Elements, mixtures and compounds

An element is a pure substance that is made from a single type of atom.

Substances which are not chemically bonded are known as mixtures.

Substances which are made of more than one type of atom bonded together are known as compounds.

Electron arrangement

1st shell: holds 2 e-

2nd shell: holds up to 8 e-

3rd shell: holds up to 8 e-

Octet Rule: atoms are stable when their outer electron shell holds 8 electrons.

There are 2 exceptions to the octet rule.

1. The cases in which there are fewer than 8 electrons in the outer shell.

2. The cases in which there are more than 8 electrons in the outer shell.

Exception: H and He.

Lewis Structures: Starting at the right, draw 4 electrons, or dots, counter-clockwise around the element symbol.

The valence electrons are the number of electrons a an outer shell of an atom that can participate in forming chemical bonds with other atoms.

Atoms with a relatively empty outer shell will want to give up electrons. For example, if an atom has 1 electron out of a possible 8 in its outer shell, it will want to give up that electron so its outer shell is now full.

Atoms with a relatively full outer shell will want to gain electrons to fill up the outer shell. For example, an atom with 6 of 8 electrons in its outer shell will try to gain 2 electrons so its outer shell is full.

Groups

Halogens:

Elements in group 17

All non-metals. Very reactive. Poor conductors of heat and electricity. Tend to form salts with metals. Ex. NaCl: sodium chloride also known as “table salt”. The melting and boiling points increase down the group because of the van der Waals force.

Chalcogens:

Elements in group 16. Contains three nonmetals, one metalloid, and one metal. Reactive group.

Transition Metals:

Elements in groups 3-12

These metals have a moderate range of reactivity and a wide range of properties. In general, they are shiny and good conductors of heat and electricity. They also have higher densities and melting points than groups 1 & 2.

Alkaline Earth Metals:

Second column on the periodic table. (Group 2)

Slightly less reactive than alkali metals. They are silver colored and more dense than alkali metals.

Alkali Metals:

These metals are extremely reactive and are never found in nature in their pure form. They are silver coloured and shiny. Their density is extremely low so that they are soft enough to be cut with a knife.

Hydrogen:

This element does not match the properties of any other group so it stands alone. It is placed above group 1 but it is not part of that group. It is a very reactive, colourless, odourless gas at room temperature.

Boron Family:

Groups (cont)

Elements in group 13. Contains one metalloid and 4 metals. Reactive. Aluminium is in this group. It is also the most abundant metal in the earth’s crust.

Carbon Family:

Elements in group 14. Contains on non-metal, two metalloids, and two metals. Varied reactivity.

Nitrogen Family:

Elements in group 15. Contains two non-metals, two metalloids, and one metal. Varied reactivity.

Lanthanides and Actinides:

These are also transition metals that were taken out and placed at the bottom of the table so the table wouldn’t be so wide. The elements in each of these two periods share many properties. The lanthanides are shiny and reactive. The actinides are all radioactive and are therefore unstable. Elements 95 through 103 do not exist in nature but have been manufactured in the lab.

Noble Family:

Unreactive non-metals. All are colourless, odourless gases at room temperature. All found in earth’s atmosphere in small amounts.

Periodic table

The columns in the Periodic Table are called Groups (there are 8 groups). The rows in the Periodic Table are called Periods (there are 7 periods).

Elements in the same group have the same number of valence electrons and will form the same kinds of ions.

The metals are found on the left of the Periodic Table. The non-metals are found on the right of the Periodic Table. There are more metals than non-metals.

Each element has an atomic number. This number is the amount of protons/electrons the atom has (if the atom is not charged).

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Periodic table (cont)

It can be found under the symbol for the element.

The mass number is the combined number of protons and neutrons. The mass number subtracted by the atomic number is the amount of neutrons it has.

It can be found above the symbol for the element.

Most gases are colourless with the exception of chlorine which is a greeny-yellow colour. Most elements are silvery-coloured metals. There are a few exceptions:
Carbon is black, sulphur is yellow.
Copper and gold are orange and yellow coloured metals respectively.
Mercury is a liquid.

Metals, non-metals and metalloids

Most elements are metals. They are usually shiny, very dense, and only melt at high temperatures. Their shape can be easily changed into thin wires or sheets without breaking. Metals will corrode, gradually wearing away, like rusting iron. Heat and electricity travel easily through metals, which is why it is not wise to stand next to a flagpole during a thunderstorm!

Non-metals, on the right side of the periodic table, are very different from metals. Their surface is dull and they don't conduct heat and electricity. As compared to metals, they have low density and will melt at low temperatures. The shape of nonmetals cannot be changed easily because they are brittle and will break.

Elements that have properties of both metals and non-metals are called metalloids. They can be shiny or dull and their shape is easily changed. Electricity and heat can travel through metalloids but not as easily as they travel through metals.

Nanotechnology

Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers.

Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering.

Nanoscience and nanotechnology involve the ability to see and to control individual atoms and molecules. Everything on Earth is made up of atoms—the food we eat, the clothes we wear, the buildings and houses we live in, and our own bodies.

Today's scientists and engineers are finding a wide variety of ways to deliberately make materials at the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, increased control of light spectrum, and greater chemical reactivity than their larger-scale counterparts.

Halogens

The elements in group 7 of the periodic table, on the right, are called the halogens.

The reactivity of halogens decreases going down the group.

The atoms of each element get larger going down the group. This means that the outer shell gets further away from the nucleus and is shielded by more electron shells. The further the outer shell is from the positive attraction of the nucleus, the harder it is to attract another electron to complete the outer shell. This is why the reactivity of the halogens decreases going down group 7.

All halogen atoms require one more electron to obtain a full outer shell and become stable.

Each atom can achieve this by sharing one electron with another atom to form a single covalent bond.

Halogens (cont)

This means that all halogens exist as diatomic molecules (consisting of two atoms).

Seperating mixtures

Separation processes: filtration, distillation, centrifuge, sublimation, absorption, crystallisation and chromotography.

To separate liquid solutions where the substances have similar boiling points, a more complex version of distillation is used called fractional distillation.

Atomic structure

Electrons are particles that orbit the nucleus. They are negatively charged.

Electrons orbit (move around) the nucleus in a circle called an electron shell.

The centre of an atom is called the nucleus.

Protons are particles that are in the nucleus. They are positively charged.

Neutrons are particles that are in the nucleus. They do not have a charge and are neutral.

Noble gases

The elements in group 0, on the right of the periodic table, are called the noble gases.

The noble gases all form colourless gases at room temperature.

They are all very unreactive.

All noble gases have full outer electron shells and do not need to gain, lose or share electrons.

Ions

Ions are atoms with extra electrons or missing electrons. When you are missing an electron or two, you have a positive charge. When you have an extra electron or two, you have a negative charge.

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Carbon

The same carbon atoms are used repeatedly on earth. They cycle between the earth and the atmosphere.

Plants pull carbon dioxide from the atmosphere and use it to make food —— photosynthesis.

The carbon becomes part of the plant (stored food).

When organisms eat plants, they take in the carbon and some of it becomes part of their own bodies.

When plants and animals die, most of their bodies are decomposed and carbon atoms are returned to the atmosphere.

Some are not decomposed fully and end up in deposits underground (oil, coal, etc.).

Carbon in rocks and underground deposits is released very slowly into the atmosphere.

This process takes many years.

Additional carbon is stored in the ocean.

Many animals pull carbon from water to use in shells, etc.

Animals die and carbon substances are deposited at the bottom of the ocean.

Fossil fuels release carbon stores very slowly.

Burning anything releases more carbon into atmosphere — especially fossil fuels.

Fewer plants mean less CO2 removed from atmosphere.

Carbon is very versatile and can be found in different forms called allotropes (which means different forms of the same element)

These allotropes include:

Charcoal: Crumbles easily, is powdery Can be used for sketching, odor eaters in shoes because it absorbs gases, used in tablets for people with digestive problems, poisonous gas filters in gas masks

Graphite: The carbon atoms form sheets that are stacked on top of each other. The sheets do not break easily but can slide across each other

Carbon (cont)

Diamond: Another form of carbon, has a rigid crystal lattice and is one of the strongest and hardest materials on Earth. Does not conduct electricity.

Carbon fibre: Strong and lightweight.

Buckyballs and nanotubes: Buckyballs are another allotrope of carbon discovered in 1985. They are balls made up of 60 carbon atoms and have the same geometric shape as a soccer ball. Nanotubes are sheets of carbon rolled into hollow tubes and they are very strong and conduct electricity and are used in miniature electrical circuits.

Isotopes

Isotopes are atoms that have the same number of protons and electrons, but a different number of neutrons.

Changing the number of neutrons in an atom does not change the element. Atoms of elements with different numbers of neutrons are called "isotopes" of that element.

There are two ways that isotopes are generally written. They both use the mass of the atom where mass = (number of protons) + (number of neutrons).

The first way is to put the mass as a superscript before the symbol of the element.

The other way is to write out the element and write the mass after a dash next to the element's name.

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