



NATIONAL EXAMINATIONS COUNCIL
P.O.BOX 3817 KIGALI

Chemistry III

003

10th Nov 2008 8.30am-11.30am

ORDINARY LEVEL NATIONAL EXAMINATION 2008

SUBJECT : CHEMISTRY III

TIME : 3 HOURS

INSTRUCTIONS:

- This paper consists of **THREE** Sections A, B and C.
- Answer **ALL** the questions in section A. (55 marks)
- Answer **THREE** questions in section B. (30 marks)
- Answer only **ONE** question in section C. (15 marks)
- Calculators may be used.

Section	PH value
A	10
B	10
C	10

Section A: Answer all questions

(55 marks)

1. a) Name two types of hardness of water. (2 marks)
 b) i) Give the causes of hardness of water. (2 marks)
 ii) Briefly explain how one of the types of hardness can be removed. (1 mark)
2. Methane burns in oxygen to give carbon dioxide and water vapour only.
 a) Write a balanced equation for this reaction. (1 mark)
 b) Calculate the volume of oxygen needed for the complete combustion of 100cm³ of methane. (All volumes of gases were measured at the same temperature and pressure) (2 marks)
3. The following techniques are used for the separation of mixtures: evaporation, chromatography, filtration, fractional distillation and sublimation. Which of these is the most suitable technique for obtaining?
 - a) Sodium chloride from a solution of sodium chloride? (1 mark)
 - b) Ammonium chloride from a white powder composed of ammonium chloride and sodium chloride? (1 mark)
 - c) Small pieces of metal from the engine oil of a car? (1 mark)
 - d) The different pigments from an extract of flower petals? (1 mark)
4. Calculate the number of water molecules in 900g of water (H₂O).
 (Relative atomic masses: H = 1, O = 16, Avogadro's number = 6.0 × 10²³ per mole). (2 marks)
5. Sodium is manufactured by the electrolysis of molten sodium chloride containing calcium chloride in the Downs cell.
 - a) Why is calcium chloride added? (1 mark)
 - b) i) Name the product at the anode. (1 mark)
 ii) Write an equation showing the discharge at the anode. (1 mark)

6. In an experiment concerning the displacement of one metal from an aqueous solution of salt by another metal, the results were tabulated as follows:

Solution	Metal A	Metal B	Metal C	Metal D
Solution of salt A	-	W	Reaction	X
Solution of salt B	Reaction	-	Reaction	Reaction
Solution of salt C	No reaction	No reaction	-	Y
Solution of salt D	Reaction	No reaction	Z	-

The table shows whether or not a reaction occurs between a metal and a solution of another metal salt.

- a) Arrange the metals in order of reactivity giving the most reactive one first. (4 marks)
 - b) State whether a reaction will take place in the spaces labeled W, X, Y and Z. (4 marks)
7. Classify solutions A, B and C.

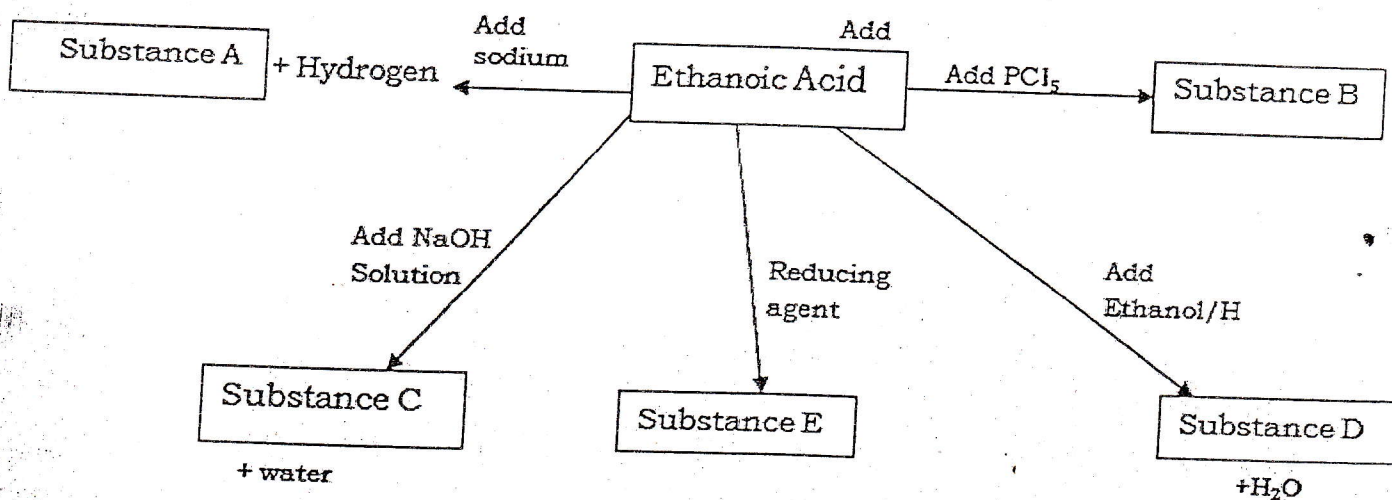
Solution	pH value
A	7
B	3
C	10

8. a) Which method can be used to separate the compounds of air? (2 marks)

- b) What is meant by air pollution? (1 mark)
- c) Name two sources of air pollution. (2 marks)
9. a) What is the cause of inertness of nitrogen? (1 mark)
- b) The following reaction: $N_{2(g)} + 3H_{2(g)} + 2NH_{3(g)}$ takes place during Haber process. Give the optimum conditions used in the process (temperatures, pressure, catalyst) for this reaction. (2 marks)
- c) What feature of the catalyst in (b) makes it efficient? (1 mark)
10. a) Give one example of (i) a reaction which shows effervescence. (1 mark)
- (ii) an exothermic reaction. (1 mark)
- b) Complete the following equations: (1 mark)
- i) $SO_2 + H_2O \longrightarrow$
- ii) $Na + H_2O \longrightarrow$
11. a) Write an equation for the reaction that takes place when hydrogen reacts with copper (II) oxide. (1 mark)
- b) i) State which of the species is a reducing agent. Give a reason for your answer. (2 marks)
- ii) Which is an oxidizing agent? (1 mark)
12. Give three means of preventing the rusting of iron. (3 marks)
13. Write the formula of:
- (a) Ammonium phosphate
- (b) Potassium chloride
- (c) Pentanol
- (d) Butane
14. An organic compound contains 40% by mass of carbon, 13.3% hydrogen and 46.7% nitrogen.
- a) Calculate the empirical formula of the compound. (2 marks)
- b) If the relative molecular mass of the compound is 60, determine its molecular formula. (Relative atomic masses: C = 12, H = 1, n = 1) (1 mark)
15. Give one example of: (a) A weak electrolyte (b) A non-electrolyte (c) A conductor. (3 marks)

SECTION B: Answer any THREE questions. (30 marks)

16. a) The following question is about some of the reactions of ethanoic acid. Study the chart below and answer the questions that follow.



- i) Write the structural or molecular formula of ethanoic acid. (1 mark)
- ii) Write an equation to show how ethanoic acid reacts with sodium carbonate. (1 mark)
- iii) Give the formula of substances A, B, C, D and E. (5 marks)
- b) Name one natural polymer and give its monomers. (2 marks)
- c) Write the structural formula of ethane. (1 mark)

17. Answer the following questions about the extraction of iron. (no diagrams are required)

- a) Give the name and formula of one mineral from which iron is extracted. (2 marks)
- b) Explain how carbon monoxide is formed in the blast furnace. (3 marks)
- c) Write the equation for the reaction by which iron is formed in the furnace from its ore. (1 mark)
- d) Name two impurities likely to be present in the "Pig iron" formed in the blast furnace. (2 marks)
- e) Explain clearly why limestone (calcium carbonate) is used in the blast furnace. (2 marks)

18. Sulphuric acid is manufactured by converting sulphur dioxide to sulphur trioxide and dissolving this in 95-98 per cent sulphuric acid, whilst adding an appropriate amount of water.

- a) How is the sulphur dioxide obtained? (2 different methods) (2 marks)
- b) i) Name one catalyst commonly used in this process. (1 mark)
- ii) Name another catalyst not commonly used and explain why. (2 marks)
- c) Why is sulphur trioxide not dissolved in water directly? (1 mark)
- d) Give two uses of sulphuric acid. (2 marks)
- e) Complete the following equations: (2 marks)
- (i) $\text{H}_2\text{SO}_4 + \text{NaCl} \longrightarrow$
- (ii) $\text{Zn} + \text{H}_2\text{SO}_{4(\text{aq})} \longrightarrow$

19. What volume of 0.1M sodium hydroxide solution:

- a) Contains 0.0025 mol of sodium hydroxide? (3 marks)
- b) Neutralizes 25cm³ of 0.05M sulphuric acid solution? (4 marks)
- c) Reacts exactly with 0.5 mol of hydrochloric acid? (3 marks)
- (Relative atomic mass: Na = 23, H = 1, O = 16, S = 32, Cl = 35.5)

20. a) Write down the electronic configuration of chlorine.

(Atomic number of chlorine = 17) (1 mark)

- b) Explain why chlorine forms an ion Cl⁻. (2 marks)
- c) Write the symbol for the magnesium ion. (Atomic number of magnesium = 12) (1 mark)
- d) Write the formula and the name for the compound formed when these two elements combine. (2 marks)
- e) Would you expect this compound to have a high or low melting point? Give a reason. (2 marks)
- f) Indicate whether the bonding in the compound will be ionic or covalent. Give a reason for your answer. (Atomic number: Mg = 12, Cl = 17). (2 marks)

SECTION C: Answer only one question. (15 marks)

21. In an experiment to determine the volume of hydrogen produced when magnesium powder reacts with dilute hydrochloric acid, the volume of hydrogen produced was measured at different intervals of time. The following results were obtained.

Time (seconds)	0	5	10	20	30	40	50	60
Volume of H ₂ (cm ³)	0	32	52	78	93	95	95	95

- a) Write down the equation for the reaction. (1 mark)
 b) Suggest three ways of speeding up this reaction. (3 marks)
 c) Plot a graph of volume of H₂ produced (on y-axis) versus time (x-axis). (8 marks)
 d) Why is the volume of H₂ constant in the last three results? (1 mark)
 e) Why is the volume of H₂ = 0 cm³ when the time = 0 seconds? (1 mark)
 f) Suggest one use of hydrogen gas. (1 mark)

22. With the help of equations where possible, state the chemical test that would be used to distinguish each pair of the following substances and state the observation in each case.

- (a) Fe²⁺_(aq) and Cu²⁺_(aq)
 (b) C₂H_{4(g)} and C₂H_{6(g)}
 (c) C₅H_{(12)(l)} and C₂H₅OH (l)

(3 marks)

END

CHEMISTRY III 2008

SECTION A

Answer to question 1.

- a) Temporary hardness, Permanent hardness
 b) i) Temporary hardness → Caused by the presence of calcium(or magnesium) hydrogen carbonate dissolves in water.

Permanent hardness → caused by the presence of calcium and magnesium chloride and sulphate (Ca²⁺ and Mg²⁺ ions)

- ii) Temporary hardness: - Boil water
 - Distillation
 - Ca(OH)₂

Or both temporary and permanent hardness: - Add sodium carbonate to precipitate calcium and magnesium carbonate

Answer to question 2.

- a) CH_{4(g)} + 2O_{2(g)} → CO_{2(g)} + 2H₂O_(l)
 b) 1 Vol of CH₄ → 2 Vol of O₂
 100cm³ of CH₄ → 2×100 = 200cm³ of O₂.

Answer to question 3.

- a) Evaporation
 b) Sublimation
 c) Filtration
 d) Chromatography.

Answer to question 4.

H₂O = (2×1)+16 = 18
 Number of moles of water = $\frac{900}{18} = 18$.
 1 mole → 6.0 × 10²³ molecules
 50 moles → 6.0 × 10²³ × 50
 = 3.0 × 10²⁵ molecules

Answer to question 5.

- a) To lower the melting point of NaCl.
 b) i) Chlorine
 ii) 2Cl⁻ - 2e⁻ → Cl₂

<p>Answer to question 6.</p> <p>a) $C > A > D > B$.</p> <p>b) $W = \text{no reaction}$</p> <p>$X = \text{no reaction}$</p> <p>$Y = \text{no reaction}$</p> <p>$Z = \text{reaction}$</p>	<p>Answer to question 7.</p> <p>A - neutral</p> <p>B - Acidic</p> <p>C - Basic</p>
<p>Answer to question 8.</p> <p>a) Fractional distillation</p> <p>b) Placing/putting harmful substances in the atmosphere/air.</p> <p>c) - Incomplete combustion of wood/charcoal or fossil fuels to give carbon monoxide.</p> <p>- Burning of coal which contains sulphur or oxides of nitrogen from exhaust fumes of cars.</p>	<p>Answer to question 9.</p> <p>a) Strong triple bonds/strong covalent bond.</p> <p>b) $450 - 500^{\circ}\text{C}$</p> <p>$200 - 50\text{dm}$</p> <p>Iron - catalyst</p> <p>c) Finely divided/powder/grater surface area.</p>
<p>Answer to question 10.</p> <p>a) i) Combustion/neutralization/metal with an acid.</p> <p>b) i) $\text{SO}_2 + \text{H}_2\text{O} \longrightarrow \text{H}_2\text{SO}_3$</p> <p>ii) $\text{Na} + \text{H}_2\text{O} \longrightarrow 2\text{NaOH} + \text{H}_2$</p>	<p>Answer to question 11.</p> <p>a) $\text{CuO} + \text{H}_2 \longrightarrow \text{Cu} + \text{H}_2\text{O}$</p> <p>b) i) Hydrogen is the reducing agent because it removes oxygen from copper (II) oxide.</p> <p>ii) Copper (II) oxide.</p>
<p>Answer to question 12.</p> <ul style="list-style-type: none"> - Oiling/greasing - Painting - Galvanizing 	<p>Answer to question 13.</p> <p>a) $(\text{NH}_4)_3\text{PO}_4$</p> <p>b) KClO_3</p> <p>c) $\text{C}_5\text{H}_{11}\text{OH}$</p> <p>d) $\text{C}_4\text{H}_8\text{H}$</p>
<p>Answer to question 14.</p> <p>a) C H N</p> <p>$\frac{40}{12}$ $\frac{13.3}{1}$ $\frac{46.7}{14}$</p> <p>3.33 13.3 3.33</p> <p>1 4 1</p> <p>Hence: CH_4N</p>	<p>b) $(\text{CH}_4\text{N})_n = 60$</p> <p>$(12 + 1 \times 4 + 14)n = 60$</p> <p>$30n = 60$</p> <p>$n = \frac{60}{30} = 2.$</p> <p>$\text{MF} = (\text{CH}_4\text{N})_2 = \text{C}_2\text{H}_8\text{N}_2$</p>
<p>Answer to question 15.</p> <p>a) Weak acid/weak base/water e.g. CH_3COOH (weak acid), $\text{NH}_3(\text{aq})$ (weak base)</p> <p>b) Petrol/ethanol/sugar solution/water.</p> <p>c) Any metal/graphite</p>	

SECTION B

Answer to question 16.

a) i) CH_3COOH .



iii) A - $\text{CH}_3\text{C(=O)ONa}$ or CH_3COONa

B - $\text{CH}_3\text{C(=O)Cl}$ or CH_3COONa

C - $\text{CH}_3\text{C(=O)ONa}$ or CH_3COONa

D - $\text{CH}_3\text{C(=O)OCH}_2\text{CH}_3$ or $\text{CH}_3\text{COOC}_2\text{H}_5$

E - $\text{CH}_3\text{CH}_2\text{OH}$ or $\text{C}_3\text{H}_7\text{OH}$

b) Polymer - proteins

Monomer - Amino acid

Or starch (polymer) \longrightarrow glucose (monomer)

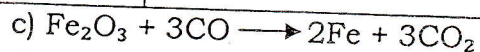
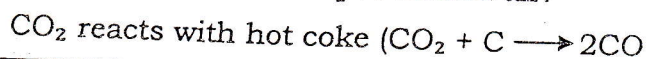
c) $\text{CH}_3(\text{CH}_2)_6\text{CH}_3$ or C_8H_{18}

Answer to question 17.

a) Iron oxide/Haematite (Fe_2O_3)

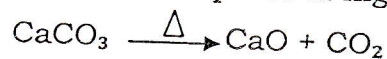
Alternatively : magnetite (Fe_3O_4), FeCO_3

b) Coke carbon burns in pre-heated air.



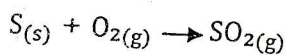
d) Sulphur/phosphorous/silicon, carbon

e) CaCO_3 decomposes at high temperature



Answer to question 18.

a) - Burning sulphur:



- Burning /roasting iron pyrites/any metal Sulphate



b) i) Vanadium pentoxide/ V_2O_5

ii) Platinum is not commonly used.

Because it is expensive and easily poisoned

c) Reaction with water too violent/vigorous

d) - Manufacture of fertilizers

- Used as acid for cars/automobile batteries

- Used as catalyst

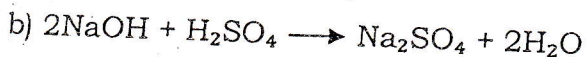


Answer to question 19.

a) $0.0025 = 0.1 \times \frac{V}{1000}$

$V = \frac{0.0025 \times 1000}{0.1}$

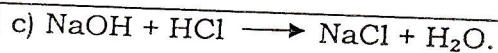
$V = 25\text{cm}^3$ (0.025dm³)



$n(\text{H}_2\text{SO}_4) = 0.5 \times \frac{25}{1000} = 0.00125$

$n(\text{NaOH}) = 2 \times 0.00125 = 0.0025$

$V = 0.025\text{dm}^3$ or 25cm^3



$0.5 \text{ mol HCl} = 0.5 \text{ mol NaOH}$.

$V \times 0.1 = 0.5$

$V = \frac{0.5}{0.1} = 5\text{dm}^3$ or 5000cm^3

Answer to question 20.

a) 2, 8, 7 or 2 : 8 : 7 or diagram

b) To attain the noble gas structure of argon by gain of an electron so that it is stable. Or to fill the outer shell so that it becomes stable.

c) Mg^{2+}

d) $\text{MgCl}_2 \longrightarrow$ Magnesium chloride.

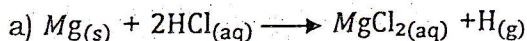
e) High melting point.

Giant ionic structure \longrightarrow strong attraction between ions or strong electrovalent bond.

f) Ionic \longrightarrow metal atoms donate electrons to non-metal atoms or a bond between a metal and a non-metal.

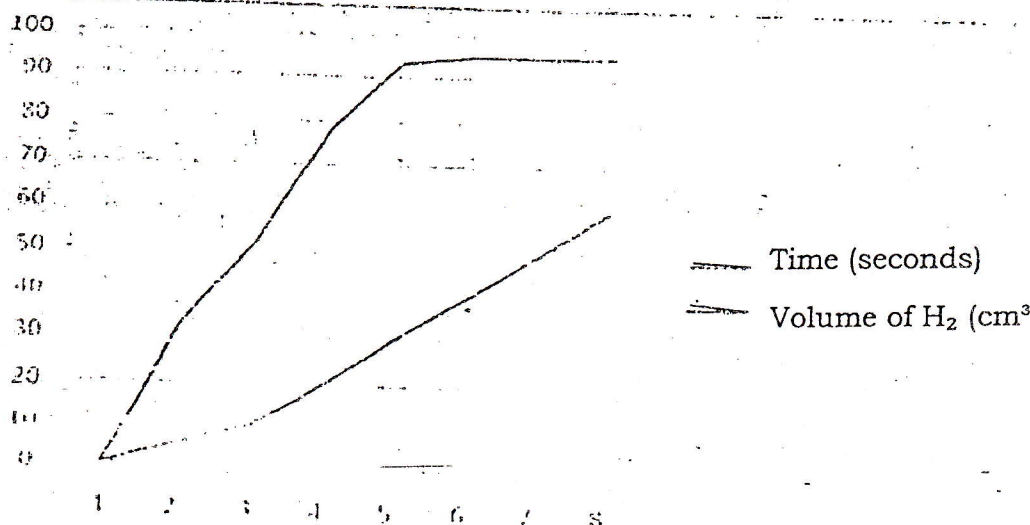
SECTION C:

Answer to question 21.



- b) - By shaking/ stir the mixture
 - Heat (increasing temperature)
 - Increasing the concentration of the reactant

c) A graph of volume of H_2 versus time:

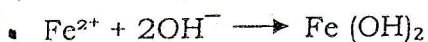


- d) Because the reaction is over
 e) Because the reaction has not yet started.
 f) Hydrogen is used: - As a fuel
 - To manufacture fats/Margarine
 - To fill balloons

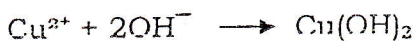
Answer to question 22.

a) Add NaOH/ NH_3 to each solution up to excess

Fe^{2+} , A green precipitate insoluble in excess



Cu^{2+} , a blue precipitate insoluble in excess.



N.B : If $NH_{3(aq)}$ is used

With Cu^{2+} , a deep blue solution is observed in excess $NH_{3(aq)}$

b) Mix with bromine water/aqueous bromine in the absence of light.

- With C_2H_4 , it decolorizes bromine water.
- $C_2H_6 \longrightarrow$ No observable reaction.

c) Add Na metal

- $C_5H_{12} \longrightarrow$ No change
- $C_2H_5OH \longrightarrow$ effervescence as H_2 is evolved.



Accept : alternatives e.g use of PCl_5

- With C_2H_5OH , an effervescence, HCl gas is produced.
- With C_5H_{12} , no observable change

END