

A Practical Primer of Physical Science Experiences for Elementary Generalist Student Teachers

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From my vantage point of forty years of work with student teachers, countless workshops throughout western Canada and the United States and involvement with provincial curricula and textbook writing, I have formed a few opinions of what might be a prudent series of explorations for elementary generalist teachers. This series has been designed using limited science equipment available from local retail stores, as many schools do not have a sophisticated science equipment inventory.

It is not meant to be a 'methods course' in the traditional sense but is intended to be a collection of activities that create understandings. These understandings will then allow the novice teacher to approach elementary physical science topics with some measure of confidence and activities that will add some pizzazz to their pedagogical pie.

The areas I have addressed in this document will involve the following:

- Properties of matter
- Changes of state
- Force, motion and friction
- Sound and light
- Physical and chemical change
- Electricity and magnetism

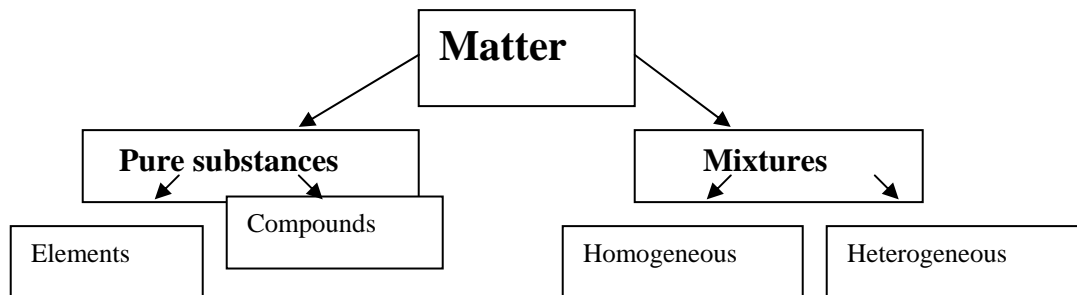
Properties of Matter

Matter is anything that has mass and occupies space. With this as the definition it is safe to say that any real object the students can see or feel is composed of matter. A bag of air or a filled balloon can provide the answer to the question of whether matter can be 'invisible'. We can certainly see that a plastic container that is inverted and immersed in water is filled with something the students cannot see. This mixture we call air.

Matter is made up of molecules and if the molecules of the particular matter we are considering are all the same then the matter is said to be a pure substance. If the matter is made up of two or more different types of molecules then the matter is said to be a mixture.

Pure substances can be made up of molecules that are composed of only one type of atom. This type of matter is called an element. (e.g. O₂) If the matter is made up of two or more different atoms, it is called a compound. (e.g. H₂O)

Mixtures are classed as either homogeneous or heterogeneous depending upon whether it can be visually separated (granola or salt +sugar) or must be chemically separated (soda pop, bronze, air). We can use the following schema to look at this classification which will suffice well into high school.



This is known as the Particle Theory of Matter where the particles are the molecules (or ions) that make up all matter. These ‘particles’ are usually molecules for the substances we will meet in elementary school and should be called molecules even though they are not referred to in texts as such. Molecules are always in motion and are colliding constantly. The faster the molecules move the more collisions there are and this is called **heat**. It is heat that is responsible for the changes of state we look at so let’s look a little closer at that.

The coldest temperature physicists can postulate is called Absolute Zero and it is the temperature at which the molecules stop moving. This temperature is -273° Celsius but it has never been reached and is not thought possible to attain. Normal room temperature (22° C) is a long way from absolute zero. The coldest atmospheric temperature recorded was -89° C in Vostok, Antarctica and the hottest was 43° C at Kayes, Mali.

Properties of Matter can be classified as physical or chemical and some can and are explored by elementary students with limited equipment. These easily observed physical properties are:

Colour *	Boiling Point *	Melting Point *
State	Solubility	Ductility
Viscosity	Hardness	Conductivity
Malleability	Magnetism	Density
Lustre	Crystalline Structure	Brittleness

Some of these physical properties (starred above) are self-explanatory and do not need further discussion. The other properties can certainly be found and detailed in an Internet search but I will quickly describe them as follows.

State – the state of the substance at room temperature – usually 22° Celsius

Solubility – whether a substance will dissolve in another substance – usually water

Ductility – a property of metals where a rod of the metal can be ‘drawn’ into a wire

Viscosity – a property of a liquid, which describes whether it will flow easily (thin or thick)

Hardness – described using Moh’s Scale of Hardness where talc = 1 and diamond = 10

Conductivity – whether the substance will conduct electricity or heat

Malleability – a property of metals where it can be beaten into thin sheets

Magnetism – a property of metals where they can be attracted by a magnet

Density – the ‘heaviness’ of a substance and is a measure of mass per unit volume (g/cm^3)

Lustre – how a substance reflects light (shiny or dull)

Crystalline Structure – whether a substance crystallizes into a form (e.g. cube, rhombus)

Brittleness –whether a substance will break or shatter easily

Chemical properties describe how a substance reacts with other substances as it changes. For our purposes they include:

Flammability – whether a substance will burn if ignited in the presence of oxygen

Non-flammability – important property of water and carbon dioxide, which smother fires

Corrosion – whether a substance will react with oxygen in a process called oxidation

Reactions with acid – whether a substance will change in the presence of an acid

As you can see, physical and chemical properties are very important when we discuss substances and can help in describing and identifying them. These words do not need to be learned as a group but rather employed when they can assist with a description or an explanation.

Discovering physical and chemical properties, especially of minerals, is often the basis of identification and then other properties such as **Streak** (colour of powdered mineral when it is forcibly scratched onto a white porcelain tile) or **Fluorescence** (how a mineral appears under ultra-violet light) will also be used.

More detail of these properties can be easily obtained if one does a search using your favourite browser. Using the search words *Physical Properties* will get you a collection of these and adding + *activities* will give you a collection of sites where you can get more information and activities to further explore the wonderful world of substances and how an understanding of them and their interactions is so important to both enjoyment of our world as well as avoiding accidents and loss of property as well as our safety.

Changes of State

Changes of state for pure substances usually occur when the molecular motion changes. If a solid is heated the molecules move faster and faster until the bonds between them weaken and the molecules can now slide over each other. This is called the melting point (or, conversely, the freezing point). If this liquid continues to be heated the molecules move faster and faster until the very fastest actually disassociate from the liquid and evaporate into a gas. We call this the boiling point. This gas can continue to be heated. Gases and liquids are also referred to as **fluids** as they can flow.

There are quite a few words we use to describe these changes of state and I will place them in a diagram in the appendix. Of course, there are several other words you could use in the boxes such as boiling, gasification, jelling, setting, or any others you may choose to add.

These terms and words should be well understood by the reader but that change of state called **Sublimation** may need some further discussion.

Sublimation is where a solid becomes a gas or a gas becomes a solid. We see this commonly with water where dry snow or ice gradually disappears in a cold, dry environment such as your freezer or during a long cold spell without precipitation. It also occurs when we get frost on a surface when the air temperature drops below freezing. It is why you can dry clothes outside on a clothesline when the temperature is well below zero. It is a phenomenon you can show to

students by regularly measuring and weighing ice-cubes in an ice cube tray left in a freezer for several weeks.

For changes of state demonstrations, please see the appendix for a diagram of this and a further explanation in Properties of Matter, FMKMT (Frenetic, Mimetic, Kinetic Molecular Theory), Crushing a Can, PuttPutt Boats, Hot Air Balloons, Geysers, Cloud in a Jar, and Cartesian Divers. A selection from these would certainly demonstrate this most important group of understandings and will be presented in the session.

Force, Motion and Friction

Force is a push or a pull and is responsible for movement of substances. Without an external force, an object will not move so to have **motion** there must be a force. **Friction** is the resistance of an object to move when acted upon by a force. If the resistance of friction is greater than the force then the object will remain in place even though it is being subjected to a force. If the force is greater than friction then the object will move.

If you are working with any one of these concepts the other two will definitely come into play and should be accounted for or at least mentioned even if they are negligible in the investigation. When we move a block of wood across a table we usually ignore the friction created by the air but it is important if you want to move it very quickly. We usually call this phenomenon **fluid resistance** and it is a property of any fluid – whether a gas or a liquid. **Streamlining** is used to reduce this fluid resistance.

Forces can be added or subtracted to create one value. This is called the **Resultant Force** or just the Resultant. An example of this is an activity I call Give Your Teacher a Lift which is outlined in the activities. I like to sit on a long folding table and have the entire class of students all put their right hips against the table, snuggle up really close and use their right hand to grasp the table edge.

I then tell them that they are going to lift the table with me on it up ten centimetres for my count of three and then let it down. It is very important to ensure they understand they are not to move their feet or lift higher than ten centimeters! To this end I show them ten centimetres with my hands. Then I say, “One, two, three, lift. One, two, three, down.” It is always a wonderful way to begin a year and show them that if everyone works together we can do wonderful things as all the little pieces we add in a positive way add up to a large and successful experience.

When we weigh something we are really measuring the force of gravity on the mass of an object. On Earth and for most elementary grades, we use the SI or metric system (tonne, kilogram, gram, milligram) when we speak of how much something ‘weighs’. However, the SI measure of force is the Newton (N) and it is usually interpreted as 102 grams on Earth. Some spring scales you might have in your science supplies measure force in Newtons but usually we use the more common gram balances in elementary school and convert the result with a calculator if it is important to do so.

Sound and Light

Both sound and light are forms of energy but very different from each other in that sound is a form of energy based upon moving molecules while light is a form of electromagnetic radiation carried by photons or energy ‘packets’ that have no mass but do have energy. Light and sound are often placed close together in elementary curricula as they are both forms of energy but they do require quite different approaches for the classroom. Students can make sound directly but it is difficult to make light directly. We use light sources created using other energies.

Sound is usually described as being vibrations that travel through air or another medium until they reach an ear. This ‘ear’ is usually a human ear but there are animals that can hear sounds both below and above a human’s range of hearing, roughly 20 – 20 000 vibrations per second or Hertz. This range is usually written 20 Hz – 20 kHz. Of course this is a variable and the range of hearing can be lessened through damage to any of the ear mechanisms. There often is deterioration due to age and accumulated damage from loud sounds as the small hairs inside the cochlea are broken.

Sound vibrations can bounce off solid material and be reflected to produce an echo. The speed of sound in room temperature air is pretty close to 330 metres per second or 1 kilometre per 3 seconds. Light travels at a much greater speed of 300 000 000 metres per second or 300 000 kilometres per second, roughly 100 000 times faster than sound. On Earth, we can assume that light travels instantaneously while sound travel can be measured.

A common demonstration is when we determine whether a thunderstorm is coming towards us or away from us. We count the number of seconds between a lightning flash and the corresponding clap of thunder. By counting the time sound takes from one flash to beginning of sound and then comparing it to the sound from the next flash you can calculate whether the storm is approaching (fewer seconds) or retreating (more seconds).

By use of cupped open hands you can certainly increase the area of your ear shell and gather up more sound. Conversely, by pinning the ear shell back with your little fingers while your fingers are flattened against your head you can see how your hearing ability is decreased. You can protect your ears from loud sounds by pushing the little flaps directly in front of the ear canal closed to completely block off the ear canal. It is much safer than sticking your fingers in your ears!

To demonstrate how sound travels in air you can use a special spring called a Slinky®. Long Slinkys® (sometimes called a Super Slinky®) can be purchased from a science supply company or online for less than \$15. It will allow you to demonstrate longitudinal waves, similar to the movement of air molecules, as well as transverse waves which are good for showing students different frequencies and their different wave lengths. The wave will bounce off the other end of a firmly held Slinky® and produce an ‘echo’ vibration.

Frequency is the number of vibrations per second (Hz). We say sounds are low or high depending upon whether the Hz is low or high. Concert pitch is a term used for a symphony orchestra to tune their instruments to play together. In concert pitch the note A above middle C is 440 Hz. Middle C is 262 Hz. Our human range of 20 - 20 000 Light can also be reflected by using rectangular pieces of plate mirror scrap you can obtain at a glass cutting shop. Sometimes

their waste bins produce very usable pieces of mirror for the classroom. I use these scraps in various ways as I work with light.

Straight reflection is a great activity on a sunny day when you can give students a small mirror and have them reflect the sunlight onto a reflector that is located on a parked car or a bicycle or even on a street sign. Street signs have glass beads embedded in the paint and they do the reflecting.

I have them 'catch' the sunlight on the ground in front of them and then have them move the sun dot towards their target reflector. When their reflected ray hits the target reflector it will appear to light up as the sunlight is being reflected right back to them. A student a few metres to the side of them will not see this as reflector are designed to send the light back to the source.

We see the moon by reflected light and when you see the moon you should be able to point to the sun even if it is below the horizon! (see appendix)

There are a few words for the students to use when studying light. I think they should know the difference between transparent, translucent and opaque. As well, they should know that transparent items can be any colour.

To work with spectra, holographic wrapping paper can be a great resource as can a spray head sprinkler on a sunny day. Place the finest spray you can so it is pointing up in the air directly in the sunshine and have the students walk around the spray until they see a rainbow. I have them write some statements and create a diagram that shows them where the 'rainbow' appears and which colour is at the top of the arch in a single rainbow. Next time you see a rainbow you can answer this question yourself!

Physical and Chemical Change

To summarize the concepts surrounding these changes I wrote a song to teach to the class. It uses the camp tune 'Waddleyatcha' - almost.

**Physical Changes! Physical Changes are changes of state
Or breaking a plate.
Chemical Changes! Chemical Changes! When molecules mate
Or separate.**

**How can we tell if it's Chemical or Physical
I see you ask with a look so quizzical.
So just let me sing of the ways I can usually tell.
Chorus
Well, it's a Physical Change if it melts or solidifies;
Sublimates or heats up and gasifies;
Breaks into pieces or gets torn apart.
Now, how's that for a start!
With a Chemical Change it's quite hard to change back
'Cause precipitates form or smoke goes up the stack.
Something is leaving; a new substance forms;
It changes it's colour; it glows or it warms.
It could turn exothermic and give off a flame
No matter what happens it's never the same.
Atoms mix in new ways and then what comes to pass
What goes in must come out! Conservation of Mass!**

So these are some ways I can tell without doubt
Just what kind of change I am talking about
So I'm gonna' go back 'n' sing the chorus again - with my friends!
 (Everyone repeats the chorus finishing with this line.)
So this is where this song about changes ends - friends!

Basically, physical changes are generally reversible and/or the substances do not change their molecular makeup. Broken glass is still glass. Chemical changes see a molecular transformation and are generally very difficult to reverse if you can do it at all.

A very easy way to show a chemical change is to use a film canister 1/4 filled with water to which you add a piece (anywhere from 1/4 to 1/3) of an Alka Seltzer® tablet and immediately cap it, invert it, and back away. In a few moments the CO₂ gas released from the tablet forces the lid off and the canister bottom shoots up in the air. Spectacular!

Electricity and Magnetism

Electricity needs dry cells and lamps. The easiest way to obtain both in quantity is to buy AA dry cells in quantity on sale and use Xmas Minilights in strings that have 300, 200, 150, 100 or 50 bulbs - only these configurations! You can cut the wires apart with standard kitchen scissors but a small, X-shaped wire cutter and insulation stripper is a wonderful tool for this. It is made with a V-notch in each blade and a screw adjust to open up the V-notch to accommodate the wire but not the insulation.

Be sure and cut the lamps apart in singles or twos and cut so there is enough the wire left on each end so a single lamp will have long enough 'leads' to reach from one end of the dry cell to the other end. Strip the insulation into a waste-basket.

The 100, 150, 200 and 300 lamp strings work because they are strung in multiples of 50 and, as they use 110 volts per string, this voltage can be divided by 50, the number of lamps, for use with a dry cell. As the lamps are connected in series, each lamp is getting 2.2 volts. A new dry cell has about 1.8 or more volts so a single lamp will light well enough for school circuits and if students use two cells the lamp will usually not burn out. Often if you can hit holiday sales, strings of 100 lamps can be bought for less than \$5 reducing the cost of each lamp and socket with leads to less than a nickel.

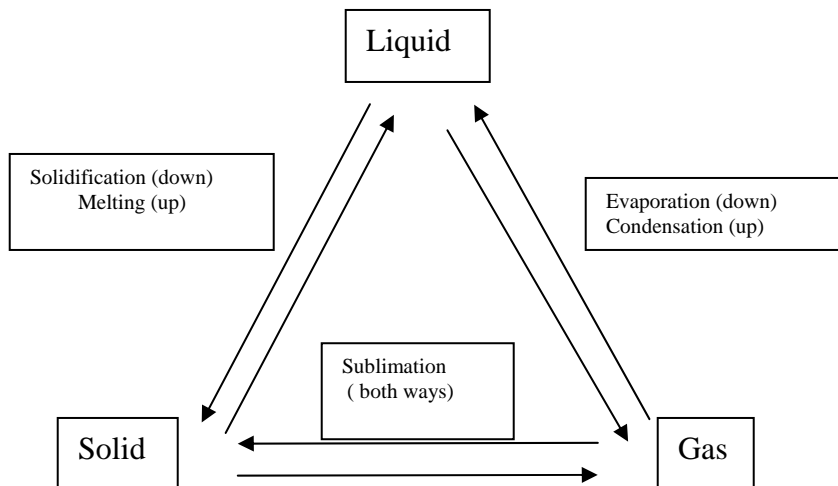
The lamp at the beginning of each string of 50 lamps will have three leads coming out of it. Simply find two of these leads that will light the lamp and cut off the other one as long as possible. For students testing lamps in series you can leave two or three lamps connected together. If you have time and equipment you can use solder to 'tin' the ends of the leads. Simply twist each end tightly and use solder to coat them to prevent them fraying.

To make a double dry-cell to give a little more voltage and brighter lamps, tape two dry cells together sideways with poles reversed. Tape a small piece of doubled tin foil over one and touch your lamp leads to the other end.

For the connection between electricity and magnetism that is a little different from the usual electromagnet I like to use a cylindrical supermagnet dropped through a 70 cm straight piece of copper water supply tube. Make sure the magnet will fit and be amazed at the interaction of a

magnetic field running past a hollow wire (the tube) where gravitational force creates electricity that slows down the fall of the magnet. Another amazing example of invisible forces in our wonderful world!

Appendices



Properties of Matter

last revised by Brian Herrin on September 4, 2008

The three states of matter described.

Matter is anything that has mass and occupies space. This means that it is composed of particles (molecules) of a substance that have some relationship to each other based upon distance apart and ability to move. These molecules are always in motion although it is not easy to see this unless we use indirect evidence.

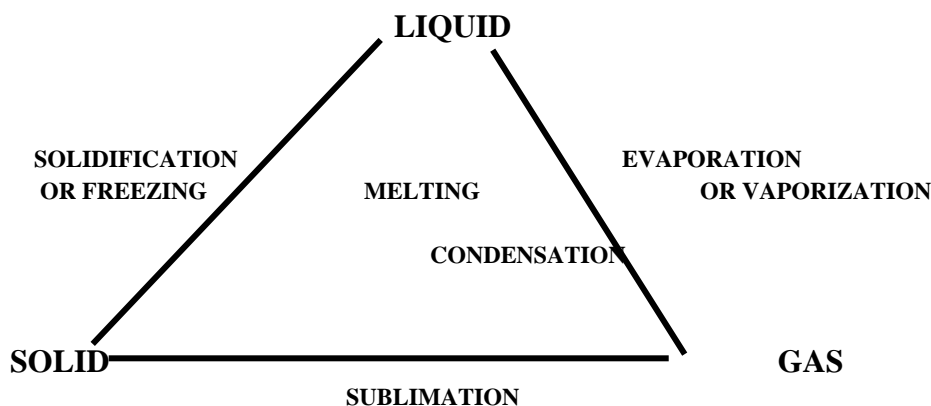
If the molecules are packed tightly together and can only vibrate in their place, the substance is called a solid. These molecules may be heated up and therefore move faster which usually causes the solid to expand slightly.

If we continue to heat up the solid, and for this example think of water in the form of ice, the bonds between the molecules eventually are broken by the molecules vibrating and the ice melts to form liquid water. In this liquid, the molecules are free to move around each other and are very gently bound together so they stay as droplets or a pool or puddle of water.

If this liquid water continues to be heated, eventually the bonds between the fastest moving liquid water molecules break and the water is said to boil and some fast moving molecules evaporate to form water vapour. If there is a lot of water vapour in one spot and the vapour recondenses into small droplets in the cooler air only to evaporate again very rapidly, we have visible steam which will leave the container, turn to water vapour and disappear. This is often an easy way to see if a chimney plume is white smoke or steam.

These physical changes do not involve any changes in the water molecule itself and are completely reversible. In fact, solid water molecules (ice) can gradually disappear to form water vapour without going through the liquid phase and water vapour can form frost without passing through the liquid phase. Both these latter processes are called sublimation. Here is a diagram that helps to describe the words as they are usually applied in chemistry or physics.

Now, where can we see these physical changes taking place? Perhaps the following diagram can help.



Solidification can be observed if you make peanut brittle as an experiment although the peanut part may be the subject of considerable controversy due to increasing numbers of children with peanut allergies. In that case, any candy making may suffice if the result is a hard, clear candy such as a sugar sucker. Indeed, a trip to a mall or candy store will give you opportunities to watch many of these processes taking place.

Melting may be seen by working with ice cubes and the exercise where ice cubes are placed in different containers and used for a test of heat transfer and conductance would be a good investigation to explore this.

Condensation takes place when a cold surface meets moisture laden air. You can see this when you breathe on a cold window pane or a mirror and it can be shown with a glass of water that has ice cubes in it. The Kool-Aid® advertisement is an example of a picture of a face drawn in condensation on a glass pitcher.

Evaporation is easily demonstrated with two soaked paper towels set up at either end of a dowel with one inside a sealable sandwich bag and the other just beside it but exposed to the air so that they are balanced. Another easy example would be puddles in the blacktop circled with chalk and visited over the next few hours or a large pan of water left in the classroom for several days.

Sublimation is best viewed during a cold spell (at least -5°C) when the snow just seems to disappear in the sun and wind. It also happens to ice cubes that are left in the freezer for a period of time. Indeed, if your freezer has a frost-free cycle, it hastens the process considerably. You can watch sublimation from vapour to solid if you place salt on snow in a plastic cup and wait for frost to form from the water vapour in the air coming in contact with the cold surface.

How do I relate this to Thermal Energy Transfer?

Well, I use my hands as models for this and put them together and vibrate them slowly to show a cool solid. I increase the speed of my vibrations to show heating until my hands begin to roll around each other while still touching which is the model for a liquid. I then move them faster and faster until I break them apart and use wide arm swings to have them collide all over the place to show a model of a gas.

The cruncher, if you will pardon the pun, is to now use an empty, washed, aluminum soft drink can filled with a little water (only two or three millimetres at the most) which is heated to boiling over a hotplate. If this can, now filled with steam, is quickly inverted into a dish of water, the steam condenses too quickly for the water to be sucked in through the opening and the can is crushed by the atmospheric pressure.

It is a spectacular demonstration and can create real excitement! Practice at home using wiener tongs bent a little to hold the can securely and be quick about inverting the mouth of the steam filled can under the water. It is completely safe if you follow precautions about distance away from a hot object and take care to keep the students away from the hot hotplate. If you are going to have a student perform this, then have them rehearse with a cold can so they can do it without hesitation.

What changes in matter can be easily reversed and what changes cannot?

Basically, physical changes (changes in state between solids, liquids and gases) are easily reversed. Breaking up a solid by crushing or smashing is not easily reversed as the pieces do not hold together any more. Dissolving solids can usually be easily reversed but I think the IRP wishes you to look at chemical versus physical changes. In a chemical change, a different substance is formed and often this is not reversible as energy is released or gases or precipitates form.

For instance, burning and rusting are chemical changes involving oxygen from the air. The change in the fuel or the steel / iron is not easily reversed. Cooking changes things (eggs - meat - bread - cookies) and this might form the basis for some discovery lessons. Rusting steel wool with vinegar is a good one for the classroom and will show results in a very short period of time. I usually help the rusting along with a liberal soaking in vinegar (acetic acid) so rusting occurs almost immediately.

What properties of matter stay the same even when other properties change?

Let's use water again. When it melts or freezes, the amount of matter does not change. The mass of the water is exactly the same mass of the ice. However, the density (i.e. weight per unit volume) does alter slightly and this makes water very special as it actually expands a little when it becomes a solid. Most other substances get smaller. I say we are fortunate as this means ice floats and therefore we can have lake turnover which oxygenates the water and prevents an ice blanket from forming on the bottom and basically extinguishing most life forms.

So - when a substance changes state - the amount of matter remains the same although the volume, shape, temperature, and colour may vary.

What makes a good thermal conductor and what is a good insulator?

This is a rather technical question and is based upon free electrons in or the density of the material. Styrofoam® is a great insulator because it has lots of closed cell air spaces that prevent convection currents from allowing the heat to move easily. Plastic, wood or glass are also used as insulators as they transmit heat slowly. Metals are poor insulators as their density allows them to transfer heat rapidly to a cooler surface.

Molecules that are moving more rapidly than their neighbours (i.e. hotter molecules) transfer some of their energy to the slower moving (i.e. colder) molecules until all the molecules are moving at the same speed (i.e. they are at the same temperature). In other words, a hot cup of coffee will cool off to the room temperature over a period of time although the room temperature will be increased an infinitesimal amount by the heat energy from the coffee being shared by the other molecules in the room increasing their speed slightly. **Brian's Bits #8419**

FMKMT

(Frenetic Mimetic Kinetic Molecular Theory)

This is a model using our hands to involve kinesthetic learning and get the concept of how molecular motion affects physical change.

For a solid the closed fists are vibrated together slowly in front of you and get faster and faster as you 'heat' up the solid. When it 'melts' you roll the fists around each other making sure they stay in contact with each other and as you do this faster and faster the 'liquid' boils.

Now move your fists at arms length and then together to collide and out again to show the molecules having large spaces between them which you can make smaller (compress or heat up the gas) or wider apart and slower (lower the pressure (expand) or temperature of the gas) to show the gaseous state. For **sublimation** you go directly from solid to gas (dry ice, cold snow or ice) or gas to solid (frost). It is a sparkling model and will help you both understand and explain phenomena you discuss with students.

Crushing a Can

Aluminum soda cans (not soldered juice cans) will show the effect of atmospheric pressure created by the condensation of steam within the can. As the steam condenses into a drop of water there is a reduction of volume as the drop is about $1/200^{\text{th}}$ of the volume of the steam.

Put @ 15ml of water inside a rinsed out soda can, put it on a hotplate and wait for it to boil briskly. Make sure you have a bowl or container filled with water close to the hotplate so you will be able to plunge the can into it easily.

When you see steam coming out of the opening and you can hear the water in a rolling boil then, using a palm up grip, carefully take hold of the can about one third of the way up the can with a pair of beaker tongs or hotdog tongs that have been bent so they will hold the can securely.

Take the can off the heat and in one smooth motion turn it upside down and immerse the top in the container of water about half way down the can. The can should implode but, if it doesn't, then wait a second more and lift the can to see how much water it sucked in. Let it pour out, crinkle the can a bit, and repeat. Sometimes perfect cans do not implode as they are too strong with no points of weakness. (cylinders versus other shapes but that is another lesson!)

PuttPutt or Steam Boats

The Steam Boat that we will be using came from Lee Valley Tools (Vancouver and Coquitlam or mail order). As it has been discontinued, you can get the steam 'boiler' unit from them. It is a fairly easy process to build a boat for it if you can drill two holes in a piece of wood and use hot glue to hold it.

In the boat the tubes and boiler are first filled with water using a pipette and the boat is placed in the water. A small candle in a holder is lit and placed underneath the very thin copper boiler. The water in the boiler boils, evaporates and the resulting steam shoots out of the tubes where the last bit condenses due to the cooling of the outside water.

This condensation results in the steam being reduced to a tiny bit of water 200 times less in volume than the steam was. This condensation of the steam pulls in cold water into the boiler where it meets the already heated copper boiler and the process repeats. The putt putt sounds are the result of the steam pushing out and the water coming back over and over again. Search the internet using the term **Putt Putt Boats** to get pictures and information.

Hot Air Balloons

Before you try this make sure that you have a good inside location (gymnasium, stairwell) with a high ceiling and that does not have hot lights that would melt the balloons. If you have hot lights then attach some thread or light string to your balloons so you can control how high they go.

Use a long gown or drapery bag from a dry cleaner (about 2 metres long) and tape up the top hanger hole with a small strip of cellulose tape. You do not need to tape up the rows of already sealed holes for the hanger slope.

Have a student stand on a chair and hold the top of the bag up in the air. Get two or three students to hold the bag open at the bottom and another to hold the tethering threads or strings. Make sure the students know that you will be controlling when they will let go. From below the bag, turn on a heat gun or a 1500 watt hair dryer on low speed/high heat and direct the stream into the bag. When the balloon is fully inflated ask the student at the top to let go. After a moment or two more have the students at the bottom let go and the balloon will rise into the air.

Do not do this outside as the balloons can get loose on the wind and hang up high in trees.

As the plastic is not biodegradable it creates a visual eyesore for a long time.

Practice responsible ballooning!

Geysers

A very simple and effective model geyser can be made from a 30 (or 100) cup coffee urn with a litre (or three litres) of water in it. You must leave the lid off and use the stem and coffee basket to hold it upright. Do not let children stand close to it as it does spray out just boiled water. It is best done outdoors with a long extension cord.

After a few seconds the urn can be heard working as the little boiling pot in the middle of the urn bottom heats a small amount of water to boiling and the resulting expansion of the water vapour pushes the water up the stem and out the top. When this happens cold water fills the boiling pot and in a few seconds it will heat it up and push it up the stem.

As the water gets warmer this happens faster and faster and the water shoots higher and higher. It is a great example of how water in the cracks of the solid rocks just above a magma 'hot spot' boils and the water works its way up the cracks until it shoots out of the surface and then drains back.

Making a Cloud in a Jar

First take a wide mouth 4litre sized glass jar and place about 20ml of water within. With the jar horizontal, swirl the water around and pour out the excess. Tip the jar on its side and have someone hold it securely. Light a match, wait a few seconds and blow it out. Immediately shove the smoldering match inside the horizontal jar so the smoldering match smoke is collected

within the jar. Dispose of the match carefully while the helper turns the jar upright still holding it securely. Quickly dangle a rubber glove inside the jar and fold the wrist band over the jar rim to seal it. This create a closed system of smoke and air holding as much water vapor as it can at room temperature.

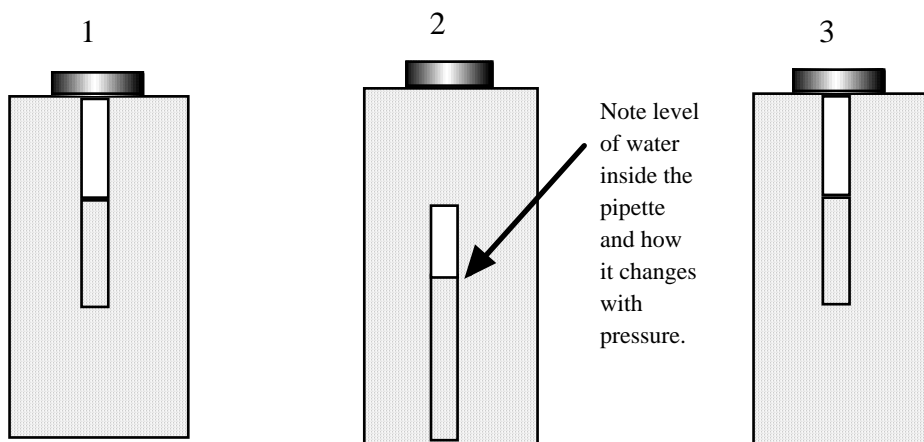
Now, reach down and grasp the rubber glove inside the jar while holding the glove on to the rim so it will not come loose. Pull up the rubber glove to create a partial vacuum inside the jar. What you are doing is lowering the temperature inside the jar slightly as there will be fewer molecular collisions due to the increased volume of the jar and glove complex. This lowered temperature means the air cannot hold all the water vapor as water vapor and the excess will condense on any correctly shaped surface available to it. Once one molecule has sat down others can ‘sit in its lap’ and condense as well. Smoke (carbon) particles are perfect for this as they contain many crevices that allow water molecules to attach easily. As all the excess water molecules sit down the result is microscopic droplets with smoke particle nuclei and they show up as a cloud within the jar. This is best observed when light is behind or beneath the jar.

(For students) We are filling the jar with as many water molecules as the warm room air can hold by making sure there is a lot of water in a thin layer around the inside of the jar. We will add in some smoke particles from a burnt match and will then seal the jar with a rubber glove and when we pull up on the rubber glove the space, or volume, inside the jar will get bigger and this will lower the temperature inside the jar as the water molecules will have more room to move around in and they won’t bang into others as often.

When the temperature drops the air can’t hold all the water molecules as a gas and some of them have to sit down on something. The smoke particles have just the right kind of place for a water molecule to sit down on and when the water does this the smoke particle gets covered with water and makes a cloud droplet. These tiny droplets show up in a shaft of light and we can see a cloud form inside the jar. Steam from a kettle goes the other way where a cloud of water droplets evaporates into water vapor and seems to disappear.

The Cartesian Diver

The classic Cartesian (René Descartes) Diver was constructed of porcelain and was difficult to understand as it was opaque but our translucent polyethylene eyedropper will let us see into the mystery. As polyethylene floats (i.e. has a density less than 1.00) we must add a weight (the hexnut) to allow it to sink.



Our example above seems to have a special bottle but in reality the best bottles to use are clear 1 or 2 liter soda bottles with the standard cap that is designed to withstand pressure. We have provided a dropper and hexnut which you must fill with water until it just barely floats. If you leave too much air in it then you will have to squeeze hard to put pressure on a large bubble. Have it just floating!

*The bottle should be completely filled with water with the diver barely floating at the top (1). When you squeeze on the flexible bottle it increases the pressure of the contents. As any liquid is virtually incompressible (and therein lies the secret of hydraulics) the increase in pressure is directly placed on the bubble of air that is holding up the eyedropper/nut combination (Hereinafter referred to as *the diver*). As this increasing pressure compresses the air in the bubble (2), the bubble becomes smaller (less buoyant) and the diver sinks. When the bottle is released (3) the bubble returns to its original size and the resulting increase in buoyancy allows the diver to rise. Make sure you carefully watch the size of the bubble when the bottle is squeezed. Your child may know what is happening but it is much more important that they enjoy what they are doing and know how to make the apparatus but do make sure they observe the bubble!*

A problem can arise when the bottle is not completely filled with water as this creates another hidden bubble up against the lid that also shrinks with the increased pressure and if the diver is not sensitive enough (i.e. barely buoyant at normal pressure) it might not sink. (*Likewise, if bubbles of air get inside hydraulic lines they must be bled out in order for the hydraulics to work.*)

Another problem may be created when the bottle is turned upside down and you make the diver sink. When the pressure is released, some of the air, which has risen along the inverted pipette stem, could be allowed to escape from the tip of the dropper and the diver will remain in a sunken condition. This means you have to set it up again (and again and again and again and....) Good luck with it!

Brian's Bits #7812

A Few Extras

Friction – Sliding vs. Rolling

Turn a table upside down on a smooth floor and have a student sit on it. Have others try to push it with one hand to see how difficult it is to move. Then place some wooden rollers (I use four 2.5cm dowels cut in half lengthwise) under it and repeat to see how the table rolls easily. You can also use a bunch of similar sized marbles and get an even better way of moving the table as it can now be rotated in 360 degrees.

Phases of the Moon

This can be demonstrated by placing the students in the center of the gymnasium while you walk around them with a white volleyball held high. Another student or adult operates a good spotlight or large flashlight and keeps it on the ball while you walk around in as large a circle as you can.

I usually begin in front of the students with the light operator standing still behind me and shining the light on the ball. The students should see a dark volleyball as there is no light coming onto it but as you begin your circle walk the thin crescent moon should begin to show and continually waxes until you get to the opposite side of the gym where the full moon is now seen. As you continue your circle walk the moon will wane until you are back in front of the spotlight operator and the moon is dark again – a new moon!

It has been the intent of the author to assist with understandings and demonstrations of phenomena that will enable elementary teachers to approach science confidently and with some

workable designs for strategies, activities and demonstrations that work and require a minimum of equipment. If there are errors or omissions – please correct them and let me know (herrin@sfu.ca) so I may correct my text. To finish I will quote Piet Hein who wrote a Grok that follows:

The road to wisdom? - Well, it's plain
And simple to express
Err and err and err again
But less and less and less.