MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR CERTIFICATE IN ELECTRICAL, CIVIL AND MECHANICAL ENGINEERING.

BCE BT 103: APPLIED SCIENCE II (CHEMISTRY)

DATE: 14/12/2017 **TIME: 8.30-10.30 AM**

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

Required data and constants:

1. Atomic numbers Na = 11, Mn= 25, Cu = 29, Ti =22, O = 8 Ba = 56, H = 1, Al = 13, C = 6, Mg = 12, Cl = 17.
2. Ka acetic acid = 1.8×10^{-5} M
3. Ka for Oxalic acid = 3.78×10^{-6}M

SECTION A: COMPULSORY)

QUESTION ONE (30 MARKS)

a) Into which part of an atom is its mass concentrated? Explain your answer.

(2 marks)

b) Explain why the atomic mass of an element is a decimal number on the periodic table

(1 mark)

c) Write the electron configurations of the following species: Na, Mn, Cu^{2+}, Ti^{4+} and O^{2-}

(5 marks)

d) Define the following terms:

i) Ionisation energy (1 mark)
ii) Electron affinity (1 mark)
iii) Electronegativity (1 mark)
iv) Effective nuclear charge (1 mark)

e) Write the lewis structures of the following ionic and covalent compounds

i) Barium oxide (2 marks)
ii) Ammonia (2 marks)
iii) Water (1 mark)

f) By giving relevant examples, differentiate between a bronsted-lowry definition of an acid and a base. (2 marks)

g) Define pH (1 mark)

h) Calculate the pH of the following acidic solutions:

i) 10^{-3} mol dm^{-3} sulphuric acid (2 marks)
ii) 3M HX which is only 50% dissociated (2 marks)

i) What is meant by a pure substance? (1 mark)

j) Differentiate between a compound and a mixture. Give practical examples.

(3 marks)

k) Differentiate between a chemical and physical change giving a practical example in each case (2 marks)

SECTION B: ANSWER ANY OTHER TWO QUESTIONS

QUESTION TWO (20 MARKS)

a) Two Elements X and Y (not their actual symbols) have atomic number 14 and 81 respectively. To which period and groups do they belong? Show your working. (2 marks)

b) Explain the following observations:

i) the first ionization energy of phosphorous is higher than that of oxygen (2 marks)

ii) the first ionization energy of magnesium is higher than that of aluminum(2 marks

ii) the third ionization energy of Mg exceptionally higher than the second ionization energy. (2 marks)

iv) atomic radii decreases across a period but increases down a group (2 marks)

v) the ionic radius of Na^+ ($2S^2 2P^6$)is greater than that of Mg^{2+} ($2S^2 2P^6$) (2 marks)

vi) the fact that group 18 elements have the highest ionization energy (2 marks)

c) i) what is shielding in atoms and how does it affect the reactivity of metals? (2 marks)

ii) Calculate the effective nuclear charge for the outermost electron in oxygen. (1 mark)

d) i) what are valence electrons? (1 mark)

ii) write down the valence electron configurations for oxygen and Aluminium (2 marks)

QUESTION THREE (20 MARKS)

a) Write the lewis structures for the following compounds: aluminium oxide, methane, carbon(iv)oxide, magnesium chloride. (4 marks)

b) Using ammonia and boron trifluoride molecules as examples, explain how a coordinate bond is formed. (3 marks)

c) Explain why transition metals have a great tendancy of forming coordinate bonds. (2 marks)

d) Using two water molecules as examples, explain how hydrogen bonds are formed (2 marks)

e) In terms of structure and bonding, explain the following observations:

i) polar organic molecules are generally soluble in water. (2 marks)

ii) The boiling point of methanol is greater than that of butane yet the relative atomic mass of butane is greater than that of methanol. (2 marks)

f) Explain the nature of covalent bond between nitrogen atom (electronegativity 3.0) and oxygen atom (electronegativity 3.5) (2 marks)

g) A tripple covalent bond involves three electron pairs. State and explain how two types of covalent bonds are formed by the electron pairs. (3 marks)

QUESTION FOUR (20 MARKS)

a) Explain what is meant by strength of an acid? (2 marks)

b) What is the lewis definition of an acid? In what way is it more general than Bronsted definition? (2 marks)

c) What is the the pH of an aqueous solution with $[OH^-] = 6.3\times10^{-1}M$ (2 marks)

d) What is the $[H_3O^+]$ of an aqueous solution with a pH of 11.8? (3 marks)

e) What is a buffer solution? (2 marks)

f) What is the pH of a buffer solution made from 0.1M acetic acid and 0.1 M sodium acetate solution? 3mks

g) i) Write down the overall dissociation equation for oxalic acid (1 mark)

ii) what volume of of 0.400 M sodium hydroxide is required to neutralize completely a 5.00×10^{-3} mole sample of pure oxalic acid. 2mks

iii) Give the equations representing the first and the second dissociations of oxalic acid. Calculate the value of the first dissociation constant K_1, if the value of the second dissociation constant K_2 is 6.40×10^{-5} (3 marks)

QUESTION FIVE (20 MARKS)

a) State three differences between physical and chemical changes (3 marks)

b) Classify the following as either physical or chemical changes

i) Rusting of Iron (1 mark)

ii) Fractional distillation of liquid air (1 mark)

iii) Combustion of charcoal (1 mark)

iv) Freezing of water (1 mark)

c) Giving suitable examples, differentiate between homogeneous and heterogeneous mixtures. In each case state a suitable method of separating the mixture. (3 marks)

d) i) Define the term compound and give three examples. (2 marks)

ii) Explain why elements form compounds and state three types of chemical combinations that aid in compound formation. (3 marks)

e) A mixture contains water, ethanol and hexane. Briefly explain how each component can be recovered from the mixture. (3 marks)

f) state the type forces holding:

i) water and ethanol molecules (1 mark)

ii) hexane molecules in mixture (e) (i) above. (1 mark)