

How does ***Particle Theory of Matter*** explain the difference between mixtures and pure substances?

1) Observation

Pure substances: uniform and consistent properties in different samples.

Mixtures: may or may not be uniform, but properties are variable.

Explanation

In a pure substance, only one type of particle is present.

- every sample is uniform throughout and each is the same as any other.

In a mixture, there are at least two types of particles are present.

- particles can be in any ratio, so that the properties of the mixture can vary between samples.

2) Observation

Pure substances can be combined in certain processes to produce new substances that also are uniform and consistent in their properties.

- these new substances also must be pure substances!

- called compounds

- these processes are called chemical changes.

We know that pure substances have only one type of particle.

We also know that in chemical changes, the reacting particles (atoms) are not destroyed, because we can get them back in subsequent chemical changes.

Explanation

The particles in a chemical reaction must fuse together to form a compound particle.

They must do this in a particular ratio: the properties always are the same, so the compound particles always must be the same.

3) a) Observation

Many pure substances can be broken down into other pure substances.

Explanation

They must be made of compound particles: ***they are compounds***;

- they have particles made up of 2 or more types of primary particles fused together

b) Observation

Some pure substances cannot be broken down by chemical changes.

Explanation

They must have particles that are not compound: ***they are elements***

- they have particles consisting of just one primary type of particle.

Chemical and Physical Changes

There are two types of change:

Physical Changes:

These are processes that combine substances into mixtures, separate mixtures, and change the object properties of substances. **In other words, the change does not alter the particles.**

e.g.: mix sand and water, chop potatoes, break a coffee mug,
evaporate salt water to make pure salt and pure water,
freeze water (any change in state).

Physical changes cause different types of particles to mix or separate.

In a physical change, no new substances are made.

Chemical Changes: (chemical reactions)

These are processes that *change pure substances into other pure substances*. This is the key criterion, a *substance that was not present in the sample before the process starts must be present at the end of the process*. **The particles of the substance are themselves changed.**

e.g.: cooking food, digesting food, burning anything.

Chemical changes cause particles to join or separate to make new types of particle.

A new type of particle means a new substance.

How do you tell if a process is a chemical change or a physical change?

A) Identify a new substance. This can be time consuming, but it is the only certain way.

- look for new physical properties. (e.g. a change in density)
- look for new chemical properties
 - types of chemical reactions that the substance will take part in
 - reacts with oxygen (combustion)
 - reacts with water
 - reacts with acids or bases

B) There are some clues that suggest that a chemical change has occurred:

- i) large amounts of energy are released or absorbed (sample gets hotter or colder)
- ii) a permanent colour change occurs (the new colour lasts as long as conditions remain the same)
- iii) a new odour is produced
- iv) a gas is created (bubbling or fizzing)
- v) a solid precipitate is made (when solutions are mixed)
- vi) the process is difficult to reverse

None of these clues is fool-proof. Write down one exception for each of the clues.

- | | |
|---|--|
| i) water freezes | ii) paint dries |
| iii) melt plastic and you start to smell it | iv) water boils (it is still water, just in the gas state) |
| v) salt precipitates when salt water evaporates | vi) a coffee mug breaks |

What do chemical changes tell us?

The fact that we can turn one pure substance into another new substance tells us that it is possible, with a chemical reaction, to change one type of particle into another!

Do we understand how this works yet?

No, not in this class anyway. We will have to get a better understanding of the nature of particles (we call them atoms now) before we can understand how a chemical reaction changes particles.

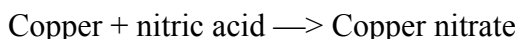
However, we can make a pretty good hypothesis for now, based on the particle theory of matter.

1) It turns out that there are two types of pure substance:

- a) one type can be broken down by chemical reactions into other pure substances.
- b) the other type cannot be broken down into other pure substances at all.

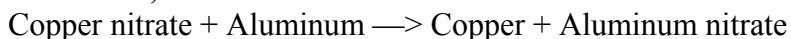
This is important. Without understanding the difference between chemical and physical changes and the difference between mixtures and pure substances, we would never have been able to understand the difference between these two types of pure substance.

2) Think back to one of the reactions that we performed as demonstrations in one of the first classes of the semester:



Copper, nitric acid, *and* Copper nitrate ***all are pure substances!*** They have consistent properties from one sample to another and they cannot be separated into other substances by physical changes.

Thus, we took Copper particles and nitric acid particles and combined them into a new type of particle. However, we also carried out this reaction:



This reaction shows us that the Copper particles must be part of the Copper nitrate particles! In other words, the Copper nitrate particles must be made up of Copper particles and nitrate particles that have been joined together into a single, compound particle!

So, the two types of pure substance are going to be called (in the same order as from 1 above):

b) Compounds:

- pure substances that can be chemically broken down into other pure substances
- have particles which consist of two or more different types of particles joined together somehow into a single, compound particle

a) Elements:

- pure substances that cannot be chemically broken down into other pure substances
- have particles that are not made up of other particles

To summarize: if our hypothesis is confirmed, we have achieved a fundamental understanding of the nature of matter, just from simple experiments and observations.