



MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FIRST YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF
BACHELOR OF AGRICULTURAL EDUCATION AND EXTENSION (AGED)

KST 104: FUNDAMENTALS OF CHEMISTRY

DATE: 31/5/2017

TIME: 2:00 – 4:00 PM

INSTRUCTIONS:

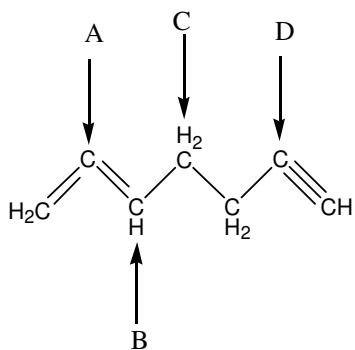
- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

Provided:

Periodic table

SECTION A: COMPULSORY (30 MARKS)

1. a) Briefly outline how gravimetric can be used to determine the amount of calcium in H_2O from Athi River. (4 marks)
- b) A 100.00 mL sample of water from Athi River was analysed for calcium content as $\text{CaC}_2\text{O}_{4(s)}$. The precipitate was filtered, washed and ignited in a crucible having an empty mass of 26.6002 g. The mass of the crucible plus CaO (56.08 g/mol) was 26.7134 g. Calculate the mass of Ca (40.08 g/mol). (4 marks)
- c) Discuss three applications of gravimetric methods of analysis. (6 marks)
- d) i) Define the pH of a solution (1 mark)
- ii) Solid sodium ethanoate is added to 0.20 M ethanoic acid until the concentration of the salt is 0.05 M. Given that the K_a for ethanoic acid is 1.74×10^{-5} M. Calculate the pH of the buffer solution formed. *Hint*. Ethanoic acid dissociates as shown in the equation below: (4 marks)
- $$\text{CH}_3\text{COOH}_{(aq)} \leftrightarrow \text{H}^+_{(aq)} + \text{CH}_3\text{COO}^-_{(aq)}$$
- e) i) State the Le Chatelier's Principle (1 mark)
- ii) Given the reversible equation: $\text{N}_{2(g)} + 3\text{H}_{2(g)} \leftrightarrow 2\text{NH}_{3(g)}$ $\Delta H = -5508$ J. Explain the effect of the following changes on the position of the equilibrium (4 marks)
- I) Pressure II) Temperature
- iii) For the equilibrium $2\text{SO}_{3(g)} \leftrightarrow 2\text{SO}_{2(g)} + \text{O}_{2(g)}$. The K_c value is 4.07×10^{-3} mol litre⁻¹ at 1000 K. Compute the K_p for the reaction at the same temperature (4 marks)
- f) Identify the type of hybridization for each of the following carbon atoms in the following structure. (2 marks)



SECTION B: ANSWER ANY TWO QUESTIONS (20 MARKS EACH)

2. a) Define the following terms;
- i) Chromophore (1 mark)
 - ii) Absorption spectrum. (1 mark)
- b) i) State Beer's Law. (1 mark)
- ii) Identify two factors that cause deviations from Beer's Law (2 marks)
- c) A complex organic compound found in plants has a molar absorptivity of $6.94 \times 10^3 \text{ L cm}^{-1} \text{ mol}^{-1}$ at a wavelength of 435 nm. Calculate;
- i) The absorbance of an $8.50 \times 10^{-5} \text{ M}$ solution of the complex when measured in 1.00 cm cell. (2 marks)
 - ii) The percent transmittance of the solution in i) above. (2 marks)
 - iii) The concentration of a solution that is in 5.00 cm cell and has the same absorbance as the solution in (i) above. (2 marks)
- d) i) Define a buffer solution (1 mark)
- ii) Derive the Henderson-Hasselbalch equation (4 marks)
 - iii) Determine the change in H^+ ions and pH when 1 mL HCl is added to one litre of pure water (4 marks)
3. a) Define the following terms as used in volumetric analysis
- i) A standard solution
 - ii) End point of a titration
 - iii) Primary standard
 - iv) Titration error (4 marks)
- b) List four requirements for a primary standard. (4 marks)
- c) Titration of 0.2121g of pure $\text{Na}_2\text{C}_2\text{O}_4$ (134.00 g/mol) required 43.31 mL of KMnO_4 . Determine the molarity of the KMnO_4 solution. The chemical reaction is:
- $$2\text{MnO}_4^- + 5\text{C}_2\text{O}_4^{2-} + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 10\text{CO}_2 + 8\text{H}_2\text{O} \quad (4 \text{ marks})$$
- d) Highlight the characteristic properties of a precipitating agent for gravimetric analysis. (4 marks)
- e) Describe how a solution of 0.1 M Na_2CO_3 (105.99 g/mol) in 2 L can be prepared from a primary standard (4 marks)

4. a) Define the following terms as used in chemical kinetics;
- i) Activation energy
 - ii) Rate of reaction
 - iii) Order of a reaction
 - iv) Rate constant (4 marks)
- b) Explain **three** factors that increase the reaction rate of a chemical reaction (6 marks)
- c) Show that for a first order reaction kinetics the half-life ($t_{1/2}$) for a reactant A can be expressed as $t_{1/2} = \frac{0.693}{k}$ where k is the rate constant (4 marks)
- d) An iron ore was analysed by dissolving a 1.1324 g sample in concentrated HCl. The resulting solution was diluted with water and iron(III) was precipitated as the hydrous oxide $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ by the addition of NH_3 . After filtration and washing, the residue was ignited at a high temperature to give 0.5374 g of pure Fe_2O_3 (159.69 g/mol). Calculate;
- I) The percent Fe (55.847 g/mol) (3 marks)
 - II) The percent Fe_3O_4 (231.54 g/mol) in the sample. (3 marks)
5. a) Plants contain organic compounds. Draw the structures of the following named organic compounds: (5 marks)
- i) 3-ethyl-2-methyloctane
 - ii) 2-Bromo-1-pentene
 - iii) 2,2,4-trimethylheptane
 - iv) 1-Bromo-5-ethyl-1,4-cyclohexadiene
 - v) 2-isopropyl-2-methylhexane
- b) i) Define the term functional group (1 mark)
- ii) Write the functional groups of alcohols, esters, ketones and aldehydes (4 marks)
- c) Highlight three physical properties of alkanes (3 marks)
- d) Describe a simple chemical test that would distinguish between pentane and pentene (3 marks)
- e) Reaction of alkenes and alkanes with oxygen involves an oxidation reaction. Using equations, explain the products of the reactions (4 marks)