Curriculum Council

Tertiary Entrance Examination, 2002

Question/Answer Booklet

CHEMISTRY

Please place your student identification label in this box

Student Number: In figures

In words _____

_____

Time allowed for this paper

Reading time before commencing work: Ten minutes
Working time for paper: Three hours

Materials required/recommended for this paper

To be provided by the supervisor

This Question/Answer Booklet
Separate Multiple Choice Answer Sheet
Chemistry Data Sheet (inside front cover of this Question/Answer Booklet)

To be provided by the candidate

Standard items: Pens, pencils, eraser or correction fluid, ruler
Special items: A 2B, B or HB pencil for the separate Multiple Choice Answer Sheet and calculators satisfying the conditions set by the Curriculum Council for this subject.

Important note to candidates

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

Structure of this paper

Part	Number of questions available	Number of questions to be attempted	Suggested working time	Marks available
1 Multiple choice	30	All	55	60 (30%)
2 Short answers	12	All	60	70 (35%)
3 Calculations	5	All	45	50 (25%)
4 Extended answers	2	1	20	20 (10%)
			Total marks	200 (100%)

Instructions to candidates

1. The rules for the conduct of Tertiary Entrance Examinations are detailed in the booklet *TEE Handbook.* Sitting this examination implies that you agree to abide by these rules.

2. Answer the questions according to the following instructions:

   Part 1 Answer **all** questions, using a 2B, B or HB pencil, on the separate Multiple Choice Answer Sheet. Do **not** use a ball point or ink pen.

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

   Feel free to write or do working on the question paper; many students who score high marks in the Multiple Choice Section do this.

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

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

3. The examiners recommend that you spend your reading time mainly reading the instructions to candidates and Parts 2, 3 and 4.

4. **Chemical equations**
   For full marks, chemical equations should refer only to those species consumed in the reaction and the new species produced. These species may be **ions** [for example $Ag^+(aq)$], **molecules** [for example $NH_3(g)$, $NH_3(aq)$, $CH_3COOH(l)$, $CH_3COOH(aq)$] or **solids** [for example $BaSO_4(s)$, $Cu(s)$, $Na_2CO_3(s)$].

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PART 1 **(60 marks)**

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

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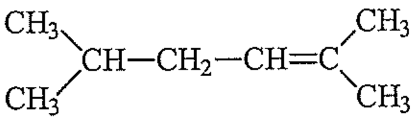
1. What is the correct name for the following formula?



(a) 1,1,4,4-tetramethylbutene

(b) 1,1,4,4-tetramethyl-3-butene

(c) 2,5-dimethyl-2-hexene

(d) 2,5-dimethyl-4-hexene

2. Which one of the following compounds can form geometric (*cis/trans*) isomers?

(a) 1-butene

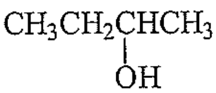
(b) 2-methyl-1-butene

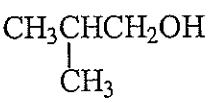
(c) 1-pentene

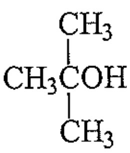
(d) 2-pentene

3. Which formula represents a substance that can be oxidised to a ketone?

(a) $CH_3CH_2CH_2CH_2OH$

(b) 

(c) 

(d) 

4. Which one of the following will change the value of the equilibrium constant (K) for a reaction?

   (a) Increasing the pressure

   (b) Increasing the state of subdivision of the reactants

   (c) Increasing the temperature

   (d) Nothing, since it is a constant

5. The solvent acetone (propanone) can be made by heating 2-propanol with a copper catalyst. The reaction, which is endothermic, is represented by the following equation.

   What happens if the temperature of the system is increased from 300°C to 400°C?

   (a) The yield of acetone increases.

   (b) The yield of hydrogen decreases.

   (c) The yield of acetone is unchanged because the forward and reverse reactions are both accelerated.

   (d) The yield of acetone decreases.

6. An element reacts vigorously with cold water to produce hydrogen. It forms colourless ions and its salts are all soluble. Which of the following is the most likely identity of the element?

   (a) Cu

   (b) Fe

   (c) K

   (d) Mg

7. An element 'X' forms chlorides $XC\ell_2$, $XC\ell_3$ and $XC\ell_4$. Which one of the following is X?

(a) C

(b) Ga

(c) Sr

(d) Ti

8. Which of the following elements has the lowest first ionisation energy?

(a) B

(b) Be

(c) K

(d) Mg

9. Which of the following is the electron configuration of N^{3-} ?

(a) $1s^2 2s^2$

(b) $1s^2 2s^2 2p^3$

(c) $1s^2 2s^2 2p^6$

(d) $1s^2 2s^2 2p^6 3s^2 3p^1$

10. Which one of the following ions does **not** have the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6$?

(a) Br^-

(b) Ca^{2+}

(c) $C\ell^-$

(d) S^{2-}

11. Which one of the following is **true** of the atoms of a given element?

(a) The number of neutrons must be greater than the number of electrons.

(b) The number of protons must be equal to the number of neutrons.

(c) The number of protons must equal the number of electrons.

(d) The number of protons must be greater than the number of neutrons.

12. Which best describes how the periodic table is ordered?

(a) The acidities of the oxides

(b) The atomic numbers of the elements

(c) The ionisation energies of the elements

(d) The masses of the atoms

13. On which one of the following does the type of bond formed between two atoms depend?

(a) Their atomic weights

(b) Their electronegativities

(c) The electrical conductivity of the compound

(d) The melting and boiling point of the compound

14. Which one of the following groups contains only oxides that would form acids when dissolved in water?

(a) MgO, CaO, $A\ell_2O_3$

(b) MgO, $C\ell_2O$, PbO

(c) NO_2, Na_2O, CO_2

(d) NO_2, SO_2, $C\ell_2O$

15. Which one of the following statements about the Group I elements is **false**?

(a) Chemical reactivity increases down the group.

(b) The first ionisation energy increases down the group.

(c) The ions have the electronic configuration of a noble gas.

(d) The oxides are all basic.

16. In which one of the following compounds is the oxidation number of sulfur higher than in any of the other compounds listed?

(a) $CuSO_4$

(b) NaSH

(c) $Na_2S_2O_3$

(d) SO_2

Questions 17 and 18 are both about the following experiment.

An electric current is passed through a solution containing 1 mol L^{-1} each of $MgSO_4$, KI and $HC\ell$, using two platinum electrodes.

17. Which one of the following species is produced at the anode?

(a) $C\ell_{2(g)}$

(b) $I_{2(aq)}$

(c) $Mg_{(s)}$

(d) $O_{2(g)}$

18. Which one of the following species is produced at the cathode?

(a) $H_{2(g)}$

(b) $I_{2(aq)}$

(c) $K_{(s)}$

(d) $Mg_{(s)}$

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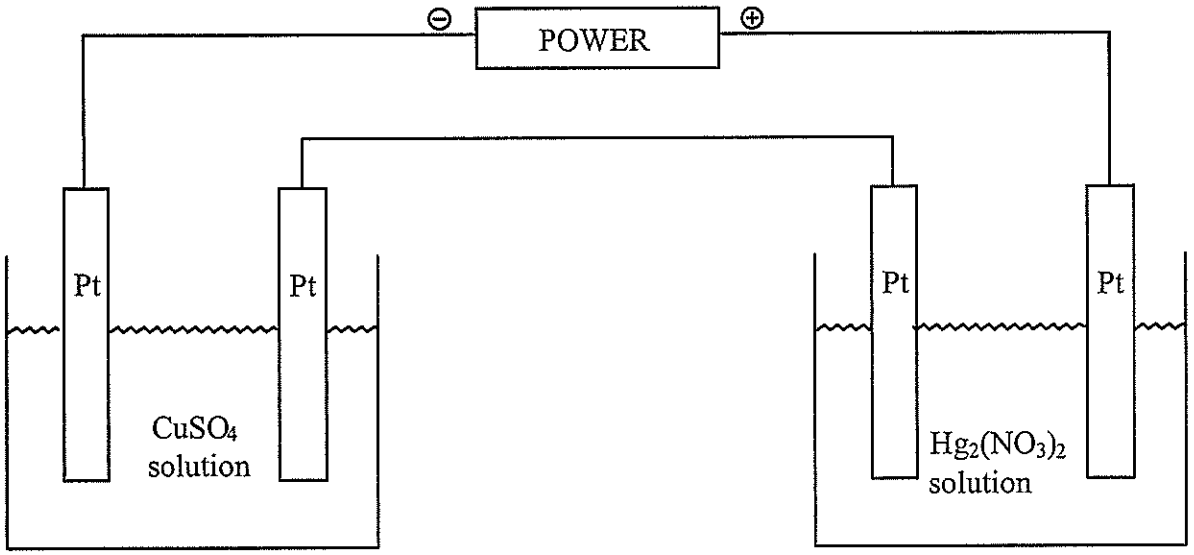
19. A quantity of electricity is passed through the two solutions as shown in the diagram below.



What is the ratio of the number of moles of copper deposited to the number of moles of mercury deposited? {that is, n(Cu):n(Hg)}.

(a) 1:1

(b) 1:2

(c) 2:1

(d) 3:1

20. For the following equation

$2H_2O_2(\ell) \rightarrow 2H_2O(\ell) + O_2(g)$

which one of the following statements is **true**?

(a) Hydrogen peroxide is acting as an acid.

(b) Hydrogen peroxide is acting as an acid and a base.

(c) Hydrogen peroxide is acting as an oxidising agent only.

(d) Hydrogen peroxide is acting as an oxidising and reducing agent.

21. Using the standard reduction potential tables predict which one of the following reactions will possibly occur spontaneously.

(a) $Zn^{2+} + Sn \rightarrow Zn + Sn^{2+}$

(b) $MnO_2 + H_2O_2 + 2H^+ \rightarrow Mn^{2+} + 2H_2O + O_2$

(c) $2MnO_4^- + 4H_2O + 6Br^- \rightarrow 3Br_2 + 2MnO_2 + 8OH^-$

(d) $Cr_2O_7^{2-} + 11H^+ + 3C\ell^- \rightarrow 2Cr^{3+} + 4H_2O + 3HC\ell O$

22. When doing oxidation-reduction titrations between potassium permanganate solution and oxalic acid solution, sulfuric acid is used to acidify the potassium permanganate. Hydrochloric acid is not used for this purpose. Why is this?

(a) Hydrochloric acid will react with the oxalic acid.

(b) Sulfuric acid produces more hydrogen ions than hydrochloric acid.

(c) The chloride ions can be oxidised to chlorine gas by the permanganate ions.

(d) The sulfate ions are used to maintain the electrical neutrality of the solutions.

23. Which one of the following is **true** of a standard solution?

(a) It must contain a primary standard substance.

(b) It must contain hydrochloric acid.

(c) It must have an accurately known concentration.

(d) It must have a concentration of 0.100 mol L^{-1}.

24. Which one of the following is most likely to be able to act as **both** an acid and a base?

(a) $C\ell^-$

(b) NH_4^+

(c) OH^-

(d) O^{2-}

25. When asked to list the properties of an acid-base indicator a student gave four statements (A – D).

A It must undergo an acid-base reaction.

B It is easily oxidised to a coloured product.

C It has acid-base conjugate forms with different colours.

D It can be used to prepare a standard solution.

The student's response was not entirely correct, as only some of the statements were true. Which combination of statements is correct?

(a) Only A and B

(b) Only A and C

(c) Only A and D

(d) Only B and C

26. Which of the following statements **best** describes a neutral aqueous solution?

(a) The concentrations of H^+ and OH^- are equal.

(b) The pH is 7.

(c) The solution contains no basic or acidic species.

(d) The solution may contain dissolved salts.

27. Each of the following salts is dissolved in water. Which answer correctly classifies the salts as acidic, basic or neutral?

	$Na_2CO_3(aq)$	$NH_4C\ell$ (aq)	$K_3PO_4(aq)$	$FeC\ell_3(aq)$
(a)	neutral	acidic	basic	basic
(b)	acidic	basic	neutral	basic
(c)	basic	acidic	basic	acidic
(d)	basic	basic	acidic	acidic

28. When the pH of a 0.01 mol L^{-1} solution of sulfuric acid is measured it is found to be significantly lower than the pH of a 0.01 mol L^{-1} solution of phosphoric acid. What is the reason for this?

(a) Phosphoric acid is a triprotic acid, while sulfuric acid is only diprotic, therefore the concentration of hydrogen ions is higher in the phosphoric acid solution than in the sulfuric acid solution.

(b) Phosphoric acid is a stronger acid than the sulfuric acid, so the phosphoric acid is more likely to produce hydrogen ions in solution than sulfuric acid.

(c) Sulfuric acid is a much stronger acid than phosphoric acid, so there are more hydrogen ions in the sulfuric acid solution than the phosphoric acid solution.

(d) The sulfuric acid solution is more concentrated than the phosphoric acid solution, therefore there will be more hydrogen ions in the sulfuric acid solution than the phosphoric acid solution.

29. In the production of alumina, bauxite is treated with hot sodium hydroxide solution. Subsequently, purified aluminium hydroxide is precipitated. Which of the following is **essential** for precipitation to occur?

(a) Addition of acid to neutralise the NaOH

(b) Cooling the solution, causing it to become supersaturated

(c) Filtering off insoluble impurities

(d) The addition of seed crystals

30. If a solution contains 1.35×10^{-3} mol L^{-1} of NaCℓ, what is the concentration in ppm of Na^+ ? (Assume the density of the solution is 1.00 g mL^{-1}.)

(a) 1350 ppm

(b) 78.9 ppm

(c) 47.9 ppm

(d) 31.0 ppm

END OF PART 1

SEE NEXT PAGE

PART 2 (70 marks)
Answer ALL questions in Part 2 in the spaces provided below.

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1. Write equations for any reactions that occur in the following procedures. If no reaction occurs write 'no reaction'.

   In each case describe **in full** what you would observe, including any
   - colours
   - odours
   - precipitates (give the colour)
   - gases evolved (give the colour or describe as colourless).

   If no change is observed, you should must state this as the observation.

(a) 1-butene is bubbled into a dilute bromine solution.

Equation _____

Observation _____

_____

[3 marks]

(b) Lead(II) nitrate solution is added to sodium iodide solution.

Equation _____

Observation _____

_____

[3 marks]

(c) Gold(III) chloride solution is added to solid copper.

Equation _____

Observation _____

_____

[3 marks]

(d) Sodium metal is added to pure acetic acid (ethanoic acid).

Equation _____

Observation _____

_____

[3 marks]

2. For each species listed in the table below draw the structural formula, representing **all** valence shell electron pairs either as : or as –
[for example, water H : O : H or H–O–H or H–O–H and so on]

Species	Structural formula (showing all valence shell electrons)
Ammonium ion, NH_4^+	
Carbon dioxide, CO_2	
Acetic acid (ethanoic acid), CH_3COOH	

[6 marks]

3. Identify by name or formula an example of each of the following.

Description	Name or Formula
An amphoteric metal	
A material used to make sacrificial anodes	
A gas which when dissolved in water gives a basic solution	
A colourless, pungent gas	
A brown gas	
An element which is liquid at room temperature	
A primary standard for a redox titration	

[7 marks]

4. Fill in the boxes of the table below with a molecule, chosen from the list provided, that matches the description in the box. While there may be more than one molecule that matches the description, only one answer per box is required.

CH_4 CH_2O $CH_2C\ell_2$ NO_2^- HF Na^+ SO_3 $C\ell_2$ H_2O NH_3

A bent, polar species	A non-polar species	A species that can form hydrogen bonds between its molecules of the same type	A triangular-planar, non-polar species
A tetrahedral, polar species	A triangular-planar, polar species	A pyramidal species	A species that only contains non-polar bonds

[8 marks]

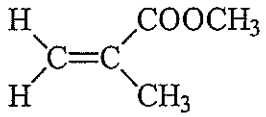
5. Concentrated ammonia solution is added dropwise to a copper sulfate solution. Initially a pale blue precipitate is formed, which dissolves on the addition of further ammonia solution to leave a dark blue solution. With the aid of equations explain the observations. (You should have at least **two** equations in your answer.)

[6 marks]

6. Draw structural formulas for **two** aromatic compounds with the molecular formula C_8H_{10}.

[4 marks]

7. (a) Given the monomer below, draw a portion of the polymer that would be produced from it (your polymer should contain a minimum of **three** monomer units).

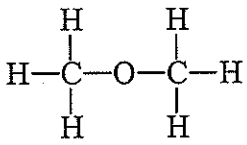


(b) What type of polymer has been produced here?

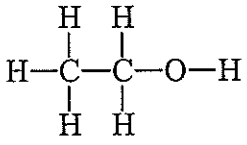
(c) What structural characteristic must the monomers of this type of polymer have?

[4 marks]

8. Consider the two compounds shown below.



A



B

Compound A is a gas at room temperature (b.p. – 24°C) and compound B is a liquid at room temperature (b.p. 78°C). The two compounds have the same molecular formula. With the aid of labelled diagrams explain why compound B has the higher boiling point.

[4 marks]

9. Write the equilibrium constant expression for each of the following:

Equation	$CaCrO_4(s) \rightleftharpoons Ca^{2+}(aq) + CrO_4^{2-}(aq)$
Equilibrium constant expression	

Equation	$4NO_2(g) + 6H_2O(g) \rightleftharpoons 7O_2(g) + 4NH_3(g)$
Equilibrium constant expression	

[4 marks]

10. The following equilibrium is being investigated:

$2ZnS(s) + 3O_2(g) \rightleftharpoons 2ZnO(s) + 2SO_2(g)$ $\Delta H = -879$ kJ

Three identical sealed boxes are set up, each containing the equilibrium mixture. Each of the boxes is treated as described below, and time is allowed for a new equilibrium to be established. In each case describe the change between the original equilibrium and the new equilibrium.

Treatment	What happens to the rate of the forward reaction? Write 'increases', 'decreases' or 'no change'.	What happens to the equilibrium position? Write 'move to the right', 'move to the left' or 'no change'.
A small amount of $O_2(g)$ is added.		
Ne(g) is pumped in, increasing the pressure of the system (no volume change).		
The reaction vessel is heated.		

[6 marks]

11. The second step in the contact process for H_2SO_4 manufacture involves the reaction

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) + 198\ kJ$$

This process is carried out at 400 to 600°C and 1 atmosphere pressure. Explain the choice of these conditions.

[5 marks]

12. Petrol and kerosene do not easily remove adhesive residue from price stickers, but acetone (propanone) and methylated spirits (ethanol) are effective. Explain.

[4 marks]

END OF PART 2

SEE NEXT PAGE

PART 3 (50 marks)

Answer ALL questions in Part 3. The calculations are to be set out in detail in this Question/Answer Booklet. Marks will be allocated for correct equations and clear setting out, even if you cannot complete the problem. When questions are divided into sections, clearly distinguish each section using (a), (b), and so on. Express your final numerical answers to three (3) significant figures where appropriate, and provide units where applicable. Information which may be necessary for solving the problems is located on the separate Chemistry Data Sheet. Show clear reasoning: if you don't, you will lose marks.

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1. 260.0 L of oxygen and 74 g of octane, $C_8H_{18}(\ell)$, were combusted in a rigid vessel. The system was initially at 20°C and 80 kPa.

   (a) Write the equation for the reaction that occurs.

   [2 marks]

   (b) After the reaction the system was cooled to 26°C. What partial pressure of carbon dioxide will be present under these conditions assuming the volume of the vessel is still 260.0 L?

   [5 marks]

   (c) What mass of the excess reactant will be present?

   [3 marks]

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2. A silver-zinc battery could be a lighter but more expensive alternative to the lead-acid accumulator battery. The silver zinc battery uses an alkaline electrolyte and produces a voltage of 1.59 V under normal operating conditions. The reaction that occurs in such a battery can be represented by the following equation:

$$Ag_2O(s) + Zn(s) + H_2O(\ell) \rightarrow Zn(OH)_2(s) + 2Ag(s)$$

The lead-acid accumulator battery produces a voltage of 2.0 V per cell under normal operating conditions. Its reaction is represented by the equation:

$$Pb(s) + PbO_2(s) + 2HSO_4^-(aq) + 2H^+(aq) \rightarrow 2PbSO_4(s) + 2H_2O(\ell)$$

(a) What is the total charge (Q) that would be produced for each gram of zinc consumed in the silver-zinc battery?

[3 marks]

(b) What is the total charge that would be produced for each gram of lead metal consumed in the lead-acid accumulator battery?

[3 marks]

(c) How long will it take for 1.00 g of zinc to be consumed in a silver-zinc battery if it produces 0.100 A?

[1 mark]

(d) How long will it take for 1.00 g of lead to be consumed in the lead-acid accumulator battery if it produces 0.100 A?

[1 mark]

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3. A hydrated compound had the empirical formula $Fe_x(CO)_y.zH_2O$. A 5.319 g sample of this compound was heated at 120°C for an hour and weighed. It was found to have a mass of 4.030 g. It was then heated for a further 30 minutes and, when weighed, was found to have a mass of 4.029 g.

   The residual compound was then burnt in pure oxygen to produce 1.914 g of Fe_2O_3 and 4.214 g of carbon dioxide. No water was produced.

   (a) Determine the values of x, y and z.

   [9 marks]

   (b) Why was the compound weighed twice during the initial heating?

   [1 mark]

SEE NEXT PAGE

4. Ilmenite is a component of mineral sands that is used in the production of titanium. Ilmenite ($FeTiO_3$) is reduced with carbon (obtained from coal) to form "reduced ilmenite" which is a mixture of iron metal and TiO_2.

$2\ FeTiO_3 + C \rightarrow 2\ Fe + 2\ TiO_2 + CO_2$.....(Equation 1)

The metallic iron content of the "reduced ilmenite" is analysed by treatment with copper sulfate solution, which dissolves the iron as Fe^{2+}. Excess Cu^{2+} is removed by the addition of aluminium powder. The resultant solution, containing Fe^{2+}, is acidified and titrated with potassium dichromate solution.

(a) Write the equation for the displacement of metallic iron by the copper sulfate solution.

[2 marks]

A 1.068 g sample of "reduced ilmenite" was treated as described, and the solution made up to 250 mL. A 50.0 mL aliquot of this solution was titrated with 0.0143 mol L^{-1} potassium dichromate solution. The endpoint occurred at 16.9 mL.

(b) Write an equation for the titration reaction.

[1 mark]

(c) Calculate the metallic iron content of the reduced ilmenite as a percentage.

[6 marks]

(d) Calculate the theoretical percentage of metallic iron in the solid product of Equation 1.

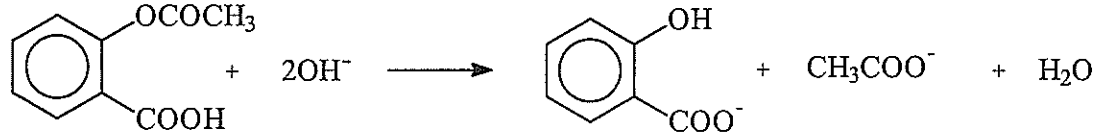
[2 marks]

(e) Excluding the possibility of experimental error, suggest a reason for any difference between the answers for (c) and (d).

[1 mark]

SEE NEXT PAGE

5. The official analysis method for aspirin (acetylsalicylic acid) is to dissolve a sample in sodium hydroxide solution and titrate the excess hydroxide with standard hydrochloric acid, using phenol red indicator. The reaction of aspirin with hydroxide is given by:



Acetylsalicylic acid

Aspirin tablets contain acetylsalicylic acid and an unreactive binding material.

To analyse a supply of aspirin tablets claimed to contain 300 mg of acetylsalicylic acid in each tablet, 20 tablets weighing a total of 7.576 g were crushed and a sample of powder weighing 0.619 g was gently boiled for 10 minutes with 30.00 mL of **approximately** 0.5 mol L^{-1} NaOH. After cooling, the solution was titrated with 0.548 mol L^{-1} HCℓ using phenol red indicator. 17.62 mL of HCℓ was required.

In a separate 'blank' titration, 30.00 mL of the same approximately 0.5 mol L^{-1} NaOH was gently boiled for 10 minutes, cooled and titrated with the standard 0.548 mol L^{-1} HCℓ. The volume of HCℓ required was 27.65 mL.

(a) How many moles of sodium hydroxide were consumed in the reaction with the 0.619 g of powdered sample?

[4 marks]

(b) What mass of acetylsalicylic acid, $C_9H_8O_4$, was in the 0.619 g sample?

[2 marks]

(c) How many tablets does 0.619 g of powder represent?

[1 mark]

(d) What is the mass of acetylsalicylic acid per tablet?

[2 marks]

(e) The British Pharmacopoeia (an authoritative catalogue of drugs) requires that aspirin tablets contain 95-105% of the mass of acetylsalicylic acid claimed. Do the tablets fit this requirement?

[1 mark]

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PART 4 (20 marks)

Answer ONE of the following two extended answer questions. Where applicable use equations, diagrams and illustrative examples of the chemistry you are describing.

Marks are awarded for the relevant chemical content of your answer, and also for coherence and clarity of expression. Your answer should be presented in about $1^1/_2$ - 2 pages. Begin your essay on the lined page following the end of the questions.

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1. Many metals are extracted from their ores by chemical processing. The following methods have been used commercially, although the methods may no longer be in use.

   Sodium is obtained by electrolysis of molten NaCℓ.

   Magnesium is obtained by electrolysis of molten $MgC\ell_2$.

   Aluminium can be obtained by reaction of sodium with aluminium chloride:

   $$AlC\ell_3\ (g) + 3\ Na\ (\ell) \rightarrow A\ell\ (\ell) + 3\ NaC\ell\ (\ell)$$

   Silicon can be obtained by treatment of silicon tetrachloride with zinc:

   $$SiC\ell_4\ (g) + 2\ Zn\ (\ell) \rightarrow Si\ (s) + 2\ ZnC\ell_2\ (\ell)$$

   Note that silicon is not strictly a metal, and does not form monatomic ions, but the E^o for the reaction $SiO_2 + 4\ H^+ + 4e^- \rightarrow Si + 2\ H_2O$ can be taken as -0.82 V.

   Lead can be obtained by roasting lead sulfide in air, then heating the lead oxide product with carbon:

   $$2\ PbS\ (s) + 3O_2\ (g) \rightarrow 2\ PbO\ (s) + 2SO_2\ (g)$$ then
   $$2\ PbO\ (s) + C\ (s) \rightarrow 2\ Pb\ (\ell) + CO_2\ (g)$$

   Copper can be obtained by roasting copper sulfide in air, and then reducing the resultant copper oxide with further copper sulfide:

   $$2\ CuS\ (s) + 3\ O_2\ (g) \rightarrow 2\ CuO\ (s) + 2\ SO_2\ (g)$$ then
   $$CuS\ (s) + 2\ CuO\ (s) \rightarrow 3\ Cu\ (\ell) + SO_2\ (g)$$

   Silver can be found in nature in the elemental state (native silver), or it can be extracted from ore by a cyanide-complex method. It is also a by-product of gold production.

   Mercury can be found in nature in the elemental state, or it can be extracted directly from the sulfide by roasting in air:

   $$HgS\ (s) + O_2\ (g) \rightarrow Hg\ (\ell) + SO_2\ (g)$$

   Discuss the chemical basis and conditions of these processes, comparing them with what you know about the extraction of metals such as aluminium, gold and iron. Consider the relative cost of reagents (other than the metal ore) and conditions in your answer. Use your E^o table as a guide to the relative ease of reduction of the metals' compounds.

OR

SEE NEXT PAGE

2. Many alcohols are industrially important. Discuss the chemistry of alcohols with reference to the examples described below.

In your answer

(a) use your understanding of intermolecular interactions to explain the variations in properties of alcohols.
(b) discuss the chemical reactions that alcohols undergo.

Physical Properties of Alcohols

Up to C_{10} the straight chain alcohols are colourless liquids with characteristic odours at room temperature. The longer chain alcohols are waxy solids. The boiling points of alcohols are considerably higher than for corresponding hydrocarbons. This is particularly true for the shorter chain alcohols. The table below gives the boiling points for some of the shorter chain alcohols and their solubility in water.

Methanol, ethanol and the propanols are miscible (completely soluble) with water. With increasing molar mass, the solubility decreases significantly.

Alcohol	Boiling point °C	Solubility in H_2O (g/100mL)
methanol	64.7	miscible
ethanol	78.3	miscible
1-propanol	97.2	miscible
2-propanol	82.4	miscible
1-butanol	117.7	6.32 g
2-methyl-1-propanol	107.9	9.5 g
2-butanol	99.5	15 g
2-methyl-2-propanol	82.6	miscible

END OF QUESTIONS

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

Write your response to Part 4 below.

Published by the Curriculum Council of Western Australia
27 Walters Drive
OSBORNE PARK WA 6017