CHEMISTRY

CHE 01

29/07/ 2022 8:30 AM - 11:30 AM

NESA NATIONAL EXAMINATION AND SCHOOL INSPECTION AUTHORITY

TTC NATIONAL EXAMINATIONS, 2021-2022

OPTION: SCIENCE AND MATHEMATICS EDUCATION (SME)

SUBJECT: CHEMISTRY

DURATION: 3 HOURS

INSTRUCTIONS:

1) Write your names and index number on the answer booklet as written on your registration form, and **DO NOT** write your names and index number on additional answer sheets if provided.
2) Do not open this question paper until you are told to do so.
3) This paper consists of **three** sections: **A**, **B** and **C**.

Section A: Attempt **all** questions	**(55 marks)**
Section B: Attempt **all** questions	**(30 marks)**
Section C: This question is compulsory	**(15 marks)**

4) **You do not need the Periodic Table.**
5) Silent non- programmable calculators may be used.

Section A: ATTEMPT ALL QUESTIONS (55 marks)

1) Read the text below and use the list of words given to fill in the blank spaces. Each word will be used once:

reduction, oxidation, gain, loss, oxidized and reduced.

An atom's increase in oxidation number through a chemical reaction is called....., and it involves a ..... of electrons; any decrease in an atom's oxidation state is called ....., and it involves the ..... of electrons. The oxidizing agent removes electrons from another substance by acquiring them itself; thus, the oxidizing agent is itself ..... Similarly, a reducing agent, or reductant, is a substance that gives up electrons, thereby causing another substance to be reduced. The reducing agent is therefore ..... in the process. **(3 marks)**

2) a) Using **s,p,d,f** orbitals notation write down the electronic configuration of aluminium (Z=13). **(2 marks)**

b) How many valency electrons does aluminium possess? **(1 mark)**

c) How did you reach this conclusion? **(1 mark)**

d) Aluminium reacts with concentrated sulphuric acid to form aluminium sulphate, sulphur dioxide and water. Write a balanced chemical equation for this reaction. S: (Z=16); O: (Z=8) **(2 marks)**

3) Describe how, in a mass spectrometer, **(3 marks)**

a) Ions are formed.

b) Ions are accelerated.

c) Ions are separated.

4) a) Define the term "**Radio isotope**". **(1 mark)**

b) Complete and balance the following nuclear equations:

Pa(Z=91), U(Z=92), Th(Z=90), Po(Z=84),Ac (Z=89), Ar (Z=18) **(4 marks)**

a. $^{235}_{92}U \rightarrow {}^{4}_{2}\alpha +$

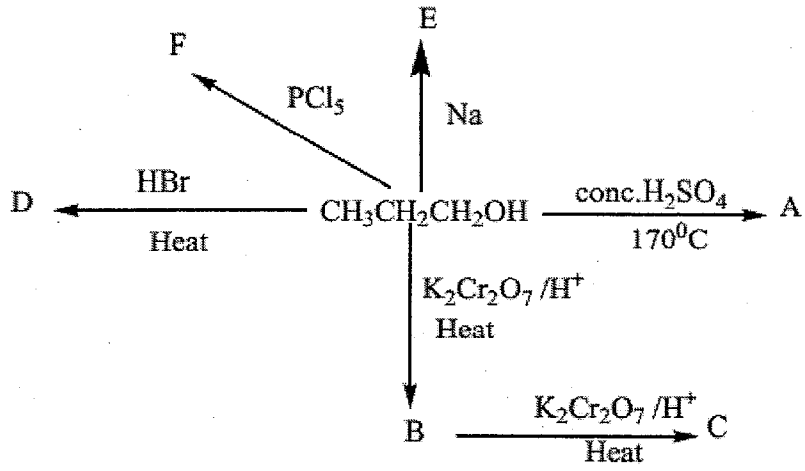
b. $^{87}_{37}Rb \rightarrow \quad + {}^{87}_{38}Sr$

c. $^{38}_{19}K \rightarrow {}^{0}_{+1}\beta +$

d. $^{55}_{26}Fe + \quad \rightarrow {}^{55}_{25}Mn$

5) Some of the reactions of propan-1-ol are shown in the diagram below.

(6 marks)



Give the structural formulae of products marked **A, B, C, D, E** and **F**.

6) When magnesium powder is added to a solution of copper (II) sulphate, its colour changes from blue to colourless and a red brown solid is formed but when pieces of silver metal are added to copper (II) sulphate, the solution retains its colour. Explain. **(4 marks)**

7) Soap is a salt of a fatty acid. Soap can be prepared by boiling vegetable oil with sodium hydroxide and adding a solution of sodium chloride to the reaction mixture.

a) What name is given to the reaction leading to the formation of soap? **(0.5 mark)**

b) Illustrate the reaction by using a chemical equation. Use a triglyceride as fat. Name the reactants and the products. **(2 marks)**

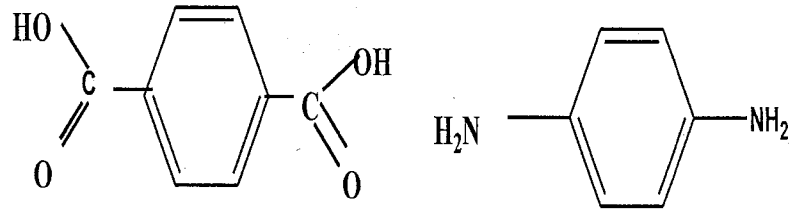
c) Name one crop from which oil for making soap can be obtained. **(0.5 mark)**

d) Why is sodium chloride added to the reaction mixture? **(1 mark)**

e) State one advantage of using detergents instead of soap. **(1 mark)**

8) a) Explain the term condensation polymer. **(2 marks)**

b) Kevlar is a condensation polymer that is used for making bullet-proof vests. Here are two monomers that could be used for making Kevlar:



i) Explain the term monomer. **(1 mark)**

ii) Give the structure of Kevlar, showing the repeated unit. **(2 marks)**

iii) What type of condensation polymer is Kevlar? **(1 mark)**

9) a) Arrange the following amines in order of increasing basicity strength.
$CH_3CH_2NH_2$, $CH_3CH_2NHCH_2CH_3$, $(CH_3)_3N$. **(3 marks)**

b) Why do alcohols have high boiling points compared to alkanes? **(2 marks)**

10) Complete the table below by comparing **ketones'** and **aldehydes'** identification test. Record the colour change observed in each case. **(4 marks)**

Testing substances	Tollens' reagent	Fehling or Benedict solution
Aldehydes	?	?
Ketones	?	?

11) A solution contains 1.0 $x10^{-2}$ M Ag^{+} and 2.0 $x10^{-2}$ M Pb^{2+}. When Cl^{-} ions are added to that solution, both AgCl (Ksp =$1.8x10^{-10}$) and $PbCl_2$ (Ksp =$1.7x10^{-3}$) precipitate out from the solution.

a) What concentration of Cl^{-} ions is necessary to begin the precipitation of each salt? **(4 marks)**

b) Which salt precipitates first? **(1 mark)**

12) What is the molarity of a solution of potassium hydroxide of pH=13.32 at 25°C? **(3 marks)**

Section B: ATTEMPT ALL QUESTIONS (30 marks)

13) a) An alkane **X** of formula mass 30, consists of 80% carbon by mass.

i) Calculate the empirical formula of **X**. **(2 marks)**

Ii) Determine the molecular formula of **X**. **(1 mark)**

b) Ethene can react to form a solid whose molecular mass is more than 10,000.

i) Name the reaction that occurs. **(1 mark)**

ii) Write the chemical equation of that reaction. **(1 mark)**

iii) State what would be observed when ethene is reacted with bromine and write a chemical equation for the reaction. **(2 marks)**

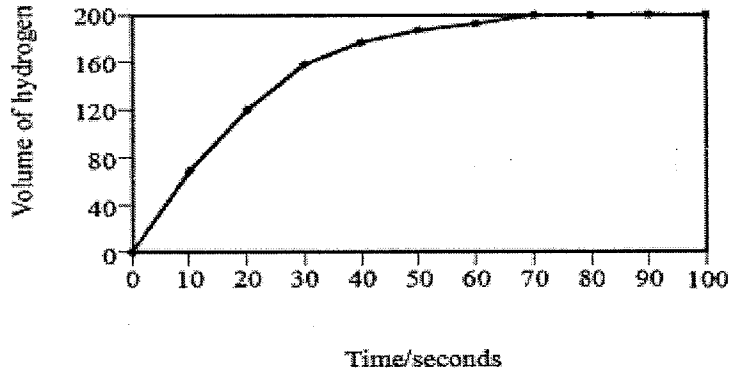
14) a) The equation below represents an exothermal reaction which is reversible $A+B \text{ ------} \rightarrow C+D \ \Delta H=-x \ KJmol^{-1}$ **(3 marks)**

i) How would an increase in temperature affect the amount of **C** and **D** in the equilibrium mixture?

ii) Give a reason for your answer in (i).

iii) Draw a labeled diagram for the energy profile for this reaction showing the reactants and products, activation energy and ΔH.

b) The graph below shows the volume of hydrogen produced as 2.00 g of magnesium ribbon reacts with 100 cm^3 of sulphuric acid, concentration 1.00 mol/dm^3.



Explain why hydrogen is produced at a faster rate at the beginning of the experiment than it is at the end of the experiment. **(3 marks)**

15) Use the data below to answer the questions that follow.

$Ag^+ + e^- \text{------} \rightarrow Ag \quad E^\theta = +0.80V$

$Fe^{2+} + 2e^- \text{--------} \rightarrow Fe \quad E^\theta = -0.44V$

a) Draw a labeled diagram to show an electrochemical cell consisting of silver and iron hal-cells/electrons. In the diagram show: **(3 marks)**

i. A salt bridge.

ii. The direction of electron flow by using an arrow.

b) Calculate the standard cell voltage for the above electrochemical cell. **(2 marks)**

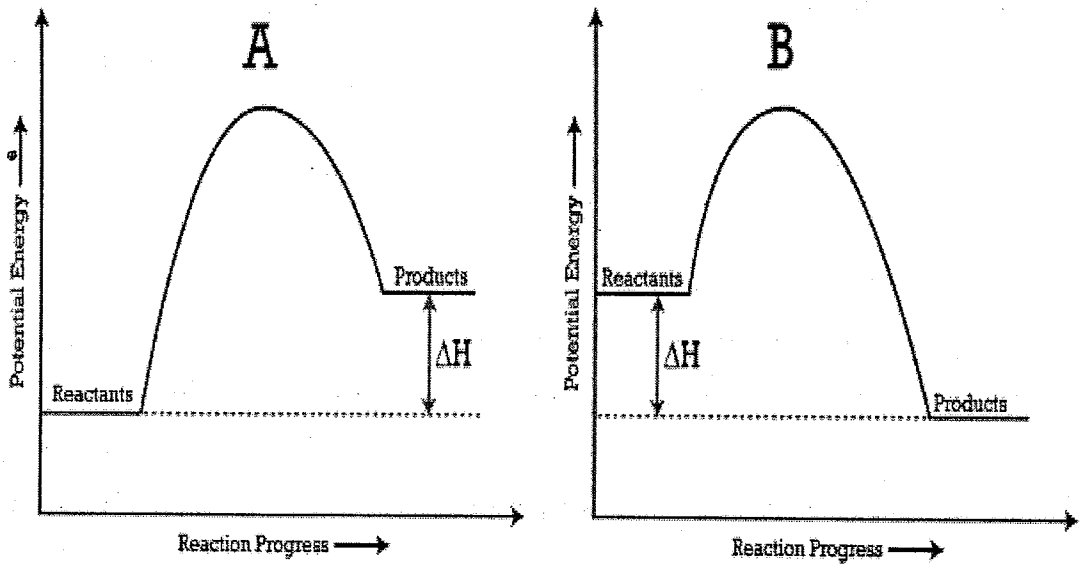
c) Write a balanced chemical equation for the cell reaction. **(2 marks)**

d) On which electrode does oxidation occur? **(1 mark)**

16) a) Why would a mixture of gases react faster when the volume they occupy is decreased? **(2 marks)**

b) The rate constant for the reaction: $H_2(g) + I_2(g) \rightarrow 2HI(g)$ is 2.7×10^{-4} at 600 K and 3.5×10^{-3} at 650 K. Calculate the activation energy of the reaction. ($R = 8.31 Jmol^{-1}K^{-1}$). **(3 marks)**

17) Study the diagrams below and answer the questions that follow. **(4 marks)**



a) What do diagrams **A** and **B** represent?
b) How does **A** differ from **B**? Explain.
c) What is meant by activation energy?

Section C: This question is compulsory (15 marks)

18) Steel is one of the alloys of iron. 1.40g of sample of steel was dissolved in diluted acid to convert all the iron into $Fe^{2+}(aq)$. The solution was made up to $100cm^3$ using distilled water. $10cm^3$ of this solution were acidified and titrated with 0.0167 $moldm^{-3}$ potassium dichromate ($K_2Cr_2O_7$) using a suitable indicator. $24.2cm^3$ of potassium dichromate were needed to reach the end point. The reduction of dichromate ions is represented by the equation:

$Cr_2O_7^{2-}(aq)+14H^+(aq)+6e^-\text{--------}\rightarrow 2Cr^{3+}(aq)+7H_2O$

a) What is meant by the term alloy? **(1 mark)**

b) Write a chemical equation to show the oxidation of Fe^{2+} to Fe^{3+}. **(2 mark)**

c) Write the overall balanced chemical equation for the reaction between acidified $Cr_2O_7^{2-}$ and Fe^{2+}. **(4 mark)**

d) Calculate the number of moles of $Cr_2O_7^{2-}$ in $24.2cm^3$ of the dichromate solution. **(2 mark)**

e) Calculate the number of moles of Fe^{2+} in $100cm^3$ of the original solution. **(1 mark)**

f) Calculate the percentage of iron in the sample of steel (Fe=56). **(1 mark)**

g) One way of preventing rusting is to convert iron into stainless steel.

i) State two conditions necessary for iron to rust. **(1 mark)**

ii) State the name of a transition metal present in stainless steel. **(1 mark)**

iii) State two other methods of preventing rust. **(1 mark)**

h) Give the electronic configuration of Fe^{3+}(atomic number of Fe=26). **(1 mark)**

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