LONDON SOUTH BANK UNIVERSITY

Atoms and Molecules

SBS-1-133

http://www.lsbu.ac.uk/biology/biolchem/

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UNIT DETAILS

Unit Title:	Atoms and Molecules
Unit Level:	1
Unit Reference Number:	SBS-1-133
Credit Value:	1 Credit = 15 CATS points
Student Study Hours:	150 hours
Contact Hours:	46 hours
Private Study Hours:	104 hours
Pre-requisite Learning (If applicable):	None
Co-requisite Units (If applicable):	Core scientific skills (Practical exercises)
Course(s):	BioScience, Food Science, iScience
Year and Semester	Year 1, semester 1
Unit Coordinator:	Professor Martin Chaplin
UC Contact Details (Tel, Email, Room)	Room B149, Tel. 0207 815 7970 email: martin.chaplin@lsbu.ac.uk
Teaching Team & Contact Details (If applicable):	Dr Tony Clark, Room E231 Tel. 0207 815 7917 email: clarkad@lsbu.ac.uk
Subject Area:	Bioscience and Food
Summary of Assessment Method:	MCQ tests and examination

SHORT DESCRIPTION

An introduction to the biological chemistry required as underpinning to the science degree courses. Starting from a basic description of the atom, the course leads steadily to cover key aspects of fundamental physical, inorganic and organic chemistry.

AIMS OF THE UNIT

To equip you with appropriate scientific background for the study of applied science.
To encourage a confident, reasoning, disciplined, inquiring and investigative approach to the study of science.
To provide you with a body of knowledge of chemical science necessary for the study of biology, biochemistry, food science and the environment.

LEARNING OUTCOMES

KNOWLEDGE AND UNDERSTANDING

Describe in qualitative terms the nature of the interactions between molecules in solids, liquids and gases,
Carry out simple calculations using the relationships between molarity, relative molecular mass, %w/v, ppm, w/w,
Describe the electronic structure of elements in the Periodic Table, particularly of those that are biologically important, and explain the structure of the Table,
Describe the different types of bonding found between atoms and predict the type of bonding to be expected in particular compounds,
Explain what a radioactive isotope and is what is meant by its ‘half-life’,
Predict the approximate equilibrium position of a reaction given the value of the Gibbs free energy change,

Explain the difference between strong and weak acids and the significance and mechanism of buffering in biological systems and differentiate between oxygen addition and oxidation,

INTELLECTUAL SKILLS

Predict the approximate shapes of simple organic molecules from their formulae and describe the range of isomers that may obey given structural or empirical formulae.
Describe the biologically relevant reactions that might be expected of organic substances of given molecular formulae.

PRACTICAL SKILLS

Display basic numerical and logical skills.

TRANSFERABLE SKILLS

Display basic numerical and logical skills.
Produce and display scientific argument and background chemical skills.

INTRODUCTION TO STUDYING THE UNIT

OVERVIEW OF THE MAIN CONTENT

The nature of matter

We will examine the concepts of atoms and molecules, their structure, mass and chemical and physical properties:
Electrons in pairs, orbitals and shells. Isotopes (stable and unstable). The formation of ions. The Periodic Table. Bonding; covalent and ionic. The structure of water and hydrogen bonding. Water as a solvent; hydrophobic and hydrophilic effects.

Reactions

We will look at chemical reactions, their direction, stoichiometry, catalysis, and energetics:
Balancing equations and stoichiometry. Activation energy and the effect of temperature and reactant concentrations on the rates of reaction. Enthalpy, entropy and free energy. Equilibrium, Le Chatelier and the role of ‘free energy’.
Ionisation, water, strong and weak acids, bases, salts, pH, pK, titrations, buffers, indicators and the Henderson-Hasselbalch equation.

Organic Chemistry

We will describe simple organic molecules and their reactions:
The tetrahedral carbon atoms, double bonds and p electrons. Resonance and conjugation, delocalisation of electrons and aromatic compounds. Electrophilic and nucleophilic groups and reactions. Functional groups: - biologically relevant properties and reactions of alkyl, alkenyl, alcohols, aldehydes, ketones, carboxylic acids, anhydrides, amines, amides and esters. Conformational isomerism, stereoisomerism, optical isomerism and cis/trans isomerism. D-/L- and S-/R- nomenclature.

OVERVIEW OF TYPES OF CLASSES

This single credit unit contains lectures, tutorials and directed student-centred learning. It consists of a total of 150 hours made up of class contact time and directed learning.

The course will be presented in a series of 24 lectures with 12 one-hour tutorials in support. Two reinforcement/revision lectures are also given. Five one-hour periods will be timetabled every other week starting in week two for the completion of multiple-choice tests. On the weeks following the tests, there will be a one-hour period for going over the answers to the previous week's test and for practising further examples. Practical work (about 18 hours) will support and reinforce the material in the theory sections and develop laboratory skills, safe practise and group participation. This practical work will form part of associated units.

For the six tutorials you will be divided into groups. Your Biological Chemistry tutor will concentrate on the needs of students who have done the least chemistry in the past. A program of guided student-centred activities is provided which includes guided reading, audio-visual aids, computer simulations, molecular modelling and problem solving.

These times are NOT optional. You must invest your time if you are to benefit from University. If you do not use your opportunity then you let us and yourself down.

All lectures, tutorials and multiple-choice test classes must be attended unless you have an excuse acceptable to your course director. All sessions have attendance sheets. Attendance is important and absence may cause you to fail. If multiple-choice test sessions are unavoidably missed, it is not usually possible to do them at an alternate time. Exceptions may be possible if sufficient prior warning is given.

The course has essential textbooks associated with it. One must be purchased to complete the background reading satisfactorily.

IMPORTANCE OF STUDENT SELF-MANAGED LEARNING TIME

Each one-hour lecture has associated with it two hours for reading your notes and the directed essential reading matter. This should be done on the same day as the lecture. The rest of the unit time is taken up with the problems. For maximum benefit these should also be done as close to their associated lectures as possible and before the following week. For these reasons you should set aside four hours each week on the same day as the Biological Chemistry unit for this work. A further four hours should be set aside at the weekend for the problems and to prepare for the following week. Recognise that Biological Chemistry is one of the more demanding Units and invest the time. The investment pays dividends.

EMPLOYABILITY

Biological chemistry lies at the foundation of all biological/biochemical learning and research. The ability to sensibly discuss associated issues is likely to impress future employers and a lack of such ability will disappoint them.

THE PROGRAMME OF TEACHING, LEARNING AND ASSESSMENT

The course consists of 12 weeks with two lectures each week (three lectures in the first and last week). They are given by Martin Chaplin (MC) or Tony Clark (AC). Attend the tutorials, as they may contain additional information and are for reinforcement of the

lecture material.
The weekly programme is given (in the next section) with the following headings:

Background reading

I give 'background reading' to impart a 'feel' for Biological Chemistry. You should read it twice, once before the lectures and again after the lectures. It does not have to be learnt. It is taken from 'General, Organic & Biological Chemistry Structures of Life' by Karen Timberlake and 'Chemistry' by Atkins and Jones. If you have 'Chemistry' by Housecroft and Constable you should use its index to find appropriate reading. Reading the textbook should generally help you with the associated assignments.

Study guide

The 'study guide' given in this unit guide is taken from 'General, Organic & Biological Chemistry Structures of Life' by Karen Timberlake, and 'Chemistry' by Atkins and Jones. If you have 'Chemistry' by Housecroft and Constable or other text books, you should use its index to find appropriate reading. They provide you with the key area of the background reading which you should study after the lectures and, as revision together with your notes before the examination. It can also be used to improve and check your lecture notes. There are fewer weekly handouts in this course as the Web-site (http://www.sbu.ac.uk/biology/biolchem/) contains most such information and you are expected to download the recommended material **in advance of the lectures**.

Related learning aids

This gives you details of ideas and study aids that will help you learn the week's material. The computer simulation has been specially written for this unit by the unit co-ordinator. You are particularly recommended to spend some time on this.

Problems

Being able to answer these, or similar, problems proves many of the learning outcomes for the unit. The competence to answer them, or similar, will be tested in the fortnightly tests and final examination so practice these problems beforehand. They should be attempted each week. When you have made a genuine attempt, you may wish to read the model answers given at the Web-site (http://www.sbu.ac.uk/biology/biolchem/).

Week 1 **a**) Atomic structure, protons, electrons and neutrons; relative atomic mass; amu; Avogadro's number. (MC)
b) The Periodic Table, metals and non-metals, groups and periods; atomic orbitals, shielding and electronegativity. (MC)
c) Isotopes, stable & unstable; mass spectra; radioactivity, half-life. (AC)

Background reading	Timberlake ; Chapters 1, 2 and 3. Atkins and Jones Chapters 1, 2 and 22
Study guide	Timberlake ; 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 3.1, 3.2, 3.5. Atkins and Jones pp 1 – 17 (atoms and the Periodic Table), 976 - 981 (radioactive decay);
Related learning aids	The Periodic Table, see back cover

Atoms & **Radioactivity** Web pages.

Problems

1 An element has atomic number 17 and atomic weight 35.453 (to 3 decimal places). What element is it? How many protons and electrons does each atom have? What, if at all, can be deduced about its isotopic composition and the number of neutrons in each atom? How many atoms are there in each gram? What is the average weight of one atom? What is the ground state electronic configuration?

2 Using the periodic table, which common element is likely to have chemical properties most similar to those of selenium (Se)? Is it likely to be more electronegative than selenium?

3 Given the melting points of the following elements, estimate the melting point of Potassium. (K). Li, 181°C; Na, 98°C; Rb, 39°C; Cs, 29°C. (Use the Periodic Table to help answer this question)

4 The half-life of a parent isotope in a rock is $5x10^6$ years. The ratio of the parent: daughter isotopes in the rock was found to be 1 : 7 in atomic proportions. What is the age of the rock?

Week 2 **d**) Ionic and covalent bonding; properties of ionic and covalent compounds; molecules, molecular mass and the mole. (MC)
e) Molecular orbitals, shapes of molecules (AC)

Background reading Timberlake Chapter 4; Atkins and Jones Chapters 7, 8 and 9

Study guide Timberlake 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10; Atkins and Jones pp 18 - 25 (substances), 68 – 71 (molar mass), 322 - 341 (ionic and covalent bonds), 363 - 372 (shapes of molecules), 388 - 394 (molecular orbitals)

Problems

5 How many molecules of water are there in a drop (= 50 l ; density = 1 g/ml)?

6 How many non-bonding electron pairs do the following molecules have in their outer atomic shells? What are the shapes of the molecules?
I_2, CO_2, HCl, NH_3, CH_4, H_2O, Ar
What is the weight of one mole of each of these substances? (Use the Periodic Table to obtain the relative atomic masses).

Test 1 **Lectures a - c**

Week 3 **f**) Molarity, calculation of molecular composition, reactions. (AC)
g) Stoichiometry of reactions, balancing equations. (MC)

Background reading Timberlake Chapters 6 and 7; Atkins and Jones Chapters 3, 4; re-read Chapter 2;

Study guide Timberlake 6.1, 6.2, 6.3, 7.1, 7.2, 7.3, 7.4, 7.5, 7.6; Atkins and Jones pp 75 - 77 (% composition calculations), 77 - 81 (compound formulae and composition), 92 - 95 (balancing equations), 138 - 151 (stoichiometry), 154 - 158 (molarity)

Related learning aids **Molarity** & **Stoichiometry** Web pages

Problems

7 What is the molarity of a 10% w/v salt (NaCl) solution? What is the % atomic composition of the solid salt?

8 How many moles of salt are there in 50 ml of a 0.2 M solution of salt (NaCl)? If

200 ml of water is added to the 50 ml of 0.2 M salt, what is (1) the final volume, and (2) the final concentration of the salt?

9 Under appropriate conditions hydrogen peroxide (H_2O_2) will react with hydrazine (N_2H_4) to give water (H_2O) and nitrogen (N_2). Write out the equation for the reaction and then balance it.

10 Ringers solution is a physiological solution used for perfusing tissues. Its composition is NaCl = 8 g, KCl = 0.42 g, $CaCl_2$ = 0.24 g, $NaHCO_3$ = 0.20 g; made up to 1 litre with H_2O. (a) What is the concentration in millimoles per litre and parts per million (ppm w/v) of the individual anions and cations. (b) What is the ionic strength of the solution?

11 In the determination of the plasma volume of a monkey, a small amount of a non-toxic dye, which is slowly cleared from the bloodstream, is injected intravenously and its concentration determined as soon as equilibrium is reached. 20 ml of an Evan's Blue solution (0.2 mg/ml) is injected and after 3 minutes a blood sample was withdrawn and found to contain 0.5 mg % (w/v) of the dye. What is the monkey's plasma volume?

12 How many grams of the following compounds are contained in 250 ml of a 0.1 M solution? (a) sucrose ($C_{12}H_{22}O_{11}$) (b) NaOH (c) $MgCl_2$?

13 How would you prepare the following solutions:
(a) 2 litres of 0.4 M Na_2HPO_4 from solid $Na_2HPO_4.2H_2O$
(b) 105 ml of 0.15 M HCl from 11.7 M HCl
(c) 4.7 ml of 0.1 M H_3PO_4 from concentrated phosphoric acid (88% w/w, density = 1.72g/ml)

Week 4 **h**) States of matter, solids, liquids and gases, the gas laws, polar and non-polar molecules; solutions. (AC)
i) Water, structure, properties and importance; surface energy and entropy; hydrogen bonding. (MC)

Background reading	Timberlake Chapters 5, 8 and 9; Atkins and Jones Chapters 5 and 10
Study guide	Timberlake 5.4, 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 9.1; Atkins and Jones 426 - 428 (hydrogen bonding), 428 - 430 (liquids), 178 - 200 (gases and the gas laws)
Related learning aids	**The gas laws** & **Water** Web pages Water Web site: http://www.sbu.ac.uk/water

Problems

14 A balloon contains 100 m^3 of hydrogen gas at standard temperature and pressure (0°C, 1 atm). What is the weight of the hydrogen? (Atomic weight of hydrogen = 1.008 to 3 decimal places). What volume does it have at 30°C and 1.1 atm pressure?

15 How many molecules of oxygen are there in each breath of air (at STP, assume one breath is one litre and 20% of the air is oxygen)?

16 Which of the following groupings would be expected to form hydrogen bonds with water? $-CH_3$, $-OH$, $-NH_2$, $-CH_2CH_3$, $>C=O$, $-CH=O$

17 Haemoglobin (the oxygen-carrying protein in the blood) reacts with O_2 to form a complex. This complex contains four moles of oxygen per mole of haemoglobin. Calculate the number of haemoglobin molecules required to carry one ml of O_2 gas under standard conditions of temperature and pressure. (b) Calculate the number of ml of O_2/100 ml blood plasma at 38°C. The molecular weight of haemoglobin is 68,000 and its concentration in plasma is 15 g/100 ml.

Test 2 **Lectures d - g**

Week 5 **j**) Water and other solvents, gas solubility; osmosis and other colligative properties; the hydrophobic effect; detergents. (MC)
k) Equilibrium; Le Chatelier's principle, effect of temperature and pressure on equilibria. (AC)

Background reading Timberlake Chapters 6 and 9; Atkins and Jones Chapters 12 and 13

Study guide Timberlake 6.8, 9.2, 9.3, 9.5, 9.7, 9.8; Atkins and Jones pp 422 - 426 (forces between molecules), 524 - 543 (solubility), 543 - 559 (osmosis), 620 - 649 (Le Chatelier's principle).

Related learning aids 'pH/Titrations' PC program section B, available from Web site
Water Web page

Problems

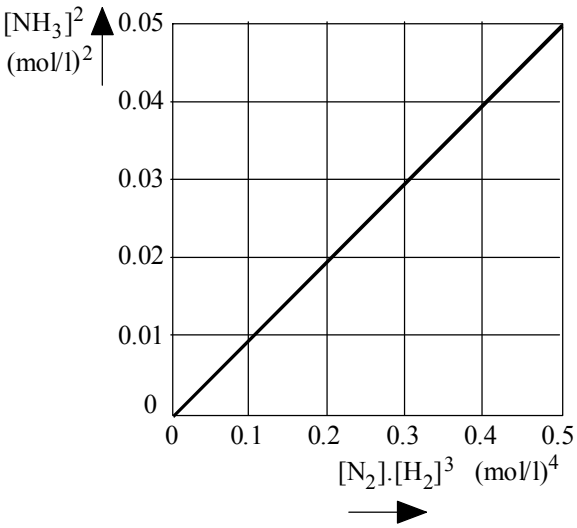
18 Why does a cucumber placed in salted water shrivels up into a pickle?

19 To make French dressing, why do you shake the oil and vinegar vigorously?

20 Which of the following materials will be expected to be more soluble in water than in petrol? sugar (sucrose), fat, candle wax, olive oil, salt (NaCl), soap

21 The data collected in an experiment to measure the equilibrium constant (K_{eq}) of the exothermic reaction below are recorded graphically.

$$N_2\,(g) + 3H_2\,(g) \rightleftharpoons 2NH_3\,(g)$$



What is the value of K_{eq}? (give the numerical value and its units)
What would be the effect of (a) increasing the temperature, (b) decreasing the pressure on the value of K_{eq}.
How would increasing the nitrogen concentration, whilst keeping the hydrogen concentration constant, effect the equilibrium concentration of ammonia?

Week 6 **l**) Introduction to transition metals, ions, electronic configuration of the different valence states, colour, simple redox reactions. (AC)
m) Water, ionisation, acids (strong and weak), bases, salts and pH. (MC)

Background reading Timberlake Chapter 10; Atkins and Jones Chapters 15 (first part) and 21

Study guide Timberlake 6.5, 10.1, 10.2, 10.3, 10.4, 10.5, 10.6; Atkins and Jones 660 - 671 (acids, bases and pH), 918 - 922

(transition metals)

Related learning aids 'pH/Titrations' PC program section A, available from Web site

Acids Web page

The Periodic Table, back cover

Problems

22 Calculate the pH of (a) 0.1 M HCl; (b) 0.1 M NaOH; (c) $3x10^{-5}$ M HNO_3; (d) $5x10^{-10}$ M $HClO_4$ (NB. In this last case, do not forget the value of the pH of a neutral solution).

23 The volume of a typical bacterial cell is of the order of 1.0 m^3. At pH 7, how many hydrogen ions are contained inside a bacterial cell? A bacterial cell contains thousands of macromolecules such as proteins and nucleic acids. What does your result indicate about the common notion that these macromolecules are continuously bathed with H^+ and OH^- ions.

24 (a) Combine the following two redox half-reactions into one balanced equation.

$$Fe^{3+} + e^- = Fe^{2+} \qquad Cl_2 + 2e^- = 2Cl^-$$

(b) Split the following reaction into two redox half-reactions.

$$2Fe^0 + 6H^+ = 2\,Fe^{3+} + 3H_2$$

Test 3 **Lectures h - k**

Week 7 **n**) The tetrahedral carbon atom and the projection of three-dimensional structures; alkanes and alkenes; double bonds, pi electrons, aromaticity and resonance; conjugated structures and the optical absorption of dyes (AC)

o) Weak acids, pK_a, the Henderson-Hasselbalch equation and buffers; acid-base titrations and indicators (MC)

Background reading Timberlake Chapter 10, 11, 12 and 13; Atkins and Jones Chapters 11 (first part), 15 and 16;

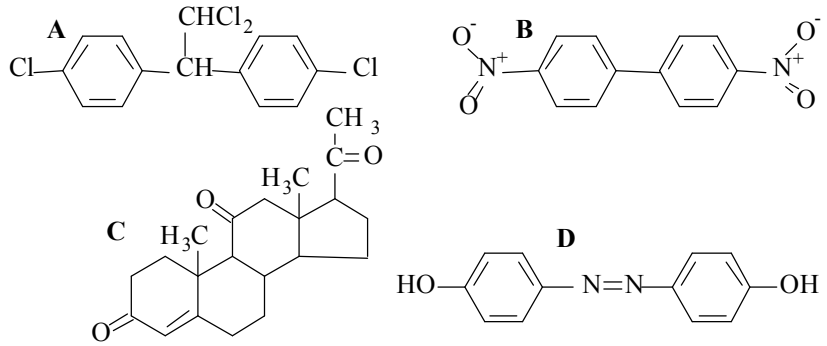
Study guide Timberlake 10.9, 10.10, 10.11, Chapter 11, 12.1, 12.2, 12.3, 13.1, 13.2, 13.3; Atkins and Jones pp 337 - 339 (resonance), 472 - 484 (alkanes, alkenes and aromatics), 671 - 692 (weak acids), 707 - 729 (titrations, buffers and the Henderson-Hasselbalch equation)

Related learning aids 'pH/Titrations' PC program section C, available from Web site

Acids & **Methane and the alkanes; alkenes** Web pages

Problems

25 By using your understanding of the conjugated systems, determine which of the following compounds are probably coloured?



26 What is the pH of a mixture of 60 ml of 0.1 M acetic acid and 40 ml of 0.2 M sodium acetate given that the pK_a of acetic acid = 4.7.

Hint: use the Henderson-Hasselbalch equation

$$pH = pK_a + \log_{10}\left(\frac{[A^-]}{[HA]}\right)$$

27 How would you make a 100 ml of a 0.1 M acetic acid:sodium acetate buffer of pH = 5.0? (pK_a acetic acid = 4.7)

Week 8 **p**) Isomers, stereo, cis/trans, optical and conformational; chirality (AC)
q) Reactions, rates of reaction, zero, first and second order rate equations (MC)

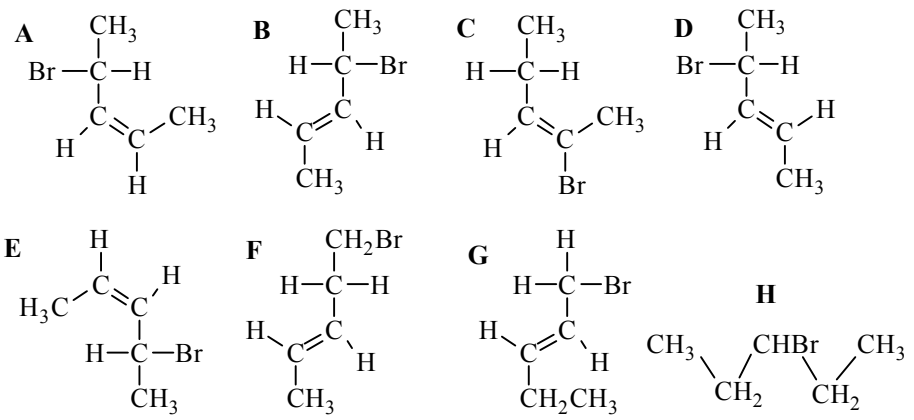
Background reading Timberlake Chapter 6, 11, 12 and 13; Atkins and Jones Chapters 11 and 13 (first part)

Study guide Timberlake 6.1, 6.2, 6.4, 6.7, 11.6, 13.3, 15.5; Atkins and Jones pp 494 - 498 (isomers), 570 - 586 (rates of reaction),

Related learning aids Chemistry model kits (in Room J302). Try making models of the compounds shown in Problem 28
Isomerism Web page

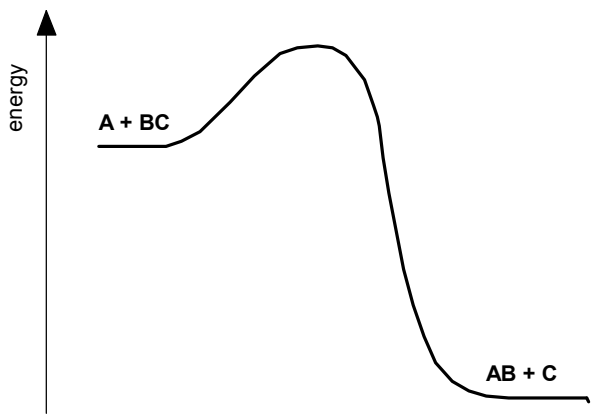
Problems

28 Which of the following molecules are chiral, which are isomers and what type of isomerism is evident?



29 The Figure below is the reaction co-ordinate diagram for the hypothetical reaction

$$A\,(g) + BC\,(g) \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} AB\,(g) + C\,(g)$$



(a) Select the action(s) that would increase the equilibrium yield

(i) Decreasing the temperature of the reaction.
(ii) Adding a catalyst
(iii) Reducing the concentration of A
(iv) Changing the mechanism of the reaction
(v) Increasing the pressure of the reaction
(vi) Decreasing the pressure of the reaction

(b) Select the true statement(s) below

(i) $k_1 > k_{-1}$ (ii) $k_1 < k_{-1}$
(iii) k_1 / k_{-1} is greater than one (iv) the equilibrium constant is less than one
(v) k_1 increases with an increase in temperature but k_{-1} does not
(vi) the activation energy in the forward direction is greater than that in the reverse direction.
(vii) the activation energy in the forward direction is greater than the heat of reaction.

Test 4 Lectures l – o

Week 9 **r**) Organic reactions; introduction to nucleophilic groups; nucleophilic substitution reactions, addition and polymerization of alkenes (AC)
s) Activation energy, effect of temperature, heat of reaction, catalysis (MC)

Background reading Timberlake Chapter 5, 6 and 14; Atkins and Jones Chapter 13, re-read Chapter 11

Study guide Timberlake 5.1, 5.2, 6.6, 13.4, 14.1, 14.6; Atkins and Jones pp 498 - 508 (polymers), 586 - 595 (activation energy and effect of temperature), 595 - 598 (catalysis), 603 – 608, 625 - 626 (rates and equilibrium)

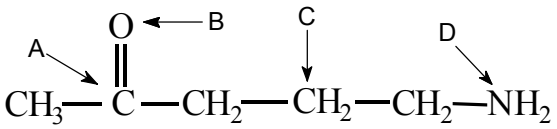
Problems

30 0.2 g of H_2 and 4 g of I_2 are confined to a 2 litre flask and heated to 700 K, where they react by a second-order process (first order in each reactant) with k = 4 $L.mol^{-1}.min^{-1}$.

$$H_2 + I_2 \xrightarrow{k} 2HI$$

(a) What is the initial reaction rate?
(b) By what factor does the reaction rate change if the concentration of both H_2 and I_2 are doubled?
(c) If a catalyst is introduced that increases the rate by a factor of 1000, by how much is the activation energy reduced?

31 Which of the following groups are electrophilic or nucleophilic?



Week 10 **t**) Alcohols, dehydration; ethers; phenols, carboxylic acids, pK_a's; anhydrides and esters, formation and hydrolysis (AC)
u) Laws of thermodynamics, Free energy, relationship to equilibrium constant, enthalpy, entropy, spontaneity (MC)

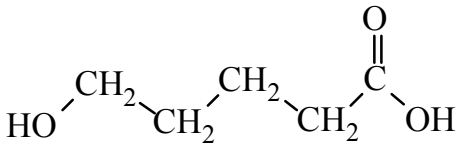
Background reading Timberlake Chapter 14 and 17; Atkins and Jones Chapter 17; re-read Chapter 11

Study guide Timberlake 17.1, 17.2, 17.3, 17.4; Atkins and Jones pp 240 - 257 (enthalpy), 756 - 782 (entropy, free energy, spontaneity and the laws of thermodynamics), 485, 488 (alcohols, phenols and ethers), 490 - 491 (carboxylic acids and esters)

Related learning aids **Thermodynamics** & **Biochemically important groups** Web pages

Problems

32 Predict what chemical reaction(s) occur when the following compound is heated by itself.



33 At equilibrium a reaction mixture comprises one part of reactant to ten parts of product. What is the equilibrium constant for this reaction?

34 Consider the chemical reaction below whose equilibrium constant is 1×10^{-3}

$$A \rightarrow B$$

a) By calculation of the Gibbs free energy for the reaction, determine if the reaction is spontaneous or non-spontaneous.

b) Given that the enthalpy change for the reaction at 25°C is +500 joules per mole, what is the entropy change?

Test 5 **Lectures o - s**

Week 11 **v**) Aldehydes and ketones, oxidation and reduction, reaction with amines and alcohols (AC)

w) Electrochemistry, half reactions, redox potential (MC)

Background reading Timberlake Chapter 15; Atkins and Jones Chapter 18, re-read Chapter 11

Study guide Timberlake 6.5, 15.1, 15.2, 15.3, 15.4, 15.5, 15.6, 15.7; Atkins and Jones pp 792 - 797 (electrochemistry), 810 - 815 (redox reactions), 489 (aldehydes and ketones)

Related learning aids **Redox** & **Biochemically important groups** Web pages

Problems

35 Given the following standard redox potentials, which of the following statements are true?

Fe^{3+}/Fe^{2+} = 0.771 V

Cu^{2+}/Cu^{+} = 0.15 V

$2O_2$, $2H^{+}/H_2O$ = 0.816 V

(a) Fe^{3+} can oxidise water (b) Fe^{2+} can reduce oxygen

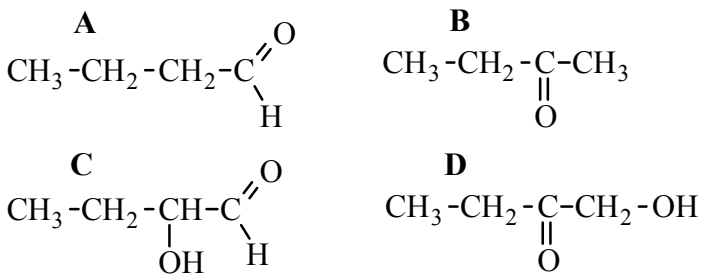
(c) Cu^{2+} can reduce oxygen (d) Cu^{+} is the strongest reducing agent

(e) the following reaction will occur spontaneously

$$Fe^{3+} + Cu^{+} \rightarrow Fe^{2+} + Cu^{2+}$$

(f) Fe^{3+} is the strongest oxidising agent

36 Predict which of the following compounds are good reducing agents.



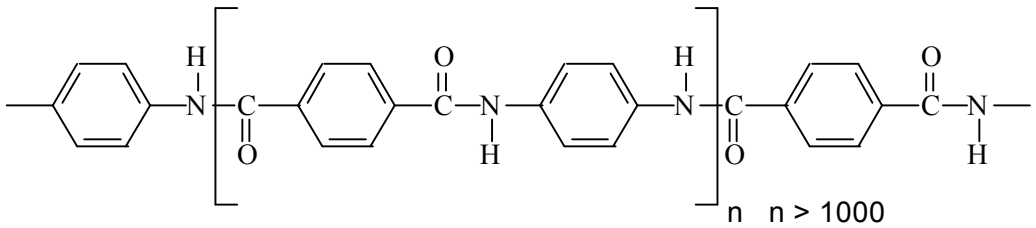
Week 12 **x**) Amines, primary, secondary, tertiary and quaternary, imidazole, pK_a's, redox properties; amides, formation and hydrolysis, (AC)
y) Revision lecture (MC)
z) Revision lecture (AC)

Background reading Timberlake Chapter 19; Re-read Atkins and Jones Chapter 11

Study guide Timberlake 19.1, 19.2, 19.3, 19.4, 19.5, 19.6, 19.7; Atkins and Jones 491 - 492 (amines and amides)

Problems

37 Predict the physical and chemical properties of the following polymer.



ASSESMENT OF THE UNIT

The assessment will be based on 60% end-of-unit multiple-choice examination and 40% from in-course multiple-choice tests. Five in-course tests will be given. The highest four marks will weighted in forming the in-course test mark. This is to allow for, and encourage, students to improve throughout the unit and should not be used as an excuse for not trying to pass all tests. These tests will be addressed to the learning outcomes of current aspects of the course, as presented in the lectures, guided reading or problems. To encourage note-taking, you are allowed to bring your hand-written notes to the in-class tests, but not to the end-of-unit examination. You will need a simple calculator for these tests. They will concentrate on the specified lectures but may contain material tested previously. The overall pass mark for this Unit is 40% with a minimum mark in the final examination of 30%.

Feedback

Feedback will normally be given to students one week after the fortnightly assessments.

LEARNING RESOURCES

CORE MATERIALS

General, Organic & Biological Chemistry Structures of Life, Karen C. Timberlake, PearsonEducation, Inc., 2004, ISBN 0-8053-8914-8
It includes an excellent and useful CD-ROM for PCs and links to its Web site, http://www.chemplace.com/college

Chemistry, Molecules, Matter, and Change, Loretta Jones and Peter Atkins, 4th edition, W. H. Freeman, 1999, ISBN 0-7167-3254-8
It includes two excellent and useful CD-ROMs for PCs and links to its Web site, http://www.whfreeman.com/chemistry/.

Chemistry, 2nd edition, by Catherine E Housecroft and Edwin C Constable, Prentice Hall, 2002, ISBN 0-130-86924-4
This is a comprehensive and more advanced textbook. Students with an 'A' or 'AS' level chemistry background are recommended this. It includes a useful Web site, http://www.booksites.net/housecroft.

Note: The purchase of one of these books should be considered essential for this unit. They contain all of the directed reading. You will find them to be useful for other units in your course and as a reference book in your later careers. Currently, you may use these web sites (except Timberlake's) even if you have not bought the books.

The Unit Web site: http://www.sbu.ac.uk/biology/biolchem/ contains much extra information concerning this unit including: Problems and their worked answers, exam-type questions and their worked answers, the pH/titrations computer program, information sheets and any notices concerning the Unit.

You are recommended to visit often.

OPTIONAL MATERIALS

There are many other textbooks available that may be used to support this unit

Tips - How to Succeed

Do you want to succeed? If you do, then you must invest sufficient time each week. It is particularly important during the first few weeks to get into a working routine.

· Plan your week in advance. Keep up-to-date with the lectures, the background reading and the example problems.

· Attend all lectures, tutorials and test sessions; they are compulsory and have attendance lists. Sit up front in the lectures and tutorials. Be punctual. If material is unavoidably missed, catch up before you are next able to attend by writing your own notes based on the directed reading and attempting the associated problems; copying inferior notes from another student is a sure way to failure. Let your personal tutor know if you have any problems preventing your attendance.

· Use time efficiently. Time is the limiting factor, so the Semester will fly by. Listen and learn while in lectures. Take notes. If the lecturer speaks too quickly so that you cannot take notes, ask him to slow down or provide notes or (desperation time) tape his lectures.

· Record clues given by lecturer about what is or is not important. Learn from the fortnightly tests and their feedback sessions. The textbook contains much material that

should be read to give background and a ‘feel’ for the subject but need NOT be learnt by heart. Make use of the textbook’s CD-ROM, web site and the computer program.

· Review the same day as your lectures. Review everything again on weekends.

Repetition is the basis of memory

Study:

Learn as you go along. There is not time enough for everything just before the exam. Look at any associated learning aids. Switch subjects every half-hour or so (find your own limit) or exercise briefly. Fresh starts are efficient. Don't just read. Stop reading after each paragraph - close your eyes - ask yourself what are the highlights of that paragraph. Have paper and pencil available, but don't try to rewrite all your lecture notes. (There is not enough time). Use colours, underline and/or highlight. For key facts that are difficult but important such as a molecular structure, put on 3 x 5 inch cards. Carry these in your pocket and review between classes or during otherwise 'wasted' time. Some students find it helpful to be part of a study group. Don't be afraid to ask for help if you have difficulties.

Repetition is the basis of memory

Self-evaluation:

Try to answer all the study problems without looking up the answers too quickly.

Taking the tests and examination: Revise your notes and the worked example problems for at least 15 hours, spread over five days, before the final examination. Go to sleep at your regular hour the night before your tests. Set your alarm to get up early and do a last minute review for short-term memory. Eat a carbohydrate breakfast such as cereal before the exam. Carry sugary sweets with you. First, answer the easy questions. Then, go back and answer the difficult ones. Don't get upset about them; you have to get 40% not 100%. Keep track of time during the exam and tests.

The Examination and tests are multiple choice. Read each question carefully. Make sure that you understand what is being asked. There is only one correct answer for each question (i.e. row on the card). If you get stuck on one question, move quickly on to the next and go back to it at the end. Make sure that you answer all the questions as it is worth being fairly bold. If you do not know the correct answer, but know some wrong answers, then you should guess between the remainder. Completely randomly chosen answers gain no credit, but it is to your advantage if you attempt all the questions.

Post-test and post-exam:

Look up topics you answered wrong, even if you have passed. Learn from your mistakes. You will need the knowledge later in your course. Some test questions may be asked again in the examination and/or later tests.

Repetition is the basis of memory

The Periodic Table of the Elements

key: essential in humans (E); atomic number; Symbol; important oxidation numbers; relative atomic mass

Period	Group 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	alkali metals	alkaline earth metals															halogens	noble gases
	s^1	s^2											p^1	p^2	p^3	p^4	p^5	p^6
1 (1s)	1 H hydrogen +1,−1 1.0078																	2 He helium 0 4.0026
2 (2s, 2p)	3 Li lithium +1 6.9412	4 Be beryllium +2 9.0122											5 B boron +3 10.812	6 C carbon +4 12.011	7 N nitrogen −3,+5 14.007	8 O oxygen −2 15.999	9 F fluorine −1 18.998	10 Ne neon 0 20.180
3 (3s, 3p)	11 Na sodium +1 22.990	12 Mg magnesium +2 24.305											13 Al aluminium +3 26.982	14 Si silicon +4 28.086	15 P phosphorus −3,+5 30.974	16 S sulfur −2,+6 32.066	17 Cl chlorine −1,+7 35.453	18 Ar argon 0 39.948
			transition metals															
	d^1	d^2	d^3	d^4	d^5	d^6	d^7	d^8	d^9	d^{10}								
4 (4s, 3d, 4p)	19 K potassium +1 39.098	20 Ca calcium +2 40.078	21 Sc scandium +3 44.956	22 Ti titanium +4 47.867	23 V vanadium +5 50.942	24 Cr chromium +6,+3 51.996	25 Mn manganese +7,+4,+2 54.938	26 Fe iron +3,+2 55.845	27 Co cobalt +3,+2 58.933	28 Ni nickel +2 58.693	29 Cu copper +2,+1 63.546	30 Zn zinc +2 65.392	31 Ga gallium +3 69.723	32 Ge germanium +4 72.612	33 As arsenic −3,+5 74.922	34 Se selenium −2,+6 78.963	35 Br bromine −1 79.904	36 Kr krypton 0 83.801
5 (5s, 4d, 5p)	37 Rb rubidium +1 85.468	38 Sr strontium +2 87.621	39 Y yttrium +3 88.906	40 Zr zirconium +4 91.224	41 Nb niobium +5 92.906	42 Mo molybdenum +6,+5,+4 95.941	43 Tc technetium +7 98.906	44 Ru ruthenium +3,+2 101.07	45 Rh rhodium +3,+2 102.91	46 Pd palladium +4,+2 106.42	47 Ag silver +1 107.87	48 Cd cadmium +2 112.41	49 In indium +3 114.82	50 Sn tin +4,+2 118.71	51 Sb antimony +3 121.76	52 Te tellurium −2 127.60	53 I iodine −1,+7 126.90	54 Xe xenon 0,+4 131.29
6 (6s, 4f, 5d, 6p)	55 Cs caesium +1 132.91	56 Ba barium +2 137.33	71 Lu lutetium +3 174.97 (La)	72 Hf hafnium +4 178.49	73 Ta tantalum +5 180.95	74 W tungsten +6,+5 183.84	75 Re rhenium +7,+4 186.21	76 Os osmium +4,+3 190.23	77 Ir iridium +3,+2 192.22	78 Pt platinum +4,+2 195.08	79 Au gold +3,0 196.97	80 Hg mercury +2,+1 200.59	81 Tl thallium +1 204.38	82 Pb lead +4,+2 207.21	83 Bi bismuth +3 208.98	84 Po polonium +4 208.98	85 At astatine −1 209.99	86 Rn radon 0 220.02
7 (7s, 5f, 6d, 7p)	87 Fr francium +1 223.02	88 Ra radium +2 226.03	103 Lr lawrencium +3 262.11 (Ac)	104 Rf rutherfordium +4 261.11	105 Db dubnium +5 262.11	106 Sg seaborgium +4 263.12	107 Bh bohrium +7 264.12	108 Hs hassium +4 269	109 Mt meitnerium +2 268	110 Ds darmstadtium 271	111 Rg roentgenium 272	112 Uub ununbium 285	113 Uut ununtrium 284	114 Uuq ununquadium 289	115 Uup ununpentium 288	116 Uuh ununhexium 292		

lanthanides	57 La lanthanum +3 138.91	58 Ce cerium +3,+4 140.12	59 Pr praseodymium +3 140.91	60 Nd neodymium +3 144.24	61 Pm promethium +3 144.91	62 Sm samarium +3 150.36	63 Eu europium +3 151.96	64 Gd gadolinium +3 157.25	65 Tb terbium +3 158.93	66 Dy dysprosium +3 162.50	67 Ho holmium +3 164.93	68 Er erbium +3 167.26	69 Tm thulium +3 168.93	70 Yb ytterbium +3 173.04
actinides	89 Ac actinium +3 227.03	90 Th thorium +4 232.04	91 Pa protactinium +5,+4 231.04	92 U uranium +6,+3 238.03	93 Np neptunium +6,+3 237.05	94 Pu plutonium +6,+3 244.06	95 Am americium +6,+3 243.06	96 Cm curium +3 247.07	97 Bk berkelium +3 247.07	98 Cf californium +3 251.08	99 Es einsteinium +3 252.08	100 Fm fermium +3 257.10	101 Md mendelevium +3 258.10	102 No nobelium +3 259.10

Period; Group; filling orbitals; inner electrons; noble gas core; outer shell

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