89/07(a)

The University of Sydney

CHEM1612 - CHEMISTRY 1B (PHARMACY)

SECOND SEMESTER EXAMINATION

CONFIDENTIAL

NOVEMBER 2003 **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 14 pages of examinable material.
- Complete the written section of 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 table.
- Each new question of the short answer section 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.
- A Periodic Table and numerical values required for any question may be found on a separate data sheet.
- Pages 8, 10, 16, 18 & 20 are for rough working only.

OFFICIAL USE ONLY

Multiple choice section

	Marks	
Page	Max	Gained
2-7	42	

Short answer section

Page	Marks			Marker
	Max	Gained		
9	7			
11	6			
12	6			
13	4			
14	13			
15	4			
17	9			
19	9			
Total	58			
Check Total				

Marks

- Gamma emission involves the radiation of high energy γ photons and accompanies most types of radioactive decay processes. γ photons typically have wavelengths less than 0.1 Å. Calculate the energy of a photon with wavelength λ = 0.1 Å. Give your answer in J per photon and kJ mol^{-1}. 3

E = J per photon	E = kJ mol^{-1}

Why is high energy or gamma radiation called ionising radiation?

- What are two of the key results arising from a wavelike description of matter? 2

- Each of the following electron configurations represents an atom in an excited state. Identify the element and write its ground state electron configuration. 2

Electron configuration of excited state	Element	Electron configuration of ground state
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4\ 4s^1$		
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^3\ 4p^1$		

Marks

- State Hund's rule and illustrate its application in the orbital box diagram of the nitrogen atom. **2**

	$1s$	$2s$	$2p_x$	$2p_y$	$2p_z$
N					

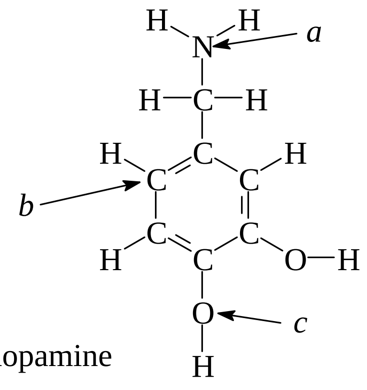
- The atomic radius decreases across a period and increases down a group within the periodic table. Explain these observations. **2**

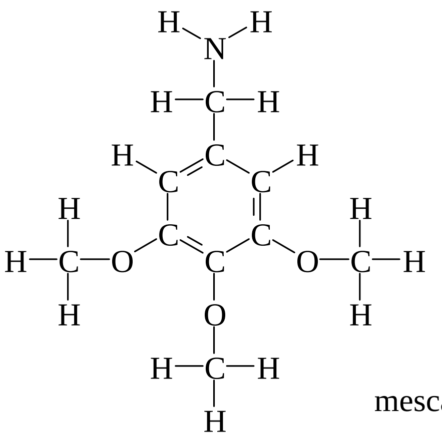
- A molecule with formula of type AX_3 is found to be polar. Which molecular shapes are possible for this molecule? **2**

THE REMAINDER OF THIS PAGE IS FOR ROUGH WORKING ONLY.

Marks
6

- The structures of dopamine and mescaline are given below.





Dopamine is involved in the transmission of nerve impulses in the brain. Complete the Lewis structure for dopamine by including all lone pair electrons.

How many π electrons are there in dopamine?

Predict the bond angles at the points labelled *a*, *b*, and *c* in dopamine.

a	
b	
c	

Mescaline is an hallucinogenic compound found in the peyote cactus. Suggest a reason for the ability mescaline to disrupt nerve impulses.

Which compound, dopamine or mescaline, has the higher solubility in water? Give reasons for your answer.

Marks

- Strong hydrogen bonds, –B:----H–A–, are typically found when both A and B are N, O, or F atoms. Give reasons for this observation.

2

- For each of the following pairs, which substance has the lower boiling point? Give reasons for your answer.

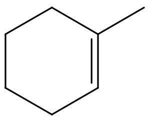
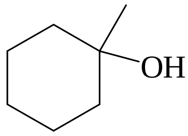
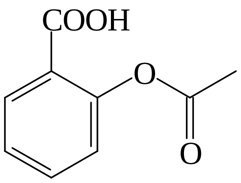
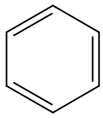
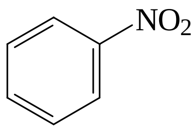
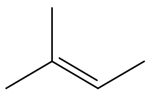
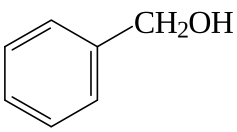
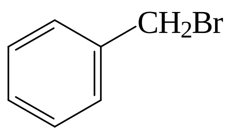
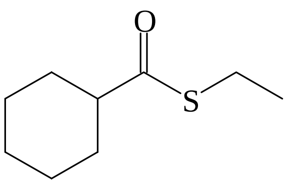
2

(a) $MgCl_2$ and PCl_3

(b) CH_3OH and CH_3CH_2OH

Marks 13

- Complete the following table. Make sure you give the name of the product or starting material where requested.

STARTING MATERIAL	REAGENTS/CONDITIONS	CONSTITUTIONAL FORMULA(S) OF MAJOR ORGANIC PRODUCT(S)
		 **Name:**
	$OH^{\ominus}$ / H_2O / heat	
		
 **Name:**	HBr / CCl_4 (solvent)	
		
	$H^{\oplus}$ / H_2O / heat	
$CH_3CH_2CH_2Br$	$(CH_3CH_2)_3N$	
$CH_3CH_2CH_2CH_2CHO$ **Name:**	1. $NaBH_4$ 2. $H^{\oplus}$ / H_2O	

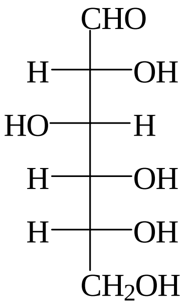
Marks
4

- Show clearly the reagents you would use to carry out the following chemical conversions. Draw constitutional formulas for any intermediate compounds. NOTE: more than one step is necessary in each case.

Marks
9

- The stucture of D-glucose is shown below. Draw the Fischer projection of L-glucose in the space provided.

D-glucose



L-glucose

D-glucose is in equilibrium with two cyclic pyranose forms. Give the Haworth projection of these two cyclic forms.

Give the products obtained when D-glucose is treated with the following reagents.

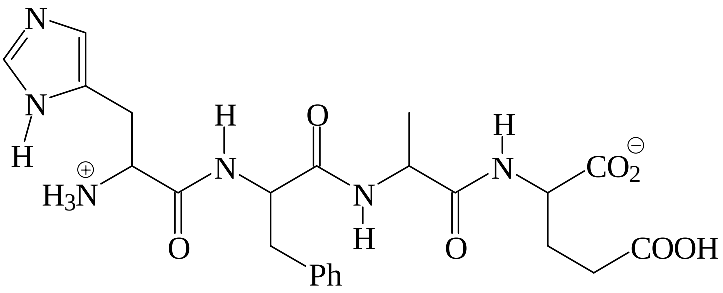
methanol / H^+	$[Ag(NH_3)_2]^+$ / $OH^−$ solution	1. $NaBH_4$ 2. dilute acid

Draw the Haworth structure of a non-reducing disaccharide, which, on acid hydrolysis, yields D-glucose as the only product.

Marks
9

- The structure of the naturally occurring tetrapeptide His-Phe-Ala-Glu, **A**, is shown below as the zwitterion.

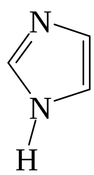
A



Give the product(s) obtained when **A** is treated with cold 1 M NaOH.

Vigorous acid hydrolysis of **A** gives four products. Give the structures of these four products in their correct ionic states as Fischer projections.

The heterocycle present in the sidechain of histidine is imidazole, whose structure is shown on the right. Give the structure of a tautomer of imidazole and state, giving reasons, whether your tautomer is aromatic.



What is the major species present when histidine is dissolved in water at pH 12. The pK_a values of histidine are 1.82 (-COOH), 9.17 ($-NH_3^{\oplus}$) and 6.04 (sidechain).

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DATA SHEET

Physical constants

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

Faraday constant, $F = 96485$ C mol^{-1}

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

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

Gas constant, $R = 8.314$ J K^{-1} mol^{-1}

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

Volume of 1 mole of ideal gas at 1 atm and 25 °C = 24.5 L

Volume of 1 mole of ideal gas at 1 atm and 0 °C = 22.4 L

Conversion factors

1 atm = 760 mmHg = 101.3 kPa

0 °C = 273 K

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

1 Å = 10^{-10} m

1 eV = 1.602×10^{-19} J

1 Ci = 3.70×10^{10} Bq

Useful formulas

Acids and Bases

$pK_w = pH + pOH = 14$

$pK_w = pK_a + pK_b = 14$

$pH = pK_a + \log\{[A^-] / [HA]\}$

Kinetics

$k = Ae^{-Ea/RT}$

$t_{½} = \ln 2/k$

$\ln[A] = \ln[A]_o - kt$

Radioactivity

$A = kN$

$\ln(N_0/N_t) = kt$

$t = 8033 \ln(A_0/A_t)$

Electrochemistry

$\Delta G° = -nFE°$

$E = E° - (RT/nF) \ln Q$

$E° = (RT/nF) \ln K$

Moles of e^- $= It/F$

Colligative properties

$\pi = cRT$

$p = kc$

$\Delta T_f = K_f m$

$\Delta T_b = K_b m$

Thermodynamics & Equilibrium

$\Delta G° = \Delta H° - T\Delta S°$

$\Delta G = \Delta G° + RT \ln Q$

$\Delta G° = -RT \ln K$

$K_p = K_c (RT)^{\Delta n}$

Quantum Chemistry

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

$\lambda = h/mu$

Gas Laws

$PV = nRT$

$(P + n^2a/V^2)(V - nb) = nRT$

Decimal fractions

Fraction	Prefix	Symbol
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

Decimal multiples

Multiple	Prefix	Symbol
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G

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

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 HYDROGEN **H** 1.008																	2 HELIUM **He** 4.003
3 LITHIUM **Li** 6.941	4 BERYLLIUM **Be** 9.012											5 BORON **B** 10.81	6 CARBON **C** 12.01	7 NITROGEN **N** 14.01	8 OXYGEN **O** 16.00	9 FLUORINE **F** 19.00	10 NEON **Ne** 20.18
11 SODIUM **Na** 22.99	12 MAGNESIUM **Mg** 24.31											13 ALUMINIUM **Al** 26.98	14 SILICON **Si** 28.09	15 PHOSPHORUS **P** 30.97	16 SULFUR **S** 32.07	17 CHLORINE **Cl** 35.45	18 ARGON **Ar** 39.95
19 POTASSIUM **K** 39.10	20 CALCIUM **Ca** 40.08	21 SCANDIUM **Sc** 44.96	22 TITANIUM **Ti** 47.88	23 VANADIUM **V** 50.94	24 CHROMIUM **Cr** 52.00	25 MANGANESE **Mn** 54.94	26 IRON **Fe** 55.85	27 COBALT **Co** 58.93	28 NICKEL **Ni** 58.69	29 COPPER **Cu** 63.55	30 ZINC **Zn** 65.39	31 GALLIUM **Ga** 69.72	32 GERMANIUM **Ge** 72.59	33 ARSENIC **As** 74.92	34 SELENIUM **Se** 78.96	35 BROMINE **Br** 79.90	36 KRYPTON **Kr** 83.80
37 RUBIDIUM **Rb** 85.47	38 STRONTIUM **Sr** 87.62	39 YTTRIUM **Y** 88.91	40 ZIRCONIUM **Zr** 91.22	41 NIOBIUM **Nb** 92.91	42 MOLYBDENUM **Mo** 95.94	43 TECHNETIUM **Tc** [98.91]	44 RUTHENIUM **Ru** 101.07	45 RHODIUM **Rh** 102.91	46 PALLADIUM **Pd** 106.4	47 SILVER **Ag** 107.87	48 CADMIUM **Cd** 112.40	49 INDIUM **In** 114.82	50 TIN **Sn** 118.69	51 ANTIMONY **Sb** 121.75	52 TELLURIUM **Te** 127.60	53 IODINE **I** 126.90	54 XENON **Xe** 131.30
55 CAESIUM **Cs** 132.91	56 BARIUM **Ba** 137.34	57-71	72 HAFNIUM **Hf** 178.49	73 TANTALUM **Ta** 180.95	74 TUNGSTEN **W** 183.85	75 RHENIUM **Re** 186.2	76 OSMIUM **Os** 190.2	77 IRIDIUM **Ir** 192.22	78 PLATINUM **Pt** 195.09	79 GOLD **Au** 196.97	80 MERCURY **Hg** 200.59	81 THALLIUM **Tl** 204.37	82 LEAD **Pb** 207.2	83 BISMUTH **Bi** 208.98	84 POLONIUM **Po** [210.0]	85 ASTATINE **At** [210.0]	86 RADON **Rn** [222.0]
87 FRANCIUM **Fr** [223.0]	88 RADIUM **Ra** [226.0]	89-103	104 RUTHERFORDIUM **Rf** [261]	105 DUBNIUM **Db** [262]	106 SEABORGIUM **Sg** [266]	107 BOHRIUM **Bh** [262]	108 HASSIUM **Hs** [265]	109 MEITNERIUM **Mt** [266]									

LANTHANIDES	57 LANTHANUM **La** 138.91	58 CERIUM **Ce** 140.12	59 PRASEODYMIUM **Pr** 140.91	60 NEODYMIUM **Nd** 144.24	61 PROMETHIUM **Pm** [144.9]	62 SAMARIUM **Sm** 150.4	63 EUROPIUM **Eu** 151.96	64 GADOLINIUM **Gd** 157.25	65 TERBIUM **Tb** 158.93	66 DYSPROSIUM **Dy** 162.50	67 HOLMIUM **Ho** 164.93	68 ERBIUM **Er** 167.26	69 THULIUM **Tm** 168.93	70 YTTERBIUM **Yb** 173.04	71 LUTETIUM **Lu** 174.97
ACTINIDES	89 ACTINIUM **Ac** [227.0]	90 THORIUM **Th** 232.04	91 PROTACTINIUM **Pa** [231.0]	92 URANIUM **U** 238.03	93 NEPTUNIUM **Np** [237.0]	94 PLUTONIUM **Pu** [239.1]	95 AMERICIUM **Am** [243.1]	96 CURIUM **Cm** [247.1]	97 BERKELLIUM **Bk** [247.1]	98 CALIFORNIUM **Cf** [252.1]	99 EINSTEINIUM **Es** [252.1]	100 FERMIUM **Fm** [257.1]	101 MENDELEVIUM **Md** [256.1]	102 NOBELIUM **No** [259.1]	103 LAWRENCIUM **Lr** [260.1]