

Chemical Monitoring and Management

1. Much of the work of chemists involves monitoring the reactants and products of reactions and managing reaction conditions.

1.1 Gather, process and present information from secondary sources about the work of practising scientists identifying:

- the variety of chemical occupations
- a specific chemical occupation for a more detailed study.

1.1.1 List at least four different chemical occupations and for each occupation give an example of the work that such a chemist would do.

.....

.....

.....

.....

.....

1.1.2 For the particular chemical occupation you studied in more detail, complete the following:

	Information gathered
Name of chemical occupation	
Industry in which this chemist is likely to be employed	
Role of this chemist	
Examples of work this chemist would undertake	

1.1.3

- (a) List the secondary sources you used in researching for this dot point, using the correct procedure for writing a bibliography.

.....

.....

.....

- (b) Assess the reliability of your secondary sources.

.....

.....

.....

1.1.4 Match up the following columns:

- | | |
|---------------------------|--|
| 1. Pharmaceutical chemist | (a) researches the chemical reactions in living things |
| 2. Analytical chemist | (b) monitors the manufacturing processes of chemicals |
| 3. Biochemist | (c) studies the chemistry of carbon compounds |
| 4. Industrial chemist | (d) researches and dispenses drugs for medicinal use |
| 5. Organic chemist | (e) develops new long chain molecules (polymers) such as plastics, synthetic fibres and adhesives |
| 6. Polymer chemist | (f) analyses concentrations of chemicals, e.g. in water, food, ores and manufactured products and develops purification techniques |

1.2 Outline the role of a chemist employed in a named industry or enterprise, identifying the branch of chemistry undertaken by the chemist and explaining a chemical principle that the chemist uses.

1.2.1 Research a practising Australian chemist. In the following table, summarise the name of the chemist, the industry or area in which this chemist works and the branch of chemistry in which he or she is involved.

	Research information obtained
Name of chemist	
Industry	
Branch of chemistry	

1.2.2

- (a) Outline the work of the chemist identified in Question 1.2.1, identifying a chemical principle that this chemist uses.

.....

.....

.....

.....

- (b) Explain how this principle is relevant to the work of the named chemist.

.....

.....

.....

1.3 Identify the need for collaboration between chemists as they collect and analyse data.

1.3.1 During the manufacture of chemicals, chemists who specialise in different areas are involved. For example, an industrial chemist, an analytical chemist and environmental chemists may all be involved in the commercial manufacture of a chemical.

Explain why it is necessary for these chemists to communicate and collaborate with each other.

.....

.....

.....

.....

.....

.....

.....

1.4 Describe an example of a chemical reaction such as combustion, where reactants form different products under different conditions and thus would need monitoring.

1.4.1 One of the main components of petrol is octane. Write equations to show the different products formed during complete and incomplete combustion of octane.

.....

.....

.....

1.4.2 Complete the table below to compare complete and incomplete combustion of fuels such as octane.

	Complete combustion	Incomplete combustion
Products formed		
Relative ratio of oxygen to fuel		
Relative amount of energy released		
Environmental effects		

1.4.3 Explain the necessity for monitoring the combustion of fuels.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

2. Chemical processes in industry require monitoring and management to maximise production.

2.1 Identify and describe the industrial uses of ammonia.

2.1.1

(a) Identify three industrial uses of ammonia.

.....

.....

.....

(b) For each of these uses, describe the way in which ammonia is used.

.....

.....

.....

.....

.....

.....

2.2 Identify that ammonia can be synthesised from its component gases, nitrogen and hydrogen.

2.2.1

(a) Construct an equation to show the synthesis of ammonia from hydrogen and nitrogen.

.....

(b) Identify the reactants in this reaction.

.....

2.2.2 Outline the source of the nitrogen and hydrogen used in the synthesis of ammonia..

.....

.....

.....

2.3 Describe that synthesis of ammonia occurs as a reversible reaction that will reach equilibrium.

2.3.1 Explain the meaning of the terms:

(a) reversible reaction

.....

(b) equilibrium

.....

.....

2.3.2 Relate these terms (reversible reaction and equilibrium) to the synthesis of ammonia from hydrogen and nitrogen.

.....

.....

.....

.....

2.3.3 Explain why the synthesis of ammonia has high activation energy.

.....

.....

.....

.....

2.4 Identify the reaction of hydrogen with nitrogen as exothermic.

2.4.1 Complete the following passage by crossing out the incorrect words.

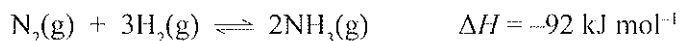
Overall, energy is released/absorbed in the reaction of hydrogen with nitrogen to form ammonia. There is more/less chemical energy in the product than in the reactants.

The energy needed to break the bonds in hydrogen and nitrogen is more/less than the energy given out when the new bonds in ammonia are formed.

The bonds in ammonia are stronger/weaker than the bonds in the reactants.

2.4.2

(a) The equation for the production of ammonia from nitrogen and hydrogen can be written as:



Outline the significance of the expression $\Delta H = -92 \text{ kJ mol}^{-1}$.

.....

.....

.....

(b) Sketch an energy profile diagram for the formation of ammonia, including labelling of enthalpy change and activation energy.

- (c) Explain how this diagram demonstrates an exothermic reaction.

.....

.....

.....

- 2.4.3** Predict whether the reverse reaction, $2\text{NH}_3(\text{g}) \rightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$ is exothermic or endothermic.

.....

2.5 Explain why the rate of reaction is increased by higher temperatures.

2.5.1

- (a) Explain why collisions between molecules are more frequent when temperatures of chemical reactions are increased.

.....

.....

- (b) Explain the relationship between rates of reactions and collisions between molecules.

.....

.....

- (c) Deduce the effect of increase in temperature on the rate of a reversible reaction at equilibrium.

.....

.....

2.6 Explain why the yield of product in the Haber process is reduced at higher temperatures using Le Châtelier's principle.

2.6.1 State Le Châtelier's principle.

.....

.....

2.6.2

- (a) Identify the effect of increasing the temperature on the equilibrium position of the Haber process.

.....

- (b) Explain the effect of increasing the temperature on the equilibrium position of the Haber process.

.....

.....

.....

.....

.....

2.7 Analyse the impact of increased pressure on the system involved in the Haber process.

- 2.7.1** Analyse the effect of increased pressure on the yield of ammonia from the Haber process.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

2.8 Explain why the Haber process is based on a delicate balancing act involving reaction energy, reaction rate and equilibrium.

- 2.8.1** With regard to the equilibrium reaction, $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$

explain the effect of low temperatures on the:

- (a) yield of ammonia

.....

.....

- (b) rate of formation of ammonia

.....

.....

- 2.8.2** A compromise temperature of about 450°C is used in the industrial manufacture of ammonia. Justify the use of this temperature.

.....

.....

.....

.....

.....

2.8.3 Explain how the effect of the relatively high temperature on the equilibrium is countered by the high pressure used (250-350 atmospheres).

.....

.....

.....

.....

2.8.4 Removing ammonia from the reaction vessel as it forms increases the yield as the reaction moves right to replace the ammonia removed (Le Châtelier's principle). However, the reactants and products are all gases. Suggest a way to separate ammonia from the other gases present in the reaction chamber.

.....

.....

2.9 **Gather and process information from secondary sources to describe the conditions under which Haber developed the industrial synthesis of ammonia and evaluate its significance at that time in world history.**

2.9.1 During this topic you researched the development of the industrial synthesis of ammonia by Fritz Haber and Carl Bosch. Outline the contribution of each scientist.

.....

.....

.....

.....

.....

.....

2.9.2 List the conditions used by Haber and Bosch to allow production of commercial quantities of ammonia.

.....

.....

.....

2.9.3 With reference to the history at that time, evaluate the significance of the Haber-Bosch process.

.....

.....

.....

.....

.....

.....

.....

.....

.....

2.10 Explain that the use of a catalyst will lower the reaction temperature required and identify the catalyst(s) used in the Haber process.

2.10.1

(a) Define catalyst.

.....

.....

(b) Explain the effect of a catalyst on a reaction.

.....

.....

(c) Identify the effect of a catalyst on an equilibrium reaction.

.....

.....

2.10.2 Sketch an energy profile for an exothermic reaction such as the Haber process demonstrating the effect of a catalyst on the profile.

2.10.3 Identify a catalyst used in the Haber process.

.....

2.10.4 Explain how the use of a catalyst in the Haber process lowers the reaction temperature required.

.....
.....
.....
.....
.....

2.11 Explain why monitoring of the reaction vessel used in the Haber process is crucial and discuss the monitoring required.

2.11.1 Complete the following cloze passage to explain the necessity to monitor the Haber process.

The formation of ammonia from and is a slow, reaction with the position of the equilibrium favouring the The conditions of the process must be carefully maintained in order to the reaction rate and encourage the reaction to proceed in the direction. Removal of the as it is formed, and the use of a high pressure and a catalyst ensure the yield of Hence monitoring of the reaction is crucial to ensure that these conditions for optimal yield are obtained.

2.11.2 Discuss the monitoring required for the Haber process.

.....
.....
.....
.....
.....

3. Manufactured products, including food, drugs and household chemicals, are analysed to determine or ensure their chemical composition.

3.1 Perform first-hand investigations to carry out a range of tests, including flame tests, to identify the following ions:

phosphate, sulfate, carbonate, chloride, barium, calcium, lead, copper, iron.

3.1.1 Use the following solubility rules to determine the solubility of the ionic compounds in the table below.

Solubility rules	
Compounds which are soluble	Compounds which are insoluble
all salts of Group I metals	all carbonates and phosphates except those of Group I and ammonium
all ammonium salts	all hydroxides except those of Group I and ammonium
all nitrates and acetates	
all chlorides, bromides and iodides except silver, lead and mercury	
all sulfates except lead, barium, mercury and strontium	
(calcium and silver sulfates are only slightly soluble)	

Compound	Solubility	Compound	Solubility
Sodium chloride		Magnesium phosphate	
Calcium hydroxide		Calcium sulfate	
Magnesium sulfate		Zinc carbonate	
Barium sulfate		Iron hydroxide	
Silver chloride		Silver phosphate	

3.1.2

(a) What are anions and cations?

.....

.....

- (b) Complete the following table to summarise the tests used to identify the listed anions and the positive result of each test. Include equations where appropriate.

Anion	Test used	Positive result and equation
Phosphate (PO_4^{3-})		
Sulfate (SO_4^{2-})		
Carbonate (CO_3^{2-})		
Chloride (Cl^-)		

- (c) Complete the following table to summarise the tests used to identify the listed cations and the positive result of each test. Include equations.

Cation	Test used	Positive result and equation
Barium (Ba^{2+})		
Calcium (Ca^{2+})		
Lead (Pb^{2+})		
Copper (Cu^+ or Cu^{2+})		
Iron (Fe^{2+})		
Iron (Fe^{3+})		

3.1.3

- (a) Describe how you carried out the flame tests, including a diagram and a risk assessment.

.....

.....

.....

.....

.....

.....

- (b) Outline the theoretical basis for the colour produced when the metal ions are heated in the flame.

.....

.....

.....

.....

- (c) Deduce why different metals produce different colours during flame tests.

.....

.....

- (d) Suggest a reason why a flame test was not used to identify lead.

.....

3.1.4 Flame tests are not used to identify anions.

- (a) Identify three types of chemical tests that are used to identify anions.

.....

.....

- (b) Identify two anions that could be distinguished by one of these tests and the property that allows this test to be used for this purpose.

.....

.....

.....

3.1.5 Discuss reasons why the chemical composition of foods, medicines and water should be constantly analysed.

.....

.....

.....

.....

.....

.....

.....

3.2 Gather, process and present information to describe and explain evidence for the need to monitor levels of one of the above ions in substances used in society.

3.2.1 Research one of the ions from Dot Point 3.1 and summarise the information into the following table:

	Summary of Information gathered
Identify the ion chosen	
Why the ion needs to be monitored	
How the ion is monitored	
Substances monitored for this ion	
Sources of the ion in these substances	
Incidents involving this metal	

3.2.2

- (a) Units commonly used to express concentrations of ions in solution are mg/L, $\mu\text{g/L}$, ppm and ppb. Explain the meaning of each of these symbols.

.....

.....

.....

.....

- (b) If the lead level in a sample of water was found to be $200 \mu\text{g/L}$, convert this measure to mg/L, ppm and ppb, showing working.

.....

.....

.....

.....

3.3 Deduce the ions present in a sample from the results of tests.

- 3.3.1** The following table shows the results of tests performed on a solution. Use these results to deduce the ions present in the solution.

Test	Result	Ions present
Add KI	Yellow precipitate	
Add OH^- ions dropwise	Deep blue precipitate that dissolves in excess hydroxide	
Spray into flame	Apple green colour	
Add AgNO_3	White precipitate that darkens on exposure to light	
Add dilute HCl	Gas produced that turns limewater milky	

- 3.3.2** Devise a flow chart to show a series of procedures that could be used to test a solution for the following cations: Pb^{2+} , Cu^{2+} , Ba^{2+} , Ca^{2+} , Fe^{2+} , Fe^{3+} .

3.3.3 Devise a flow chart to show a series of procedures that could be used to identify if the following anions are present in a solution: SO_4^{2-} , CO_3^{2-} , Cl^- , PO_4^{3-} .

3.3.4 A student has three colourless solutions in unlabelled beakers. The three solutions are sodium chloride, calcium chloride and sodium carbonate, but the student does not know which solution is in which beaker. Describe how the student could identify each solution.

.....

.....

.....

.....

.....

3.4 Identify data, plan, select equipment and perform first-hand investigations to measure the sulfate content of lawn fertiliser and explain the chemistry involved.

3.4.1

(a) Compare the terms 'qualitative analysis' and 'quantitative analysis'.

.....

.....

.....

(b) Describe an example of each type of analysis.

.....

.....

.....

.....

3.4.2

- (a) Describe the method you used to carry out an investigation to determine the sulfate content of lawn fertiliser. Use procedural text type.

- (b) For any chemical reaction in the procedure, write an equation and explain the chemistry.

3.4.3

The following experiment was carried out to find the sulfate content of a commercial lawn fertiliser:

A sample of the fertiliser was weighed and found to be 1.05 g.

This sample of the fertiliser was dissolved in acid.

Excess of a barium chloride solution was added to precipitate the sulfate as barium sulfate.

The mixture was filtered and the precipitate (barium sulfate) collected in the filter paper.

After collecting the precipitate, washing and drying it, the mass of barium sulfate was found to be 1.25 g.

- (a) Calculate the percentage of sulfate in the fertiliser. Show all working.

- (b) Write a conclusion for this experiment.

3.5 Analyse information to evaluate the reliability of the results of the above investigation and to propose solutions to problems encountered in the procedure.

3.5.1

- (a) Collect results for the percentage sulfate in the fertiliser analysed from the other groups in your class and collate them in the following table. Alternately, you may be able to repeat the experiment with your group.

Group	Sulfate content (%)

- (b) Analyse your results, using the following questions as a guide:

Were the results reproducible? How large was the range? What could differences be attributed to? What improvements could be made?

.....

.....

.....

.....

.....

.....

.....

.....

- (c) Evaluate the reliability of the results (include a judgement based on the evidence above).

.....

.....

.....

3.5.2 Analyse the method used in this experiment to identify problems encountered and propose possible solutions. Use the following table format. Samples have been completed to give you an idea.

Step in the procedure	Problems encountered, if any	Possible solutions	Validity of the step
Grind fertiliser powder and accurately weigh sample.	Can be accurately carried out with care.	Take care grinding and transferring chemical.	Valid procedure, if carried out carefully.
Dissolve fertiliser in acid.	Not all fertiliser dissolved. and since some sulfate compounds are insoluble it was difficult to decide if all sulfates had dissolved.	Add more acid, heat and allow time for dissolution. ($\text{SO}_4^{2-} + \text{H}^+ \rightarrow \text{HSO}_4^-$).	Valid step if carried out with extreme care. However, this is a possible source of error.

3.6 Describe the use of atomic absorption spectroscopy (AAS) in detecting concentrations of metal ions in solutions and assess its impact on scientific understanding of the effects of trace elements.

3.6.1 Compare the terms emission spectroscopy and absorption spectroscopy.

.....

.....

.....

.....

.....

.....

3.6.2

(a) Identify the Australian scientist who is credited with the invention of the technique called atomic absorption spectroscopy.

.....

(b) Outline the principle of atomic absorption spectroscopy (AAS).

.....

.....

.....

.....

(c) Describe how an atomic absorption spectrometer works, including a diagram in your answer.

.....

.....

.....

.....

.....

.....

.....

.....

3.6.3 Describe some uses of atomic absorption spectroscopy in different areas of science.

.....

.....

.....

.....

.....

3.6.4

(a) Define trace elements and identify some examples.

.....

.....

(b) Explain the importance of trace elements to living things.

.....

.....

.....

.....

.....

(c) Explain how atomic absorption spectroscopy led to an understanding of the role of trace elements in organisms.

.....

.....

.....

.....

.....

3.6.5 Assess the impact of atomic absorption spectroscopy (AAS) on our understanding of the effects of trace elements.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

3.7 **Gather, process and present information to interpret secondary data from AAS measurements and evaluate the effectiveness of this in pollution control.**

3.7.1

(a) Define the terms standard solution and absorbance.

.....

.....

.....

.....

(b) Relate these terms to the technique of AAS.

.....

.....

.....

3.7.2

(a) Explain the use of a calibration curve in quantitative analysis.

.....

.....

.....

.....

.....

.....

(b) Explain why this is an example of a quantitative technique.

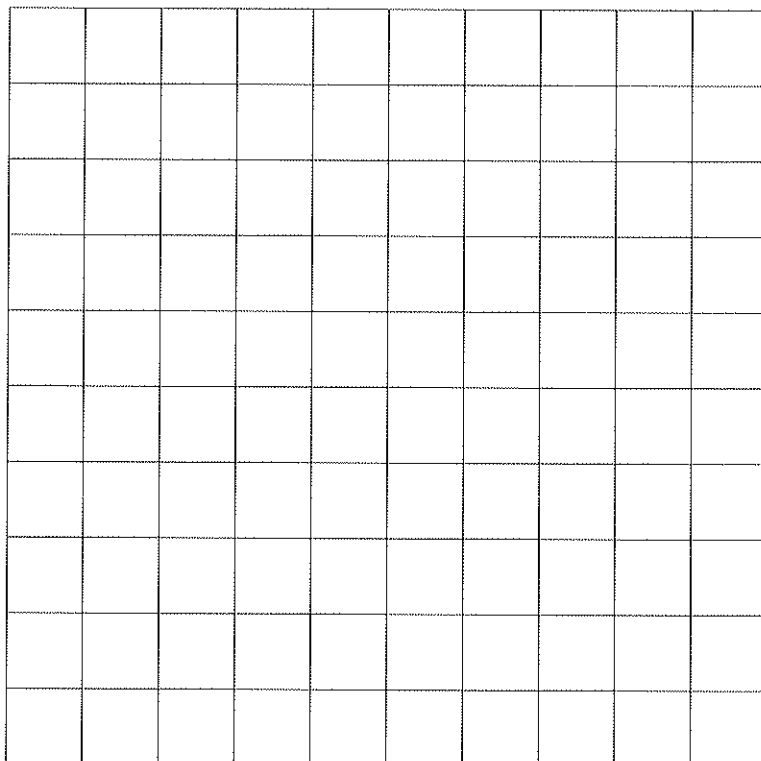
.....

.....

3.7.3

- (a) The following data was collected by using copper ion standards in an AAS with a wavelength setting of 327.4 nm. Construct a calibration curve on the grid provided using this data.

Concentration of copper ions in standard solutions (ppm)	Absorbance
0	0
1	0.15
2	0.25
4	0.50
6	0.68
8	0.84



- (b) Three samples of water from different locations in a river were analysed for the presence of copper pollution using atomic absorption spectrometry (AAS).

Using your calibration curve from part (a), determine the concentration of copper in ppm and in g/L in each of these samples if their absorbance readings were:

- (i) 0.30
- (ii) 0.15
- (iii) 0.51

- (c) State an hypothesis to account for the variation in copper levels in different areas of the river.

.....

.....

3.7.4

- (a) Identify possible sources of metal contamination in waterways, atmosphere and soil.

.....

.....

.....

- (b) Identify some organisations responsible for pollution control.

.....

.....

.....

3.7.5 Evaluate the effectiveness of atomic absorption spectroscopy (AAS) in pollution control.

.....

.....

.....

.....

.....

.....

4. Human activity has caused changes in the composition and the structure of the atmosphere. Chemists monitor these changes so that further damage can be limited.

4.1 Describe the composition and layered structure of the atmosphere.

4.1.1 Complete the following table to summarise information about the layers of the atmosphere.

Name of layer	Minimum and maximum distance from the surface of the Earth (km)	Composition	Temperature
Troposphere	0 – approximately 15		Variable. This is the layer where weather is determined.
Stratosphere			
Ionosphere (made up of two layers called the and)		Ions and atomic particles	

4.1.2 Discuss the relative mass of atmospheric gases through the layers of the atmosphere.

.....

.....

4.2 Identify the main pollutants found in the lower atmosphere and their sources.

4.2.1 Identify three chemicals that commonly occur as pollutants in the lower atmosphere and identify a harmful effect for each of these pollutants.

.....

.....

.....

.....

4.2.2 Complete the following table to summarise the main pollutants in the troposphere and both the artificial and natural sources of each pollutant.

Pollution	Sources – artificial	Sources – natural
Nitrogen oxides (NO_x , e.g. NO , NO_2)		
Volatile organic compounds, e.g. hydrocarbons		
Carbon monoxide (CO)		
Carbon dioxide (CO_2)		
Sulfur dioxide (SO_2)		
Particles		
Lead		

4.3 Describe ozone as a molecule able to act both as an upper atmosphere UV radiation shield and a lower atmosphere pollutant.

4.3.1

(a) Outline the sources of ozone in the stratosphere and troposphere.

.....

.....

.....

.....

(b) Outline the distribution of ozone in the atmosphere.

.....

.....

.....

(c) Discuss the problems associated with ozone in the lower atmosphere.

.....

.....

.....

4.3.2

- (a) Discuss the effects of ultraviolet radiation on humans.

.....

.....

.....

.....

.....

- (b) Outline why this issue is of particular importance in Australia.

.....

.....

- (c) Discuss the importance of UV absorption by ozone in the stratosphere.

.....

.....

.....

.....

.....

.....

4.4 Describe the formation of a coordinate covalent bond.

4.4.1

- (a) Recall the meaning of the term covalent bond.

.....

.....

- (b) Outline the formation of a coordinate covalent bond.

.....

.....

- (c) Compare the formation of normal covalent bonds and coordinate covalent bonds.

.....

.....

.....

4.4.2 Describe the formation of the ammonium ion from ammonia and a hydrogen ion. Include a diagram in your answer.

.....

.....

.....

4.5 Demonstrate the formation of coordinate covalent bonds using Lewis electron dot structures.

4.5.1 Draw diagrams showing the formation of coordinate covalent bonds in the following substances, using Lewis dot structures. Distinguish the coordinate bond from other covalent bonds by use of an arrow.

(a) carbon monoxide

(b) hydronium ion

(c) ozone

4.6 Compare the properties of the oxygen allotropes O_2 and O_3 and account for them on the basis of molecular structure and bonding.

4.6.1 Define the term allotrope and identify an example.

.....

.....

.....

4.6.2 Justify the classification of O_2 and O_3 as allotropes.

.....

.....

.....

.....

4.6.3 Complete the following table to compare the properties of oxygen gas and ozone.

Property	O_2 (oxygen gas)	O_3 (ozone)
State and colour		Pale blue gas
Odour	Odourless	
Reactivity		
Effect on humans	Essential for life	
Melting point and boiling point	M.P. B.P.	M.P. B.P.
Structure and bonding		Three oxygen atoms held together with 1 double covalent bond and 1 single coordinate covalent bond.
Shape	Molecule is linear shape	

4.6.4 Account for these different properties in terms of structure and bonding.

.....

.....

.....

.....

.....

.....

.....

.....

4.7 Compare the properties of the gaseous forms of oxygen and the oxygen free radical.

4.7.1

- (a) Define free radical.

.....

.....

- (b) Draw the electron dot structure for the oxygen free radical.

4.7.2 Identify and explain the properties of the oxygen free radical.

.....

.....

.....

.....

4.7.3 Compare the properties of the oxygen free radical with those of O_2 and O_3 .

.....

.....

.....

.....

4.8 Identify and name examples of isomers (excluding geometrical and optical) of haloalkanes up to eight carbon atoms.

4.8.1

- (a) Recall the names of the straight chain alkanes from C1 to C8.

.....

.....

- (b) Recall the names of the elements in the halogen group.

.....

.....

- (c) Explain the term haloalkane.

.....

.....

- (d) List the prefixes for the halogens that are used in naming haloalkanes.

.....

.....

4.8.2 Devise a set of rules for naming haloalkanes.

.....

.....

.....

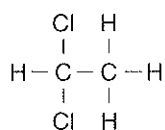
.....

.....

4.8.3

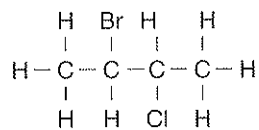
- (a) Name the following compounds:

(i)



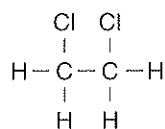
.....

(ii)



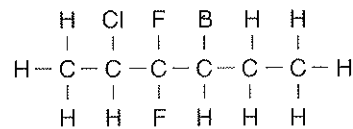
.....

(iii)



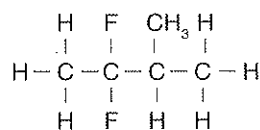
.....

(iv)



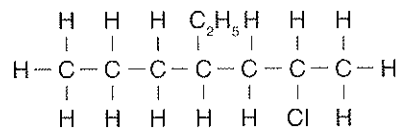
.....

(v)



.....

(vi)



.....

(b) Draw structural formulas for the following chemicals:

(i) 1,2-dichloro-1,2-difluoroethane

(ii) 1,2-dibromo-1,2,3-trifluoropropane

(iii) dichloro-difluoromethane

(vi) 1,2-dichloro-1,1-difluoropentane

(v) 1,3-dibromo-1,2,2-trifluoropropane

(vi) 1,1-dichloro-4,4-difluoro-2-methylbutane

4.8.4 Identify any isomers amongst the haloalkanes in Question 4.8.3. Explain why they are called isomers.

.....

.....

.....

.....

4.9 Gather, process and present information from secondary sources including simulations, molecular model kits or pictorial representations to model isomers of haloalkanes.

4.9.1 Describe how you modelled isomers of haloalkanes, identifying the isomers within your structures.

.....

.....

.....

.....

4.9.2 Draw and name all possible straight chain isomers for C_3H_6BrCl .

4.10 Identify the origins of chlorofluorocarbons (CFCs) and halons in the atmosphere.

4.10.1

(a) Define chlorofluorocarbons (CFCs) and name some examples.

.....

.....

.....

(b) Define halons and name two examples.

.....

.....

4.10.2 Identify the origins of CFCs and halons in the atmosphere.

.....

.....

.....

.....

4.10.3 Outline the uses of CFCs and halons and relate these uses to their properties.

.....

.....

.....

.....

4.10.4

(a) Draw structural formulas for the following CFCs and halons.

(i) trichlorofluoromethane

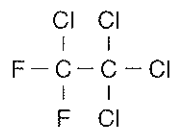
(ii) dichlorodifluoromethane

(iii) bromotrifluoromethane

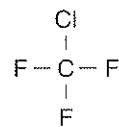
(iv) 1,1,2-trichloro-1,2,2-trifluoroethane

(b) Name the following compounds

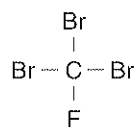
(i)



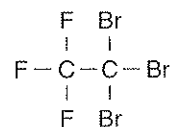
(ii)



(iii)



(iv)



4.11 Analyse the information available that indicates changes in atmospheric ozone concentrations, describe the changes observed and explain how this information was obtained.

4.11.1 Describe the natural cycle of ozone formation and decomposition.

.....

.....

.....

.....

.....

.....

4.11.2 Discuss the methods used by meteorological and research organisations to monitor ozone levels.

.....

.....

.....

.....

4.11.3

(a) Outline reasons why we monitor ozone levels.

.....

.....

.....

.....

(b) Describe the changes that have been observed in ozone levels since monitoring has been undertaken.

.....

.....

.....

.....

(c) Analyse the information obtained about ozone levels.

.....

.....

.....

.....

.....

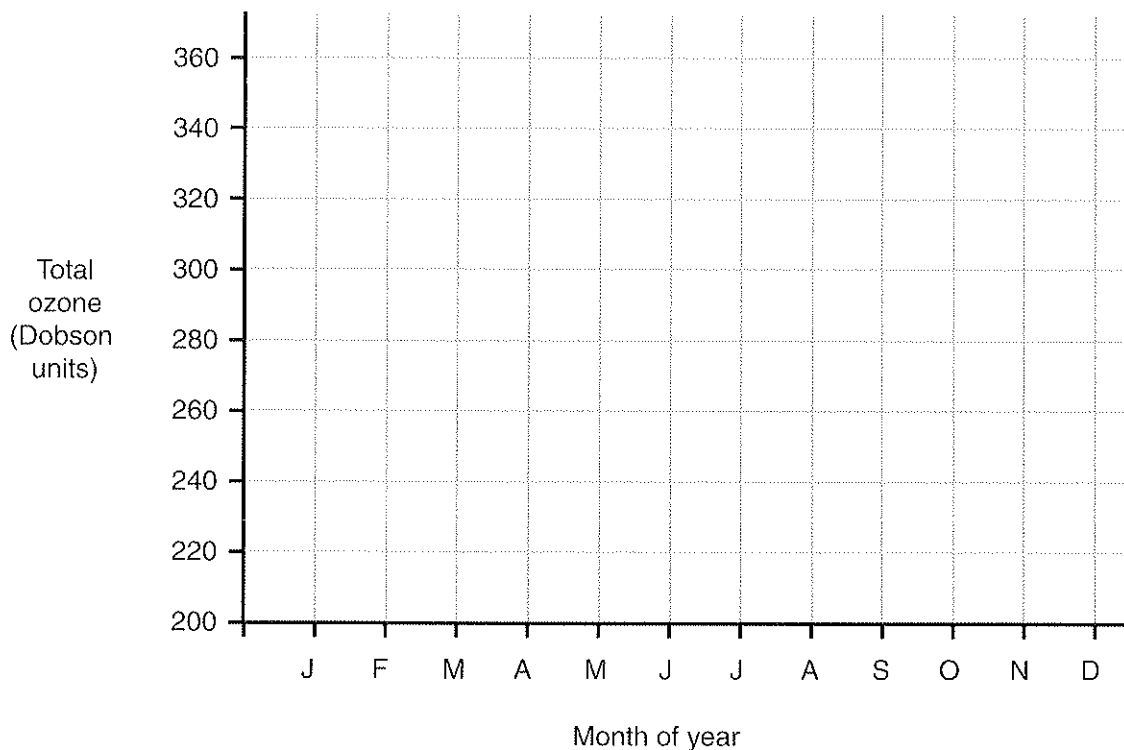
.....

- 4.11.4** The table below gives the total ozone levels, in Dobson units, above Sydney Harbour Bridge over a period of two years. The figures are for the first day of each month during 2004 and 2005. They were recorded by the TOMS spectrometer.

Total ozone over the Harbour Bridge (Dobson units):

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2004	283	299	277	251	260	236	276	307	322	331	302	280
2005	265	259	254	247	285	297	301	282	339	353	301	298

- (a) Graph these figures on the grid below.



- (b) Outline two similarities between the two graphs.

.....

.....

- (c) Draw a conclusion based on these values.

.....

.....

4.12 Present information from secondary sources to write the equations to show the reactions involving CFCs and ozone to demonstrate the removal of ozone from the atmosphere.

4.12.1 Identify some reliable sources of information you used to research measurement of ozone levels.

.....

.....

4.12.2 Use equations to show the:

(a) effect of ultraviolet light on CFCs in the stratosphere

.....

.....

(b) effect of the free chlorine radical (Cl) on ozone

.....

.....

(c) fate of the chlorine oxide radical

.....

.....

4.12.3 Describe the net result of the reactions in Question 4.12.2.

.....

.....

4.12.4 Explain why a small amount of CFC can break down thousands of ozone molecules.

.....

.....

.....

.....

4.13 Discuss the problems associated with the use of CFCs and assess the effectiveness of steps taken to alleviate these problems.

4.13.1 The use of CFCs for such things as refrigerants, aerosol propellants, solvents and foam-blowing agents led to the release of thousands of tonnes of these chemicals into the atmosphere. Discuss the problems caused.

.....

.....

.....

.....

.....

.....

4.13.2

(a) Outline the steps taken since the mid-1980s to address the problem.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Assess the effectiveness of these steps.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

4.14 Present information from secondary sources to identify alternative chemicals used to replace CFCs and evaluate the effectiveness of their use as a replacement for CFCs.

4.14.1 Identify the types of chemicals now used to replace CFCs as refrigerants, giving examples.

.....

.....

.....

.....

.....

4.14.2 Evaluate their effectiveness as replacement chemicals.

[illegible]

4.14.3 Discuss the problems associated with the use of CFCs and assess the effectiveness of steps taken to alleviate these problems.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins or other markings on the paper.

5. Human activity also impacts on waterways. Chemical monitoring and management assists in providing safe water for human use and to protect the habitats of other organisms.

5.1 Identify factors that affect the concentrations of a range of ions in solution in natural bodies of water such as rivers and oceans.

5.1.1 Identify the ions commonly found in natural ground water and surface water such as rivers and oceans.

.....

.....

5.1.2 Outline the factors affecting the ions found in:

(a) rivers and surface water

.....

.....

.....

.....

(b) oceans

.....

.....

.....

5.1.3

(a) Define hard water.

.....

.....

(b) List the ions that cause hardness in water.

.....

.....

(c) Outline problems associated with use of hard water.

.....

.....

.....

5.1.4 Identify some factors that determine the pH of surface water and ground water.

.....

.....

.....

.....

5.1.5

(a) What is meant by the turbidity of water?

.....

(b) Suggest factors that increase turbidity of water.

.....

.....

.....

.....

.....

5.2 Identify that water quality can be determined by considering:
**concentrations of common ions, total dissolved solids, hardness,
turbidity, acidity, dissolved oxygen and biochemical oxygen demand.**

5.2.1 Define and explain the significance of:

(a) dissolved oxygen (DO)

.....

.....

.....

.....

(b) biochemical oxygen demand (BOD)

.....

.....

.....

.....

5.2.2

- (a) Identify ions whose presence would indicate pollution of water with sewage and agricultural run-off.

.....

.....

- (b) Explain the significance of the N:P ratio.

.....

.....

.....

.....

5.2.3 Describe the effect of air pollution, with sulfur and nitrogen oxides, on ions in waterways.

.....

.....

5.2.4 Describe the effect of increased salinity, due to irrigation and land clearing, on waterways.

.....

.....

.....

.....

5.2.5 Complete the table to summarise how each of the following tests can be used to assess water quality.

Test for	Effect on water quality
Concentration of common ions	
Total dissolved solids (TDS)	
Hardness	
Turbidity	
pH	
DO and BOD	

5.3 Perform first-hand investigations to use qualitative and quantitative tests to analyse and compare the quality of water samples.

5.3.1 Complete the following table to summarise the methods you used to analyse water samples.

Test for	Method used	Qualitative or quantitative test?
Common ions		
Insoluble solids		
TDS		
Hardness		
Turbidity		
Acidity		
DO		
BOD		
Phosphate		

5.3.2 Describe the results and draw a conclusion about the quality of one of the water samples you analysed.

.....

.....

.....

.....

.....

- 5.3.3** A group of Year 12 students tested a water sample to find the concentration of undissolved solids present. The method they used was as follows.

Measure 800 mL of Sample A.

Weigh a filter paper.

Filter the 800 mL sample of water through the filter paper.

Dry the filter paper.

Reweigh.

Repeat the drying and reweighing process until a constant weight is obtained.

The results they obtained are shown in the following table.

	Result (g)
Weight of dry filter paper	0.85
Filter paper + solid – Weight 1	5.99
Filter paper + solid – Weight 2	3.62
Filter paper + solid – Weight 3	3.54
Filter paper + solid – Weight 4	3.54

- (a) Calculate the concentration in g L^{-1} of the undissolved solids in their water sample.
Show all working.

.....

.....

.....

- (b) Explain why the students repeatedly heated and reweighed the filter paper and contents.

.....

.....

.....

- 5.3.4** Another group of students tested a sample of water to find the total dissolved solids present.

To do this they filtered a sample of the water, measured some of it into a clean, dry evaporating basin, heated until all the water had evaporated and weighed the basin. They obtained the following results:

Procedure	Result
Volume of water after filtering	90 mL
Weight of evaporating basin	289.4 g
Weight of basin plus water	364.4 g
Weight of basin after evaporation	291.6 g

Calculate the concentration of the total dissolved solids in their water sample in g L^{-1} .

.....

.....

.....

.....

5.4 Gather, process and present information on the range and chemistry of the tests used to:

- **identify heavy metal pollution of water**
- **monitor possible eutrophication of waterways.**

5.4.1

- (a) List three toxic heavy metals.

.....

- (b) For one of the heavy metals listed, outline its harmful effects on the human body or the environment.

.....

.....

.....

.....

- (c) Two characteristics of heavy metal pollution that present problems are bioaccumulation and biomagnification. Outline the meaning of these terms.

.....

.....

.....

.....

5.4.2

- (a) Define eutrophication.

.....

.....

- (b) Describe the steps in eutrophication of a waterway.

.....

.....

.....

.....

.....

.....

- (c) Outline the cause of eutrophication.

.....

.....

5.4.3 During this topic you researched the tests used to identify heavy metal pollution of water. Use the following table to summarise your research findings.

Methods used to test for heavy metals	Chemistry

5.4.4 During this topic you researched the tests used to monitor possible eutrophication of water. Use the following table to summarise your research findings.

Methods used to test for eutrophication	Chemistry

- 5.4.5** A river sources in some high mountains, then flows across a plain through farmlands. After meandering for some distance, the river divides, one tributary (A) flowing through a town and industrial area before reaching the sea. The second tributary (B) flows through a forest before reaching the sea.

Describe the differences likely to be observed in the water at each river delta, account for these differences and outline how the differences could be verified.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

5.5 Gather, process and present information on the features of the local town water supply in terms of:

- **catchment area**
- **possible sources of contamination in this catchment**
- **chemical tests available to determine levels and types of contaminants**
- **physical and chemical processes used to purify water**
- **chemical additives in the water and the reasons for the presence of these additives.**

5.5.1

- (a) Define the term catchment area.

.....

.....

- (b) Describe your local catchment area.

.....

.....

.....

.....

5.5.2 Identify some activities that are permitted in a catchment area and some that are not permitted.

.....

.....

.....

.....

5.5.3 Identify possible sources of water contamination in your local catchment area.

.....

.....

.....

.....

5.5.4 Complete the following table to show the chemical tests available for monitoring water contaminants and the contaminants each test will detect.

Test for contaminants	Contaminants detected by this test
AAS	
Flame test	
Precipitation reaction tests	
Add acid and test for carbon dioxide produced	
Gravimetric analysis	
Electrical conductivity	
Turbidity	
Acidity	
DO	
BOD	
Colorimetric tests for nitrogen and phosphorus content and N:P ratio	

5.5.5 Identify organisms whose presence would indicate water contamination.

.....

.....

.....

.....

5.5.6

- (a) Complete the following table to explain the addition of the listed chemicals during the water purification process.

Chemical additive	Reason for adding chemical
Iron(III) chloride or aluminium hydroxide and a cationic polymer	
Sulfuric acid	
Limewater or other alkali	
Fluoride	
Chlorine	

- (b) Identify two physical processes used in water purification.

.....

.....

5.6 Describe and assess the effectiveness of methods used to purify and sanitise mass water supplies.

5.6.1 Describe the methods used to purify and sanitise our water supplies.

.....

.....

.....

.....

.....

.....

.....

.....

5.6.2 Assess the effectiveness of these methods.

.....

.....

.....

.....

.....

.....

5.7 Describe the design and composition of microscopic membrane filters and explain how they purify contaminated water.

5.7.1 Explain the need to use recycled water or treated sewage or desalinate sea water in Australia.

.....

.....

.....

.....

5.7.2

(a) Describe the composition of membrane filters.

.....

.....

.....

(b) Explain how membrane filtration works.

.....

.....

.....

.....

.....

.....

(c) Distinguish between the terms microfiltration, ultrafiltration and nanofiltration.

.....

.....

.....

.....

.....

.....

5.7.3 Outline the advantages and disadvantages of including a membrane filtration step in water purification.

5.7.4 Society can impact on developments in science resulting in new technologies. Discuss this statement in relation to water treatment.

Notes

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.