

Physical vs. Chemical Changes

Course: Integrated Physics and Chemistry (Grades 9–12) **Subject:** Science **Time:** ~50 min standard · ~90 min block **Work mode:** Independent · pencil only Science

Start Here

This is a **paper investigation**. You will study a particle-model diagram, read a short passage, and analyze a table of described changes and their observations using a pencil. You do **not** need a computer, a lab, or any materials besides this packet and a pencil. There are **no hazards** — nothing is mixed, heated, or measured; every observation you need is already printed for you. Work by yourself and do your best thinking. Write in complete sentences where you are asked to explain, and always point to the **evidence** that supports your answer. If a question is hard, skip it, keep going, and come back. Reading the passage quietly aloud to yourself is allowed and encouraged.

Start Notice & Wonder 5 min

Think about two everyday events: an ice cube melting in a glass, and a piece of toast burning until it is black and smoking.

1An ice cube melts into liquid water; a slice of bread burns into black, smoking char. Both are called "changes," but they feel different. Write **one thing you notice** and **one thing you wonder** about how these two changes are different.

2In which of those two changes do you think a **brand-new substance** was made — something that was not there before? Give your best first idea and say what makes you think so.

Build Read the Science 8–12 min

Physical changes, chemical changes, and the signs of a reaction

Matter can change in two very different ways. The key question is always the same: **Was a new substance made?**

- **Physical change** — the substance changes its **state, shape, or size**, but it is still the **same substance**. No new material forms. The same particles are just rearranged or moved farther apart. Examples: melting, freezing, boiling, dissolving, crushing, bending, or cutting. A physical change can usually be **reversed** (liquid water can be frozen back into ice).
- **Chemical change (chemical reaction)** — the starting substances are changed into **one or more new substances** with new properties. The particles are taken apart and rebuilt into different combinations. Examples: burning, rusting, digesting food, and many mixtures that react. A chemical change is usually **hard to reverse**.

Signs that a chemical reaction may have occurred. You cannot see the particles, so scientists look for observable **evidence**. Watch for:

- **Gas / bubbles** forming when nothing was boiling.
- **Color change** that is not simply mixing two colors.

- **Temperature change** — the material gets hotter or colder on its own (energy is released or absorbed).
- **Precipitate** — a solid that suddenly appears when two clear liquids are combined.
- **Light** or **odor** given off (for example, a flame or a new smell).

Important cautions. A single sign is a *clue*, not proof. Some physical changes *look* like reactions: boiling water makes bubbles (just water vapor, not a new substance); dissolving salt can cool the water; mixing paint changes color without making anything new. The strongest case for a chemical change is when a sign appears **and** you can tell a **new substance with new properties** is present and the change is hard to undo.

Conservation of mass. In *either* kind of change, atoms are never created or destroyed — they are only rearranged. So the **total mass stays the same**. If gas escapes into the air, the leftover solid weighs less, but the mass of the solid *plus* the escaped gas still equals the starting mass.

Word Bank

physical change

a change in state, shape, or size with **no new substance** formed (e.g., melting, dissolving).

chemical change

a change that forms **one or more new substances** (also called a chemical reaction; e.g., burning, rusting).

substance

a single kind of matter with its own fixed properties (color, density, boiling point, etc.).

precipitate

a solid that forms and settles out when two liquids are combined.

evidence

an observation you can point to that supports a claim (a sign of change).

conservation of mass

the rule that total mass stays the same because atoms are only rearranged, never made or destroyed.

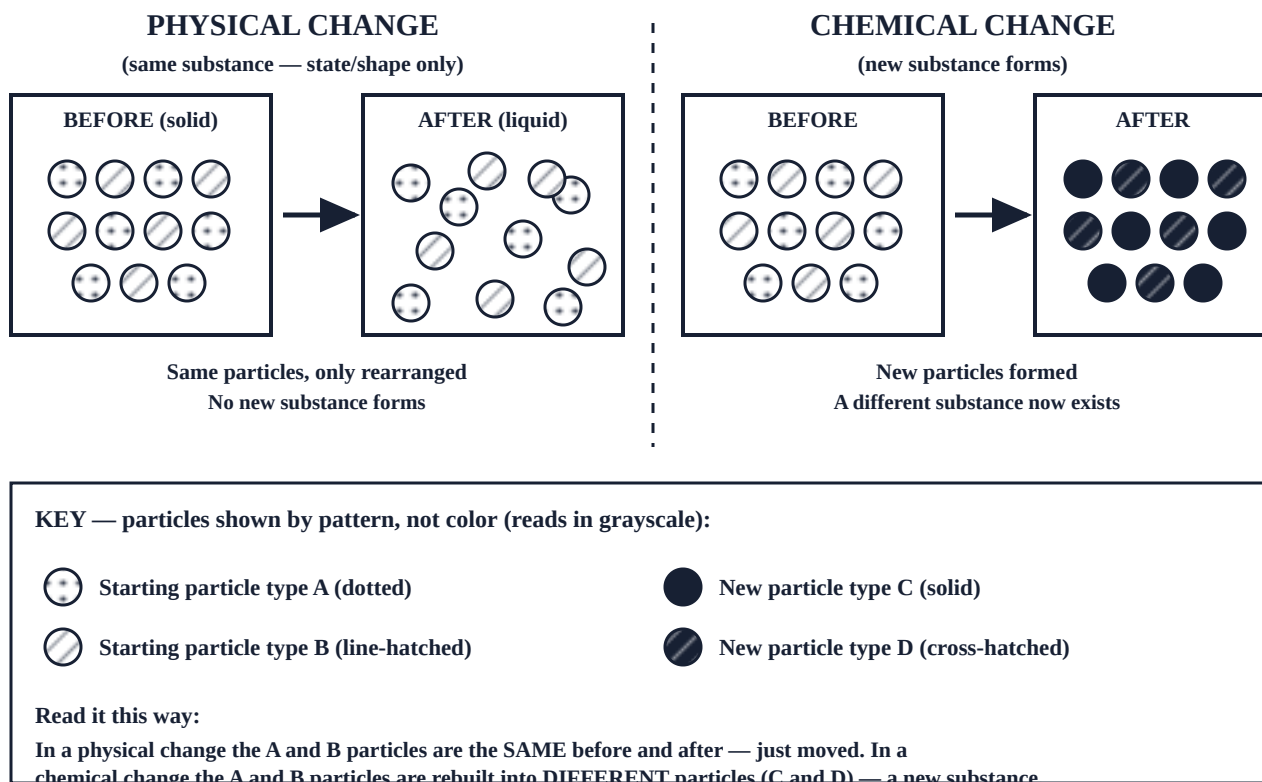


Figure 1. A particle model of the difference between the two changes. On the **left**, a **physical change**: the same particles (dotted type A, line-hatched type B) appear before and after — they are only spread farther apart, so **no new substance** forms. On the **right**, a **chemical change**: the starting

particles are rebuilt into **new particles** (solid type C, cross-hatched type D), so a **new substance** now exists. Meaning is carried by **patterns and labels**, not color, so the figure reads clearly in grayscale.

3Using Figure 1, describe in one sentence how you can **tell from the particles** whether a change is physical or chemical. Use the words **same particles** and **new particles**.

Apply Use the Data 20–25 min

Table 1 describes six changes and the observations someone recorded for each. You will not perform these — the observations are given. Study the table, then answer. (These are original descriptions written for this packet.)

Table 1. Six described changes and the observations recorded for each (original scenarios).

#	Change described	Observations recorded
A	An ice cube is left on a warm counter.	The solid turns to liquid water; no bubbles, no color change; it can be refrozen into ice.
B	A strip of shiny iron sits outdoors for two weeks.	A flaky orange-brown layer builds up; the new coating is brittle and does not conduct or shine like the iron did.
C	A spoon of table salt is stirred into a glass of water.	The salt seems to disappear; the liquid stays clear; evaporating the water leaves the salt behind unchanged.
D	Two clear liquids are poured together.	Instantly a cloudy white solid forms and settles to the bottom; the mixture also feels slightly warm.
E	A birthday candle burns.	The flame gives off light and heat; wax disappears; a faint smoky odor and a little water vapor and gas are produced.
F	A sheet of paper is folded and torn into small pieces.	The pieces are smaller but still white paper; nothing bubbles, heats, or changes color.

4**Classify and justify.** For each change A–F, write **P** (physical) or **C** (chemical), then in a few words **justify** your answer by naming the **evidence** from Table 1 you used.

- A) Ice melting _____ Evidence: _____
- B) Iron rusting _____ Evidence: _____
- C) Salt dissolving _____ Evidence: _____
- D) Two liquids poured _____ Evidence: _____
- E) Candle burning _____ Evidence: _____
- F) Paper torn _____ Evidence: _____

5**Strongest sign.** Look again at change **D** (two clear liquids form a cloudy solid). Two signs were recorded: a **precipitate formed** and the mixture **felt slightly warm**. Which single sign is the **strongest evidence** that a chemical reaction occurred, and why is the other sign by itself weaker?

6**Trap check.** A classmate says, "Change A (ice melting) and change C (salt dissolving) must be chemical because the ice disappears and the salt disappears — the stuff is gone!" Explain why **disappearing is not evidence of a new substance** here. Point to the observation in Table 1 that shows the substance is still the same.

7**Observation vs. inference.** Write **O** if the statement is an observation (something recorded directly in Table 1) or **I** if it is an inference (a conclusion you reason out).

- _____ a) In change D, a cloudy white solid formed and settled to the bottom.
- _____ b) A new substance was created when the two liquids in change D were combined.
- _____ c) In change B, a flaky orange-brown layer built up on the iron.

____ d) The rust in change B is a different substance than the iron it formed on.

8Two look-alikes. Boiling water makes bubbles, and burning a candle makes bubbling gas too. Using the idea of a **new substance**, explain why the bubbles from **boiling water** are a **physical** change but the gas and light from a **burning candle** are a **chemical** change.

Explain Claim–Evidence–Reasoning 7–10 min

Question 9. Here is a **borderline case**. A shiny silver spoon is left in a dish for a month and slowly turns dull and dark on the surface; the dark coating can be gently rubbed off, revealing shiny metal underneath, and the coating has a different color and dullness than the silver. Is this a **physical** or a **chemical** change? Write a **claim**, support it with **two pieces of evidence** from the description, then explain your **reasoning** using the idea of a new substance and its properties.

Sentence stems you may use: "This is a ____ change because..." · "One piece of evidence is..." · "A second piece of evidence is..." · "This shows a new substance formed because its properties (color / dullness) are different from..."

Claim

Evidence (two pieces from the description)

Reasoning

Block-period addition — conservation of mass:

Extend your reasoning above. When the silver tarnishes, atoms from the air combine with the silver surface, so the dark coating actually has **slightly more mass** than the clean silver did. When a candle (change E) burns, the leftover candle weighs **less** because gas escapes into the air. On the lines below, explain how **both** results still obey **conservation of mass** — that atoms are only rearranged, never created or destroyed — and why you would have to **trap the gases** to show the total mass did not change.

Close ACE Wrap-Up 5 min

Articulate

In your own words, explain the one question you ask to tell a physical change from a chemical change.

Connect

Point to one row of Table 1 whose observations give the clearest evidence of a **chemical** change. Name the sign.

Extend

Give a **new** everyday example (not in Table 1) of a chemical change, and name the sign of a reaction you would expect to see.

Continue Early Finisher & Block Extension optional · block ~+30 min

If you finish early (no new materials needed):

Build your own sorting table. On the back of this page, make a two-column chart headed "Physical" and "Chemical." List at least **four changes from your own life** (for example: chopping vegetables, a nail rusting, sugar dissolving in tea, wood burning in a campfire). For each one, write the **sign** or reasoning that put it in that column. Circle the one change you were least sure about and write one sentence explaining why it was tricky.

Block-period extension — design an evidence test:

Imagine you are handed a sealed clear bag containing a mystery solid and a small tube of liquid that you can break to mix them, **without opening the bag**. Describe a plan, using only observation, to decide whether mixing them causes a **chemical** change. List the **signs** you would watch for, explain how the sealed bag lets you check

conservation of mass (weigh the bag before and after), and state which single observation would most convince you a **new substance** formed. Write it as a short numbered procedure.

Turn in: Hand in this whole packet with your name, class period, and date filled in. Make sure questions 1–9 and the ACE box are answered. The block conservation-of-mass paragraph, the early-finisher sorting table, and the block evidence-test plan are optional — turn them in too if you did them.

HS_IPC_PhysChemChange_01 — Physical vs. Chemical Changes Student Packet