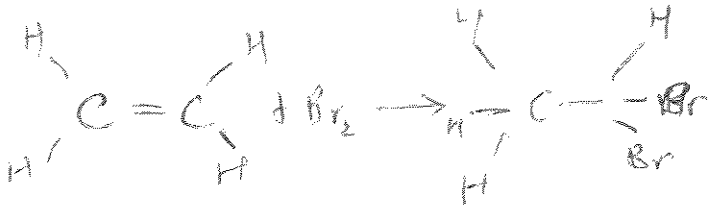
Detach grid from Question paper

Student Number: ANSWERS



HALF-YEARLY EXAMINATION 2005

CHEMISTRY

YEAR 12

SECTION A

15 multiple choice questions – 1 mark each

	A	B	C	D
1			X	
2				X
3		X		
4	X			
5			X	
6		X		
7				X
8			X	
9	X			
10				X

Total:

SECTION A

Questions 1 - 10 - multiple choice

Attempt ALL questions

Choose the best answer and indicate your choice by placing a cross (X) in the appropriate space on the Answer grid.

1. The reaction of ethene with bromine is:

chlorination of alkanes

A a substitution reaction that occurs spontaneously
B a substitution reaction that occurs in the presence of a catalyst
C an addition reaction that occurs spontaneously
D an addition reaction that occurs in the presence of a catalyst

adding atoms to alkenes and alkynes.

2. A student was asked to distinguish between two white powders, one of which was glucose and the other sodium chloride.

Which physical property would be the best to test?

A solubility in water → both glucose and sodium chloride are soluble in water
B hardness
C thermal conductivity
D electrical conductivity in aqueous solution

3. Zinc metal can be formed by extracting it from its ore. The first step in this extraction process is to roast the sulphide ore in air.

$$2ZnS_{(s)} + 3O_{2(g)} \rightarrow 2ZnO_{(s)} + 2SO_{2(g)}$$

N° Moles ZnS $= \frac{300}{(65.39 + 32.07)} = 3.078$ moles.

300 g of zinc sulphide is roasted with air.
The volume of sulfur dioxide released into the atmosphere at 101.3 kPa and 298 K is closest to:

Mole ratio $ZnS : SO_2 = 1 : 1$

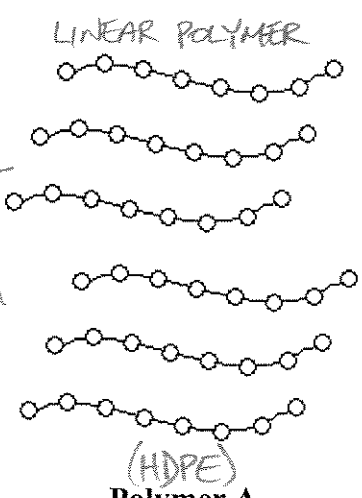
∴ N° Moles $SO_{2(g)} = 3.078$ moles

At 298 K 1 mole = 24.79 L

∴ Amount $SO_{2(g)}$ released $= 24.72 \times 3.078 = 76.3$ L

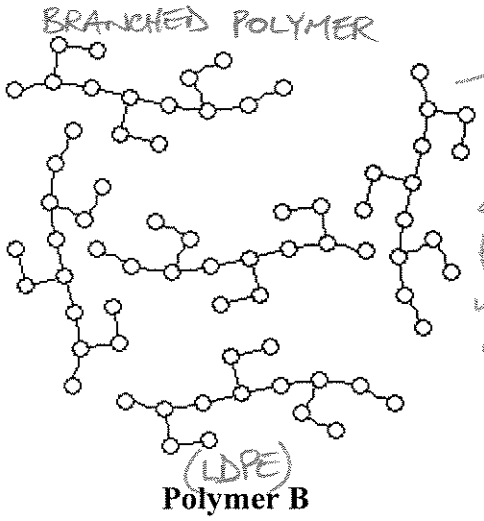
A 130 mL
B 75 L
C 130 L
D 75 000 L

4. Each line in the diagram below represents a strand in the polymer chain polyethylene.



Polymer A

quite rigid as their chains can pack closely together and dispersion forces between chains hold the chains tightly.



Polymer B

side chains disrupt the packing and are more flexible due to weaker dispersion forces.

Compared with Polymer B, Polymer A would:

A be more rigid and dense
B more easily dissolved in a non-polar substance such as kerosene
C react rapidly with bromine water
D take much longer to break down in sunlight

5. Consider the reaction described by the equation below:

$$C_2H_5OH \rightarrow C_2H_4 + H_2O$$

This reaction is an example of:

A polymerisation
B hydration
C dehydration
D addition

6. The pH of 0.0015 mol L^{-1} nitric acid is closest to:

A 2
B 3
C -2
D 1.5

$pH = -\log_{10}[0.0015]$
$= 2.8$
≈ 3

7. Swimming pools are sterilised by adding calcium hypochlorite, $Ca(OCl)_2$, or sodium hypochlorite, NaOCl. The equilibrium involved is:

$$OCl^-_{(aq)} + H_2O_{(l)} \Leftrightarrow HOCl_{(aq)} + OH^-_{(aq)}$$

The species that is best at destroying bacteria and at resisting decomposition by sunlight is HOCl.

Identify the reaction conditions that will favour the formation of HOCl.

A adding NaOH will add OH^- and shift equilibrium in reverse direction
B adding HCl will neutralise OH^- and shift equilibrium in forward direction
C adding water will shift equilibrium in forward direction to reduce $[H_2O]$
D both B and C

8. When using a pipette, you should always:

A rinse it with distilled water before use
B ensure it is clamped vertically → burette
C rinse it with the solution to be used
D ensure that the last drops are drained by shaking or blowing it

9. The conjugate base of the HSO_4^- is:

$HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$
acid — conjugate base

A SO_4^{2-}
B H_2SO_4
C SO^{4-}
D SO_3^{2-}

10. The pH of four acids and their concentrations are shown in the table below.

Acid	Conc. (mol L^{-1})	pH
A	0.1	1.0
B	0.05	1.0
C	0.01	2.0
D	0.1	2.0

Which acid in the table is the weakest?

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

SECTION B

Questions 11 – 16 - 30 marks

Attempt ALL questions

Write your answers in the space provided after each question.

11. Polyvinylchloride (PVC) is a widely used polymer.

(a) Identify the systematic name for the monomer used to manufacture PVC. [1]

vinyl chloride → 1-chloroethene or chloroethene

(b) Identify ONE use of PVC and account for its use in terms of its properties. [2]

USES	PROPERTIES
building materials (pipes, conduit, cladding, panels) kitchen utensils, credit cards)	rigid, impervious to water, oils and most organic material, poor conductor of electricity
bottles, garden hoses, upholstery coverings, electrical insulation	flexible, impervious to water, oils and most organic materials

(c) Explain why the recycling of plastics is an important means of conserving our fossil fuel resources. [2]

* modern society has a huge use of plastics
* this places a greater demand on a limited supply of fossil fuel resources which are key ingredients in the manufacture of plastics.
* plastics do not break down readily and recycling is a good way of substituting some of starting ingredients.

1mk * the non-polar alkyl chain forms dispersion forces with non-polar solutes and allows ethanol to act as a solvent for some non-polar substances including some hydrocarbons and oils.

12. Many cosmetic and pharmaceutical preparations require the use of a solvent such as ethanol, which can be produced by the fermentation of sugars.

(a) Relate the use of ethanol as a solvent to the nature of the ethanol molecule. [2]

* a range of substances including polar, non-polar and some ionic compounds dissolve readily in ethanol. It is also miscible in water.

NATURE OF MOLECULE
* ethanol molecule consists of a polar hydroxy (-OH) end and a non-polar alkyl (CH_3CH_2-) end.

1mk * the ability of ethanol to act as a solvent for polar substances is due to polar nature of O-H bond and dipole-dipole forces or hydrogen bonds formed with other polar molecules.

(b) Describe the conditions required to produce ethanol by the fermentation of glucose. [2]

$C_6H_{12}O_{6(aq)} \xrightarrow{\text{yeast}} 2CH_3CH_2OH_{(aq)} + 2CO_{2(g)} + \text{heat}$
glucose → ethanol

* suitable grain or fruit dissolved in water, source of glucose.

2mk * yeast is added
* air is excluded, but CO_2 may be released through a water trap.
* the mixture is kept at about blood temperature, 37°C.

(c) Explain how mass changes can be used to monitor the fermentation reaction. A suitable equation should be included in your answer. [2]

1mk $C_6H_{12}O_{6(aq)} \xrightarrow{\text{yeast}} 2CH_3CH_2OH_{(aq)} + 2CO_{2(g)} + \text{heat}$
glucose → ethanol

* the fermentation reaction converts glucose into ethanol and CO_2.
* the CO_2 can bubble out of solution and be released through a water trap.
* the reaction vessel can be weighed before and after fermentation to measure and calculate the loss of CO_2 produced as glucose is converted to ethanol.
* when mass loss remains constant, the reaction has finished and yeast stopped producing $CO_{2(g)}$

GALVANIC CELLS = oxidation occurs at anode, reduction at cathode.
* if overall cell emf of a redox reaction is positive then reaction occurs as written (forward dir^n)

13. The equations below show the half reactions involved in the operation of a vanadium redox cell.

$V^{3+} + e^- \Leftrightarrow V^{2+}$ $E^0 = -0.26$ V
$V^{2+} \rightleftharpoons V^{3+} + e^-$ $E^\circ = +0.26$V

$VO_2^+ + 2H^+ + e^- \Leftrightarrow VO^{2+} + H_2O$ $E^0 = 1.00$ V
$VO_2^+ + V^{2+} + 2H^+ \rightleftharpoons VO^{2+} + V^{3+} + H_2O$ $E^\circ_{(cell)} = 1.26$V

The reaction direction depends on whether the cell is charging or discharging.
* half equation with most positive E° is reduction reaction at cathode.

(a) Identify the anode reaction when the cell is operating as a galvanic cell. [1]

$V^{2+} \rightleftharpoons V^{3+} + e^-$ $E^\circ = 0.26$ V (least positive E°)

(b) Write the overall cell reaction when the cell is operating as a galvanic cell. [1]

$VO_2^+ + V^{2+} + 2H^+ \rightleftharpoons VO^{2+} + V^{3+} + H_2O$

(c) Calculate the theoretical cell voltage that this cell could deliver under standard conditions. [1]

$E^\circ_{(cell)} = 1.00 + 0.26 = 1.26$ V

CANCELLED

(d) Describe ONE advantage of the vanadium redox cell in terms of its impact on society or the environment. [2]

* can act as a chemical store of energy produced by other means, eg wind or solar.

or

* well suited to electrically powered vehicles so will produce less pollution

* offer greater efficiency, less maintenance and a longer lifespan than other storage batteries such as lead-acid batteries

14. Use net ionic equations to explain the amphiprotic nature of sodium hydrogen carbonate in acidic and basic conditions. [4]

(1mk) $HCO_3^-(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq) + OH^-(aq)$

(1mk) the hydrogencarbonate is reacting as a base (proton acceptor)

(1mk) $HCO_3^-(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CO_3^{2-}(aq)$

(1mk) the hydrogencarbonate ion is reacting as an acid (proton donor)

can act as an acid or a base.

15. The procedure below was carried out to decarbonate a soft drink.

- Weigh an unopened can of soft drink using an electronic balance
- Open the can
- Place the can on a hot plate until it just begins to boil
- When cool, reweigh the can to determine the mass loss

(a) Explain why heating the soft drink will cause the carbon dioxide to be lost. [3]

(1) As the temperature increases, the solubility of carbon dioxide decreases. This is because the solution reaction is exothermic.

(1) $CO_2(g) + H_2O(\ell) \rightleftharpoons H_2CO_3(aq) + \text{Heat energy}$.

(1) According to Le Chatelier's Principle adding heat forces the equilibrium to the left producing CO_2(gas). (Use an equation.)

(b) Describe a modification required to make the results more valid and reliable for calculating the mass loss of carbon dioxide. [2]

Water is lost to the atmosphere through the boiling of the soft drink. A control can with (1) same volume of water (or flat soft drink) should be heated at the same time. The mass difference (1) between the cans is the loss due to CO_2 gas.

(Some CO_2 is lost when can is first opened)

(Fractional distillation to keep water while releasing CO_2 gas)

16. Potassium metabisulfite, $K_2S_2O_5$, is added to wine to prevent oxidation. It works by reacting with water and the acids in wine as follows:

$$S_2O_5^{2-}{}_{(aq)} + H_2O_{(l)} \rightarrow 2HSO_3^-{}_{(aq)} \quad (1)$$

Then $HSO_3^-{}_{(aq)} + H_3O^+{}_{(aq)} \Leftrightarrow SO_{2(aq)} + 2H_2O_{(l)}$ (2)

Use the above equation to explain how the addition of metabisulfite affects the pH of the wine. [5]

(1) Potassium metabisulfite dissolves in water to form $S_2O_5^{2-}$ ions. These ions react with water (as in equ ①) to produce HSO_3^- ions

(1) As the wine produces H_3O^+ ions in the bottle the pH of the wine falls as it becomes more acidic.

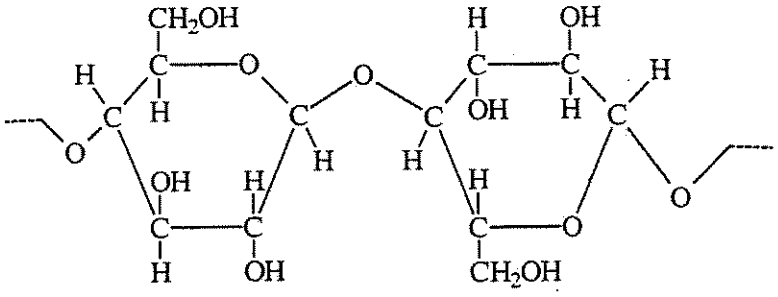
(1) The HSO_3^- ions accept ~~electrons~~ protons from the hydronium ions to produce SO_2 (aq) and water. In this way

(2) the wine pH is not permitted to fall continuously to acidic (low) levels as shown in equation (2).

SECTION C

Question 17 – 18 - 5 marks each

17. Cellulose is an example of a natural biopolymer produced by condensation. Molecules of glucose ($C_6H_{12}O_6$) join together to form this complex molecule. A section of its structure is shown in the following diagram.



(a) Cellulose is a major component of biomass. What does the term biomass mean? [1]

Biomass is the material produced by living organisms

(b) The production of cellulose from glucose produces another product. What is the name of the second product? [1]

Water.

(c) Discuss the potential of cellulose as a raw material in the production of petrochemicals. [3]

Main points.
① Reasons for and against cellulose to produce petrochemicals
① Reasons for renewable resource
or excellent explanation.

Cellulose is the main component of biomass. In theory any carbon containing substance could provide the starting synthesis for polymers. However, there is no efficient way of converting cellulose to glucose to produce ethanol by fermentation which could then produce ethene to replace petrochemical sources. If it could be done economically the big advantage is that it is a renewable resource.

18. As a major practical task a student was set four tasks:

- Prepare a standard solution from a primary standard
- Use this standard to determine the concentration of a hydrochloric acid solution
- Use the hydrochloric acid solution to determine the concentration of sodium hydroxide solution
- Use the standardised sodium hydroxide solution to determine the amount of citric acid in a sample of lime juice.

(a) Name a specific primary standard and outline the characteristics which make its use suitable. [2]

e.g. Sodium carbonate;
Characteristics are: HIGH PURITY (1)
VERY STABLE (1) SO as not to react with atmosphere.

(b) The HCl solution was standardised and found to have a concentration of 0.608 mol L^{-1}. The student then determined the amount of citric acid in a sample of lime juice, using the method shown below.

A sodium hydroxide solution was standardised against the hydrochloric acid and found to have a concentration of 0.075 mol L^{-1}. 25 mL of lime juice was diluted to 250 mL and 25 mL samples of the diluted solution were titrated with the sodium hydroxide to determine how much citric acid was present.
The reaction was:

SHOULD BE → 3

$$C_6H_8O_7 + (2)NaOH \rightarrow C_6H_5O_7Na_3 + 3H_2O$$

Given that the average amount of NaOH used was 40.0 mL, calculate the concentration of citric acid in the original lime juice. [3]

CALCULATION USING 2 NaOH 2 : 1 molar ratio.
No. of mol of NaOH in reaching = $\frac{40 \times 0.075}{1000} = 3.0 \times 10^{-3}$
∴ No. of mol of $C_6H_8O_7$ required = $\frac{3.0 \times 10^{-3}}{2} = 1.5 \times 10^{-3}$
∴ 25mL of diluted soln. contains 1.5×10^{-3} mol. ∴ Molarity = 0.06M
∴ Conc. of citric acid in original sample = 0.6M (mol L^{-1})

CALCULATION USING 3 NaOH
No. of mol of $C_6H_8O_7$ neutralised = $\frac{3.0 \times 10^{-3}}{3} = 1.0 \times 10^{-3}$
∴ Conc. in original sample = 0.4 mol L^{-1}

End of Paper