Explainer: What Is Chemistry?

In this explainer, we will learn how to describe the field of chemistry, its position within the physical sciences, and its relation to other sciences.

Chemistry is a scientific discipline that studies matter, what it consists of, its properties and uses, and how it changes. Matter is anything that has mass and takes up space. Everything we can smell, touch, taste, or feel is made of matter, so the study of chemistry touches almost every aspect of our daily lives.

Definition: Chemistry

Chemistry is the study of matter and what it consists of, its properties, its uses, how it changes and reacts with other substances, and the conditions under which those changes occur.

Chemistry is used to create new materials like plastics, synthetic fibers, metal alloys, and ceramics. Chemistry helps us understand the chemical reactions that occur in the human body and allows us to develop new medicines and treatments for disease. Chemistry is involved in creating cosmetics, paints, food additives, fireworks, fertilizers, fuels, and disinfectants.

Example 1: Identifying Everyday Processes That Involve the Study of Chemistry

Chemistry is involved in many aspects of our everyday lives. Which of the following processes related to making a cup of coffee does **not** involve chemistry in some way?

A. The diffusion of milk through the mixture of coffee and water
B. The flow of electric current to the heating element and conversion into heat energy
C. How much coffee dissolves in the water
D. The processing of coffee beans from the plant to produce the ground coffee
E. The production and properties of the ceramic cup

Answer

Chemistry is the study of matter and what its properties are, what it consists of, and how it changes. Matter is anything that has a mass and takes up space, which encompasses nearly everything we interact with in our everyday lives, including making a cup of coffee.

All the substances used in making the coffee—the beans, the cup, the milk, the water—are all made of matter. The properties of these substances and the way they combine and interact all involve chemistry.

Besides matter, we also interact with energy on a daily basis. However, the study of energy and how energy changes is largely in the domain of physics, not chemistry. So, the process of electric current being converted into heat energy that would be used to heat the water does not involve chemistry; rather, this process involves physics. The correct answer is choice B.

Chemistry is a physical science, which means that it studies nonliving systems. The physical sciences include chemistry, physics, astronomy, and earth sciences. We can contrast the physical sciences with life sciences, such as biology and ecology, which study living systems.

Definition: Physical Sciences

Physical sciences are a branch of science that investigates nonliving systems.

Definition: Life Sciences

Life sciences are a branch of science that investigates living systems.

Example 2: Identifying the Branch of Science That Is Not a Physical Science

Chemistry can be classified as a physical science because it involves the study of matter and its motion. Which of the following is **not** a physical science?

A. Physics
B. Astronomy
C. Earth science
D. Materials science
E. Biology

Answer

Physical sciences study nonliving systems. Some examples of nonliving systems are matter and energy (studied by chemistry and physics), planets and stars (studied by astronomy), the earth and the atmosphere (studied by earth science), as well as metals, plastics, and ceramics (studied by materials science).

Living systems are studied by the life sciences, such as biology. Biology is the only science on the list above that is a life science and not a physical science, so the correct answer is choice E.

Chemistry involves understanding the particles that make up matter—the elements, atoms, ions, and molecules. Chemists investigate the way these particles bond with each other and undergo chemical reactions to form new compounds and substances. Everything is made of these particles and chemical reactions are occurring everywhere, so it should come as no surprise that chemistry is involved in so many other fields of study. This is why chemistry is often referred to as the central science.

Biology and other life sciences need chemistry to understand the thousands of chemical reactions that occur in plant and animal cells. For example, a botanist that studies plants needs chemistry to understand photosynthesis, a chemical reaction where a plant makes the sugar glucose using energy from the Sun.

Ecologists and environmental scientists use chemistry to understand how specific molecules interact with the environment. For example, ecologists have used chemistry to create nontoxic and effective pesticides. Scientists in these fields also use chemical techniques to identify chemical species in the environment.

Astronomers are able to determine the makeup of distant stars, asteroids, and planets by understanding the chemistry of different elements and how different elements interact with light and radiation. It is because of chemistry that we understand so much of the universe despite how far these bodies are from Earth.

The fields of medicine, nutrition, and pharmacology require an understanding of the chemical reactions that occur in the human body to create new medicines and improve an individual's health. Engineers need to understand the chemical properties of different materials in order to design buildings, vehicles, and joint replacements. Forensic scientists use chemical methods to test blood, fibers, and DNA to identify criminals.

Example 3: Identifying the Science Discipline That Overlaps with Chemistry on a Research Problem

A company specializes in analyzing soil samples and developing new fertilizers to increase the productivity of crops. Apart from chemistry, which other discipline would this research involve?

A. Agronomy

B. Pharmacology

C. Computer Science

D. Physics

E. Psychology

Answer

Chemists are able to understand the properties of the substances that make up fertilizers and soil, how to analyze those substances, and how to synthesize them. However, chemists are often not too familiar with agriculture, so a chemist might need someone with additional knowledge for this project.

Agronomy is the science and technology of agriculture. Agronomists understand the science of plants, soil, water, and everything else that goes into growing more productive crops, so agronomy would certainly be involved in this study. The correct answer is choice A.

Example 4: Identifying the Field of Science apart from Chemistry Involved in Drug Discovery Research

A chemist may be interested in the synthesis and production of new drug molecules. Apart from chemistry, which other discipline would typically be involved in this study?

A. Metallurgy

B. Physics

C. Earth science

D. Agriculture

E. Pharmacology

Answer

Synthesizing and producing new drug molecules requires the knowledge of the properties of these molecules and the reactions involved to create them. Chemists are very familiar with the properties of molecules, making them important for this field.

Once these new drug molecules have been produced, it is important to understand how they interact with the human body to ensure the medicine is effective and safe. While a chemist might have some knowledge of this, the study of how drugs affect the body and how the body responds to a drug falls under the field of pharmacology, so the correct answer is choice E.

Chemistry can be broken down into different branches. The main branches of chemistry are physical chemistry, analytical chemistry, organic chemistry, inorganic chemistry, computational chemistry, and biochemistry. There are also several other specializations of chemistry including environmental, theoretical, nuclear, polymer, and materials chemistry.

Physical chemistry studies the properties of substances and their structure as well as how chemical reactions occur. Physical chemists use theories from physics and mathematics to understand the chemical properties of substances.

Analytical chemistry uses experimental techniques to identify, separate, or quantify matter and its properties. Analytical chemistry is used to test food, water, cosmetics, and pharmaceuticals for safety. Forensic science uses analytical chemistry techniques to provide evidence that is used to solve crimes. Research in analytical chemistry often involves creating new experimental techniques that can be used in other branches of chemistry.

Organic chemistry studies the structure, properties, and reactions of compounds that are made primarily of carbon and hydrogen. Organic chemists are involved in synthesizing pharmaceuticals, petroleum products, cosmetics, plastics, and cleaning products, to name but a few.

Inorganic chemistry studies the properties and reactions of substances that are not carbon based, such as metals, salts, and other materials. It is involved with understanding the properties of metals and the creation of new alloys for specific applications. Inorganic chemistry is used to create paints, pigments, and microchips for computers.

Computational chemistry solves chemical problems through the creation and use of computer simulation and theoretical models. Many experiments are studied through computational calculations or simulations first before they are performed in the lab. This can help chemists understand which experiments are likely to be successful and cut back on the cost of reagents.

Biochemistry lies at the intersection of biology and chemistry. This field studies the chemicals and chemical reactions that occur in biological systems. Biochemists research the proteins in the human body to find new cures for disease and help create biofuels, new kinds of foods, and biodegradable plastics.

Example 5: Identifying Branches of Chemistry

Chemistry can be partitioned into different branches. Which of the following is **not** a recognized branch of chemistry?

A. Inorganic chemistry
B. Physical chemistry
C. Organic chemistry
D. Analytical chemistry
E. Particle chemistry

Answer

Chemistry studies matter and what its properties are, what it consists of, and how it changes. Chemistry is a broad field of science that can be divided into many branches and specialties.

The main branches of chemistry are physical chemistry, analytical chemistry, organic chemistry, inorganic chemistry, computational chemistry, and biochemistry.

Physical chemistry studies the fundamental properties of substances and the particles that make them up.

Analytical chemistry uses experimental techniques to identify, separate, or quantify substances.

Organic chemistry focuses on substances that are primarily made of carbon, while inorganic chemistry focuses on substances that are not carbon based.

Computational chemistry uses computers to solve problems in chemistry by creating models and simulations.

Biochemistry studies the chemical reactions that occur in biological systems.

Of the answer choices in this problem, the only one that is not a recognized branch of chemistry is choice E: particle chemistry.

Chemistry and chemists are currently involved in tackling some of the most important global issues. Chemistry is highly involved in researching renewable sources of energy, such as solar cells. Research in nanotechnology is improving the way drugs can be delivered, providing better catalysts, and discovering new materials for energy storage.

Advances in green chemistry are also helping minimize and even eliminate the amount of waste and hazardous materials being produced.

Key Points

- Chemistry is the study of matter and what it consists of, its properties and uses, and how it changes.
- Chemistry is a physical science.
- Chemistry is a highly interdisciplinary science that frequently overlaps with other sciences.
- The branches of chemistry are physical chemistry, organic chemistry, inorganic chemistry, analytical chemistry, computational chemistry, and biochemistry.