TEVETA

Technical Education Vocational and Entrepreneurship Training Authority

DIPLOMA IN SCIENCE LABORATORY TECHNOLOGY

LEVEL 6 YEAR I EXAMINATIONS

FINAL INTEGRATED SUMMATIVE EXAMINATIONS

SITTING: NOVEMBER/DECEMBER 2025

SUBJECT: FOUNDATION CHEMISTRY THEORY

TIME: THREE (3) HOURS **TOTAL MARKS: 100**

PASS MARK: 50

INSTRUCTIONS TO CANDIDATE

1. Write your Examination number and National Registration Card (NRC) number on the answer booklet provided. Ensure you append your signature in the space provided on the answer booklet.
2. Write the ANSWER SCRIPT SERIAL NUMBER on the examination register and on the entry slip.
3. This paper has SEVEN (7) questions. Question ONE (1) is COMPULSORY. answer FOUR (4) questions from the remaining SIX (6) questions.
4. Diagrams may be used where necessary to clarify your answer.
5. Cellphones and programmable calculators are not allowed in the examination room.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

QUESTION ONE (COMPULSORY)

(a) Define:

i. Atomic number. (2 marks)

ii. Isotopes. (2 marks)

(b) An unknown element contains 56 protons, 54 electrons, and a mass number 135. Determine the:

i. Atomic number of this element. (2 marks)

ii. Name and symbol of this element. (2 marks)

iii. Number of neutrons it contains. (2 marks)

iv. Charge on this ion. (2 marks)

(c) A particular element exists in two stable isotopic forms. One **(1)** isotope has a mass of 34.9689 amu (75.77% abundance). The other isotope has a mass of 36.9659 amu. Determine the:

i. Average mass of the element. (4 marks)

ii. Identity of the element. (1 mark)

iii. Orbital electronic configuration of its neutral atom. (3 marks)

[Total: 20 marks]

QUESTION TWO

(a) 4.80 dm^3 of chlorine gas was reacted with sodium hydroxide solution at room temperature and pressure as shown in the equation below.

$$\mathbf{Cl_{2\,(g)} + 2NaOH_{\,(aq)} \rightarrow NaCl_{(aq)} + NaOCl_{(aq)} + H_2O_{(l)}}$$

Determine the:

i. Number of moles of Cl_2 reacted. (2 marks)

ii. Mass of NaOCl formed. (3 marks)

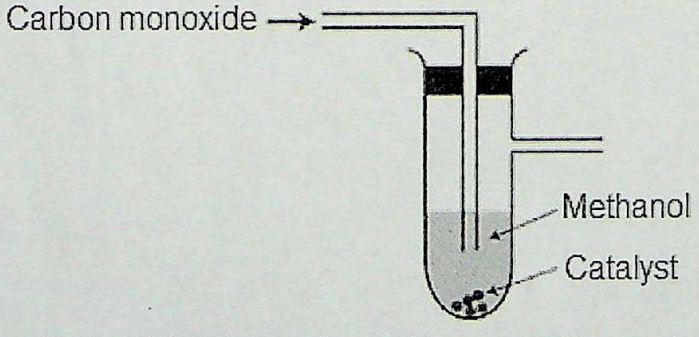
iii. Volume of sodium hydroxide solution required if the concentration of the sodium hydroxide was 2.00 mol dm^{-3}. (3 marks)

iv. Ionic equation for this reaction. (2 marks)

(b) In an experiment, Methanol reacts with carbon monoxide in the presence of a catalyst to produce ethanoic acid as shown in the equation below:

$$CH_3OH_{(l)} + CO_{(g)} \rightarrow CH_3COOH_{(l)}$$

In the above experiment, 9.0g of methanol reacted completely with 7 g carbon monoxide in a reaction vessel as shown below.



i. Determine the theoretical yield of ethanoic acid formed at the end of the reaction. (7 marks)

ii. Calculate the percentage yield, given that 12 g of methanol was actually obtained. (3 marks)

[Total: 20 marks]

QUESTION THREE

(a) Define the terms acid-base according to Bronsted-Lowry theory. (2 marks)

(b) Explain

i. The meaning of the phrase 'strength of an acid'. (5 marks)

ii. Two **(2)** uses of household products which are alkaline in nature. (4 marks)

(c) Describe the working principle of an acidic buffer. (5 marks)

(d) The pH of rainwater in a polluted area was found to be 3.50. Calculate the hydrogen ion concentration in this polluted rainwater. (4 marks)

[Total: 20 Marks]

QUESTION FOUR

The table shows the atomic number and boiling points of some noble gases

Gas	**helium**	**neon**	**argon**	**Krypton**	**xenon**
Atomic number	2	10	18	36	54
Boiling point / °C	-253	-246	-186	-152	-107

(a) Explain trends in boiling points using the ideas about forces between atoms. (2 marks)

(b) Xenon forms a number of covalently bonded compounds with fluorine.

i. Define the term covalent bond. (2 marks)

ii. Draw a dot-and-cross diagram for xenon tetrafluoride, XeF_4. (2 marks)

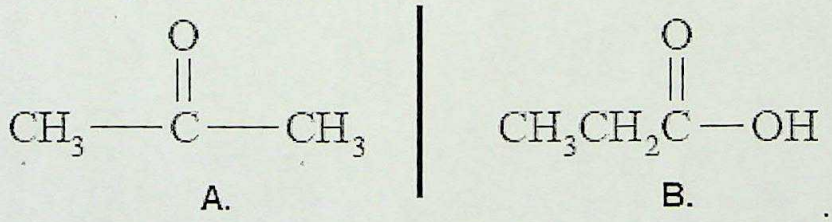
iii. Write the shape for XeF_4. (2 marks)

(c) Water is extensively hydrogen bonded. This gives it irregular (peculiar) properties.

i. Explain reasons for ice to be less dense than liquid water. (3 marks)

ii. State two (2) irregular properties of water. (3 marks)

(d) Refer to the structures shown below.



A. B.

i. Identify the compounds A and B (2 marks)

ii. State the compound with a higher boiling point. (1 mark)

iii. Explain the reason for the higher boiling point in the compound (3 marks)

[Total: 20 Marks]

QUESTION FIVE

(a) State the:

i. Collision theory. (2 marks)

ii. Le Chatelier's principle. (2 marks)

(b) List six **(5)** factors that affect the rate of chemical reaction. (5 marks)

(c) An equilibrium is established when sulphur dioxide reacts with oxygen to produce sulphur trioxide with Vanadium pentoxide as the catalyst:

$$2SO_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2SO_{3\,(g)}$$

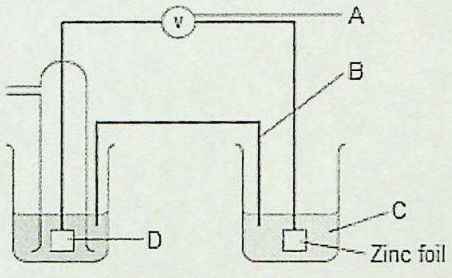
i. Explain the effect on the equilibrium position when the pressure in the vessel is lowered. (3 marks)

ii. Given that the reaction vessel initially contains $[SO_2]$ =0.8 mol/L, and $[O_2]$ = 0.5 mol/L, and at equilibrium the concentration of SO_3 is 0.6 mol/L. Calculate the value of the equilibrium constant K_c. (8 marks)

[Total: 20 Marks]

QUESTION SIX

The diagram shows an electrochemical cell designed to find the standard electrode potential for zinc.



(a) Identify the parts labelled A, B, C and D. (4 marks)

(b) Explain the functions of B, C and D. (6 marks)

(c) During an electrolysis practical lesson, one of the SLT students allowed the current of 3.0 A to flow through a solution of copper (II) sulphate for 30.0 minutes. Determine the:

i. Charge transferred during electrolysis. (2 marks)

ii. Mass of copper deposited. (3 marks)

(d) A voltaic cell consists of Mg electrode in a 1.0 M $Mg(NO_3)_2$ solution and a Cd electrode in a 1.0 M $Cd(NO_3)_2$ solution.

Given that: $E°Cd^{2+}/Cd$=-0.4V; $E°Mg^{2+}/Mg$ = -0.37 V

i. Determine the overall cell reaction, at 25°C. (1 mark)

ii. Calculate the standard cell potential. (4 marks)

[Total: 20 Marks]

QUESTION SEVEN

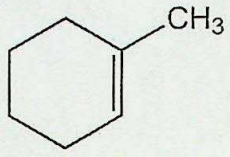
(a) The skeletal formula of hexane is



Draw the four (4) structural isomers of hexane. (8 marks)

(b) State the IUPAC nomenclature of the following compounds.

i.



(2 marks)

ii. CH_3CHO (2 marks)

iii. $CH_3CH_2CH_2CHCHCH_2CH_3$ (2 marks)

iv. $CH_3CH_2OCH_3$ (2 marks)

(c) A homologous series has the functional group R-OH. State

i. The name of the homologous series having the functional group R-OH. (2 marks)

ii. Two **(2)** uses of a compound with two **(2)** carbons in the homologous series named in b (i). (2 marks)

[Total: 20 Marks]

Useful data

Avogadro's constant = 6.022×10^{23}

Rydberg's constant = 1.0967×10^{7}

Speed of light 2.998×10^{8} m/s

Planck's h: 6.626×10^{-34} Js

R=0:08206Latm/Kmol

R=0:08314Lbar/Kmol

R=82:06cm3atm=Kmol

R=8:314J/Kmol

R=1:987cal/Kmol

Proton mass : $1.672621637\ 10^{27}$ kg

Molar volume at room temperature and pressure = 2400 dm^3

Molar volume at standard temperature and pressure = 22.4 dm^3

Periodic Table of the Elements

hydrogen 1 **H** 1.00794																	helium 2 **He** 4.002602
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.012182											boron 5 **B** 10.811	carbon 6 **C** 12.0107	nitrogen 7 **N** 14.00674	oxygen 8 **O** 15.9994	fluorine 9 **F** 18.9984	neon 10 **Ne** 20.1797
sodium 11 **Na** 22.98977	magnesium 12 **Mg** 24.3050											aluminium 13 **Al** 26.981538	silicon 14 **Si** 28.0855	phosphorus 15 **P** 30.97376	sulphur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.984
potassium 19 **K** 39.0983	calcium 20 **Ca** 40.078	scandium 21 **Sc** 44.95591	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.9415	chromium 24 **Cr** 51.9961	manganese 25 **Mn** 54.93805	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.9332	nickel 28 **Ni** 58.6934	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.409	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.64	arsenic 33 **As** 74.9216	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.798
rubidium 37 **Rb** 85.4678	strontium 38 **Sr** 87.62	yttrium 39 **Y** 88.90585	zirconium 40 **Zr** 91.225	niobium 41 **Nb** 92.90638	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.9055	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.8682	cadmium 48 **Cd** 112.411	indium 49 **In** 114.818	tin 50 **Sn** 118.710	antimony 51 **Sb** 121.760	tellurium 52 **Te** 127.60	iodine 53 **I** 126.9045	xenon 54 **Xe** 131.293
caesium 55 **Cs** 132.90545	barium 56 **Ba** 137.327	lutetium 71 **Lu** 174.967	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.9479	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.207	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.217	platinum 78 **Pt** 195.078	gold 79 **Au** 196.96655	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.3833	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.980	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	darmstadtium 110 **Ds** [271]	roentgenium 111 **Rg** [272]	ununbium 112 **Uub** [285]		ununquadium 114 **Uuq** [289]				

Key:

element name
atomic number
symbol
atomic weight

lanthanum 57 **La** 138.9055	cerium 58 **Ce** 140.116	praseodymium 59 **Pr** 140.90765	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.964	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.9253	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.930	erbium 68 **Er** 167.259	thulium 69 **Tm** 168.934	ytterbium 70 **Yb** 173.04
actinium 89 **Ac** [227]	thorium 90 **Th** 232.038	protactinium 91 **Pa** 231.0359	uranium 92 **U** 238.0289	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]