VCE Chemistry

Examples of learning activities specific to sustainable development challenges

For the nine Sustainable Development Goals (SDGs) nominated in the VCE Chemistry Study Design, teachers can embed narratives relevant to concepts across Units 1–4 into learning activities, as in the examples in the table below.

*Table of examples of learning activities (with description and external links to teaching resources) relevant to a specific Sustainable Development Goal.*

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| SDG | Examples of learning activities |
| Goal 2: Zero hunger | Students relate the solubility of agrochemicals to their chemical structure. Students can also investigate the chemical process of eutrophication in water bodies, caused by excess nutrient run-off from fertilisers.  Students undertake a systems perspective to [inquire about the actual feedstock of ammonia-based fertilisers](https://cen.acs.org/environment/green-chemistry/Industrial-ammonia-production-emits-CO2/97/i24), namely methane from fossil fuels. CH4 is used to produce H2 by steam methane reforming (SMR), with CO2 as a by-product. In Unit 3, students can also investigate the potential for electrolysis to replace SMR as the main process to produce the necessary H2 feedstock for fertiliser production. |
| Goal 6: Clean water and sanitation | Investigate the chemical behaviour of chlorine in water, and the importance of chlorination for treating water for consumption. In Unit 3, students can investigate further the oxidising strength of chlorine, and how when chlorine is dissolved in water, the equilibrium mixture formed varies depending on the pH.  Investigate the [chemistry underpinning the Flint water crisis](https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/past-issues/2016-2017/december-2016/flint-water-crisis.html), and how neglecting to maintain a level of phosphate corrosion inhibitors in the lead (or iron) pipelines lead to a shift in chemical equilibria in solution, leading to oxidation of the metal pipes and leaching of soluble metal.  Students can inquire about the rationale for why what is considered ‘safe’ drinking water varies for different chemical pollutants, or more specifically what are the different concentration limits and why.  Students investigate the ongoing development of TiO2 and ZnO-based photocatalysts, which are increasingly being used as heterogeneous catalysts for water purification (via OH radical generation). |
| Goal 7: Affordable and clean energy | Students can investigate what chemistry-relevant obstacles need to be overcome to realise the ‘hydrogen economy’; for example, how the molecular size and energy density of hydrogen molecules is a challenge for piping to, and storage of, hydrogen at refuelling stations.  Students can investigate novel electrosynthesis processes, such as the [example of producing NH3 directly from N2.](https://www.monash.edu/science/news/current/world-first-discovery-could-fuel-the-new-green-ammonia-economy) Students can debate the feasibility of ‘electrification’ of chemical processes, which will require more mined metals (copper, nickel, iron, etc.) to make the turbines that will then generate electricity to make processes like steel and cement production less emission-intensive. But in the meantime, the ‘electrification’ of chemical pathways will still be driven by burning fossil fuels.  Students can compare the [advantages and disadvantages](https://greenliving.lovetoknow.com/Advantages_and_Disadvantages_of_Non_Renewable_Energy) of the use of fossil fuels and biofuels as energy sources, to develop criteria to evaluate any renewable or non-renewable energy source in terms of sustainability. |
| Goal 9: Industry, innovation and infrastructure | Students [make concrete from more sustainability sourced feedstocks](https://eschemistry.org/resources/sust-concrete/), and compare their strength to concrete made from traditional feedstocks that are scarce in supply. Students relate the structure and properties of glass, plastics and even waste concrete (demonstrating closed loop recycling as an example of a circular economy) to their potential as a sustainable feedstock in concrete production.  Students access secondary sources on the internet to investigate innovative processes for metal recycling from electronic devices, including hard-to-recover metals such as gold and silver. Students can compare these processes with crude, hazardous chemical processes using strong acids, utilised predominantly in low- and middle-income countries, leading to serious toxic residue build-up.  Students can investigate the chemical processes underpinning the production of the so-called [‘colours’ of hydrogen](https://blog.csiro.au/green-blue-brown-hydrogen-explained/) (blue, green, brown and others), and relate this to ongoing efforts to produce hydrogen as a renewable feedstock for chemical and energy production without producing greenhouse gas emissions. |
| Goal 11: Sustainable cities and communities | Students investigate the re-purposing of non-biodegradable plastics (i.e. end-of-use plastics) that we will still need for many applications (polyethylene gas pipes, Perspex windows), and relate these to the structure, properties and behaviour of the monomer and native polymer.  After developing some knowledge of galvanic cells and batteries, students can explore some of the chemical underpinnings for recharging stations for battery electric vehicles, and can estimate how many battery electric vehicles can be supported by the number of current recharging stations in cities across Victoria and Australia. |
| Goal 12: Responsible consumption and production | Students can prepare in the laboratory biodegradable polymers from different renewable feedstocks, and relate the strength and durability of biodegradable and non-biodegradable polymers to their chemical structure (several example activities are provided in the list of learning activities linked to specific green chemistry principles).  Students investigate another ‘trend’ in the periodic table, namely the recyclability of the element. Students compare the properties of the 30­–35 elements often found in electronic devices, to establish what makes separation and recovery of most elements difficult.  Students investigate the applications, chemical processes and pathways that have led to several elements being considered [critically endangered.](https://www.acs.org/content/acs/en/greenchemistry/research-innovation/endangered-elements.html) |
| Goal 13: Climate action | Students can use [an interactive applet](https://kcvs.ca/details.html?key=irWindows) to investigate how the global warming potential (GWP) of greenhouse gases is related to the infrared portion of the electromagnetic spectrum, because different greenhouse gases absorb in different parts of the infrared spectrum. (Part 2 of this [Climate change chemistry lessons resource](https://www.beyondbenign.org/bbdocs/curriculum/high-school/Climate_Change_Chemistry.zip) from Beyond Benign (US) has an activity on modelling GWP of greenhouse gases.)  Students can investigate the basic chemical principles of recent innovative techniques being trialled to [*directly* remove CO2 from the atmosphere.](https://www.iea.org/reports/direct-air-capture) |
| Goal 14: Life below water | Students can investigate the relative impact of different metal contaminants in a controlled experiment by adding dropwise ppm levels of different heavy metal contaminant solutions (Cu2+, Zn2+, Ag+, Ba2+, Pb2+/4+, Co2+ from soluble metal compounds) to *Elodea canadensis* in test tubes and measure the impact on aquatic environments over a period of a few weeks, qualitatively and quantitatively (loss of leaves).  Applying their emergent understanding of chemical equilibria and Le Chatelier’s principle, students can explore the impact of anthropogenic emissions on aquatic environments, including how the reduction of pH in aquatic systems shifts the equilibrium between CaCO3 and Ca2+ ions in solution to the right, increasing stress on coral and aquatic life reliant on producing shells as aragonite (a form of calcium carbonate). Students can investigate how the saturation of calcium ions in solution is being used as a measure of health for the planet, through the [planetary boundaries framework.](https://planetaryboundaries.kcvs.ca/) |
| Goal 15: Life on land | Students can expand their investigation of the traditional ‘food versus fuel’ debate; the production of paints, flooring, surface coverings and many clothes will need new feedstocks that are not in competition with food for land use. |