NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION

GENERAL CHEMISTRY (PST1142)

Main Examination Paper

NOVEMBER 2024

This Examination Paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Periodic Table and graph paper.

Internal Examiner: Irene Mpofu

External Examiner: Dr S.J. Mpofu

INSTRUCTIONS

1. Section A: Answer two (2) questions.
2. Section B: Answer any three (3) questions.
3. Each question carries 20 marks
4. Use of calculators is permissible

Mark Allocation

QUESTION	MARKS
1	20
2	20
3	20
4	20
5	20
6	20

SECTION A: Answer two questions. [40]

Question 1

a) State what you understand by the terms: i) relative atomic mass. (ii) mass number. (iii) mole. [6]

b) Copy and complete the table

Particle	Relative Mass	Relative charge
Electron		
Neutron		
Proton		

[6]

c) The element Bromine with a relative atomic mass of 79.90 has two isotopes ^{79}Br and ^{81}Br.
(i) Compare and contrast the two isotopes. [6]
(ii) State and explain which of the two isotopes ^{79}Br and ^{81}Br is more common in the element. [2]

Question 2

a) Show by means of a diagram the bonding within a molecule formed when ammonia reacts with Boron trifluoride, BF_3 in a 1:1 ratio to give a white crystalline solid. (3)

b) Predict the type of bond formed and the formula of the compound between
(i) X and Y. (ii) X and Z. (iii) Y and Z. (iv) X and X.
Given that X, Y and Z represent elements of atomic numbers 8, 17 and 56 respectively. [8]

c) The electronegativities of carbon, oxygen and sulphur are 2.5, 3.5 and 2,5 respectively.
Draw the Lewis structures of carbon dioxide, carbon disulphide and sulphur dioxide. Comment on the likely polarity of the molecules. [9]

SECTION B: Answer any three questions. [60]

Question 3

a) Write the electron configuration of bromine. [2]

b) The table shows sets of quantum numbers for four electrons.

Electrons	Quantum numbers			
	n	l	m_l	m_s
I	0	0	0	½
II	1	1	0	½
III	2	1	-1	-½
IV	3	3	3	½

State with reason if each set of quantum numbers is possible or not possible. Where possible name the orbital. (10)

b) Caproic acid contains carbon, hydrogen and oxygen. When 0.450g of the acid is burned 0.418g of water and 1.023g of carbon dioxide are formed.
Calculate the percentage of carbon, hydrogen and oxygen in caproic acid. [8]

Question 4

a) Copper exists as two isotopes, copper-63 and copper-65 with percentage abundances of 69.1% and 30.9% respectively.
(i) Calculate the relative atomic mass of copper. [3]
(ii) Use the relative atomic mass obtained in (i) to calculate the mass in grams of a single atom of copper. [3]

b) Phosphine (PH_3) burns in oxygen to produce phosphorus pentoxide (P_2O_5) and water.
(i) Write a balanced equation for the burning of phosphine in oxygen. [2]
(ii) Calculate the mass of phosphorus pentoxide that will be produced when 17.0g of phosphine are reacted with 16.0g of oxygen gas. [8]
(iii) Calculate the percentage yield if 12.6g of phosphorus pentoxide is obtained when 17,0g of phosphine reacts with 16.0g of oxygen gas. [4]

Question 5

a) Copy and complete the table. The central atom is underlined.

Species	Number of electron pairs around central atom	Hybridisation	Molecular Geometry
$\underline{N}F_3$			
$\underline{S}O_3$			
$\underline{I}Cl_3$			
$\underline{B}H_3$			

[12]

b) Predict the bond angles in NH_4^+; NH_3; NH_2^-. Explain your reasoning. [8]

Question 6

a) Explain the following observations as fully as you can.
(i) The compound XeF_4 is known but NeF_4 is not known. [4]
(ii) The boiling point of H_2Te (-2.2 °C) is greater than that of H_2S (-60.7 °C) but less than that of H_2O. [4]
(iii) The first ionisation energy of magnesium (738 kJ mol^{-1}), is higher than that of sodium (495 kJ mol^{-1}). [4]
b) The table shows the composition of two oxides of lead.

Oxide	Percentage	
	Lead	Oxygen
Yellow powder	92.80	7.20
Bright red powder	90.55	9.45

(i) Determine the formulae of the yellow powder and the bright red powder. [5]
(ii) Write a balanced equation for the reaction of the yellow powder with oxygen to produce the bright red powder. [3]

Ptable

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H 1.00794	Atomic Sym Weight																2 He 4.00260
2	3 Li 6.941	4 Be 9.01218											5 B 10.811	6 C 12.0107	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797
3	11 Na 22.9897	12 Mg 24.305											13 Al 26.9815	14 Si 28.0855	15 P 30.9737	16 S 32.065	17 Cl 35.453	18 Ar 39.948
4	19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9380	26 Fe 55.845	27 Co 58.9331	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.38	31 Ga 69.723	32 Ge 72.63	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.798
5	37 Rb 85.4678	38 Sr 87.62	39 Y 88.9058	40 Zr 91.224	41 Nb 92.9063	42 Mo 95.96	43 Tc (98)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.904	54 Xe 131.293
6	55 Cs 132.905	56 Ba 137.327	57–71	72 Hf 178.49	73 Ta 180.947	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.084	79 Au 196.966	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	89–103	104 Rf (267)	105 Db (268)	106 Sg (271)	107 Bh (272)	108 Hs (270)	109 Mt (276)	110 Ds (281)	111 Rg (280)	112 Cn (285)	113 Uut (284)	114 Fl (289)	115 Uup (288)	116 Lv (293)	117 Uus (294)	118 Uuo (294)

C Solid
Hg Liquid
H Gas
Rf Unknown

Metalloids

Nonmetals
- Other nonmetals
- Halogens
- Noble gases

Metals
- Alkali metals
- Alkaline earth metals
- Lanthanoids
- Actinoids
- Transition metals
- Post-transition metals

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

57 La 138.905	58 Ce 140.116	59 Pr 140.907	60 Nd 144.242	61 Pm (145)	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.925	66 Dy 162.5	67 Ho 164.930	68 Er 167.259	69 Tm 168.934	70 Yb 173.054	71 Lu 174.966
89 Ac (227)	90 Th 232.038	91 Pa 231.035	92 U 238.028	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)