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TEACHER GUIDE

CHEMICAL VS. PHYSICAL CHANGES GRADES 3-5

COMMON MISCONCEPTIONS

- **Chemical changes are caused by heat.**
Chemical changes can be caused by heat, such as toast being burned in a toaster, but heat can also cause physical changes (like when water boils away to steam). Chemical changes are also caused by other means where heat is not a factor.
- **Melting and boiling are chemical changes.**
Melting and boiling are physical changes. Melting happens when heat is added to a solid, and boiling occurs when heat is added to a liquid. Melting is the phase change between solid and liquid, and boiling causes liquid to evaporate to gas. Phase changes are physical changes because the material changes forms but does not result in a new substance.

PHYSICAL CHANGES

Physical changes to matter occur when two or more substances are mixed together and the resulting products are not different types of substances than those you started with. For example, if apples, bananas, and strawberries are cut up and mixed together, the fruit has only undergone a physical change because the fruit salad is still made up of apples, bananas, and strawberries. Phase changes happen when a solid melts into a liquid, a liquid freezes into a solid, a liquid evaporates into a gas, a gas condenses to a liquid, a gas is deposited directly as a solid, or a solid sublimates directly to a gas. These are all examples of physical changes because although a substance's form has changed, it is still the same substance. Whether ice, liquid in a glass, or steam, water is still H_2O .

CHEMICAL CHANGES

When matter changes and a new substance is formed, a chemical change has taken place. Two or more different substances may react (fizzing, bubbling, etc.) when mixed together. There are many ways for chemical change to occur. Substances may mix at the atomic level and combine to form new chemical structures (this level of detail is not addressed in this lesson). Burning materials often creates new substances. Rusting metal, or rotting food or milk, are other examples of chemical changes.

CAUSE AND EFFECT

The crosscutting concept of cause and effect is inherent in what happens during both chemical and physical changes. Something that is done to one or more substances—mixing in another substance, adding heat, cooling, etc.—*causes* a change (*effect*) that we classify as physical or chemical depending on the properties of the resulting substance(s). Cause and effect can be specifically explored through flame tests, as different gases cause different results (effects) that are key in identifying otherwise difficult to differentiate gases.

OBSERVATIONS AND DATA AS EVIDENCE

It is key for students to understand not only what physical and chemical changes are, but how we know which one has occurred. To be able to classify a reaction as one or the other, it is key to be able to identify the end product to determine whether it is a new substance or not. During the video, Dr. Jeff, Zoe, and Izzy conduct tests on the products of some of the reactions to learn what the substance is. Flame tests are introduced as a way to identify different types of gases. Students observe how flame reacts to CO_2 (flame is extinguished) which is visibly no different from the surrounding air. They also observe how hydrogen reacts to flame (flash and pop) on both a small and large scale. It is key for students to understand that the flame tests - and other methods Dr. Jeff, Izzy and Zoe demonstrate - are an important part of understanding physical changes. The evidence that verifies whether a change is physical or chemical comes from knowing what product was made.

MIXTURES

Some non-NGSS states cover the closely-related topic of mixtures. If you need to do this, explain that a mixture is the physical combining of two or more materials. Both of these materials maintain their physical properties and **no new substance is formed**. Use examples like paper clips and rubber bands mixed together, or baseballs and footballs mixed together. Liquids can easily lead to confusion. Materials in a mixture can be separated out using physical processes, like putting all the baseballs in one basket and all the footballs in another.

