Chemistry 1010

Physical, Chemical, and Nuclear Changes



Review

Which state of matter matches the following pictures?



What could the circles in these pictures represent?

usually molecules, could also be atoms or ions

How can you tell that the particles in a liquid or a gas are moving?

two liquids or two gases mix together without stirring

Which of the changes of state require energy, and which give off energy?

give off energy: condensing, freezing, depositing require energy: evaporating, melting, subliming

Why does it require energy for a substance to melt?

you have to get the particles moving

Why does it require energy for a substance to evaporate? you have to get the molecules moving a lot faster Why is energy given off when a substance freezes?

the molecules slow down and release energy

What temperature will each of the following substances be in at the melting point of water?



Why do different substances have different melting and boiling points?

size of molecules, attractive forces between molecules

Introduction

What was the definition of chemistry given at the beginning of this course?

chemistry = the study of matter and the changes it undergoes

in other words . . .

the study of all the stuff in the universe and what can happen to it

We've talked a lot about how matter is organized.

Now it's time to talk about how matter can change.

In this lecture, we will talk about how to recognize the three types of changes, and how to represent them with equations.

3 Types of Changes

Let's begin by looking at 3 examples:

1) ice melting



2) hydrogen burning



3) tritium decaying



What can we observe happening when ice melts?



solid ice goes to liquid water the surroundings get colder

What is happening to the water molecules?



they break out of their arrangement and start moving around

How can we represent this change with an equation?



What do we observe when hydrogen burns?

bright light and heat is given off hydrogen is consumed oxygen is required too

What is happening to the molecules?



hydrogen and oxygen atoms separate, hydrogens join to oxygens

How can we represent this change with an equation?



What is tritium? a radioactive isotope of hydrogen

What do we observe when tritium decays?



light is given off

What is happening to the atoms?



a neutron turns into a proton an electron leaves the hydrogen turns into a helium

How can we represent this change with an equation?



In which of these three changes are...

the atoms different? tritium decaying

the atoms still the same but the molecules different? hydrogen burning

We call all changes in which the molecules remain the same:



physical changes

We call all changes in which the molecules are different but the atoms are still the same:



We call all changes in which the atoms are different:



nuclear reactions

In physical changes:



only the arrangement of molecules changes no chemical bonds are broken no new compounds or elements are formed

In chemical reactions:



chemical bonds are broken and formed new compounds are formed the elements stay the same

In nuclear reactions:



new elements are formed total number of protons and neutrons stays the same What happens to the energy in each of these changes? How could we show this in the equations?



ice melting: energy is absorbed $H_2O_{(s)}$ + energy $\longrightarrow H_2O_{(l)}$



hydrogen burning: energy is given off $2 H_2 + O_2 \rightarrow 2 H_2O + energy$



tritium decaying: energy is given off

How much energy is involved?



6 kJ/mol 241 kJ/mol 1,790,000 kJ/mol

How do the changes in energy compare between the three types?

physical < chemical < nuclear

Other examples of these changes

1) What does this equation represent?

 $2 \text{ K} + 2 \text{ H}_2 \text{ O} \longrightarrow \text{ KOH} + \text{ H}_2$







adding potassium to water

What kind of change is this? How can you tell?

chemical reaction

bonds between atoms change atoms are still the same

 $C_{11}H_{22}O_{11} + H_{2}O \rightarrow C_{11}H_{22}O_{11(aq)}$ aqueous = dissolved in water



sugar molecules





water molecules







What kind of change is this? How can you tell?

physical change

the molecules are still there no bonds broken

$n^{\circ} + {}^{235}U \rightarrow {}^{92}Kr + {}^{141}Ba + 3 n^{\circ}$



atomic bomb – fission reaction

What kind of change is this? How can you tell?

nuclear reaction

new elements are formed massive amounts of energy released

$H_2O_{(g)} \longrightarrow H_2O_{(l)}$

water condensing

What kind of change is this? How can you tell?

physical change

the molecules are still there no bonds broken

4 ¹H \rightarrow ⁴He + 2 e⁺

this is the process of fusion in our sun hydrogen is converted to helium

What kind of change is this? How can you tell?

nuclear reaction

new elements are formed massive amounts of energy released

4 Fe + 3 $O_2 \rightarrow 2 Fe_2 O_3$

iron rusting

What kind of change is this? How can you tell?

chemical reaction

new compound formed atoms are still the same

Write an equation to represent the following changes.

dry ice subliming

charcoal burning $C + O_2 \rightarrow CO_2$

fusion of plutonium-241 and neon-20 ²⁴¹Pu + ²⁰Ne → ²⁶¹Rf

Which type of changes are most common?

physical change – very common

chemical change – pretty common

nuclear change - not very common