Stage 6 Chemistry - Acids, bases and equilibrium

Drinking Water Depth Study program

Sydney WATER

Depth Study inquiry question - "How does the application of chemistry (acid/base and equilibrium) in an industrial setting (Sydney Water) treat drinking water for the protection of public health?"

Sydney Water Depth Study program is designed to complement our free excursion program. Our excursion program includes:

- full syllabus links (reference to module content points, working scientifically outcomes and skills, ideas for practical first-hand investigations, secondary sources investigations, creating fieldwork report/presentation and data analysis)
- (Optional) Delivery of an excursion by a Sydney Water Education Officer.
- Sydney Water website links to content pages, experiments and resources (PowerPoint presentations, animations and videos).

Duration:
4 – 8 hours

Suggested Assessment:
1. Fieldwork report
2. Presentation

Syllabus content

Inquiry question: What factors affect equilibrium and how?

- investigate the effects of temperature, concentration, volume and/or pressure on a system at equilibrium and explain how Le Chatelier's principle can be used to predict such effects.

Inquiry question: How are solutions of acids and bases analysed?

- conduct a practical investigation to prepare a buffer and demonstrate its properties
- describe the importance of buffers in natural systems.

Inquiry question: How are the ions present in the environment identified and measured? (Module 8)

- analyse the need for monitoring the environment.

Sydney Water aim for activity

- Students will learn about the importance of acid/base and equilibrium chemistry in our treatment of drinking water.
- Students will also investigate factors that affect equilibrium systems and how this knowledge is used to make reliable predictions to treat drinking water.
- Our excursion is the starting point for an acid, base, and equilibrium Depth Study; looking at how various chemical reactions in an industrial/ real-life setting are part of treating clean, safe drinking water to protect public health.

Syllabus knowledge and understanding outcomes

Module 6: Acid/Base Reactions CH12-13

Describes, explains and quantitatively analyses acids and bases using contemporary models

- explore acid/base analysis techniques that are applied in industries
- describe the importance of buffers in natural systems.

Working scientifically outcomes

Planning CH11/12-2 Designs and evaluates investigations in order to obtain primary and secondary data and information

- assess risks, consider ethical issues and select appropriate materials and technologies when designing and planning an investigation.

Analysis and problem solving CH11/12-5 Analyses and evaluates primary and secondary data and information

- assess relevance and reliability of the gathered information
- collate useful and relevant information into water filtration process that relates to acid/base and their uses and applications
- evaluate the effect of buffers in natural systems.

Communicating CH11/12-7 Communicates scientific understanding using suitable language and terminology for a specific audience or purpose

- propose ideas in a coherent and logical way and correctly use scientific terminology and principles
- present information on the science and chemistry of acid/base reactions and buffers
- summarise from a range of sources and appropriately acknowledge sources.

Conducting investigations CH11/12-3 (Optional) Conducts investigation to collect valid and reliable primary and secondary data and information

- employ and evaluate safe work practices and manage risks
- use appropriate technologies to ensure and evaluate accuracy
- select and extract information from a wide range of reliable secondary sources and acknowledge them using an accepted referencing style.

Teaching, learning and assessment	Resources
Lesson 1 – Introduction This Depth Study program plan applies some content from Module 5/6 relating to equilibrium and acid/base reactions. The resources for this study are found on our HSC Chemistry webpage. 1. Explain details of the task. **Q.** Why is a first-hand investigation valuable? **A.** Because it allows you to develop the following skills: - fieldwork observations - applying theory to real life - replicating practical activities. 2. Explain Sydney Water's role and responsibility in water management. See our Education webpages for more information. - Who is Sydney Water and what do they do? See our About us webpage for more information. - Why is safe drinking water important? See our Safe drinking water webpage for more information. - Where does my water come from? See our water network web page for more information. 3. Excursion preparation. **Q.** What will we be doing during the excursion? **A.** See the High school webpage for more information. **Q.** Where can I find more information about the excursion site? **A.** See our Penrith Water Recycling Plant webpage for more information. **Q**. What are the basic safety and risk assessments on industrial sites? **A.** This photo shows you how people dress and work in an industrial site. Various personal protective equipment (PPE) is used to minimise risks. Can you come up what risks this PPE is for?  **Activity:** Students can create a risk assessment table according to the use of PPE. Hints and tips from HSC markers - First-hand investigations involve great opportunities to develop essential numeracy skills through practical measurement and the collection, representation and interpretation of data. - Fieldwork reports and engagement with community experts involve systematic scientific inquiry of real-life application promote students to achieve top marks in the HSC. Further investigations and extension options. • First-hand practical investigations at school. - Calculate the equilibrium constant K_{sp} of calcium hydroxide and effects of temperature using titrations. - Investigate the effect of increasing carbon dioxide on acidification of water. - Identify the effect of pH on the flocculation efficiency in drinking water. • Secondary sourced investigations. - Comparison of different disinfection techniques.	**Sydney Water resources** High school see HSC Chemistry *Make a simple filter experiment* *Drinking water taste test* Education About us Orchard Hills Water Filtration Plant Water quality & filtration *Drinking water filtration factsheet* Water sources Water network **Other resources** Singapore's National Water Agency pub.gov.sg

- Comparative study of water treatment in another country (PUB Singapore has helpful resources). • Communication surveys – what do people think about their drinking water? - Taste test lesson and campaigns research on bottled water versus tap water. - Investigate the impact of water restrictions on the community.	
Lesson 2 – **Secondary research** **Q**. Where does Sydney's drinking water come from? **A**. Most of the water we drink in Sydney comes from rainwater captured in dams. A small amount comes from desalination or is drawn from rivers. See our Water sources webpage for more information. **Activity**: Students can investigate the urban water cycle as a PowerPoint or animation on our Urban water management webpage. **Q**. How does Sydney Water treat drinking water? **A**. Raw water is treated to meet some of the strictest drinking water standards in the world. See our Water quality and filtration and Drinking water filtration webpages for more information. **Activity**: You can find out where your water comes from. Go to our Water network webpage for more information. **Q**. What are the separation techniques used at Orchard Hills Water Filtration Plant? **A**. Separation techniques include screening, chemical mixing (coagulation and flocculation), filtration, and disinfection. See our Orchard Hills Water Filtration Plant webpage for more information. **Q**. What are coagulation and flocculation? **A**. Fine particles are removed using chemicals that make the particles group together. Coagulation is a process causing small particles to bind together and form larger ones ('floc'). This makes them bigger, heavier and easier to remove. The process of bringing them together by gentle mixing is called flocculation. See our Water quality and filtration webpage for animated videos about this process. **Activity**: Students can practice balancing chemical equations. We have downloadable Balancing chemical equations card activity to help students understand the chemistry behind the treatment process. See our HSC Chemistry webpage for more information. **Q** What are the *Australian Drinking Water Guidelines (ADWG)*? **A**. The ADWG provides guidance to water regulators and suppliers on monitoring and managing drinking water quality. The ADWG have safety and aesthetic guidelines. The application of chemistry is not just about making water safe to drink, but also to meet public perception. See ADWG webpage for more information. **Q.** Can you describe water? What does it look like? What does it taste like or feel like? What do want your drinking water to be? **A.** Encourage students to think about a substance that they take for granted. It's a substance that keeps us alive, keeps us clean and is needed to keep us fed and clothed. It also makes us feel good. The chemistry involved in managing water for public health is important. Students can develop positive, informed values and attitudes towards chemistry by understanding the application of classroom learning in their everyday lives. **Optional activity** – Complete the Water taste test lesson. See our HSC Chemistry webpage for more information.	**Sydney Water resources** High school see HSC Chemistry *Make a simple filter experiment* *Drinking water taste test* Education About us Orchard Hills Water Filtration Plant Water quality & filtration *Drinking water filtration factsheet* Water sources Water network **Other resources** Australian Drinking Water Guidelines nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines

Lesson 3 – Field trip Students will visit a working water recycling plant to explore how we treat and manage wastewater for re-use to protect public health and the environment. Refer to our program outline on our Excursion request webpage for more information.	**Sydney Water resources** Excursion request High school see HSC Chemistry
Lesson 4 – Analysing data and information **Activity**: Students can use secondary sourced data (lessons 1-2) to compare with excursion observations. Students can also investigate the following sources of information and data. • Sydney Water's drinking water analysis results provide quarterly drinking water quality report for up to 70 different characteristics. See our Drinking water analysis results webpage for more information. • Orchard Hills Water Filtration Plant webpage provides additional technical details for the excursion site. Students can identify the water filtration process that relates to acids, bases and equilibrium, and their uses and applications to protect public health. • NSW Health drinking water webpage also provides information on water quality. • WaterNSW webpage provides information on the state's rivers and water supply systems, as well as live dam data across NSW. Students can evaluate the importance of chemistry in natural systems used as sources for drinking water. **Activity**: After students have gathered all the relevant data and information, they can analyse and create a scientific report or presentation. **Q**. What did we find out about the application of acids, bases and equilibrium? **A.** The outcomes to water quality would be affected significantly if these systems are not maintained. **Q**. What was valuable to learn about the greater context of water filtration? **A**. Water filtration processes shows the application Chemistry in real-life and is essential to maintaining public health.	**Sydney Water resources** High school see HSC Chemistry *What's in wastewater factsheet* Orchard Hills Water Filtration Plant Water quality & filtration *Drinking water filtration factsheet* Water analysis *Quartely drinking water reports* **Other resources** WaterNSW NSW Health - drinking water
Lesson 5 **Example: Depth Study – fieldwork report / presentation** A report may require students to: • describe the context of the site: - how water filtration works - how the chemicals are used to form predictable outcomes of clean drinking water - how pH and buffers affect the efficiency of the reactions. • describe and justify methods used during the investigation: - how valid, accurate and reliable the results are - what were some of the flaws and improvements. • assess risks, consider ethical issues and select appropriate materials and technologies when designing and planning an investigation • process and analyse first-hand laboratory activities, fieldwork and secondary data: - how the theory fit the results observed on the day - what graphs can were compiled, for example, a graph for pH versus turbidity or settling rate versus turbidity - how this is useful, for example, in testing efficiency of filtration rate. • communicate the results and conclusions of the fieldwork, laboratory and research investigations.	**Sydney Water resources** High school see HSC Chemistry **Other resources** NESA - The scientific research report

Conclusion **Evaluation questions** • What could you do to help manage our water for the future? • Why are working scientifically, collaboration and communication skills important? • Why do we have to continuously evaluate our scientific methods? • How has your excursion experience helped you understand chemistry's real-world applications? **Reflection activity** - students finish these statements: 1. I used to think (at the start of these lessons) 2. but now I think (at the end of these lessons). **Practice questions -** practice some sample HSC questions using your Water Recycling Depth Study knowledge. See our HSC Chemistry webpage for links to questions. **Got students interested in a career with Sydney Water or research and development?** See our Sydney Water careers webpage for more information on working here. Find out about the latest research from Sydney Water on our Reports and publications webpage.	**Sydney Water resources** High school see HSC Chemistry Careers Reports & publications **Find out more** • sydneywater.com.au/education • facebook.com/SydneyWater • instagram.com/sydneywater • twitter.com/SydneyWaterNews