Ten signs of a chemical change

1. **Bubbles of gas appear.** Gas-producing reactions run to completion when the gas can leave the reaction mixture.

   Gaseous products appear as bubbles only after the reaction mixture has become saturated with the gas. If there are no rough surfaces or dust particles to nucleate the bubbles, the reaction may produce a supersaturated gas solution.

   Bubbles can also be produced when the liquid boils, or when air dissolved in the liquid comes out of the solution as the liquid is warmed.

2. **A precipitate forms**. When mixing a pair of soluble reactants in solution, the sudden appearance of a solid that 'rains down' (precipitates) into the bottom of the container is a sign that a reaction has occurred. Sometimes the precipitate particles are too small to settle out; in this case, look for a cloudy solution. If the amount of precipitate is very small, you can sometimes detect fine particles of precipitate suspended in a solution by shining a very bright light through the liquid. If you can see the beam of light in the solution, fine suspended particles are present.

   For reactions that occur in a melt, don't confuse precipitate with simple freezing.

3. **A color change occurs.** Every compound absorbs a characteristic set of colors of light. This absorption spectrum is a chemical fingerprint for detecting the presence of that compound. When the compound is altered in a chemical reaction, the fingerprint will change, as the reaction progresses. (For a more detailed explanation of why color change accompanies some chemical reactions, see Water to Wine).

   It is possible to have a color change without a chemical change, however, because a compound's absorption spectrum isn't the only thing that affects its color. For example, heating zinc oxide changes it from white to yellow but no real chemical change occurs. The color change is caused by holes and other defects that are created in the zinc oxide lattice as the compound is heated. (See also experiment on heating of hydrated copper(II) sulphate)

4. **The temperature changes.** It takes energy to break chemical bonds. And energy is released when new chemical bonds form. When the reaction involves more bond-breaking than bond making the energy required is often absorbed from the surroundings, making them cooler. When there is more bond-making than bond breaking, the excess energy is released, making the surrounding hotter.

5. **Light is emitted.** Sometimes energy is released by bond-forming reactions in the form of light. This occurs in most combustion reactions. Living things that glow in the dark-such as fireflies, funguses, and deep sea creatures-produce light without heat, using chemical reactions.

6. **A change in volume occurs.** Density is a characteristic of a compound, and if new compounds are produced as other compounds are consumed in the reaction, the change in density can cause the reacting mixture to expand or contract as the reaction proceeds. Sometimes this volume change can be large and very rapid- and an explosion occurs!

   Of course, volume increases and decreases will also accompany temperature and pressure changes, so these must be held constant if volume is being monitored to see if a reaction is occurring.

7. **A change in electrical conductivity occurs.** Some reactions produce or consume ions (charges particles) in a solution. Changes in the character and concentrations of the ions will cause the reacting mixture's ability to conduct electricity to change.

8. **A change in the melting point or boiling point occurs.** The melting or boiling point is characteristic of a compound; when the composition of a mixture changes, the melting point and boiling point also change.

9. **A change in smell or taste occurs.** Since many chemical reactions have poisonous reactants or products, this method of detecting chemical change isn't recommended!

10. **A change in any distinctive chemical or physical property occurs.** Pick a property that uniquely characterizes one of the compounds involved in the suspended reaction, and monitor it. If the property really distinguishes that compound from all the others, you'll see it change when a reaction occurs.