I. Physical Changes

A physical change is any change NOT involving a change in the substance's chemical identity. Here's another way to say it:

a change that alters the physical form of a substance without changing its chemical identity.

Here are some examples:

(1) any phase change. Moving between solid, liquid and gas involves only the amount of energy in the sample (this amount is the subject of future lessons). There is no effect on the chemical identity of the substance. For example, water remains water, no matter if it solid, liquid or gas.

By the way, all phase changes include sublimation (solid to gas) and deposition (gas to solid). Since they are fairly unusual phase changes, teachers like to use them for test questions.

(2) grinding something into a powder. Or the reverse process of making a bigger lump of stuff, say by melting lots of small pellets of copper into one big piece.

(3) iron (and many other metals) can be made to be magnetic. This change in no way affects the chemical identity of the element. Iron that is magnetized rusts just as easily as iron that is not magnetized. (Yes, rusting is a chemical change. Rust is chemically different from iron.)

Now would be a good time as any to list the names of the various phase changes:

Change	Name of change
Solid to liquid	melting, fusion
Liquid to gas	boiling, evaporation
Solid to gas	sublimation
Gas to solid	deposition
Gas to liquid	condensation, liquefaction
Liquid to solid	freezing, solidification

An example of sublimation is dry ice. It is solid carbon dioxide and goes directly from the solid state to gas in the open atmosphere. You can make liquid carbon dioxide, but it must be done under about 5 atmospheres of pressure.

Deposition is a bit of a non-standard word, but it fits better than using sublimation or condensation again. Ice cubes in the freezer undergo sublimation to water vapor, even with the ice is cold. The vater vapor deposits back onto the solid ice without even going through the liquid phase. By the way, this is how ice cubes become "welded" together if they sit undisturbed in the freezer.

Here is a great example of deposition. First a fact: solid water exists in nine different solid forms (at various combinations of temperature and pressure), called ice I to ice IX. (The one we use in our sodas is ice I.) There is a tenth solid form which is only obtained when water vapor is deposited onto a solid surface which is below -120 °C. At -80°C it spontaneously changes to ice I, however it cannot be obtained by cooling ice I.

II. Chemical Changes

A "chemical change" means that the reacting compound(s) are changed into new compounds. The actual atoms involved remain, they are simply rearranged into the new compounds. The rearrangement is called a chemical reaction. For example:

$2H_2O \longrightarrow 2H_2 + O_2$

is a chemical reaction in which water is broken down into the hydrogen and oxygen which make it up. Notice how the amounts of hydrogen atoms (four) and oxygen atoms (two) do not change from one side of the arrow to the other. However, the arrangements of the atoms is different. Some chemical bonds (the one involved in the water) have been broken and some new chemical bonds (the one in hydrogen and oxygen) have been formed.

This is another way to define "chemical change:"

A process in which chemical bonds are broken and new ones are made.

A process like grinding some salt crystals into a fine powder does not involve the breaking of chemical bonds and the formation of new ones, so it is a physical change.

A chemical change always involves a change in the chemical relationship between the various substances involved. This change is seen in the fact that some chemical bonds are broken and some bonds are newly made.

Here is another example of a chemical change:

$N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$

While all three substances are gases, the two reacting substances are quite different chemically from the product. This is because the bonds between the nitrogen atoms have been broken, as well as between the hydrogen atoms. In the place of these broken bonds has come something not present in the reactants, bonding between a nitrogen atom and some hydrogen atoms.

Obviously, chemistry is made up of many chemical reactions (which are the cause of chemical changes). One interesting one is the ion-exchange column, of which one type is used to remove certain chemicals from drinking water.

Remember, chemical change always alters the chemical characteristics of a given substance. Chemical change always results in new chemical substance(s) being produced and the substance(s) that were present at the start of the change are always consumed.

Go to a few questions on physical and chemical changes

Worksheet: Physical and Chemical Changes

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1. Label each process as a physical or chemical change:

a. perfume evaporating on your skin
b. butter melting
c. wood rotting
d. charcoal heating a grill
e. autumn leaves changing color
f. a hot glass cracking when placed in cold water
g. melting copper metal
h. burning sugar
i. mixing sugar in water
j. digesting food

2. Which of the following would NOT be a physical change?

a. freezing water to make ice cubes
b. melting gold to make jewelry
c. burning gasoline in a lawnmower
d. boiling water for soup
e. tearing a piece of aluminum foil

3. Which of the following is NOT a physical change?

a. grating cheese
b. melting cheese
c. fermenting of cheese
d. mixing two cheeses in a bowl

4. Which are physical and which are chemical changes?

a. boil
b. burn (combustion)
c. condense
d. corrode
e. crumple
f. ferment
g. melt
h. rust
i. crush
j. freeze
k. oxidize
l. tarnish
m. explode

n. grind
o. rot
p. vaporize
q. photosynthesis
r. sublimation

5. If a certain mixture is homogeneous, you would properly conclude that the physical properties and the composition:

a. are different from one part of the sample to another
b. vary smoothly from top to bottom of the sample
c. are the same in every small volume element from the sample
d. none of these

6. Label each process as a physical or chemical change:

a. Moth balls gradually vaporize in a closet
b. hydrofluoric acid attacks glass (used to etch glassware)
c. A chef making a sauce with brandy is able to burn off the alcohol from the brandy, leaving just the brandy flavoring
d. Chlorine gas liquefies at -35 °C under normal pressure
e. hydrogen burns in chlorine gas

7. Label each process as a physical or chemical change:

a. fogging a mirror with your breath
b. breaking a bone
c. mending a broken bone
d. burning paper
e. slicing potatoes for fries
f. mixing sugar with coffee
g. frying chicken
h. a nail rusting
i. paper ripping
j. wood burning
k. mixing water and food coloring
l. food molding (rotting)
m. writing on paper
n. dyeing fabric

8. Is concrete a heterogeneous mixture?

Go to the worksheet answers

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