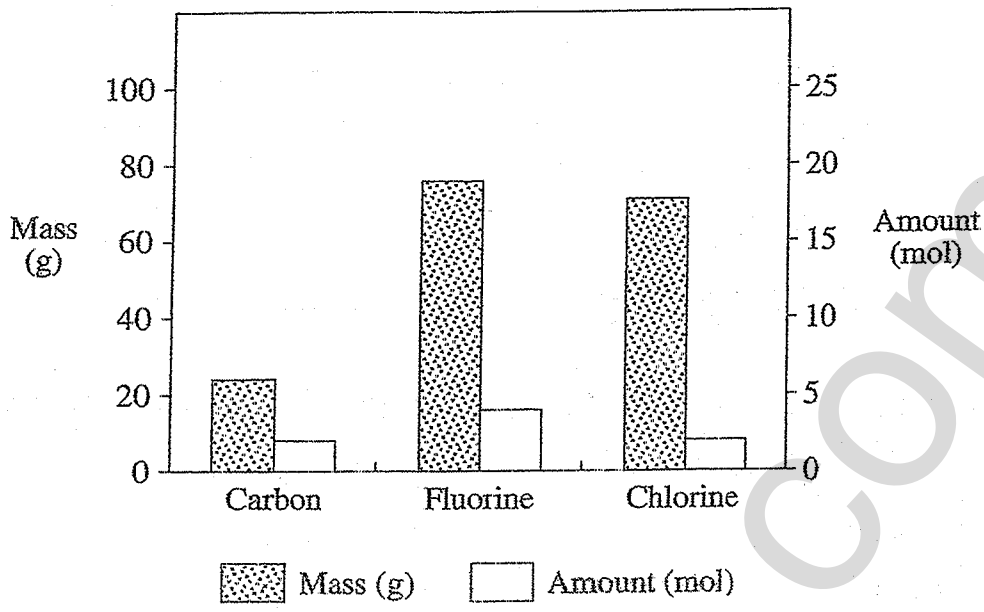
(A) Ethane, ethanol, ethanoic acid.

(B) Ethanoic acid, ethane, ethanol.

(C) Ethanoic acid, ethanol, ethane.

(D) Ethanol, ethane, ethanoic acid.

7. The graph shows the mass and amount of carbon, fluorine and chlorine atoms in one mole of a compound.



What is the molecular formula for this compound?

(A) CF_2Cl

(B) CF_2Cl_2

(C) $C_2F_3Cl_3$

(D) $C_2F_4Cl_2$

8. The table below shows some properties of four commonly used radioisotopes.

Name of isotope	Half-life	Ionising power
Technetium-99	hours	low
Cobalt-60	years	high
Carbon-14	thousands of years	low
Uranium-238	millions of years	moderate

Which of these isotopes would be most suitable for **killing** cancerous cells in radiotherapy?

(A) Technetium-99

(B) Cobalt-60

(C) Carbon-14

(D) Uranium-238

9. Phenol red is an acid-base indicator, yellow 6.8 – red 8.4.
Methyl orange indicator, red 3.1 – yellow 4.4.

A small quantity of soil was added to 5 mL of pure water, stirred for 5 minutes, allowed to settle and filtered. When one sample of the filtrate was tested with phenol red, the colour turned yellow. When another sample was tested with methyl orange, the colour turned yellow.

What is the best conclusion about the soil?

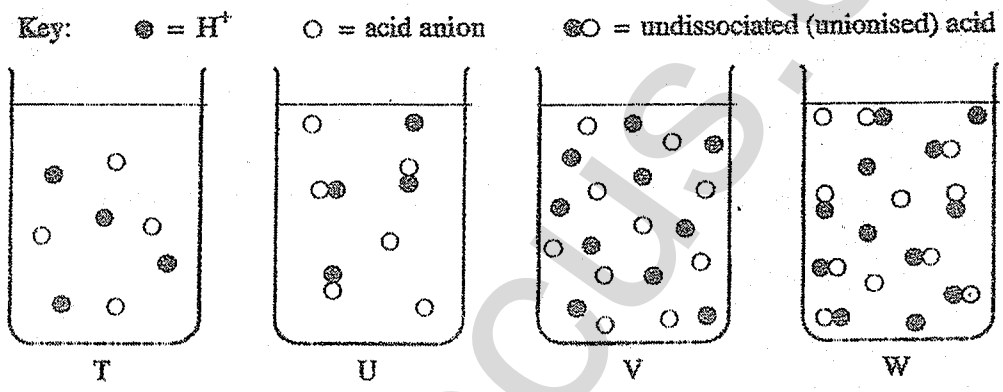
(A) That it is slightly acidic and has a pH less than 8.4.

best → (B) That it is slightly acidic and has a pH less than 6.8.

(C) That it is slightly alkaline and has a pH less than 6.8.

(D) That it is very acidic and has a pH less than 4.4.

10. The following diagrams represent samples of four acids.



Which beaker can best be described as containing a sample of dilute, strong acid?

(A) T

(B) U

(C) V

(D) W

11. The Haber Process is used to synthesise ammonia in the following exothermic reaction.

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)} + \text{heat}$$

Which of the following procedures would increase the equilibrium yield of ammonia?

(A) Decrease both the temperature and pressure.

(B) Decrease the temperature and increase the pressure.

(C) Decrease the pressure and increase the temperature.

(D) Increase both the temperature and the pressure.

12. Which of the following best describes a solution with a pH of 5? $[H^+] = 10^{-5}$

(A) Contains $[H^+]$ of concentration 10^{-5}M.
(B) More acidic than a substance with a pH of 4.
(C) Basic
(D) Contains an equal concentration of hydroxide and hydronium ions.

13. The pH of unpolluted rainwater is about 6.0. Which of these gases contributes most to this?

(A) CO_2
(B) N_2
(C) NO_2
(D) O_3

.0095 mol HCl .01 mol NaOH

14. 0.40 g of sodium hydroxide was weighed and dissolved in 15.0 mL of water in a conical flask. The solution was then titrated with 0.50 M hydrochloric acid. The endpoint was detected when 19.0 mL of acid has been added. The value of 19.0 mL was less than the expected 20.0 mL. This difference could be explained if:

(A) the burette had been rinsed with water prior to adding the hydrochloric acid solution
(B) the equivalence point was reached before the endpoint
(C) the sodium hydroxide solution had been left exposed to the air for a long period of time before the titration was performed
(D) the conical flask contained 25.0 mL of water instead of 15.0 mL

15. A student prepares four solutions of acids, such that they are all of the same pH (pH = 6.0). Which of the following solutions is the most dilute?

(A) Hydrochloric acid
(B) Ethanoic acid
(C) Citric acid
(D) Carbonic acid

Student No. .....

Section II – 65 marks
Attempt ALL questions
Allow about 1 hour 30 minutes for this section

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

Marks

Question 16 (5 marks)

Polyethylene (polyethene) is a very important chemical in today's society.

(a) Outline the **THREE** main steps in the commercial production of polyethylene. Text p 15-17 3

Initiation - Excess ethylene monomers are combined with an organoperoxide initiator + a catalyst. The double bonds break and a free radical site occurs in each monome (1)

Propogation - The free radical sites on the monomers enable the monomers to join together making long chains. Catalysts, temp + pressure control structure of the chains (1)

Termination - An inhibitor is added to stop the reaction. The free radical sites are joined together or completed with another free radical and the chain building stops. (1)

(1/2) for naming stages (1/2) description

(b) By altering the conditions under which polyethylene is produced, two different polymers can be produced, LDPE and HDPE.

Compare the uses of LDPE and HDPE, relating to their physical properties. 2

LDPE - low density, soft (1/2) + flexible - used for plastic film, soft flexible bags + toys, squeezable bottles (1/2)

HDPE - high density (1/2), tough + rigid - used for tough rigid containers like milk crates, plastic caps, hard toys, utensils (1/2)

(1/2) properties

(1/2) uses

Student No. .....

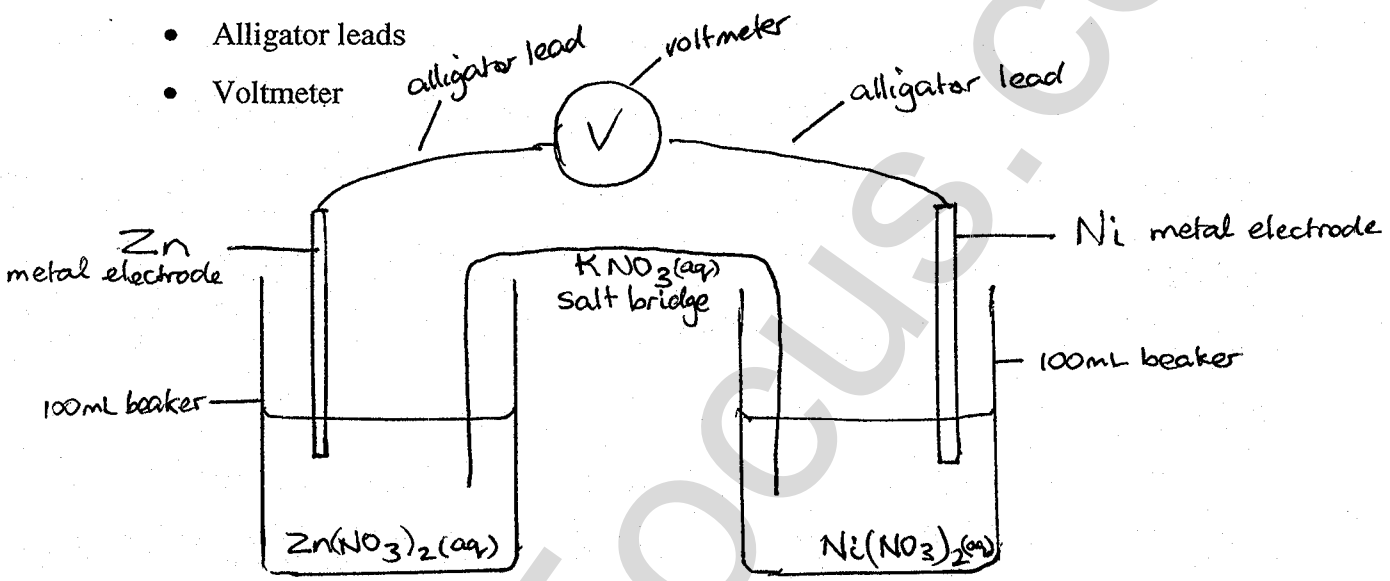
Marks

Question 17 (8 marks)

(a) Using the standard electrode potentials on your data sheet and equipment from the list below, construct a fully labelled scientific diagram of a galvanic cell. **3**

Equipment:

- Zinc metal, nickel metal
- Zinc nitrate solution, nickel nitrate solution, potassium nitrate solution
- Filter paper
- 2 x 100 mL beakers
- Alligator leads
- Voltmeter



½ each, metal electrodes . . . . . (1)

½ each, correct solutions in each beaker . . . . . (1)

½ salt bridge in right place with KNO_3 . . . . (½)

½ for voltmeter and leads in right place . . . . (½)

Take off ½ mark if so messy interpretation has been difficult.

Question 17 continues on page 10

It can be drawn with Zn & Ni the other way around.

Student No. .....

Marks

Question 17 (continued)

has to be all correct

(b) Write the reduction half-equation. **0.5**

$Ni^{2+}_{(aq)} + 2\bar{e} \rightarrow Ni_{(s)}$

(c) Write the oxidation half-equation. **0.5**

$Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2\bar{e}$

(d) Write the overall redox equation. **0.5**

$Zn_{(s)} + Ni^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + Ni_{(s)}$

* Take off ½ only once for lack of states.

(e) Calculate the standard e.m.f. of the cell. Show working. **1.5**

(Oxidⁿ $Zn \rightarrow Zn^{2+} + 2\bar{e}$) $E^\circ = 0.76V$ (½)

(Reductⁿ $Ni^{2+} + 2\bar{e} \rightarrow Ni$) $E^\circ = -0.24V$ (½)

Total emf $= 0.52\ V$ (½)

(f) In the laboratory, you would not obtain a voltage close to the standard e.m.f. as calculated in part (e). State **ONE** possible reason for this. **1**

The solutions were not the standard concentration of 1M (1)

OR The temperature was not the standard 25°C

End of Question 17

Student No. .....

Marks

Question 18 (5 marks)

Over the past 100 years, there has been an enormous increase in the amount of fossil fuel used. As supplies of these are finite, a suitable alternative must be found.

(a) Explain why ethanol can be regarded as both a fuel and as a renewable resource. 2

Burns in air (½) to produce energy (½) ($C_2H_6O + 3O_2 \rightarrow 2CO_2 + 3H_2O$ + heat)
If it is produced by fermenting sugars (½) from renewable crops like sugar cane, (½) ($C_6H_{12}O_6 \xrightarrow{\text{yeast}} 2C_2H_6O + 2CO_2$),
it is a renewable resource

(b) Evaluate the conversion of starch (or glucose or sucrose) to ethanol as a source of ethanol. MAKE A JUDGEMENT BASED ON CRITERIA. 3

If ethanol is produced by fermenting starch (waste biomass) then

(1) it has the following advantages – renewable, energy efficient
if completely solar powered, CO_2 neutral ie CO_2 used to make the plant is released when the ethanol burns.

(1) However, there are many disadvantages – large tracts of land are used up to grow the biomass, accompanied by soil erosion, deforestation, fertiliser run-off, salinity, disposal of large amounts of smelly waste; the process is not completely solar-powered so high energy use from non-renewable sources, use of fossil fuel energy means it is also not CO_2 neutral when burnt, and it is expensive.

Evaluation (1) At present, the disadvantages of producing ethanol from fermenting starch rather than from ethene outweigh the advantages. When fossil fuel energy can be eliminated from the process and land degradation from the cropping reduced, then ethanol from starch would be a good alternative.

Student No. .....

Marks

Question 19 (7 marks)

(a) During your HSC course you have performed an experiment to compare the reactivities of an alkene and an alkane.

Outline how you conducted this experiment in your school laboratory using a named alkene and a named alkane. **2**

1. Br_2 water, which is orange, was added to a test tube containing 2mL cyclohexene and a test tube of cyclohexane. (2mL) (1)

2. The test tubes were stoppered and shaken. (½)

3. Colour changes were observed immediately, and after 10-20 minutes. (½)

(If test tubes in dark + test tubes in light are used, the answer to (c) will have to be marked accordingly)

(b) In this experiment, you were required to select an appropriate alkene and alkane based on safety information. Justify your choice. **1**

Cyclohexane is classed as not-hazardous if used in small (2mL) amounts, with good ventillation and protective clothing. Cyclohexene, as with all the similar MW alkenes, is hazardous but able to be used with caution and in small amounts (2mL) Both are liquids at room temperature so easily handled.

(c) Summarise your results from this experiment and include relevant chemical equations to explain your observations. **4**

Cyclohexene immediately decolourised Br_2-water (1)

$C_6H_{10(l)} + Br_{2(aq)} \rightarrow C_6H_{10}Br_{2(l)}$ (1)

(colourless orange colourless)

(cyclohexene bromine water 1,2-dibromocyclohexane)

Cyclohexane only decolourised the Br_2 water after lengthy exposure to U.V. light (1)

$C_6H_{12(l)} + Br_{2(aq)} \xrightarrow{\text{U.V. light}} C_6H_{11}Br_{(l)} + HBr_{(aq)}$ (1)

(colourless orange colourless colourless)

(cyclohexane bromine water bromocyclohexane hydrogen bromide)

Must include colours in description or equations
equations
U.V. light for cyclohexane

May - use structural formula
- compare test tubes in dark + light.

Student No. .....

Marks

Question 20 (5 marks)

Since Luigi Galvani undertook his famous experiments into "animal electricity" there have been great advances in our ability to harness electrochemical energy in the form of batteries.

Using your knowledge of the dry cell or lead-acid cell, evaluate it in comparison to one of the following:

- button cell
- fuel cell
- vanadium redox cell
- lithium cell
- Gratzel cell

in terms of: chemistry, cost/practicality, impact on society, environmental impact. **5**

Properties	Dry cell / lead acid	
Chemistry SEE ATTACHED TABLE		(1)
Cost/Practicality MARKING WILL DEPEND		(1)
Impact on society ON WHAT KIDS USE.		(1)
Environmental impact		(1)

Evaluation: A ..... would be a good choice for ..... and a ..... would better suit ..... (1)

Student No. .....

Marks

Question 21 (7 marks)

(a) Describe why some isotopes are stable and others are unstable. **1**

Isotopes with $Z < 83$ and a proton:neutron ratio within the zone of stability are stable. Those with $Z > 83$ and p:n outside the zone of stability are unstable. (Must mention the $Z \gtrless 83$ + p:n ratio)

(b) Write an equation to represent the alpha decay of Thorium-230. **1**

$^{230}_{90}Th \longrightarrow {}^{4}_{2}He + {}^{226}_{88}Ra$ (must be completely correct)

(c) The Lucas Heights nuclear reactor in Sydney currently produces radioisotopes for use in a range of medical treatments and diagnoses.

identify components, relationships between → implications

Using your knowledge of a named medical radioisotope, analyse the benefits and problems associated with its use. **5**

Answers must include name (½) primary use (½)

Benefits must give details – (2)

Problems must be consistent with details of benefits (2)

The benefits & problems must be discussed so that relationships between them and implications for safe use are specified.

The following model answer is based on their Text Book pp 64–65.

Name: F-18, C-11, N-13, O-15 Use: Positron Emission Tomography

Benefits: PET scanning involves the injection of a short lived radioisotopes into the bloodstream. As the blood passes through the body images are made and used for diagnosis of tumours, or brain disorders. Because the radioisotope attaches specifically to different molecules, the image picks up abnormalities where the tagged molecules accumulate. Hence diagnosis occurs quickly without invasive surgery in parts of the body like the brain that could be permanently damaged.

Problems A short lived radioisotope (ie very short half-life) must be used so that dangerous radioactivity is removed from the body quickly. Associated radiation can damage healthy tissue so the isotopes must be carefully chosen & eliminated from the body quickly. The isotopes have to be produced close to the hospital & production & use must be carried out with sufficient safeguards so workers & residents nearby are protected.

Student No. .....

Marks

Question 22 (4 marks)

(a) Recent evidence suggests that there has been an increase in atmospheric concentrations of oxides of sulfur and nitrogen due to industrial plants and vehicle emissions through the burning of fossil fuels.

Explain, including relevant equations, how this may be contributing to the formation of acid rain. **2**

Burning Fossil Fuels. $S + O_2 \rightarrow SO_2$ and $2SO_2 + O_2 \rightarrow 2SO_3$ (1)

When dissolved in rain $SO_2 + H_2O \rightarrow H_2SO_3$ (sulfurous acid)

and $SO_3 + H_2O \rightarrow H_2SO_4$ (sulfuric acid) } (1)

While rain is normally acidic due to $[CO_2]$, the pH falls even lower with H_2SO_4

(b) Outline reasons for concern about the release of these oxides with respect to the environment. **2**

The reasons that concerns are justified are –

1. pH of lakes & streams in Europe & North America has decreased in recent times, reducing fish populations & killing invertebrates. (1)

2. In areas of Europe & US where SO_2 & NO_x emissions have been high, large tracts of forest have been destroyed or damaged (1)

OR $N_2 + O_2 \rightarrow 2NO$ and $2NO + O_2 \rightarrow 2NO_2$ (1)

$2NO_2 + H_2O \rightarrow HNO_3 + HNO_2$ (1)

nitric acid, nitrous acid

Student No. .....

Marks

Question 23 (4 marks)

When carbon dioxide dissolves in water the following equilibrium process occurs.

$$CO_{2(g)} + H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)} + \text{heat}$$

Explain, in terms of Le Chatelier's Principle, what happens:

(i) to the solubility of carbon dioxide in a soft drink bottle if the pressure decreases (i.e. when the lid is opened). 2

(1) Le Chatelier's Principle says that when an equilibrium is disturbed it will adjust itself to minimise the disturbance. When the lid is

(1) opened the equilibrium shifts to the (½) left as written above because $[CO_{2(g)}]$ has been reduced, so $CO_{2(aq)}$ comes out of solution to replenish the $CO_{2(g)}$. (½)

(ii) when a bottle of soft drink is heated. 2

The equilibrium shifts to the (1) left, using up the extra heat, so more $CO_{2(g)}$ is produced. (1) By this happening the affect of the addition of heat is minimised, according to Le Chateliers principle

Le Chateliers principle should be stated completely at least once.

(i) Can also be answered as number of gas particles.

$CO_{2(g)} + H_2O \rightleftharpoons H_2CO_{3(aq)}$

1 mole gas → 0 moles gas.

∴ When gas removed from left, reaction shifts left.

Student No. .....

Marks

Question 24 (4 marks)

A student places 2.4 g of magnesium into a beaker containing 4M nitric acid. They observed that the acid fizzed vigorously until the magnesium had disappeared and a colourless liquid remained.

(a) Write a balanced symbol equation for this reaction. **1**

$Mg_{(s)} + HNO_{3(aq)} \longrightarrow Mg(NO_3)_{2(aq)} + H_{2(g)}$

(b) Calculate the number of moles of Magnesium that reacted, showing ALL working. **1**

$n_{Mg} = \frac{2.4\ g}{24.3\ g mol^{-1}}$ (½)

$= 0.1\ mol$ (½)

(c) Assuming that this reaction was carried out at 25°C and 100 kPa, calculate the volume of gas produced. **2**

$n_{H_2} = n_{Mg}$ from the equation in (a) (½)

$V_{H_2} = n_{H_2} \times V_{25°C}$

$= 0.1\ mol \times 24.79\ L\ mol^{-1}$ (½)

$= 2.479\ L$ (½)

$= 2.5\ L$ to correct sig. fig. (½)

Student No. .....

Marks

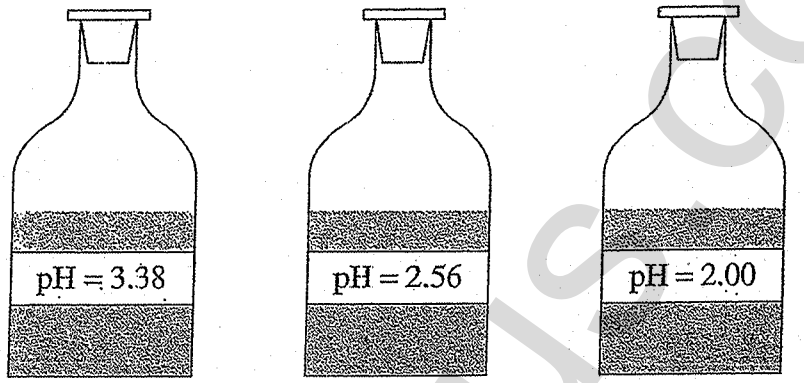
Question 25 (8 marks)

(a) Calculate the pH of 0.0060 M hydrochloric acid. **1**

$pH = -\log(6.0 \times 10^{-3})$

$= 2.2$ (1)

(b) The diagram shows three reagent bottles containing acids.



0.01 mol L^{-1} Acetic acid | 0.01 mol L^{-1} Citric acid | 0.01 mol L^{-1} Hydrochloric acid

Explain why the pH of these acids are different, even though they have the same concentrations. Include suitable equations for acetic acid and hydrochloric acid to assist your explanation. **3**

Acetic acid and citric acid are weak acids that are only partially ionised (½) $[H_3O^+] < [CH_3COOH]$ ie $< 0.01 mol L^{-1}$ + pH > 2 (½) eg $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$ (½)

Hydrochloric acid is a strong acid, that is fully ionised (½) $HCl + H_2O \rightarrow H_3O^+ + Cl^-$ (½)

and $[H_3O^+] = [HCl]$ $= 0.01$ M and pH = 2 (½)

Marks can be given if the answer is expressed differently so long as the full explanation is logically followed through.

Question 25 continues on page 19

Student No. .....

Marks

Question 25 (continued)

(c) Define the term *amphiprotic*. **1**

The amphiprotic substance can donate a proton or accept a proton. (It is a B-L acid or a B-L base)

(d) Write **TWO** chemical equations to show that the dihydrogen phosphate ion $(H_2PO_4^-)$ is amphiprotic. Identify a conjugate acid/base pair in one of your equations. **3**

$H_2PO_4^- + OH^- \rightleftharpoons HPO_4^{2-} + H_2O$ (1)

B-L acid B-L base conjugate base conjugate acid

conjugate pair

$H_2PO_4^- + H_3O^+ \rightleftharpoons H_3PO_4 + H_2O$ (1)

B-L base B-L acid conjugate acid conjugate base

conjugate pair (1)

End of Question 25

Conjugate pairs

$H_2PO_4^-/HPO_4^{2-}$

OH^-/H_2O

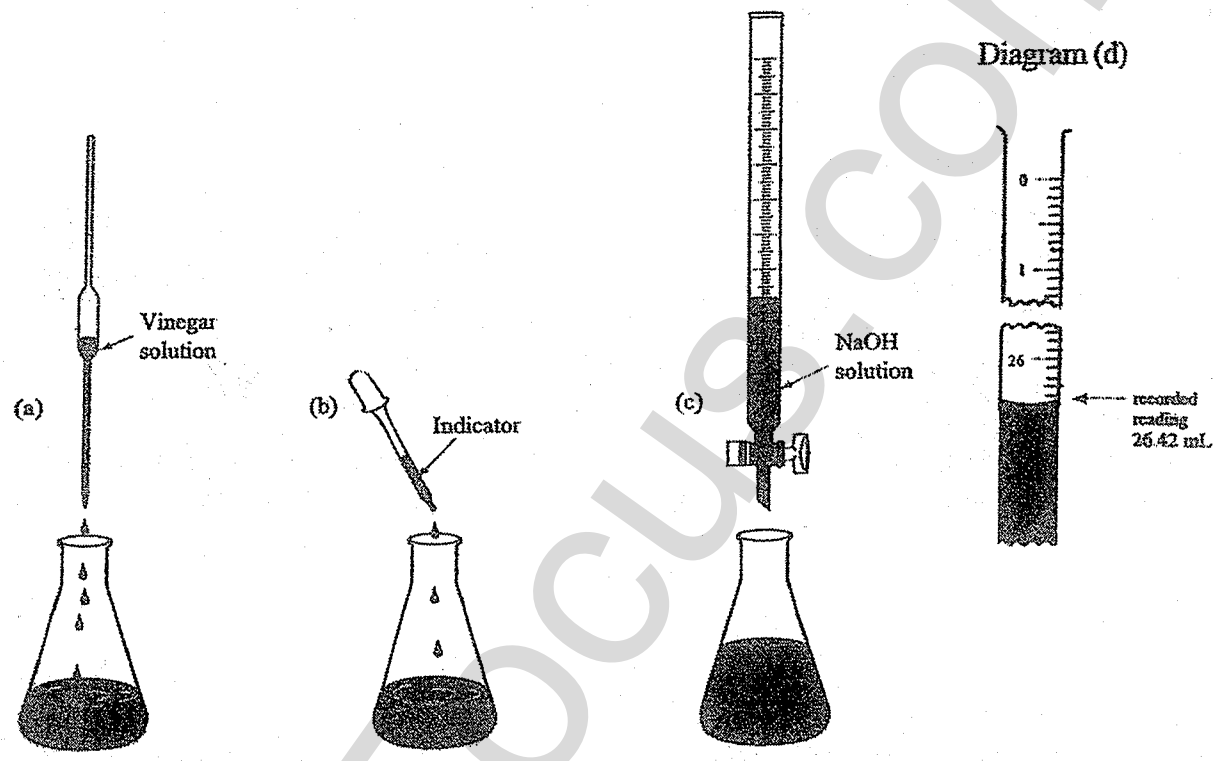
$H_2PO_4^-/H_3PO_4$

H_3O^+/H_2O

Question 26 (7 marks)

A student determines the ethanoic acid content in white vinegar by titration with a standard NaOH solution. The equation for the reaction is:

$$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$$



The following procedure was used:

Step 1: Wash burette with distilled water then fill the burette with 0.100 M NaOH and record the volume

Step 2: Wash a 20 mL pipette with distilled water and then fill with the vinegar solution and allow to run into the conical flask.

Step 3: Add five drops of the indicator phenolphthalein to the conical flask.

Step 4: Titrate the vinegar solution till the endpoint is reached. Record the volume as shown in diagram (d).

Question 26 continues on page 21

Student No. .....

Marks

Question 26 (continued)

(a) Unfortunately, the student made a number of mistakes.

State **ONE** mistake made in:

(i) Step 1: Rinsing with distiled water

(ii) Step 2: Rinsing with distilled water **2**

(b) The student then correctly repeats the titration three times. The experimental results for the three titrations are:

Titration Number	1	2	3
Final Reading (mL)	22.48	22.55	22.43
Initial Reading (mL)	0.05	0.05	0.06
Titre (mL)	22.43	22.50	22.37

43
37
50
3 | 130
438

(i) Calculate the appropriate values of NaOH required for the titration by filling in the table above, and then calculate the average titre of the titration. **1**

22.43 mL

.....

.....

(ii) From the titration, determine the number of moles of ethanoic acid in a 20 mL sample of vinegar. **2**

$n_{CH_3COOH} = n_{NaOH} = 22.4 \times 10^{-3}\ L \times 0.100\ mol\ L^{-1}$ (1)

$= 2.24 \times 10^{-3}\ mol$ (1)

(iii) Calculate the concentration of CH_3COOH in the 20 mL sample of vinegar in moles per litre. **2**

$C_{CH_3COOH} = \frac{2.24 \times 10^{-3}\ mol}{0.020\ L}$ (1)

$= 0.112\ mol\ L^{-1}$ (1)

Student No. .....

Marks

Question 27 (2 marks)

(a) Identify the products formed when propanoic acid and butanol are refluxed with acid catalyst. **1**

butyl propanoate (½) and water (½)

(b) State **ONE** advantage of using reflux to prepare the ester. **1**

The reactants and products are volatile. The reflux condenser catches them, condenses them and returns them to the flask so they are not lost.

End of Paper

DATA SHEET

Avogadro constant, N_A ..... 6.022×10^{23} mol^{-1}

Volume of 1 mole ideal gas: at 100 kPa and

at 0°C (273.15 K) ..... 22.71 L

at 25°C (298.15 K) ..... 24.79 L

Ionisation constant for water at 25°C (298.15 K), K_w ..... 1.0×10^{-14}

Specific heat capacity of water ..... 4.18×10^3 J kg^{-1} K^{-1}

Some useful formulae

$$pH = -\log_{10}[H^+] \qquad \Delta H = -mC\Delta T$$

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2.94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2.91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2.87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2.71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2.36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1.68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1.18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0.83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0.76 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0.44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0.24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0.14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0.13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0.00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0.16 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0.34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0.40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0.52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0.54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0.62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0.80 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1.08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1.10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1.36 V
$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2}H_2O$	1.36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1.40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1.51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2.89 V

Aylward and Findlay, *SI Chemical Data* (5th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	Symbol of element	Name of element
79	Au	Gold
Atomic Weight	197.0	

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.41 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [97.91] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanides	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po [209.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223.0] Francium	88 Ra [226.0] Radium	89–103 Actinides	104 Rf [261.1] Rutherfordium	105 Db [262.1] Dubnium	106 Sg [266.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

Lanthanides

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [144.9] Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinides

89 Ac [227.0] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237.0] Neptunium	94 Pu [244.1] Plutonium	95 Am [243.1] Americium	96 Cm [247.1] Curium	97 Bk [247.1] Berkelium	98 Cf [251.1] Californium	99 Es [252.1] Einsteinium	100 Fm [257.1] Fermium	101 Md [258.1] Mendelevium	102 No [259.1] Nobelium	103 Lr [262.1] Lawrencium

Where the atomic weight is not known, the relative atomic mass of the most common radioactive isotope is shown in brackets.
The atomic weights of Np and Tc are given for the isotopes ^{237}Np and ^{99}Tc.