99/21(a) # The University of Sydney

CHEM1405 **FIRST SEMESTER EXAMINATION**

FACULTY: VETERINARY SCIENCE

CONFIDENTIAL

JUNE 2000 **TIME ALLOWED: THREE HOURS**

GIVE THE FOLLOWING INFORMATION IN BLOCK LETTERS

SURNAME			**OTHER NAMES**		
SID NUMBER		**FACULTY**		**TABLE NUMBER**	

INSTRUCTIONS TO CANDIDATES

All questions are to be attempted. There are 17 pages of examinable material.

Complete the examination paper in **INK.**

Read each question carefully. Report the appropriate answer and show all relevant working in the space provided.

The total score for this paper is 100. The possible score per page is shown in the adjacent tables.

Each new question begins with a •.

Electronic calculators, including programmable calculators, may be used. Students are warned, however, that credit may not be given, even for a correct answer, where there is insufficient evidence of the working required to obtain the solution. Logarithms may also be used.

Numerical values required for any question as well as a Periodic Table are printed on a separate data sheet.

Pages 3, 8, 11, 17, 21 & 24 are for rough work only.

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Multiple choice section

	Marks	
Pages	Max	Gained
2-15	50	

Short answer section

Page	Marks			Marker
	Max	Gained		
16	11			
18	7			
19	4			
20	10			
22	8			
23	10			
Total	50			
Check Total				

	Marks
• Write balanced equations for the dissolution of the following compounds in water.	2
$MnSO_4$	
Li_2CO_3	
• The standard enthalpy of combustion of acetylene, C_2H_2(g) is –1300 kJ mol^{-1} at 298K. What is ΔH_f° (acetylene) in kJ mol^{-1}? Data ΔH_f° CO_2(g) = –393.5 kJ mol^{-1} ΔH_f° H_2O(l) = –285.8 kJ mol^{-1}	3
ΔH_f° =	
• List the key properties and interactions in an aerosol.	3
• The human eye is able to detect as little as 2.35×10^{-18} J of green light of wavelength 510 nm. Calculate the minimum number of photons of this wavelength that can be detected by the human eye.	3
Answer:	

	Marks
• Biochemists have discovered more than 400 mutant varieties of hemoglobin, the blood protein that carries oxygen in the body. A physician studying a variety associated with a fatal disease uses the following experiment to find its molar mass. In the experiment, 2.5 mg of the protein is dissolved in water at 5.0 °C to make 1.50 mL of solution. The solution is found to have an osmotic pressure of 4.75×10^{-3} atm. What is the molar mass of the hemoglobin variety.	**3**
Answer:	
• Normal arterial blood has an average pH of 7.40. Phosphate ions form one of the buffering systems in the blood. Use the acid ionisation constant data on the data page to identify which one of the following conjugate acid/base pairs would be suitable for preparing a buffer to be used in experiments on blood. Indicate your choice by circling the appropriate pair.	**4**
HPO_4^{2-}/PO_4^{3-} $H_2PO_4^{-}/HPO_4^{2-}$ $H_3PO_4/H_2PO_4^{2-}$	
Calculate the ratio of the base to conjugate acid that must be present in blood to buffer it to pH 7.40.	
Define buffer capacity. Does the above ratio affect the buffer capacity?	

Marks
4

- The isotope ^{99m}Tc (Tc is the element technetium) is in an excited nuclear state and decays to its ground state by gamma emission. The first order integrated rate equation can be used to calculate the amount it decays with time. The half-life of ^{99m}Tc is 5.97 hours. What is the first order constant for its decay?

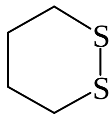
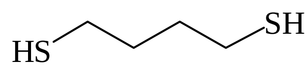
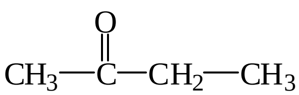
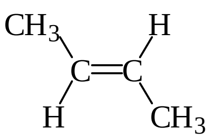
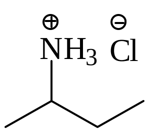
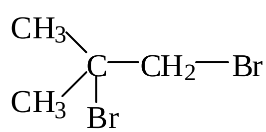
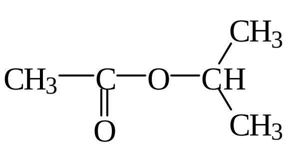
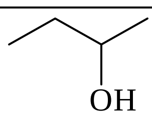
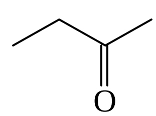
k =

Compounds of ^{99m}Tc are prepared at the nuclear reactor in the south of Sydney. They are used for medical imaging of the heart, bones, lungs and liver. A 20.0 mL solution leaves the reactor containing 20.0 μg of excited ^{99m}Tc, what mass of excited state ^{99m}Tc will remain when it is injected into a patient 2.0 hours later?

Answer:

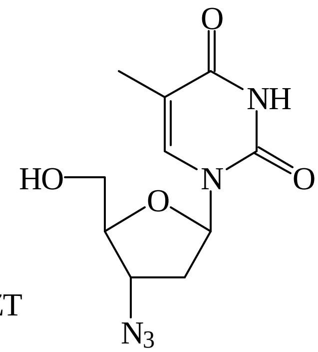
- Complete the following table.

Marks 10

STARTING MATERIAL	REAGENTS/CONDITIONS	CONSTITUTIONAL FORMULA(S) OF MAJOR ORGANIC PRODUCT(S)
		
 **Name:**	1. $NaBH_4$ 2. $H^{\oplus}$ / H_2O	
 **Name:**	dilute H_2SO_4 / heat	
	dilute NaOH	
	Br_2 (CCl_4 solvent)	
	$H^{\oplus}$ / H_2O / heat	
 **Name:**		

Marks
8

- AZT is an analogue of the nucleoside thymidine and is clinically used in the treatment of AIDS. It differs from thymidine in that the 3'–OH group is replaced by an azido group (–N_3).



AZT

Classify the sugar present in AZT as a furanose or pyranose.

Is the sugar present as the α-anomer or the β-anomer?

How many stereogenic centres are there in AZT?

Hydrolysis of AZT gives the sugar 3-azido-2-deoxyribose and the nucleic base thymine. Give the structure of thymine and the structure of one tautomer of thymine.

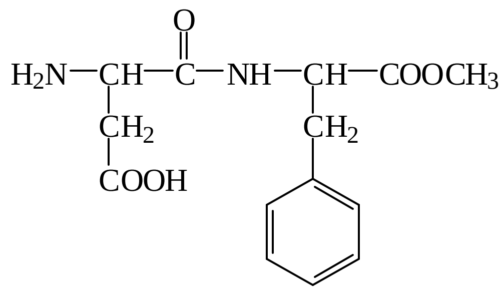
thymine	tautomer

The sugar, 3-azido-2-deoxyribose, gives two products on treatment with acidified methanol. Give the constitutional formulas (using Haworth structures) of these products.

Product 1	Product 2

Marks
10

- Aspartame, a non-nutritive artificial sweetener, on hydrolysis gives 1 mol of aspartic acid (Asp), 1 mol of the aromatic amino acid phenylalanine (Phe) and 1 mol of methanol.



aspartame

List the functional groups present in aspartame.

Give the structures of the amino acids Asp and Phe as the zwitterions.

Asp	Phe

The pK_a values of aspartic acid are 2.0, 3.9 and 10.0. Give the structure of the predominant species present in a water solution of aspartic acid at pH 1.0 and pH 11.0.

pH 1.0	pH 11.0

99/21(b) # The University of Sydney

CHEM1405 - Chemistry 1 (Veterinary Science)

FIRST SEMESTER EXAMINATION **JUNE 2000**

Numerical Data

Physical constants

Planck constant = h = 6.626×10^{-34} joule second

Speed of light in vacuum = c = 2.998×10^{8} metre second^{-1}

Avogadro constant = N_A = 6.022×10^{23} mole^{-1}

Mass of electron = m_e = 9.109×10^{-31} kilogram

Ideal gas constant = R = 8.314 joule kelvin^{-1} mole^{-1}

= 0.08206 litre atmosphere kelvin^{-1} mole^{-1}

Conversion factors

1 nm = 1 nanometre = 10^{-9} metre

1 kJ = 1 kilojoule = 10^{3} joule

1 mg = 1 milligram = 10^{-3} gram

1 L = 1 litre = 10^{-3} metre^3

1 mL = 1 millilitre = 10^{-3} litre

1 Hz = 1 hertz = 1 second^{-1}

Acid ionisation constants

H_3PO_4 $pK_{a,1} = 2.15$ $pK_{a,2} = 7.20$ $pK_{a,3} = 12.38$

Useful equations required for CHEM1405

$E = h\nu = hc / \lambda$ $\lambda = h / mu$

$\Delta G = \Delta H - T\Delta S$

$\pi = MRT$

$pH = -\log[H^+]$ $pOH = -\log[OH^-]$ $pH + pOH = 14$

Henderson-Hasselbalch equation $pH = pK_a + \log([\text{cong base}]/[\text{acid}])$

For first order integrated rate law $t_{½} = \ln 2/k$

$\ln[A]_0 - \ln[A]_t = kt$

A periodic table is printed on the other side of this data sheet.
Atomic weights are included in the periodic table.