

## “Sometimes, solid + liquid = gas”

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Addresses California Content Standards for Grade 3 Physical Science, items 5 and 6: (5) Matter has 3 states, and (6) Combining substances can create new substances with different properties.

### Materials

water  
vinegar (acetic acid) (~ 1 cup/class)  
fresh lemon juice (3 lemons/class)  
liquid base??

flour (1 cup/class)  
baking soda (1 cup/class)  
salt (1 tablespoon/class)

indicator (liquid from boiled red cabbage – boil at least 10 minutes, and filter out cabbage)

Dixie cups (~ 1/ kids). Preferably, some bigger (for doing reactions), and some smaller clear plastic cups, so students can see the effect of indicators  
Small-necked bottle  
Balloon  
paper towels or a dishtowel or two

### Vocabulary:

(write on board):  
phase (solid, liquid, gas)  
phase change  
evaporation  
melting  
hypothesis  
experiment  
physics: study of matter and energy  
chemistry: the study of the composition, structure and properties of different materials

### Lesson Plan

1: Introduce self. I am a physicist, interested in the study of energy and matter, and how you can change different types of matter from one form into another. Today, we're going to do some experiments to study this question. During the experiment, if you have any questions at all, please raise your hand, and I'll call on you.

2) Let's consider something simple, like water. Who can tell me some forms that water can have? Liquid, gas solid (ice). What about snow? Can there be different forms of solids? **{find an example?}** What makes matter change phases? (heat/temperature./cooling)

3) Are there other ways to get different phases of matter? What about if we mix different types of matter? Can we mix a solid and a liquid, and get a gas, for example?

4) How can we find out? Try it? Key thing about science – you can make whatever guess you want but experiments tell you what's right. Scientists call this guess a 'hypothesis' We can phrase it "I think that..." or "I hypothesize that..." Does someone want to make a hypothesis about what will happen if we mix a gas and a liquid?

5) I brought along some solids and liquids that we can use to do some experiments:

**Liquids – I hand out**

water

vinegar (acetic acid) [bring bottle if possible]

fresh lemon juice [bring lemons]

liquid base ?? dilute bleach – for demonstration only (don't let kids use)

**Solids – teacher hands out**

flour

baking soda

salt

So, we do some experiments and see what happens. Let's divide into groups of 4 (3 or 5 is OK if the numbers work that way).

I'm going to give you each a cup to mix things in. Can one person from each group come up and get a solid, and another get a liquid. ¼ of a cup of liquid is probably good (less for the lemon juice), and a tablespoonful of the solids.

Now, go ahead and mix the solid and liquid – what do you see

(go around and check with groups, draw table?)

6) So, can someone report on what happened. Here is a table where we can record our results. I'll put a 'F' (for fizzing) if something happened, and a 'N' if nothing happened.

	Flour	Baking soda	salt
Water			

vinegar			
Lemon juice			

Please save your chemicals; we'll return to them later.

7) What happens when we mix the chemicals? (sometimes fizzing, bubbling, sometimes nothing ???) What can we conclude? When something happens, we can call this a "chemical reaction" But, how do we know that it's giving off gas? What's one characteristic of gas? It doesn't weight much/ takes up lots of room, so if a gas is given up, the material will take up more volume.

8) Let's try a modified experiment. I have here a bottle. I'm going to put some baking soda and some vinegar, and then quickly slip this balloon over the top. What happens? The balloon blew up. Why? Well, if the reaction gives off a gas. Gas is much less dense than solids or liquids, so it can take up lots of room.

9) Now, let's go a little bit further? We saw that some materials reacted, and some didn't. Let's stick with the liquids. Do you think that lemon juice and vinegar are alike in some way, since they seem to produce similar reactions? Let's see if they are. I have here a bit of liquid called an "indicator." I'm going to come around and pour a bit of indicator onto both your solid and your liquid, and I want you to look and see what happens. Pay particular attention to the color.

10) What happens?

Water	Vinegar	Lemon juice	Baking soda	flour

So, what do we see here?

Vinegar and lemon juice turn the indicator purple/red, while baking soda turns it yellow/green.

11) So, what can we conclude? The liquids that produced the gas turn indicator red/purple, while baking soda (the solid that reacted) turns indicator yellow/green

12) Maybe what we have is a general rule here. We call the materials that turn this indicator red/purple acids, and the materials that turn it yellow or green are called 'bases' What we can see is that acids react with bases, and vice-versa. In the reactions we've tried today, these reactions give off a gas, but with other acid-base reactions, that may not happen.

13) What other things would you like to test?

14) So, to summarize: we wondered (hypothesized) that if you could mix a solid and liquid you could (not) produce a gas. We tried an experiment and found out that our hypothesis was right (wrong)

**Maybe use...see how it goes**

An alternate table for displaying results

Material	Hypothesis	Observation
Water + flour		