SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

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Victorian Certificate of Education
1998
CHEMISTRY
Common Assessment Task 1: Written examination

Wednesday 10 June 1998: 11.45 am to 1.30 pm
Reading time: 11.45 am to 12 noon
Writing time: 12 noon to 1.30 pm
Total writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*
A	19	19
B	6	6

Directions to students

Materials
Question and answer book of 18 pages, with a detachable data sheet in the centrefold.
Answer sheet for multiple-choice questions. You should have at least one pencil and an eraser.
An approved calculator may be used.

The task
Detach the data sheet from the centre of this book during reading time.
Please ensure that you write your **student number** in the space provided on this book and your **name** and **student number** in the space provided on the answer sheet for multiple-choice questions.
This paper consists of two sections, Section A and Section B.
Answer **all** questions from Section A. Section A is worth 19 marks.
Section A questions should be answered on the answer sheet provided for multiple-choice questions.
Answer **all** questions from Section B. Section B is worth 50 marks.
Section B questions should be answered in the spaces provided in this book.
There is a total of 69 marks available.
Working space is provided throughout this book.
All written responses should be in English.

At the end of the task
Place the answer sheet for multiple-choice questions inside the front cover of this book.

SECTION A

Specific instructions for Section A

Section A consists of 19 multiple-choice questions. Section A is worth approximately 28 per cent of the marks available. You should spend approximately 25 minutes on this section.

Choose the response that is **correct** or **best answers** the question, and indicate your choice on the multiple-choice answer sheet according to the instructions on that sheet.

A correct answer is worth 1 mark, an incorrect answer is worth no marks. No mark will be given if more than one answer is completed for any question. Marks will **not** be deducted for incorrect answers. You should attempt every question.

Question 1

Two different emulsions are made from oil and water using a suitable surfactant. Emulsion A is a water in oil emulsion and emulsion B is an oil in water emulsion. A student tests both emulsions by measuring their electrical conductivities and by rubbing a small sample of each on the back of his hand. Emulsion A has the

A. higher conductivity and feels cooler than emulsion B.

B. higher conductivity and feels warmer than emulsion B.

C. lower conductivity and feels cooler than emulsion B.

D. lower conductivity and feels warmer than emulsion B.

The following information is referred to in Questions 2 and 3 below.

Some bromine, Br_2, is added to some pure water at 25 °C. The resultant solution is found to be slightly acidic due to the equilibrium

$$Br_2(aq) + H_2O(aq) \rightarrow HOBr(aq) + H^+(aq) + Br^-(aq);\ \Delta H = +150\ kJ\ mol^{-1}$$

Question 2

Hypobromous acid, HOBr, and bromide ions, $Br^-(aq)$, are both colourless; bromine, $Br_2(aq)$, is brown. Which one of the following gives two different ways of reducing the intensity of the brown colour?

A. raising the temperature; adding a drop of concentrated $OH^-(aq)$.

B. raising the temperature; adding a drop of concentrated $H^+(aq)$.

C. lowering the temperature; adding a drop of concentrated $OH^-(aq)$.

D. lowering the temperature; adding a drop of concentrated $H^+(aq)$.

Question 3

If the pH of the bromine solution is found to be 6.20 at 25 °C, then the hydroxide ion concentration in mole per litre will be

A. $10^{-6.20}$

B. $10^{-7.00}$

C. $10^{-7.80}$

D. $10^{-14.00}$

Question 4

Which one of the following is **not** a desirable property for the precipitate obtained in a quantitative gravimetric procedure?

A. stability and non-reactivity with other ions

B. known formula and high molecular mass

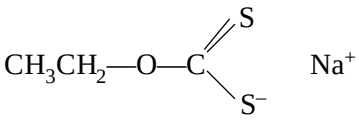
C. white in colour and high solubility

D. low solubility and stability when heated

Working space

The following information is referred to in Questions 5–8.

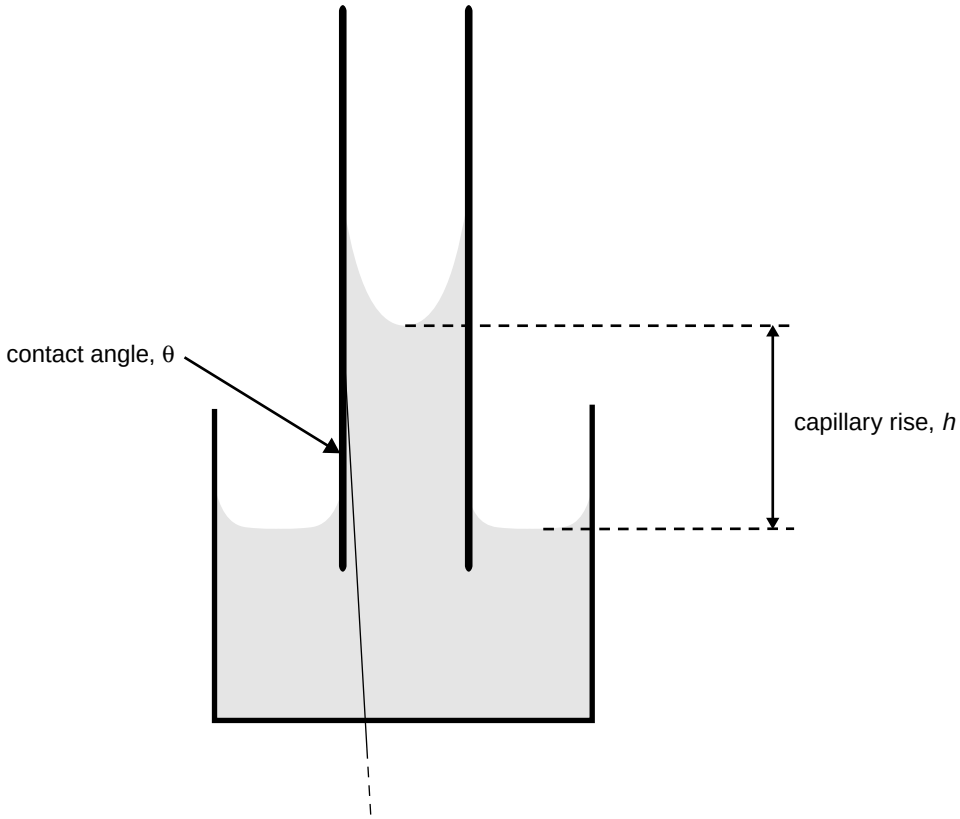
Sodium ethyl xanthate is a surfactant with the structure



sodium ethyl xanthate

Question 5

Consider an aqueous solution of sodium ethyl xanthate in contact with a glass surface.



In comparison to pure water, the sodium ethyl xanthate solution would have a

A. lower surface tension and a higher capillary rise.

B. higher surface tension and a higher capillary rise.

C. lower surface tension and a lower capillary rise.

D. higher surface tension and a lower capillary rise.

The following additional information concerning an industrial use of sodium ethyl xanthate is referred to in Questions 6–8.

The froth flotation technique is used for separating the valuable substance, zinc sulfide, from its ore. The ore contains zinc sulfide, which may be regarded here as an ionic solid, and other substances that are of no significant value.

To separate the valuable zinc sulfide from the unwanted substances

- the ore is first ground to a fine powder and mixed with excess water
- the surfactant sodium ethyl xanthate is then added and air is blown through the aqueous mixture
- zinc sulfide particles become attached to small air bubbles and float to the surface of the aqueous mixture where they are removed. In this way zinc sulfide is separated from the unwanted materials.

Question 6

During the separation process xanthate anions become preferentially attached to zinc sulfide particles. The most important component of the bonding between the xanthate and the zinc sulfide would probably be

A. ionic bonding between the zinc cations and the $-S^-$ in the xanthate anion.

B. hydrogen bonding between the –O– of the xanthate anion and the zinc sulfide surface.

C. ionic bonding between the Na^+ of the sodium xanthate and the zinc sulfide surface.

D. dispersion forces between the CH_3CH_2- and the zinc sulfide surface.

Question 7

During this process, zinc sulfide particles become attached to small air bubbles. An important reason for this is

A. the hydrophobic ends of the xanthate anions attached to the zinc sulfide particles prefer to be in air rather than in an aqueous environment.

B. the hydrophilic ends of the xanthate anions attached to the zinc sulfide particles prefer to be in air rather than in an aqueous environment.

C. small air bubbles in water are destabilised by xanthate anions which collect preferentially at the surface of the bubbles.

D. small air bubbles in water are stabilised by the xanthate anions which collect preferentially at the surface of the bubbles.

Question 8

As well as attaching themselves to zinc sulfide particles, xanthate anions are also attracted to the air-water interface. The bonding between the xanthate anions and water molecules would be

A. hydrogen bonding and ion-dipole attraction.

B. dispersion forces and ion-dipole attraction.

C. dispersion forces, hydrogen bonding and ion-dipole attraction.

D. dispersion forces and hydrogen bonding.

Question 9

Sodium hydrogen carbonate ($NaHCO_3$) is used in cooking because it releases carbon dioxide when heated according to the equation

$$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$$

One cake recipe requires 4.0 g of sodium hydrogen carbonate. The cake is to be baked in an oven at 200 ºC. What is the volume in litres of the CO_2 that would be released? Assume that the pressure in the oven is 104 kPa and that the $NaHCO_3$ completely decomposes according to the above equation.

A. 0.38

B. 0.76

C. 0.90

D. 1.80

Question 10

15.0 mL of 0.100 M iron (III) nitrate ($Fe(NO_3)_3$) reacts with 25.0 mL of 0.150 M potassium hydroxide (KOH). The maximum mass, in gram, of iron (III) hydroxide ($Fe(OH)_3$) that can be precipitated from the reaction is

A. 0.133

B. 0.160

C. 0.400

D. 0.481

Question 11

In a mixture of alcohols, each component can be identified using high performance liquid chromatography. The alcohol with the longest retention time will be the one which

A. is the most soluble in the mobile phase.

B. has the smallest molar mass.

C. will emerge first from the column.

D. adsorbs most strongly on the stationary phase.

Question 12

What volume of water, in millilitres, must be added to 30 mL of 10 M ammonia solution in order to make a 0.50 M solution of ammonia?

A. 120

B. 150

C. 570

D. 600

Question 13

When water is added to a dilute solution of $NH_3(aq)$, the pH of the solution

A. rises and its percentage dissociation increases.

B. falls and its percentage dissociation increases.

C. rises and its percentage dissociation decreases.

D. falls and its percentage dissociation decreases.

Working space

Question 14

Many saturated and unsaturated hydrocarbons have structural isomers. The number of structural isomers of butane and butene is, respectively

A. 2 and 2

B. 2 and 3

C. 3 and 2

D. 3 and 4

Question 15

The equilibrium constant for the self-ionisation of water, K_w, has a value of 10^{-14} at 25 ^oC and 10^{-15} at 0 ^oC. The pH of pure water at 0 ^oC is

A. 7.0 and the water is neutral.

B. 7.0 and the water is slightly acidic.

C. 7.5 and the water is neutral.

D. 7.5 and the water is slightly basic.

Question 16

The reaction between octene and hydrogen can be represented by the equation

$$C_8H_{16}(g) + H_2(g) \rightarrow C_8H_{18}(g)$$

Which of the following terms is **not** a correct description of this reaction?

A. reduction

B. hydration

C. addition

D. hydrogenation

Question 17

A catalyst is frequently used to help generate a product in an industrial process. It achieves this by

A. increasing the value of the equilibrium constant for the reaction.

B. decreasing the value of the equilibrium constant for the reaction.

C. lowering the activation energies of the forward and back reactions by an equal amount.

D. lowering the activation energy of the forward reaction only.

Question 18

'Neoprene' is a synthetic polymer, formed from the monomer chloroprene.

Chloroprene is represented by the formula

$$CH_2 = CCl - CH = CH_2$$

Butadiene is represented by the formula

$$CH_2 = CH - CH = CH_2$$

and, in a particular reaction, the chloroprene reactant contains a small amount of butadiene as an impurity. When the chloroprene containing the butadiene impurity is polymerised, the final product is most likely to be

A. 'neoprene' containing a small amount of butadiene as an impurity.

B. a mixture of 'neoprene' and poly(butadiene).

C. a co-polymer of chloroprene and butadiene.

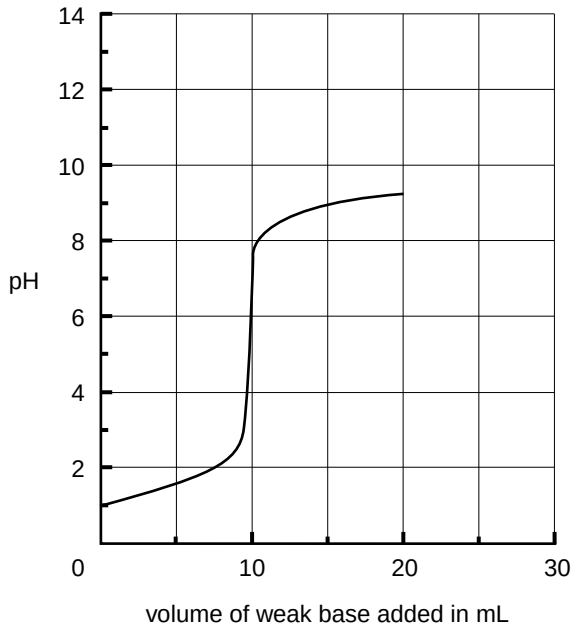
D. a mixture of 'neoprene' and poly(ethene).

Question 19

Different indicators change colour over different pH ranges and it is important to choose the correct indicator to obtain an accurate result in a titration.

Indicator	pH range for colour change	Colour	
		Acid form	Base form
phenolphthalein	8.2 – 10.0	colourless	pink
methyl violet	0.3 – 3.0	yellow	violet
indigo carmine	11.6 – 14.0	blue	yellow
methyl red	4.2 – 6.3	red	yellow

If a certain weak base is added to a strong acid, the following curve is obtained showing the variation of pH with the volume of weak base added.



Which of the above indicators would be the best choice to use in the titration?

A. phenolphthalein

B. methyl violet

C. indigo carmine

D. methyl red

END OF SECTION A
TURN OVER

SECTION B

Specific instructions for Section B

Section B consists of six short-answer questions numbered 1 to 6. A total of 50 marks is available for these questions. You should answer all of these questions. Section B is worth approximately 72 per cent of the marks available. You should therefore spend approximately 65 minutes on this section.

The marks allotted to each question are shown at the end of each question.

Questions must be answered in the spaces provided in this book.

To obtain full marks for your responses you should

- give simplified answers with an appropriate number of significant figures for all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure all chemical equations are balanced and that the formulas for individual substances include an indication of state for example, $H_2(g)$; NaCl(s).

Question 1

Hydrogen can be produced industrially by the reaction of methane with water according to the following equation

$$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g); \quad \Delta H = +206.1 \text{ kJ mol}^{-1}$$

a. Give an expression for the equilibrium constant for this reaction and calculate the equilibrium constant at a particular temperature if the equilibrium concentrations at this temperature are $[CH_4] = 0.200$ M; $[H_2O] = 0.100$ M; $[CO] = 0.900$ M; $[H_2] = 0.500$ M.

2 marks

b. Show the effect on the percentage yield of hydrogen of the following actions by placing ticks in the appropriate boxes in the following table.

	increased H_2 yield	no change in H_2 yield	reduced H_2 yield
adding more carbon monoxide at constant volume and constant temperature			
adding excess argon gas at constant volume and constant temperature			
halving the volume of the reaction vessel at constant temperature			
increasing the temperature at constant volume			

4 marks

c. At a particular temperature, the equilibrium constant for this reaction is 1.50 M^2. A mixture of 0.100 M CH_4, 0.100 M H_2O, 0.200 M CO and 0.200 M H_2 is heated to this temperature. As the mixture goes to equilibrium, describe what will happen to the concentrations of each of the gases in the mixture by placing ticks in the appropriate boxes in the following table.

	increased concentration	no change in concentration	reduced concentration
CH_4			
H_2O			
CO			
H_2			

2 marks

Total 8 marks

Question 2

a. Sulfur trioxide produced during the Contact Process is not reacted directly with water to make sulfuric acid. Instead it is reacted with sulfuric acid to make oleum, $H_2S_2O_7$. Oleum is then reacted with water to make sulfuric acid.

i. Write an equation for the reaction of sulfur trioxide that produces oleum.

ii. Write an equation for the reaction in which oleum produces sulfuric acid.

1 + 1 = 2 marks

b. Unsaturated hydrocarbons such as ethene and propene are produced industrially from saturated hydrocarbons by a process called *cracking.*

i. Briefly describe the conditions needed for cracking a saturated hydrocarbon.

ii. Write chemical equations showing the possible products of the cracking of propane.

2 + 2 = 4 marks

Total 6 marks

Question 3

In the blast furnace, the reduction of iron oxide to iron can be represented by the equation

$$3CO(g) + Fe_2O_3(s) \rightarrow 2Fe(l) + 3CO_2(g)$$

a. Give the oxidation numbers of

carbon in CO(g) .....

iron in $Fe_2O_3(s)$ .....

2 marks

b. Write chemical equations to show how carbon monoxide is produced in the blast furnace.

2 marks

c. Calcium carbonate, $CaCO_3$, is normally added to the mixture in a blast furnace. Briefly describe, with appropriate chemical equations, the purpose of the calcium carbonate.

3 marks

Total 7 marks

Working space

Question 4

The percentage of manganese in steel needs to be carefully monitored. One method for the determination of the manganese content is to first dissolve the steel in nitric acid. This converts the manganese into manganese (II) ions, $Mn^{2+}(aq)$. The manganese (II) ions are then oxidised to form the deep purple permanganate ions, $MnO_4^-(aq)$. The concentration of permanganate ions can then be determined colorimetrically.

a. What is the oxidation number of manganese in the permanganate ion?

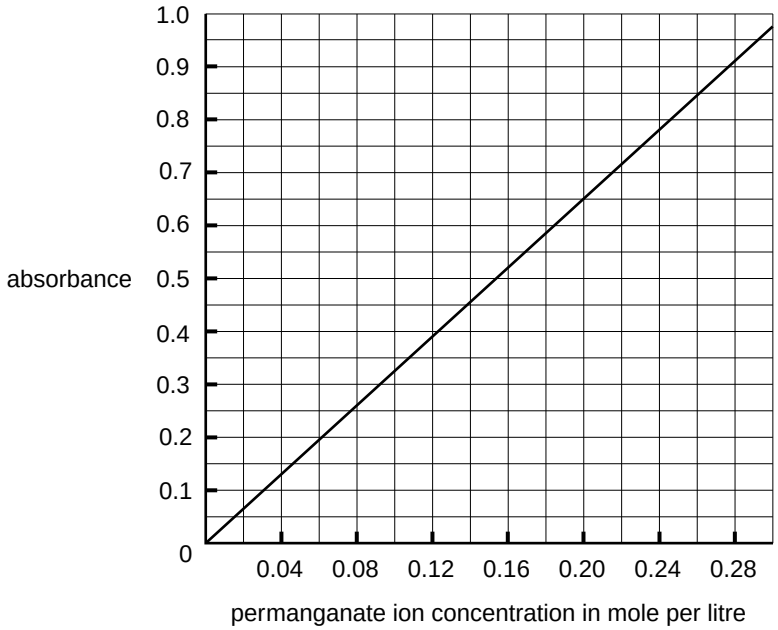
1 mark

b. Give the half equation for the oxidation of manganese (II) ions to permanganate ions.

1 mark

In a particular experiment, 12.5 g of a sample of steel containing manganese was dissolved in acid and the manganese oxidised to permanganate. The volume of the solution was made up to 100 mL. The absorbance of a 1mm thick sample of this solution was then measured in a colorimeter to be 0.65 at a preselected wavelength of 600 nm.

A set of standard solutions of potassium permanganate were made up and the absorbances of 1mm thick samples of these solutions were measured. A graph of permanganate ion concentration versus absorbance is given below.



c. What is the concentration of permanganate ions in the solution whose absorbance was 0.65?

1 mark

d. Calculate the mass of manganese in the steel sample.

2 marks

e. Calculate the percentage by mass of manganese in the steel sample.

1 mark

f. Explain what factors would be taken into account in choosing a wavelength (in this case 600 nm) at which to measure the absorbance of a potassium permanganate solution.

1 mark

g. Give two possible sources of systematic error in this determination of the amount of manganese in the steel sample.

2 marks

Total 9 marks

Working space

Question 5

a. Calcium carbonate ($CaCO_3$) is used as a 'brightener' in paper. A 0.987 g sample of paper containing $CaCO_3$ was added to 50.0 mL of 0.100 M HCl and allowed to stand. CO_2 was evolved according to the reaction

$$CaCO_3(s) + 2HCl(aq) \rightarrow CO_2(g) + CaCl_2(aq) + H_2O(l)$$

After the evolution of CO_2 had stopped, the paper sample was removed, washed with distilled water, dried and weighed. The dried paper weighed 0.830 g.

i. What was the percentage by mass of $CaCO_3$ in the original paper sample?

ii. Why was the paper washed with distilled water before it was dried?

2 + 1 = 3 marks

b. A second sample of paper, weighing 1.532 g, was added to another 50.0 mL of 0.100 M HCl and allowed to stand until the evolution of CO_2 had stopped. The solution was heated to drive off all the CO_2 from the solution. 27.0 mL of a 0.100 M NaOH solution were required to neutralise the residual HCl.

i. How many mole of NaOH were used in the reaction with the residual HCl?

ii. How many mole of $CaCO_3$ reacted with the HCl?

iii. What volume of CO_2 was released at 100 kPa and 21 ^oC?

iv. Calculate the percentage by mass of $CaCO_3$ in the paper sample.

1 + 3 + 2 + 1 = 7 marks

c. In a series of determinations, it was found that the results obtained by the titration technique described in **b.** were significantly more reproducible than results obtained from the technique described in **a.** Give the possible reason or reasons for this.

1 mark

Total 11 marks

Working space

Question 6

a. A VCE student has an aqueous solution of ethanol of unknown concentration. The student is also provided with a thin capillary tube, a ruler, some pure water, some pure ethanol, beakers and a balance. Explain how, using the materials provided, the student could obtain an estimate of the concentration of ethanol in the aqueous solution.

4 marks

b. The list of contents on the bottle of a child's bubble bath mix states that it contains ammonium lauryl sulfate, $CH_3(CH_2)_9SO_3NH_4$.

i. Write an equation showing the products formed when this substance is dissolved in water.

ii. The ammonium lauryl sulfate is directly responsible for the formation of bubbles in the bubble bath. It also has another function. What is that function?

iii. Briefly explain in chemical terms how the ammonium lauryl sulfate carries out that other function.

2 + 1 + 2 = 5 marks

Total 9 marks

END OF QUESTION AND ANSWER BOOK