JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION (SCIENCES)

1ST YEAR 1ST SEMESTER 2017/2018 ACADEMIC YEAR

MAIN REGULAR

COURSE CODE: SCH 102

COURSE TITLE: Basic Inorganic Chemistry

EXAM VENUE: **STREAM: (BEd. Science)**

DATE:

TIME: **EXAM SESSION:**

INSTRUCTIONS:

1. **Answer question 1 (Compulsory) in section A and ANY other 2 questions in Section B.**
2. **Candidates are advised not to write on the question paper.**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**
4. **Some important information/formulas are found on the last page of this question paper**

SECTION A

Question 1

a) Discuss the four quantum numbers that fully describes the electronic configuration of an atom. (4 marks)

b) Describe the electronic configurations (*spdf*) of the following atoms. (4 marks)

   i. Sodium atom
   ii. Magnesium atom
   iii. Fluoride atom
   iv. Iron atom

c) Describe the energy level diagram for the sodium and iron atoms. (6 marks)

d) Discuss the shapes of atomic orbitals in an *s* orbital, *p* orbital and *d* orbital (6 marks)

e) The formation of ammonium phosphate fertilizers involves the following reactions.

   i. $2Ca_3(PO_4)_2 + 6SiO_2 + 10C \rightarrow P_4 + 10CO + 6CaSiO_3$
   ii. $P_4 + 5O_2 + 6H_2O \rightarrow 4H_3PO_4$
   iii. $H_3PO_4 + NH_3 \rightarrow (NH_4)_3PO_4$

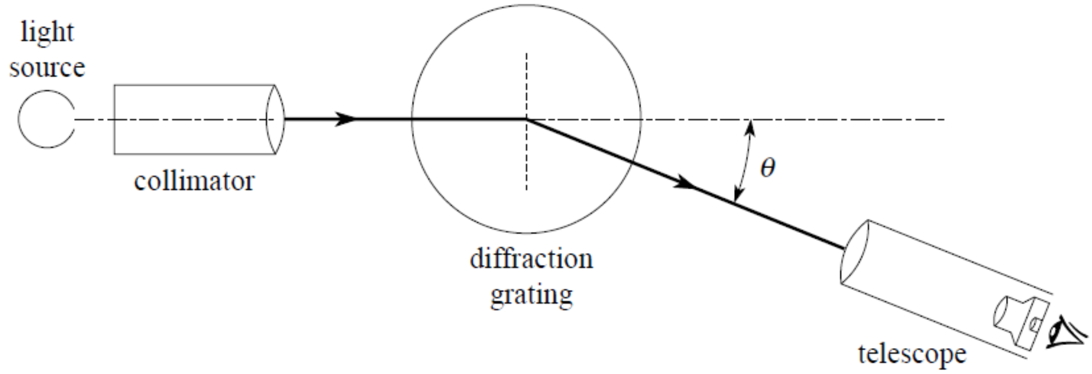
   Write complete redox reactions with oxidation numbers for each element shown and the reduced/oxidized species indicated. (6 marks)

f) The following reactions involve Brønsted-Lowry Acid and Brønsted-Lowry Base forward reactions. In each reaction, discuss why the chemical species can be identified as a Brønsted-Lowry Base or Brønsted-Lowry Acid (4 marks)

   i. $HClO_2(aq) + NaIO(aq) \rightarrow HIO(aq) + NaClO_2(aq)$
   ii. $HS^-(aq) + HF(aq) \rightarrow H_2S(aq) + F^-(aq)$

SECTION B

Question 2



a) The above spectrometer has a diffraction grating as the light dispersion device. Given that the light is diffracted at an angle of 32^o determine the wavelength of the diffracted light. (5 marks)

b) Use the electron box and arrow configurations in combination with Pauli exclusion principle and Hund's rule to demonstrate the electronic configuration of V^+, V^{2+}, V^{3+}, V^{4+}, and V^{5+} (5 marks)

c) Use the Bohr equation to determine the Bohr radius of H atom at n = 1. (5 marks)

d) An increase in the principal quantum number from n = 1 to n = ∞ corresponds to the ionization of the atom and the ionization energy can be determined from the equation below. Given that one mole of a substance contains 6.022×10^{23} mol^{-1} particles, determine the first ionization energy for H. (5 marks)

Question 3

a) Given that the principal quantum number, n, is 3, and using the rules that govern quantum numbers *n* and *l*, write down the allowed values of *l* and m_l, and determine the number of atomic orbitals possible for n = 4.

(5 marks)

b) Discuss the possible sets of quantum numbers that describe an electron in a 2*s* atomic orbital. What is the physical significance of these unique sets?

(5 marks)

c) Confirm that the experimentally observed electronic configuration of K, $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $4s^1$, is energetically more stable than the configuration $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $3d^1$. (5 marks)

d) Briefly discuss the following principles: The aufbau principle, The Pauli exclusion principle, and The hands rule. (5 marks)

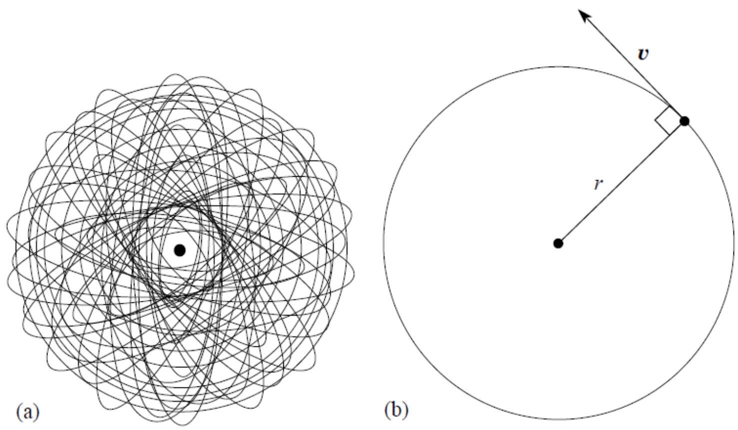
Question 4

a) Brirfly discuss electron transitions that make up the Lyman and Balmer series in the emission spectrum of atomic hydrogen (use of a diagram is prefered). (10 marks)

b) Use the first 30 elements in the periodic table to demonstrate why they are lebelled as *s* block, *d* block, and *p* block elements. (10 marks)

Question 5

a) Using the diagram shown below, discuss the Rutherfords model of an atom and the Bohr’s model of an atom. Include in your discussion the Bohrs’ postulates. (20 marks)



Periodic table

Key:

1 H 1.008	
1	Atomic number, Z
H	Element symbol
1.008	Relative atomic mass, A_r

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.008																	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.01	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.54	30 **Zn** 65.41	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.91	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** 98.91	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.40	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
55 **Cs** 132.91	56 **Ba** 137.34	**La–Lu**	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.19	83 **Bi** 208.98	84 **Po** 210	85 **At** 210	86 **Rn** 222
87 **Fr** 223	88 **Ra** 226.03	**Ac–Lr**	104 **Rf** [261]	105 **Db** [262]	106 **Sg** [266]	107 **Bh** [264]	108 **Hs** [277]	109 **Mt** [268]	110 **Ds** [271]	111 **Rg** [272]	112 **Uub** [285]						

Lanthanoids	57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** 146.92	62 **Sm** 150.35	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.92	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
Actinoids	89 **Ac** 227.03	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	94 **Pu** 239.05	95 **Am** 241.06	96 **Cm** 244.07	97 **Bk** 249.08	98 **Cf** 252.08	99 **Es** 252.09	100 **Fm** 257.10	101 **Md** 258.10	102 **No** 259	103 **Lr** 262

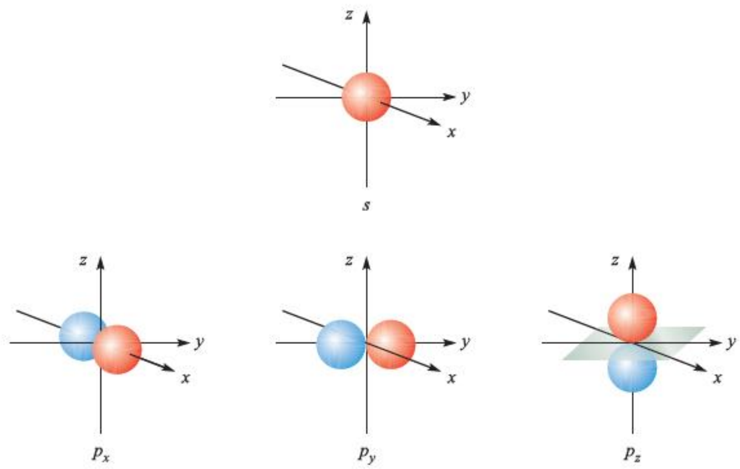


Fig. 1.9 Boundary surfaces for the angular parts of the 1*s* and 2*p* atomic orbitals of the hydrogen atom. The nodal plane shown in grey for the $2p_z$ atomic orbital lies in the *xy* plane.

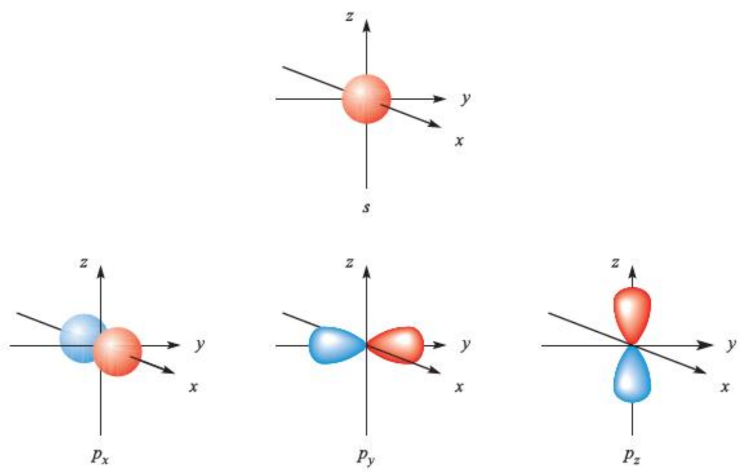


Fig. 1.10 Representations of an *s* and a set of three degenerate *p* atomic orbitals. The lobes of the p_x orbital are elongated like those of the p_y and p_z but are directed along the axis that passes through the plane of the paper.

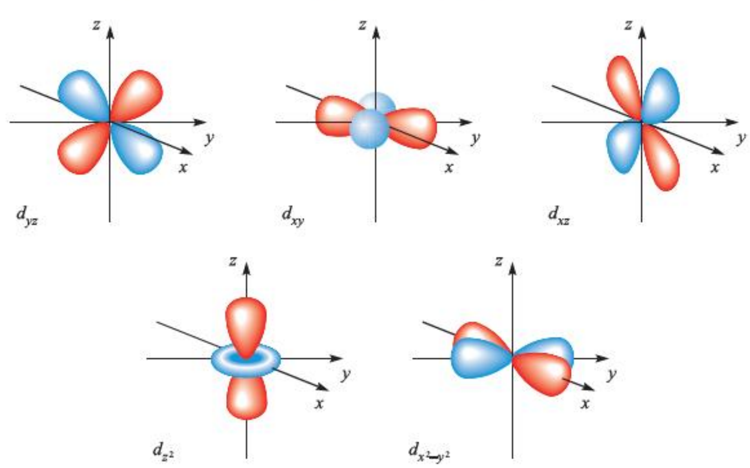


Fig. 1.11 Representations of a set of five degenerate *d* atomic orbitals.

a) Grating relation nλ = ndsinϴ

b) Ionization energy $IE = E_{\infty} - E_1 = \frac{hc}{\lambda} = hcR(\frac{1}{1^2} - \frac{1}{\infty^2})$ Where h = planks constant; R = Rydberg constant for hydrogen = 1.097 x 10^7 m^{-1} or 1.097 x 10^5 cm^{-1}; c = 2.998 x 10^8 ms^{-1}

c) Bohr radius (r_n), $r_n = \frac{\varepsilon_0 h^2 n^2}{\pi m_e e^2}$

ε_0 = permittivity of vacuum = 8.854 x 10^{-12} Fm^{-1}

h=Planks constant = 6.626 x 10^{-34} Js

n = 1, 2, 3, ….describing a given orbit

m_e = electron rest mass = 9.109 x 10^{-31} kg

e = charge on an electron (elementary charge) = 1.602 x 10^{-19}C