

Student No.



Barker College

2006
YEAR 12
EXAMINATION TERM 1

Chemistry

ANSWER SHEET

Staff Involved:

PM THURSDAY 6 APRIL

- TER*
- ASH
- KHW
- RZS
- RJP

110 copies

Section I – Multiple Choice

Choose the best response and fill in the response oval completely

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



Barker College

**2006
YEAR 12
EXAMINATION
TERM 1**

Chemistry

Staff Involved:

- TER*
- ASH
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PM THURSDAY 6 APRIL

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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 – 22

65 marks

- Attempt Questions 16 – 27
- 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.

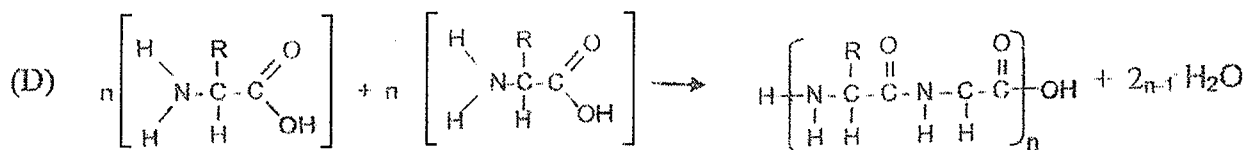
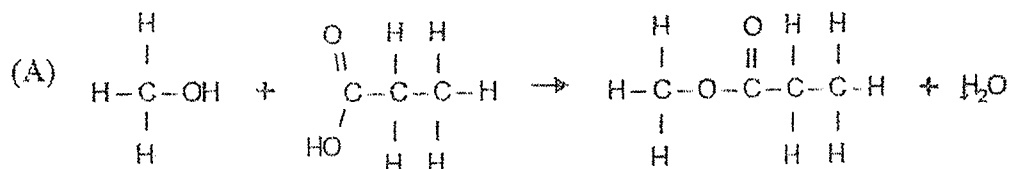
(A) ☒ (B) ☒ (C) ☐ (D) ☐

correct
↙

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

- (A) Ethenylbenzene
- (B) Chloroethene
- (C) Benzylethene
- (D) Chlorobenzene

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



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	22.7
Ethanol	29.6
Propanol	33.6
Petrol (octane)	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) Ethanoic acid
 - (C) Ethyne
 - (D) Ethyl ethanoate
6. The boiling points of three compounds are:

Compound A: 78.3°C

Compound B: -88.6°C

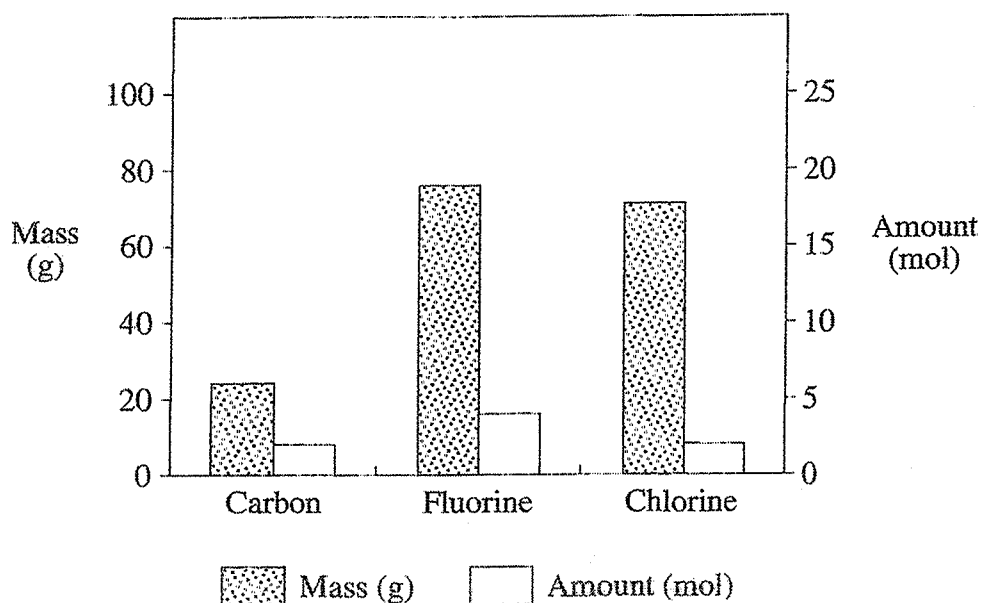
Compound C: 117.9°C

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) $\text{C}_2\text{F}_3\text{Cl}_3$
 (D) $\text{C}_2\text{F}_4\text{Cl}_2$
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?

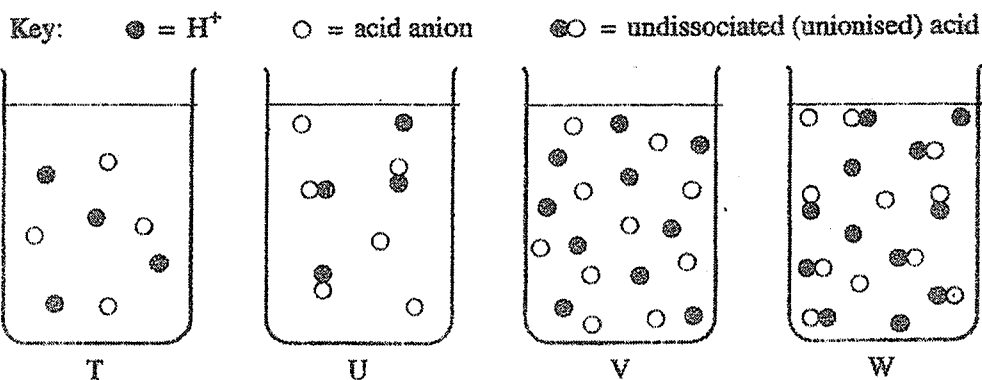
- (A) Technetium-99
 (B) Cobalt-60
 (C) Carbon-14
 (D) Uranium-238

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.

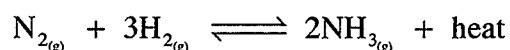
What is the best conclusion about the soil?

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



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?
- (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
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.

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- (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

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Question 17 (7 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

Question 17 continues on page 10

Student No.

Marks

Question 17 (continued)

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

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

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- (d) Write the overall redox equation. 0.5

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

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- (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

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End of Question 17

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.

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- (b) Evaluate the conversion of starch (or glucose or sucrose) to ethanol as a source of ethanol.

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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.

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

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

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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		
Cost/Practicality		
Impact on society		
Environmental impact		

Evaluation:

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Question 21 (7 marks)

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

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

1

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

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

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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.

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

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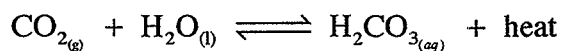
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Question 23 (4 marks)

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



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).

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

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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

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

1

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

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Question 25 (8 marks)

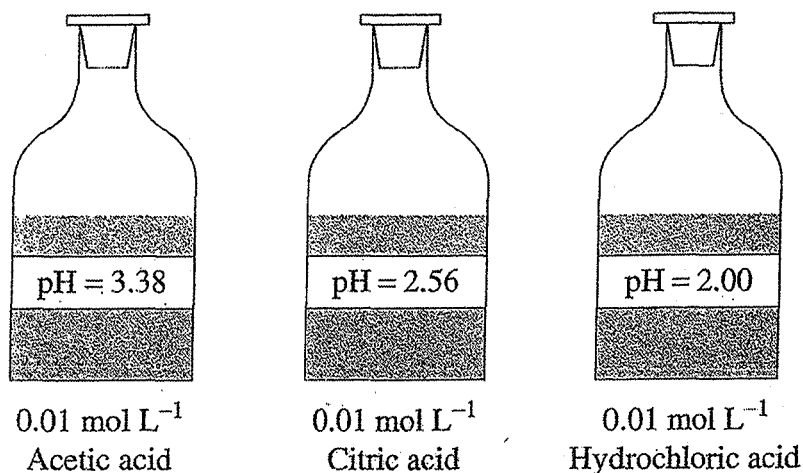
- (a) Calculate the pH of 0.0060 M hydrochloric acid.

1

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



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

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Question 25 continues on page 19

Question 25 (continued)

- (c) Define the term *amphiprotic*.

1

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- (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

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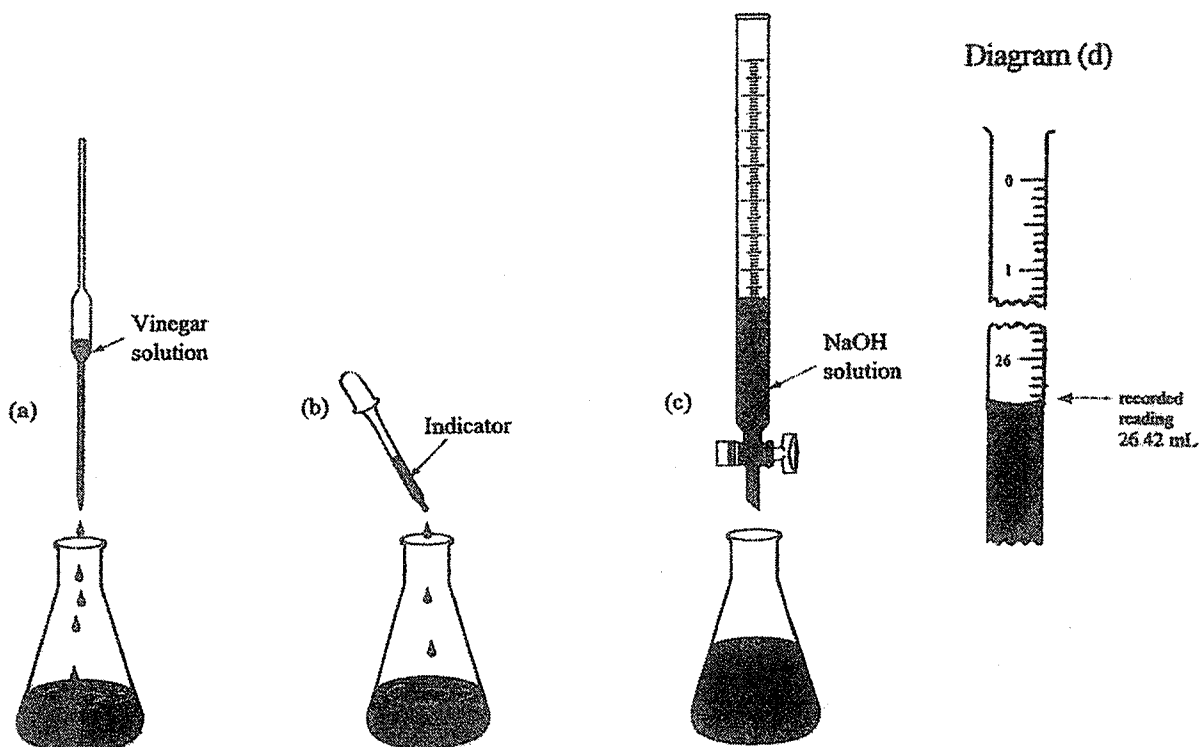
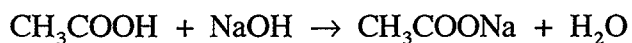
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End of Question 25

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:



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

Question 26 (continued)

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

State **ONE** mistake made in:

(i) Step 1:

(ii) Step 2: **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)			

- (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**

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

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

Student No.

Marks

Question 27 (2 marks)

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

1

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

1

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End of Paper



Barker College

2006**YEAR 12****EXAMINATION TERM 1**

Chemistry

ANSWER SHEET

Staff Involved:

PM THURSDAY 6 APRIL

- TER* MLC & Q16+17 (p8-10) 12marks
- ASH Q 18-19 (p11+12) 12marks
- KHW Q 25, 26, 27 (p.18-22) 17marks
- RZS Q 22, 23, 24 (p15-17) 12marks
- RJP Q 20, 21 (p13-14) 12marks.

110 copies

Section I – Multiple Choice

Choose the best response and fill in the response oval completely

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



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TERM 1**

Chemistry

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General Instructions

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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

15 marks

Allow about 25 minutes for this section

Use the multiple-choice answer sheet

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

(A) (B) (C) (D)

(A)  (B)  (C)  (D) 

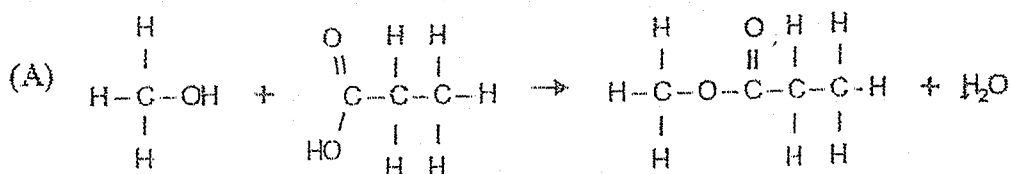
(A)  (B)  (C)  (D) 

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

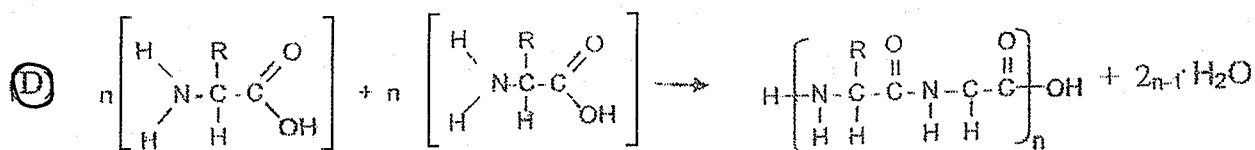
- (A) Ethenylbenzene
- (B) Chloroethene
- (C) Benzylethene
- (D) Chlorobenzene

Text book p. 16

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



Text p 18



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) Ethanoic 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

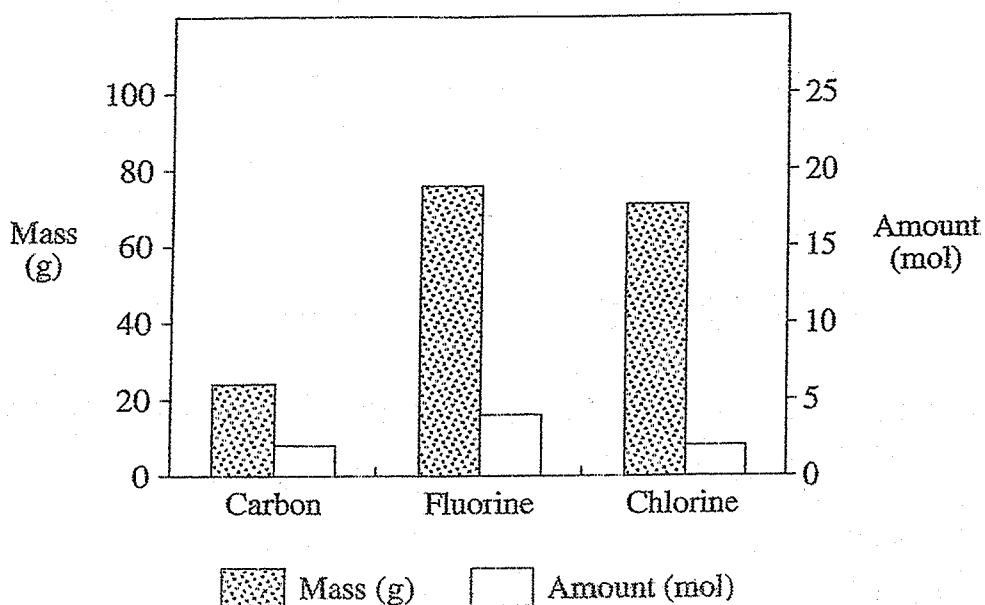
Text p 144

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.
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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?

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

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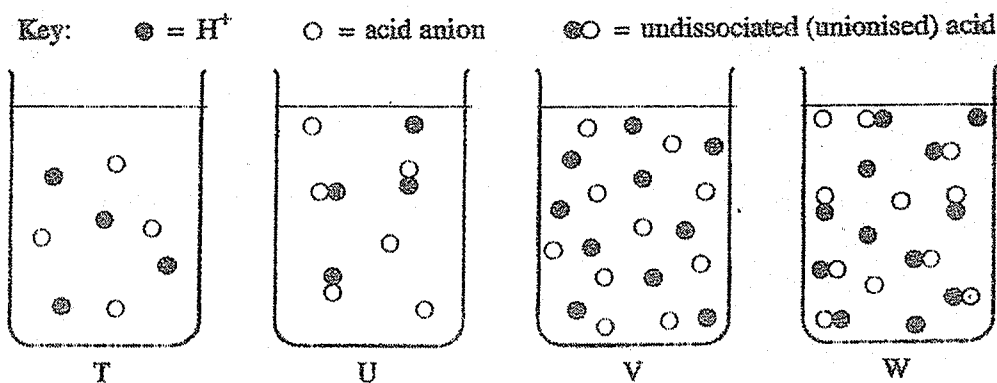
9. Phenol red is an acid-base indicator, yellow 6.8 – red 8.4.
Methyl orange indicator, red 3.1 – yellow 4.4.

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?

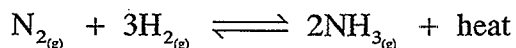
- best → (A) That it is slightly acidic and has a pH less than 8.4.
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Which of the following procedures would increase the equilibrium yield of ammonia?

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(B) Decrease the temperature and increase the pressure.
(C) Decrease the pressure and increase the temperature.
(D) Increase both the temperature and the pressure.

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 - (C) Basic
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 - (C) NO_2
 - (D) O_3
14. $.0095 \text{ mol HCl}$ $.01 \text{ mol NaOH}$
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:
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 - (B) Ethanoic acid
 - (C) Citric acid
 - (D) Carbonic acid

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. Test p 15-17 3

- ① Initiation - Excess ethylene monomers are combined with an organoperoxide initiator + a catalyst. The double bonds break and a free radical site occurs in each monomer
- ① Propagation - 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. $\left(\frac{1}{2}\right)$ for naming stages $\left(\frac{1}{2}\right)$ 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 $\left(\frac{1}{2}\right)$ flexible - used for plastic film, soft flexible bags + toys, squeezable bottles $\left(\frac{1}{2}\right)$

HDPE - high density $\left(\frac{1}{2}\right)$, tough + rigid - used for tough rigid containers like milk crates, plastic caps, hard toys, utensils $\left(\frac{1}{2}\right)$

 $\left(\frac{1}{2}\right)$ properties $\left(\frac{1}{2}\right)$ uses

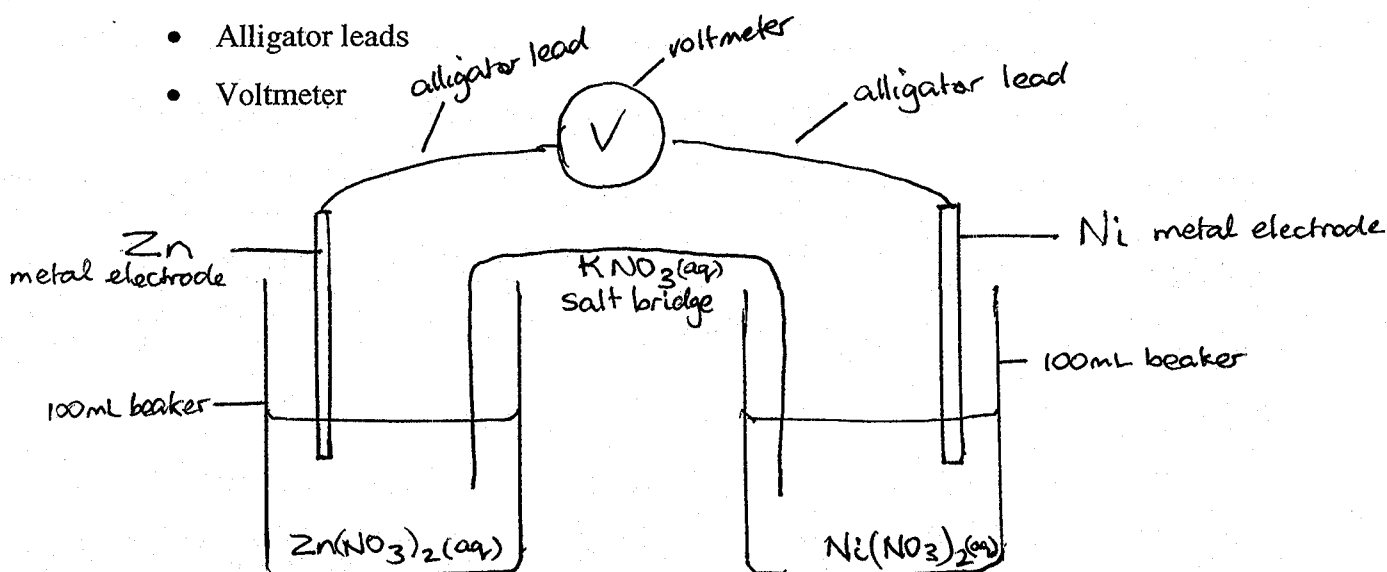
Question 17 (8 marks)

- (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



- $\frac{1}{2}$ each, metal electrodes ①
 $\frac{1}{2}$ each, correct solutions in each beaker ①
 $\frac{1}{2}$ salt bridge in right place with KNO_3 ①
 $\frac{1}{2}$ for voltmeter and leads in right place ①

Take off 1 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.

Question 17 (continued)

- has to be all correct
- (b) Write the reduction half-equation. 0.5
- $$\text{Ni}^{2+}_{(aq)} + 2\bar{e} \rightarrow \text{Ni}_{(s)}$$
- (c) Write the oxidation half-equation. 0.5
- $$\text{Zn}_{(s)} \rightarrow \text{Zn}^{2+}_{(aq)} + 2\bar{e}$$
- (d) Write the overall redox equation. 0.5
- $$\text{Zn}_{(s)} + \text{Ni}^{2+}_{(aq)} \rightarrow \text{Zn}^{2+}_{(aq)} + \text{Ni}_{(s)}$$
- * Take off $\frac{1}{2}$ only once for lack of states.
- (e) Calculate the standard e.m.f. of the cell. Show working. 1.5
- $$\begin{array}{llll} \text{(Oxid}^n \text{ Zn} \rightarrow \text{Zn}^{2+} + 2\bar{e}) & E^\circ = 0.76\text{V} & \left(\frac{1}{2}\right) \\ \text{(Reduct}^n \text{ Ni}^{2+} + 2\bar{e} \rightarrow \text{Ni}) & E^\circ = -0.24\text{V} & \left(\frac{1}{2}\right) \\ \hline \text{Total emf} & = 0.52\text{V} & \left(\frac{1}{2}\right) \end{array}$$
- (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
- OR The temperature was not the standard 25°C

End of Question 17

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 $\left(\frac{1}{2}\right)$ to produce energy $\left(\frac{1}{2}\right)$ $(C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O + \text{heat})$
 If it is produced by fermenting sugars $\left(\frac{1}{2}\right)$ from renewable crops like sugar cane $\left(\frac{1}{2}\right)$ $(C_6H_{12}O_6 \xrightarrow{\text{yeast}} 2C_2H_5OH + 2CO_2)$,
 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 i.e. CO_2 used to make the plant is released when the ethanol burns.
 However, there are many disadvantages - large tracts of land are used up to grow the biomass, accompanied by soil erosion, deforestation,
 ① 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.

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. ②

3. Colour changes were observed immediately, and after 10-20 minutes. ③
(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 ventilation and protective clothing.

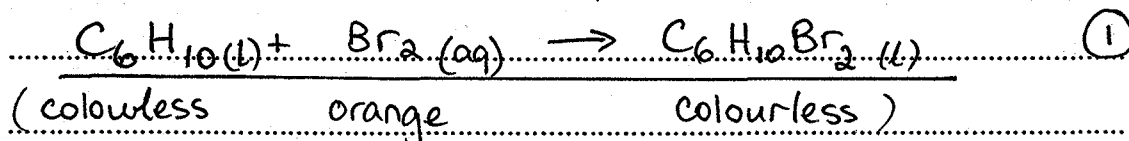
Cyclohexene, as with all the similar M.W. alkenes, is hazardous but able to be used with caution and in small amounts (2mL)

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.

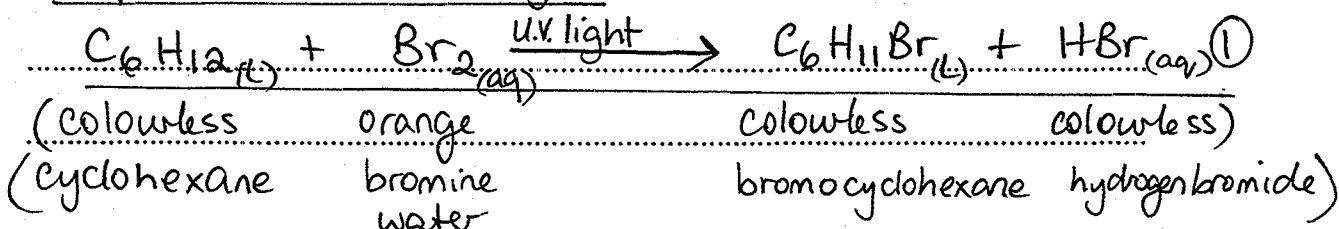
4

Cyclohexene immediately decolourised Br_2 -water ①



(cyclohexene bromine water 1,2-dibromocyclohexane)

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



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

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

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
Cost/Practicality		
MARKING	WILL	DEPEND
Impact on society		
ON	WHAT	KIDS USE.
Environmental impact		

①

①

①

①

Evaluation: A - - - - - would be a good choice for - - - - -
and a - - - - - would better suit - - - - -

①

Question 21 (7 marks)

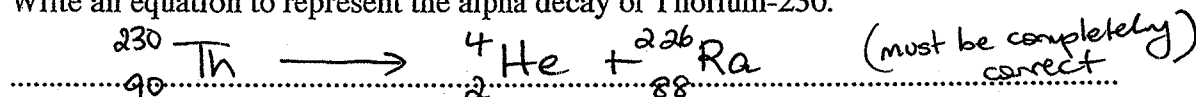
- (a) Describe why some isotopes are stable and others are unstable.

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 $Z > 83$ + p:n ratio)

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

1



- (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 (1/2) primary use (1/2)

{ 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 radioisotope 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 14 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 that workers & residents nearby are protected.

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

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

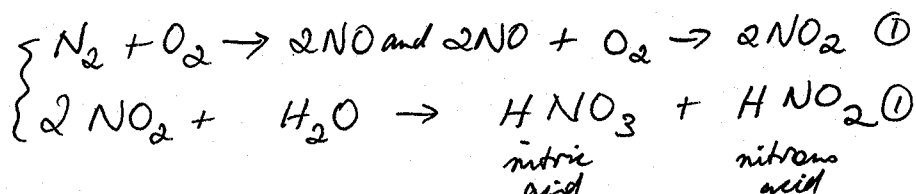
- (b) Outline reasons for concern about the release of these oxides with respect to the environment.

2

The reasons that concerns are justified are -

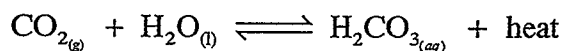
1. pH of lakes & streams in Europe & North America has decreased in recent times, reducing fish populations & killing invertebrates. ①
2. In areas of Europe & US where $SO_2 + NO_x$ emissions have been high, large tracts of forest have been destroyed or damaged. ①

OR



Question 23 (4 marks)

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



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

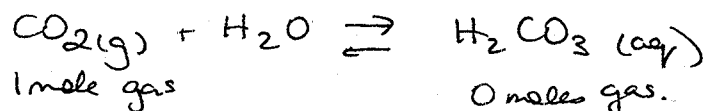
① { Le Chatelier's Principle says that when an equilibrium is disturbed it will adjust itself to minimise the disturbance. When the lid is opened the equilibrium shifts to the ^①/₂ left as written above because $[\text{CO}_{2(g)}]$ has been reduced, so $\text{CO}_{2(aq)}$ comes out of solution to replenish the $\text{CO}_{2(g)}$. ^②/₂

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

The equilibrium shifts to the ^①/₂ left, using up the extra heat, so more $\text{CO}_{2(g)}$ is produced. ^①/₂ By this happening the effect of the addition of heat is minimised, according to Le Chatelier's principle.

Le Chatelier's principle should be stated completely at least once.

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



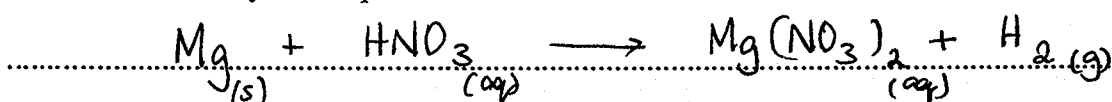
∴ When gas removed from left, reaction shifts left.

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



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

1

$$\begin{aligned} n_{\text{Mg}} &= \frac{2.4 \text{ g}}{24.3 \text{ g mol}^{-1}} \quad \left(\frac{1}{2}\right) \\ &= 0.1 \text{ mol} \quad \left(\frac{1}{2}\right) \end{aligned}$$

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

2

$$\begin{aligned} n_{\text{H}_2} &= n_{\text{Mg}} \text{ from the equation in (a)} \quad \left(\frac{1}{2}\right) \\ V_{\text{H}_2} &= n_{\text{H}_2} \times V_{25^\circ\text{C}} \\ &= 0.1 \text{ mol} \times 24.79 \text{ L mol}^{-1} \quad \left(\frac{1}{2}\right) \\ &= 2.479 \text{ L} \quad \left(\frac{1}{2}\right) \\ &= \underline{\underline{2.5 \text{ L to correct sig. fig.}}} \quad \left(\frac{1}{2}\right) \end{aligned}$$

Question 25 (8 marks)

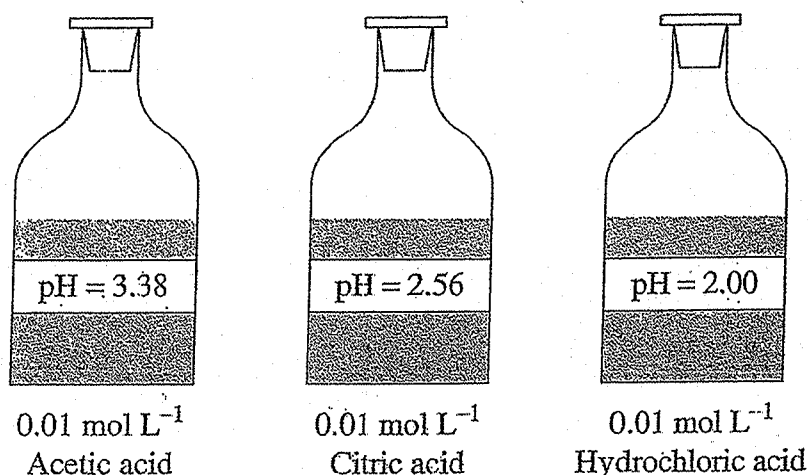
- (a) Calculate the pH of 0.0060 M hydrochloric acid.

1

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

$$= 2.2 \quad (1)$$

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



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 $(\frac{1}{2})$ $[\text{H}_3\text{O}^+] < [\text{CH}_3\text{COOH}]$
 ie $< 0.01 \text{ mol L}^{-1}$ and $\text{pH} > 2$ $(\frac{1}{2})$ eg $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}_3\text{O}^+$ $(\frac{1}{2})$
 Hydrochloric acid is a strong acid, that is fully ionised $(\frac{1}{2})$ $\text{HCl} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^-$ $(\frac{1}{2})$
 and $[\text{H}_3\text{O}^+] = [\text{HCl}] = 0.01 \text{ M}$ and $\text{pH} = 2$ $(\frac{1}{2})$

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

Question 25 (continued)

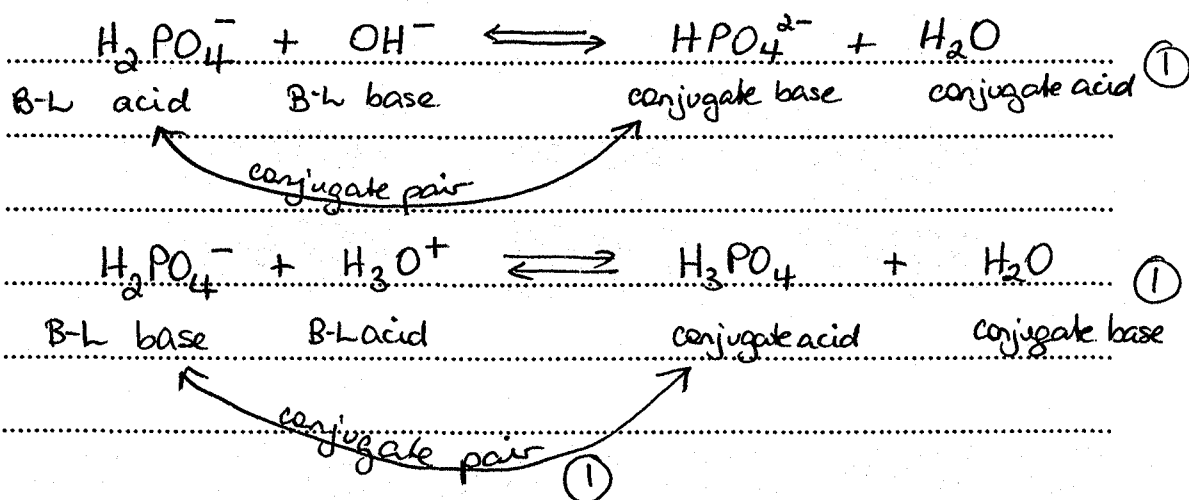
- (c) Define the term
- amphiprotic*
- .

1

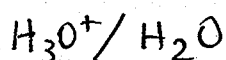
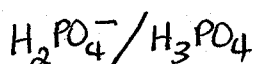
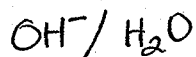
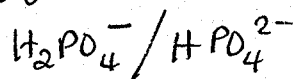
The amphiprotic substance can donate a proton
or accept a proton. (It is a B-L acid or a B-L base)

- (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

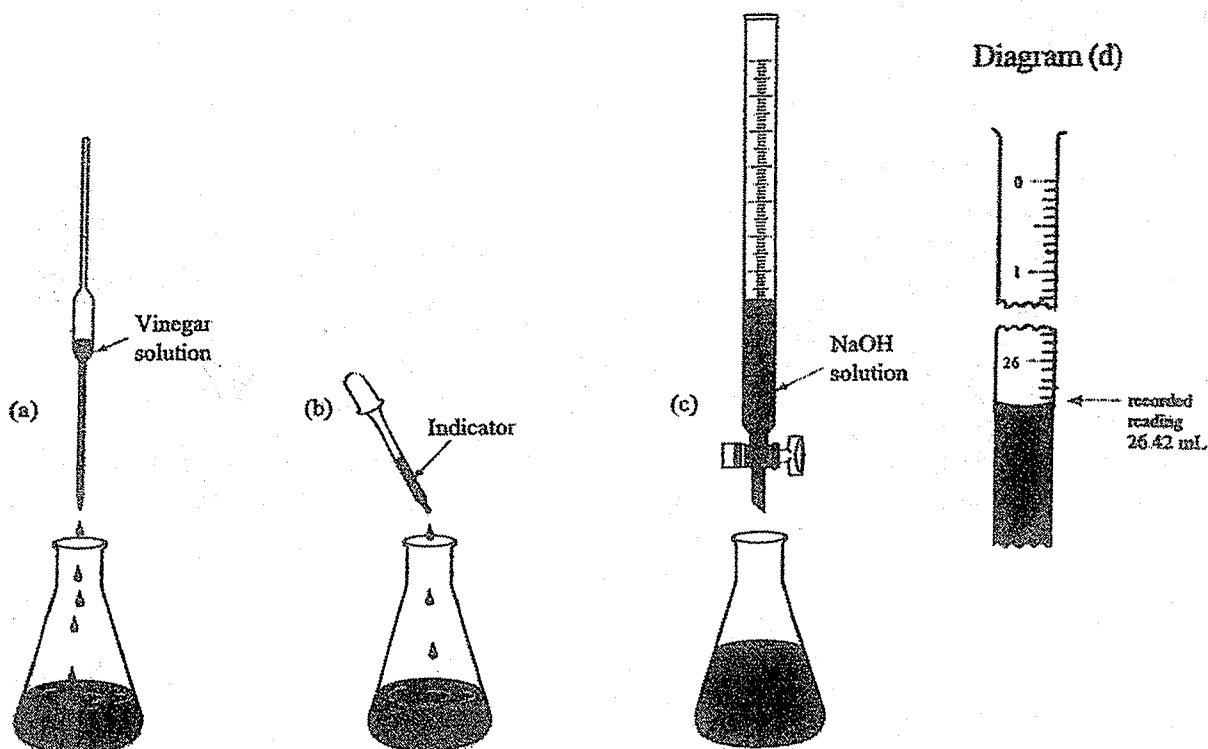
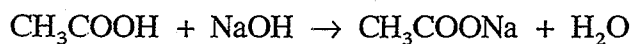


End of Question 25

Conjugate pairs

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:



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

Question 26 (continued)

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

State ONE mistake made in:

- (i) Step 1: Rinsing with distilled 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

$$\begin{array}{r} 43 \\ 37 \\ 50 \\ 3 \overline{) 130} \\ 438 \end{array}$$

- (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

$$\begin{array}{r} 22.43 \\ 22.44 \\ \hline \end{array} \text{ mL}$$

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

2

$$\begin{aligned} n_{\text{CH}_3\text{COOH}} &= n_{\text{NaOH}} = 22.4 \times 10^{-3} \text{ L} \times 0.100 \text{ mol L}^{-1} \quad (1) \\ &= 2.24 \times 10^{-3} \text{ mol} \quad (1) \end{aligned}$$

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

2

$$\begin{aligned} c_{\text{CH}_3\text{COOH}} &= \frac{2.24 \times 10^{-3} \text{ mol}}{0.020 \text{ L}} \quad (1) \\ &= 0.112 \text{ mol L}^{-1} \quad (1) \end{aligned}$$

Question 27 (2 marks)

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

1

..... butyl ⁽¹⁾propanoate and ⁽¹⁾water

- (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