South East Technological University

Department of Applied Sciences

Summer 2023

Programme Code(s):	CW_SABFQ_D / CW_SASCI_C / CW_SABRE_B
	CW_SAOPT_B / CW_SAASC_D
Year:	1
Module:	ZCHEC1102 CHEMISTRY 2
Date:	2/05/23 9.30AM – 12.30PM
Duration:	3 hours
Examiners:	Ms. Olivia Fitzgerald
	Dr. F. Ryan

Special Requirements:	

Instructions to Candidates:	
1	Write your Name, Student ID, Course and Year on your answer book
2	Answer Question 1 and any other 3 questions
3	Marks as indicated in the brackets. Total = 100 marks

Chemistry Year 1

Summer 2023

Instructions: Answer QUESTION 1 and any other THREE questions

Question 1 **Answer FIVE parts** **Total 25 marks**

1) Explain VSPER theory and list two limitations of this theory?

(5 marks)

2) Explain the difference between "Intramolecular forces" and "Intermolecular forces" in molecules with the aid of a diagram and discuss the effect of intermolecular forces?

(5 marks)

3) Illustrate with a diagram, the 4 main classes of Hydrocarbons including examples of each class?

(5 marks)

4) Calculate the Ka for acetic acid given the following information:
The concentration of acetic acid [CH_3COOH] = 0.9M
The concentration of hydronium ions[H_3O^+] = 4×10^{-3}

$$CH_3COOH + H_2O = CH_3COO^- + H_3O^+$$

(5 marks)

5) In relation to environmental chemistry, define B.O.D and explain what this test is used for?

(5 marks)

6) What is the electrochemical series and list the following in order of decreasing reactivity: Zinc, Magnesium, Copper, Potassium and Gold.

(5 marks)

Question 2: **Answer all parts** **(Total 25 marks)**

Molecular Structures and Forces

a. Based on VSPER theory, determine the geometric shapes of the following molecules: (Refer to the periodic table and the table below for assistance)
   i. Beryllium Chloride ($BeCl_2$),
   ii. Methane (CH_4)
   iii. Silicon tetrachloride ($SiCl_4$)
   iv. Ammonia (NH_3)
   v. Water (H_2O)

Groupings of Electrons	Bonded Electrons	Lone Pairs of Electrons	Molecular Shape
1	1	0	Linear
2	2	0	Linear
2	1	1	Linear
3	3	0	Trigonal planar
3	2	1	Bent
3	1	2	Linear
4	4	0	Tetrahedral
4	3	1	Trigonal pyramidal
4	2	2	Bent
4	1	3	Linear

(10 marks)

b. Discuss London Dispersion Forces under the following headings:
   a. What are London Dispersion Forces?
   b. What causes them to exist?
   c. How are they influenced?
   d. How are the properties of a substance affected by these forces?
   e. Which molecule would you expect to have a higher boiling point neopentane or n-pentane and why, based on London Dispersion Forces theory?

(10 marks)

c. Rank the following molecules from weakest to strongest intermolecular forces such as hydrogen bonding, polar covalent and non-polar covalent attractions:
   Hydrochloric acid (HCl), water (H_2O) and carbon tetrabromide (CBr_4)

(5 marks)

Question 3: **Answer all parts** **(Total 25 marks)**

Hydrocarbons

a. Alkanes are considered "saturated hydrocarbons" explain this term and give examples of some common everyday alkanes?

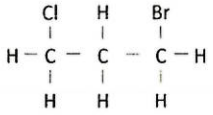
(5 marks)

b. Discuss **alkanes** under the following headings in comparison to alkenes/alkynes:

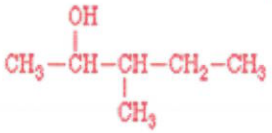
i. Main reactions
ii. Bond length and bond type between Carbon atoms
iii. Melting point and boiling point
iv. Solubility
v. Conductivity

(10 marks)

c. According to IUPAC naming rules, name **ALL** of the following compounds.



(a)



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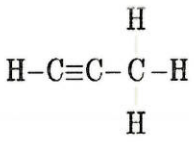
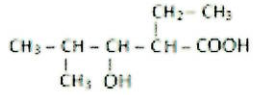
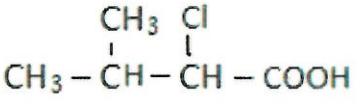


(c)



(d)



(e)

(10 marks)

Question 4: **Answer all parts** **(Total 25 marks)**

Acid/Bases/Buffers

a) Discuss the main differences between the definitions of acids/bases according to the scientists **Arrhenius, Bronsted-Lowry and Lewis**?

(5 marks)

b) Classify the following as a strong acid, weak acid, strong base or a weak base

- Sodium hydroxide (NaOH),
- Acetic acid (CH_3COOH),
- Sulphuric acid (H_2SO_4),
- Ammonium hydroxide (NH_4OH),
- Phosphoric acid (H_3PO_4)

(5 marks)

c) Determine **the $[H_3O^+]$ concentration** in a 1.0×10^{-2}M NaOH solution based on your knowledge of the water dissociation constant (Kw) and its value of 1.0×10^{-14}?

(5 marks)

d) In relation to pH buffers answer the following questions:

What is meant by **buffer capacity**?

Define the **Henderson-Hasselbalch** equation.

(5 marks)

e) Determine the **pH** of a weak acid HF given the following information

Concentration of hydrofluoric acid [HF] = 0.010M

Ka for HF = 6.8×10^{-4}

$$HF + H_2O = H_3O^+ + F^-$$

(5 marks)

Question 5: **Answer all parts** **(Total 25 marks)**

Environmental Chemistry

a. Answer the following:
   a. Explain what is meant by **hard water, temporary** and **permanent** hardness (water)?
   b. What is the main **source** and what are the main **causes** of water contamination in the world today?

(5 marks)

b. Discuss some of the **physical processes** involved in water treatment?

(5 marks)

c. Many **chemicals** are used in the treatment of water. What is the function and purpose of the following chemicals in water treatment?
Provide examples of a chemical for each function.

Flocculants, neutralising agents, corrosion inhibitors, coagulants, antifoam, algaecides and disinfectants.

(5 marks)

d. A 25ml sample of polluted river was taken and diluted to 1L with well-oxygenated water. Two bottles A and B were filled with the diluted water and their dissolved oxygen concentrations were determined. Testing was carried out immediately for bottle A and 5 days later for bottle B. Results obtained were 12.8 ppm (A) and 8.2 ppm (B).

   i. What is the B.O.D of the polluted river water?
   ii. Why was it necessary to store bottle B in the dark for 5 days?
   iii. Why was it necessary to dilute the sample with well-oxygenated water?

(10 marks)