

Chemistry Notes

Day Two

Summer 2011

1 States of matter

Chemistry studies matter in its various states. The three states we will consider are solid, liquid, and gas. Solids have fixed shape and volume; liquids have fixed volume but variable shape; and gases have variable shape and variable volume.

2 Physical and chemical properties and changes

Physical properties are properties inherent to a substance, while chemical properties involve a substance's ability to form new substances.

2.1 Examples

| Property | Type |
|---------------------------------------|----------|
| Boiling point of water | Physical |
| Hardness of diamond | Physical |
| Fermentation of sugar to form alcohol | Chemical |
| Metal wire conducting electricity | Physical |
| Metal melting | Physical |
| Paper combusting in air | Chemical |

3 Elements and compounds

Elements are a single type of atom. All of the entries on the periodic table (e.g. oxygen, hydrogen, and iron) are elements. Compounds are specific combinations of multiple different elements. H_2O , $\text{C}_6\text{H}_{12}\text{O}_6$, and NaCl are all compounds.

3.1 Examples

| Example | Type |
|---|----------|
| Water (H_2O) | Compound |
| Nitrogen (N) | Element |
| Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) | Compound |

4 Mixtures

Mixtures have variable composition, while pure substances are made up of the same substance throughout. Pure substances are always elements or compounds. Homogeneous mixtures (AKA solutions) are the same throughout, while heterogeneous mixtures differ throughout.

4.1 Examples

| Example | Type |
|------------------------------------|-----------------------|
| Gasoline | Homogeneous mixture |
| Copper | Pure substance |
| Air | Homogeneous mixture |
| Salt water | Homogeneous mixture |
| A stream with gravel at the bottom | Heterogeneous mixture |

5 Energy and specific heat

Energy is different than matter. It is not solid, liquid, or gas. Rather, it is the capacity to do work. Energy can be measured in either joules or calories, with:

$$1 \text{ cal} = 4.184 \text{ J}$$

To find the specific heat of an object, we use the formula:

$$Q = s \times m \times \Delta T$$

The diagram illustrates the formula for calculating the energy required to heat a substance. It consists of four boxes arranged horizontally, connected by mathematical symbols. The first box contains 'Energy (heat) required (Q)', followed by an equals sign, then a box for 'Specific heat capacity (s)', a multiplication sign, a box for 'Mass (m) in grams of sample', another multiplication sign, and finally a box for 'Change in temperature (ΔT) in °C'.

6 Atomic theory

The atom is composed of a tiny nucleus at its center with electrons orbiting around the outside. The nucleus is composed of protons and neutrons.

| Particle | Relative charge |
|----------|-----------------|
| Proton | +1 |
| Neutron | 0 |
| Electron | -1 |

7 The periodic table

The periodic table contains every element now known to us. It can be used to determine the electron configuration of atoms (see attached figures) and the relative atomic radius of elements. Remember, atomic radius increases from top to bottom, and decreases from left to right.

| | |
|---------------|---------------|
| <u>Helium</u> | element |
| 2 | atomic number |
| He | symbol |
| 4.003 | atomic mass |

8 Isotopes and allotropes

Isotopes are different forms of the same element, with different numbers of neutrons. Carbon-12 and carbon-14 are different isotopes of carbon, for example. Allotropes, on the other hand, are different structural forms of an element. Each atom remains unchanged in different allotropes, but the way the atoms are bonded together changes. Graphite and diamond are different allotropes of carbon, for instance.

9 Ions

Ions are charged atoms, represented by a plus or a minus sign following the atom's symbol. For instance, a calcium atom that gives up two electrons becomes a Ca^{2+} ion, while a chlorine atom that gains an electron becomes a Cl^{-} ion.

10 Acknowledgements

Some information Zumdahl's *Introductory Chemistry: A Foundation*.