MAPPING THE PFAs— CONQUERING CHEMISTRY HSC COURSE

Introduction to the PFAs

CHART SHOWING PRESCRIBED FOCUS AREAS IN DETAIL

PRESCRIBED FOCUS AREA (GENERAL)	HSC COURSE PFA —*A STUDENT:*	DETAILS OF THIS PRESCRIBED FOCUS AREA
1 the history of chemistry	H1. evaluates how major advances in scientific understanding and technology have changed the direction or nature of scientific thinking	• applies to the thinking and to the knowledge at that time in the past • should be addressed using terminology appropriate to the time • gives us an insight into the use of the Scientific Method in the past • allows us to gain an appreciation of the importance and significance of the work done in the past • gives us an insight into how general thinking in society has changed over time
2 the nature and practice of chemistry	H2. analyses the ways in which models, theories and laws in chemistry have been tested and validated	• is tentative, i.e. information is not fixed but in a state of flux • is empirical (based on the scientific method—research, experimentation, observation) • involves hypothesising, theories and models • may show bias (e.g. cultural, religious, gender specific) • shows how the constraints brought about by limitations in technology in the pursuit of further knowledge often lead to developments and advancements in that technology

PRESCRIBED FOCUS AREA (GENERAL)	HSC COURSE PFA —*A STUDENT:*	DETAILS OF THIS PRESCRIBED FOCUS AREA
3 applications and uses of chemistry	H3. assesses the impact of particular advances in chemistry on the development of technologies	• can be very contemporary, involving latest discoveries • may also have a strong historical emphasis • usually highlights the strong link between research and implementation, especially in fields such as health and genetics
4 implications of chemistry for society and the environment	H4. assesses the impacts of applications of chemistry on society and the environment	• has a strong overlap with the previous PFA • includes ethical considerations and contentious issues • requires a knowledge of chemistry sufficient to make predictions • may also require a good depth of general and background knowledge, i.e. wider reading
5 current issues, research and developments in chemistry	H5. describes possible future directions of chemical research	• is constantly changing, drawing on recent and current events in chemistry • requires reading of newspapers and popular science magazines, e.g. *New Scientist* • subscribing to local research organisations is beneficial • involves ethical and technical aspects of chemical issues

INTEGRATION OF THE PFAs USING CONQUERING CHEMISTRY (HSC COURSE)

Conquering Chemistry (4th ed) is easily able to integrate the PFAs into teaching objectives and outcomes. Throughout the text, sections of the syllabus lend themselves to particular PFAs and their associated backgrounds in Chemistry. The following table highlights the sections of the CC text which address particular identifiable PFAs. The notes suggest ways in which lessons or further research may assist students address these important syllabus objectives.

CONQUERING CHEMISTRY HSC (CHAPTER SECTION / PAGE NUMBERS)	PRESCRIBED FOCUS AREA (NUMBER AND DESCRIPTION)	NOTES AND DETAILS OF PFA INTEGRATION
MODULE 1: PRODUCTION OF MATERIALS 1.10 pp. 20–1	H4 assesses the impacts of applications of chemistry on society and the environment	**Polyethylene, PVC** and **polystyrene** have had a broad impact on our modern society. Their use has had an effect on the environment in terms of the use of valuable resources (oil), by the release of ozone-damaging chlorine (PVC) and landfill from plastic packaging and throw-away plastic bags and containers. Students could research topics such as recycling and the use of plastics in society.
1.11 p. 22	H5 describes possible future directions of chemical research	The use of **natural polymers** as replacements for oil-based polymers will be an on-going direction of chemical research in the next few decades. Students could research this topic and relate their findings to the latest chemical research.
1.15 p. 28	H5 describes possible future directions of chemical research	**Synthetic, biodegradable biopolymer** research will be an increasingly urgent direction in chemical research.
1.19 p. 34	H3 assesses the impact of particular advances in chemistry on the development of technologies	This topic lends itself to assessing the impact of **ethanol technologies** for using ethanol as a cleaner fuel in future applications. The production and use of ethanol as an alternative fuel can be researched, with emphasis on the chemical methods involved.
2.9 & 2.10 pp. 53–60	H4 assesses the impacts of applications of chemistry on society and the environment	The use of various **electrochemical cells**, commonly called batteries, has had an enormous impact on our society. The environmental concerns centre on the disposal of heavy metals used in these cells, namely lead and cadmium. Heavy metal pollution can be researched, and related to their use in electrochemical cells.
2.11 & 2.12 pp. 60–63	H5 describes possible future directions of chemical research	Future sources of power such as **fuel cells** and the **Gratzel cells** will be crucial to our society in future years. Further chemical research is being undertaken into these sources of electricity in order to make them smaller and more efficient. Much information is available about these cells on the Internet.

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3.7 p. 80 Also 3.12 pp. 86–8	H3 assesses the impact of particular advances in chemistry on the development of technologies	The discovery of **nuclear fission** led to its subsequent applications in the atomic bomb, nuclear power, nuclear medicine and other nuclear technologies. Students will find an overwhelming amount of information on these topics on the Internet and from Physics texts.
MODULE 2: THE ACIDIC ENVIRONMENT 4.9 pp. 121–3	H4 assesses the impacts of applications of chemistry on society and the environment	The presence of **atmospheric oxides** is having a considerable effect on the environment. The production of these oxides in chemical reactions largely during combustion needs to be understood so that the problem may be tackled effectively.
4.10 pp. 123–6 *Also* 4.11 p. 126	H5 describes possible future directions of chemical research	Considerable challenges in attempting to reduce, neutralise and capture **oxide emissions** will involve chemical research and chemical answers. 'Scrubbing' emissions from coal-fired power stations and 'clean coal' technology can be researched by students.
5.1, 5.2 & 5.3 pp. 146–50	H2 analyses the ways in which models, theories and laws in chemistry have been tested and validated, *also* H1 evaluates how major advances in scientific understanding and technology have changed the direction or nature of scientific thinking	The development of the **definition of an acid** is an example of developments in chemical understanding leading to different models and theories, being subjected to testing and subsequent modifications. Arrhenius, Lavoisier, Bronsted-Lowry and others show how the theory of acids has changed and evolved over time. The nature of scientific thinking regarding the **model of an acid** came about with the increased ability to make observations of acids and bases. pH meters are just one example of improved technology in this area.
MODULE 3: CHEMICAL MONITORING & MANAGEMENT 6.2 pp. 196–7	H3 assesses the impact of particular advances in chemistry on the development of technologies	**Gas chromatography**, developed as a result of advances in analytical chemistry, provides an example of a technological application in chemistry.
6.6 & 6.7 Pp. 200–4	H1 evaluates how major advances in scientific understanding and technology have changed the direction or nature of scientific thinking	**The Haber process** for the synthesis of ammonia provides us with a good opportunity to study the historical aspect of chemistry. The Haber process, while historically significant, involves considerable application of chemical concepts, including those of chemical equilibrium and of techniques to monitor the process.

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6.18 pp. 225–8	H3 assesses the impact of particular advances in chemistry on the development of technologies	The invention and use of **Atomic Absorption Spectroscopy** has made a great impact in the area of chemical monitoring. The need for a technology which enables the detection and measurement of cations at extremely low concentrations led to AAS, an Australian invention.
6.19 p. 230	H4 assesses the impacts of applications of chemistry on society and the environment	The use of **AAS** in the study of **trace elements** in living organisms as well as the physical environment has allowed a greater understanding of their roles and occurrences. Research into this invention and its uses would provide good background for this PFA.
7.5 pp. 239–41	H5 describes possible future directions of chemical research	The **minimisation of pollution** will continue to be a field for further chemical research as emission regulations are continually made stricter in response to the need for better air quality in our cities. Research into emission regulations, largely led by Europe, will provide detail on this topic.
7.9 pp. 247–9	H1 evaluates how major advances in scientific understanding and technology have changed the direction or nature of scientific thinking	The **depletion of ozone** in the stratosphere was caused largely by the lack of understanding of the chemistry of **haloalkanes**, particularly **chlorofluorocarbons**. With better understanding of the chemistry, the direction of scientific thinking led to the Montreal Protocol, banning the use of CFCs and the future restoration of the ozone layer. This is a well-documented phenomenon and provides a good example of this PFA.
7.13 pp. 257–8	H4 assesses the impacts of applications of chemistry on society and the environment	The use of chemistry to solve a chemically-induced problem (the **depletion of ozone in the stratosphere**) by developing alternatives to CFCs is a classic example of the application of chemistry and its impact on society and the environment.
8.5 pp. 268–70	H2 analyses the ways in which models, theories and laws in chemistry have been tested and validated	The questions and problems posed by **salinity** of soils and waterways provide an example of how chemical techniques have been applied and modified as our understanding of the nature of the problem has increased.
8.6 pp. 270–4	H4 assesses the impacts of applications of chemistry on society and the environment	**Dissolved oxygen and biological oxygen** demand measurements are used extensively in environmental studies and controls. This, along with similar measurement techniques, shows how applications of chemistry can have an impact on the environment. Students also studying Biology will have a particular interest in this area.

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8.13 & 8.14 pp. 289–94	H5 describes possible future directions of chemical research	It is possible for students, while studying these sections, to undertake further research into **water recycling and purification** techniques which may incorporate future developments.
OPTION 1: INDUSTRIAL CHEMISTRY 9.9 p. 331	H4 assesses the impacts of applications of chemistry on society and the environment	The wide-ranging uses of **sulfuric acid** for fertiliser and for the manufacturing of other materials have significant impacts on our society and on the environment when leaks or spills occur. Neutralisation of spills and other containment techniques can be researched.
10.4 p. 352 10.5,6&7 Pp. 352–7	H3 assesses the impact of particular advances in chemistry on the development of technologies	The commercial preparation of **sodium hydroxide** is also the source of chlorine, needed for PVC production. This topic lends itself to a study of the advances in chemistry and how technologies have interacted with these advancements.
10.6 pp. 354–6	H4 assesses the impacts of applications of chemistry on society and the environment	The implications for the environment caused by the use of **mercury** for chemical applications in the mercury cell as well as other sources like electrochemical cells (see CC sections 2.9 and 2.10), provides an opportunity for further research for this PFA.
10.7 pp. 356–7	H5 describes possible future directions of chemical research	The development of the **membrane cell** to overcome the problems associated with earlier cells (especially the mercury cell) relates well to this PFA. Students may use it as an example of future directions and a consequence of further research into the production of sodium chloride.
10.16 pp. 369–70	H4 assesses the impacts of applications of chemistry on society and the environment	The environmental effects of the use of **phosphates** and other substances found in household detergents provide students with a readily available opportunity to address this PFA in both aspects—society and the environment.
OPTION 2: SHIPWRECKS, CORROSION & CONSERVATION 11.3 pp. 398–401	H1 evaluates how major advances in scientific understanding and technology have changed the direction or nature of scientific thinking	The development of the understanding of **electron transfer** began with the work of Galvani and Volta. The CC text outlines this development through to present-day understanding. This topic integrates naturally with history of chemistry, and can be used by students to address PFA 1.

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	H2 analyses the ways in which models, theories and laws in chemistry have been tested and validated	The theories describing the nature of electricity have undergone several changes since **Galvani and Volta**. These changes show a development in the models chemists have had to explain electricity. The CC text traces these changes. Students could undertake further research into the work done by the scientists listed.
11.4 pp. 401–4	H3 assesses the impact of particular advances in chemistry on the development of technologies	The progression in **metallurgy**, applied specifically to shipbuilding, is outlined in the text. Further applications—e.g. aircraft—could be investigated.
12.6 pp. 420–1 12.7 pp. 421–3 12.8 pp. 423–4	H4 assesses the impacts of applications of chemistry on society and the environment	**Rust and corrosion** prevention is a multi-billion dollar industry. The application of chemistry to this problem is many faceted, as outlined in the text. Without this knowledge, our society would be severely restricted by the limitations placed on the use of metals due to corrosion. The CC text outlines the applications of chemistry used to prevent rust and corrosion, tying in well with this PFA.
OPTION 3: FORENSIC CHEMISTRY 13.2 pp. 458–9	H2 analyses the ways in which models, theories and laws in chemistry have been tested and validated	This section of the text does not relate directly to PFA H2 as much as it relates to the general nature of the PFA—the nature and practice of chemistry. **Accuracy, thoroughness** and **ethical considerations** are mentioned in the text. Further investigations into these areas of scientific behaviour could be undertaken.
13.5 pp. 461–2	H4 assesses the impacts of applications of chemistry on society and the environment	The testing of **soils** is a vital role played by chemical analysts. The wider application of the techniques to environmental chemistry and its importance in forensic chemistry can be investigated at this point.
14.6 p. 487	H2 analyses the ways in which models, theories and laws in chemistry have been tested and validated	The way in which the **structure of proteins** has been found, along with the role of the structure in the function of proteins, is an example of the development of scientific thinking and how this has been tested and validated using technology.

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14.7 pp. 488–9 14.8 pp. 489–91 14.9 pp. 491–2 14.10 pp. 492–5 14.11 p. 495	H3 assesses the impact of particular advances in chemistry on the development of technologies	The testing and identifying of **proteins** and **amino acids** by techniques including chromatography and electrophoresis shows how the advances in chemistry are tied closely to advances in technologies. These sections may also be usefully related to PFAs 4 and 5, in implications for society and future directions of research being undertaken in this field.
14.18 pp. 506–7	H5 describes possible future directions of chemical research	The use of **DNA data banks** along with the collection of DNA from the population are issues which relate to the future direction of chemical research and its implications.
15.2 pp. 512–4 15.3 pp. 514–6 15.4 pp. 516–8	H3 assesses the impact of particular advances in chemistry on the development of technologies	The sections of the text on **gas-liquid chromatography**, **high performance liquid chromatography** and **mass spectrometry** provide an opportunity to integrate this PFA into the lessons. Emphasis can be placed on how these advances in chemistry have led to technologies which have a major role in forensic chemistry.
15.12 pp. 526–8	H3 assesses the impact of particular advances in chemistry on the development of technologies	In a similar manner to the above sections, the application of chemical advances to the development of **atomic absorption spectroscopy** is a clear example of this PFA. Students may investigate the background to this Australian discovery.