

# Chemistry

## *The Central Science*

GLOBAL  
EDITION



Fourteenth Edition in SI Units

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**Lecture** on Monday 10:10-11:00; 11:10-12:00

**Lecture/Drill/Quiz** Wednesday 8:00-

**Total points: 1200**

Two Exams: 800 points

Quiz/Homework: 250 points

Class interaction/attendance: 150 points

**\*Prepare two notebooks for quiz and homework**

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**Text in English**

**Powerpoint Contents in English**

**Exam in English**





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# What is Chemistry?

Chemistry is the study of **matter**, its properties, and the changes it undergoes.

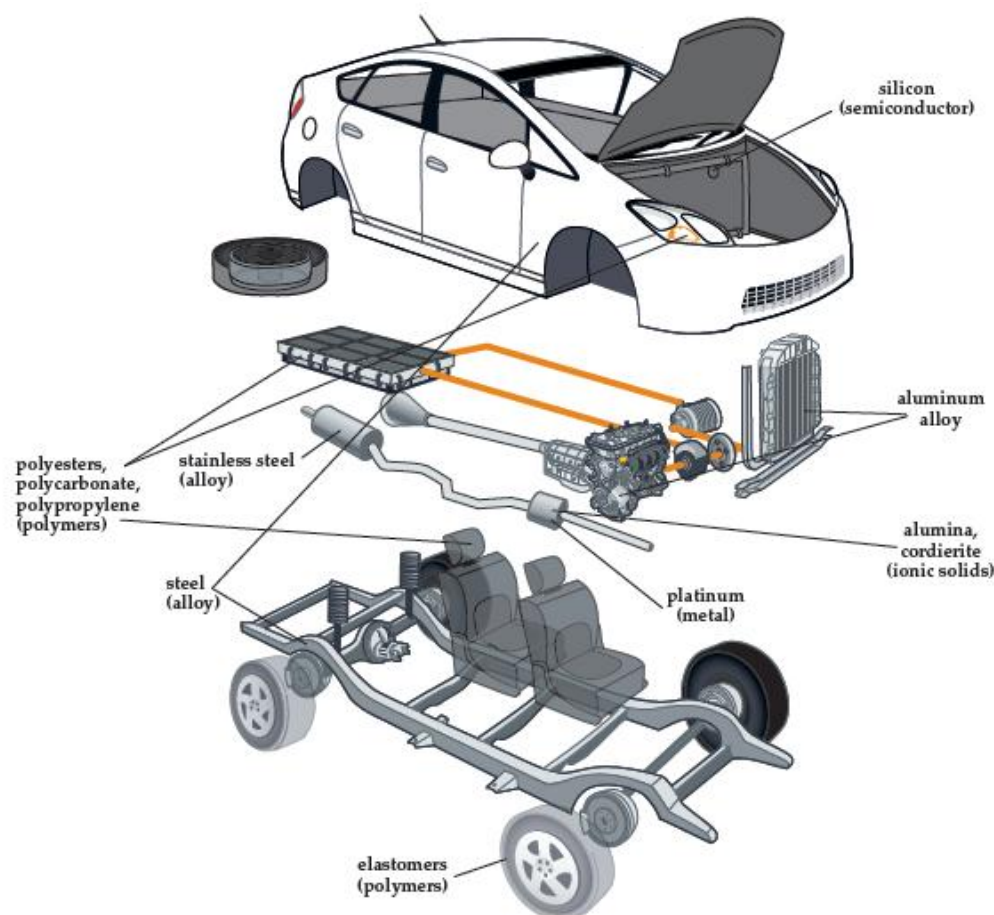
## Why Study Chemistry?

Chemistry lies near the heart of many matters of public concern, such as improvement of health care, conservation of natural resources, protection of the environment, and the supply of energy needed to keep society running. Using chemistry, we have discovered and continually improved upon pharmaceuticals, fertilizers and pesticides, plastics, solar panels, light-emitting diodes (LEDs), and building materials. We have also discovered that some chemicals are harmful to our health or the environment. This means that we must be sure that the materials with which we come into contact are safe. As a citizen and consumer, it is in your best interest to understand the effects, both positive and negative, that chemicals can have, in order to arrive at a balanced outlook regarding their uses.

There are over a billion motor vehicles in the world. Improvement in the fundamental understanding of the structure and properties of materials has enabled the development of motor vehicles that are safer, more powerful, more comfortable, and more fuel efficient. Let's take a look at some of these modern materials (Figure 12.38).

**Metals and metal alloys** are incorporated into many parts of an automobile. For example, **aluminum** is the primary component of the radiator, intake manifold, and engine block. **Steel** is typically the material used for the frame and body. **Stainless steel** is utilized in mufflers, exhaust silencers, and catalytic converters. The inside

of the catalytic converter contains small particles of **platinum** group metals that are deposited onto a honeycomb-shaped structural ceramic. The **ceramic** is composed of the ionic solids **alumina** ( $\text{Al}_2\text{O}_3$ ) coated onto **cordierite** ( $\text{Mg}_2\text{Al}_4\text{Si}_5\text{O}_{18}$ ). **Semiconducting oxides** are used for the oxygen sensor to monitor the air/fuel ratio in the exhaust gases, which is controlled by the engine control computer that is based on **silicon**, a **covalent network solid**. **Polymers** are found in a motor vehicle too, with **polyesters** in seat covers and carpets, **polycarbonate** optical reflectors, and **polypropylene** in bumpers and car batteries.

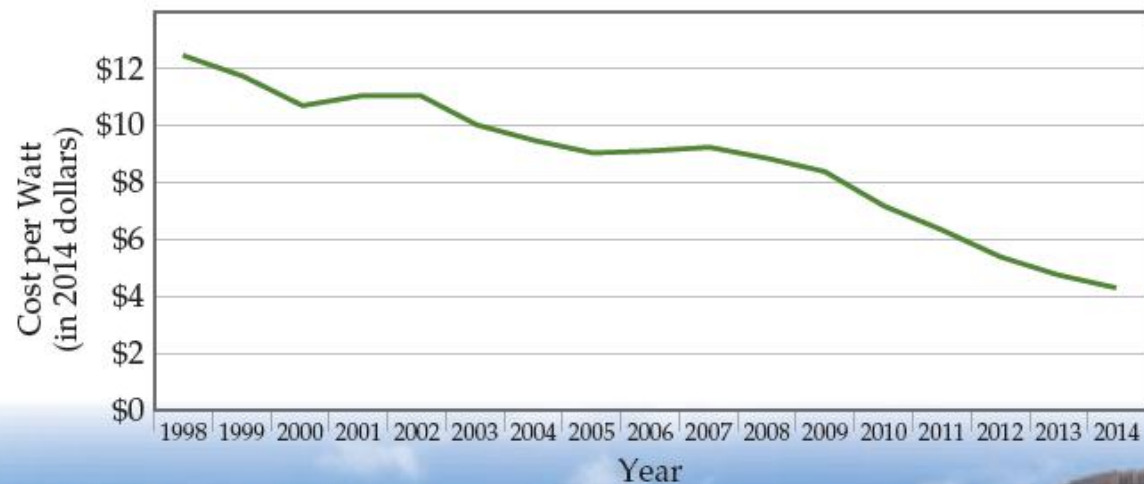




**Solar Energy Steps Up.** Given the challenges society faces in trying to mitigate the effects of climate change, the need for affordable clean energy has never been greater. Given the massive amount of energy our planet receives from the Sun, solar energy has long been touted as a technology of the future. The problem for decades has been the relatively high cost of solar power compared to energy generated from burning fossil fuels. However, in recent years the cost of solar energy has decreased more rapidly than most people thought possible, decreasing more than 50% in just the past five years (Figure 1.22).

Not surprisingly, over the last six years the number of solar panel installations worldwide has increased sixfold. Over the same period, the number of coal plants operating in the United States has decreased by 38%, from 523 to 323. China is on track to install plants capable of generating more than 18 gigawatts, twice the solar energy capacity of the United States. Furthermore, with the price of solar energy dropping rapidly, there is reason to believe that developing nations may forgo building fossil fuel power plants and skip straight to green energy technologies like solar and wind.

Recently, chemists have discovered a new class of materials called halide perovskites that have the potential to bring the cost of solar energy down even further. Solar cells made with halide perovskites have been shown to be nearly as efficient as single crystal silicon solar cells, but can be prepared from inexpensive solution methods that differ from the more costly and energy-intensive methods used to produce silicon solar cells. There are still many challenges to be overcome before halide perovskites can be used in commercial solar panels.



▲ **Figure 1.22** The cost of energy generated by photovoltaic modules. The median price per watt of electricity generated has dropped by two-thirds since 1998. The cost figures here include the cost for fully installed residential solar panels.



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專欄

## 洋垃圾轉進台灣

🕒 2018年06月20日

環境資訊中心記者

日前英國媒體報導，去年中國下令嚴格限制「洋垃圾」的進口後，台灣等其他東南亞國家，淪為歐美塑膠垃圾的新出口，以英國為例，今年1月至4月與去年同季相比，送往台灣的塑膠垃圾增加了10倍。環保署坦言，的確本季從世界各國進口廢塑膠約有12.89萬公噸，較去年同期成長約2.57倍。主要是從日本、菲律賓、美國、英國等國進口…



# Toxic Wastes and the Superfund Act

The story of one of the most significant environmental disasters involving chemical pollutants began in 1892. This was the year when developer William T. Love proposed the building of a canal linking the upper and lower portions of the Niagara River, which is the river feeding Niagara Falls in western New York. By 1910, however, the project had lost its financial backing and all that remained was a ditch some 60 feet wide and 3000 feet long. Located just east of the town of Niagara Falls, the ditch was purchased by the Hooker Chemical Corporation, which maintained it as a dump site for toxic chemical wastes, including poisonous heavy metals such as mercury and cancer-causing solvents such as benzene. By the early 1950s, Love Canal was completely filled and covered over with earth, creating a long vacant field.

At about this time, the population of the town of Niagara Falls was growing rapidly and more land was needed for the building of new communities. In 1953, a local school board, using the threat of eminent domain, convinced Hooker Chemical to sell the land above and around Love Canal. Hooker sold the land for \$1, with a warning of the dangers of the toxic wastes and a disclaimer of all subsequent liability. An elementary school was soon built directly above the toxic wastes, along with 800 single-family homes and 240 apartments in the surrounding neighborhood.

Over the years, the buried canisters ruptured, spewing their toxic contents underground. Being close to Lake Erie, the water table of Love Canal is close to the surface. After heavy rains, the water table would rise to mix with the leaking toxic wastes, which would leach away toward the basements of neighboring houses. In some places, the wastes would leach directly to the surface. The residents complained about foul odors and health issues, but city and county officials did not know how to respond aside from installing fans in homes or covering pools of toxic wastes with dirt.



A 1978 aerial view of the south end of the Love Canal district.

Finally, in 1978, health officials began to study the situation. They found numerous toxins in the surrounding soil and were able to correlate these toxins to reported health problems such as miscarriages and birth defects. The school was closed, and 239 families living on or immediately adjacent to Love Canal were evacuated. A fence was built around the canal to keep people away from the toxic wastes. The many families living just outside the fenced area, however, grew increasingly angry. They not only continued to face unusual health problems but also were unable to move away, because their homes were no longer sellable. Their concerns captured little attention until on May 19, 1980, they held hostage two representatives of the Environmental Protection Agency (EPA), with the demand that the government buy their homes so that they could relocate. Jimmy Carter promised the funding that allowed all Love Canal families to leave.

Love Canal turned the nation's attention to the problem of toxic wastes. It was soon recognized that Love Canal was just one of thousands of areas where toxic wastes were improperly disposed of. To remedy this massive problem, in December 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act, which established a "Superfund" that would provide the money to

clean up abandoned hazardous sites. This fund was to be supported by special taxes on industries related to the production of toxic chemicals. Furthermore, in cases where the polluter could be identified, the act granted the government the authority to enforce a "polluter pays" policy. For example, the federal government spent \$101 million from the Superfund to remedy the Love Canal toxic wastes. By 1995, federal courts ruled that the Hooker Corporation, despite its original disclaimer, was liable. Occidental Petroleum, which had bought Hooker in 1969, was thus required to reimburse the \$101 million to the Superfund and to pay the \$27 million in interest the Superfund would have earned had this money not been spent.

Over its history, however, the Superfund has received only a small fraction of its funding from the collection of fines from the polluters. The reason is that in many cases, the polluter cannot be identified or has since gone out of business or has no money to pay. Then in 1994, Congress decided that chemical industries should no longer pay the Superfund tax. As shown in Figure 3, until that year, these taxes (shown in green) were the main source of funding. Since then, the government has had to dedicate increasing amounts of public money each year to keep the Superfund program afloat. For

## Questions

1. Write down any **5** chemical elements.
2. Write down **5** molecules.
3. Write down **5** different **compounds**.
4. (i) Are you interested in studying Chemistry at all?  
(ii) How do you rate your background knowledge in Chemistry?  
(iii) **Explain why you are required to study Chemistry?**