Chemistry Conference 2016

Teaching Units 3 and 4 in 2017

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The following ideas about timetables and assessment have been developed during the writing of resources and books for the new Study Design. This is not an official VCAA document.
They will be on CEA website: www.cea.asn.au

Unit 3: How can chemical processes be designed to optimise efficiency?

Area of Study 1

What are the options for energy production?

Outcome 1

Compare fuels quantitatively with reference to combustion products and energy outputs, apply knowledge of the electrochemical series to design, construct and test galvanic cells, and evaluate energy resources based on energy efficiency, renewability and environmental impact.

Unit 3: How can chemical processes be designed to optimise efficiency?

Area of Study 2
How can the yield of a chemical product be optimised?

Outcome 2

Apply rate and equilibrium principles to predict how the rate and extent of reactions can be optimised, and explain how electrolysis is involved in the production of chemicals and in the recharging of batteries.

Possible Unit 3 AoS 1 Timetable

Week	Concepts	Text Ch	Minimum set text questions (+ Sept '16)	VCAA require about 3.5-5 hours for pracs and investigations testing outcomes. Possible practical work – maybe 4-5 class pracs plus demos Worksheets from Student Workbook (SW) *You tube* clips for interest and clarification	SAC Dates and details
Semester 1: Unit 3: How can chemical processes be designed to optimise efficiency? **Area of Study 1: What are the options for energy production?**					
1	Fuel choices • Types of fuels • Fossil fuels and biofuels Compared in terms of energy content, energy transformations and efficiencies, renewability and environmental impact.	1		SW Worksheets 1,2 You tube: biodiesel production (Discovery Channel) https://www.youtube.com/watch?v=GWWqSX3cE7o biodiesel vs petrol (BBC) https://www.youtube.com/watch?v=Zph5usgWkN0	**Outcome 1:** • **8% on total marks for the year** • **VCAA offers range of possibilities** • **Suggestions here are** ○ **A report of lab investigation (any listed – maybe the student investigation of half -equations.** ○ **or A comparison of two electricity-generating cells (The dry cell vs fuel cells or car battery vs fuel cells)**
2	• **Comparison of 2 transport fuels: petrodiesel and biodiesel** ○ **Structure and bonding important** ○ **Suitability in different climates**	1		SW Worksheets 5, 6	
3	• Exothermic and endothermic reactions • Energy profile diagrams	2		Demos: Endothermic reaction between two solids and Chemical oven	
4	Heat capacity and heat of combustion	2		Prac: Molar heats of solutions	
5	• Gases • The universal gas equation	3		SW Worksheets 3, 4 Prac: Molar volume of hydrogen Demo: Balloon in a flask and the expanding marshmallow	
6	• Calculations involving gases and combustion of fuels • Calculations involving energy changes	3		Demos: Products of combustion of a hydrocarbon Prac: Energy from different fuels (earlier(?) but requires knowledge of calculations; can use specific heat capacity or leave till end of Food and use calibrated calorimeter).	
7	Redox reactions • Revision Year 11 including definitions, balancing half-equations, oxidation nos • Galvanic cells and electrochemical series • **Comparison with test tube reaction where there is direct contact** • Secondary cells including recharging and **battery life**	4 5		SW Worksheets 7, 8, 9, 10 Prac: Half-cells and the electrochemical series Prac: Student design: Order of half-equations in the electrochemical series Prac: The dry cell Favourite demos: e.g. Thermite reaction ,breathalyser, some done in Year 11	
8	Fuel cells • Design features • Comparison with combustion and greenhouse production • **Storage of hydrogen** • **Comparison of fuel cells and galvanic cells**	6		SW Worksheets 11 Prac: Fuel cells Prac old 3rd Ed TRB: Car battery and fuel cells You tube: Fuel cells https://www.youtube.com/watch?v=LDwS31OE7akP Plus others on hydrogen economy	

Possible Unit 3 AoS 2 Timetable

Area of Study 2: How can the yield of a chemical product be optimised?					
9	Rates of chemical reactions • Rates of reaction • Collision theory • Catalysts	7		SW Worksheets 14, 15 Prac: Measuring the rate of reaction Prac: Factors affecting the rate of reaction Demo: Foam column + other favourites e.g. exploding can, catalytic oxidation of NH_3	
Term 1 holidays – adjust timetable as needed					
10	Equilibrium • Dynamic equilibrium • The equilibrium law – homogeneous systems only • Calculations involving equilibrium constants K_c **no** acid- base equilibrium or K_a; pH in Y11	8		SW Worksheets 16, 18, 19 Prac: Discovering the equilibrium law Prac: Effect of concentration changes on equilibrium yields Demo: Effect of changes in volume on equilibrium yields	**Outcome 2:** • **8% on total marks for the year** • **VCAA offers range of possibilities** • **Suggestions here are** ○ **Annotations of at least 2 practical activities e.g. rate or equilibrium** ○ **OR Response to a set of structured questions (test)**
11	Le Chatelier's Principle • Factors favouring yield • Conc-time graphs as a means of representation • **Competing equilibrium including CO/O_2**	8		SW Worksheets 17 Prac: Effect of temperature on equilibrium yields You tube: Carbon monoxide poisoning https://www.youtube.com/watch?v=wKIrbq2pWvw	
12	Electrolysis • Electrolytic cells • Use of electrochemical series to predict electrode reactions • Commercial electrolytic cells general operating principles – molten and aqueous electrolytes using different electrodes • Comparison with galvanic cells	9		SW Worksheets 20, 21 Demo: Electrolysis Prac: Electrolysis of aqueous solutions Demo: Tin crystals by electrolysis	
13	Faraday's Laws • Laws • Combination with stoichiometry to determine current, time, amount of products at electrodes.	9		SW Worksheets 22, 23 Prac: Faraday's first law of electrolysis Prac: Determination of Faraday's constant and Avogadro's number Exercise: Determining Faraday's first law using second-hand data Prac: Optimum conditions for electroplating	
14	Revision/Catch up				

Thoughts about teaching Unit 3

- This timetable allows for disruptions; a gentle introduction (slight rearrangement of the SD).
- More pracs provided than needed – provides you with choices. Some, plus others in the 4th Ed TRAB or 3rd Ed TRB, could be used as basis for SACs.
- Column called ***Minimum set questions …*** once Heinemann text is available in September, this column will be updated by adding suggested text book questions.
- Mostly **energy, rates and equilibrium** from the present course. Added extras increase the interest e.g. comparison of petrodiesel and biodiesel.
- **Gases** – this is the only time gases are taught. Only the universal gas equation is required; gases are taught here as most products of the combustion of fuels are gaseous. Little time to do the Gas Laws first, but maybe a practical exercise would develop all that is required to give the background.
- **Endothermic reactions and energy profile diagrams** – suggest this is taught with exothermic (although SD puts it in AoS 2 with Rates).

Thoughts about teaching Unit 3

- **Heat capacity** – introduced here and calorimetry taught as the last topic in Unit 4. Could stay with VCAA order as calorimetry will interrupt discussions at this stage, or doing it here means less connected with food which makes appropriate pracs easier.
- **Stoichiometry** – calculations are included here, students have done this topic in Year 11 and, as we have always done, really emphasise the mole, stoichiometry and limiting reactants in Year 11.
- **Redox reactions** – emphasise this well in Year 11 and jump almost straight into Galvanic cells. Consider teaching balancing complex half-equations and oxidation numbers in Y 11.
- **Galvanic cells** – Normal treatment of 1^o, 2^o and fuel cells, distinguishing between batteries and fuel cells. Suggest teach 2^o cells here rather than after electrolysis as in SD. Hydrogen storage – dig out your old CATs knowledge and update!

Unit 3 Assessment 16%

- Outcome 1: 8%
- Outcome 2: 8%

Unit 4: How are organic compounds categorized, analysed and used?

Area of Study 1

How can the diversity of carbon compounds be explained and categorised?

Outcome 1

Compare the general structures and reactions of the major organic families of compounds; deduce structures of organic compounds using instrumental analysis data and design reaction pathways for the synthesis of organic molecules.

Unit 4: How are organic compounds categorized, analysed and used?

Area of Study 2

What is the chemistry of food?

Outcome 2

Distinguish between the chemical structures of key food molecules, analyse the chemical reactions involved in the metabolism of the major components of food including the role of enzymes, and calculate the energy content of food using calorimetry.

Possible Unit 4 AoS 1 Timetable

Week	Concepts	Text Ch	Minimum set text questions (+ Sept '16)	VCAA require about 3.5-5 hours for pracs and investigations testing outcomes. Possible practical work – maybe 4-5 class pracs plus demos Worksheets from Student Workbook (SW) *You tube* clips for interest and clarification	SAC Dates and details
Semester 2: Unit 4: How are organic compounds categorised, analysed and used? Area of Study 1: How can the diversity of carbon compounds be explained and categorised?					
Semester 1 Week 16 Semester 2 Week 1	Structure and nomenclature of organic compounds (Revision Y11 – except stereoisomers) • Carbon compounds and structural isomers • **Stereoisomers: optical isomers and geometric isomers** • Types of hydrocarbons: alkanes (including cyclohexane), alkenes, **alkynes, benzene**	10		SW worksheets 24, 25, 26, Demo: Model building of enantiomers and cis-trans geometric isomers	
Semester 1 Week 17 Semester 2 Week 2	Functional groups: structures and naming (Revision Y11): • Alkanes (including cycloalkanes) • Alkenes, alkynes, benzene • haloalkanes, • primary amines • **primary amides** (no naming) • alcohols (primary, secondary, tertiary) • **aldehydes, ketones,** • carboxylic acids and • non-branched esters **(Note: Naming limited up to C8: noncyclic hydrocarbons, haloalkanes, 1°amines, alcohols (1°, 2°, 3°), carboxylic acids and non-branched esters. Up to 2 functional groups)**	10		SW Worksheets 27 Prac: Modelling functional groups and organic reactions You tube: Silver mirror test for aldehydes: RSC http://www.rsc.org/Education/EiC/issues/2007Jan/ExhibitionChemistry.asp Video https://www.youtube.com/watch?v=y-4qqcCxD6g	
Term 2 holidays – adjust timetable as needed					
Semester 1 Week 18 Semester 2 Week 3	Properties of organic compounds • Physical properties • trends of properties including boiling point, **viscosity and flashpoint with reference to structure and bonding** Reactions of alkenes, haloalkanes and alcohols • oxidation of 1° **and 2° alcohols** • substitution reactions of haloalkanes • addition reactions of alkenes	11		SW Worksheets 28, 29 Prac: Reactions and properties of some organic compounds You tube: Flashpoint testing (dangerous!) https://www.youtube.com/watch?v=w_nVhkvPEpI	

Possible Unit 4 AoS 1 Timetable

4	• hydrolysis of esters • **condensation reaction between carboxylic acid and amine to form amide** • condensation reaction between carboxylic acid and alcohol to form ester • Organic pathways: the pathways used to synthesise primary haloalkanes, primary alcohols, primary amines, carboxylic acids and esters • **Calculations of atom economy and percentage yield of single-step or overall pathway reactions.**	11		Prac: Oxidation of alcohols Demo: Making a condensation polymer to form the amide nylon Prac: Preparing artificial fragrances and flavours (could be done in Year 11 as well)	**Outcome 1:** • **8% on total marks for the year** • **VCAA offers range of possibilities** • **Suggestions here are** ○ **Annotations of at least two practical activities from a practical logbook (could use modelling and reactions ; different food pracs)** ○ **OR Response to a set of structural questions (test)**
5	Spectroscopy • The electromagnetic spectrum • IR Spectroscopy • NMR spectroscopy – introduction • Carbon 13 NMR	12		CEA Chemical detectives app Exercise: Data analysis of organic compounds by IR SW worksheets 30, 31 You tube: IR (RSC) https://www.youtube.com/watch?v=DDTIJgIh86E H-NMR (RSC) https://www.youtube.com/watch?v=uNM801B9Y84	
6	Spectroscopy • Proton NMR • Mass spectroscopy • Combined techniques	12		Exercise: Interpretation of NMR spectra of a number of organic compounds – data analysis Exercise: Interpretation of a number of mass spectra of organic compounds – data analysis SW worksheets 32 You tube: MS (RSC) https://www.youtube.com/watch?v=J-wao0O0_qM	
7	Chromatography (all revision Y11) • Principles revision • HPLC revision Volumetric analysis • Principles of volumetric analysis (Revision Y11)	13		SW Worksheets 33 Prac: Chromatography of a vegetable extract You tube: HPLC (RSC) https://www.youtube.com/watch?v=kz_egMtdnL4	
8	• Acid base titrations (Revision Y11) • Redox titrations	14		SW Worksheets 34 Prac: Analysis of aspirin tablets Prac: Analysis of ascorbic acid in vitamin C tablets Prac: Determination of the ethanoic acid concentration of vinegar	

Possible Unit 4 AoS 2 Timetable

Semester 2: Unit 4: How are organic compounds categorised, analysed and used? **Area of Study 2: What is the chemistry of food?**					
9	Food molecules • Proteins: formation, structure, essential amino acids • Carbohydrates: formation, structure, **storage of excess as glycogen, comparison of glucose, fructose, sucrose and aspartame** • Fats and oils: formation, structure, differences between sat and unsat fatty acids, **essential, omega labelling** • **Vitamins: essential, Vitamin C and D**	15		SW Worksheets 35, 36, 37, 38, 39 Prac: Modelling proteins, fats and fatty acids and carbohydrates Prac: Testing for proteins Prac: Breaking down the starch polymer Prac: Reactions of carbohydrates Prac: Tests for fatty acids and glycerol Prac: Measuring Vit C in foods Demo: Detection of unsaturated fats You tube: Fatty acids https://www.youtube.com/watch?v=UnZadq2kB0g	**Outcome 2:** • **8% on total marks for the year** • **VCAA offers range of possibilities** • **Suggestions here are** ○ **A report of lab investigation (any listed)**
10	Metabolism of food • Metabolism of food • Enzymes: models, acid base properties, enzyme activity, **difference between denaturation and hydrolysis** • Carbohydrates: digestion starch compared to **cellulose, lactose intolerance, GI ranking, hydrolysis of starches (amylose and amylopectin)** • Fats and oils: hydrolysis, **oxidative rancidity, antioxidants** • **Co-enzymes: action during catalysis**	16		SW Worksheets 41, 42, 43 Prac: Action of enzymes You tube: GI index (simple overview) https://www.youtube.com/watch?v=F1YDR2S7SPU Oxidative rancidity (includes ideas for prac investigation) https://www.youtube.com/watch?v=1jhMw7Y9DI0 Oxidative rancidity reactions (complex) https://www.youtube.com/watch?v=3REr9hDZ2b4 Coenzymes https://www.youtube.com/watch?v=flFtSU8E9zw	
11	The energy content of food • **Comparison of energy content of proteins, carbohydrates and fats/oils** • **Glucose as primary energy source and cellular respiration** • Calorimetry: solution and bomb, calibration, **analysis of temperature-time graphs from solution calorimetry**	17		SW Worksheets 40, 44 Prac: Calibration of a calorimeter Prac: Heat of solution of the dissolution of potassium nitrate Prac: Energy content of a biscuit/peanut SW Worksheets	
This following period for the Practical Investigation is moveable. Needs 7-10 hours so 2-3 weeks.					
12					
13					
14					
Term 3 holidays – move as needed – may contain Trial exams in some schools					
15	Revision				
16	Revision				**Trial exam**
17	Revision – leaving school - a messy week!				

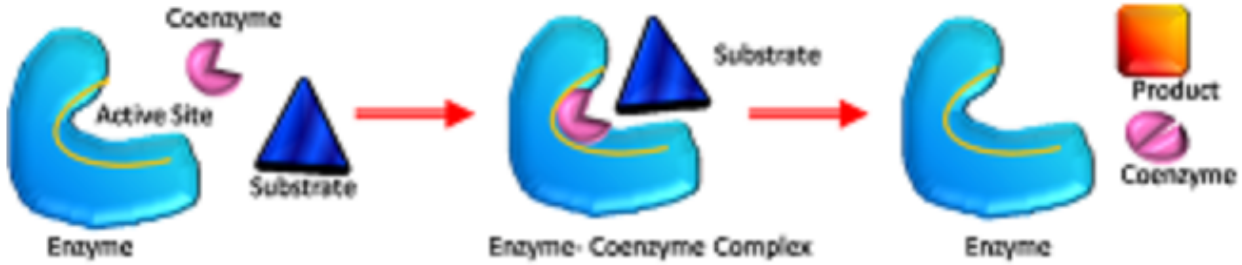
Thoughts about AoS 1 Unit 4

- **Modelling isomers and functional groups**. Teach as much about structure, structural isomers and naming of organic compounds in Year 11 – leave stereoisomers to Year 12; make models of optical isomers to see they are not superimposible.
- **Geometric isomers**: *cis* and *trans* – these are only meant to be simple; this is not the IUPAC way of distinguishing geometric isomers about a C=C double bond but it is commonly used for simple molecules.
- Remember to include **aldehydes and ketones** this year.
- **Bonding is revised** and needs to be emphasied in Year 11 so that properties of organic compounds are understood including viscosity.
- **Oxidation of alcohols**: important students understand the differences between 1^{o}, 2^{o} and 3^{o} alcohols.
- **Formation of an amide** – no naming needed just the reaction
- **Atom economy and percentage yield** (multi-step calculation as well). This links to Green Chemistry so could make reference in Year 11.

Thoughts about AoS 2 Unit 4

- Plenty of **new material** – interesting and not really difficult conceptually – relates to life; some of us have seen parts in years gone by!
- **Bonding and structure** used to explain differences: sugars, vitamins, amylose and amylopectin
- **Oxidative rancidity** – some uncertainty about the level of complexity needed. The VCAA has indicated equations for radical reactions are ***not*** needed. Something like:
  - Oxygen produces free radicals that are very reactive
  - Antioxidants, e.g Vitamin C slows the rate of oxidation by providing H atoms

- **Co-enzymes**: could be very difficult but probably not required. A diagram might be helpful -



- **Energy**: importance of glucose and cellular respiration; finish with calorimetry including temp-time graphs.

Unit 4 Assessment 24%

- Outcome 1: 8%
- Outcome 2: 8%
- Outcome 3: 8% Present as digital scientific poster

Unit 4: How are organic compounds categorized, analysed and used?

Area of Study 3

Practical investigation

Outcome 3

Design and undertake a practical investigation related to energy and/or food, and present methodologies, findings and conclusions in a scientific poster.

Possible Unit 4 AoS 3 Timetable

This following period for the Practical Investigation is moveable. Needs 7-10 hours so 2-3 weeks.					
Area of Study 3: Practical investigation could be done at end of Unit 3 or during or at the end of Unit 4.					
Semester 1 Week 15	**Practical investigation – if *Energy* is the topic** *(could be moved according to your program)*	18		SW Worksheets If choosing ***An aspect of energy***, the following pracs might provide ideas for investigation: Prac: Energy from different fuels Prac: Order of half-equations in the electrochemical I series Prac: Fuel cells Prac: Electrolysis of aqueous solutions Prac: Faraday's first law of electrolysis Prac: Determination of Faraday's constant and Avogadro's number Demo: Determining Faraday's first law of electrolysis using second-hand data Prac: Fermentation You tube: Measuring vitamin C in foods (RSC) https://www.youtube.com/watch?v=1P3W9DykGBg	
Semester 1 Week 16	Practical investigation	18			
Semester 1 Week 17	Complete poster (U4AoS3)				**Outcome 3: Present as digital scientific poster**
Area of Study 3: Practical investigation could be done at end of Unit 3 or during or at the end of Unit 4.					
Semester 2 Week 12	**Practical investigation – if *Food* is the topic** *(could be moved according to your program)*	18		SW Worksheets If choosing ***Aspects of Food*** the following pracs might provide ideas for investigation: Prac: Making protein models Prac: Testing for proteins Prac: Action of enzymes Prac: Breaking down the starch polymer Prac: Reactions of carbohydrates Prac: Tests for fatty acids and glycerol	
Semester 2 Week 13	**Practical investigation**	18			
Semester 2 Week 14	Complete poster (U4AoS3)	18			**Outcome 3: Present as digital scientific poster**

Concepts to teach in Year 11 investigations

Variables

- Independent
- Dependent
- Controlled

Validity

Reliability

Accuracy

Precision

Errors

Develop skills:

- using a log book
- producing a scientific poster

Possibly teach and emphasise in Year 11 for use in Year 12

- **Bonding and structure:** so students can see the consequences of different types of bonding
- **Redox**: balancing complex redox half-equations and oxidation numbers
- **Stoichiometry:** teach fully – even limiting reactant
- **Green Chemistry principles**: atom economy and % yield ideas
- **Organic**: all required functional groups, structural isomers and naming, maybe even some of the reaction types
- **Chromatography**: Y11 is almost the same as Y12
- **Specific terms and skills** for carrying out **investigations** and producing posters
- **Emphasise prac work** to develop skills and confidence.

Resources

- Text books – Pearson (Heinemann) and Jacaranda
- Pearson *Lightbook* – interactive digital key knowledge text and activities
- *Student workbook* containing essential knowledge, worksheets, suggested pracs
- *CEA Chemical detectives* – app to teach structural analysis using spectroscopy
- Youtube clips

Resources with text book

- Pracs with teachers guide sections and risk assessments, safety notes, etc
- Fully worked solutions to all questions in the print text book
- A planner/timetable with suggestions of how and when to teach the material in Years 11 and 12
- Sample exams and answers
- Area of Study review questions and answers
- Answers to the *Student Workbook* worksheets and notes about the pracs and development of SACs