**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**SCHOOL OF BIOLOGICAL AND PHYSICAL SCIENCES**

**UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF EDUCATION (SCIENCE)**

**2ND YEAR 1ST SEMESTER 2016/17**

# MAIN REGULAR

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**COURSE CODE: SCH 3211**

**COURSE TITLE: INORGANIC CHEMISTRY**

**EXAM VENUE: PHY LAB** **STREAM: (BED SCI)**

**DATE: 06/09/16** **EXAM SESSION: 2.00 – 4.00 PM**

**TIME: 2:00HRS**

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**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**

**Section A, Answer <u>all</u> the questions (30 marks)**

**Question 1**

a) Given the equation below, determine the Bohr radius of H atom at n = 1.

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

$\varepsilon_0$ = 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

(2 marks)

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

$IE = E_\infty - E_1 = \frac{hc}{\lambda} = hcR(\frac{1}{1^2} - \frac{1}{\infty^2})$ 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 $10^8$ $ms^{-1}$ (3 marks)

c) Given that the principal quantum number, n, is 2, 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 = 3. (3 marks)

d) Discuss the possible sets of quantum numbers that describe an electron in a 2*s* atomic orbital. What is the significance of the physical significance of these unique sets? (3 marks)

e) 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 $1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^6$, $3d^1$. (3 marks)

f) Determine the ground state electronic configuration of P (Z = 15). (3 marks)

g) Briefly discuss the following principles: The aufbau principle, The Pauli exclusion principle, and The hands rule. (6 marks)

h) The atomic numbers of He, Ne, Ar and Kr are 2, 10, 18 and 36 respectively. Briefly describe their ground state electronic configurations and comment upon their similarities or differences. (4 marks)

i) Calculate the energy associated with the first orbit of $He^+$. What is the radius of this orbit? (3 marks)

(30 marks)

**Section B. Answer any <u>TWO</u> questions**

**Question 2**

a) Using a diagram, demonstrate the boundary surfaces of the following orbitals

i. *s* orbital (3 marks)

ii. *p* orbitals (3 marks)

iii. *d* orbitals (5 marks)

b) Using an illustration of a well labeled energy level diagram of electron in the hydrogen atom, show the Lyman, Balmer and Paschen series of transitions that occur for n = 1, 2 and 3 respectively.

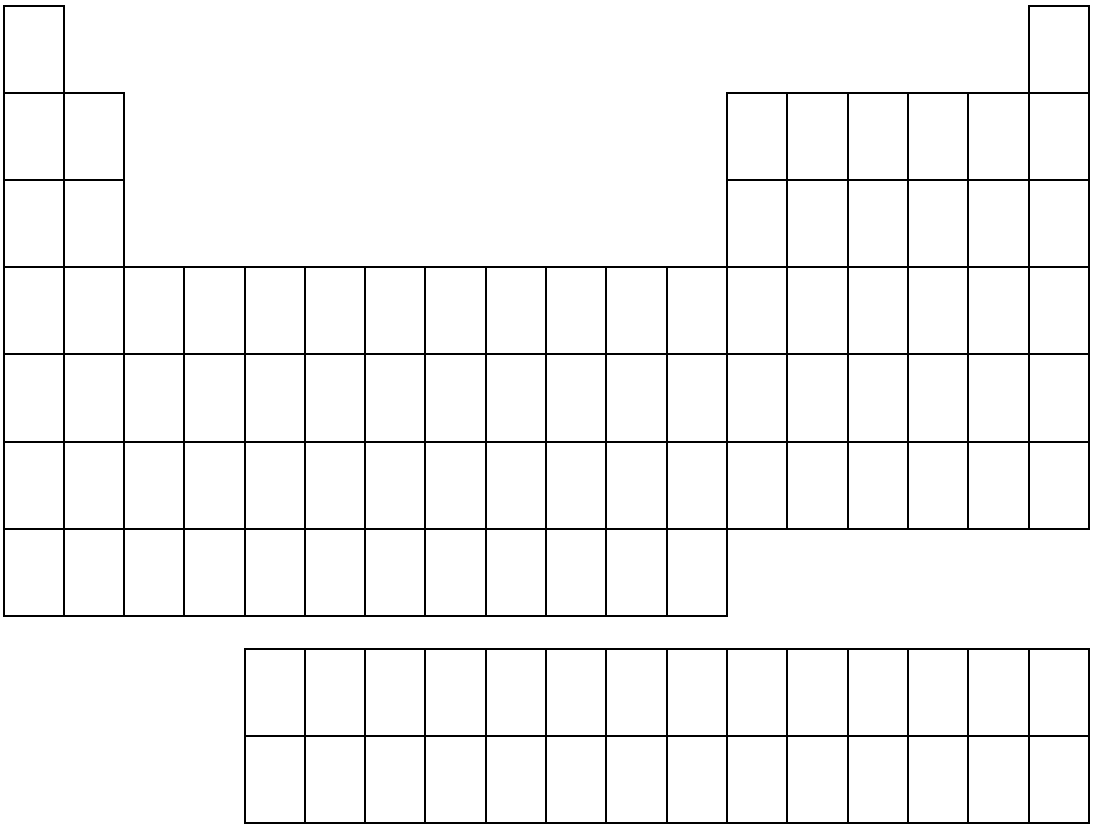
(6 marks)

c) What are the frequency and wavelength of a photon emitted during a transition from n = 5 state to the n = 2 state in the hydrogen atom?

(3 marks)

**Question 3**

a) Using the aufbau principal, that electrons fill orbitals from bottom up, complete the following periodic table of elements by indicating the *s*-block elements, *p*-block elements, *d*-block elements, and *f*-block elements. (5 marks)



d) Given the aluminum element with 13 electrons, describe its:

i. *spdf* electronic configuration (2 marks)

ii. orbital box notation (2 marks)

iii. Core electronic configuration (2 mark)

iv. Energy level diagram for the electrons (4 marks)

**Question 4**

a) Briefly discuss the limitations of the Bohr's theory. (4 marks)

b) Using De-Brogile's equation, determine the wavelength of a ball of mass 0.1 kg moving with a velocity of 10 m $s^{-1}$. (4 marks)

c) Determine the mass of a photon with wavelength 3.6 Å. (4 marks)

d) Briefly discuss the Heisenberg's Uncertainty Principle and its significance. (4 marks)

e) A microscope using suitable photons is employed to locate an electron in an atom within a distance of 0.1 Å. What is the uncertainty involved in the measurement of its velocity? (4 marks)

(20 marks)

**Question 5**

a) Using well labeled diagrams, discuss four (4) types of inorganic solids. (4 marks)

b) Briefly discuss the following bonding between inorganic molecules

i. Ionic bonding (4 marks)

ii. Covalent bonding (4 marks)

iii. Dative bonding (4 marks)

c) Briefly discuss the shapes of the following molecules

i. NaCl

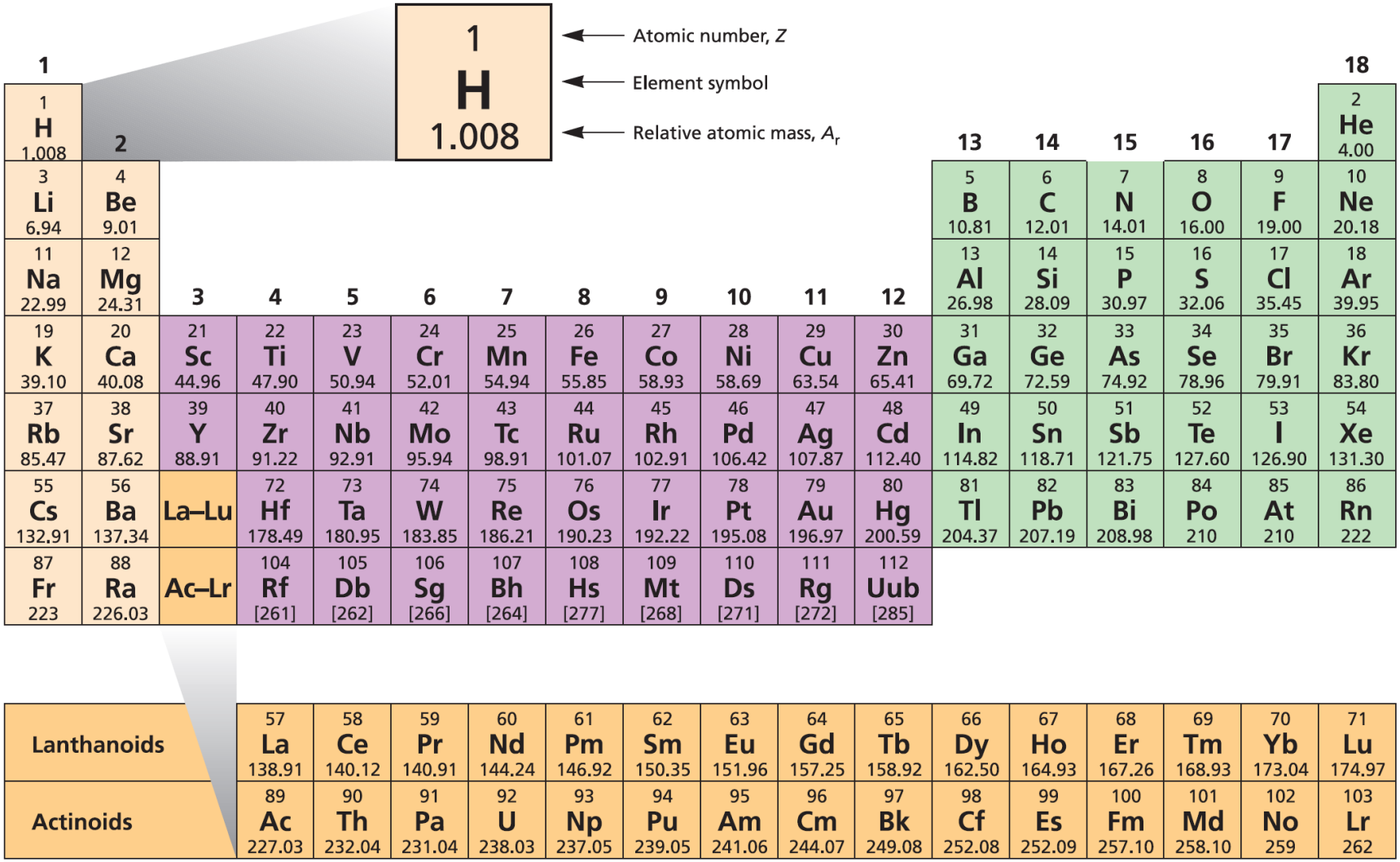
ii. $H_2O$

iii. $NH_4$

iv. $CH_4$ (4 marks)

(20 marks)

## Periodic table




| 1 | | | | | | | | | | | | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 H 1.008 | 2 | | | | | | | | | | | | | | | | 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 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 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] | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |