Section 4: Science and Me

The following maps the videos in this section to the Texas Essential Knowledge and Skills for Science TAC §112.35(c).

4.01 Science in Everyday Life

- Chemistry (3)(B)
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4.02 Chemistry as a Career

- Chemistry (3)(D)
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4.03 A Short History

- Chemistry (3)(F)

Note: Unless stated otherwise, any sample data is fictitious and used solely for the purpose of instruction.

Safety Note: Any chemicals mentioned in these videos are potentially harmful and should be handled with the appropriate safety precautions.

4.01

Science in Everyday Life

While it may seem distant and unnecessary at times, the study of science, and specifically chemistry, shapes the world around us and affects our lives every day. From the clothes we wear to the foods we eat, virtually every aspect of our daily lives is influenced by scientific discovery and technology.

Materials

One of the largest and most important fields in chemistry is the study of materials and how we use different materials to make our society better. Chemists are constantly researching new materials for specific applications to solve many of the world's biggest problems. If you read a scientific journal or listen to a news report, you will likely hear about how scientists are working on these solutions:

- Developing environmentally friendly biomaterials to replace traditional plastics
- Using carbon nanotubes to create stronger materials and bone grafts
- Synthesizing new silicon wafers that will increase computing power

Energy

As the global population continues to increase, one challenge that we face is powering our homes and businesses in a cost-effective and environmentally sustainable fashion. As we will investigate in later sections, burning fossil fuels like petroleum does release large amounts of energy but creates concerns for some. As a result, scientists are constantly looking for alternative methods to produce the electricity we need without side effects on the environment. A few of the leading technologies are listed below.

- Proton exchange membrane (PEM) fuel cells react with hydrogen gas and oxygen gas to produce water and an electric current.
- Photovoltaic (PV) cells in solar panels convert the energy from sunlight to an electric current that is used to charge a battery system for later use.
- Nuclear reactors release large amounts of heat that is used to generate steam and push turbines, creating electricity.

1. One of the biggest roadblocks preventing the mainstream use of alternative forms of energy is the cost of producing the electricity. Suppose that Flannel Panels, a solar panel company, claims that they can produce electricity for 9.5 cents per kilowatt-hour. Ignite Lignite, a traditional coal-burning power plant, claims they can produce electricity and sell it for 6.0 cents per kilowatt-hour. Jane and her family use 1,500 kilowatt-hours of electricity per month.

   i. Calculate the cost of powering Jane's home for a year using Flannel Panels.

   ii. Calculate the cost of powering Jane's home for a year using Ignite Lignite.

4.02

Chemistry as a Career

While it is easy to see the importance of studying chemistry if you wish to pursue a career as a chemist, you may be surprised to find out how many other careers in various fields use chemistry in the professional environment. A few of the fields are listed below, but there are many more chemistry-related professions that are not listed here.

Health Sciences

Health science professionals use chemistry every day to maintain the health of patients.

- A pharmacist studies the body's biochemical responses to drugs to make sure that prescriptions are administered safely and effectively.
- Registered nurses use their knowledge of chemistry to formulate plans for patient care and recommend pharmaceutical treatment in collaboration with doctors.

Engineering

Engineers apply the concepts of chemistry to other fields to manufacture new materials or optimize processes for the benefit of society.

- A chemical engineer uses knowledge of reaction mechanisms to calculate the precise flow of chemicals needed to synthesize a product.
- A materials engineer studies how different atoms and compounds will affect a material's different properties, such as strength and corrosion resistance.

Government

Policymakers must have a deep understanding of chemistry to make better laws governing our society and the environment.

- Hazardous waste management policies promote the safe chemical treatment of wastewater and solid waste so that our natural resources can be used more efficiently.
- Public health professionals work to maintain the health of an overall society in a variety of ways, which include creating policies on disease-prevention methods and changing public perception to prevent the spread of diseases.

1. Briefly explain how each of the following professionals might use chemistry in day-to-day tasks.

   i. Sports therapist

   ii. Surfboard manufacturer

   iii. Clothing designer

4.03

A Short History of Chemistry

The roots of modern chemistry date back thousands of years to when the ancient Egyptians extracted iron from its ore using crude and inefficient methods. Chemistry has evolved significantly in the time since then. That evolution can be broken up into a few distinct chronological periods.

Prehistoric Chemistry

The study of chemistry up until around 300 B.C. is referred to as the prehistoric period of chemistry.

- 450 B.C. – A Greek philosopher named Empedocles claims there are four elements: earth, air, fire, and water.
- 430 B.C. – Democritus proposes his idea of the atom, the simplest particle that makes up matter.
- 350 B.C. – Aristotle adds a fifth element, aether, to Empedocles's previous assertion.

Alchemy

Expanding on Aristotle's ideas, the chemists from around 300 B.C. to around 1700 A.D. focused much of their efforts on discovering the ***Philosopher's Stone***, a legendary substance capable of turning metals like iron into more valuable metals like gold or silver.

- A.D. 800 – Jabir ibn Hayyan (also called Geber), a Persian chemist, develops procedures for the production of many acids, including hydrochloric acid and nitric acid.
- A.D. 1260 – The German friar Albertus Magnus is credited with the discovery of the element arsenic.
- A.D. 1267 – Roger Bacon, an English chemist and philosopher, proposes an early form of the scientific method.
- A.D. 1661 – The Irish chemist Robert Boyle publishes *The Skeptical Chymist*, which distinguished between alchemy and chemistry, effectively ending the period of alchemists.

Traditional Chemistry

In the period from A.D. 1700 to A.D. 1880, chemists developed many of the laws and theories we know today.

- A.D. 1778–1789 – Antoine Lavoisier, a French chemist, discovers and names the element oxygen. He also publishes what is considered to be the first chemistry textbook.
- A.D. 1801 – An English chemist named John Dalton proposes an atomic theory that was widely accepted for nearly 100 years.
- A.D. 1869 – Dmitri Mendeleev, a Russian chemist, develops the first periodic table.

Modern Chemistry

In the period from A.D. 1880 to the present day, scientific discoveries in the field of chemistry were marked by the use of more advanced equipment and more analytical methods, compared to previous eras.

- A.D. 1885 – Eugene Goldstein, a German physicist, discovers the particle that will later be named the proton using a cathode ray.
- A.D. 1897 – English physicist J. J. Thomson discovers the electron with a cathode ray tube experiment.
- A.D. 1898 – Marie and Pierre Curie discover the elements polonium and radium that led to the discovery of radioactivity.
- A.D. 1909 – American physicist Robert Millikan measures the charge of electrons using an oil-drop experiment.
- A.D. 1926 – Erwin Schrödinger provides an equation for the atomic mechanics of an electron’s movement around a nucleus.
- A.D. 1932 – James Chadwick discovers the existence of a neutrally charged particle in the atom, which he called the neutron.
- A.D. 1953 – James Watson and Francis Crick propose the structure of the DNA molecule.

1. Which of the following statements is true?

   A. Robert Millikan proposed the nuclear model of the atom.
   B. The charge of the electron was first measured with a cathode ray tube.
   C. An oil-drop experiment led Thomson to propose the plum-pudding model of the atom.
   D. A cathode ray tube experiment led to the discovery of the electron.