

233/1

— CHEMISTRY — Paper 1



(THEORY)

Mar. 2021 – 2 hours

Name ..... Index Number .....

Candidate's Signature ..... Date .....

**Instructions to Candidates**

- (a) Write your name and index number in the spaces provided above.
- (b) Sign and write the date of examination in the spaces provided above.
- (c) Answer **all** the questions in the spaces provided in the question paper.
- (d) Non-programmable silent electronic calculators and KNEC mathematical tables may be used.
- (e) All working **must** be clearly shown where necessary.
- (f) This paper consists of 16 printed pages.
- (g) Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.
- (h) Candidates should answer the questions in English.

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

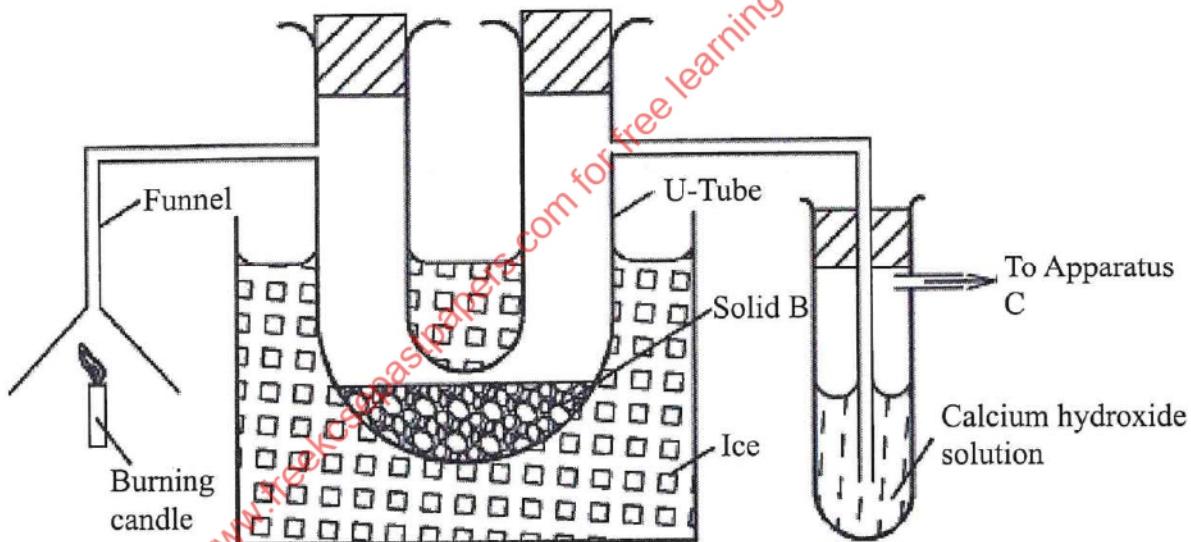
17	18	19	20	21	22	23	24	25	26	27	28				

Grand Total



1. Element A has mass number 40 and 21 neutrons.
- (a) Write the electron arrangement of element A. (1 mark)
- .....  
.....
- (b) Give the formula of the compound formed when element A reacts with sulphur. ( $S = 16.0$ ) (1 mark)
- .....  
.....

2. Study the setup in Figure 1 and then answer the questions that follow.



**Figure 1**

- (a) At the end of the experiment, solid B changed from white to blue. Explain. (1 mark)
- .....  
.....
- (b) The other product of the burning candle formed a white precipitate with the calcium hydroxide solution. Write an equation for the reaction. (1 mark)
- .....  
.....

- (c) State the role of apparatus C. (1 mark)

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.....

3. (a) State and explain the factors that are considered when collecting a gas by displacement of:

- (i) air; (1 mark)

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.....  
.....

- (ii) water. (1 mark)

.....

- (b) Other than collecting a gas by displacement of air or water, state another method that can be used to collect a gas. (1 mark)

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4. (a) Carbon(II) oxide was passed over 4.1 g of heated oxide of copper in a combustion tube until there was no further change. The mass of the final substance was found to be 3.29 g. Complete **Table 1** and determine the empirical formula of the oxide.

(Cu = 64.0; O = 16.0)

**Table 1**

Element	Cu	O
Mass (g)		
Number of Moles		

Empirical formula ..... (2 marks)

- (b) State the property of carbon(II) oxide that was demonstrated in the experiment. (1 mark)

.....

5. (a) Draw the structural formula of 2-methylbut-2-ene. (1 mark)

.....  
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- (b) Bromine water was added to 2-methylbut-2-ene.

- (i) State the observation made. (1 mark)

.....  
.....

- (ii) Name the type of the reaction that took place. (1 mark)

.....



6. Table 2 shows pH values of solutions of compounds D, E, F and G.

**Table 2**

Compound	D	E	F	G
pH value of solution	2	5	7	13

- (a) State which one of the compounds is likely to be:
- (i) sodium chloride; (½ mark)
- .....
- (ii) ammonium nitrate. (½ mark)
- .....
- (b) Select *two* compounds that can be used to illustrate the amphoteric nature of an oxide. (1 mark)
- .....
- (c) Give a reason for the answer in (b). (1 mark)
- .....
- .....
- .....
7. Draw a labelled diagram of the setup of apparatus that can be used to electrolyse lead(II) bromide. (3 marks)



8. (a) State the difference between a covalent bond and a dative covalent bond. (1 mark)

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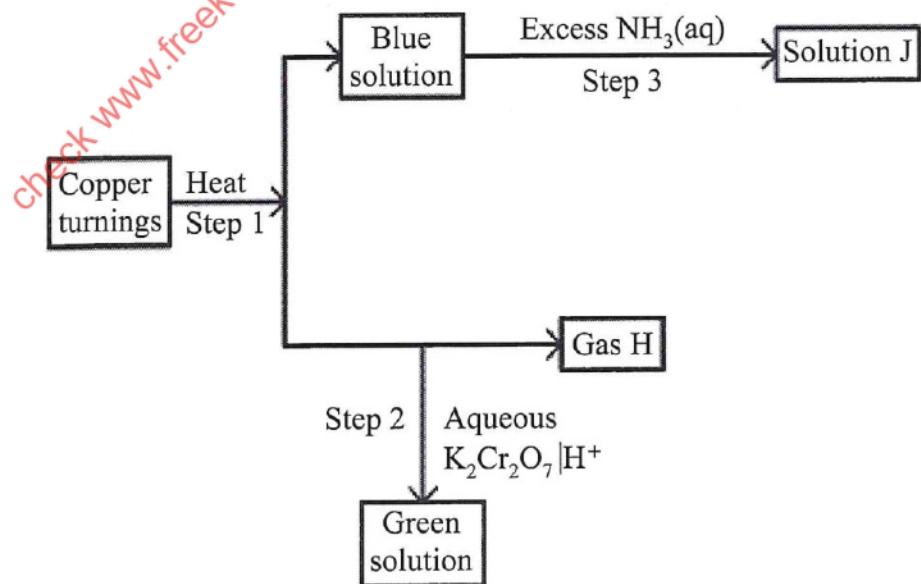
- (b) Using dots (•) and crosses (x) to represent electrons, draw a diagram to show the bonding in ammonia. (1 mark)

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- (c) Using the diagram in (b), state *one* property that makes ammonia react with hydrogen ion. (1 mark)

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 .....

9. Figure 2 shows a reaction scheme starting with copper turnings. Study it and answer the questions that follow.



**Figure 2**

- (a) State the reagent that is added in step 1. (1 mark)
- .....

- (b) Identify gas H ..... (1 mark)

- (c) Write the formula of the complex ion in solution J. (1 mark)
- .....

10. When chlorine is bubbled through hot concentrated sodium hydroxide solution, sodium chlorate(V), sodium chloride and water are formed.

- (a) Write an equation for the reaction. (1 mark)
- .....
- .....

- (b) Sodium chlorate(V) and sodium chloride have different solubilities in water. Name a method that can be used to separate the salts. (1 mark)
- .....

- (c) Give *one* use of sodium chlorate(V). (1 mark)
- .....
- .....

11. Excess dilute hydrochloric acid was added to an alloy of copper and zinc in a beaker.

- (a) State the observations made. (2 marks)
- .....
- .....
- .....

- (b) Excess aqueous sodium hydroxide was added to 2 cm<sup>3</sup> of the solution obtained in the reaction. Write an ionic equation for the reaction that occurred. (1 mark)
- .....
- .....

12. Study the information in **Table 3** and answer the questions that follow. The elements belong to the same chemical family. (The letters are not actual symbols of the elements).

**Table 3**

Element	Atomic radius (nm)	Ionic radius (nm)	Ionisation energy kJ/mol
L	0.157	0.095	494
K	0.203	0.133	418
M	0.123	0.060	519
N	0.235	0.169	376

- (a) Classify the elements as either metals or non-metals. Give a reason. (1 mark)

.....  
.....

- (b) (i) Identify the element which is
- I. least reactive ..... (½ mark)
- II. most reactive ..... (½ mark)
- (ii) Give a reason for the answer in b (i). (1 mark)

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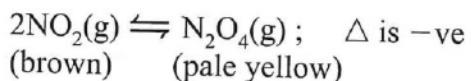
13. Nitrogen(IV) oxide is prepared by heating lead(II) nitrate.

- (a) Write an equation for the reaction. (1 mark)

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- (b) At room temperature, nitrogen(IV) oxide exists as an equilibrium mixture with dinitrogen tetroxide.



State the observation made when the mixture is placed in an ice-bath. Give a reason.

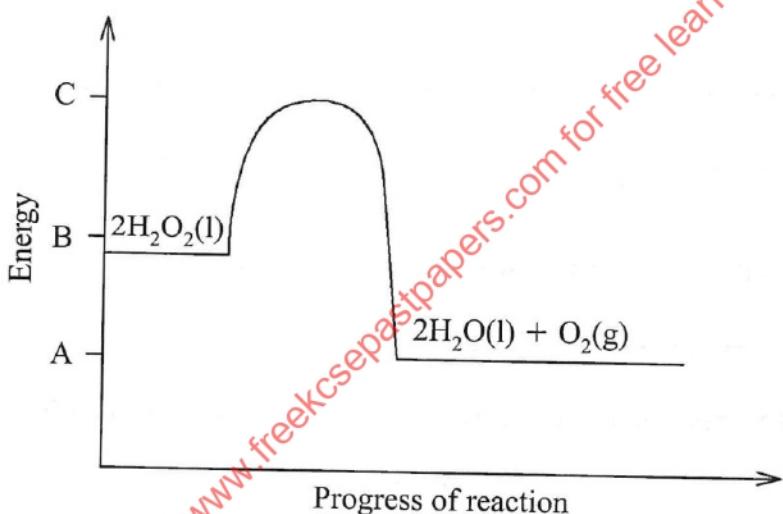
(2 marks)

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14. Figure 3 shows an energy level diagram for the decomposition of hydrogen peroxide using a catalyst.



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**Figure 3**

- (a) Using the energy values A, B and C, write an expression for:

- (i)  $\Delta H$  of the reaction; (1 mark)

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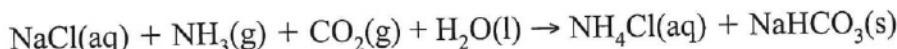
- (ii) activation energy. (1 mark)

.....

- (b) On the same axis, sketch a curve that would be obtained if the reaction was carried out without a catalyst. (1 mark)



15. Sodium carbonate is prepared on large scale by the Solvay process. The equation for the main reaction that takes place in the carbonator is:



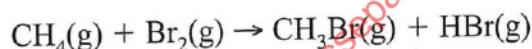
- (a) Describe how the sodium carbonate is obtained from the products of the carbonator. (1½ marks)

.....  
 .....  
 .....  
 .....

- (b) One of the by-products of the Solvay process is calcium chloride. Explain how the calcium chloride is formed in this process. (1½ marks)

.....  
 .....  
 .....

16. Methane reacts with bromine as shown in the following equation.



Using the bond energies in **Table 4**, calculate the enthalpy change,  $\Delta H$  for the reaction.

**Table 4**

Bond	Bond energy (kJ mol <sup>-1</sup> )
C – H	412
C – Br	276
Br – Br	193
H – Br	366

(3 marks)

17. Some compounds such as CFCs and DDT are regarded as environmental pollutants. Give the complete names of:

(a) CFCs; (1 mark)

(b) DDT. (1 mark)

18. Use the information in **Table 5** to answer the questions that follow.

Table 5

Liquid	Boiling point (°C)	Miscibility with water
Propanone	56	Miscible
Octane	126	Immiscible
Water	100	—

(a) State the method that can be used to separate propanone and water. (1 mark)

(b) Describe how a mixture of water and octane can be separated. (2 marks)

19. 6.2 g of phosphorus was reacted with excess oxygen to form phosphorus(V) oxide. Determine the mass of the oxide formed. ( $O = 16.0$ ;  $P = 31.0$ ) (2 marks)
- .....  
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20. Compound V reacts with water as shown in the following equation.



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- (a) Give the structural formula of compound V. (1 mark)
- .....  
.....  
.....

- (b) Other than the use of the catalyst, name another condition necessary for this reaction. (1 mark)
- .....  
.....

- (c) This type of reaction is called hydrolysis or hydration. State another name that can be used to describe the reaction. (1 mark)
- .....  
.....

21. Salts may be classified as soluble or insoluble.

- (a) Select from the following list a pair of compounds that can be used to prepare a soluble and an insoluble salt.

$HNO_3$ ,  $Pb(NO_3)_2$ ,  $KNO_3$ ,  $BaO$ ,  $NaCl$

- (i) Soluble salt (1 mark)
- .....

- (ii) Insoluble salt (1 mark)
- .....



- 912 (b) Describe how a soluble salt is obtained from its solution. (1 mark)

.....  
.....  
.....

22. 912 (a) State **one** factor that affects the preferential discharge of ions at the cathode. (1 mark)

.....

- (b) Sodium sulphate was electrolysed using inert electrodes. Write the equation for the reaction that takes place at the:

- (i) cathode; (1 mark)

.....  
.....

- (ii) anode. (1 mark)

.....  
.....

23. Consider the following reaction.



Determine the oxidation numbers of chlorine and sulphur in the reactants and products.

(2 marks)

	Reactants	Products
Sulphur		
Chlorine		

24. (a) A volume of sulphur(IV) oxide gas diffused from an apparatus in 96 seconds.

Calculate the time taken by an equal volume of carbon(IV) oxide to diffuse under the same conditions. ( $C = 12.0$ ;  $O = 16.0$ ;  $S = 32.0$ ) (1 mark)

.....  
.....  
.....

- (b) The rate of diffusion of neon was found to be 1.45 times faster than that of an equal volume of gas X at room temperature. Determine the relative formula mass of gas X ( $Ne = 20.0$ ). (2 marks)
- .....  
.....  
.....

25. Complete combustion of one mole of an alkanol,  $C_xH_yOH$  gave four moles of water. ( $C = 12.0$ ,  $H = 1.0$ ,  $O = 16.0$ )

Determine the:

- (a) values of x and y

(i) x (1 mark)

.....

(ii) y (1 mark)

.....

- (b) number of moles of oxygen required for the complete combustion. (1 mark)
- .....
- .....

26. Radioactive decay of  $^{228}_{90}\text{Th}$  gives X,  $^{224}_{86}\text{Ra}$  and gamma radiation.

(a) Identify X ..... (1 mark)

(b) Write a nuclear equation for the decay. (1 mark)

(c) The half-life of  $^{228}_{90}\text{Th}$  is 1.9 years. If after 5.7 years the mass of  $^{228}_{90}\text{Th}$  was found to be 1.25 g. Determine the initial mass of the radioactive isotope. (1 mark)

27. Figure 4 shows part of the structure of a polymer.

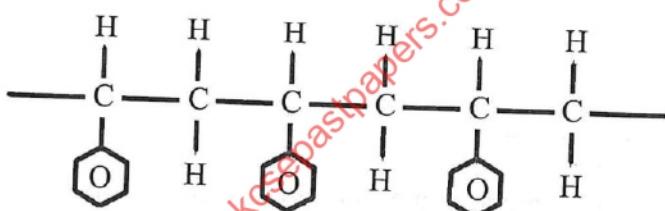


Figure 4

(a) Give the name of the polymer. (1 mark)

(b) Draw the structure of the monomer used. (1 mark)

(c) Give **one** use of the polymer. (1 mark)

28. Figure 5 shows variation of number of outermost electrons (a) with atomic number of elements in the periodic table.

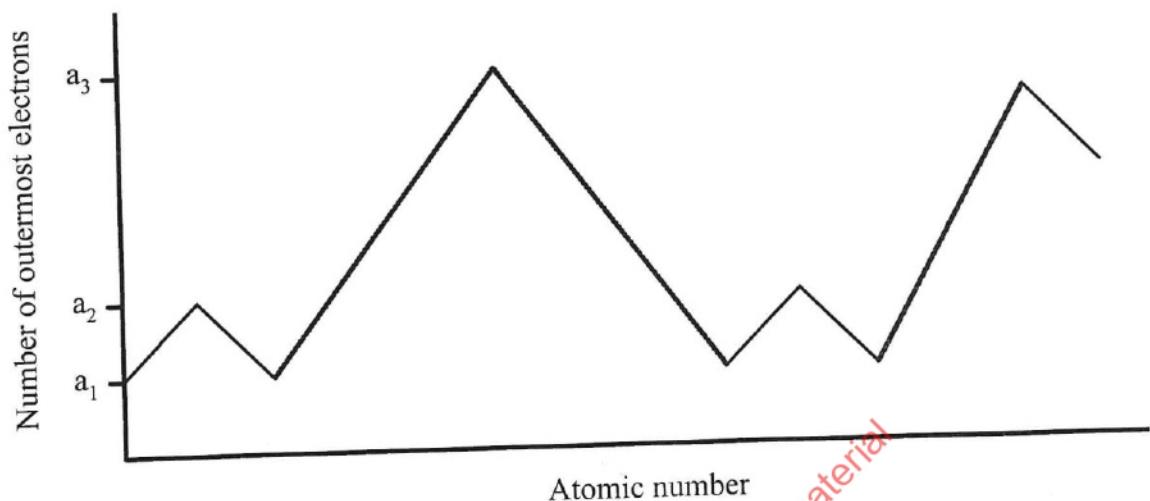


Figure 5

(a) Give the values of

(i)  $a_1$

(1 mark)

(ii)  $a_3$

(1 mark)

(b) State why elements with  $a_1$  and  $a_2$  outermost electrons do *not* react with each other.

(1 mark)

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