INTRODUCTION

The teacher should have the students view lessons 1 through 20 as they appear on the videos. My experience with this approach has indicated that students become mentally involved in the lessons.

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THINKING WITH SCIENCE

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By Don Hansler

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3	The Bubbly Liquid (Yeast Fermentation)
4	Floating and Sinking Caps (Flotation and Density)
5	The Potato (Osmosis)
6	The Strange Radish Seedlings (Effects of Light on Plants)
7	The Glowing Lamp (Conductivity of Solutions)
8	The Diving Vial (Density and Air Pressure)
9	Angry Liquids (Immiscibility of Some Liquids)
10	The Broken Jar (Expansion of Freezing Water)
11	The Changing Board (Mechanical Advantage of Levers)
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13	The Volcano (Density of Different Solutions)
14	The Collapsing Can (Air Pressure)
15	Acceleration (Variations in Acceleration by Mass)
16	Crystals and No Crystals (Contents of Seawater)
17	The Changing Weight (Densities of Liquids)
18	The Dizzy Thermometer (Wet and Dry Thermometers)
19	The Magic Balloon (Effect of Temperature on Air Volume)
20	Another Volcano (Density of Liquids at Different Temperatures)

Descriptions of Activities from "Thinking With Science"

1. The Floating Egg

   Focus:

   The students are shown two jars, A and B, each about half-full of a clear, colorless liquid. Egg A sinks in liquid A, but egg B floats in liquid B.

   Focus Question:

   Why does egg A sink, and egg B float?

   Conditions:

   Liquid A is plain tapwater. Liquid B contains 4 tablespoons of salt.

2. The Floating Egg, Modifications:

   Focus:

   The students are shown two jars, C and D, each about half-full of a clear, colorless liquid. Egg C sinks in liquid C, but egg D floats in liquid D.

   Focus Question:

   Why does egg C sink and egg D float?

   Conditions:

   Liquid C is tapwater containing two tablespoons of salt (not enough to float an egg). Liquid D contains 1 tablespoons of salt *and* 3 tablespoons of sugar (a total enough to float an egg).

3. The Bubbly Liquid

   Focus:

   The students are shown two sets of identical equipment. In each, a glass pop bottle is about half-full of a milky-looking liquid. Each bottle is plugged with a one-hole stopper containing a glass tube, which is connected to a rubber tube. The other end of each rubber tube contains a short piece of glass tubing which is under the surface of a clear liquid in a jar. There are bubbles coming from the tube of bottle A, but no bubbles coming from the tube of bottle B.

   Focus Question:

   Why are there bubbles coming from tube A, but not tube B?

   Conditions:

   Bottle A contains tapwater and 1/2 teaspoon of yeast. Bottle B contains the same, plus 1 tablespoon of sugar. The yeasts in B can metabolize the sugar, and can thus produce carbon dioxide gas, which comes off in the form of bubbles. The jars where the ends of the tubes are contain only water.

4. Floating and Sinking Caps

Focus:

The students are shown two small jars, A and B, each about half-full of a clear, colorless liquid. Two medicine vial caps, A and B, are dropped into the respective jars. A, a smaller one, floats; B, a larger one, sinks.

Focus Question:

Why does cap A float, but cap B sink?

Conditions:

Liquid A is tapwater; the plastic caps will float in it. Liquid B is rubbing alcohol; it is less dense than water, and the plastic caps will sink in it.

5. The Potato

Focus:

The students are shown two jars, A and B, each about half-full of a clear, colorless liquid. In liquid A, there is a piece of potato, about the shape of a french-fry. In liquid B, there is a somewhat similar piece of potato. When the two pieces of potato are measured, A is 63 mm. long, and B is 56 mm. long.

Focus Question:

Why is A 63 mm. long, and B 56 mm. long?

Conditions:

Both potato pieces were 60 mm long to begin with. Liquid A is plain tapwater. Liquid B is tapwater containing 1 tablespoon of salt. Through osmosis, A absorbs water, but B loses water, from the cells.

6. The Strange Radish Seedlings

Focus:

The students are shown four containers of radish seedlings. Group A are about 2 inches tall, upright, and green. Group B are about 4 inches tall, and light yellow. Group C are about 2 inches tall, but all of them are leaning over to one side. Group D are barely peeking through the soil.

Focus Question:

Why do these groups of radish seedlings look so different?

Conditions:

Group A had normal light and heat. Group B were covered with a box, so they got no light. Group C were in a tilted container. Group D were in a colder room.

7. The Glowing Lamp

Focus:

The students are shown a piece of equipment which has the following parts, connected in the order listed: a bare copper wire coil; a piece of insulated copper wire about 1 foot long; a lamp receptacle containing a 6-volt lamp; a piece of insulated copper wire about 1 foot long; a 6-volt lantern battery; a piece of insulated copper wire about 1 foot long; a bare copper wire coil.

When the coils are dipped in liquid A, the lamp does not light.
When the coils are dipped in liquid B, the lamp lights.
When the coils are dipped in liquid C, the lamp lights.
When the coils are dipped in liquid D, the lamp does not light.

Focus Question:

Why does the lamp light with liquids B and C, but not with liquids A and D?

Conditions:

Liquid A is plain tapwater. Liquid B is a salt solution. Liquid C is dilute hydrochloric acid. Liquid D is rubbing alcohol.

8. The Diving Vial

Focus:

The students are shown a gallon jar, filled to within 2 inches of the top with a clear, colorless liquid. Floating in the liquid, there is an upside-down small glass vial. The jar is covered by an airtight sheet of rubber. When the top is pressed tightly, the vial sinks to the bottom. When the top is released, the vial comes back to the surface.

Focus Question:

Why does the vial sink when the rubber top is pressed? Why does it return to the surface when the top is released?

Conditions:

The liquid in the jar is water. The space at the top of the jar contains air. The vial has been arranged so that it contains just the right balance of air and water, and it barely floats. When the rubber top is pressed, the pressure is transferred from the top, to the air, to the water in the jar, to the air in the vial. The latter compresses, allowing more water to enter the vial, so the vial sinks. The reverse process occurs when the rubber top is released.

9. Angry Liquids

Focus:

The students are shown two small jars, A and B, each about half-full of a clear, colorless liquid. They are also shown

two other small jars, G and R, each almost full of a green liquid and a red liquid, respectively. When a turkey baster is used to drop some of G in A, and some of R in B, G sinks to the bottom of A, but R floats on B.

Focus Question:

Why does G sink and R float?

Conditions:

Liquid A is mineral oil. Liquid B is Karo syrup. Liquids G and R are simply water with the respective food colorings.

10. The Broken Jar

Focus:

The students are shown two large wide-mouth peanut butter jars, A and B. A is broken into several pieces, but B is whole.

Focus Question:

Why is A broken and B whole?

Conditions:

Both jars were filled with water and then placed in the freezer. However, the lid was placed on A, but not on B. The water in both expanded as it formed ice. A was not able to expand, because of the lid, so the glass broke from the expansion. The freezing water in B expanded right out of the open mouth, so the glass didn't break.

11. The Changing Board

Focus:

The students are shown a 24-inch board, that has the middle marked with a zero, and each end marked with numbers, beginning with 1 and numbering through 12 on end A, and beginning with -1 and numbering through -12 on end B. The board has a styrofoam cup pinned to each end, in order to hold weights (nails all the same size). The board is placed on an engineer's ruler (triangular cross section), so that the ruler forms a fulcrum. With the fulcrum at zero, 3 nails are placed in cup A, and the students are then asked to predict how many nails must be placed in cup B, to cause end B to go down. Then their predicted amount is tried. (This procedure is repeated over and over with different numbers of nails and different placements of the fulcrum).

Focus Question:

(Modified and variable. Ask the students to predict the number of nails is will take to balance various numbers of of nails in cup A, and also with various placements of the fulcrum.)

Conditions:

The farther the fulcrum is from cup A, the more nails it will take to balance the board when they are placed in cup B.

12. The Pale Leaves

Focus:

The students are shown two jars, A and B. Jar A is about half-full of a clear colorless liquid. It also contains two bright green primrose leaves. Jar B is about half-full of a clear, green liquid. It contains two pale yellow primrose leaves.

Focus Question:

Why are the leaves so pale in Jar B?

Conditions:

The leaves have been in the liquids for several days. Liquid A is tapwater. Liquid B is rubbing alcohol. The green chlorophyll of the leaves is soluble in alcohol, but not in water.

13. The Volcano

Focus:

The students are shown a two-gallon glass aquarium almost full of a clear, colorless liquid. Two small stoppered bottles, R and B, are carefully lowered into the aquarium. R contains a red liquid; B contains a blue liquid. When the stoppers are carefully removed at the same time, the red liquid rises quickly upward, toward the surface of the aquarium liquid, but the blue liquid stays in the bottle. Later, if a student suggests turning the blue bottle over, the blue liquid comes out and sinks to the bottom.

Focus Question:

Why does the red liquid rise, but the blue liquid not rise?

Conditions:

The clear aquarium liquid is a very dilute salt solution. The red liquid is plain tapwater containing red food coloring. The blue liquid is a concentrated salt solution containing blue food coloring.

14. The Collapsing Can

Focus:

The students are shown two tightly stoppered paint-thinner cans. A is normal, B is very collapsed. While they are looking at these cans, another can, C, is shown. 1 cup of water is added, then it is placed on a hotplate until steam starts coming out of the mouth. Then can C is removed from the

hotplate, and it is closed tightly with a lid. After a few minutes, can C also begins to collapse.

Focus Question:

Why is can A normal and can B collapsed?

Conditions:

Can B had water in it when it was heated, but can A didn't. Both were closed tightly after being removed from the hotplate. The plain air in can A didn't contract enough when cooling to create a partial vacuum, but the water vapor in can B contracted enough to create a partial vacuum, thus allowing the outside air pressure to collapse the can.

15. Acceleration

Focus:

The students are shown an acceleration cart (borrowed from the Physics teacher), a launching platform, and three identical-looking small sealed boxes. The platform is a piece of plywood raised on two 2x4's, so that the cart can pass under it. A rubber band is attached to a nail on the plywood, and by attaching the other end of the rubber band to a hook on the cart, the cart can be "launched" by stretching the rubber band and then letting go. When this procedure is used with boxes A, B, and C, the cart goes the following distances on the flat, smooth table surface: A= 98 inches; B= 65 inches; C= 32 inches.

Focus Question:

Why does the cart go different distances when containing the three different boxes?

Conditions:

Box A is empty; box B contains an 8-ounce fishing sinker; box C contains two 8-ounce fishing sinkers.

16. Crystals and No Crystals

Focus:

The students are shown three clear, colorless bowls. Bowl A contains nothing. Bowl B is lightly coated with small, white crystals. Bowl C is heavily coated with large, white crystals.

Focus Question:

Why do the three bowls have different amount of crystals?

Conditions:

All three bowls were originally filled with water or water solutions. A contained distilled water; B contained tapwater; C contained seawater. All three liquids were evaporated by

placing the bowls in the oven at a relatively low temperature. The crystals in B are the residue from the small amount of minerals in ordinary tapwater. The large crystals in C are the residue from the relatively large amount of dissolved salt and other minerals in seawater.

17. The Changing Weight

Focus:

The students are shown a single-pan balance that has been modified by taping a pencil to its arm. From the pencil, a bolt is hung on a string. The two larger weights on their respective weight-arms are placed so that the balance is "balanced". This piece of equipment is on top of a box, so that the bolt dangles freely. Then, the bolt is dangled into three separate jars: A, B and C. The jars are in boxes so that the students can't see their contents. When the bolt is weighed (using the finest scale gradation), its weight in the three different jars is as follows: A= 9 grams, B= 7 grams, and C= 5 grams.

Focus Question:

Why did the bolt weigh different amounts in the three jars?

Conditions:

Jar A contained only air; jar B contained alcohol; jar C contained water. Weights "weigh" less in denser mediums.

18. The Dizzy Thermometer

Focus:

The students are shown three identical thermometers that have a cotton ball attached to each of their bulbs by means of a rubber band. These thermometers are then placed in slots cut in a cardboard box. The closed side of the box is facing the students, so that they can't see what the teacher does to each of the thermometers. The teacher records the temperature reading of each thermometer at the start. Then the teacher dips thermometer A in jar A, thermometer B in jar B, and thermometer C in jar C. After 5 minutes, the thermometers are read again. Thermometer A reads about the same as at the start. B reads about 5 degrees cooler, and C reads about 10 degrees cooler.

Focus Question:

Why did the thermometers have different readings after 5 minutes?

Conditions:

Jar A contained only air. Jar B contained water. Jar C contained rubbing alcohol. The water evaporates, thus absorbing heat. The alcohol evaporates even faster, thus absorbing even more heat.

19. The Magic Balloon

Focus:

The students are shown a glass pop bottle that has a balloon placed over its mouth. When the bottle is placed in bucket A, the balloon inflates. When the bottle is placed in bucket B, the balloon deflates.

Focus Question:

Why did the balloon inflate with bucket A, and deflate with bucket B?

Conditions:

Bucket A contained hot water; heat from the water expanded the air in the bottle. Bucket B contained ice water, which absorbed heat from the air in the bottle, and caused it to contract.

20. Another Volcano

Focus:

The students are shown a 2-gallon glass aquarium containing a clear, colorless liquid. They are then shown two small stoppered bottles, one containg a red liquid, and the other containing a blue liquid. The bottles are slowly and carefully lowered into the aquarium liquid. Then the stoppers are carefully removed simultaneously. The red liquid rises, but the blue liquid stays in the bottle. If a student happens to suggest turning the blue bottle over, the blue liquid settles to the bottom of the aquarium.

Focus Question:

Why did the red liquid rise, and the blue liquid not rise?

Conditions:

The aquarium liquid is room-temperature tapwater. The red liquid is hot tapwater. The blue liquid is cold tapwater.

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INTEGRATING THINKING SKILLS THROUGH INQUIRY

or

INTEGRATING THINKING SKILLS INSTRUCTION INTO THE EXISTING CURRICULUM BY USING THE INQUIRY APPROACH

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