State of the (chemical) Union Demo...

This demonstration gives students a concrete visual reference for many ideas related to changes of state and other physical properties.

Materials:

12 tennis balls
Clear plastic box (25 cm x 40 cm) with 20 cm high sides.

Activity:

Place about 12 balls in the dishpan, or rectangular box with low sides. Arrange them into a regular cubic lattice (in a single layer). Tilt the pan so students can see the geometric arrangement of the layer.

With no motion, they represent atoms in a crystal at absolute zero.

Tilt the box slightly and tap the side with your hand. *"The atoms begin to vibrate as the crystal warms up*". Gentle tapping causes rearrangement of the balls into a hexagonal close-packed lattice ... a "*phase transition to a denser form*".

Tap more strongly and the balls on top will slide down to the bottom as the "*crystal melts into a liquid*".

Continue to increase the strength of the tapping as you tilt the box into a more horizontal position. " *The liquid is heating up*". Occasionally, a ball will bounce out of the box as "*evaporation*" begins. [Later, you can relate this to vapour pressure].

Finally, with a flip of the wrists, "*boil*" the balls out into the classroom. The class will never forget that "*molecules in a gas are flying around*". Students near the front feel under a lot of pressure!

Now, they will want to throw them back. But they can't throw the balls too fast because they will just hit the bottom of the pan and bounce out again. " *We have to slow down gas molecules before they will condense into a liquid again*".

Explanation:

This model is very close to the kinetic theory model and so is very reliable as a framework for discussion. Students can predict that if the molecules were "sticky", it would take more shaking before they boiled. (Hydrogen bonding elevates boiling temperature of water).

They understand that heavy "super-balls" might bounce out with less shaking than lighter, softer balls (boiling point is not always related to mass of the molecule), but with similar molecules, we would expect that the lighter ones would boil more easily than heavier ones… (Methane is a gas, octane is a liquid at room temperature, etc.)

VARIATIONS AND EXTENSIONS:

With two different types of balls (like styrofoam balls), the firmer ones tend to bounce out first... allowing you to **model distillation**. Use the clear box with higher sides so students can see the action of the balls inside the box as well as the ones bouncing out.

Tennis balls are about the same size as some Styrofoam balls.

The Styrofoam ones "evaporate" first, every time.

Occasionally, a tennis ball will bounce out early*. "What happens when we hurry a distillation by heating too fast? We get poor separation of components!"*

Use a hypodermic syringe and a heavy gauge needle [**Care!**] to half-fill some tennis balls with water <u>before the demonstration</u>. Place them in the "distillation box" along with normal air-filled tennis balls. The normal ones will bounce out first. Can atoms look the same but have different masses? "Isotope so!"

(HINT: If the balls are completely water-filled, they bounce almost as well as a normal one. Here we want the water to slosh around inside the half-filled ball to absorb some of the momentum of collision.)

ESP: Homemade fire extinguisher

Children will explore how combustion requires oxygen.

Materials:

Small candle
Water
Glass bowl (sides must be at least twice as high as the candle flame)
Effervescent tablets
Clock with second hand

Activity:

1. Light a candle and place a few drops of wax in the center of the glass bowl.
2. Fix the candle onto this wax and allow it to harden.
3. Pour enough water into the bowl so that $\frac{1}{2}$ of the candle is under water.
4. Drop one quarter of a tablet of antacid into the bowl and record how long it takes for the candle to be extinguished. During this time you do not want to breathe into the bowl or have any wind blowing into the room. This would remove the gas you are creating in the bowl.
5. If the candle does not extinguish, your bowl may be too large or you will require more antacid in the water!!!
6. For experimentation, increase the amount of antacid in the bowl.

Explanation:

As the tablet dissolves, two chemicals within this solid react together in the presence of water: sodium bicarbonate (baking soda) and citric acid. The reaction is very similar to baking soda and vinegar, as vinegar is a dilute solution of acetic acid!! When these chemicals are dissolved in the water, they undergo a chemical change as a gas is generated. This gas is carbon dioxide (the same gas you breathe out!!) and is actually heavier than the air around us!! When carbon dioxide is released at the top of the water (when the bubbles burst) it remains on top of the water and continues to rise until it spills over the bowl (or it is blown out by your breath!). As the carbon dioxide level increased in the bowl, it pushes the oxygen out of the bowl. Without oxygen, the candle cannot remain lit so its fire is extinguished.

Water Bottle Rocketry!

Children will observe three states of matter as they fly through the air.

Materials:

Water bottle with a pop top (there are many brands out there)
Small amount of water
Four effervescent tablets
One wide-mouthed container slightly larger than the water bottle

Activity:

1. Put on your safety goggles and go outside!!!
2. Fill the water bottle about 1/6 full with water.
3. Break apart the effervescent tables and quickly place them into the water.
4. Seal the bottle very quickly making certain that the pop-top is sealed securely.
5. Place the bottle upside down into the wide-mouthed container.
6. Wait a short while and enjoy the rocket as it flies into the air.

Explanation:

When the effervescent tablets are placed in water, carbon dioxide gas is created. This is the gas that is found within each of the tiny bubbles as the tablets dissolve. As the bubbles reach the top of the water level, they burst open and its gas escapes inside the bottle. Since the bottle cannot stretch very well, the pressure inside continues to build until it is too great and then the pop top is forced open. The force of all the water and the gas rushing out of the tiny opening pushes the bottle upwards!

Potato Cannon

A flame-free potato launcher is always a good time!

Materials:

Three or four large potatoes
Cutting knife
Two feet of 1/2" PVC pipe
Wooden dowel rod (it should be over two feet long and wide enough to slide through the PVC tube)

Procedure:

1. Carefully cut the potatoes into 1" thick slices.
2. Place a slice of the potato on the ground. Take the PVC pipe and stab it through a potato slice so a plug is created on one end.
3. Place another potato slice on the ground and repeat for the other end of the PVC.
4. Hold the launcher in one hand and the wooden dowel in the other.
5. Aim the launcher towards an open area - never in the direction of a person.
6. Use the dowel to quickly push one end of the potato plug up towards the other.
7. The potato on the opposite end should propel through the air.

Explanation:

The potato launchers work due to the concept that air takes up space. Once you create a potato plug on each end, you have trapped air inside the PVC pipe. When you push one potato plug with the wooden dowel, the air inside the pipe has to go somewhere. There is enough pressure created to push the opposite potato plug out of the pipe and into the air.

MOM and Cabbage Juice

Children will simulate how antacids affect your stomach pH.

Materials:

Red cabbage juice (from activity in Chapter 12)
Milk of Magnesia
Water
Large clear bowl
Spoon
Vinegar
Measuring cups/spoons

Activity:

1. Fill the measuring cup half-full with water.
2. Add $\frac{1}{4}$ cup red cabbage juice.
3. Add $\frac{1}{4}$ cup milk of magnesia.
4. Stir well to mix.
5. Add two tablespoons of vinegar.
6. Stir well and watch the color change. After the solution returns to its original color, add more vinegar and repeat.
7. The colors will continue to return until the amount of vinegar exceeds $\frac{1}{4}$ cup.

Explanation:

The red cabbage juice contains a molecule called flavin which turns red in acidic solutions, purple in neutral solutions and greenish-yellow in strong basic solutions. The addition of milk of magnesia in the water makes the solution slightly basic and will turn the solution a blue-green color. When vinegar is introduced, the color of the solution will turn form blue-green to purple and then to red. However, there is more milk of magnesia than acid in the solution. Therefore, the solution will slowly revert back to a more basic solution. You can witness this occurring as the colors move back from red to purple and back to a blue-green. This will continue until you add more acid than milk of magnesia. When there is no more milk of magnesia to neutralize the acid, the color change will stay at red as the solution will remain acidic.

A Cool Colorful Hot Pack

Children will create a modified hot and cold pack.

Materials:

Ziplock baggie
2Tbs baking soda
2Tbs red cabbage juice (see recipe below)
2Tbs calcium chloride (sold as Morton Ice Melter in the auto section of stores)
2Tbs vinegar
Activity worksheet (see attached)

Activity:

To make the red cabbage juice, chop one head of red cabbage and place into one gallon of boiling distilled water for about 15 minutes. The liquid should look like grape soda. Let the fluid cool and then strain the cabbage out of the solution. Pour the liquid back into the plastic jug. You can refrigerate or freeze the leftovers for use in the future (I would recommend it!)

1. Place the calcium chloride in the baggie. Seal it up and make observations on the worksheet.
2. Place the red cabbage juice into the baggie and seal it up. Gently shake until all of the solid particles are dissolved. Make observations on the worksheet.
3. Place the baking soda into the mixture. Seal the baggie and gently shake. Be prepared to open the baggie to release some of the gas that will be produced. Make observations on the worksheet.
4. Place the vinegar into the baggie and seal it up very well. You may need to reopen it once again to release any extra gas that is produced. Make observations on the worksheet.
5. When you are finished, the baggie can be thrown out with the trash.

Explanation:

Changes in color, temperature and volume are indications that a chemical reaction is taking place. This is different from a physical change in which no new molecules are being produced. Cabbage juice is a very good acid/base indicator. It will turn greenish blue for a base (like calcium chloride) and pin for acids (like vinegar).

The temperature of the mixture increased while the calcium chloride was dissolving as this reaction is an exothermic reaction. The decrease in temperature after the addition of the baking soda is known as an endothermic reaction. This reaction requires energy in the form of heat (which it absorbs from the air, the baggie and your hand)! As heat is removed from your hand to keep the reaction continuing, the solution feels cool to the touch!

Signs of Change Data Sheet

Under the **COLOR** column you will write the color the substance in your bag turns after you add the material indicated.

Under the **TEMPERATURE** column, circle the words **colder**, **warmer** or **same** to describe the temperature of the baggie after you add the material indicated.

Under the **VOLUME** column, circle words **same**, **bigger** or **much bigger** to describe the volume of the baggie after you add the material indicated.

Under the **BUBBLES** column, circle **yes** or **no** to indicate whether or not you observe bubbles.

Material	Color	Temperature	Volume	Bubbles
Calcium chloride		*No temperature change*	*No change in volume*	*None*
Red Cabbage Juice		Colder Warmer Same	Same Bigger Much Bigger	Yes No
Baking Soda		Colder Warmer Same	Same Bigger Much Bigger	Yes No
Vinegar		Colder Warmer Same	Same Bigger Much Bigger	Yes No

Signs of Change Data Sheet

1. **Where did you observe any color changes?**

2. **When did you observe a temperature change?**

3. **When did you observe any volume changes?**

4. **Based on your observations, what properties would you look for to see if a chemical change has occurred?**

Answers to the questions:

1. **Where did you observe any color changes?**

Answers may vary; however, there should be color changes after the addition of baking soda and after the addition of vinegar. Students may also not a change in color of the red cabbage juice when it is added to the calcium chloride.

2. **When did you observe a temperature change?**

The baggie will get warmer after the red cabbage juice is added to the calcium chloride and it will get colder when the baking soda is added to the calcium chloride/indicator mixture. The baggie will also get colder when the vinegar is added to the baggie, but this is difficult to observe since the baggie is already pretty cold.

3. **When did you observe any volume changes?**

The volume will increase when the baking soda is added. There will also be an increase in volume when the vinegar is added.

4. **Based on your observations, what properties would you look for to see if a chemical change has occurred?**

Color, temperature and volume changes indicate a chemical change has occurred.