



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION

ENVIRONMENTAL CHEMISTRY (PST2043)

Main Examination Paper

NOVEMBER 2024

This Examination Paper consists of 6 pages

Time Allowed: **3 hours**
Total Marks: 100
Special Requirements: Calculator, Periodic Table
Internal Examiner: Mr SA Phiri
External Examiner: Dr SJ Mpofu

INSTRUCTIONS

1. SECTION A: Answer **both** questions.
2. SECTION B: Answer any **three (3)** questions on separate answer sheets.
3. Each question carries **20marks**
4. Use of calculators is permissible
5. Important data is at the back

MARK ALLOCATION

QUESTION		MARKS
SECTION A	1	20
	2	20
SECTION B	3	20
	4	20
	5	20
	6	20
TOTAL		100

SECTION A

1. a) Water pollutants may be classified according to their sources.
 - i. Describe 3 point sources of surface water pollution, giving examples. [6]
 - ii. Suggest 3 methods of reducing surface water pollution from point sources. [3]
- b) Industrial gases and some natural processes contribute to the formation of acid rain.
 - i. Name 3 acids that are predominant in acid rain. [3]
 - ii. Write equations for:
 1. Formation of acid rain.
 2. Chemical weathering. [8]
2. a) Calculate the wavelength required to dissociate the N_2 molecule. [5]
- b) Calculate the ideal pressure at the stratosphere [5]
- c) List 3 factors that affect a watershed. [3]
- d) Define and explain the following terms
 - i. Salinity in ocean water
 - ii. Non-point source [4]
- e) Explain why ozone destruction via the reaction of O_3 with atomic oxygen does not occur to a significant extent in the lower atmosphere. [3]

SECTION B

3. a) i. Treatment of water is one of the main ways of reducing the spread of water borne diseases. Describe the operations of a surface water treatment plant. Use diagrams where necessary.

ii. Describe 2 ways of improving the water treatment plant to make it more effective and efficient. [10]

b) List and explain 3 green uses of municipal sludge. [5]

c) Explain the microbiological processes for the removal of Phosphorus? [5]

4. a) Give reasons why the temperature profile of the stratosphere is different from that of the troposphere. [5]

b) Although the temperatures in the thermosphere are in the region of 1200°C, the actual temperatures measured using a thermometer are far less than that. Give reasons for this phenomenon. [10]

c) Explain the use of chemical oxygen demand test in environmental chemistry. [5]

5. a) Explain the formation of smog leading to the formation of ozone. [6]

b) The composition of nitrogen in the atmosphere is 79%. Calculate the concentration in mol·L⁻¹ assuming $P_o = 101.325$ KPa. [6]

c) Describe the formation of hydroxyl radicals from photochemical smog and how they further react with CH₄ and CO₂. [8]

6. a) Explain three approaches to phytoremediation [6]

b) State the Treaty that banned the use of freons as refrigerants and how it came to its existence. [4]

c) List and describe 5 chemical uses of biocides. [10]

Important Data

Troposphere: 0-15 km Temperature -60°C

Stratosphere: 15-50 km Temperature -2°C

Mesosphere: 50-85 km Temperature -90°C

Thermosphere: 85-500 km Temperature 1200°C

Bond Energy

Bond	Energy / KJmol ⁻¹
O=O	497
N=N	410
N≡N	946
O-O	150
H-Cl	431
Cl-Cl	242
H-I	299

$$R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$$

$$F = 96500 \text{ C mol}^{-1}$$

$$1 \text{ atm} = 760 \text{ Torr} = 760 \text{ mmHg} = 101325 \text{ Pa} = 101.325 \text{ KPa}$$

$$h = 6.626 \times 10^{-34} \text{ J}$$

$$c = 3 \times 10^8 \text{ ms}^{-1}$$

$$g = 9.81 \text{ ms}^{-2}$$

$$L = 6.02 \times 10^{23} \text{ mol}^{-1}$$

$$e = -1.60 \times 10^{-19} \text{ C}$$

$$\text{specific heat capacity of water} = 4.18 \text{ kJ kg}^{-1} \text{ K}^{-1}$$

$$\text{molar gas volume (V}_m\text{)} = 22.4 \text{ dm}^3 \text{ mol}^{-1} \text{ @ stp}$$

$$= 24 \text{ dm}^3 \text{ mol}^{-1} \text{ under room conditions}$$

$$K_{w(\text{H}_2\text{O})} = 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6} \text{ @ } 25^\circ \text{C}$$

$$m_p = 1.67 \times 10^{-27} \text{ kg}$$

$$m_n = 1.67 \times 10^{-27} \text{kg}$$

$$m_e = 9.11 \times 10^{-31} \text{kg}$$

END OF PAPER

1 H Hydrogen 1.008																	2 He Helium 4.003	
3 Li Lithium 6.94	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180	
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.085	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948	
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.630	33 As Arsenic 74.922	34 Se Selenium 78.97	35 Br Bromine 79.904	36 Kr Krypton 83.798	
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium [97]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.904	54 Xe Xenon 131.293	
55 Cs Cesium 132.905	56 Ba Barium 137.327	* 57 - 70	71 Lu Lutetium 174.967	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	78 Ir Iridium 192.217	79 Pt Platinum 195.084	80 Au Gold 196.997	81 Hg Mercury 200.592	82 Tl Thallium 204.38	83 Pb Lead 207.2	84 Bi Bismuth 208.980	85 Po Polonium [209]	86 At Astatine [210]	86 Rn Radon [222]
87 Fr Francium [223]	88 Ra Radium [226]	** 89 - 102	103 Lr Lawrencium [262]	104 Rf Rutherfordium [267]	105 Db Dubnium [270]	106 Sg Seaborgium [269]	107 Bh Bohrium [270]	108 Hs Hassium [270]	109 Mt Meitnerium [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [281]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [293]	118 Og Oganesson [294]

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*Lanthanide series

57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.242	61 Pm Promethium [145]	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.045
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**Actinide series

89 Ac Actinium [227]	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium [237]	94 Pu Plutonium [244]	95 Am Americium [243]	96 Cm Curium [247]	97 Bk Berkelium [247]	98 Cf Californium [251]	99 Es Einsteinium [252]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]
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