



# UNIVERSITY OF NAIROBI

FIRST SEMESTER EXAMINATIONS 2013/2014

FIRST YEAR EXAMINATIONS FOR THE DEGREES OF BACHELOR OF SCIENCE  
IN CIVIL ENGINEERING, ENVIRONMENTAL AND BIOSYSTEMS ENGINEERING  
AND MECHANICAL ENGINEERING

FCE 181/FEB 105/FME 151 : GENERAL AND INORGANIC CHEMISTRY

DATE: APRIL 23, 2014

TIME: 8.30 A.M. – 10.30 A.M.

Answer ALL questions in Section I and ONE question in Section II

## SECTION I

1. a) Define the following terms:

- i) Ionization energy (2 marks)
- ii) Electron affinity (2 marks)
- iii) Electronegativity (2 marks)

b) A hydrogen atom exists with its electron in the  $n = 6$  state. The electron undergoes a transition to the  $n = 2$  state. Given  $R_H = 1.0974 \times 10^7 \text{ m}^{-1}$ ,  $h = 6.626 \times 10^{-34} \text{ Js}$ ,  $c = 3.0 \times 10^8 \text{ m/s}$ , Calculate

- i) the energy of the photon emitted (4 marks)
- ii) its frequency (3 marks)
- iii) its wavelength in nanometers (3 marks)

2. a) State and explain Coulomb's law (3 marks)

b) Draw the Lewis structure and determine the molecular geometry of each of the following molecules:

- i)  $\text{H}_2\text{O}$  (2 marks)
- ii)  $\text{NH}_3$  (2 marks)
- iii)  $\text{PCl}_3$  (2 marks)

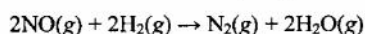
c) Draw a molecular orbital diagram for  $\text{N}_2$  (4 marks)

d) Using the Born-Landé equation, calculate the lattice energy of  $\text{TiO}_2$ , which has the rutile structure with a Madelung constant,  $M$ , of 2.408. The effective ionic radii of  $\text{Ti}^{4+}$  ( $z^+ = 4$ ) and  $\text{O}^{2-}$  ( $z^- = 2$ ) are respectively 60.5 and 136 pm, with a Born exponent,  $n$ , of 8. The Avogadro's number,  $N_A$ , is  $6.022 \times 10^{23} \text{ mol}^{-1}$ , the permittivity of vacuum,  $\epsilon_0$  is  $8.854 \times 10^{-12} \text{ F/m}$  and the electronic charge,  $e$ , is  $1.602 \times 10^{-19} \text{ C}$  (5 marks)

3. a) State Le Chatelier's principle **(2 marks)**  
 b) Using suitable examples state and explain any **THREE** factors that affect chemical equilibria **(9 marks)**  
 c) Define the following terms:  
 i) Solubility **(2 marks)**  
 ii) Saturated solution **(2 marks)**  
 d) How does temperature affect the solubility of gases? Explain **(3 marks)**

**Section II**

4. a) The reaction of nitric oxide with hydrogen at 1280°C is:



Given the following data,

Run	[NO] <sub>0</sub> (M)	[H <sub>2</sub> ] <sub>0</sub> (M)	Initial Rate (M/min)
1	0.010	0.010	0.006
2	0.020	0.030	0.144
3	0.010	0.020	0.012

Determine the:

- i) Rate law **(5 marks)**  
 ii) Rate constant **(4 marks)**  
 b) A certain reaction proceeds through first order kinetics. The half-life of the reaction is 180 s. What percent of the initial concentration remains after 900s? **(4 marks)**  
 c) The activation energy of a first order reaction is 50.2 kJ/mol at 25°C. Determine the temperature at which the rate constant will double,  $R = 8.314 \text{ Jmol}^{-1}\text{K}^{-1}$  **(5 marks)**
5. a) Atmospheric stratification describes the structure of the atmosphere, dividing it into distinct layers. Discuss the main features of the Troposphere and the Stratosphere. **(10 marks)**  
 b) What is the importance of ozone and what are the consequences of its depletion? **(4 marks)**  
 c) List any **TWO** greenhouse gases and explain how they cause global warming **(4 marks)**