

CHEM1907 - Chemistry 1 Life Sciences A Molecular (Advanced)

and

CHEM1908 - Chemistry 1 Life Sciences A (Advanced)**FIRST SEMESTER EXAMINATION****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**OFFICIAL USE ONLY**

All questions are to be attempted. There are 16 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 6, 9 & 20 are for rough work only.

Multiple choice section

Pages	Marks	
	Max	Gained
7-15	33	

Short answer section

Page	Marks		Marker
	Max	Gained	
2	6		
3	8		
4	10		
5	10		
16	9		
17	8		
18	7		
19	9		
Total	67		
Check Total			

- A dilute water solution of hydrogen peroxide (H_2O_2) can be used as a mild antiseptic. The concentration of hydrogen peroxide may be determined by titration with acidified permanganate ion, MnO_4^- , forming $\text{O}_2(\text{g})$, H_2O and Mn^{2+} ions. Write a balanced equation for this reaction showing the oxidation and reduction half reactions as well as the overall reaction.

Marks 6

OXIDATION
half reaction

REDUCTION
half reaction

OVERALL
reaction

A 10.0 mL sample of H_2O_2 solution was acidified with H_2SO_4 and titrated against a 0.0200 M solution of KMnO_4 . The titration required 17.6 mL of the KMnO_4 solution.
(a) Calculate the mass of H_2O_2 that reacted.

ANSWER:

(b) Calculate the volume of $\text{O}_2(\text{g})$ measured at 300 K and 102 kPa evolved during this titration.

ANSWER:

- In a laboratory experiment plants are grown in red light of wavelength 700 nm. Calculate the energy of one photon of this light.

**Mark
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ANSWER:

Experiments show that 48 photons of light of wavelength 700 nm are required for the synthesis of one molecule of glucose. Given that the energy required for the formation of one mole of glucose by photosynthesis at 298 K is 2870 kJ, calculate the efficiency (energy used/energy input) of photosynthesis in this reaction.

ANSWER:

- An M^{3+} ion of the element M has an electronic configuration of $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$.

2½

Identify the element M by name.

Write the ground state electronic configuration of M.

How many electrons in this atom have quantum number $l = 1$ (as one of their quantum numbers)?

How many electrons in this atom have quantum numbers $n = 3$ and $l = 2$?

How many electrons in the M^{3+} ion of element M have quantum numbers $n = 3$, $l = 2$, $m_l = -2$ and $m_s = +½$?

- Diethyl ether ($\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$) has a boiling point of 34.5°C , whereas an isomer, 1-butanol ($\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$) has a boiling point of 117°C . Explain the difference in their boiling points.

1½

- For each of the following:

i) Write a Lewis structure showing valence shell electron pairs (σ and, if present, π and non-bonding).

ii) Describe the shape of the molecule or ion.

iii) Indicate the hybridisation state of the central atom.

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	BrF_5	ICl_2^+	SO_3^{2-}
i)			
ii)			
iii)			

	SnCl_2	XeF_2	N_3^-
i)			
ii)			
iii)			

Which of the above molecules are polar?

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- With the aid of appropriate examples and diagrams, give brief explanations of the following intermolecular forces.

**Mark
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hydrogen bonding

dispersion forces

- Complete the following table.

4

Chemical Formula	Systematic Name
$[\text{Co}(\text{NH}_3)_6]\text{Br}_3$	
	pentaaquachloroiron(III) chloride
	tetraamminedichlorochromium(III) nitrate
$\text{Na}_2[\text{CuCl}_4]$	

- List the elements K, Ca, Sc and S in order of increasing atomic size.

2

smallest

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 largest

List the atoms Be, Cl, Li and S in order of increasing electronegativity.

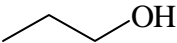
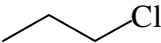
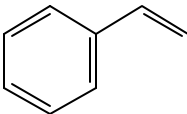
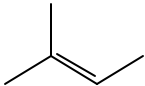
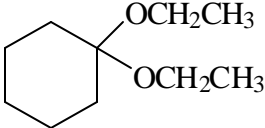
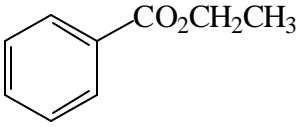
lowest

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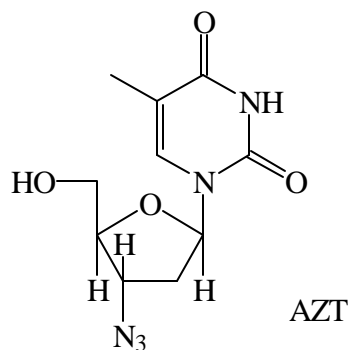
 highest

- Complete the following table.

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9**

STARTING MATERIAL	REAGENTS/CONDITIONS	CONSTITUTIONAL FORMULA(S) OF MAJOR ORGANIC PRODUCT(S)
		
	H ₂ / Pd on C ethanol solvent	
	HCl (CCl ₄ solvent)	
	1 M HCl	
N(CH ₂ CH ₃) ₃	CH ₃ CH ₂ I	
	3 M NaOH / heat	
CH ₃ CH ₂ Br		CH ₃ CH ₂ CH ₂ -O-CH ₂ CH ₃

- 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 ($-N_3$).



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Give the molecular formula of AZT.

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

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

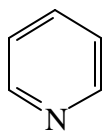
Give an example of a nucleotide derived from AZT.

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.

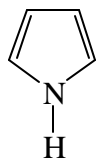
thymine	tautomer

- Explain with the aid of diagrams why pyridine forms a salt with dilute HCl, whereas pyrrole does not.

3



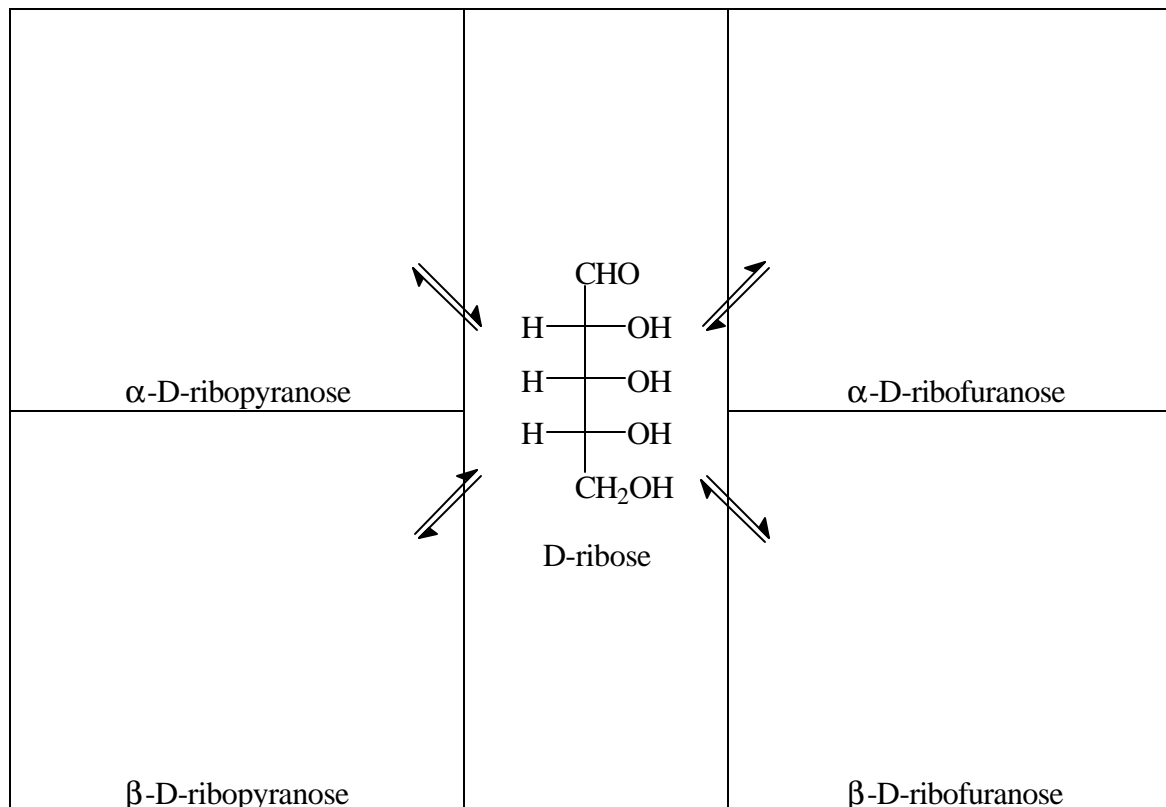
pyridine



pyrrole

- At equilibrium in aqueous solution, D-ribose exists as a mixture containing 20% α -pyranose, 56% β -pyranose, 6% α -furanose and 18% β -furanose forms. Draw Haworth formulas in the appropriate boxes below for each of these forms.

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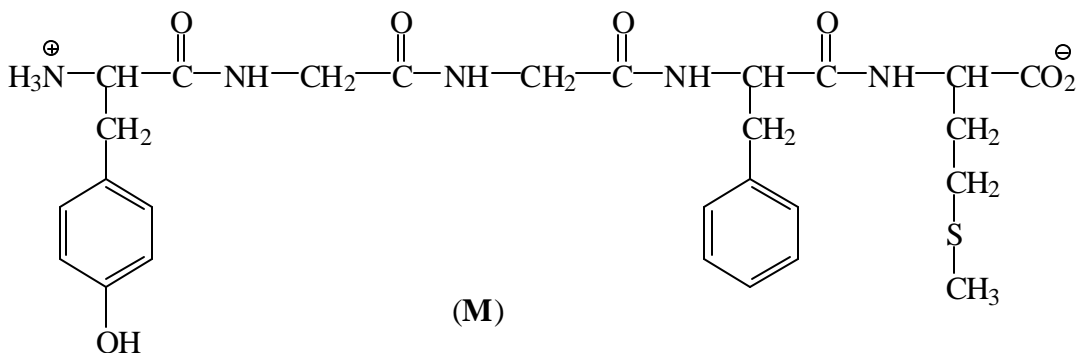
Give the formula in Fischer projection, of the product, (**K**), formed when D-ribose is treated with sodium borohydride.

Specify the optical rotation of (**K**) as “(+)”, “(-)”, “zero”, or “cannot be predicted”. Briefly justify your choice.

Give the stereoformula of the product formed when β -D-ribopyranose is heated with methanol and an acid catalyst.

- The neurohormone Tyr-Gly-Gly-Phe-Met (**M**) known as methionine enkephalin is a naturally occurring peptide which controls pain perception in vertebrates.

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Name the functional groups in (**M**).

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Four amino acids (tyrosine, glycine, phenylalanine and methionine) are obtained on complete acid hydrolysis of (**M**). Draw the stereof formulas of L-tyrosine and L-methionine in the boxes below. Indicate their absolute configurations using the (*R*)- and (*S*)- convention.

L-tyrosine	Absolute configuration	L-methionine	Absolute configuration

Give the constitutional formula for the product obtained when tyrosine, the *N*-terminal amino acid in compound (**M**), is dissolved in 1 M NaOH solution.

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- Give the constitutional formula of the cyclic dipeptide (**N**), obtained when glycine methyl ester is heated. Explain why (**N**) does not exist as a zwitterion.

2

<p>(N)</p>	<p>Explanation</p>
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22/09(b) The University of Sydney

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FIRST SEMESTER EXAMINATION

JUNE 2000

Numerical Data

Physical constants

Planck constant = $h = 6.626 \times 10^{-34}$ joule second

Speed of light in vacuum = $c_0 = 3.00 \times 10^8$ metre second⁻¹

Avogadro constant = $N_A = 6.022 \times 10^{23}$ mole⁻¹

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} metre³

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

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