SEE WHAT PHYSICAL SCIENCE IS ALL ABOUT T.M.

K-3

MATTER:

Physical Properties

* **What are physical properties?** [lesson]

  Characteristics of an object that can be observed with our senses (color, size, weight, texture, taste, odor).

The Five Senses

* **Our most important sense, vision:** [lesson]

  1. With our vision, we can determine shape, size, color, texture and how far away (range finding) something is.
  2. Model anaology: Compare to a video camera with the video recorder as the brain. The image is stored on the videotape (brain cells).

* **Investigating vision:** [activity]

  1. Color an American flag with black and green stripes and an orange field with black stars. Place a dot on the lower right corner of the field. Outline the flag with a black border.
  2. Place the flag on white paper. Stare at the black dot for one minute, quickly remove the flag.
  3. You should see a red, white and blue afterimage on the white paper.
  4. Explanation: Eyes tire. When you look at white paper, all the colors in white are reaching your eyes, but parts of your "screen" are tired of seeing green (for example) so, instead of seeing all colors (white), you see white minus green or mostly red (the complementary color). Black will be white and orange will appear blue.

* **How blind people read:** [observational activity]

  1. Look up the Braille alphabet, glue popcorn onto 2 X 3 rectangles to spell words.
  2. Make secret messages for others to decode.

* **Making approximations:** [observational activity]

  1. Fill two glasses to the very top with water. How many pennies can be dropped in before the water overflows? (Solicit approximations) Carefully drop in pennies.

     Explanation: Surface tension holds water particles together and allows many pennies to go in before water overflows.

  2. See how many drops of water go on the face (or back) of a penny (use an eyedropper).

     Variation: Put detergent in the water. This breaks up the surface tension and you will get fewer drops.

     (Always have students make approximations whenever possible before performing activities).

* **Hearing:** [activities]

1. Using a portable tape recorder, gather sounds, play back in class. Students try to identify.

   Variation: (Sequencing) Place sounds out of sequence. Have students determine proper order (i.e., car door opening, buzzer, seat belt click, engine starts, car drives away).

2. Encourage use of "sound words" (i.e., plop, crash, crackle, buzz).

3. Rattle cans: Material inside, students best describe the sound they hear (good for process skills) and, secondly, try to identify mystery objects.

4. Mimic sounds ("What sound does a chicken make?").

5. Hearing impaired: Discuss sign language and hearing aids (amplifiers). Cup hands behind ears to make simple amplifiers. Observe ears of many different animals (infer how ears help them).

6. Locating sounds with triangulation: Subject holds a paper towel tube to one ear. Lab partner taps spoons behind subject's head. Subject trys to locate where sound is coming from. Make careful observations. Discuss in class.

   Explanation: Draw a face on the blackboard without the tube. Draw in the spoons at one location. Ask students which ear would hear the sound first. Now, draw in the tube. Show that the sound to that ear must travel further. Now which ear hears the sound first? See if actual results supports this theory (advanced).

* **Taste and smell:** [activities]

1. Safety:

   a. Don't taste unknown chemicals.

   b. Properly smell chemicals by wafting hand over the top (clear liquids could be bad, i.e., ammonia). Actively involve students with this!

2. Smell cups:

   paper cups
   cheese cloth
   rubber bands
   various aromatics
   various non-aromatic objects (i.e. penny, glass)

   Students go from station to station and record smell from each (numbered) cup. Discuss results as a class (odors are caused by gases -- chemicals in the air -- our nose is a "gas detector").

3. Compare taste and smell (taste only detects salty, sweet, sour and bitter). Students pinch their noses, eat a peppermint candy. They won't be able to identify its taste until they open their noses.

4. Demonstrate safety with quinine water and 7-UP (both are similar in many ways) -- except taste!

5. Describe taste and smell of various herbs (taste all herbs yourself before doing this activity).

6. Make blue or red 7-UP to demonstrate that sometimes we must rely on our sense of taste over other senses (vision, in this case).

* **How long does it take to dissolve a candy?** [experiment]

1. Distribute a hard candy to each student. All start together and dissolve the candy in their mouths without biting candy.
2. Make a histogram on a board. Number of students vs. time (time should be convenient intervals of 10 to 30 seconds). Each student raises his/her hand when the candy disappears. At the end of each interval (i.e., 30 seconds) you count hands and say, "hands down." Record this value for that interval and go on to the next (each student only raises his/her hand once). Start your first interval when the first hand goes up. [Ideally, you'll get a "bell-shaped" curve.]
3. Extension: Distribute two different kinds of candy. Try the same experiment. This introduces variables -- "If we use two kinds of candy, we really can't answer the original question. We could find out which candy dissolves first, though."
4. Collect data as in #2 above. You may get a double peak -- one for candy "A" and a second for candy "B".

* **Identifying unknowns with the sense of touch.** [observational activity]

1. Use words to describe shape and texture (i.e., grooved, fuzzy, smooth, round).
2. Touch box (cardboard box with arm holes). Most importantly, students communicate these observations (characteristics) to rest of class using "touch" words.

* **Sense of touch — where are the "touch receptors"?** [experiment]

1. Use cardboard with 2 nails in end (1 cm. separation). Test different areas of the body. Do you feel one point or two? Record results (i.e., fingertips are sensitive, elbow is not). This is a "qualatative" experiment ("yes" or "no" results).
2. Advanced: Use 2 rulers with nails taped on ends. Can do same experiment but find an actual value for each body area. This is a "quantitative" experiment (we are measuring an actual quantity or value).

   In performing this experiment, start with nails far apart and move them closer and closer together until the subject feels only 1 point (record the body part and the distance the nails are apart).

<u>Dissolving rates</u>

* **The three states of matter:** [observational activity]

1. Drop an Alka Seltzer tablet into a tank of water.
   Note: solid (tablet), liquid (water) and gas.

* **Do things dissolve faster in hot or cold water?** [observational activity]

   bullion cubes — glass of hot water — glass of cold water

1. Make a prediction first, based on theory of particle motion.
2. Use particle model (refer to K-3 Earth Science, "Meteorology") to explain why hot water dissolves the cube faster.
3. Advanced: Use particle model to explain why solids have a definite shape, liquids form the shape of the container and gases spread out.

* **Who can melt an ice cube first?** [observational experiment]

    ice cubes   clear plastic bag

1. Can treat data as in candy experiments.
2. Discuss methods used to melt ice.

<u>Identifying unknowns</u>

* **Mystery containers — what's inside?** [observational activity]

1. Sealed milk cartons with various solids, liquids, and gases inside (try cotton balls, honey paperclips, etc.).
2. What could you (hypothetically) do to a container to learn more about the material inside? [possible ideas: float it, hold a magnet next to it, weigh it, spin it, etc.]
3. This is a good activity to introduce density -- occupies same space but weighs more.

<u>Making measurements - units, length, weight, volume</u>

* **What is a unit?** [lesson]

1. A unit is a word that follows a number and describes how you measured the quantity ("15" alone means nothing, but "15 feet" or "15 hands" gives meaning to the measurement).
2. **The metric system is important** to learn, as is the English system -- use both interchangeably.

* **Measuring length in "shoes"** [observational experiment]

1. Using paper "shoes" of various lengths, students discover that in order to make comparisons, all "shoes" must be equal (in length).
2. Discuss the importance of standardized units.
3. Make length measurements with a standard length "shoe" ("Big shoe" = 1 foot) with 12 subdivisions (inches).

* **Use rulers, tape measures and metersticks:** [observational activity]

1. If possible, make approximations before the actual measurement is performed.
2. Include proper units after each number.

<u>Using the balance and graduated cylinder</u>

* **How to use the balance:** [lesson]

1. Set all weights at zero. Move the heaviest weight first. Move it until the arm falls, back the weight up one notch.
2. Go to next heaviest weight, follow step 1.
3. Continue with third weight ("slider", if one exists) until balance is reached.
4. Add up all weights.
5. Advanced: Give students experience reading 10th's of a gram.

* **How much does it weigh?** [observational experiment]

1. Guess the weight of various objects (record guesses).

2. Weigh them and compare guess to actual.

* **Creative uses of a balance:** [observational activity]

1. Weigh a handful of rulers, record weight. When rulers are returned, total should have the same weight.

   This technique can be used for anything (i.e., a box of compasses, tests, pencils, worksheets).

2. You can count paper. First, weigh ten sheets, then multiply this weight by ten. Set this value on balance and stack paper on platform until balance is achieved -- you should have 100 papers.

   This technique is especially useful for approximating or counting large numbers (i.e., find out how many sunflower seeds are in a bag).

3. Mini-balance activities are great for utilizing extra time -- be creative!

   Example: Everybody writes down a guess for the weight of a candy. A student weighs it, closest guess gets the candy (working with metric units and making approximations is **very** important)!

* **Measuring volume using water displacement:** [observational activity]

graduated cylinder (0-50 or 0-100 ml.)
NOTE: When ordering graduated cylinders, get plastic "single scale"

overflow can
water

1. Students should get experience using the graduated cylinder first. Have them measure how much water is in a test tube, small cup, baby food jar, etc. Record results.

2. Explain "the bathtub principle" (water that overflows equals same amount of space as object takes up).

3. Fill overflow can to very top. Place empty cup under spout. Drop object into can. Take water that overflows and pour it into a graduated cylinder. Record value.

4. With practice, students can approximate the volume of an object then make the actual measurement and compare the two values.

* **- Develop process skills by involving students as much as possible in these activities.**

MECHANICS:

Classifying by position and motion

* **Identify your position in the room:** [observational activity]
  1. Use words to help accurately communicate this information (near, far, in front of, behind, etc.).
  2. Advanced: On an index card, each student lists name and describes his/her location. Read each in class. Can others identify the student?

* **Using grid patterns:** [observational activity]
  1. Students receive grid pattern. Make appropriate marks at specific grid coordinates.
  2. Put letters in the matrix. Students find letters from corresponding coordinates to spell out a mystery word, i.e., (1,5) (4,5) (2,8) spells "FUN".
  3. Practice reading maps. Start with simple homemade maps. Advance to an actual map.
  4. Review cardinal directions (north, south, east, west).

     Using graph paper and a "directional spinner", students plot steps in particular directions as each spin is made (at end of exercise all students should be at same point).
  5. Using a map, identify a starting point and a destination. Students must explain how they will get to the destination.

* **Ordering events by time:** [observational activity]

  Cut out pictures of a ball bouncing. Place in proper order so that ball will bounce properly when pictures are "flipped."

Investigating motion and energy

* **How does the number of turns on a wind-up toy affect the distance it moves?** [experiment]
  1. Identify one side of winder with tape or ink dot. Define what one turn of winder means.
  2. Place toy on surface, allow it to move, measure distance (cm.) it moves. Record (1) number of turns of winder and (2) distance it moves.
  3. Hypothesize: If we wound up toy a second time with **same** number of turns how far would it go? (Good guess is the value from first experiment). Try it. Introduce idea of sample sizes and that more than one measurement may be necessary to find out the range of possible values.
  4. Predict: If we wind up toy twice as many times, will it go twice as far? Try it.
  5. Collect data for one turn, two turns, three turns, etc. Evaluate data. Compare toys, etc.
  6. Introduce idea of potential (stored) and kinetic (moving) energy.

     We put our energy into spring by winding the toy. Spring stores energy until toy moves. Stored energy is converted to motion.

* **Energy sources and transference:** [lesson]

Follow some energy form back to its primary source (i.e., we eat food, food gets energy from sun).

* **Which toy car rolls the furthest?** [experiment]

cardboard ramp	2 toy cars

When something rolls down to a lower point it is converting "stored" energy of height into energy of motion (we must use energy to get it back to the top of the hill).

1. Roll toys down ramp. Record distances.

2. Discussion questions: (1) Why do they stop (eventually)? Introduce resistive force (friction), and (2) Why does one go further than the other?

3. Introduce variables (one at a time).

    a. How does ramp height affect distance a car rolls (must use same car each time).

    b. How does ramp surface affect distance it rolls (must keep height and choice of car constant).

    c. How does the weight of the car affect the distance it goes?

    d. Do paper "nose cones" help a car roll further?

* **Object identification:** [activity]

paper squares, circles and triangles of various colors

Use shapes in order to:

1. Identify physical properties.
2. Identify position of a particular shape.
3. Develop skills in sequencing.

<u>Friction</u>

* **What is friction?** [lesson/activity]

Heat (increased motion of particles) is caused by energy of motion.

1. Rub palm of hand on pants -- both hand and pants get hot.

* **Which material has the most friction?** [observational experiment]

cardboard	plastic cups	string
construction paper	pencils (bearing surfaces)	tape
sandpaper	pennies	ruler

1. Place five pennies in top cup (on test surface). Place pennies one at a time in hanging cup until it pulls top cup (from the 15 cm mark to the 10 cm mark). Note: We're keeping all variables constant except that which we are testing (the test surfaces).

2. Record value (in pennies) for each material. Compare results.
   a. Discrepancies may appear. Discuss with class what might have caused these differences between groups (possible answers: each group had different cups, different string, etc.)
   b. Test theories above with new experiments (see next * below).

* **How does the top cup affect the friction?** [experiment]

1. Using the cups of one group, make five measurements on the same surface. Are all five values roughly equal?
2. Replace only the top cup with that of another group. Repeat #1 above. Are all results roughly equal? Did changing the top cup make a difference?

Simple machines

* **How to (easily) give a teacher a lift.** [observational activity]

   5-6 ft. long two-by-four
   log or wood four-by-four (for fulcrum)

1. Make a 1st class lever with the log placed 12-15 inches (30-40 cm.) in from one end. Have a student lift you up.

   Note that you go up only a short distance, while the student must push through a long distance.

* **Types of levers:** [lesson/demonstration]

1. 1st class: **Fulcrum between** Load and Force.

   Examples: (a) removing top on paint can, (b) scissors and pliers (c) can openers.

2. 2nd class: Fulcrum on one end, Force on the other, **Load in between.**

   Examples: (a) paper cutter, (b) can opener.

3. 3rd class: Load on one end, Fulcrum on the other, **Force now in between.**

   Advantage is to maximize movement, not to lift heavy weights.

   Examples: fishing pole, broom, rake, tongs, tweezers, shovel, fly swatter.

* **Analyze different levers:** [observational activity]

1. Hammer when used to remove nails.
2. Why do we sometimes place a block of wood under the hammer? (changes from 3rd class to 1st class lever)

* **Types of inclined planes:** [observational activity]

1. Demonstrate advantage of using a ramp to move a heavy object.
2. Wedges: cutting tools, scissors, knife blade, chisel (2 inclined planes, back to back).
3. Safety: show a large pair of cutters. Discuss (a) sharp "wedge" edges (b) great mechanical advantage with long lever arm.
4. The screw: an inclined plane wrapped around a shaft.
   a. Use a pencil and two paper inclined planes, wrap around pencil, evaluate each.

* **Wheel and axel:** [observational activity]

1. Examples: doorknob, screwdriver (the larger the handle, the greater the mechanical advantage)

   Demonstrate how vice grips on screw driver increases power; explain steering wheel on car.

* **Gears and pulleys:** [observational activity]

1. Fixed pulleys change direction of force.
2. Movable pulleys increase mechanical advantage.
3. (Advanced) Use pictures of gears (i.e., one with 8 teeth and another with 16 teeth). Analyze direction of rotation and amount of movement.

* **How the location of the fulcrum affects the mechanical advantage of a lever:** [experiment]

ruler
3 pencils
fishing weight (3/4 oz.) (20 gms.)
7 pennies
tape

1. Place fulcrum (3 pencils taped together) at 6" (15 cm.) mark. With fishing weight on one end at 12", measure number of pennies required to balance.

2. Move fulcrum closer to weight to 7" mark (move in 2 cm. if using metric ruler). Approximate the number of pennies required to balance weight. Try it and record results.

3. Continue, moving fulcrum in 1" (2 cm.) each time. Record fulcrum location and number of pennies required to balance.

4. Predict: What would happen if fulcrum was moved out to the 5" (13 cm.) mark? Try this and see if predictions were correct.

* – **Develop process skills by involving students as much as possible in these activities.**

HEAT:

Sources of heat

* **Review** [lesson]

1. Nature of heat: Movement of particles as a solid is heated to a liquid and then to a gas (K-3 Earth Science, "Meteorology").
2. Sense of touch as a "heat sensor" (K-3 Physical Science, "Matter").
3. Friction in machines produces heat (K-3 Physical Science, "Mechanics").

* **Where does heat come from?** [lesson]

1. Sun -- nuclear reactions (a giant hydrogen bomb) heats our planet. If it were turned off, land would cool down in 2 weeks. Ocean (holds more heat) would cool down in 1,000 years.
2. Chemical reactions -- burn fuel (i.e., light a match). When we eat food, our bodies use chemicals and the food to keep us warm.
3. Friction -- materials rubbing together.
   a. Rub a pencil eraser on table, feel eraser.
4. Electricity (a form of friction) -- electrons in wire are moving, hit each other, produce heat (toaster).
5. Geothermal heat -- from radioactivity inside the earth.

Use of thermometer, scientific methods

* **Use of the thermometer:** [lesson/activities]

1. Types: double scale (°F/°C) with plastic or metal back (alcohol filled).
2. Note each subdivision is 2°.

   Hand out large drawing of a thermometer with all 2° numbers listed. Students can draw a red line at proper level of alcohol.
3. Bulletin board cardboard thermometer (°F/°C) with red "slider". Record outside temperature each day and set the level on bulletin board (refer to page ES(P)-15).

* **How does the temperature vary throughout the room?** [observational experiment]

1. Use one thermometer for every two students (number each thermometer for inventory).
2. Remind students not to shake thermometers or touch bulb end.
3. Students read and record temperature.
4. Draw a rectangle (representing the room) on the blackboard. Record all temperatures and locations within the rectangle. Analyze results. What causes variations?
5. Discuss possible errors (i.e., inaccurate thermometers). Solicit ways to test all thermometers (put all in a glass of water or switch them).

* **How warm/cold are the mystery liquids?** [observational experiment]

Students go from station to station, measuring and recording temperature and time (optional) of various numbered samples of water in styrofoam cups. Student groups list samples in order of temperature. Discuss results.

Heat transfer by conduction

* **How does heat transfer through liquids?** [observational activity]

large glass or plastic container of cold water
smaller glass or plastic container of hot blue water (do not use styrofoam)

1. Record temperature of each.

2. Place small container in large one. Hypothesize what will happen in 10 minutes (if students realize that hot gets colder and cold gets hotter, have them guess the "equilibrium" temperature).

3. What would happen with twice as much hot water in small container? Hypothesize, then try it.

* **How does heat move through solids?** [observational activity]

knitting needle
clothespin
candle
wax
wood dowel
wire
plate

1. Drip wax on needle, hold it in candle flame (using clothespin). Students hypothesize what will happen (wax progressively falls off as heat travels).

2. Connect needle and dowel together with wire. Try again (wax drops off metal but not wood -- introduce two new words: "conductor" and "insulator").

* **Which metal transfers heat the fastest?** [observational activity]

copper rod*
steel rod (etc.)
2 candles
2 clothespins

1. Put wax drippings on each rod at same distances.

2. Place each in similar fires at same time. Record time each "drip" melts.

   * - copper pipe will work, but note that you are not controlling variables (pipe has a hole in middle, steel or aluminum do not).

Conductors and insulators

* **Which objects are conductors and which are insulators?** [observational experiment]

various objects (plastic spoon, metal fork, popsicle stick, straw, etc.)
styrofoam cup of hot water

1. Observe and record which objects get hot (to the touch). Group into "conductors" and "insulators".

*** – Develop process skills by involving students as much as possible in these activities.**

LIGHT:

Sources of light

* **Review** [lesson]
  1. Shadows from sunlight (K-3 Earth Science, "Astronomy").
  2. Our eye as a sensor of light (K-3 Physical Science, "Matter").

* **Where does light come from?** [lesson]
  1. Sun is our most important source of light.
     a. Plants use sunlight; produce oxygen, food and eventually coal and oil which we burn to make artificial (electric) light.
  2. Artificial light:
     a. From chemical reactions (candles, matches, etc.). We also put chemicals in batteries to make electricity to make light.
     b. From motion of objects (falling water or blowing wind to generate electricity).

Transmission through different materials

* **How well do different materials pass light?** [observational experiment]

  Students classify various materials into three groups (hold each to light):
  1. Opaque (block all light).
  2. Translucent (pass some light).
  3. Transparent (clear).

How a magnifier works

* **Magnifiers, how they work:** [lesson/activity]

  wax paper
  eyedropper
  magnifiers
  newspaper

  1. Students place a drop of water on wax paper over newsprint. Make observations -- conclude that a magnifier must be curved (outward) and transparent.
  2. Observe stamps, etc., with magnifying glass.

Reflection and mirrors

* **What is reflection?** [observational activities]

  rubber ball
  mirrors (with taped edges)

  1. Explain "reflection" with rubber ball. Demonstrate angle in = angle out and surface must be smooth.
  2. Have students make careful observations with their mirrors to see if reflecting light really does follow the rules explained in #1 above.
  3. Place a target on the wall. Students must hit the target with light from their mirror.

* **Mirror relay:** [activity]

two teams of students
4 mirrors (can be mounted securely on wood for safety)
2 targets

Two students from each team run to "X's" (aiming positions), pick up mirrors and aim light beam. Light must travel from sun to student #1, to student #2, then to target (teacher is judge). Continue until all team members have hit the target.
Note: Do not allow students to run with mirrors. Pick up and set down on "X's", instead.

Shadows

* **Four important properties:** [teacher information]

1. A shadow forms whenever light hits a solid object.
2. A shadow moves when object or light source moves.
3. A shadow may change its shape when the object is turned or rotated.
4. Shadows are longer when the light source is low and shorter when source is high.

* **Shadow activities:**

1. Silhouettes of faces (side view) on paper (identify the mystery silhouette).
2. Use overhead or slide projector for shadow fun or suspend a sheet in front of room and light from behind. Two students can make a four-armed person, etc.
3. Students sit in a circle with one light source in center. Each observes shadows generated by particular objects (pencil with pin in eraser, popsicle stick with washer, tissue tube, etc.).
4. Students predict what will happen if light source is raised or lowered. Try it. Students make observations of shadows outside (early morning and lunch time). See if classroom model works in a real situation.
5. Outline student shadows with chalk on blacktop (or use crayons on butcher paper).
6. Use solargraphic or sunprint paper to investigate shadows (available from science supply houses).
   a. Note where it is whiter. Solicit explanations (even where there is a shadow, some light can reflect in).

Colors - pigments, light

* **Which color of plastic affects sunprint paper the most?** [observational experiment]

red, green, blue plastic strips
sunprint paper
water (for developing)

1. Allow students to hypothesize first.
2. Perform the experiment (place an opaque object [i.e., safety pin] on paper also). Don't overexpose paper.
3. Evaluate results, form a conclusion: Paper is mostly sensitive to blue light (white light has all colors in it). The paper "sees" only blue light. Some animals can see colors that we cannot.

* **How do primary colors combine to make other colors?** [activity]

red, blue and yellow water
small plastic vials
eyedropper
color wheel
crayons

1. Students color in six of twelve boxes on color wheel: (red, purple, blue, green, yellow, and orange) leaving a space between each.

   Explain how mixing the primary colors (red, blue yellow) should make the color found between each.

2. Test to see if in-between colors really are a result of mixing primary colors (i.e., 2 squirts of blue + 2 squirts of yellow make 4 squirts of green).

   Discuss contamination of chemicals -- supply cups of clear water to clean eyedroppers.

3. Mix correct colors (and amounts) to identify the resulting color for the empty boxes (i.e., 4 squirts of green + 4 squirts of yellow make 8 squirts of yellow-green).

   Find corresponding crayon and color in the appropriate box.

* **How does colored paper look through colored filters?** [observational experiment]

Note: Primary colors of light are red, blue and green.

6-pack rings from soda cans
colored plastic (red, blue, green)
yarn
colored construction paper

1. With three students per group, one wears goggles, one holds up different colors of paper and the third records results (switch roles for each of the three goggles).

* - **Develop process skills by involving students as much as possible in these activities.**

SOUND:

Sources of sound

* **Identify sources of sound:** [activities]

1. List objects that make sounds (optional: describe the sound each makes -- door creaking, water faucet dripping, firework exploding, loud shirt, cricket chirping, scissors cutting, etc.).

2. Students close their eyes. Teacher makes sounds (scissors cutting, papers rustling, etc.). Students identify objects.

3. Play back taped sounds -- students identify. Variation: "How does a particular sound make you feel?"

Nature of sound

* **How sound travels:** [lesson/observational activity]

1. Sound will not travel through an empty space (vacuum).

2. Model: Use dominos and a rubber ball to demonstrate that sound radiates out in all directions.

3. Model: Place five checkers end-to-end. Flick another checker into the line. Energy is transformed from one particle to another with a "pushing" motion.

Intensity, frequency and pitch

* **What does a sound wave look like?** [observational activities]

Slinky
2 twist ties

1. Hang Slinky vertically. Gather up 3 or 4 loops and release. This demonstrates a "push" wave.

2. Volume or loudness: Pluck 1 loop with increasing force -- show strength of "signal" passing through the spring.

3. Frequency or pitch: In a ten-second interval, students count waves. First pluck slowly (about 1 per second), then faster (2 per second).
   Relate to sound: slow = low sound
   fast = high sound.
   real fast -- very high (dogs may hear when we can't)
   Use a pitch pipe, etc., to reinforce.

4. Hold a vibrating tuning fork in a bowl of water (try on your overhead projector).

* **What is moving to make the sound?** [observational activity]

Students identify what is moving for a particular sound to be made (radio speaker moves, gases from a match, etc.).

Relationship of length, tension and mass to pitch

* **How does length of a tuning fork affect the sound it makes?** [observational activity]

  various tuning forks

  Conclude that longer forks make lower sounds.

* **How does length of a ruler affect the sound it makes?** [observational experiment]

  Students pluck rulers over the edge of a table. Discover that longer ones produce lower sounds.

* **Investigate length:** [observational experiment]

  "guitar" made with ruler, 2 pencils, and a rubber band.
  Note: shorter bands vibrate faster and produce higher pitched sounds.

* **Investigate tension:** [observational experiment]

  When band is pulled tight it vibrates faster (higher sound). Note: You should control variables when testing rubber bands. Use the same size bands and keep length constant as the variable you are testing here is tension (tightness).

* **Investigate mass:** [observational experiment]

  1. Glasses (with varying amounts of water in each) and nail.
     Conclusion: One with most water (most massive) produces lowest note.

  2. Mix up glasses. Students order all from low to high pitch.

* **Ruler experiment - which is heavier?** [observational experiment]

  1 wood ruler
  1 plastic ruler
  balance

  1. Extend both rulers equal distances over edge of a table.

  2. Pluck each one and determine which ruler produces the lowest note.

  3. Use results from "*Investigating mass" above to infer which ruler should weigh the most (logically guide your students through this — inferring is an advanced process skill).

  4. Weigh the rulers and see if, in fact, the "low note ruler" weighs the most.

Simple instruments

* **Instrument evaluation:** [observational activity]

  Look at various musical instruments. Identify the principle or principles by which they work. Do they (1) vary length
  (2) vary tension, or
  (3) vary mass?

  Examples: guitar (all three)
  flute (length of air column)
  xylophone (length)

* **(Extra) Put playing cards on bicycle wheels (with clothespins):** [activity]

The faster they flap, the higher the pitch.

* **Making simple instruments:** [activities]

1. Sliding whistle: Straw (partially cut), glass of water (or blow across top of a bottle).
2. Kazoo: Tissue tube with hole punched in top, wax paper, rubber band.
3. Sound effects with Slinky and cardboard cup.

How our vocal chords work

* **Model of vocal chords (with a balloon):** [observational activity]

We have two vocal chords. Using our muscles, we can vary the tension on them and make them vibrate. We can also change the length of the air column with our mouth and tongue.

* **Listen to swallowing noise (or voice) with a paper towel tube** (placed against throat).

Sound travels through matter

* **Through gases:** [lesson]

All sound we hear is traveling through air so we already know that sound travels through air (gas).

* **Through solids:** [activity]

1. Place ear on desk top, scratch table with hand.

   Indians put ear to ground to listen for herds of animals.
2. Put tuning fork and ear on table. Observe intensity.
3. Using a plastic cup connected to a spoon with a string, tap the spoon. Listen in the cup. Students describe how sound travels through spoon, string, cup and air.

   Variation: Plastic cup three-way string telephone.

* **Through liquids:** [activities]

1. Ear against tank of water. Tap rocks under water (sound actually going through liquid/water), solid (glass) and gas (air inside the ear).

Echoes

* **What are echoes?** [lesson/observational activity]

1. Sound reflects off certain objects. Reflection occurs when sound hits something different, i.e., travels through air then hits a solid (mountain). Some is absorbed, some bounces back like a ball. Because it takes time for sound to go all the way to the mountain and back we hear an echo.
2. Use a Slinky (horizontal on table) to demonstrate echoes (remember, sound is a "push" wave).

How the ear works

* **The ear:** [lesson/observational activity]

1. Range: 20 waves per second (low sound), to
   20,000 waves per second (high sound)

2. Tubes in ear with liquid in them help us keep our balance and allow us to sense motion.

3. Use a beaker of water to demonstrate tubes:

   a. Lean left -- more water on one side than the other.

   b. Lean right -- reverse effect.

   c. Spin around -- swirl water. Note: it is high on all sides and low in middle. Also, when "person" stops moving, the water keeps spinning (this makes us dizzy).

   Ear infections (or rocking boats) can upset our sense of balance.

4. Ear collects sound vibrations, transfers them into a liquid in the cochlea -- 24,000 tiny hairs (rulers) of various lengths vibrate depending on sound. Vibrations are converted to electrical impulses which are fed to the brain via nerves (like wires) where they are analyzed (like a computer).

5. Discuss ear safety (putting objects into your ear, listening to loud noises, etc.).

*** - Develop process skills by involving students as much as possible in these activities.**

ELECTRICITY/MAGNETISM:

Types of magnets

* **Imagine discovering a magnet for the first time:** [lesson]

Early man discovered this invisible force - used it in medicine, etc.

* **Types of magnets, associated items, proper handling:** [teacher information]

1. Bar magnet - most versatile, made of steel or alnico (an alloy of aluminum, nickle and cobalt).

2. Ring magnets - north on one side, south on the other. Can stack on a pencil.

3. Horseshoe magnet - more expensive, should have at least one per school. Can be used to show that magnets can do heavy work.

4. Keepers - used to save magnetic energy (metal strip that goes from one pole to the other).

5. Store bar magnets north to south together.

6. Compass - A bar magnet on a pivot. Has many valuable uses. Get large, inexpensive compasses (40 mm diameter). Put numbers on back of each for inventory control.

7. Iron filings - one pound (500 grams) per class is sufficient. Can be stored in a shaker (identify with "Fe - Iron").

What is a magnet

* **Using a compass to identify objects as magnets:** [lesson]

1. When one end of the object is near the compass, one end of the needle points toward it.

   AND

2. When the other end of the object is near the compass, the other end of the needle points toward it.

NOTE: Both conditions 1 and 2 must be met, as metals that are not magnets (i.e. paper clip) may attract either end of the compass needle.

* **Model of a magnet:** [observational activity]

Hypothesis: A magnet is many, many tiny little compasses all pointed in the same direction.

Model: A test tube half-full of iron filings.

A. Test with a compass, does it meet both conditions 1 and 2 on previous page? (should not)

B. Line up particles by stroking the test tube with your horseshoe (or very strong) magnet - use only one pole, stroke in only one direction.

Test again (should meet both conditions).

C. "What happens if all the particles ("tiny compasses") get disoriented?"

Shake test tube and test again with compass.

D. "How can we cause a magnet to lose its magnetism?"

"Shaking the magnet" is a good guess but not correct - since it is a solid, it must be "shaken" in extremes (i.e. dropping it, hitting it with a hammer, heating it in a flame).

* **Which parts of the magnet are strongest?** [observational experiment]

Place a bar magnet in a pile of paper clips. Note (or count) where the clips stick and where there are relatively few.

* **Test relative strength of each pole (or separate magnets):** [observational experiment]

Hang paper clips end-to-end on each pole. Record maximum number. You may get better (differential) results if you use lighter objects (i.e. staples).

<u>Testing materials</u>

* **Test different materials to see if they are magnetic or nonmagnetic:** [observational experiment]

magnet	thumb tacks
paper baking cups	paper clips
sesame seeds	pennies
aluminum foil strips	

Record results, make a list of those items (or baking cup numbers) that are magnetic and those that are nonmagnetic.

"By doing this experiment, what can we conclude about magnetic materials?"

1. Only metal objects are attracted.
2. Not all metal objects are attracted.

* **Test materials to see if the magnetic field passes through it:** [observational experiment]

magnets	paper clips
cardboard	thin plywood
steel sheet	glass dish
cork with thumbtack	water

Student groups can each carry their magnet and paper clip to various stations and record the results of each test.

Magnet on one side of test material, paper clip on the other.

"Can we move the paper clip?" - record results.

* **Are sample items magnets or not?** [observational experiment]

Using inquiry methods, assist class in developing techniques for testing items. (solution: "use compass")

Assign numbers to baking cups with a sample in each (use about 10 samples with half of them magnetized)
Test items with compass, record results.

Info: To make magnets, rub one pole of a magnet along one end of object, flip both around and rub other pole along the other end.

Interacting poles

* **Investigate interaction between magnetic poles:** [observational experiment]

Student groups experiment with two bar magnets and discover this conclusion:

Like poles repel, unlike poles attract (use a worksheet with directions if necessary).

The earth's magnetic field

* **Is the red end of a compass needle a north or a south magnetic pole?** [observational activity]

Take time to let class discuss how this question might be answered.

Test the compass with a magnet. Find out that the red end is a north pole (attracts a south magnetic pole).

Present the idea that the earth has a huge (bar) magnet in it. Ask how we would find out which pole of the magnet is at the north end of the earth.

Use the compass - red points north, therefore, the earth's north end is really a south magnetic pole. The red end of the compass is called the "north-seeking" end . . . this can be confusing but it is a good exercise in logic.

* **Identify the unknown poles:** [observational activity]

Tape ends of two bar magnets.

Question: Can we determine which ends are north and which are south? (can't use compass)

Answer: We can only determine which are like and which are unlike.

If we suspend one magnet in a cradle (string), the "north" end will spin around and point north (assuming we know which way is north). We can then tell the polarity.

The compass

* **Homemade compasses:** [observational activity]

1. Magnetized needle, cardboard, jar, thread and pencil.

2. Floating compass: cork, magnetized needle, tape, jar and water.

Field lines

* **Detecting field lines with iron filings:** [observational activity]

1. Glass baking dish with magnet underneath.
   Place on overhead projector. Sprinkle iron filings on dish.

2. Use sunprint (solargraphic) paper.

3. Use spray adhesive.

* **Make a bulletin board display entitled, "Magnets"** [observational activity]

* **Use same techniques above to investigate interacting fields.**

The nature of electricity

* **Electricity - analogy:** [lesson]

Moat around castle, king wanted a boat ride in moat, how would he make the water move?
(all solutions require some form of power to push the water around)

All electric circuits need: (1) a driving source and (2) a complete circle.

In an electric circuit we don't push water but rather tiny particles called "electrons" through the wire. Flow from minus (-) to plus (+).

A villan throws boulders into the moat to slow down the water (concept of resistance).

Light bulb is also resistance (wire is very narrow and electrons get pushed closer together causing heat and, eventually, light (energy of motion is converted to heat and light energy).

Simple circuits

1.5 volt "D" cells with holders
GE-14 bulbs (2.5 volt) with sockets
wire

* **Make a complete "circle":** [observational experiment]

1 battery   1 bulb   2 pieces of wire

If there is a break in the circuit, the light goes out.

* **Analogy: Hold hands and pass a "pulse" around in a complete circle:** [observational activity]

Try to locate a "break" in the circle (troubleshooting the circuit).

Testing materials

* **Test materials by placing each in the circuit (circle):** [observational experiment]

Observe whether or not the bulb lights. Record results. List conductors and insulators.

Electromagnets

* **Relationship between electricity and magnetism:** [observational experiment]

1. Test a coil of copper wire with compass. Is it a magnet? (no)

2. Connect coil to 1.5 volt cell and then test with compass (it is now a magnet).

   Note: This is a "short circuit" and should only be connected momentarily. (Explanation: No boulders in the moat so current runs rapidly, battery runs out of power faster).

Conclusion: When electrons flow through a wire, it makes a magnet.

* **How does amount of current affect magnetic field?** [observational experiment]

1. Wrap 6 turns of hook-up wire (18-gauge) around a compass, connect for about 5 seconds to battery, record amount of deflection (mark with crayon).

2. Place bulb in circuit, see if deflection is as much (Note: This is the principle involved in electrical meters - show a meter if you have one - less current, less magnetic force).

* **Make and test an electromagnet:** [observational experiment]

nail
1.5 volt battery
18-gauge wire (20 turns)
paper clip

1. Test nail with paper clip. Is it a magnet?

2. Wrap wire around the nail.

3. Connect to battery (short time). Is it now a magnet? (test with paper clip)

4. When disconnected, is there any residual magnetism left in the nail? (if so, how could we get rid of it?)

Use of electricity and conservation

* **Appreciation/conservation:** [lesson/activity]

Students should develop an appreciation for electricity - be aware that it costs money and should be conserved.

1. Discuss where we get our household electricity (fossil fuels, water power, nuclear power plants, etc.)

2. List appliances that use electricity and how they make life easier for us.

Safety

1. Discuss dangers of high voltage - even household current can kill.

2. Use only batteries for experiments. Respect high voltage.

*** - Develop process skills by involving students as much as possible in these activities.**