

SECTION A: Multiple Choice [30 %, 2 Marks Each]

Circle the letter for the correct answer in each question.

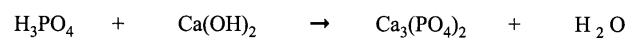
1. Write the nuclear symbol for the species that has **36 neutrons** and **28 electrons**.
 - a) ${}^{66}\text{Ge}^{2+}$
 - b) ${}^{66}\text{Ni}^{2+}$
 - c) ${}^{66}\text{Zn}^{2+}$
 - d) ${}^{66}\text{Fe}^{2+}$
 - e) ${}_{66}\text{Kr}^{6+}$

2. Which one of the following Name-Formula combinations is **NOT CORRECT**? (Which answer is **FALSE**?)
 - a) Lithium aluminum sulfate, LiAlSO_4
 - b) Chloric acid, HClO_3 (aq)
 - c) Cobalt (II) bromide tetrahydrate, $\text{CoBr}_2 \cdot 4\text{H}_2\text{O}$
 - d) Dinitrogen pentoxide, N_2O_5
 - e) Potassium hydrogen phosphate, K_2HPO_4

3. A student carries out an oxidation reaction with element Z, which is in Group 13. What is the general formula of the expected oxide?
 - a) ZO
 - b) Z_2O
 - c) Z_2O_3
 - d) Z_3O_4
 - e) Z_3O_2

4. The maximum driving speed limit in Botswana is 120 km/hr. What is this speed in m/s?
- a) 20.0 m/s
 - b) 0.0333 m/s
 - c) 200 m/s
 - d) 33.3 m/s
 - e) 100 m/s
5. How many oxygen (O) atoms are there in 175 g of $\text{Na}_2\text{S}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$? The molar mass is 194.13 g/mol
- a) 5.43×10^{24}
 - b) 1.63×10^{24}
 - c) 2.71×10^{24}
 - d) 1.09×10^{24}
 - e) 1.20×10^{24}
6. A sample of a compound of chlorine and oxygen contains 59.63 % Cl by mass. Determine the empirical formula.
- a) Cl_2O
 - b) Cl_2O_3
 - c) ClO_2
 - d) Cl_2O_5
 - e) Cl_2O_7

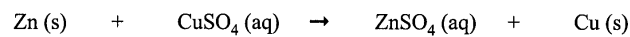
7. When the equation



is balanced, the proper sequence of stoichiometric coefficients is

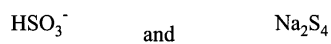
- a) 3, 2, 1, 6
- b) 2, 3, 1, 6
- c) 2, 3, 6, 1
- d) 2, 3, 3, 1
- e) 3, 2, 6, 1

8. In the following reaction



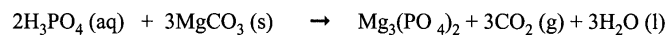
identify the reducing and oxidising agent, respectively

- a) Zn^{2+} and Cu^{2+}
 - b) Zn and CuSO_4
 - c) Zn and Cu
 - d) ZnSO_4 and CuSO_4
 - e) Zn^{2+} and CuSO_4
9. Calculate the oxidation numbers for the S atoms in the two species:



- a) + 4 and - 2
- b) + 6 and - 1
- c) + 4 and - 0.5
- d) + 6 and + 0.5
- e) + 4 and - 1

10. Magnesium carbonate reacts with phosphoric acid according to the equation



How many gram of carbon dioxide will be produced when 50.0 g of MgCO_3 (Molar mass = 84.31 g/mol) reacts completely with H_3PO_4 ?

- a) 52.2 g
b) 13.1 g
c) 26.1 g
d) 50.0 g
e) 33.3 g
11. A given mass of hydrogen occupies 40.0 L at 700 torr. What volume will it occupy at 5.00 atm pressure and at the same temperature? (1 atm = 760 torr)
- a) 7.37 L
b) 18.3 L
c) 217 L
d) 153 L
e) 76.8 L
12. Which of the following sets of quantum numbers are **acceptable** (allowed) in a ground state atom?

- i) $n = 3, l = -2, m_l = 0, m_s = +\frac{1}{2}$;
ii) $n = 2, l = 2, m_l = -1, m_s = -\frac{1}{2}$;
iii) $n = 6, l = 2, m_l = +2, m_s = +\frac{1}{2}$;
iv) $n = 4, l = 0, m_l = 0, m_s = -\frac{1}{2}$;
v) $n = 3, l = 2, m_l = -3, m_s = +\frac{1}{2}$

- a) i) and ii)
b) iii) and v)
c) ii) and iv)
d) iv) and v)
e) iii) and iv)

13. How many unpaired electrons are in the electron structure of ${}_{24}\text{Cr}$?
- a) 2
 - b) 4
 - c) 3
 - d) 6
 - e) 5
14. Which one of the following statements is **FALSE**?
- a) Expanded octet requires a large atom with nd orbitals
 - b) Electronegativity decreases down the group
 - c) Formal charge can be used to evaluate stability of resonance structures
 - d) Ionic radius of cations decrease down the group
 - e) Electronegativity affects the polarity of a chemical bond
15. Which one of the following compounds is expected to have the most favourable (largest) **lattice energy**?
- a) LiF
 - b) KF
 - c) Li_2O
 - d) NaCl
 - e) Li_3N

SECTION B: Multiple Choice [30 %, 3 Marks Each]

1. At 25 °C the average speed for molecules of an unknown gas is 2.77 times that for Xe (g). What could be the formula of this unknown gas?
- a) SF₆
 - b) BeF₂
 - c) UF₆
 - d) NO₂
 - e) NH₃
2. If 250 mL of 0.150 M CaCl₂ (aq) solution is mixed with 250 mL of 0.150 M AlCl₃ (aq) solution, what is the molarity of Cl⁻, in the resulting mixed solution?
- a) 0.150 M
 - b) 0.375 M
 - c) 0.250 M
 - d) 0.188 M
 - e) 0.225 M
3. Which of the following is **TRUE** regarding the number of un-paired electrons in

	${}_{16}\text{S}$	${}_{33}\text{As}$	${}_{25}\text{Mn}^{2+}$
a)	2	3	5
b)	3	2	5
c)	2	5	3
d)	4	3	7
e)	5	2	3

7. The geometry of the IF_4^+ cation is best described as:
- a) Tetrahedral
 - b) See saw molecule
 - c) Square planar
 - d) Octahedral
 - e) Square pyramidal
8. Which one of the following molecules is polar (has a dipole moment, $\mu \neq 0$)?
- a) CS_2
 - b) BF_3
 - c) PCl_3
 - d) CF_4
 - e) SF_6
9. Give the number of sigma (σ) bonds, pi (π) bonds, and unshared/lone pairs of valence electrons in the CNO^- anion.
- a) 2 σ , 2 π , and 4 lone pairs
 - b) 1 σ , 3 π , and 4 lone pairs
 - c) 4 σ , 0 π , and 8 lone pairs
 - d) 0 σ , 4 π , and 4 lone pairs
 - e) 2 σ , 0 π , and 0 lone pairs
10. What is the hybridization of the Br atom in the BrF_3 molecule?
- a) sp
 - b) sp^2
 - c) sp^3
 - d) sp^3d
 - e) sp^3d^2

SECTION C:[40 %]

Answer each question in the space provided. If you require more space use the back of the page. You may do your rough work on the back of the printed page, but cross it out before submitting your paper.

1. Write the, i) Balanced chemical equation, ii) Complete ionic equation,
iii) Net ionic equation; for each of the following reactions (a & b):

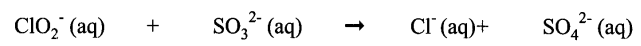
a) Hydrochloric acid added to an aqueous solution of silver nitrate

[3 marks]

b) Aqueous acetic acid reacted with a solution of barium hydroxide

[3 marks]

2. Use the method of half-reactions to balance the following ionic equation in basic solution:



[6 marks]

- 3a.** Write the ground state electron configuration of the following atoms or ions. Use the [rare gas configuration] abbreviation for completely filled electron shells

[4 marks]



- 3b.** Arrange the following in order of increasing electronegativity:

P, Se, Si, Cl, S

[1 mark]

Arrange the following in order of decreasing metallic character:

Sb, Ba, F, Sr

[1 mark]

4. For the following molecules and ions:

- i) Write the Lewis dot structures;
- ii) Describe by name the overall geometry of valence electron pairs;
- iii) Describe by name the geometry of the molecule or ion;
- iv) Describe the bond angles expected in the structures.

[8 marks]

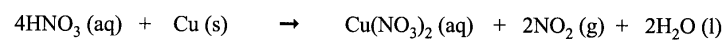
a) IF_5

b) NO_2^-

5. Write three different non-equivalent resonance structures for H_2PO_4^- as $(\text{HO})_2\text{PO}_2^-$ with a central P atom. Determine the most reasonable structure by calculating the formal charges on each of the differently bonded atoms.

[8 marks]

6. A piece of Cu metal 3.31 cm x 1.84 cm x 1.0 cm reacts with 157 mL of 1.35 M nitric acid solution. The density of copper is 8.92 g/cm³. From the following equation:



What volume of NO₂ at 1.01 atm and 297 K will be formed?

[7 marks]

PERIODIC TABLE OF THE ELEMENTS

<http://www.chem.qmw.ac.uk/fupace/rtw/table.html>

1 1.00794 H	2 4.00260 He																	18
3 6.941 Li	4 9.01218 Be	5 10.81 B	6 12.011 C	7 14.0067 N	8 15.9994 O	9 18.9984 F	10 20.179 Ne	11 22.9898 Na	12 24.305 Mg	13 26.9815 Al	14 28.0855 Si	15 30.9738 P	16 32.06 S	17 35.453 Cl	18 39.948 Ar			
19 39.0983 K	20 40.08 Ca	21 44.9559 Sc	22 47.88 Ti	23 50.9415 V	24 51.996 Cr	25 54.9380 Mn	26 55.847 Fe	27 58.9332 Co	28 58.69 Ni	29 63.546 Cu	30 65.38 Zn	31 69.72 Ga	32 72.59 Ge	33 74.9216 As	34 78.96 Se	35 79.904 Br	36 83.8 Kr	
37 85.4678 Rb	38 87.62 Sr	39 88.9059 Y	40 91.22 Zr	41 92.9064 Nb	42 95.94 Mo	43 98 Tc	44 101.07 Ru	45 102.906 Rh	46 106.42 Pd	47 107.868 Ag	48 112.41 Cd	49 114.82 In	50 118.69 Sn	51 121.75 Sb	52 127.6 Te	53 126.9 I	54 131.29 Xe	
55 132.905 Cs	56 137.33 Ba	57 174.967 Lu	58 178.49 Hf	59 180.948 Ta	60 183.85 W	61 186.207 Re	62 190.2 Os	63 192.22 Ir	64 195.08 Pt	65 200.59 Au	66 200.59 Hg	67 204.383 Tl	68 207.2 Pb	69 208.908 Bi	70 209 Po	71 210 At	72 210 Rn	
87 223 Fr	88 226.025 Ra	89 227.028 Ac	90 232.038 Th	91 231.036 Pa	92 238.029 U	93 237.048 Np	94 244 Pu	95 244 Am	96 244 Cm	97 247 Bk	98 251 Cf	99 252 Es	100 257 Fm	101 258 Md	102 259 No	103 259 Lr	104 259 Uuo	

Lanthanides:

57 138.906 La	58 140.12 Ce	59 140.908 Pr	60 144.24 Nd	61 145 Pm	62 150.36 Sm	63 151.96 Eu	64 157.25 Gd	65 158.925 Tb	66 162.50 Dy	67 161.930 Ho	68 167.26 Er	69 166.934 Tm	70 173.04 Yb
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Actinides:

89 227.028 Ac	90 232.038 Th	91 231.036 Pa	92 238.029 U	93 237.048 Np	94 244 Pu	95 244 Am	96 247 Cm	97 247 Bk	98 251 Cf	99 252 Es	100 257 Fm	101 258 Md	102 259 No
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