

Teacher Notes- “Candlelight Journey Through The 3 States Of Matter”

Teaching the states of matter doesn't have to be difficult. It can indeed be easy and even pleasant, as this activity demonstrates. In it students will observe a lit candle in total silence and write their observations. Then each student will share an observation. And those you will build on, gradually introducing them to the states of matter.

The emphasis in this lesson is on energy, which is constantly entering and leaving atoms, causing them to speed up and slow down. You can use it anytime during your chapter on the states, but it's a perfect chapter opener.

Materials per group of 4 students:

1-candle and holder

Additional Teacher Materials:

Lighter/matches

Beforehand:

1. Decide how many candles to light:
 - a. If you aren't sure if candles are allowed in your building, ask your principal. But before going in to talk, be ready to explain the need for them, as well as precautions you'll take. Some buildings don't allow *decorative* candles, but allow them for purposeful lessons like this.
 - b. If you aren't comfortable with candles right in front of students, you can get by with just one large one at the front or center of the room, though there are obvious drawbacks. To see if this will work for you, light a candle and walk around your darkened classroom to see how well every student would be able to see. You may also come up with another idea in the process.
 - c. Putting each candle in a plastic box or on something non-flammable will reduce risk and waxy mess.
2. Prepare yourself:
 - a. Close all window blinds.
 - b. Remind yourself and students where the running water, the fire extinguisher, and other emergency items are around your room, should anything go wrong.
 - c. If you have exhaust fans, turn them on. When all the candles get blown out there's going to be some smoke.
 - d. Think ahead about what *could* go wrong, and then decide what you would do if anything were to happen. Plan on speaking to your students about getting



anything too close to the flame. Books should be removed from the table top. Hair and loose clothing kept back.

- e. Put matches or lighter in your pocket, or in an accessible place student's can't get to.
- f. Set out candles and stands *the day before*. Leave yourself time to realize you're missing something, research something or even make a change. In the morning read through the notes one last time. Relax and have fun along with your students. Remember- you're only as effective as your plan.

Procedure:

1. Ask students to take out a sheet of paper and title it "Candle Observations". If candles are not yet out, have students get them now. Also have students remove everything else from their table top or desk except their paper and pencil.
2. Before turning out the lights and lighting the candles, introduce the lesson and talk to students about what is about to happen, and the purpose of this activity.
3. Turn off the lights and light candles. As you do, remind students how much you trust them by doing this. Be specific with your warnings so they know you've thought about this ahead of time and realize the danger:

"Students- keep everything, and that means EVERYTHING, at least 2 feet away from the flame. And please don't blow at the flame either since it interferes with the purpose of this lesson (*and annoys everyone else*).

(*and since most students like to please, also throw in...*) Be a responsible person today so I won't get called into my principal's office and have to explain how one of you burned yourself in my class. **Any silliness at all, and your candle will be immediately blown out (be ready to enforce this!).**"

Caution: Keep flammables, loose clothing, hair, and hands well away from the flame. Locate all fire safety equipment and be familiar with their operating procedure BEFORE class begins. Comply with all fire codes in your building. Keep matches and lighters out of student reach. Blow out candles as soon as the lesson is over.

4. If you want, this would also be an ideal time to talk about using candles safely at home. Most students aren't aware that the flame is over 1,000° F. Candles are beautiful, soothing, and aromatic. But keep them away from curtains, papers, and anything else flammable.
5. Now on to the lesson:

"We are starting a chapter on solids, liquids, and gases today. They are all around us, and right now it is also happening right in front of you. All 3 states of matter, solid, liquid, and gas, are occurring right now around your candle.

We will now take 5 quiet minutes and observe the candle. Study it. Let your mind go, and notice things you never have before. As you notice things write them down on your paper.

The reason I want you to observe for 5 minutes is because for the first minute or two you'll be noticing things you've always noticed about candles, and the last minute or two you'll notice some new and interesting things. There's no certain number of things I want. Just a good list.

When the 5 minutes are up, you will each share one observation. I'll mark the time on my watch right now. You may begin observing and writing."

6. Note what time the class began their 5 minute observation period. During the 5 minutes, stay seated and observe your students. That tells them that you think this is the most important thing going on, and they can't get away with anything silly like they could if you were distracted with busywork. While students are observing the flame for 5 minutes, you'll also have a chance to watch them being enthralled with the movements of the flame, and struggle to put their thoughts into the right words.
7. When the 5 minutes are up, tell students to choose one observation they wrote and be ready to share it when called on. It's ok if they share one that's already been said. When you're speaking at this point, use a soft voice because it fits the mood and sets a tone of respect. Ask students to speak up when it is their turn, as if they're talking to the person sitting furthest from them.
8. With the lights still off, call on students for their observations. As they share, listen to every word they say. If they have a very soft voice repeat what they said for others to hear. Be appreciative of each thought, and make it a point early on to build on the thoughts of a student not typically successful.
9. When leading the discussion, do more listening than speaking. Although there are some ideas you need to eventually get across (see step 11), it may be best to let your teacher notes go. That will seem scary at first, but the discussion always turns out better when it originates from the students.
10. Here are a few observations that you'll likely hear from students:
 - The candle got smaller the longer it burned
 - Some of the liquid wax ran down the side and turned back into a solid
 - My candle is red
 - The flame is blue on the bottom, then yellow, and red on top
 - There is a small "halo" about an inch around the flame
 - The top of the flame is brightest
 - The middle of the flame is brightest
 - There is a shadow dancing at the bottom of the candle holder
 - The flame moves with the air currents
 - The top of the candle stick is glowing
 - The end of the wick glows orange
 - The area just around the burning wick is black

11. When they mention things like “wax ran down the side”, that’s an opportunity for you to incorporate today’s main topic- the states of matter. Notice with them that the wax was a solid, then liquid, then solid again. All the while staying wax. How in the world does that happen? Don’t talk long- you’ll bore them. Someone else will bring the same point up again soon.
12. During class today there are two essential points you’ll need to work in:

1.) Nothing changed chemically
and
2.) Energy causes change

13. Build on the first point:

1.) Nothing Changed Chemically

“Look at the candle stick. It’s a solid, right? Made of wax. Look at the liquid below the flame. What is it chemically? (*not sure*)

If I burned a piece of paper, we’d be left with a mess of black ash. The paper is gone and we can’t get it back, right? (*yes*)

We’ve made something new, so we say a chemical change has occurred. Has a chemical change occurred today with the wax? (*I don’t think so*)

Is that puddle still wax, or is it something else? (*it’s still wax*)

How do you know? (*when it ran down the side, it hardened and turned back into solid wax*)

Good. And that’s what we call a physical change. It’s like tearing a sheet of paper in half- its physical appearance has changed but it’s still paper.

So... solid wax and liquid wax are the same, huh? (*yes*)

They look different, but chemically they’re both wax.

Now, if I take an ice cube out of the freezer and set it on a table, it will turn into a puddle. If I put that back into the freezer, it’s ice again, which I can take back out and melt, put back in, and on and on. Chemically, it stays H₂O the whole time, just like chemically this stays wax the whole time. I wonder why it changes then.

The wax changes, it liquefies, but then hardens and turns back into the exact same stuff. It changed, but not chemically, right? (*right*)”

14. Later, after more student thoughts have been share, you can plant the next thought:

2.) Energy Causes Change

“We know now that solid wax and liquid wax are chemically the same. And if the solid and liquid wax are chemically the same, I wonder what makes the solid wax different from the liquid? You know, they’re not *exactly* the same- one is a solid, the other a liquid. (*long silence*)

Let me ask you this- when did the solid wax begin melting into a liquid...at what moment? (when it was lit)

Good. And if we blew the candles out, would they stop melting? (yes)

The heat from the fire is causing it to change from solid to liquid. We could test that if we wanted to by blowing out the candle and seeing if it stops turning into a liquid, and we all know that would happen.

So, fire caused our wax to melt. But what about our ice cube- there was no fire there? Or a piece of chocolate in your mouth. What could be happening to cause the change? (*if there’s still silence say...*) another name we use for fire is..... (heat), very good, and heat is.....(energy?)

ENERGY!

The wax, the ice, the chocolate all melt, or liquefy, when energy is added.

There we go! Good ‘ole energy.

Now, let’s say I had the power to take all the energy out of you. How active are you? (not at all)

Ok, good. Let’s go the other way- what if I increased your energy by 100 times, what happens? (I’m more active)

Yes- you’re more active! Are you still the same person, chemically? (yes)

Sure you are! Now look at the liquid wax on the top of your candle. You knew all along it was the same as the solid wax, but maybe you weren’t sure why. Until now.

The only difference between the liquid and solid wax is the energy. If energy goes into the atoms that make a solid, it turns into a liquid. And then if enough energy is removed it can turn back into a solid. The atoms themselves never change.

And remember our proof- not until fire, or heat, or, what was that other word? (energy) appears will the solid become a liquid. If we had left your candle in the box for a hundred years and done nothing with it, it would never liquefy, would it? (no)

So, energy can go in. And energy can also come out. Watch wax run down the side of your candle, then slow down and harden. Anyone now want to try to explain why that happens? (wax runs down the side, away from the heat, so it cools and its energy goes down, and it turns back into a solid)

Great!”

15. For most students this is plenty enough to think about, and if they understood most of what you said, it’s been a good day. But if your students have room in their minds for

more, you can venture into the realm of gases. Continue the same dialogue, only now it's an increase in energy from a liquid. Some students might even discover that the area on the table around the base of the candle feels waxy. That got there when the wax briefly turned into a gas.

16. Turn lights on and have students blow out candles.

17. In a 45 minute class period, you should still have about 10 useful minutes. Most textbooks have a series of drawings of what the atoms in a solid, liquid, and gas look like (increasingly more active). Have students copy those drawing along with the captions below their candle observations for homework.

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