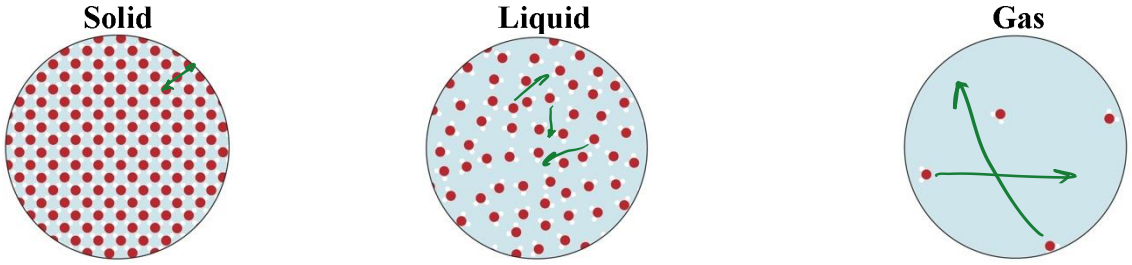
Target Inquiry Activity
Physical + Chemical Changes
Modified version of "Change You can Believe In" and "The Only Thing Constant in Life is Change" by Target Inquiry GVSU - 2009, Chad Bridle, Grandville High School

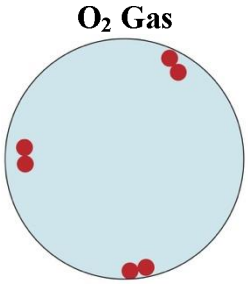
Name Answer Key
Group #_____ Role_____
*Partners*_____

PROBLEM / QUESTION
How is the behavior of atoms and molecules different in physical changes versus chemical changes?

PREDICTIONS *(Might be assigned for homework.)*
1) In the large circles below, sketch how you believe solids, liquids and gases appear on the atomic level. Use a small circle, O, to represent an atom. Below each large circle, describe the motion and arrangement of the atoms.



2) In the large circle on the right, sketch what you think O_2 gas would look like on the atomic level. *O_2 means that two oxygen atoms are bonded together to form an oxygen molecule.*



3) Take a moment and think about what might be the difference between the terms physical change and chemical change. Write down a basic definition of each. *(Please write what you think without looking it up anywhere. Your answer does not need to be completely "right." We will be discussing different definitions in class.*

Physical Change:

Chemical Change:

ANALYSIS of Particulate Diagrams of various Physical/Chemical Changes ("Change Cards"):

Your group has been given nine "Change Cards." Each card represents a change that a substance or substances undergo. The large circle(s) on the left contain the particles before they undergo the change and the large circle(s) on the right contain the particles after they undergo the change. Each large circle is a snapshot of a situation, so the number of atoms shown "before" and "after" may not be the same.

The particles on the cards that have a + or – are called ions. Ions can form when atoms lose or gain electrons. *For example, if a copper atom loses an electron it will turn into a positive copper ion. If a chlorine atom gains an electron, it will turn into a negative chloride ion*. Ions and atoms of the same element have different properties.

For each "Change Card," your group's task is to determine whether the change is *physical* or *chemical*. To do so first describe any changes that occur to the particles—did they change or simply rearrange? Second, based on your definition of physical and chemical changes, decide on the type of change. Third, defend your decision. Record your determinations in the chart given on next page.

Change A: Describe the changes to particles:

PHYSICAL OR CHEMICAL CHANGE? __PHYSICAL____ DEFEND YOUR DECISION:
The particles do not change, they only become intermixed.

Change B: Describe the changes to particles:

PHYSICAL OR CHEMICAL CHANGE? __PHYSICAL____ DEFEND YOUR DECISION:
The particles do not change, they only become rearranged.

Change C: Describe the changes to particles:

PHYSICAL OR CHEMICAL CHANGE? __CHEMICAL____ DEFEND YOUR DECISION:
The solid Mg and the O_2 gas particles rearrange to become solid Mg (Mg^+O^-).

Change D: Describe the changes to particles:

PHYSICAL OR CHEMICAL CHANGE? __CHEMICAL____ DEFEND YOUR DECISION:
Solid Mg and aqueous H^+Cl^- rearrange to become gaseous H_2 and aqueous Mg^+Cl^-.

Change E: Describe the changes to particles:

PHYSICAL OR CHEMICAL CHANGE? __CHEMICAL____ DEFEND YOUR DECISION:
Solid Fe and aqueous O_2 become solid Fe_2O_3 (Fe^+ & O^-)

Change F: Describe the changes to particles:

PHYSICAL OR CHEMICAL CHANGE? __PHYSICAL____ DEFEND YOUR DECISION:
Liquid H_2O becomes gaseous H_2O but the particles do not change.

Change G: Describe the changes to particles:

PHYSICAL OR CHEMICAL CHANGE? __PHYSICAL____ DEFEND YOUR DECISION:
Solid NaCl (Na^+ & Cl^-) mix with H_2O molecules to make aqueous NaCl, but the particles do not change.

Change H: Describe the changes to particles:

PHYSICAL OR CHEMICAL CHANGE? __PHYSICAL____ DEFEND YOUR DECISION:
Solid H_2O becomes liquid H_2O but the particles do not change.

Change I: Describe the changes to particles:

PHYSICAL OR CHEMICAL CHANGE? __CHEMICAL____ DEFEND YOUR DECISION:
Aqueous H^+Cl^- and aqueous $Na^+HCO_3^-$ become gaseous CO_2, liquid H_2O, and aqueous Na^+Cl^-.

CONCLUSIONS: Based on your lab group's discussions and decisions write concise, one-sentence descriptions for *physical change* and *chemical change.*

Physical Change: A transformation where the particles become rearranged but do not change their composition.

Chemical Change: A transformation where the particles change their composition to make new, different, particles.

CONNECTIONS TO THE REAL WORLD

Each change on the cards (A-I) represents a real process that you probably have seen or heard about. Below are descriptions of each of these processes in some real-world situation. Label each real world situation with its corresponding Change (Choose the correct "Change" letter, A-I) You will be given an *Atom Key* to help you identify what elements are represented on each of the Change Cards.

__G__ 1) Many cold packs consist of a solid compound, such as NaCl, that is mixed with water when the bag is punched. Upon mixing the temperature decreases.
(Disclaimer: In reality, adding NaCl to water does not decrease the temperature much. However, adding the similar compound, KCl, to water does decrease the temperature alot.)

***Observations**: A white solid disappears into solution when added to liquid water. Gets cold.*
***Equation**: $NaCl\ (s) \rightarrow NaCl\ (aq)$ [to make colder use: $KCl\ (s) \rightarrow KCl\ (aq)$]*

__E__ 2) Cars have been made from steel, which is mostly iron, since their introduction into society in the early 20th century. Iron is useful because it is very strong, but one problem with iron is that when the iron interacts with oxygen, it forms rust which flakes off the iron.
***Observations**: A gray metal interacts with oxygen gas forming a reddish-brown solid.*
***Equation**: $4\ Fe\ (s) + 3O_2\ (g) \rightarrow 2\ Fe_2O_3\ (s)$*

__B__ 3) Copper has been used by humans for about 10,000 years. Due to its excellent flexibility and great ability to conduct electricity, copper is used for electrical wires as well as in pipes for plumbing.
***Observations**: A brown metal wire is bent.*
***Equation:** $Cu\ (s) \rightarrow Cu\ (s)$*

__C__ 4) Original camera "flash bulbs" consisted of very fine magnesium filaments. An electrical current, triggered by the camera shutter, heats the filament until it ignites and burns, very quickly and brightly, with the oxygen in the air.
***Observations:** When heated, a gray metal disappears, a white powder to forms and a bright white light is seen.*
***Equation:** $2\ Mg\ (s) + O_2\ (g) \rightarrow 2\ MgO\ (s)$*

__H__ 5) Before the invention of the refrigerator, perishable food was often kept in ice boxes, which were cooled using blocks of ice. Ice was often stockpiled in large "ice houses" during the winter and could often be kept from melting until the following winter.
***Observations:** Ice slowly disappears and liquid water forms.*
***Equation:** $H_2O\ (s) \rightarrow H_2O\ (l)$*

D 6) Henry Cavendish is credited with identifying hydrogen gas as a unique element in 1766. Cavendish produced hydrogen gas by combining a metal, such as magnesium, with a strong acid, such as hydrochloric acid. Hydrogen production soon became useful as balloonists found this "lighter than air" gas quite useful.

***Observations**: A silvery metal is added to a colorless solution. Bubbles form.*

Equation: $Mg\ (s) + 2\ HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2\ (g)$

I 7) Sodium bicarbonate, commonly known as baking soda, is used to make baked goods light and fluffy. It does so by decomposing to produce water vapor and carbon dioxide gas. This decomposition process is initiated by the presence of an acid, HCl, which exists as ions in water.

***Observations:** A white powder is added to a colorless solution. The white solid disappears into the solution and bubbles form.*

***Equation**:* $NaHCO_3\ (s) + HCl\ (aq) \rightarrow NaCl\ (aq) + H_2O\ (l) + CO_2\ (g)$

F 8) The first train locomotives were powered by steam. A very hot fire, usually coal powered, heats a large tank of water called a boiler. When the water evaporates and turns to steam, the boiler becomes highly pressurized by the steam. The high pressure steam is then used to push large pistons, which turns the wheels.

***Observations:** Liquid water disappears and a foggy gas is formed.*

***Equation**:* $H_2O\ (l) \rightarrow H_2O\ (g)$

A 9) Rubbing alcohol has many uses, most commonly as an antiseptic for cleaning minor cuts or contaminated surfaces. Household rubbing alcohol is a mixture of isopropanol and water.

***Observations:** Two colorless liquids are mixed forming a colorless solution.*

Equation: $C_3H_7OH\ (s) \rightarrow C_3H_7OH\ (aq)$

MACROSCOPIC OBSERVATIONS of physical and chemical changes.

In the descriptions of the changes given in the previous section, the "observations" that are listed are what one would call "macroscopic observations." Macroscopic observations are observations that you can actually see with your eyes. Obviously, these macroscopic observations are different from the atomic level diagrams on the cards.

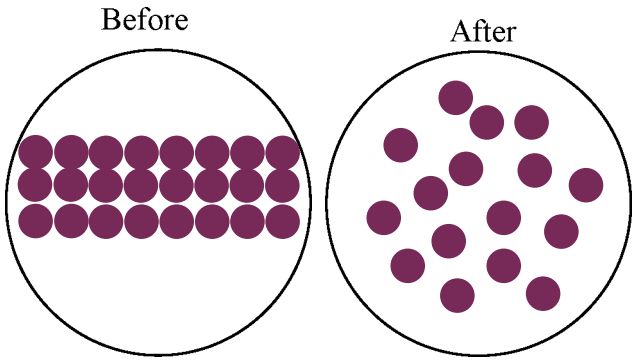
Often macroscopic observations can give us clues as to whether a physical or chemical change has occurred. Based on the situations described above and your own knowledge of common changes, indicate whether the observations listed below are most indicative of a Physical Change, a Chemical Change or possibly both by putting in "check marks" where appropriate. For each observation, defend your decision by stating specific changes (Use Changes A-I or other common changes).

Physical	Chemical	Observations	Defend decision
	X	Color Change	E: Fe & O make rust
X	X	A gas is formed	F: H_2O boils; D: Mg + HCl release H_2 (g)
X		Change in shape	B: Cu wire is bent
X	X	A solid is formed	H reversed: H_2O freezes; C: Mg + O_2 make MgO
X	X	Heat is produced	Dissolving some compounds; Wood burning
X	X	A liquid is formed	H: H_2O melts; I: liquid H_2O is produced
	X	Light is produced	C: Mg + O_2 gives off bright light.

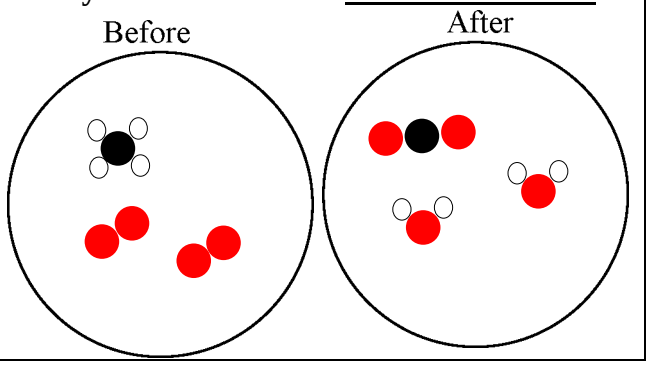
REFLECTING ON LEARNING

1) For the following two situations, decide whether the change described is physical or chemical. Then, in the space provided, illustrate the change at the particulate level. Use colored pencils and your *Atom Key* to correctly represent each particle.

a) Pure copper can be heated until it melts just below 2000°F. The liquid copper can be poured into molds.
Physical or Chemical? Physical



b) Natural gas consists mostly of methane gas, CH_4. Natural gas is used to heat homes and cook food. The methane is "burned" by reacting with oxygen gas, O_2. The products of this reaction are carbon dioxide gas, CO_2, and water vapor, H_2O.
Physical or Chemical: Chemical



2) The following are some traditional ways of differentiating between physical changes and chemical changes. Which definition below is the most correct and useful definition? B

a) A physical change is easily reversed, while a chemical change is not easily reversed.
b) During a chemical change, a new substance is formed. During a physical change, no new substance is formed.
c) No bonds are formed or broken during a physical change. Bonds are formed and broken during a chemical change.
d) A chemical change is associated with a large energy change, whereas a physical change is associated with a small energy change.

3) **Classify each of the following as either a physical change or a chemical change.**

C	a) Burning a log
P	b) Melting a piece of solid wax
C	c) Food spoiling
P	d) Obtaining gasoline by distilling crude oil (crude oil is a mixture of hydrocarbons—one of which is gasoline)
P	e) Making rock candy by crystallizing solid sugar from a concentrated sugar/water solution.
P	f) Production of dry ice (solid CO_2) from pressurized CO_2 gas.
C	g) Refining copper from copper ore *(2 common copper ores are CuS and Cu_2O)*
P	h) Desalination of sea water by boiling the away the water and recollecting it.
C	i) Fermentation of the sugars in corn to form ethanol.
P	j) Separating sand out of a sand/water mixture by filtration.
P	k) Distilling wine (a 12% alcohol/water mixture) to form gain alcohol (an 80% alcohol/water mixture)
P	l) Dissolving sugar into tea.
P	m) Collecting oxygen from air by pressurizing and cooling air. Liquid oxygen condenses out of the air