Model based Inquiry

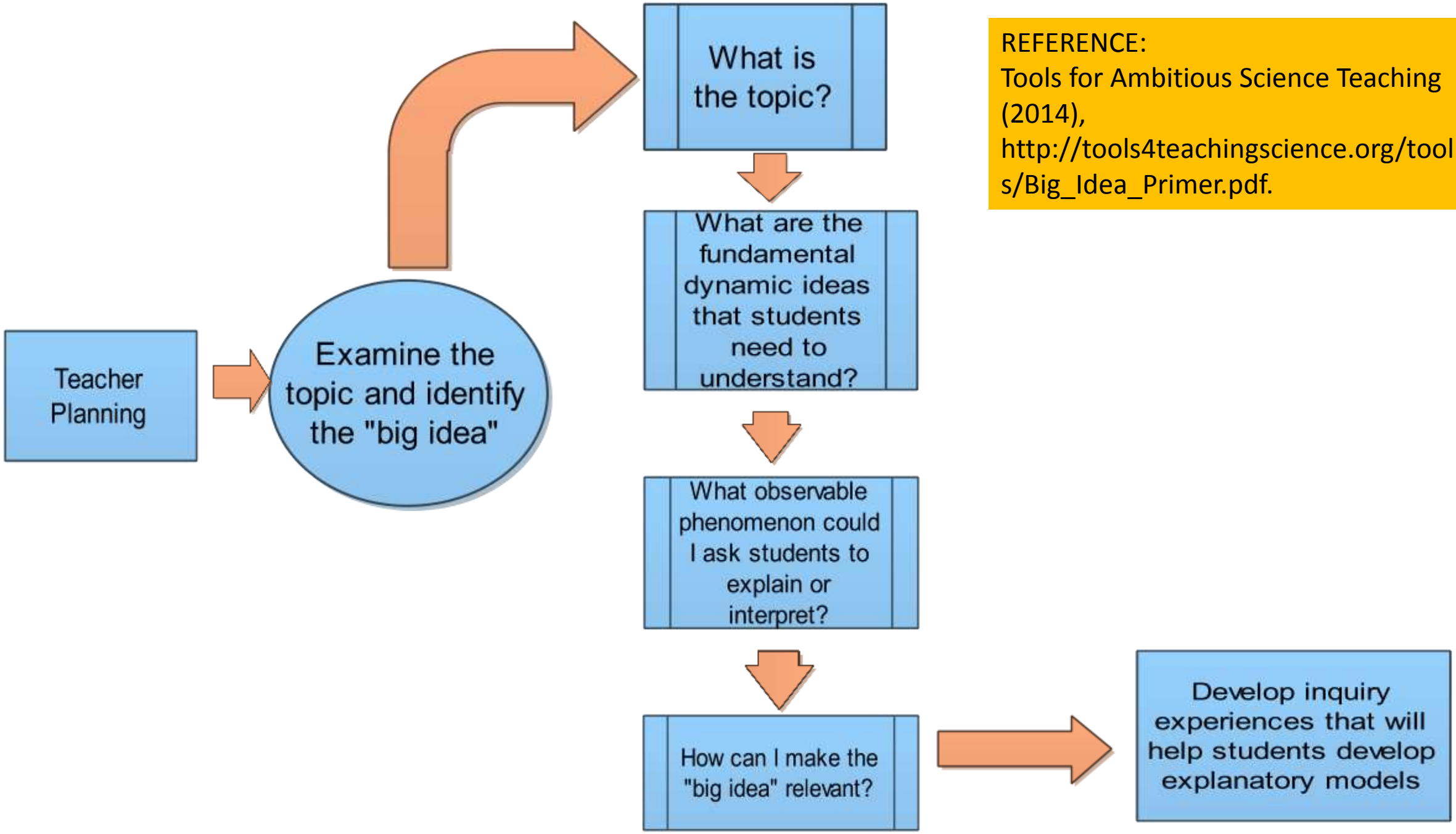
Engaging learners to develop a deeper understanding of scientific concepts.

What is meant by modelling in science?

- A process by which scientists use models to represent ideas about the natural world to each other, and then collaboratively make changes to these representations overtime in response to new evidence and understandings.

Don’t textbooks and teachers often use models to explain and represent things?

- Modelling is a knowledge building activity. It is the **process** of constructing the model that generates knowledge.
- Explanatory models in science use ***unobservable*** features, events, processes, and structures to explain what we can ***observe*** or ***detect***.
- Models are revisable and students revise their model explanations as their understanding deepens.



REFERENCE:
Tools for Ambitious Science Teaching (2014), http://tools4teachingscience.org/tools/Big_Idea_Primer.pdf.

Sequencing:

- Students were shown a video clip of an incident that they were to try to explain using models.
- Students drew initial models to try to explain what was happening.
- Students used computer simulations to try to picture what was happening at the microscopic level.
- Students participated in a number of inquiry type of activities.
- Students engaged in group and class discussion.
- Students continuously revisited their models and through group discussion their models evolved to reach the causal explanation.

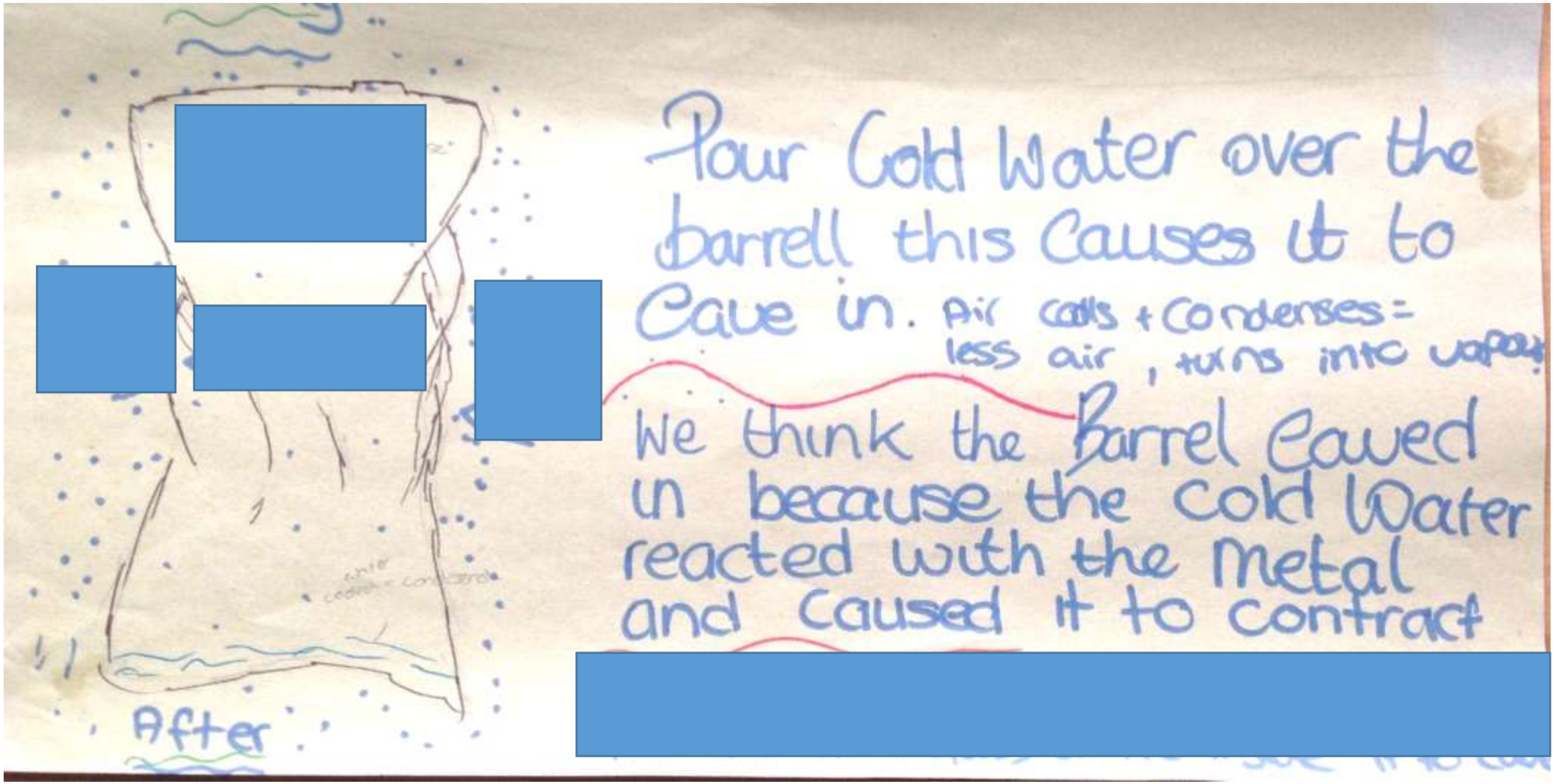
Topic : Pressure

- Motivating Phenomenon:

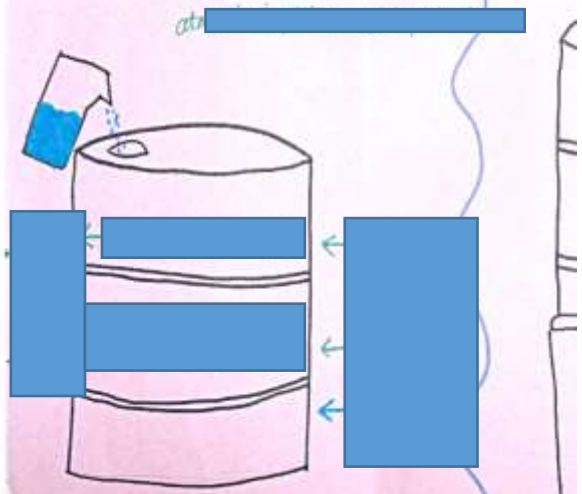
Two videos. The first shows a collapsing tanker and the second shows a more staged type of setup. Videos were edited to remove any explanations. Students are to attempt to develop a causal explanation for the second and then apply this to explain what may be happening in the collapsing tanker.

https://www.youtube.com/watch?v=Zz95_VvTxZM

https://www.youtube.com/watch?v=TvPX107lhWc&feature=youtu.be


Pour Cold Water over the barrell this causes it to cave in. Air cools + condenses = less air, turns into vapour
We think the barrel caved in because the cold water reacted with the metal and caused it to contract
After

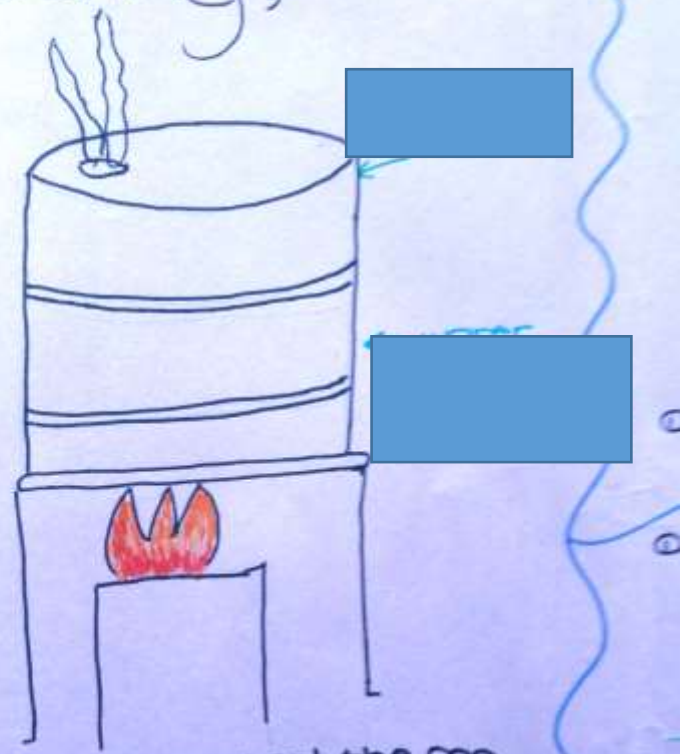
Before;



① Fill barrell with 1/10 of the volume with water.

② Doesnt matter if its cold or hot water!

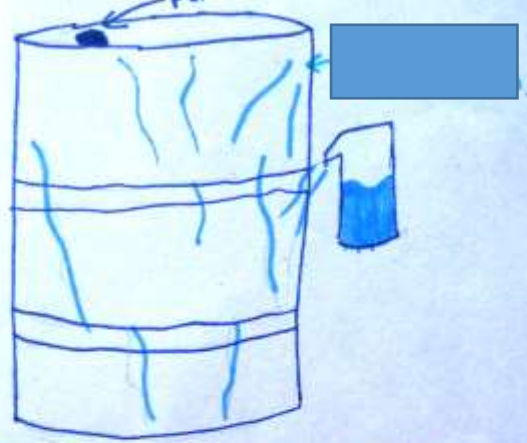
During;



① They heated the can so that the water would turn to water vapour.

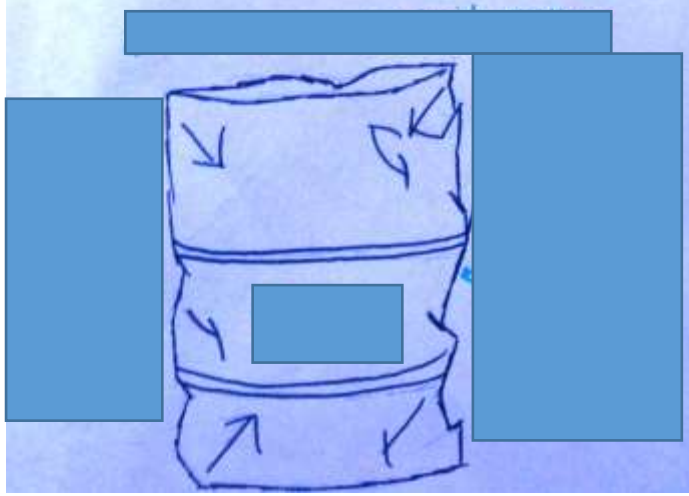
② Then take can off heat.

after;

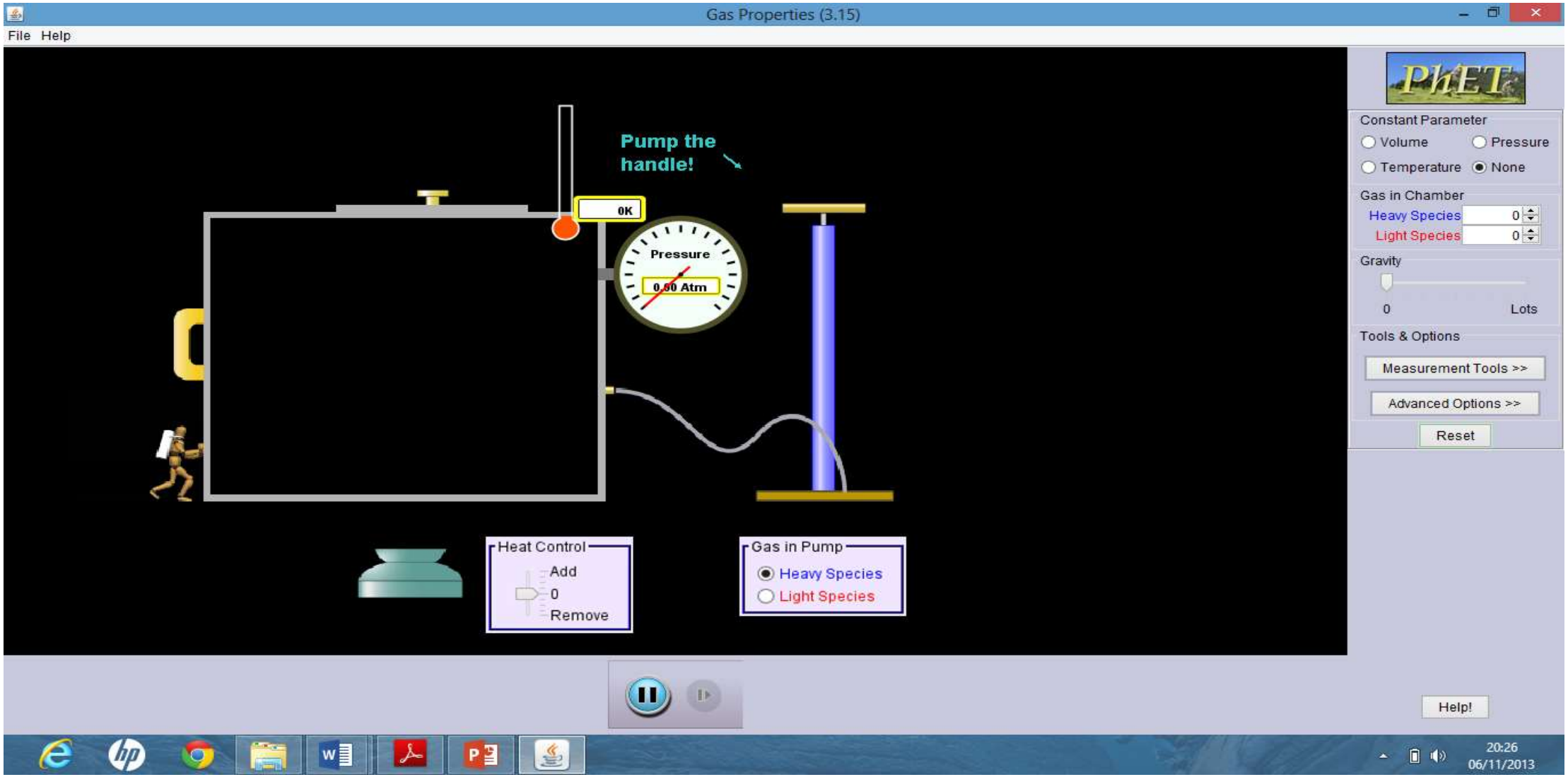


① They poured cold water on the can to cool it down.

① The can crushed because of the cold water.

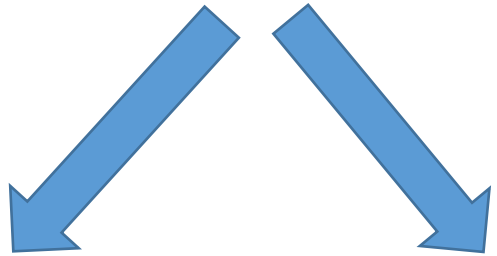


PhET simulation on gasses



Assessment for learning is crucial to the process.

Looking at the initial models it was clear that students were clear that a force was acting on the can causing it to crush.



get them thinking about balanced and unbalanced forces and motion

Address the issue of a pulling force causing the can to collapse

Guided inquiry: egg activity and marshmallow activity

Two students were setting up the equipment they needed to prove Hooke's Law (remember that is the experiment which looks at the extension caused by hanging a mass on a spring.) They set up their equipment as shown and they then hung a mass on the spring. The mass initially moved downwards pulling the spring down but then it stopped moving.

The students were asked about the forces acting. The students discussed their answer.

Student one: When the spring moves down there is a force acting downwards and force causes motion. But when the movement stops there are no forces acting because there is no motion.

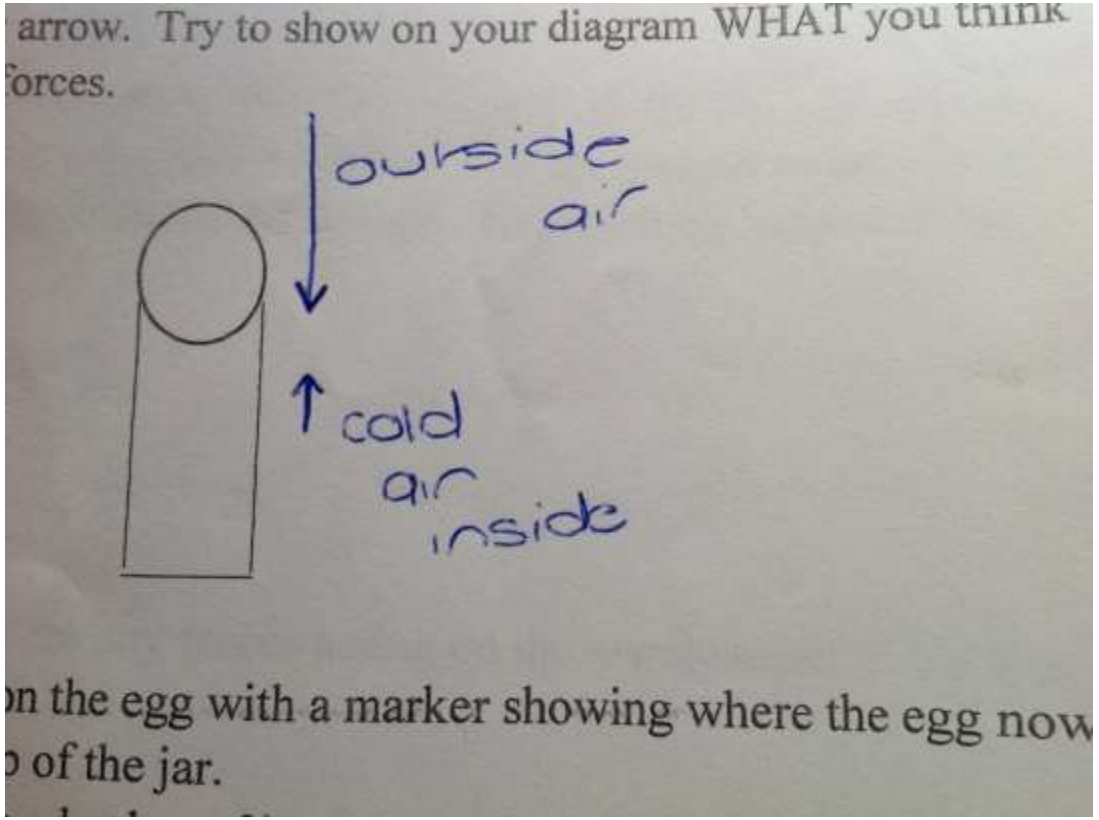
Student two: I think that when the movement stops the Weight is still acting downwards. There is still a downwards force but the spring exerts a force in the opposite direction. There are still forces acting but they are balanced.

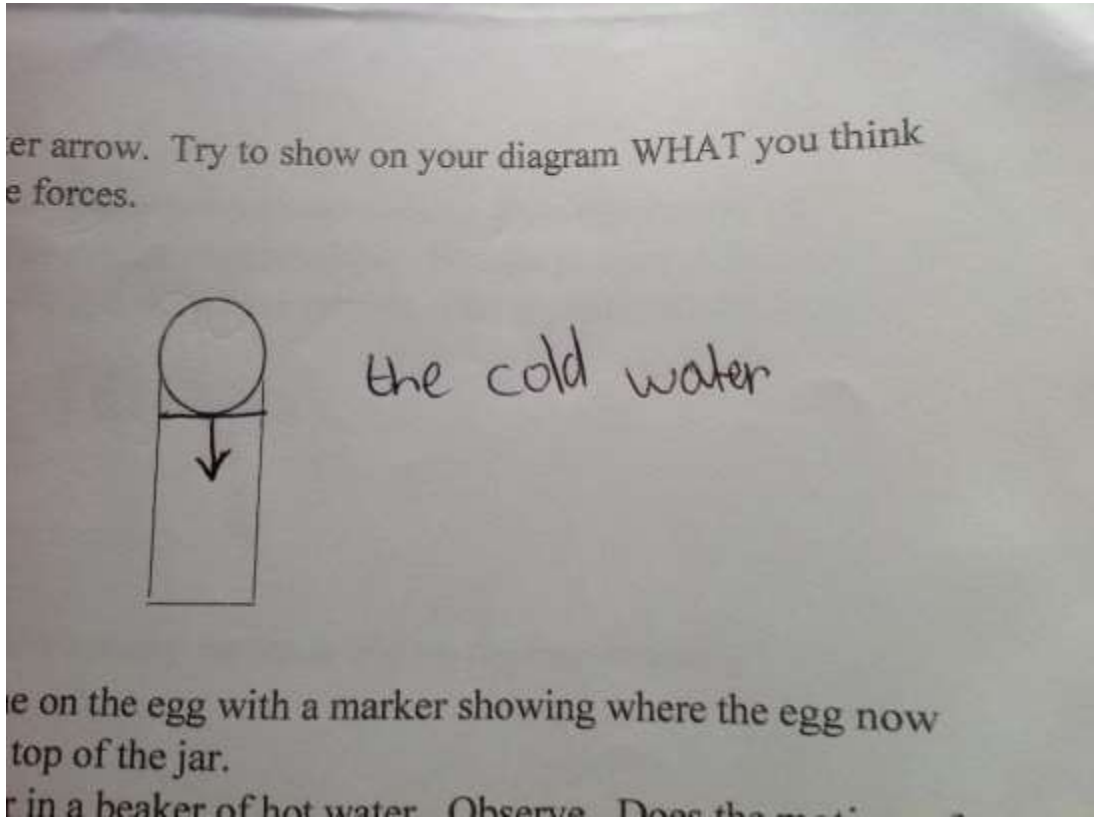
Which answer do you think is correct and why? Write your explanation below.

Egg activity

- Boiling water is initially placed in the jar.
- When the jar is placed in a bowl of ice the egg begins to move into the jar.
- This was part of a guided inquiry activity and students were asked to represent on a diagram what forces were acting on the egg as it moved into the jar.

Student responses..

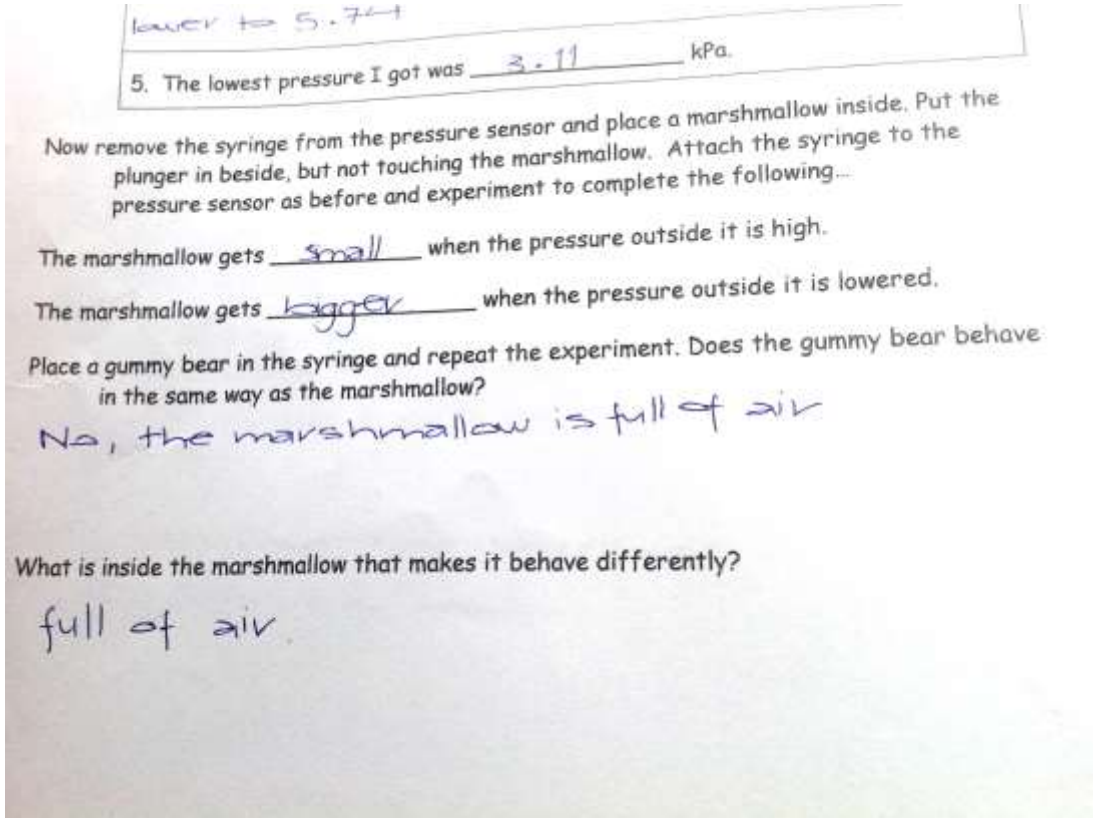




Marshmallow activity

- Students were asked to record pressure readings and to note what happened to the marshmallow. They were then asked to replace the marshmallow with a gummy bear and to account for any differences in what happened..

Student responses


lower to 5.74

5. The lowest pressure I got was 3.11 kPa.

Now remove the syringe from the pressure sensor and place a marshmallow inside. Put the plunger in beside, but not touching the marshmallow. Attach the syringe to the pressure sensor as before and experiment to complete the following...

The marshmallow gets small when the pressure outside it is high.

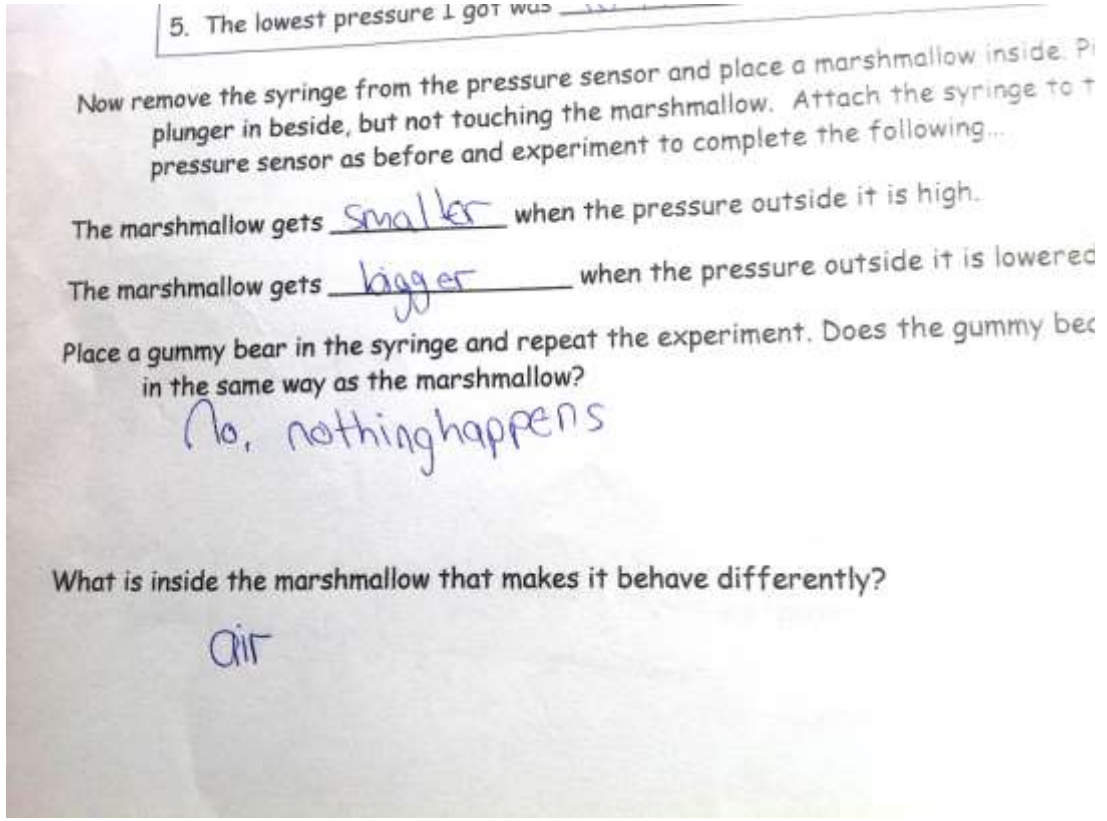
The marshmallow gets bigger when the pressure outside it is lowered.

Place a gummy bear in the syringe and repeat the experiment. Does the gummy bear behave in the same way as the marshmallow?

No, the marshmallow is full of air

What is inside the marshmallow that makes it behave differently?

full of air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No, nothinghappens

What is inside the marshmallow that makes it behave differently?

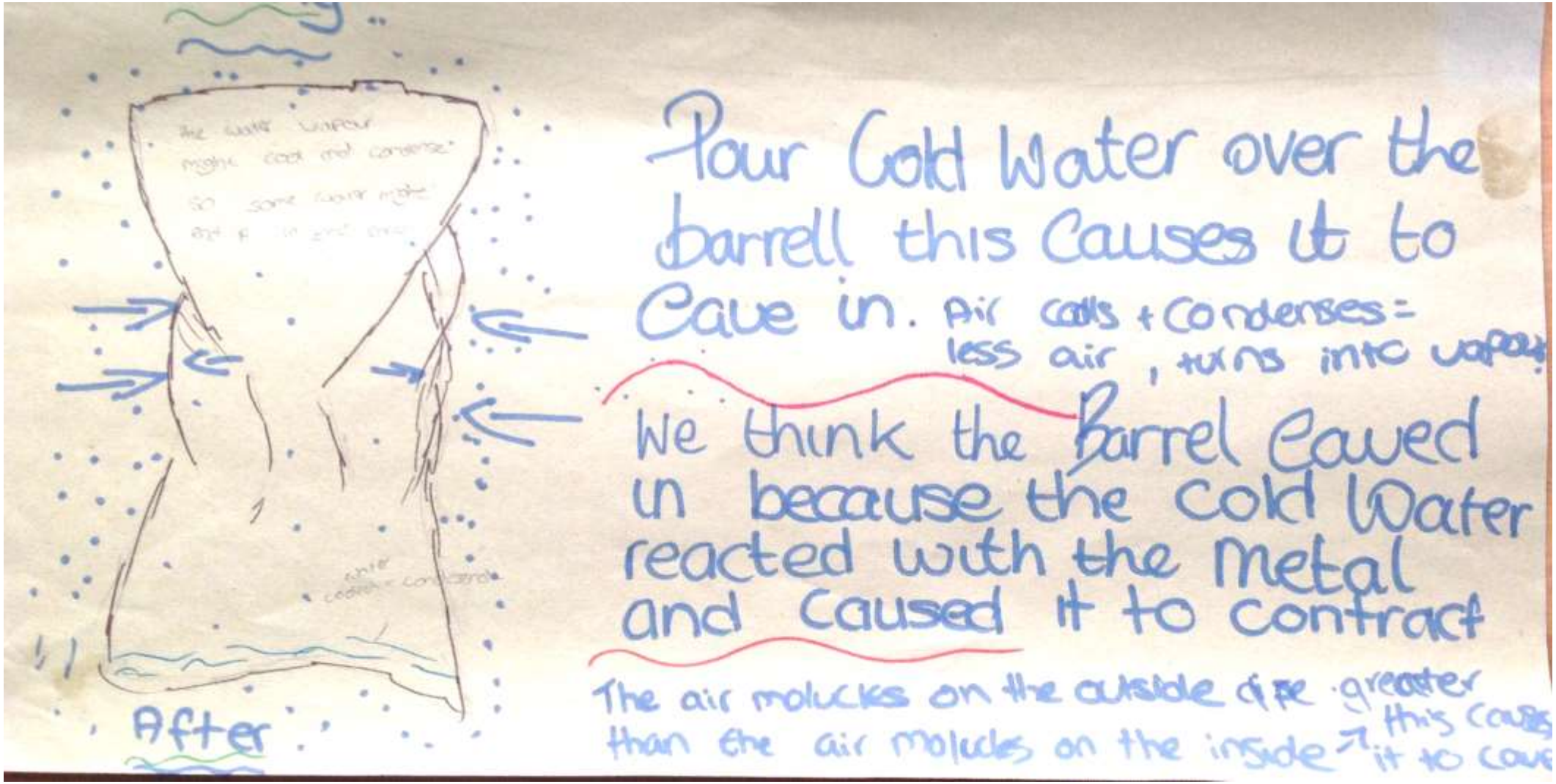
air

Over the course of two weeks students, working in groups, developed the following causal explanation for the collapsing railway tanker

- Initially the pressure inside and outside the vessel is the same.
- Outside pressure occurs as a result of atmospheric pressure caused by air molecules moving and colliding with the sides of the tank.
- Inside the tank moving air molecules colliding with the tank cause pressure.
- When the can collapses the atmospheric pressure outside the tank exerts a greater force on the tank than that exerted by molecules moving inside the tank.
- As the forces acting on the tank are unbalanced the tank collapses inwards.

Pour boiling water into 1/10 of the volume of the barrel

The outside air molecules are equal to the air molecules on the inside. They are both bouncing of each other and the can



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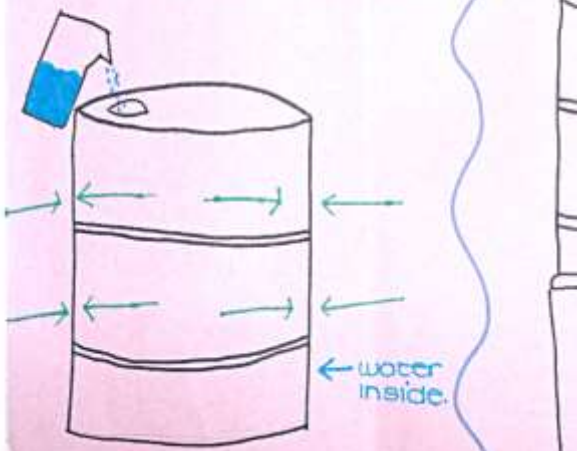
Before;

atmospheric pressure = inside pressure.



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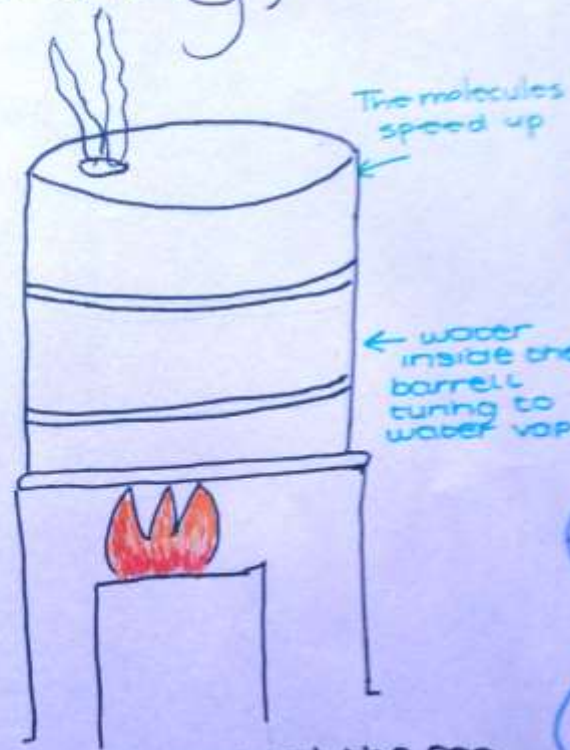

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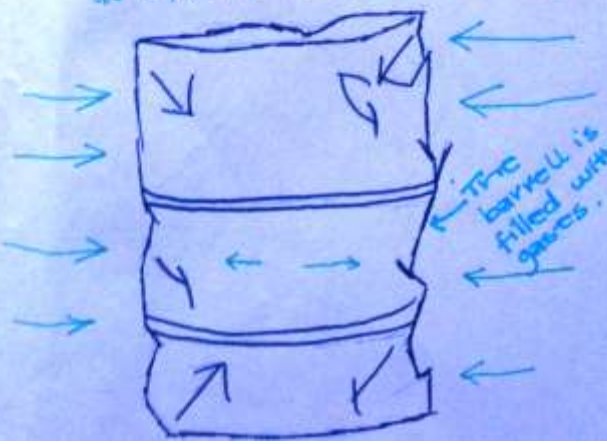
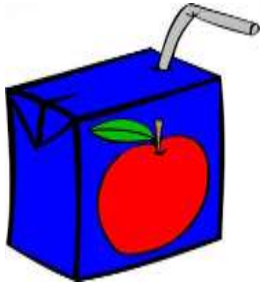
atmospheric pressure > inside pressure



Did the process work?

- I was impressed with the level of understanding which the students showed in the summative assessment activity. The summative assessment activity involved transfer of understanding. It also served as a formative assessment activity in telling me where students were in terms of their understanding of some of the big ideas.
- Less able students answered at a higher level than they would have previously.
- Able students enjoyed the challenge of the process and I believe it will help their understanding as we move forward.
- At times students found being asked to revisit their models a little frustrating. But this was their first exposure to developing models and they needed more pushing to try to explain what was happening at a microscopic level.

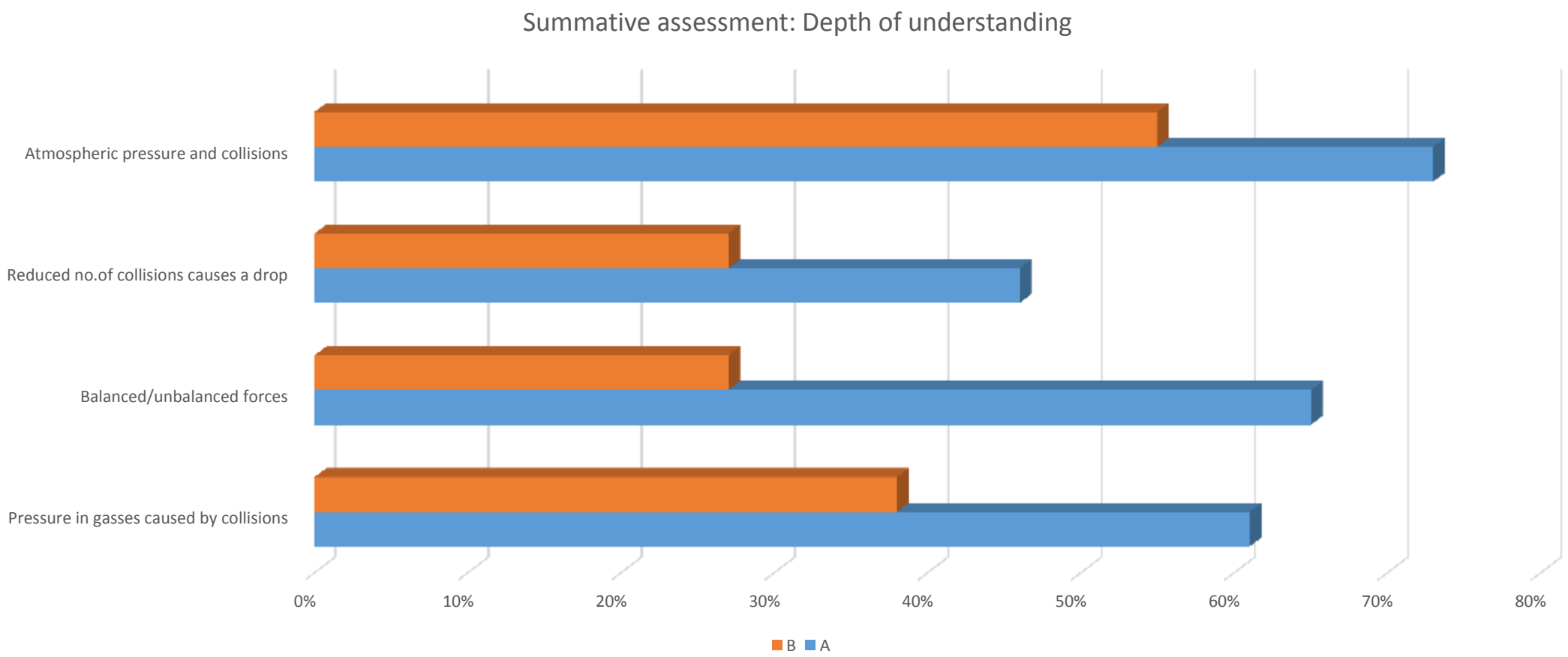
Summative assessment



- The juice carton is empty of juice. How could a student get the juice carton to collapse inwards using only the straw? Give a detailed explanation of your answer explaining the situation before and after the collapse. You will need to include a scientific diagram with your answer.

- **Idea Checklist:** These ideas need to be included in your explanation.
- Atmospheric pressure
- Pressure
- Changes in Pressure
- Forces (Balanced and Unbalanced)
- Molecules
- Collisions
-
- When using an idea, be sure to explain *what* it means and *why* you are using it.
- **Scientific Diagram** (show what is happening that we can't see)

A comparison of depth of understanding



Group A were taught using modelling,