STUDENT NAME _____

YEAR 12 CHEMISTRY

HANDBOOK

Contents

ERRORS

When instruments are manufactured, there is a specified uncertainty within which the instrument is designed to deliver accurate results. You do not need to remember the various uncertainties of instruments exactly, however you are required to know the probable range (to within a power of 10) within which an instrument should operate. Typical uncertainties are:

pipette	± 0.02 mL
burette	± 0.02 mL
top loading balances	± 0.005 g
10 mL measuring cylinders	± 0.1 mL
100 mL measuring cylinders	± 1 mL
250 mL standard flasks	± 0.2 mL

Errors in experimental work can be classified in three categories:

Gross Errors or Mistakes

These are due to careless work or apparatus that is temporarily faulty. By being careful and repeating the experiment several times these errors are easily detected and eliminated.

Systematic Errors

These result from an error in the equipment. They can be eliminated by careful calibration of the instrument.

Random Errors

These errors arise from random variations. They cannot be eliminated, but are reduced by repeating the experiment several times and averaging the results.

SIGNIFICANT FIGURES

All of your numeric answers in the examination must be calculated to the correct number of significant figures. Generally you will lose one mark once only on your paper if your answers are incorrect to more one significant figure. Whilst one mark may not seem especially large, it is easy to express answers correctly.

The following rules will allow you to determine the correct number of significant figures.

- A significant figure is either an integer or a zero that follows an integer. For example: 0.0100 has three significant figures; 100 has three significant figures; 0.001 has one significant figure; 1001.0 has five significant figures; 0.0040 has two significant figures.
- For addition and subtraction:

When determining the number of significant figures for your answer, use the smaller number of decimal places present in the values you used for the calculations.

Example: Use the Law of Conservation of Mass to calculate the mass of product formed when 1.00 g C_6H_{12} reacts completely with 0.0442 g H_2 gas.

Solution: 1.00 + 0.0442 = 1.0442 = 1.04 (2 decimal places)

- For multiplication and division:

When determining the number of significant figures for your answer, use the smallest number of significant figures present in the values you used for the calculation.

Example: How many mole of hydrogen gas is present in a 5000 litre container at a pressure of 101.325 kPa and a temperature of 300 °C?

Solution: Because the temperature is given to three significant figures, your answer can only be correct to three significant figures, despite the four for the volume and the six for the pressure.

STATES OF MATTER IN EQUATIONS

All reactants and products in equations should have their states correctly included. This means you must use the terms (aq), (g), (s) and (l) properly. You lose one mark once only on your paper for incorrect states in equations.

REVISION HINTS

YOUR REVISION PROGRAM

As part of your revision program, you should:

- Memorise all the key ideas including definitions, important equations, and details of instruments, industrial processes and cells.
- Go over the outcome statements in the Study Design.
- Go over questions you have done during the term from your text book. You should be able to do this quite quickly. There is no need to do them all again; just select typical examples of each type. Try working out the main steps in your head to save time. Particularly select the questions with which you previously had difficulty or needed someone to show you.
- Complete past VCAA exam papers. Because this is a relatively new course, the old papers (pre-2008) are not entirely relevant. However large sections are still appropriate and your teacher will be able to tell you what you can omit. The VCAA produced a Sample Exam for use in 2013 that is entirely relevant is 2.5 hours long. It is most important that you complete these papers for each Unit and check the answers that can be found on the CEA website.
- The Sample Exams can be found via the CEA website, under VCE Chemistry,
- All papers can be downloaded from the VCAA or **CEA websites:** **www.cea.asn.au** .
- The more past examinations you do, the better your marks will be. It is not necessary to do them as complete exams. As you revise topics, you can complete the appropriate questions, being careful to keep to the time suggested for each question. At other times you may decide that you need practice in doing multiple choice questions - 20 in 20 minutes is a good idea.
- Mark your exams carefully from the answers provided. If you were incorrect, look at the appropriate section in your notes to assist your memory. **Even if you are correct, it is important to read the correct answer fully, especially as it is written by the examiners. Whenever the examiners report states that this question was badly done, you can almost guarantee that the topic will be examined again in a very similar manner.**
- Make sure you speak to your teacher about the problems you are constantly finding.
- When you complete 2 or 3 papers, **read your notes completely** to remind yourself regularly of the details of the course. During the weeks before the exams in June and November, this should occur at least twice a week until the exam. You should have one complete set of notes. Amalgamate all revision notes, class notes and summaries.

YOUR REVISION TIMETABLE

You should make up a revision timetable. Work backwards from your examinations. Naturally you will revise for a specific exam the night before. Be careful to allocate equal time during the prior weekend to all subjects in which you have an exam. Work backwards through the weeks before the exams.

IN THE EXAM

During the reading time read the whole paper slowly and carefully. Do not flip back and forward. During the reading time you will slow down your pulse rate and allow your thoughts to begin to work in an ordered way. Take some deep breaths and consciously regain your full composure. By reading with understanding your mind will start to work on the problems. During this time you may also find material in one section of the paper that will assist you with a different question!

Decide whether you are doing the multiple-choice or structured questions first.

When completing the multiple choice questions do all questions. Do not leave any blank, even if you have to guess. Before you hand in your paper, double check that you have answered all questions. Be careful to write the correct answer in the correct box. In case you misalign your answers, circle the correct letter in the exam booklet, allowing a quick check if needed at the end.
In the extended answer section, do the question of which you are most certain first.
Check the time at the end of each question.

Reread each question when you finished it and check you have answered all parts, balanced all equations, and included all states and units.
If you complete your answer away from the expected section, clearly direct the marker to follow your working.
Set out your answers clearly, stating the formulae you intend to use, as this often earns marks.

e.g. $n(NaOH) = c \times V$

$pH = -\log_{10}[H_3O^+]$

FORMULAE

Formulae must be memorised because no information can be taken in to the examination in your calculator memory. Your calculator must not be programmable.

$n = m / M$	$n = \frac{\text{number of particles}}{N_A}$
$n = cV$	$pH = -\log_{10}[H_3O^+]$
$pV = nRT$	$[H_3O^+] = 10^{-pH}$
$n = V / V_m$	$[H_3O^+] \times [OH^-] = 10^{-14}$ at 25°C
$Q = I \times t$	$E = 4.184 \times m \times \Delta T$
$Q = n$(electrons) $\times F$	$E = V \times I \times t$
	C.F. $= (V \times I \times t) / \Delta T$
$A_r = \sum$ (relative isotopic mass x relative abundance) / $\sum$ total relative abundance	

n amount in moles
m mass in grams
M molar mass in grams per mole
N_A Avogadro's Number = 6.023×10^{23}
c concentration in moles per litre (M)
V volume in litres
P pressure in kilopascals (kPa)
T temperature in Kelvin
R general gas constant = 8.31 J K^{-1} mol^{-1}
V_m molar volume in litres at specified conditions; commonly used conditions are SLC (25°C, 1 atm) or STP (0°C,1 atm)
Q charge in Coulomb
I current in amps
t time in s
V voltage in volts
F Faraday = 96500 C.
S.H.C of water = 4.184 J $°C^{-1}$ g^{-1} – in the Data Book
C.F. calibration factor

VCAA KEY SKILLS for UNITS 1 - 4

Investigate and inquire scientifically

• work independently and collaboratively as required to develop and apply safe and responsible work practices when completing all practical investigations including the appropriate disposal of wastes;
• conduct investigations that include collecting, processing, recording and analysing qualitative and quantitative data; draw conclusions consistent with the question under investigation and the information collected; evaluate procedures and reliability of data;
• construct questions (and hypotheses); plan and/or design, and conduct investigations; identify and address possible sources of uncertainty;
• apply ethics of scientific research when conducting and reporting on investigations.

Apply chemical understandings

• make connections between concepts; process information; apply understandings to familiar and new contexts;
• use first and second-hand data and evidence to demonstrate how chemical concepts and theories have developed and been modified over time;
• analyse issues and implications relating to scientific and technological developments;
• analyse and evaluate the reliability of chemistry related information and opinions presented in the public domain.

Communicate chemical information and understandings

• interpret, explain and communicate chemical information and ideas accurately and effectively;
• use communication methods suitable for different audiences and purposes;
• use scientific language and conventions correctly, including chemical equations and units of measurement.

UNIT 3 VCAA STUDY DESIGN

Chemical pathways

AREA OF STUDY 1: Chemical analysis

Key knowledge

- volumetric analysis including determination of excess and limiting reagents and titration curves: simple and back titrations, acid-base and redox titrations
- gravimetric analysis
- calculations including amount of solids, liquids and gases; concentration; volume, pressure and temperature of gases
- the writing of balanced chemical equations, including the use of oxidation numbers to write redox
  equations, and the application of chemical equations to volumetric and gravimetric analyses
- principles and applications of chromatographic techniques (excluding features of instrumentation and operation), and interpretation of qualitative and quantitative data from:
  - thin layer chromatography (TLC), including calculation of Rf
  - high performance liquid chromatography (HPLC) and gas chromatography (GC) including Rt and the use of a calibration graph to determine amount of analyte
- principles and applications of spectroscopic techniques (excluding features of instrumentation and
  operation), and interpretation of qualitative and quantitative data from:
  - atomic absorption spectroscopy (AAS) including electron transitions and use of calibration graph to determine amount of analyte
  - infrared spectroscopy (IR) including use of characteristic absorption bands to identify bonds
  - proton and carbon-13 nuclear magnetic resonance spectroscopy (NMR) including spin, the application of carbon-13 to determine number of equivalent carbon environments; and application of proton NMR to determine structure: chemical shift, areas under peak and peak splitting patterns (excluding coupling constants), and application of n+1 rule to simple compounds
  - visible and ultraviolet spectroscopy (visible-UV) including electron transitions and use of calibration graph to determine amount of analyte
  - mass spectroscopy including determination of molecular ion peak and relative molecular mass, and identification of simple fragments
- matching analytical technique/s to a particular task: single and combined techniques.

AREA OF STUDY 2: Organic chemical pathways

Key knowledge

- structure including molecular, structural and semi-structural formulae, and International Union of Pure and Applied Chemistry (IUPAC) nomenclature of alkanes, alkenes, amines, haloalkanes, alkanols (C_nH_{2n+1OH}), alkanoic acids ($C_nH_{2n+1}COOH$) and esters up to C10
- common reactions of organic compounds including equations: addition reactions of alkenes (addition of hydrogen halides and water limited to symmetrical alkenes), substitution reactions of alkanes and primary haloalkanes, oxidation of primary alkanols, and esterification
- chemical bonding:
  - primary, secondary and tertiary structures of proteins
  - the role of the tertiary structure of proteins in enzyme action
  - denaturing of proteins: effect of changes in pH and temperature on bonding
  - primary and secondary structure of DNA
- organic reaction pathways including appropriate equations and reagents:
  - production of esters from alkenes
  - condensation reactions that produce lipids (limited to triglycerides)
  - condensation and polymerisation reactions that produce large biomolecules including carbohydrates, proteins and DNA
  - production of biochemical fuels including the fermentation of sugars to produce ethanol
  - function of organic molecules in the design and synthesis of medicines including the production of aspirin from salicylic acid.

Possible UNIT 3 TIMETABLE

Week	Concepts	Text Chapt	Questions from text	W/s in w/book	Pracs/Demos	SAC Dates & Details
			bold = essential			
Sem 1 Intro at end of Year 11	Overview of analytical techniques - titrations introduced in Year 11	3			p 38: Analysis of brick cleaner **or below in Year 12 week 1**	
Term 1 1	Overview of analytical techniques; stoich of s, l and g including gas stoich.; excess problems; gravimetric analysis;	1, 2	Ch 1: 1, 5 6 Ch 2: 5 - **8**, 9, 10, **16**, 17, 19, 20,**21**,**24**,31,34,**35**,**36,**41**,44, 46,48**		p 37: Analysis of brick cleaner	
2	Revise mole, stoich Conc. (M, %v/v, %m/v); volumetric analysis	1, 2 3	Ch 3: 1c,3,**4,5**, 6-8, 11c, **14,15**, 16, **17**, 18, **19, 20,**21,**23**,24,**25**	1 and 3 5		**p 48: Gravimetric determination of sulphate - eei**
3	Revise acid/base theory; pH; indicators; back titration; titrations curves	4	Ch 4: **5,6,7, 8,9,**10, **13,15**, 16, 18, **20,21, 22-**24,**25,26, 27,28**	2, 4	p 50: Back titration: N_2 in lawn feed	
4	Redox reactions; oxid. nos.; redox titrations; balancing redox eqs.	5	Ch 5: 1-5,**6,7, 10,11,**15,**18,**19, 22, **24,**25,26, **28**,**29,**31,33,**34**	6		**p 53: Determination of Fe(II) content of lawn fertiliser - eei**
5	Chromatography - TLC, GLC, HPLC; R_f & R_t; calibration; interpreting chromatograms;	6	Ch 6: 2 - 4,**8,10**, 14, 19, **20**, 21	8	TRAB p 45: theoretical exercise - Ethanol content of wine by gas chromatography	
6	Spectroscopy - o/view electromagnetic spectrum; flame tests; AAS, UV-vis; NMR; IR	7	Ch 7: **5,**7,9,10, **12**,14,**15**,17,**18,** 20,**23,**25,29, **32,33**, 38, **40**	7, 10, 12, 13	TRAB P 56: data analysis - Interpretation of nmr spectra of a no. of organic compounds	**p 55: Colorimetric determination of phosphorus content of lawn fertiliser**
7	Mass spectroscopy; interpreting spectrum	8	Ch 8: 1,4,**5,**7,8, 13,**16,18,20**	9, 11	TRAB p 58: data analysis - interpretation of mass spectra	**eei report under test conditions**
8	Bonding in hydrocarbons; homologous series; alkanes and alkenes; isomers and naming	9	Ch 9: 1-4, 8, 9, **11,12,**13,15,**16,18,**20,**22,**23,24	16	Incursion / excursion on instrumentation	
9	Functional groups; common organic reactions	9, 10	Ch 10: 2, 3, **4, 6-9,11,13-17,** 21,22,**23-27,**29,30,**33,34**	15, 21	p 93: Preparing artificial fragrances and flavours	
Holidays	**Area of Study Review;**		**p 124: all**			

(move as needed)	**exam revision of this area of study**		**questions; complete and revise all AoS 1**			
Term 2	Organic reaction pathways; synthesis of medicines e.g.	10, 14	Ch 14: **1,5**, 9,**13**	16 (Q1 and 2), 24		
10	aspirin; drug development					
11	Biochemical fuels	10, 11	Ch 10: 19,20, **31** Ch 11: 3, 11, 12, **13**	20	p 95: Reactions and properties of some organic compounds	
12	Biomolecules: Fats; carbohydrates; proteins	12	Ch 12: 1-**3**, **7**,**8**, 10, 29,	17	p 98: Modelling functional groups and organic reactions	
13	Proteins; enzymes; denaturation	12	Ch 12: 12,**13**,14, **16**,**17**,**21**,32,**33**,**34**,**41**,**43**,45,**46**	18, 19, 22		p 101: **Written report of a practical activity** - Prep of Aspirin
14	DNA function, structure bonding	13	Ch 13: 2,6,**7**,**17**, **18**	22, 23		
15	Complete all topics; Area of Study Review		**p 239: all questions**	14, 16 (Q3)		**Stimulus material** - DNA and protein
16	Revision of Unit 3					
17	Revision of Unit 3					
18	Mid-year internal exams					
Sem 2						
1 (19)	**Unit 4:** Chemical energy; exo and endothermic r/ns; ΔH; energy profile diagrams; manipulation of thermochemical equations; rates; catalysts; activation energy	15	Ch 15: 1,2,**4**,6,8, **9**,**10**,**12**,15,18,**20**	25, 26	p 138: Factors affecting rates of reaction Demos: TRAB p 94: Foam column TRAB p 128: Chemical Oven TRAB p 129: Endothermic reaction b/w 2 solids	
2 (20)	Equilibrium law; K; temp effect; Le Chatelier's principle; calculations	16	Ch 16: **3**,**5**,**6**,**7**, **8**,**9**,**10**,**11**,**12**,13-15,**17-21**,**23**,**25-32**,**36**,**37**	27, 30	TRAB p 96: Theoretical exercise - discovering the equilibrium law.	
Holidays	**Review Ch 15 and 16 carefully**		**Complete rate, e/brium quest; Complete AoS review p360: Q 1-12; 17-21**			

UNIT 4 VCAA STUDY DESIGN

Unit 4: Chemistry at work

AREA OF STUDY 1: Industrial chemistry

Key knowledge

- collision theory and factors that affect the rate of a reaction including temperature, pressure, concentration and use of catalysts, excluding: a formal treatment of the Maxwell-Boltzmann distribution, reaction mechanisms and rate laws
- energy profile diagrams and the use of ΔH notation including: activation energy; alternative reaction pathways for catalysed reactions; and deduction of ΔH for an overall reaction given energy profiles or ΔH of two related reactions
- equilibrium: representation of reversible and non-reversible reactions: homogeneous equilibria and the equilibrium law (equilibrium expressions restricted to use of concentrations), Le Chatelier's Principle and factors which affect the position of equilibrium
- pH as a measure of strength of acids and bases; Kw, Ka for weak acids
- application of equilibrium and rate principles to the industrial production of one of ammonia, sulfuric acid, nitric acid:
  - factors affecting the production of the selected chemical
  - waste management including generation, treatment and reduction
  - health and safety considerations
  - uses of the selected chemical.

AREA OF STUDY 2: Supplying and using energy

Key knowledge

- comparison of the renewability of energy sources including coal, petroleum, natural gas, nuclear fuels and biochemical fuels
- application of calorimetry to measure energy changes in chemical reactions in solution calorimetry and bomb calorimetry, including calibration of a calorimeter and the effects of heat loss
- use of the electrochemical series in predicting the products of redox reactions and deducing overall equations from redox half equations
- limitations of predictions made using the electrochemical series, including the determination of maximum cell voltage under standard conditions
- the chemical principles, half-equations and overall equations of simple primary and secondary galvanic cells
- the chemical principles, half-equations and overall equations of fuel cells; advantages and disadvantages of fuel cells compared to conventional energy sources
- the chemical principles, half-equations and overall equations of simple electrolytic cells; comparison of electrolytic cells using molten and aqueous electrolytes, and inert and non-inert electrodes
- application of Faraday's laws in electrochemistry.

Possible UNIT 4 TIMETABLE

Week	Concepts	Text Chapt	Questions from text	W/sheet in w/book	Pracs / Demos (reference in w/book)	SAC Dates & Details
Sem 2			**bold = essential**			
Term 3	Acid/base equilibria	16, 17	Ch 17: **1,2,3,5,**6, 7,**9,10,11,13, 14,15,16-22.**	28	p 141: Extent of hydrolysis of two acids	
3	introduction					
4	Kw; pH; pKa;	17		29	p 143: Determination of 2 acidity constants	P 146: **Written report of a practical activity**: Effect of changes in concentration on equilibrium
5	Chem. Indust; ; OH and S; Waste management; MSDS;	18	Ch 18: 9,13,15,**28, 32**	31, 34, 35	TRAB p 116 Demo - Carbon Pillar	
	Sulfuric acid production	21	Ch 21: **1,2,**5,**7,8, 9,13,**15,18 **p 360: Complete all questions in review of AoS 1**		TRAB p117: Properties of sulfuric acid TRAB p 114: Flowchart of Contact process (hi.com)	
6						P 145: Industrial production of sulphuric acid – **a report, response or an analysis**
7	Energy sources; energy converters and transfers; biochemical fuels	23, 24	Ch 23: 4,5,8,9,11 Ch 24: 8,12,14, 15, **18**	40		
8	Calorimetry; calculations; ΔH	25	Ch 25: 2,4,**5,6,**7, **10,11,**13,**21,22,24, 26,28, 33,34,**35,36		p 187: Calorimetry and enthalpy changes	
9	Galvanic cells; recharging; fuel cells; the electrochemical series and E°	26, 27	Ch 26: **1,4,**5,**6,**7, 8,**9,**10, 11,13, **14** Ch 27: 5, 12,**13, 14,19,21,**23	38, 39, 41	p 195: Fuel cells	
10	Electrolysis; electrolytic cells	28	Ch 28: **3-7,**8,9, **11**,12,**14,17,18,19, 20,23,**25,26,29,30,**3 1**, 33	42, 43, 44, **45**	Use Worksheet 45 (p179) as an exercise; TRAB p 147: Demo of Tin crystals by electrolysis	
11	Faraday's Laws; Complete review AoS 2	28	**p463: Complete all question in review of AoS 2**	46, 47	p 193: Determination of Faraday's constant and Avogadro's constant	
12						**p 195: Summary report:** Fuel cells, Half-cells and electrolysis
Holiday	**Complete revision of**		**Exam papers**			

move as needed	**Unit 4 including exam questions. Aim for 100 hours (20 hours per subject) during these holidays on revision of all subjects to be examined – this can seriously be achieved if your students are organised! They will still have the evening off and some relaxation periods.**					
Term 4						
13	Revision; Trial exam 1					
14	Revision; Trial exam 2					
15	Revision					

Examples of suitable exam questions from previous VCAA exams for the final exam in November
(Please note that these suggestions are not endorsed by the VCAA)

Relevant questions from old Unit 3 exams

2000	**Section A**	1 - 18, 20
	Section B	1, 2, 4, 5, 6
2001	**Section A**	1 - 4, 8 – 12, 16 - 22
	Section B	1- 5 (treat Q 3 as TLC)
2002	**Section A**	1 -15, 17,19, 20
	Section B	1b, 1c, 2 – 6, 7c
2003	**Section A**	1 – 10, 12 - 20
	Section B	1 - 7
2004	**Section A**	1 - 20
	Section B	1 – 4, 6
2005	**Section A**	1 – 20
	Section B	1 – 4, 6 -8
2006	**Section A**	2 - 20
	Section B	1 - 6
2007	**Section A**	1 – 8, 10 - 20
	Section B	1-3, 4a, 4b, 5c, 5d, 6, 7
2008	**Section A**	1 – 10, 12 - 19
	Section B	1 - 7
2009	**Section A**	1 - 18
	Section B	1 - 10
2010	**Section A**	1 - 20
	Section B	1 - 8
2011	**Section A**	all
	Section B	all
2012	**Section A**	All
	Section B	all

Relevant questions from old Unit 4 exams

2000	**Section A**	2, 3, 4, 5, 8 -12, 14, 15, 16
	Section B	1, 2, 4
2001	**Section A**	1, 2, 9, 10, 11, 13, 15
	Section B	1 – 4, 7
2002	**Section A**	7 – 9, 11, 13 – 15, 18, 19, 20
	Section B	3, 4b, 5b, 6
2003	**Section A**	1 -9, 17, 18, 19,
	Section B	1a, 1b, 2, 3, 4, 5, 6,
2004	**Section A**	2 – 9, 16 - 18
	Section B	3, 4, 5, 8a, 8b
2005	**Section A**	1, 2, 5 – 11
	Section B	2a, 2b, 3, 4, 5, 6b, 7, 8,
2006	**Section A**	2 – 8, 12, 14,15
	Section B	4, 5, 8, 9a-c
2007	**Section A**	4, 7, 11, 15, 16, 17, 18, 19
	Section B	4a-c, 5, 6, 7, 8
2008	**Section A**	all
	Section B	1 – 4, 6 - 9
2009	**Section A**	all
	Section B	1 – 6a, 6b, 7
2010	**Section A**	all
	Section B	1 – 4, 6 -8
2011	**Section A**	all
	Section B	2 - 8
2012	**Section A**	all
	Section B	1 – 4, 6 -8