99/21(a) # The University of Sydney

CHEM1405 **FIRST SEMESTER EXAMINATION**

FACULTY: VETERINARY SCIENCE

CONFIDENTIAL

JUNE 2001 **TIME ALLOWED: THREE HOURS**

GIVE THE FOLLOWING INFORMATION IN BLOCK LETTERS

FAMILY NAME		**SID NUMBER**	
OTHER NAMES		**TABLE NUMBER**	

INSTRUCTIONS TO CANDIDATES

All questions are to be attempted. There are 18 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 short answer 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, 20 & 24 are for rough work only.

OFFICIAL USE ONLY

Multiple choice section

	Marks	
Pages	Max	Gained
2-15	50	

Short answer section

Page	Marks Max	Gained		Marker
16	10			
17	8			
18	6			
19	7			
21	5			
22	8			
23	6			
Total	50			
Check Total				

	Marks
• Write a balanced equation for the dissolution of $Mn(ClO_4)_2$ in water.	3

• Complete the following table.

Formula	Systematic Name
$FeCl_3 \cdot 6H_2O$	
	ammonium carbonate
$K_2Cr_2O_7$	
	lead(IV) oxide

• The first step in the preparation of lead from its ore (galena, PbS) involves roasting the ore. $2PbS(s) + 3O_2(g) \rightarrow 2SO_2(g) + 2PbO(s)$. Calculate the standard enthalpy change for this reaction. Data: ΔH_f° PbS(s) = –98.3 kJ mol^{-1} ΔH_f° PbO(s) = –219.0 kJ mol^{-1} ΔH_f° $SO_2(g)$ = –296.8 kJ mol^{-1}	3
ΔH° =	

• Briefly explain how addition of a solution of a large cation can result in the coagulation of a colloid.	2

• Draw the Lewis structure for carbonyl chloride, $COCl_2$.	2

	Marks
• The sugar *stachyose* is found in the seeds of several leguminous plants. A solution containing 100 mg of this compound in 10.0 mL of water has an osmotic pressure of 0.351 atmosphere at 285 K. Calculate the molar mass of *stachyose*.	**3**
Answer:	
• A component of the buffering action in blood plasma is due to the hydrogencarbonate ion / carbonic acid equilibrium. The hydrogencarbonate ion concentration in a sample of blood plasma was found to be 0.0230 M. Calculate the concentration of carbonic acid in this sample if its pH is 7.30 at 37 °C. The pK_a of H_2CO_3 is 6.10 at 37 °C.	**3**
Answer:	
• Write equations to show what happens to a buffer solution containing equimolar amounts of HPO_4^{2-} and $H_2PO_4^-$, when (a) H_3O^+ is added, (b) OH^- is added.	**2**
(a)	
(b)	

Marks 6

- The hydrolysis of table sugar (sucrose) occurs by the following overall reaction.

$$\underset{\text{(sucrose)}}{C_{12}H_{22}O_{11}(aq)} + H_2O(l) \rightarrow \underset{\text{(glucose)}}{C_6H_{12}O_6(aq)} + \underset{\text{(fructose)}}{C_6H_{12}O_6(aq)}$$

A nutritional biochemist studied the kinetics of the process and obtained the following data.

sucrose (M)	time (hours)
0.501	0
0.451	0.50
0.404	1.00
0.363	1.50
0.267	3.00

The reaction is first order with respect to sucrose.

(a) Use the above data to determine the rate constant and the half-life of the reaction.

k =	$t_{½}$=

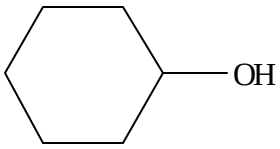
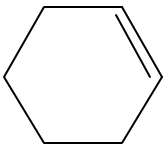
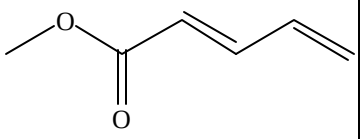
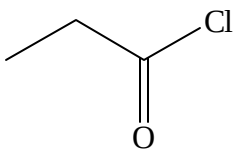
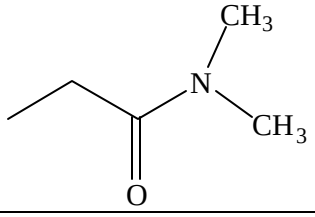
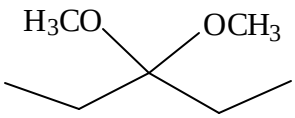
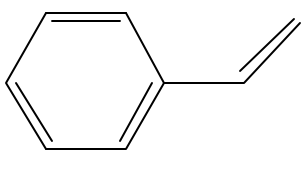
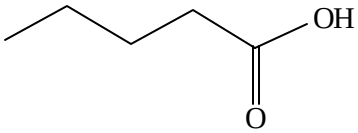
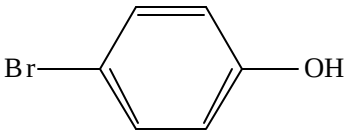
(b) How long does it take to hydrolyse 75% of the sucrose?

	Answer:

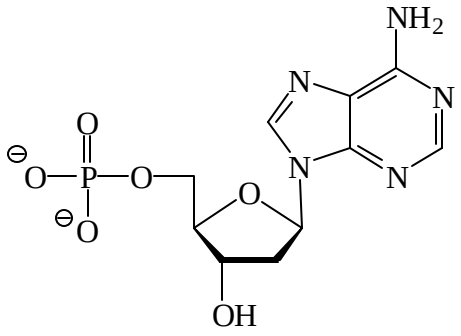
(c) Other studies have shown that this reaction is actually second order, but appears to follow first order kinetics. (Such a reaction is termed a pseudo first order reaction.) Suggest a reason for this apparent first order behaviour.

- Complete the following table.

Marks 7

STARTING MATERIAL	REAGENT/CONDITIONS	CONSTITUTIONAL FORMULA(S) OF MAJOR ORGANIC PRODUCT(S)
		
	Dilute NaOH heat	
		
	H^+ / H_2O heat	
	Br_2 in CCl_4 solvent	
	$K_2Cr_2O_7 / H_2SO_4$	
	Cold dilute NaOH	

- The structure of dAMP, a nucleotide important in DNA synthesis, is shown on the right. Hydrolysis of dAMP by heating in 3 M HCl produces adenine and β-D-2-deoxyribofuranose.



Marks 5

Give the constitutional formula of β-D-2-deoxyribofuranose.

β-D-2-Deoxyribofuranose is in equilibrium with another cyclic furanose. Give the structure and name of this sugar.

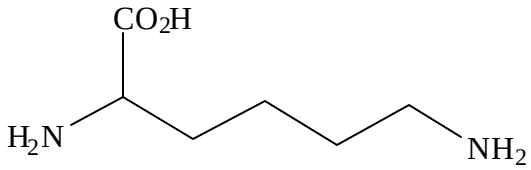
Name:

Give the structure of adenine and the structure of one tautomer of adenine.

adenine	tautomer

Marks

- The structure of the amino acid lysine is shown on the right.



lysine

6

The pK_a values of lysine are 2.18 (α-COOH), 8.95 (α-NH_3^+), 10.79 (sidechain). Give the structures of the predominant species present in a water solution of lysine at pH 2.18 and pH 13.00.

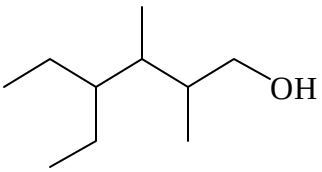
pH 2.18	pH 13.00

Give the constitutional formula of the dipeptide Lys-Lys as the zwitterion.

- Give the constitutional formula of (*E*)-1-bromo-2-pentene.

1

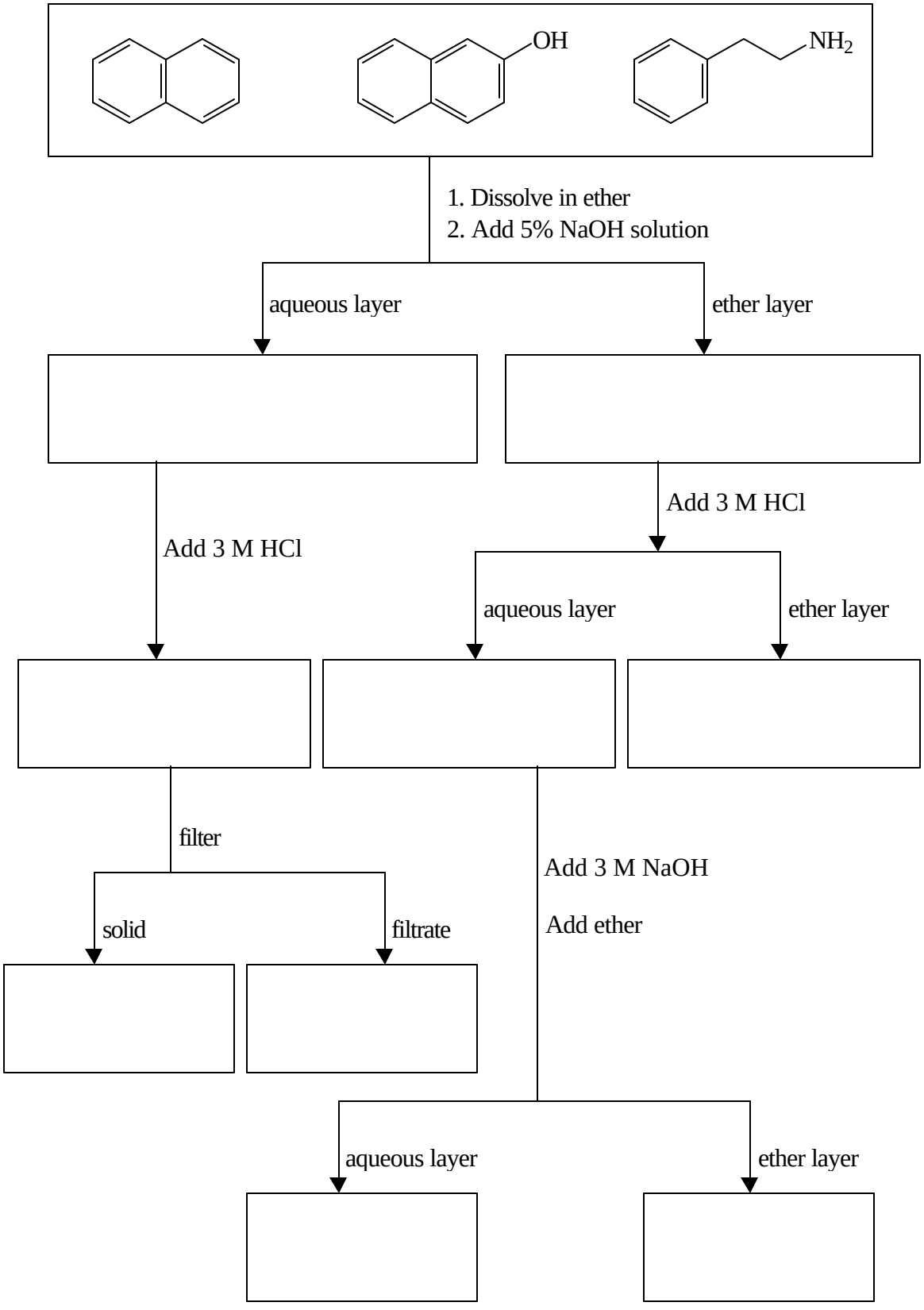
- Name the following compound.



1

Marks **6**

- Organic compounds may be readily separated in the laboratory by extraction methods using acid-base chemistry. Complete the following flowsheet by showing the constitutional formulas of all species that will be present in the aqueous and organic phases and hence show how a mixture of naphthalene, 2-hydroxynaphthalene and 2-phenylethylamine could be separated.



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CHEM1405 - Chemistry 1 (Veterinary Science)

FIRST SEMESTER EXAMINATION **JUNE 2001**

Numerical Data

Physical constants

Planck constant = $h = 6.626 \times 10^{-34}$ J s

Speed of light in vacuum = $c = 2.998 \times 10^{8}$ m s^{-1}

Avogadro constant = $N_A = 6.022 \times 10^{23}$ mol^{-1}

Ideal gas constant $= R = 8.314$ J K^{-1} mol^{-1}

$= 0.08206$ L atm K^{-1} mol^{-1}

Conversion factors

1 nm = 10^{-9} m

1 kJ = 10^{3} J

1 mg = 10^{-3} g

1 L = 10^{-3} m^3

1 mL = 10^{-3} L

1 Hz = 1 s^{-1}

Acid ionisation constants

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

Useful equations

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

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

$\pi = iMRT$

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

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

For first order integrated rate law: $\ln[A]_0 - \ln[A]_t = kt$

$t_{½} = \ln 2 / k$

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