CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

Autumn Examinations 2015

Module Title: Biological Chemistry 2

Module Code: CHEM6009

School: Science & Informatics

Programme Titles(s):
BSc Hons Nutrition & Health Science Year 1
BSc Hons Herbal Science Year 1
BSc Hons Pharmaceutical and Biotechnology Year 1
BSc Hons Biomedical Science Year 1
BSc Applied Biosciences Year 1

Programme Code:
SNHSC_8_Y1
SHERB_8_Y1
SPHBI_8_Y1
SBISC_8_Y1
SBIOS_7_Y1

External Examiner(s): Dr Carmel Roche
Internal Examiner(s): Dr William Doherty, Dr Mary Lehane

Instructions:
Attempt THREE questions.
Section A is compulsory.
Attempt 8 out of 10 parts from Section A.
Attempt one question each from sections B and C.
Show all calculations and rough work on the answer book.

Duration: 2 Hours

Sitting: Autumn 2015

Requirements for this examination: Periodic Table, Standard Enthalpy Tables

Useful Constants $R = 8.31 Jmol^{-1}K^{-1}$, $0.0821 Latm\ mol^{-1}\ K^{-1}$

Note to Candidates: Please check the Programme Title and the Module Title to ensure that you have received the correct examination paper.
If in doubt please contact an Invigilator.

SECTION A

Q1. Attempt Eight of the following. All questions carry equal marks.

i) Illustrate the pH profile, (titration curve), obtained when a strong acid is titrated against a strong base. Show how the end-point is determined from the graph.

ii) Distinguish between a strong acid and a weak acid. Give appropriate examples.

iii) For which of the following reactions will the equilibrium mixture contain the least products. Give a reason for your answer.

(i) $Cl_2\,(g) \leftrightarrow 2Cl\,(g)$ $K = 6.4 \times 10^{-39}$

(ii) $Cl_2\,(g) + 2NO_2\,(g) \leftrightarrow 2ClNO_2\,(g)$ $K = 1.8$

iv) Give the formula of the conjugate base of each of the following acids

$HOCl$, H_2O, $CH_3NH_3^+$, H_2CO_3

v) Calculate the equilibrium constant for the following reaction at 800K from the following data

$2SO_2(g) + O_2(g) \leftrightarrow 2SO_3(g)$

$[SO_2] = 3.0 \times 10^{-3} moldm^{-3}$, $[O_2] = 3.5 \times 10^{-3} moldm^{-3}$,

$[SO_3] = 5.0 \times 10^{-2}\, moldm^{-3}$

What is the equilibrium constant for the reverse reaction?

vi) Draw structures for the following molecules:

i) 2-methylbut-1-ene

ii) 2, 2, 3-bromochloronitrohexane

vii) Distinguish, giving examples, between addition and substitution reactions.

viii) Write the reaction mechanism for the reaction of but-1-ene with hydrogen bromide.

ix) Define the terms Nucleophile and Electrophile and give examples of each.

x) Distinguish between saturated and non-saturated hydrocarbons and give examples of each.

SECTION B

Q2.

a) State Le Châtelier's Principle.

b) Predict the effect on the following equilibrium when:

$$4NH_3(g) + 3O_2(g) \leftrightarrow 2N_2(g) + 6H_2O(g)$$

(i) O_2 is added

(ii) NH_3 is removed

(iii) Water is removed

(iv) Pressure is decreased

c) The equilibrium constant value, Kc, for the following reaction at 150 ^oC is 280.

$I_2(g) + Br_2(g) \leftrightarrow 2\ IBr(g)$

If 0.263 mols of IBr (g) in a 3.15 L flask is allowed to reach equilibrium at this temperature, what are the equilibrium concentrations of IBr, I_2 and Br_2?

d) Write the equilibrium expression for each of the following reactions. In each case indicate whether the reaction is homogeneous or heterogeneous:

(i) $2\ O_3(g) \leftrightarrow 3O_2(g)$

(ii) $C(s) + 2\ H_2(g) \leftrightarrow CH_4(g)$

(iii) $4HCl(aq) + O_2(g) \leftrightarrow 2H_2O(l) + 2Cl_2(g)$

Q3.

a) Derive the Henderson – Hasselbalch equation, explain in words each of the terms of the equation.

b) Calculate the change in pH of the following buffer solution, Benzoic acid / Sodium benzoate, each with a concentration of 3.25 $moldm^{-3}$, when 6.70cm^3 0.8 $moldm^{-3}$ HCl is added to the solution.

c) Calculate the pH or $[H^+]$ ion, whichever is appropriate, for each of the following solutions

(i) 0.30 $moldm^{-3}$ HNO_3

(ii) 4 x 10^{-3} $moldm^{-3}$ NaOH

(iii) a solution prepared by dissolving 0.45g HBr in water and diluting to 500mL in a volumetric flask.

(iv) 0.15 $moldm^{-3}$ solution of Hydrogen peroxide (H_2O_2) (Ka 1.8 x 10^{-12})

(e) a solution of pH = 3.45

d) Calculate the pH of a 0.300 M solution of benzoic acid. K_a = 6.46 x 10^{-5}

SECTION C

Q4.

a) Define the terms empirical and molecular formula.

b) Dianabol is one of the anabolic steroids that has been used by some athletes to increase the size and strength of their muscles. It is similar to the male hormone testosterone.

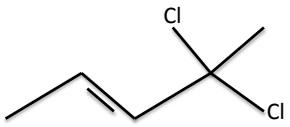
The molecular formula of Dianabol, which consists of carbon, hydrogen, and oxygen, can be determined using the data from two different experiments.

In the first experiment, 14.765 g of Dianabol is burned, and 43.257 g CO_2 and 12.395g H_2O are formed. In the second experiment, the molecular mass of Dianabol is found to be 300.44.

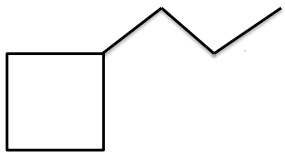
Deduce the molecular formula for Dianabol from this data.

c) Name the following organic compounds using the IUPAC rules:

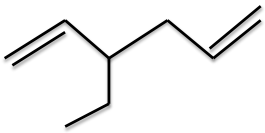
a.



b.



c.



Q5.

(a) Draw the structures of the following organic compounds:

i. 4-methyl-2-pentene

ii. 3 methyl-4butyl-octane

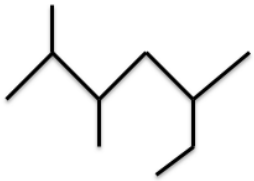
iii. 2 methyl pent-1-ene

2-bromo-1-chloro-3-methylcyclopentane

(b) Describe, giving relevant examples, geometrical isomerism in alkenes.

(c) State Markovnikov's rule and give an example of a typical reaction

(d) Predict which of the molecules below will have the highest boiling point and justify your answer.

a 

b 

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