

Changes in Matter

There are **three kinds of changes** that matter can undergo:

1. Physical Changes

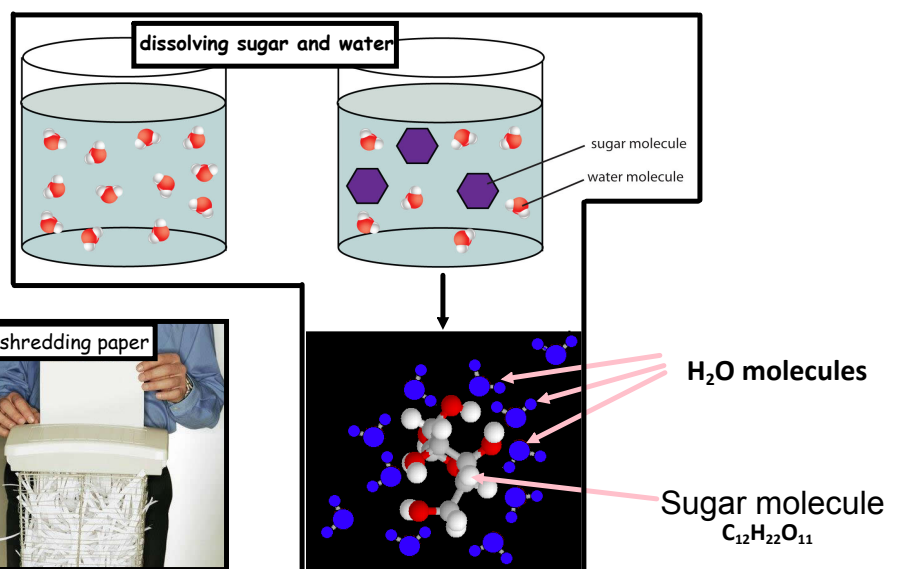
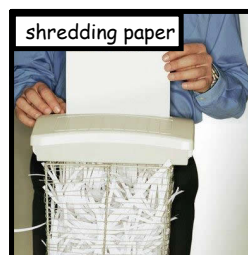
2. Chemical Changes

3. Nuclear Changes

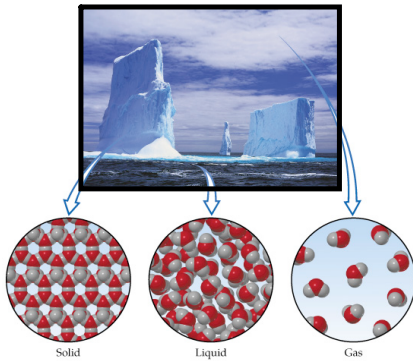
Important for you: understand the basic differences between these types of changes; also be able to identify examples as being physical, chemical, or nuclear changes.

1. Physical Changes = changes where the identity of the substance is not changed

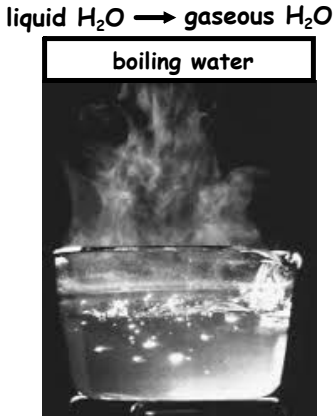
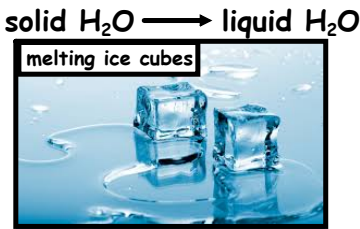
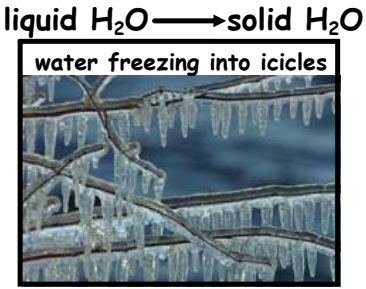
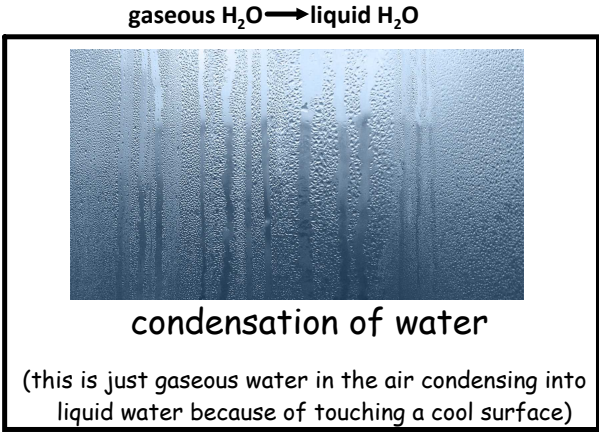
Examples:



All phase changes are physical changes!



The molecules are the same regardless of whether they exist as a solid, liquid, or gas. They just move further apart as they go from solid to liquid, and liquid to gas.

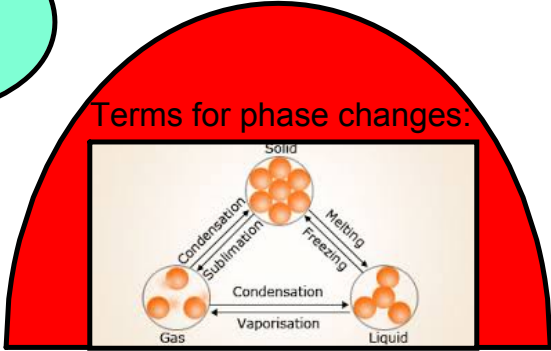


Here's another interesting phase change: the sublimation of dry ice...



Solid carbon dioxide, CO₂ sublimates directly into gaseous carbon dioxide!

"dry ice" is frozen CO₂ (carbon dioxide). It is at -78.5°C

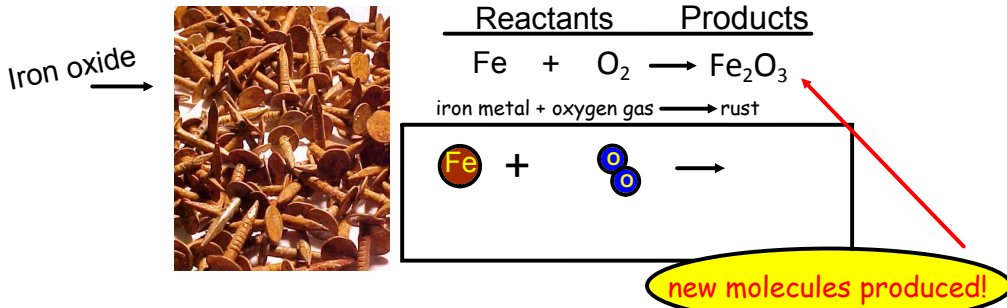


2. Chemical Changes

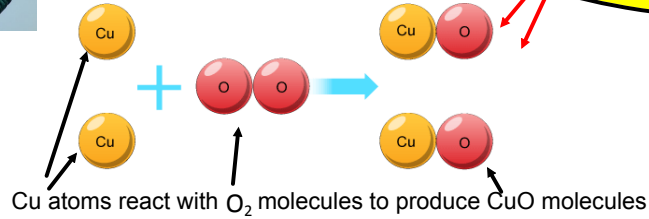
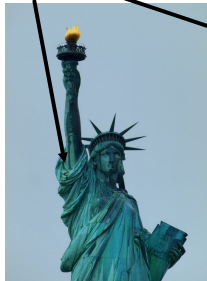
= changes where new substances (new molecules) are produced.

Examples:

Formation of rusts (metal oxides):



Copper oxides

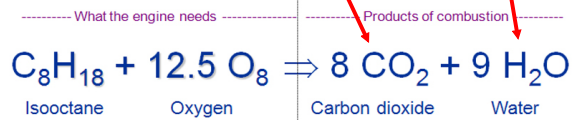
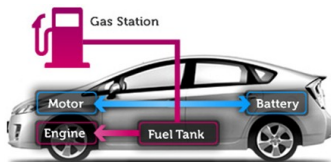


Burning (always involves oxygen gas reacting with something):

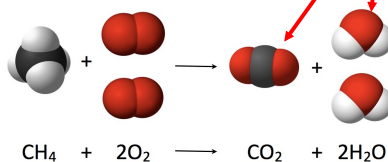
Synonyms:

Combustion = Burning

Burning gasoline:



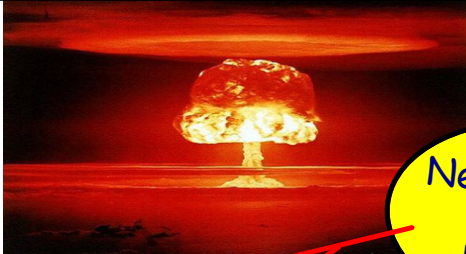
Burning methane:



3. Nuclear Changes

= changes where new ELEMENTS (on periodic table) are produced.

Fission:



e.g.s:



$${}_{92}^{235}\text{U} + {}_0^1\text{n} \rightarrow {}_{56}^{140}\text{Ba} + {}_{36}^{93}\text{Kr} + 3 {}_0^1\text{n}$$

&

$${}_{92}^{235}\text{U} + {}_0^1\text{n} \rightarrow {}_{54}^{144}\text{Xe} + {}_{38}^{90}\text{Sr} + 2 {}_0^1\text{n}$$

New Elements Produced

The sun produces its energy through fusion!



a day without fusion is like a day without sunshine

Fusion:

e.g.:

the Sun fuses 620 million metric tons of hydrogen each second

$$\text{Deuterium} + \text{Deuterium} \rightarrow \text{Helium} + \text{energy}$$
$${}_1^2\text{H} + {}_1^2\text{H} \rightarrow {}_2^4\text{He} + \text{energy}$$

New Element Produced

Alpha decay
 α -decay

e.g.

$${}_{88}^{222}\text{Ra} \rightarrow {}_2^4\text{He} + {}_{86}^{218}\text{Rn}$$

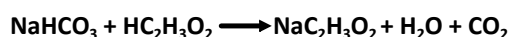
Beta decay
 β -decay

e.g.

$${}_{6}^{14}\text{C} \rightarrow {}_{7}^{14}\text{N} + {}_{-1}^0\text{e}$$

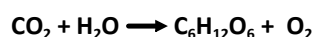
Classify each of the changes below as being physical (P), chemical (C), or nuclear (N):

___ 1. Baking soda and vinegar react and bubbling results:



___ 2. A magnet is used to pick up iron filings.

___ 3. During photosynthesis a green plant uses carbon dioxide and water to produce glucose (a simple sugar).



___ 4. Carbon-14 isotopes are unstable and decay into Nitrogen-14.

___ 5. Salt is dissolved in water.

___ 6. A peeled apple turns brown.

___ 7. An egg white turns from clear to white as it cooks.

___ 8. Bronze is made by melting Copper and Tin, mixing them together, and then letting the mixture re-solidify.

___ 9. Wood is burned: $\text{C} + \text{O}_2 \longrightarrow \text{CO}_2$

___ 10. Heat is released when Uranium-238 changes into Thorium-234.

___ 11. Napthalene, C_{10}H_8 , is the main ingredient of mothballs. Napthalene is a solid that sublimates to release the aromatic gas characteristic of mothballs.

___ 12. A silver ring tarnishes over time.

___ 13. The inside of your car windows fog-up on a rainy day.

___ 14. Protein is digested by enzymes in the stomach.

___ 15. Insects are sterilized using gamma rays, which are a biproduct as Cobalt-60 decays to Nickel-60.

For each item below, describe two changes that could be made to the item that would constitute physical changes, and two changes that would constitute chemical changes.

	2 physical changes	2 chemical changes
an apple		
a block of wax		
a glass of milk		
a cup of sugar		
a piece of paper		
A block of silver		

Writing Equations for Alpha- and Beta- Decay Reactions

Alpha Decay (α -decay)

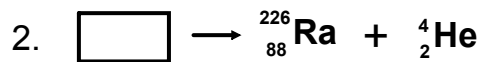
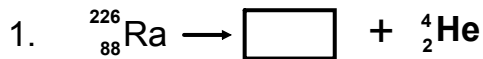


Rules:

- ${}_2^4\text{He}$ (an α -particle) is always produced
- total mass on reactant side = total mass on product side
- atomic number total reactant side = atomic number total product side

Law of conservation of mass hold true
since $234 + 4 = 238$. Total
mass reactants = total mass reactants!

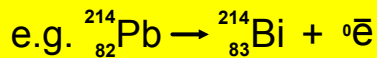
Fill in the blanks:



- Write the equation for the α -decay of Po-210.
- Write the equation for the α -decay of Rn-222.

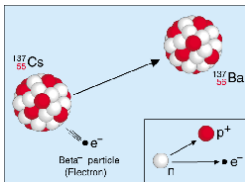
Alpha- and beta-decay
are also called transmutations.
For example, U-238 "transmutes"
into Th-234, and Pb-214 "transmutes"
into Bi-214.

Beta Decay (β -decay)



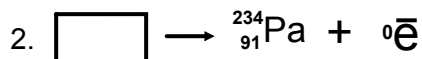
Rules:

- ${}_0^0\bar{e}$ (a β -particle) is always produced
- mass reactant isotope = mass product isotope (since mass $\bar{e} = 0$)
- atomic number of product isotope is 1 more than that of reactant isotope



According to the law of conservation of mass, the mass of the product isotope must equal the mass of the reactant isotope (for beta decay). This is because, within the nucleus of the reactant isotope, a neutron converts into a proton and an electron. The electron (with negligible mass) is all that's lost. The proton has the same mass as the neutron, so the mass is unchanged.

Fill in the blanks:



- Write the equation for the β -decay of Pa-234.
- Write the equation for the β -decay of Ac-227.

1. Write the equation for the α -decay of:

a) Po-214

b) U-234

c) Th-228

d) Bi-212

e) Rn-220

2. Write the equation for the β -decay of:

a) Ra-228

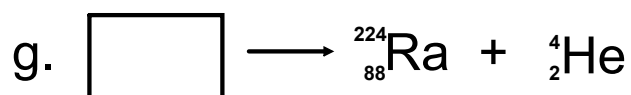
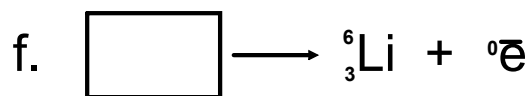
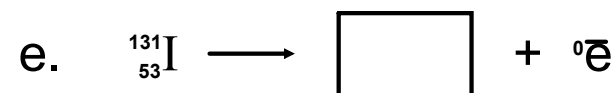
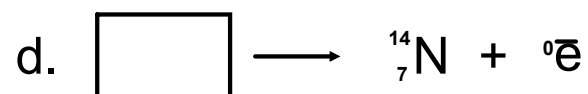
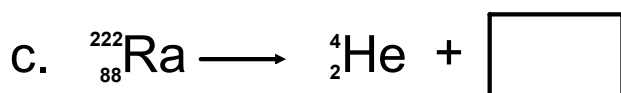
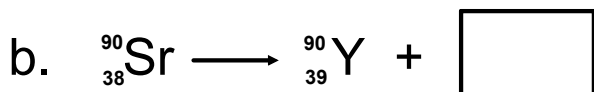
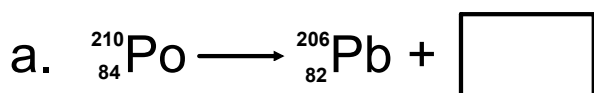
b) Tl-208

c) Fr-223

d) Bi-214

e) Pb-212

3. Fill in the spaces in the following equations:



4. a) For alpha-decay: Explain, according to the law of conservation of mass, why the mass number of the product isotope is 4 less than the mass number of the reactant isotope.

b) For beta-decay: Explain, according to the law of conservation of mass, why the mass number of the product isotope is equal to the mass number of the reactant isotope.