A TEACHING UNIT ON

ELECTRICITY

FEATURING

THE HISTORIC FOLSOM POWER HOUSE

CALIFORNIA SCIENCE STANDARDS COMPATIBLE FOR GRADE 4

written by
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in cooperation with
California State Parks and
The Gold Fields State Park District

This instructional package is composed of two files: this electricity unit and a teacher's guide. Teachers who plan to use the unit should download both files.

Credits

Support from the following persons in the development of these materials has been deeply appreciated:

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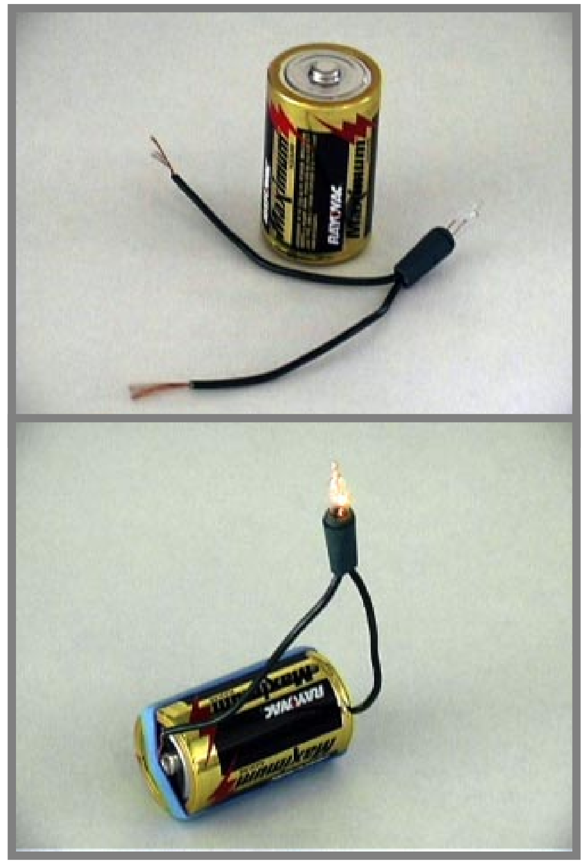
Part A: Lesson Plans

Lesson 1. A Circuit.

Materials. Each group will need:



- One light bulb and socket. *Cut up an old string of miniature light bulbs.*
- One D cell battery (standard-sized flashlight battery)
- A thick rubber band that will fit tightly around the battery.
- Chart paper and markers (or white board and markers)

Lesson Steps:

Step 1 Make Observations. Before passing out materials, say to the children: “See how many different ways you can make the light bulb light up.” Each time they find a way, they should make a drawing of it.

Step 2 Sharing Information. When each group has at least 1 circuit drawn, collect the charts and hang them in the front of the room.

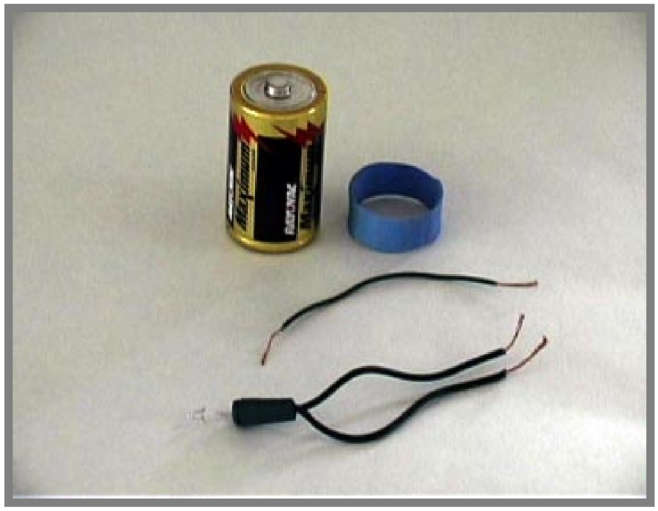
Step 3. Drawing Conclusions. Ask children to examine the drawings and identify “what was always the same” when the light bulbs lit.

Step 4 Settling Disputes. If children draw an incorrect conclusion or if children disagree about a conclusion, have them come to the front of the room and attempt to show that they are correct with a light bulb and battery.

Step 5 Summarize. The teacher lists on the board all the “things that were the same.” Some examples that children may come up with are: “You always had to touch one wire to the bottom of the battery.” or “You always had to touch one wire to the top of the battery.” or “You always had to touch both ends of the battery with the wires.” or “You couldn’t get it to light by touching the bulb to the curvy part of the battery.” etc.

Step 6 Closure. Explain that the word “circuit” is another way of saying “circle” and that electricity always travels in a circle. Ask one or two children to trace the “circuit” on their chart so the whole class can see. Then ask each group to make a drawing of a light bulb in a circuit using arrows to show the circular path taken by the electricity through the battery, through the wires, and through the bulb.

Lesson 2: Switch in a Circuit.

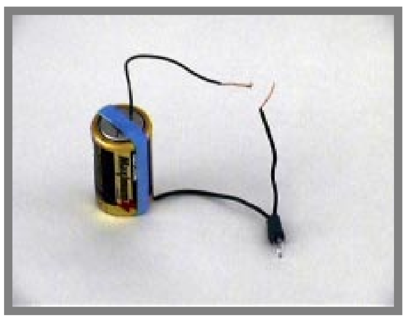


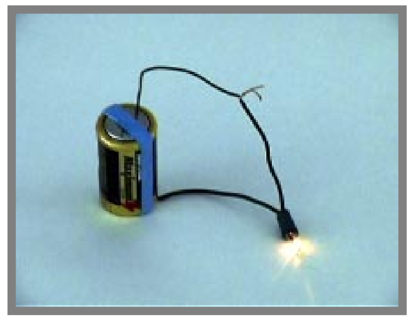
<u>Materials</u>. Each group will need:

- a light bulb and socket
- a thick rubber band
- a D cell battery
- a piece of wire about 6” long

<u>Lesson Steps</u>:

Step 1 Review. Review the term “circuit.” Give as many children a chance to explain what it takes to make a circuit and how electrons flow in a circuit. Have some children trace the circular path through a circuit in front of the class.





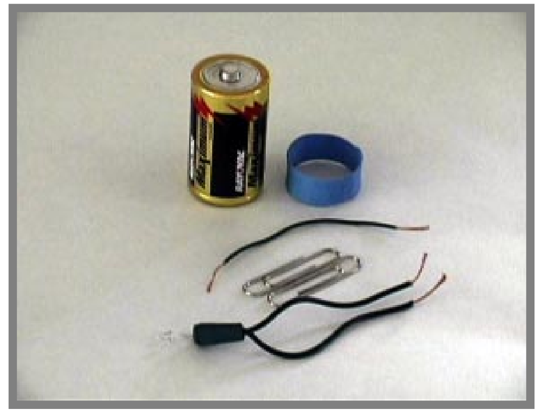
Step 2 Observations. Distribute the materials and have the children make a “switch” by twisting the bare wire ends together. Ask the children, “How were you able to make the light turn on and off?” and “What happened to the electrons coming from the battery when you disconnected the wires?”

Step 3 Solving Disputes. When a child gives an incorrect answer or when children disagree about an answer, have them attempt to get a circuit to switch on and off using their idea. In other words, whenever possible, have the children test their own answers.

Step 4 Summarize. Introduce the word “switch.” Explain that a “switch” is anything that breaks or completes a circuit.

Step 5 Communicating. Pass out chart paper (or white boards) and markers so that each group can make two drawings of their circuit: one showing the switch open and one showing the switch closed. Explain that they should label all the parts and use arrows to show how electrons moves through the circuit and switch.

Lesson 3: Old Switches at the Folsom Powerhouse



<u>Materials</u>. Each group will need:

- handout "Switches at the Folsom Powerhouse"
- circuit and switch materials from previous lesson
- 2 large paper clips

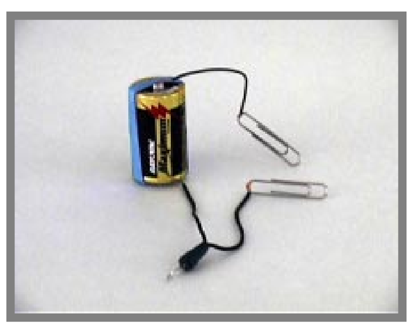
<u>Lesson Steps</u>

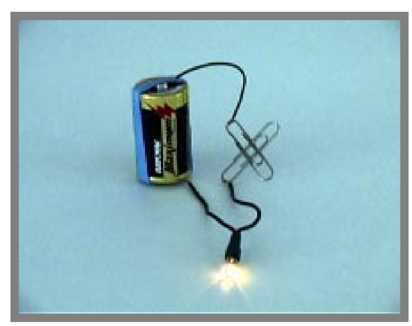
Step 1 Review. Review the important ideas learned in the previous lessons. Ask "Can you explain how to make a light bulb light up in a circuit?" "Can you explain how a switch works in a circuit?" Let as many children give their ideas as possible so that important concepts are repeated and many get to talk.

Step 2 Application. If you have not already done so, explain to the children that they will soon be taking a field trip to the Folsom Powerhouse and that this unit on electricity is preparing them for that visit. Explain that you are going to give them a picture of switches that were used at the Folsom Powerhouse. This type of switch is called a "knife" switch. Their task is to construct a switch for their circuits that works the same way. Give out the handouts.

Step 3 Modeling. When the children think they have constructed a good model, they should draw a picture of it, label its parts, and list any "good" or "bad" features of this type of switch. Pass out several extra paper clips per group, their original circuit materials, and the handout.

Step 4 Communicating. Ask each group to present their drawings to the class and what they identified as "good" or "bad" features of the knife switch. There is a lot of contact area in a knife switch. A lot of electrical current can flow through it. That is why knife switches were used in places like the Folsom Powerhouse.





Step 5 Setting Goals. Ask the children if they think they will be able to locate the knife switches when they visit the Folsom Powerhouse. Ask if they think they will be able to explain why knife switches were used to the parents that go along on the field trip? After a few responses are shared, the lesson is over.

Lesson 4: Exploring Circuits: Series and Parallel

Materials. Each group will need:

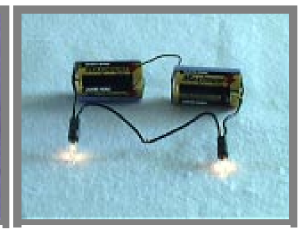
- at least 2 sets of circuit and switch materials from the previous lesson

Lesson Steps

Step 1 Review. Ask children to explain the parts of a circuit, what is necessary for a light bulb to light up in a circuit, and how a switch works.

Step 2 Explore. Handout about 3 sets of circuit materials for each group. Tell the children their goal is to put the materials together so that two or more lights light up. When they are finished, they should draw a picture of their circuit and answer the following question on their drawing: "Did you get more than one light to light up using one circuit or more than one circuit?" To the right are examples:

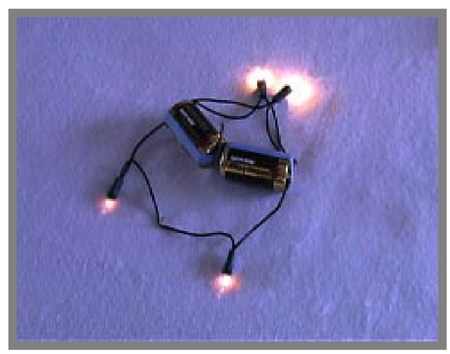
2 circuits
1 bulb in each circuit



1 circuit
2 bulbs in the circuit

Step 3 Analyzing. When they are finished with their drawings, have them stick their drawings on a chart in front of the room under one of the following titles: "One Circuit" and "More Than One Circuit." When all the drawings have been correctly placed under the proper heading, tell the children that a single circuit with more than one light bulb in it is called a "series" circuit and several circuits with one light bulb in each is called a "parallel" circuit. Ask the children to point to circuit drawings that are "seriesÆ circuits and "parallel" circuits.

Step 4 Applying #1. Challenge the children to hook up their materials so that some bulbs glow dimly while others remain bright. When they succeed in doing so, they will have created a combination of a series and a parallel circuit. When the children finish, have each group draw a diagram of their arrangement and clearly label the parts that make up a "series" circuit and the parts that make up a "parallel" circuit. Mount the drawings around the room.



Note: In *Part C: Investigations* there is a page that can help guide children in setting up an experiment to determine "What Affects the Brightness of Lights in a Circuit." If you choose, you could carry out that activity next before going on to Lesson 5.

Lesson 5: Predicting Circuits: Series and Parallel

<u>Materials</u>. Each group will need:

- handouts “Predicting Circuits #1” and “Predicting Circuits #2”
- at least 3 sets (more would be better) of circuit and switch materials from the previous lesson

<u>Lesson Steps</u>

Step 1 Review. Ask children to explain and demonstrate the parts of a circuit, what is necessary for a light bulb to light up in a circuit, and how a switch works. Also, use the circuit drawings hanging around the room as illustrations. Have individual children go up to some of the drawings and show the parts that are “parallel” circuits and the parts that are “series” circuits.

Step 2 Predicting. Pass out the handouts for Lesson 5 titled “Predicting Circuits.” Go over the directions with the children so they understand what to do. First they should decide which arrangements on the handout show a “series” circuit, which show a “parallel” circuit, and which are a combination of both “series” and “parallel” circuits. Before they begin, ask several children to explain how they will know if a circuit is a “series” circuit or a “parallel” circuit.

Step 3 Testing Predictions. Pass out several groups of circuit materials to each group so they can test their predictions.

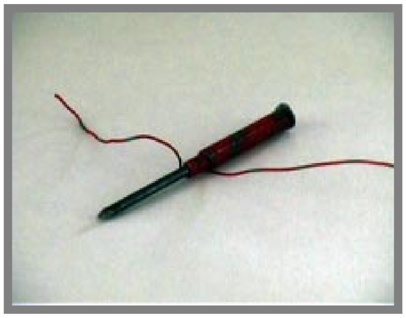
Lesson 6: Electromagnets

<u>Materials</u>. Each group will need:

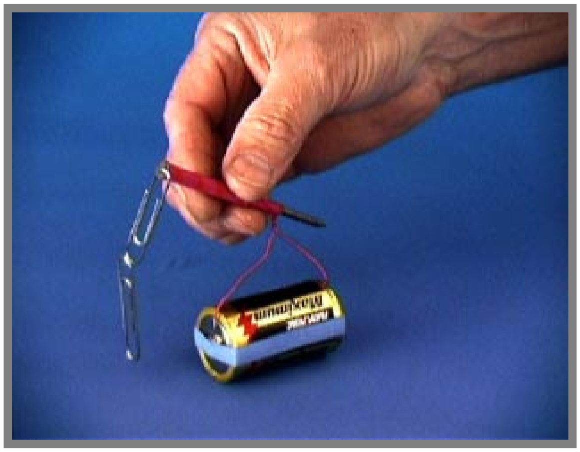
- a 3 foot length of insulated wire.
- an 8d box nail.
- a D cell battery
- some paper clips
- drawing materials

<u>Lesson Steps</u>:

Step 1 Introduction: Say, "Electricity can not only be used to make light, but it can also create magnetism. Today our class will learn how to use electricity to turn a nail into a magnet."



Step 2 Modeling. Before passing out materials, show how to wrap a wire neatly around a nail. Show them how to put a twist in the wire so it won't unravel. Ask the children to explain what they think they would need to get electricity to run through the wire. They should say something like: "Touch the two wires to the ends of the battery." Explain that they can test their electromagnets by picking up the paper clips.



Step 3 Communicating. Ask the children to make a drawing of their electromagnet labeling all the parts and using arrows to show how they think the electricity travels through the circuit. Collect the drawings and mount them in front of the room.

Lesson 7: Electromagnets Pull, Push, and Spin.

<u>Materials</u>. Each group will need:

- electromagnets from previous lesson
- a D Cell battery
- a small permanent magnet (round or square magnets can be purchased at local hardware or electrical supply stores.
- charting materials
- OPTIONAL handout "How Electromagnets Do Work"

<u>Lesson Steps</u>:

Step 1 Review. Review the important ideas from the previous lessons. Ask children to explain what is meant by a circuit, how electricity travels in a circuit, what is a switch in a circuit, what happens when electricity travels through a wire around a nail, what is a series circuit, what is a parallel circuit?

Step 2 Introduction. Explain that electromagnets can be used to do work. In today's lesson, the class will find out how electromagnets can be used to move things.

Step 3 Modeling. Before passing out materials, explain that each group should use the materials to find out how an electromagnet can be used to pull, push or spin something. They should draw 3 pictures, one labeled "pulling," one labeled "pushing," and the last labeled "spinning." When they get the electromagnet to pull, push, or spin the little magnet, they should draw a picture of what happened.

OPTIONAL Step 3 Modeling. If your children need more direction, pass out the handout for Lesson 3: "How Electromagnets Do Work." Tell the children to hold their electromagnets and the small, round magnet the same way as in the pictures. Then direct them to draw pictures labeled "pulling," "pushing," and "spinning."

Step 4 Connecting to Life Experiences. When the groups are finished, collect and display the charts at the front of the room. Then ask the class: "Can you think of an electric machine that pulls, pushes, or spins something?" As the children give ideas, list them on the board. You are likely to get most ideas about electric machines that "spin" something. However, most children and adults are not aware of how much electromagnets are used all around us. We'll take care of that problem in the next lesson.

Step 5 Extending. Give the children an overnight assignment. Tell them to find 5 electric machines at home that pull, push, or spin something. They should draw the machine they find and label the part of the machine where they think the electromagnet is that does the pulling, pushing, or spinning.

Lesson 8: Electromagnets in Our Lives

<u>Materials</u>:

none

<u>Lesson Steps:</u>

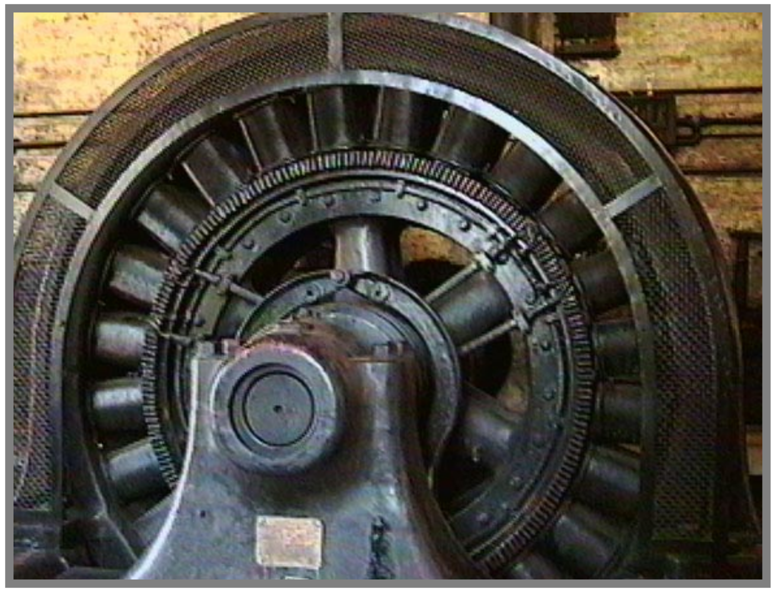
Step 1 Review. Review the important ideas of the previous lessons. Ask what the word "circuit" means. Ask someone to explain how to put a "switch" in a circuit. Ask the children to explain how to make an electromagnet. Ask children to explain a series and parallel circuit.

Step 2 Applying. Electromagnets can pull, push and spin things. Ask the children to share the results of their overnight assignment. (They have had a day to think about this and should come up with more ideas.) As they give ideas, list them on the board under the headings "pull," "push," and "spin." Following is a chart generated in this way:

pull	push	spin
junk yard crane	electric stapler	CD player
picture on TV screen	electric nail gun	computer hard drive
picture on computer monitor		video camera
		ceiling fan
		air conditioner
		furnace fan
		paper shredder
		electric weed whip
		food mixer
		electric can opener
		electric pencil sharpener

Step 3 Valuing. Ask the children if they think their lives would be very different if there were no electromagnets. In the discussion that follows, the children should conclude that electromagnets have a powerful influence on their lives.

Lesson 9: Electromagnets at the Folsom Powerhouse



Materials. Each group will need:

- handout "Electromagnets at the Folsom Powerhouse"

Lesson Steps:

Step 1 Review. Review the terms circuit and switch. Ask the children to explain how to make an electromagnet. Ask them to name some things that contain electromagnets. Ask them to explain series and parallel circuits. Ask them to tell you what types of things electromagnets can do. (pull, push and spin things)

Step 2 Applying. Before distributing the handout, explain that the children will be given a photograph taken at the Folsom Powerhouse. The task of each group will be to locate electromagnets in the picture. Explain to the children that all electromagnets are the same in certain ways. They should look at the pictures and make a list of the ways the electromagnets in the pictures are the same as the electromagnets they made in class.

Step 3 Clarifying. (See *Teacher's Guide* if you need help in identifying the electromagnets in the picture.) Go over the photo handout with the children helping to clarify their ideas. As groups read off their list of how electromagnets are alike, list them on the board. If there is a disagreement, have children use one of the model electromagnets made in class and the photographs to justify their ideas. Then have them complete the drawing of their own electromagnet on the handout with the photo and draw lines between their drawing and the photo to show the parts that are the same (e.g. the metal core, the wire coil)

Step 4 Setting Goals. Ask the children if they think they will be able to locate examples of electromagnets when they visit the Folsom Powerhouse. Ask them if they think they could explain to their parents how electromagnets are made and what they can do? (We hope the children will go home and share materials and what they have learned with their parents. If parents are impressed with the words and ideas the children are using, they are very likely to praise them – the children will then return to your classroom with more motivation to learn.)

Lesson 10: Moving Water Can Push Things

<u>Materials</u>. Each group will need:

- an empty, half-gallon milk carton (have extras available)
- a plastic soda straw
- access to water

<u>Lesson Steps</u>:

Step 1 Review. Ask the children to explain the kind of things electromagnets can do. (Pull, push and spin.) Ask them if they think they could use water to pull, push and spin things? Let several give some ideas.

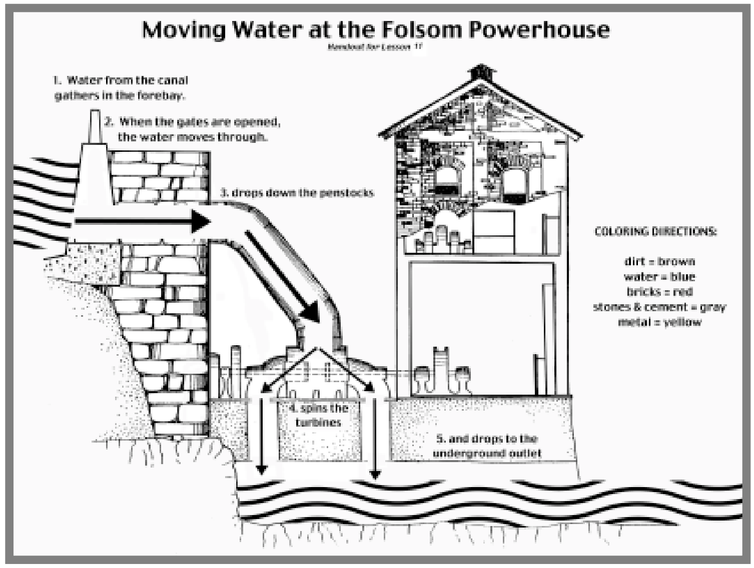
Step 2 Directions. Before passing out materials, explain that each group will poke a hole in the milk carton with a pencil so that the soda straw will fit into it snugly. Demonstrate (see Teacher's Guide). Then, demonstrate how to hold the soda straw closed while filling the carton with water. Explain that the class will go outside together and each group will use the jet of water to see what things they can move with it.

Step 3 Do the Activity.

Step 4 Discussion. Ask the children what kind of motion they were able to get with the stream of water. All will have been able to push things, some will have found a way to make things spin.

Step 5 Summary. It is not likely that any will find a way to make water pull things, though it can be done. However, if children conclude that the water can be used to push and spin things, that is sufficient for this lesson.

Lesson 11: Moving Water at the Folsom Powerhouse



Materials: Each child will need:

- a handout "Moving Water at the Folsom Powerhouse" A miniature of the handout is on the right.
- colored pencils, markers or crayons (brown, blue, red, gray and yellow)

Lesson Steps:

Step 1. Review. Ask children to recall how the jets of water were able to move things in the last lesson. Have several children identify things that were pushed or spun by the water.

Step 2. Directions. Hold up one of the handouts "Moving Water at the Folsom Powerhouse." Tell them that they should study the five steps on the handout that describe how water moves through the Folsom Powerhouse. Allow the children to discuss with one another how the water moves to clarify their understanding of the drawing. When they think they understand the drawing clearly, they are to color it with colored pencils, markers or crayons using the following scheme:

1. dirt = brown
2. water = blue
3. bricks = red
4. stones and cement = gray
5. metal = yellow

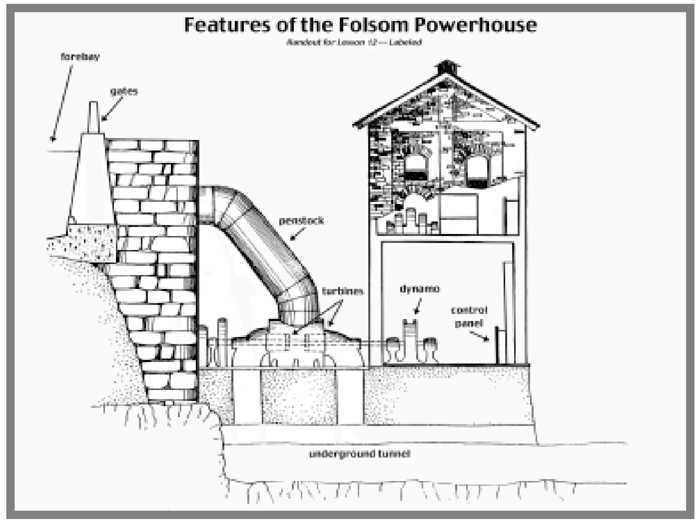
Have several children hold up their colored drawings at the front of the room so their color scheme can be seen and discussed. Some children will be able to observe and distinguish things in greater detail than others. Through this activity, children are assisted in identifying the parts of the powerhouse.

Step 3. Setting Goals. Ask the children if they think they will be able to locate the 5 areas on the handout when they visit the powerhouse. You could ask them some questions that will help them to focus their observations, such as:

> "How will you be able to tell the penstock pipes from other pipes at the powerhouse?" "What would you find at the bottom of the penstock pipes?" "If you cannot see the underground tunnel, what evidence of the tunnel might you look for?" (possible answer: the tunnel openings beneath the building) "Would the forebay be up high or down low?" etc.

Lesson 12: Features of the Folsom Powerhouse

<u>Materials</u>. Each group will need:



- handout "Features of the Folsom Powerhouse" (Labeled) a miniature of this handout is shown on the right.
- handout "Features of the Folsom Powerhouse" (Unlabeled)

<u>Lesson Steps</u>:

Step 1 Review. Ask the children to explain how water can be used to push things. Ask the children to explain the kind of work electromagnets can do and give some examples.

Step 2 Learning and Labeling Terms. Pass out the unlabeled drawing. As you list the terms on the board and explain what each term means, have the children use the terms to label their drawing:

- a body of water gathered high above the powerhouse (forebay)
- an opening that drops the water into the powerhouse (gate)
- large pipe guiding falling water down to the powerhouse (penstock)
- high pressure water turning a water wheel and axle (turbine)
- the axle from the turbines that spins electromagnets (generator)
- wires taking electricity out of the powerhouse (power lines)
- underground tunnel where the water leaves the powerhouse

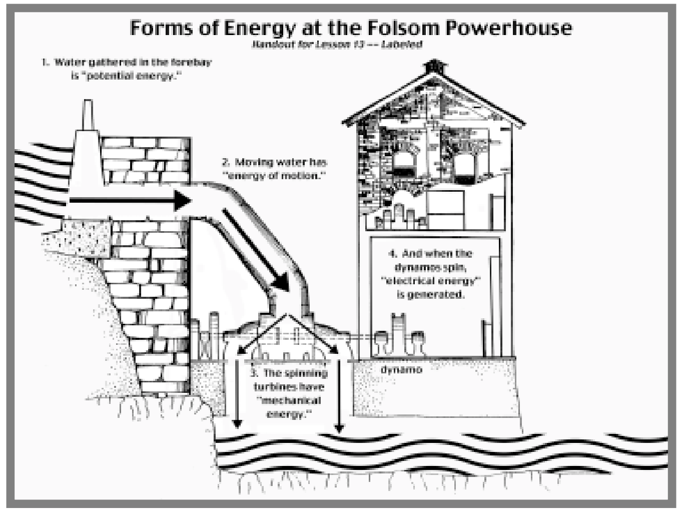
Step 3 Reference. Give the children the labeled handout to use as a reference and study guide.

Step 4 Review and Drill. This is a great time for team races. Tape 4 unlabeled handouts at the front of the room. Have the children line up in groups. When you state a name or a definition, the child in the front of the line for each group races to the front of the room to place their finger on the correct spot. Award points to teams when their member was the first to correctly point out the feature. Competition is kept at the "team" level rather than the individual level and, after playing the game for several days in a row, you will find that the children know the terms and definitions.

Step 5 Assess. Use the unlabeled handouts to determine if the children can correctly spell the terms and correctly label the drawing.

Step 4 Setting Goals. Ask the children if they think they will be able to locate these parts of the Folsom Powerhouse on their visit. Get them "jazzed-up" about being able to visit the Powerhouse, identify, and explain its parts. Motivation now will pay off on the field trip.

Lesson 13: Energy Changes Form at the Folsom Powerhouse



<u>Materials</u>. Each group will need:

- handout "Forms of Energy at the Folsom Powerhouse" (Labeled) A miniature of this handout is shown on the right.
- handout "Forms of Energy at the Folsom Powerhouse" (Unlabeled)

<u>Lesson Steps</u>:

Step 1 Review. Ask the children to locate and explain each of the major features of the Folsom Powerhouse: forebay, penstocks, turbine, generator, and high power lines.
Ask the children to explain how the energy of falling water eventually becomes electricity.

Step 2 Formalizing Understanding. Using pictures or a drawing on the blackboard, introduce children to the following terms: potential energy, energy of motion, mechanical energy and electrical energy. Explain that when water has been raised up, it has the potential of producing work as it falls back to the ground. As water flows downward, it has energy of motion. When water sets a wheel in motion, we say that the wheel has mechanical energy, and when mechanical energy produces electricity, we call it electrical energy.

Step 3 Modeling. Tell them that they will be given a drawing of the Folsom Power Plant. They are to label the parts of the picture that illustrate each of those types of energy.

Step 4 Setting Goals. Ask the children how they might explain how energy changes form to visitors at the Folsom Power Plant.

Lesson 14: Quiz – Generating Electricity at the Folsom Powerhouse

<u>Materials.</u> Each child will need:

- handouts **–** Several pages of quiz questions are provided in the handouts section. You should choose the particular pages you want to use.

<u>Lesson Steps:</u>

Step 1 Giving Directions. Hold up a copy of the two handouts and explain how they are to be used.

Step 2 Taking the Quiz. Pass out the handouts of quiz items you have selected.

This is the last lesson in the series. Ideally, you have scheduled the field trip to the Folsom Powerhouse so that it will occur within a reasonable time after finishing these lessons. See Parts B and C for more models you may choose to have children build and ideas for independent investigations children may carry out on their own.

Part B: Models

The models described in this section may be constructed as a full class, small group, or individual project. If a picture is worth a thousand words, a model must be worth at least a million!

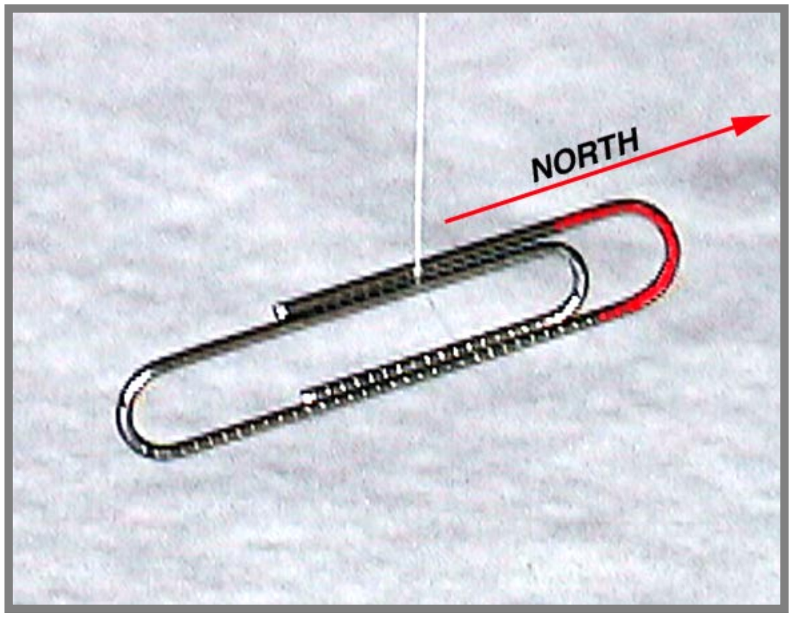
Construct Your Own Magnet and Compass

Materials:

- a three foot piece of thread
- a large paper clip
- a permanent magnet

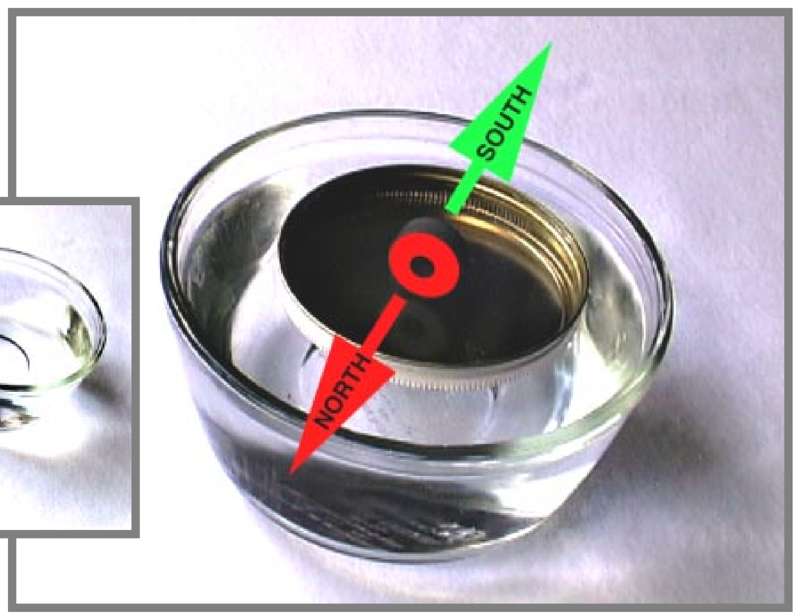
Directions:

1. Stroke a paper clip with a magnet. Then carefully lift the magnet away from the paper clip and back to the starting position. Then stroke the paper clip again, always in the same direction. Do this about 30 times. (see sequence of pictures above)



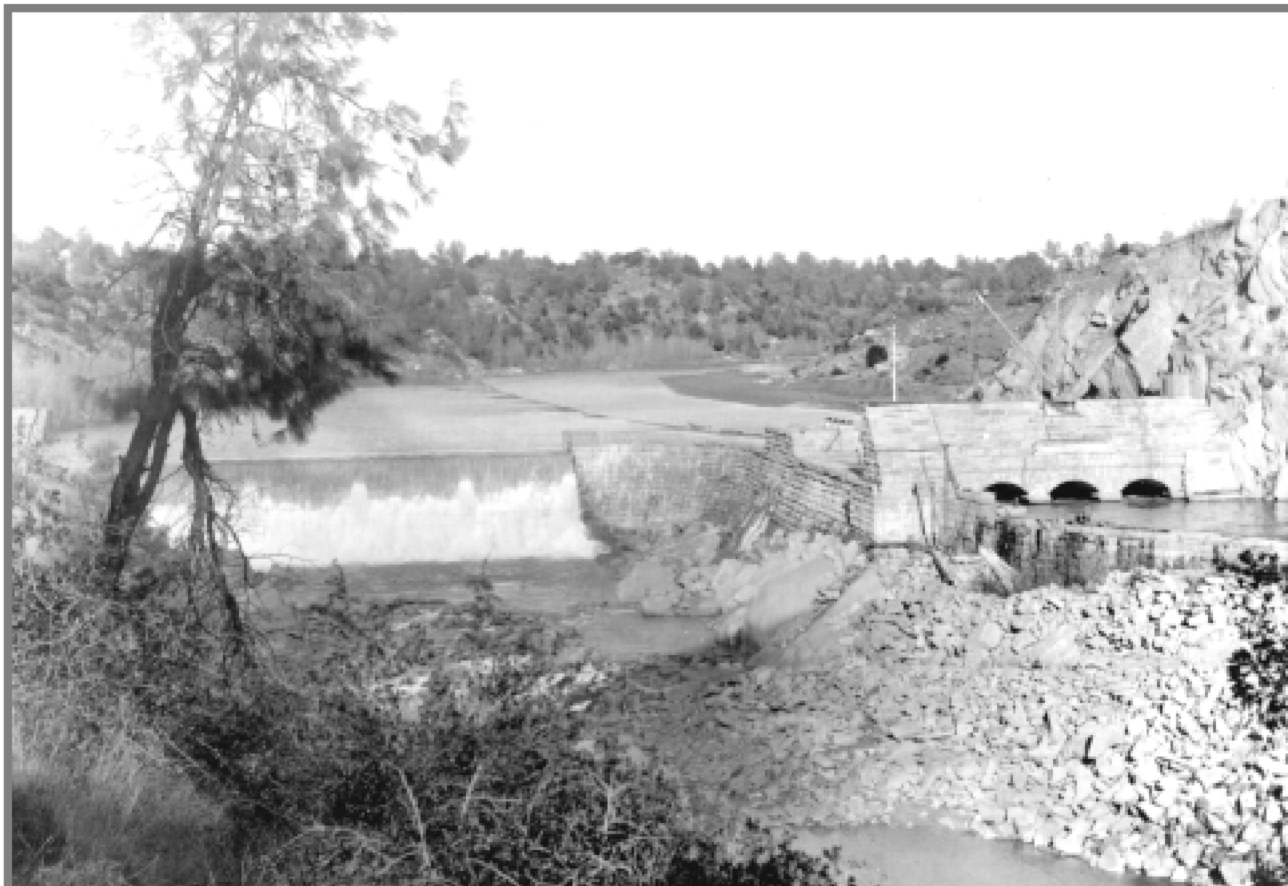
2. Once the paper clip is magnetized, tie a piece of thread to the center of the paper clip wire. Hold the paper clip with the thread so that it swings freely and is not close to other metal objects. The paper clip will rotate until one end is pointing North.

   COLOR THE END OF THE PAPER CLIP THAT POINTS NORTH RED. THEN IT WILL BE EASY TO REMEMBER WHICH END IS THE NORTH POLE.



You can also make a compass using a permanent magnet by placing the magnet on a jar lid and floating it in a bowl of water. Just make sure that the poles of the magnet are pointed to the sides.

Construct a Model of the Historic Folsom Dam



Original photo by D. K. Hubbs, Fair Oaks, California.
Copy by Gene Scott, Auburn, California.
Digitized by Steve Gregorich, Placerville, California

Refer to the photo above to construct a model of the original Folsom Dam and its canal that sent water downstream to the Folsom Powerhouse. With a little planning, you can briefly fill the model with water and operate the gates.

Materials:

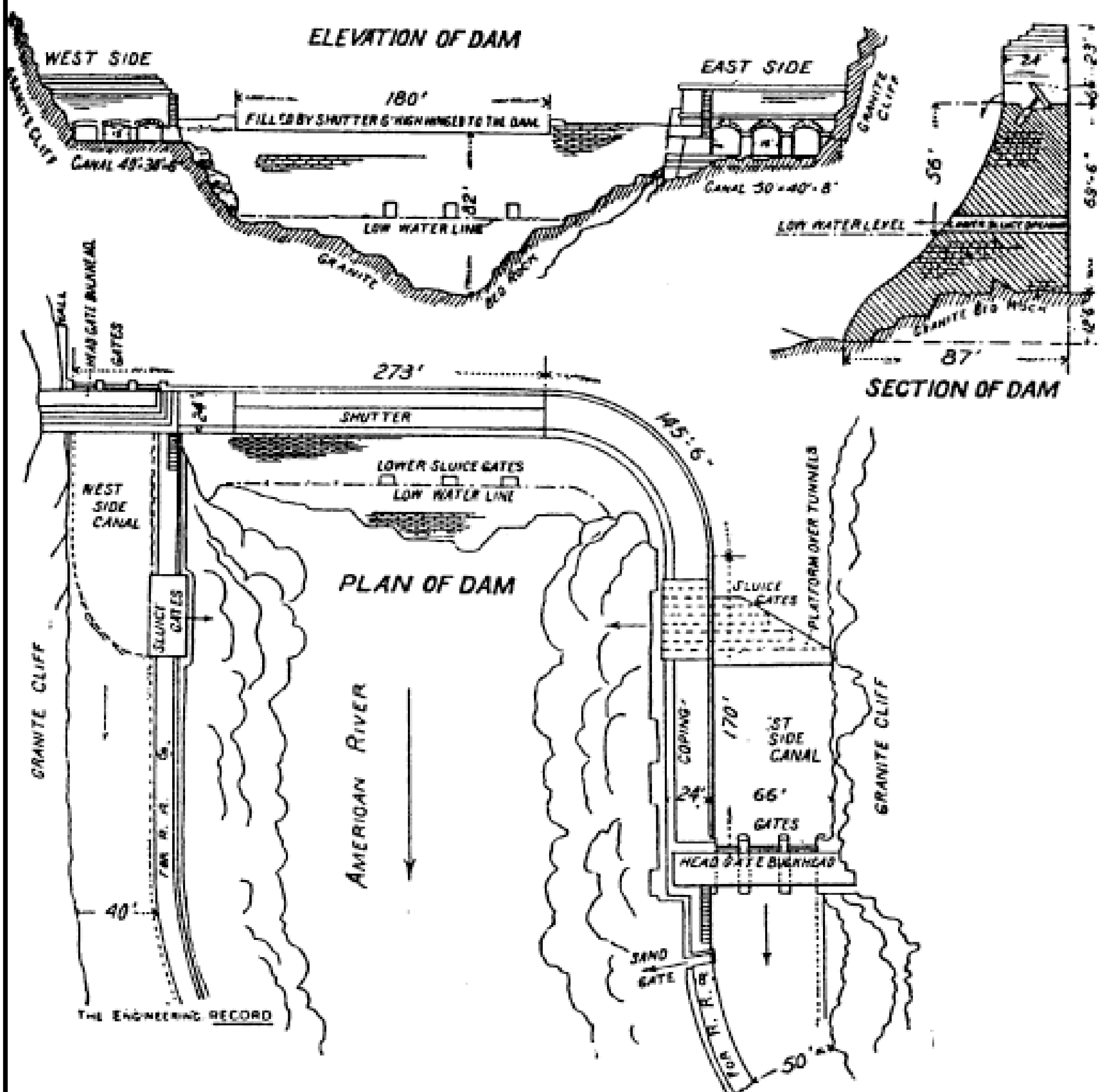
- about 4 pounds or more of ceramic clay or modeling clay
- A large baking pan or some other waterproof container to hold the model
- A waterproof, flat material for the gates.

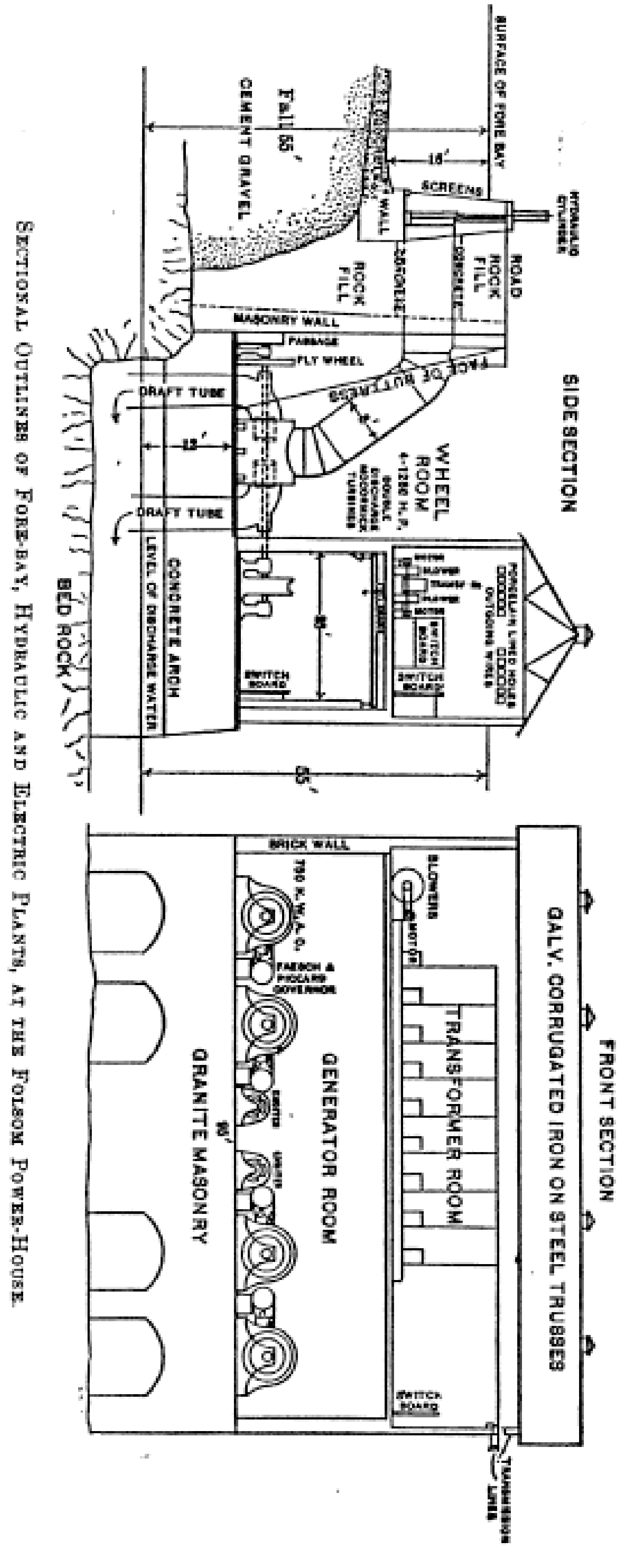
See the next page for engineer drawings of the Historic Folsom Dam.

If you want to make your model dam more realistic, these historical engineering drawings will help.

ELECTRIC-POWER TRANSMISSION PLANTS IN CALIFORNIA.

By W. F. C. Hasson.





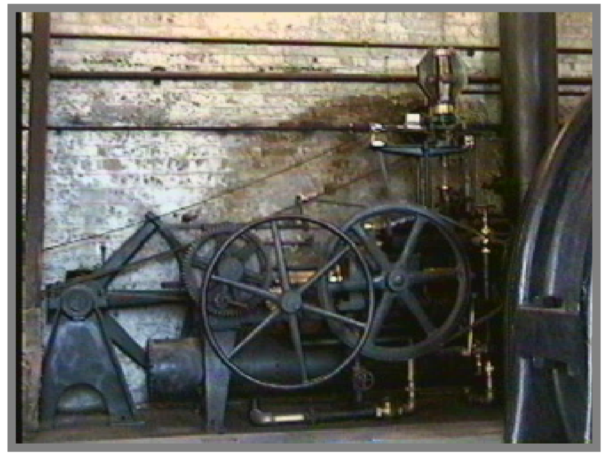
Sectional Outlines of Fore-bay, Hydraulic and Electric Plants, at the Folsom Power-House.

Construct a Model of the Folsom Powerhouse

Use these engineering drawings of the Folsom Powerhouse to construct a model of it. If you draw your pictures of the Powerhouse walls on cardboard, you can glue the walls together and then add cardboard sections for the roof. You might use tissue paper tubes or the cardboard tubes from a box of plastic wrap for the penstocks.

You could use many different materials to create your model. For instance, you could build the walls out of sugar cubes, clay, or even mud. Many different materials will work – use your creativity!

Construct a Speed Controller



An important problem in operating the Folsom Powerhouse was controlling the speed of the turbine and dynamo so that they produced a steady supply of electricity without speed-ups or slow-downs. To do that, a special speed controller kept the turbine spinning at a steady rate. On the right is a picture of one of the speed controllers at the Folsom Powerhouse.

You can construct a speed controller that is not exactly the same as the one used at the Folsom Powerhouse, but the idea is the same. Your speed controller uses fan blades and wind resistance to control the speed of a descending weight.

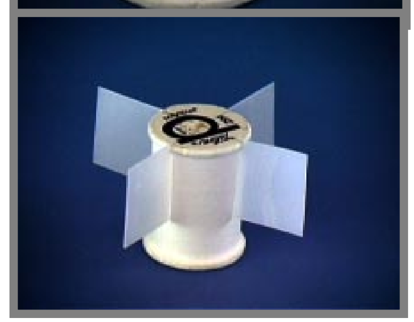
<u>Materials</u>:

- the foam winding spool from a spool of thread
- 4 pieces of thin cardboard or plastic about 1/2 inch square (In the picture on the right, plastic was cut from the side of a milk jug for this purpose.)
- 3 feet of thread
- a large paper clip (or some other weight)
- a nail or stick that will fit easily into the hole in the spool. (The nails used to make electromagnets will work just fine here.)

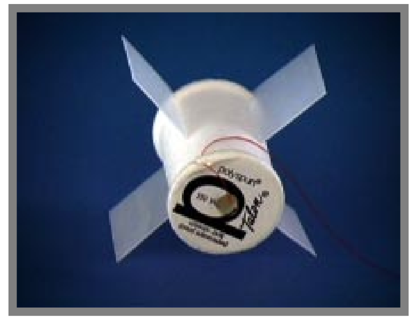
<u>Directions</u>:

1. With adult supervision, make 4 shallow cuts in the foam spool.

2. Slide one of the plastic squares into each cut in the spool.
3. Use white glue to glue the squares to the foam. Let dry.

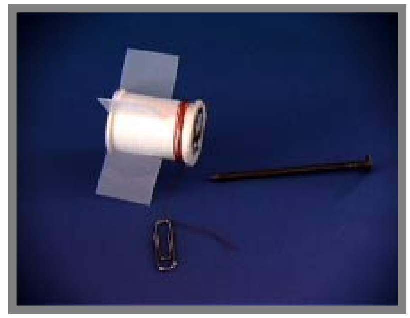


4. Glue one end of the string onto the spool. Let dry.

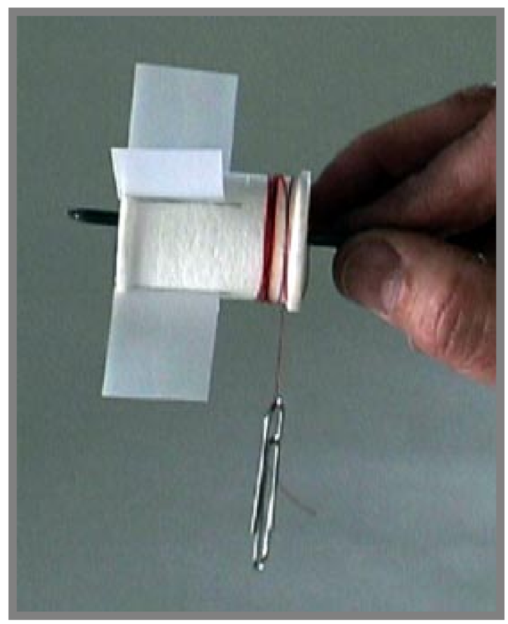


5. Tie the weight to the other end of the string.

6. Wind the string around one end of the spool.
7. Insert a nail or stick into the hole of the spool.

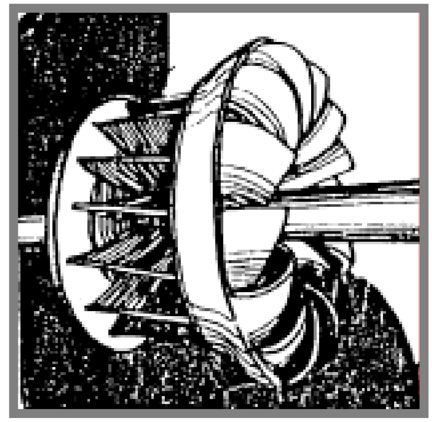


8. Hold the speed controller by the end of the nail and let the weight drop.



Construct a Water Turbine

On the right is a drawing of one of the water turbines in the Folsom Powerhouse. The turbine turns an axle that spins the generator to create electricity. You can construct a water turbine too.



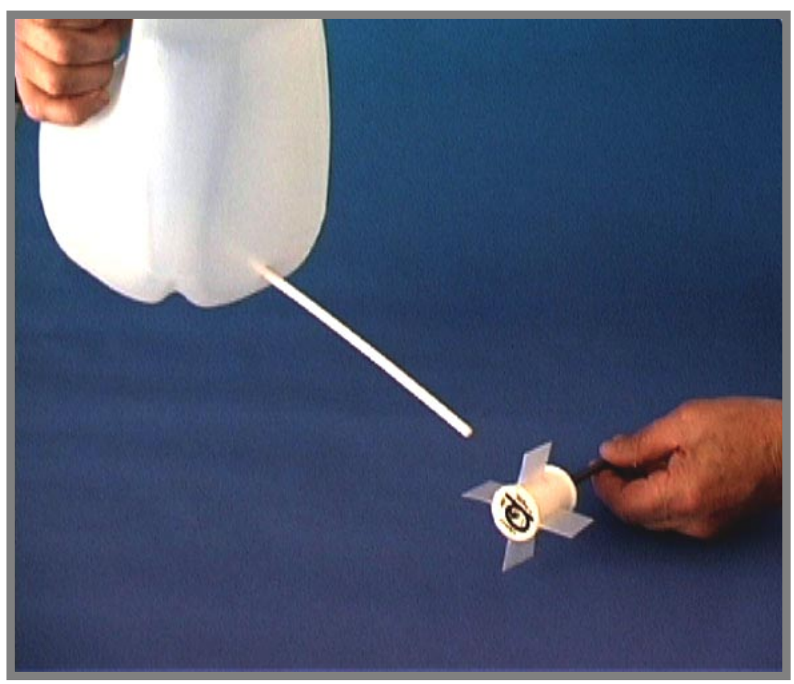
Materials:

- a wind fan made from a thread spool (see "Construct a Speed Controller."
- some waterproof glue
- a 1 gallon plastic milk jug
- a soda straw

Directions:

1. Construct a wind fan as shown in "Construct a Speed Controller." (You can use the wind fan from that lesson.)

2. Glue the vanes of the wind fan to the thread spool with waterproof glue or simply put waterproof glue over the original white glue.



3. Poke a hole in a plastic milk jug with a pencil and insert a soda straw into the hole snuggly. (You can use the same materials from lesson 8.)

4. Direct a jet of water from the jug and soda straw onto the blades to make them spin.

This model demonstrates how moving water turns the blades of a water turbine. The water turbine in turn spins the electric generator to produce electricity.

Part C: Investigations

The following four investigations are based on previous lessons and models constructed in the unit:

Investigations	Lessons	Construction Models
What Affects the Brightness of Lights in a Circuit?	Lessons 1-5	Magnet & Compass
What Affects the Power of an Electromagnet?	Lessons 6-9	(in the lesson plan)
How Do Electromagnets Affect a Compass?	Lessons 6-9	Magnet & Compass
What Affects the Speed of a Water Turbine?	Lessons 10-13	Speed Controller

The description for each investigation is written as if it were speaking directly to the student to help him/her get started on an investigation. The pages may be copied and distributed to your class.

What Affects the Brightness of Lights in a Circuit?

The Question. What things could you change in your circuit to see if it makes the lights glow brighter or dimmer? What if you put 2 light bulbs in the circuit – would they glow dimmer, remain just as bright, or would they glow brighter? What if you used more wire? What if you added another battery? Can you hook up the light bulbs in different ways that might change their brightness?

Investigating. You can investigate this question 2 ways:

1. You could find the answers by looking them up in books or on the Internet. If you find some answers, you could try them out with your circuit to see if you can get them to work.

2. You could decide to perform experiments to get your own answers. You could make a list of all the things that you think might affect the brightness of light bulbs and try them out one at a time.

Be sure to keep careful notes. When you are ready to report your results you can present your experiments, observations, and conclusions accurately.

Observing. How will you observe what happens? Can you think of a way to *measure* the brightness of a bulb? How will you keep things the same so you don't make mistakes in your observations? For instance, what if the battery grows weaker as you carry out your experiments, what will you do to make sure you don't mistake the affects of a weak battery for something else?

Reporting your Results. When you are ready to make your presentation to the class, think how you could show your question, what you did, and what resulted in a simple and clear way. Here is a list of things that are usually included in the presentation of research:

- A statement of the question you investigated. It should be simple and clearly stated.
- An explanation of the procedure you followed to find answers. For instance, you may have set up some experiments and took notes of the results of each one. You should describe how you counted or measured things.
- A display of your observations is very helpful. If you can chart or graph the observations you made, it will make your results much easier to understand. Photos or drawings showing what happened are also very helpful.
- You should state the conclusions you reached. You should honestly admit if you were not able to reach a definite conclusion and explain any problems that got in your way or mistakes you made in drawing conclusions.

What Affects the Power of an Electromagnet?

The Question. What things could you change in your circuit to see if it makes the electromagnet more or less powerful? What if you put 2 electromagnets in the circuit – would they each be able to pick up more or fewer paperclips? What if you used a longer wire and wound more turns around the nail? What if you added another battery? Can you hook up the electromagnets in different ways that might change their strength?

Investigating. You can investigate this question 2 ways:

1. You could attempt to find the answer to these questions by looking them up in books or on the Internet. If you find some answers, you could try them out with your electromagnet to see if you can get them to work.

2. You could decide to perform experiments to get your own answers. You could make a list of all the things that you think might affect the strength of an electromagnet and try them out one at a time.

Be sure to keep careful notes. When you are ready to report your results to the class, you can present your experiments, observations and conclusions accurately.

Observing. How will you observe what happens? Can you think of a way to *measure* the strength of an electromagnet? How will you keep things the same so you don't make mistakes in your observations? For instance, what if the battery grows weaker as you carry out your experiments, what will you do to make sure you don't mistake the affects of a weak battery for something else?

Reporting your Results. When you are ready to make your presentation to the class, think about how you could show your question, what you did, and what resulted in a simple and clear way. Here is a list of things that are usually included in the presentation of research:

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- You should state the conclusions you reached. You should honestly admit if you were not able to reach a definite conclusion and explain any problems that got in your way or mistakes you made in drawing conclusions.

How Do Electromagnets Affect a Compass?

The Question. Can an electromagnet affect the way a compass points? Which way does a compass point when you hold it near the head of the nail of your electromagnet? Which way does it point if you hold it near the point of the nail? What if you switch the wires on the battery so the electric current flows the other way – does that affect the way the compass points?

Investigating. You can investigate this question 2 ways:

1. You could attempt to find the answers by looking them up in books or on the Internet. If you find some answers, you could try them out with your electromagnet and compass to see if you can get them to work.

2. You could decide to perform experiments to get your own answers. You could make a list of all the ways you could test the magnetic field of your electromagnet with a compass.

Be sure to keep careful notes. When you are ready to report your results to the class, you can present your experiments, observations and conclusions accurately.

Observing. How will you observe what happens? How will you keep things the same so you don't make mistakes in your observations? How will you take notes so you don't get mixed up? For instance, what if the battery grows weaker as you carry out your experiments, what will you do to make sure you don't mistake the affects of a weak battery for something else?

Reporting your Results. When you are ready to make your presentation to the class, think about how you could show your question, what you did, and what resulted in a simple and clear way. Here is a list of things that are usually included in the presentation of research:

- A statement of the question you investigated. It should be simple and clearly stated.
- An explanation of the procedure you followed to find answers. For instance, you may have set up some experiments and took notes of the results of each one. You should describe how you counted or measured things.
- A display of your observations is very helpful. If you can chart or graph the observations you made, it will make your results much easier to understand. Photos or drawings showing what happened are also very helpful.
- You should state the conclusions you reached. You should honestly admit if you were not able to reach a definite conclusion and explain any problems that got in your way or mistakes you made in drawing conclusions.

What Affects the Speed of a Water Turbine?

The Question. What makes a water turbine go faster or slower? Does the amount of water in the milk jug make the turbine turn faster? Does the height the water drops affect the speed of the turbine? What about the size of the turbine blades? What else might affect the speed of a water turbine?

Investigating. You can investigate this question 2 ways:

1. You could attempt to find the answers by looking them up in books or on the Internet. If you find some answers, you could try them out with the water turbine you made in class.

2. You could decide to perform experiments to get your own answers. You could make a list of all the things you could change, one at a time, to see if they affect the speed of the turbine.

Be sure to keep careful notes. When you are ready to report your results to the class, you can present your experiments, observations and conclusions accurately.

Observing. How will you observe what happens? Can you find some way to measure the *speed* of the turbine? How will you keep things the same so you don't make mistakes in your observations? How will you take notes so you don't get mixed up? For instance, what if you hold the turbine at a slightly different angle without noticing it, what will you do to make sure you don't mistake the affects of holding the turbine differently for something else?

Reporting your Results. When you are ready to make your presentation to the class,5, think about how you could show your question, what you did, and what resulted in a simple and clear way. Here is a list of things that are usually included in the presentation of research:

- A statement of the question you investigated. It should be simple and clearly stated.
- An explanation of the procedure you followed to find answers. For instance, you may have set up some experiments and took notes of the results of each one. You should describe how you counted or measured things.
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Part D: Handouts

Switches at the Folsom Powerhouse

Handout for Lesson 3

This is a picture of old fashioned 'knife" switches used at the Folsom Powerhouse long ago. Use paper clips to make a knife switch. Draw a picture of your knife switch and circuit in the box below. List some "good" and "bad" features of the old fashioned switch.

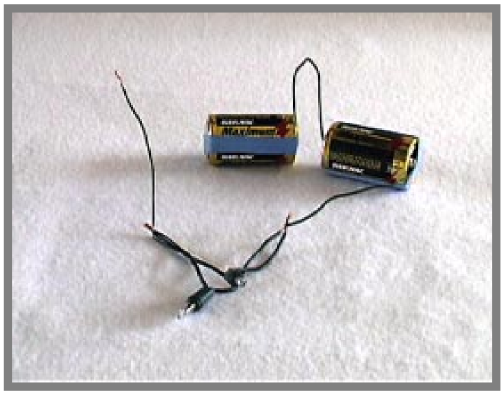
Drawing of my "knife" switch and circuit.

Good and bad features of the knife switch.

Predicting Circuits #1

Handout for Lesson 5

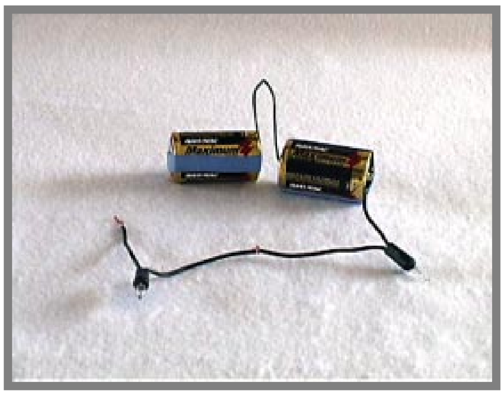
Predict what will happen when the last wire is connected to the battery. Circle your answer. Also, circle "series" or "parallel" to tell what kind of circuit you see in the picture.



PICTURE 1.

All bulbs will be bright.
Some will be bright and some dim.
All bulbs will be dim.

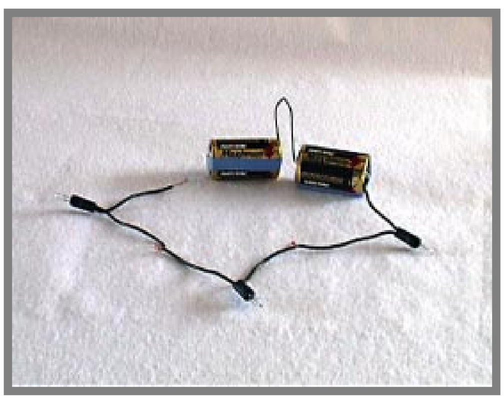
This is a (series) (parallel) circuit.



PICTURE 2.

All bulbs will be bright.
Some will be bright and some dim.
All bulbs will be dim.

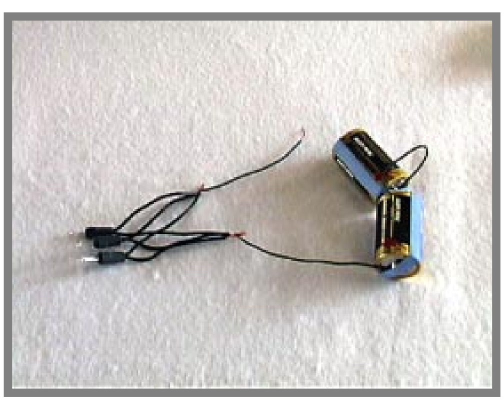
This is a (series) (parallel) circuit.



PICTURE 3.

All bulbs will be bright.
Some will be bright and some dim.
All bulbs will be dim.

This is a (series) (parallel) circuit.



PICTURE 4.

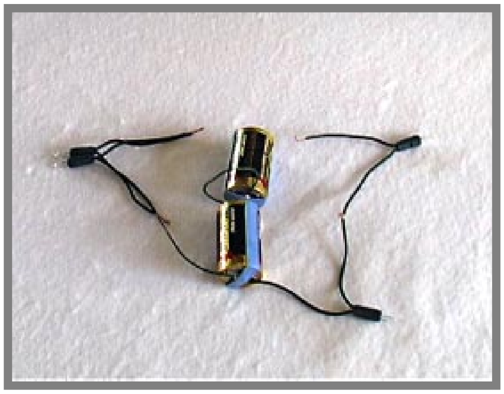
All bulbs will be bright.
Some will be bright and some dim.
All bulbs will be dim.

This is a (series) (parallel) circuit.

Predicting Circuits #2

Handout for Lesson 5

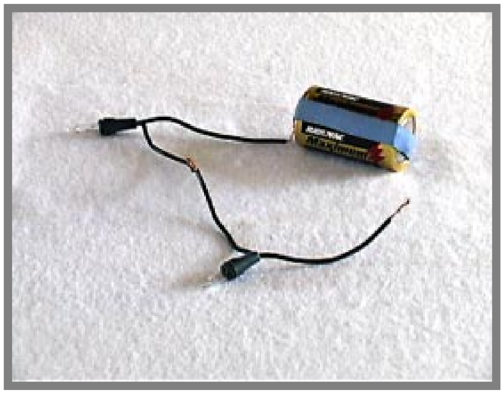
Predict what will happen when the last wire is connected to the battery. Circle your answer. Also, circle "series" or "parallel" to tell what kind of circuit you see in the picture.



PICTURE 1.

All bulbs will be bright.
Some will be bright and some dim.
All bulbs will be dim.

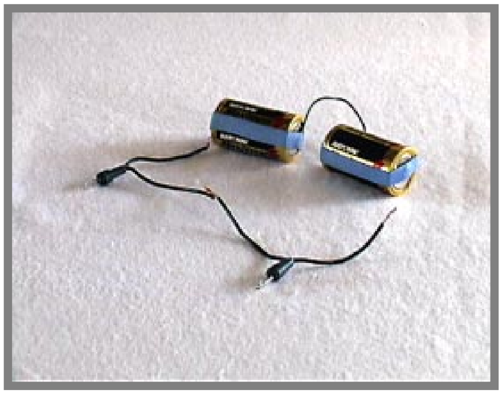
This is a (series) (parallel) (series and parallel) circuit.



PICTURE 2.

All bulbs will be bright.
Some will be bright and some dim.
All bulbs will be dim.

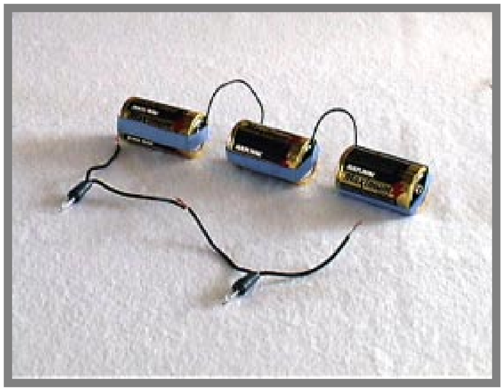
This is a (series) (parallel) (series and parallel) circuit.



PICTURE 3.

All bulbs will be bright.
Some will be bright and some dim.
All bulbs will be dim.

This is a (series) (parallel) circuit.



PICTURE 4.

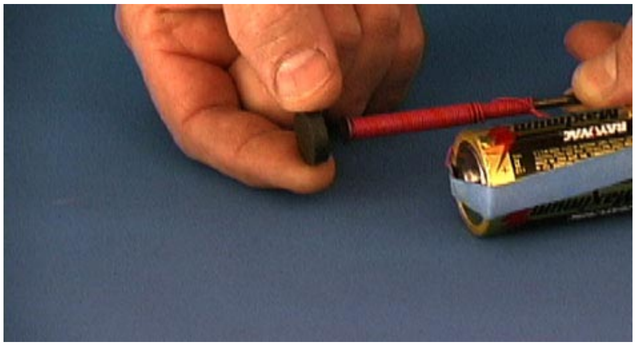
All bulbs will be bright.
Some will be bright and some dim.
All bulbs will be dim.

This is a (series) (parallel) circuit.

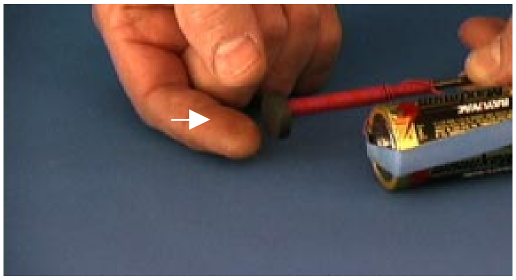
How Electromagnets Push, Pull, and Spin

Optional Handout for Lesson 7

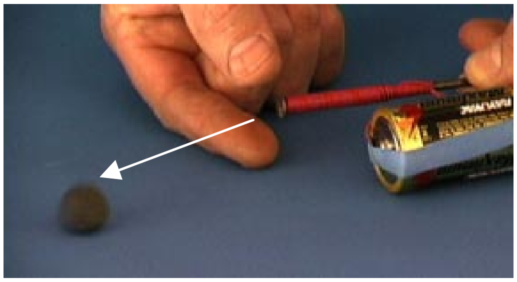
PULLING AND PUSHING: Electromagnets can pull or push things. The picture below shows how to hold an electromagnet close to one side of a small magnet. Be sure that a flat side of the magnet is facing the top of the nail. Then let go. The small magnet will be pulled toward, or pushed away from, the electromagnet, depending on which side of the small magnet faces the electromagnet.



The pictures below show what happens when the small magnet is pulled toward or pushed away from the electromagnet.



The electromagnet attracts one side of the small magnet, and . . .

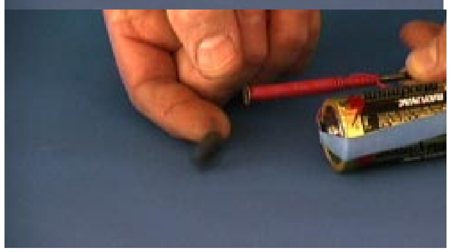


repels the other side.

The sequence of pictures below shows the small magnet first being pushed away, then spinning around, and then pulled back to the electromagnet. This shows how an electromagnet can "spin" something.

1.

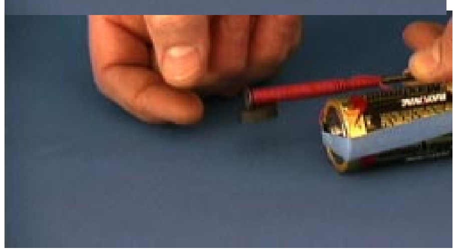
2.



3.

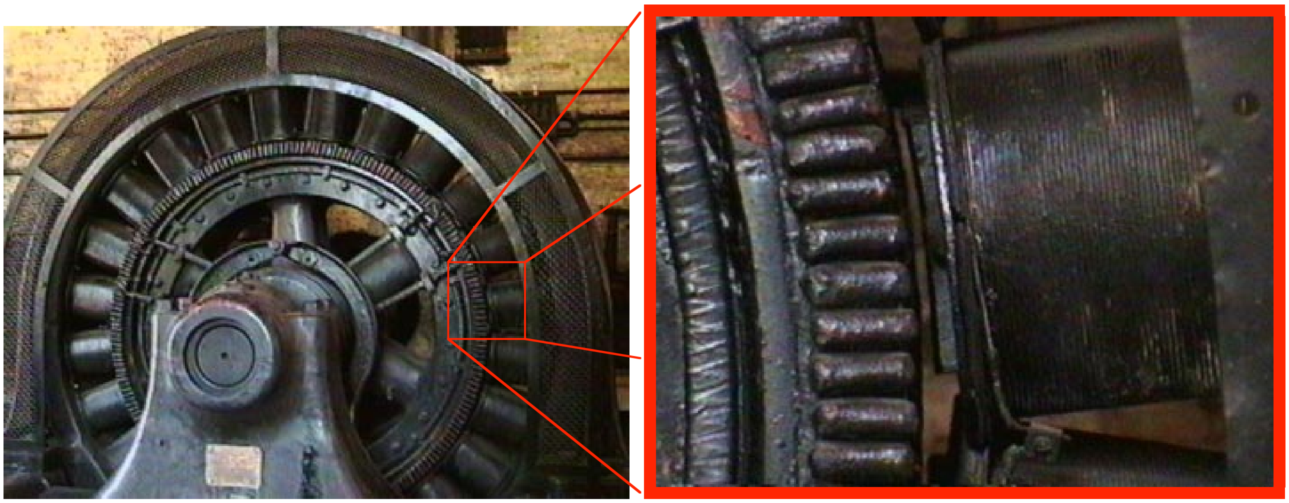
4.

5.



Electromagnets at the Folsom Powerhouse

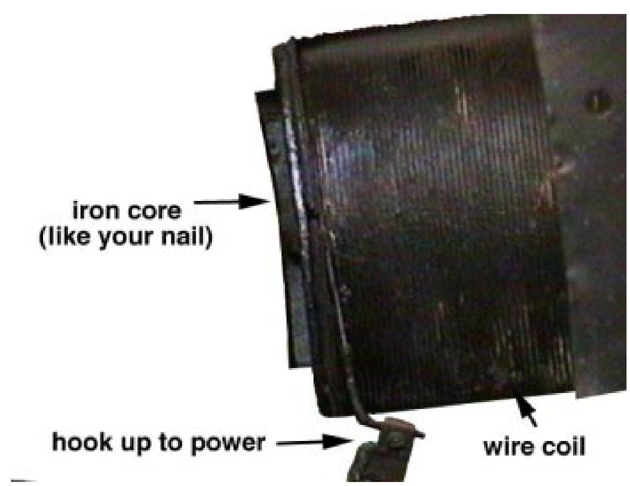
Handout for Lesson 9



On the left is a picture of an electric generator at the Folsom Powerhouse. A small piece of the picture is "blown up" on the right. In the blow up, you can see a large coil of wire wrapped around an iron rod – this is an electromagnet just like the one you made in class.

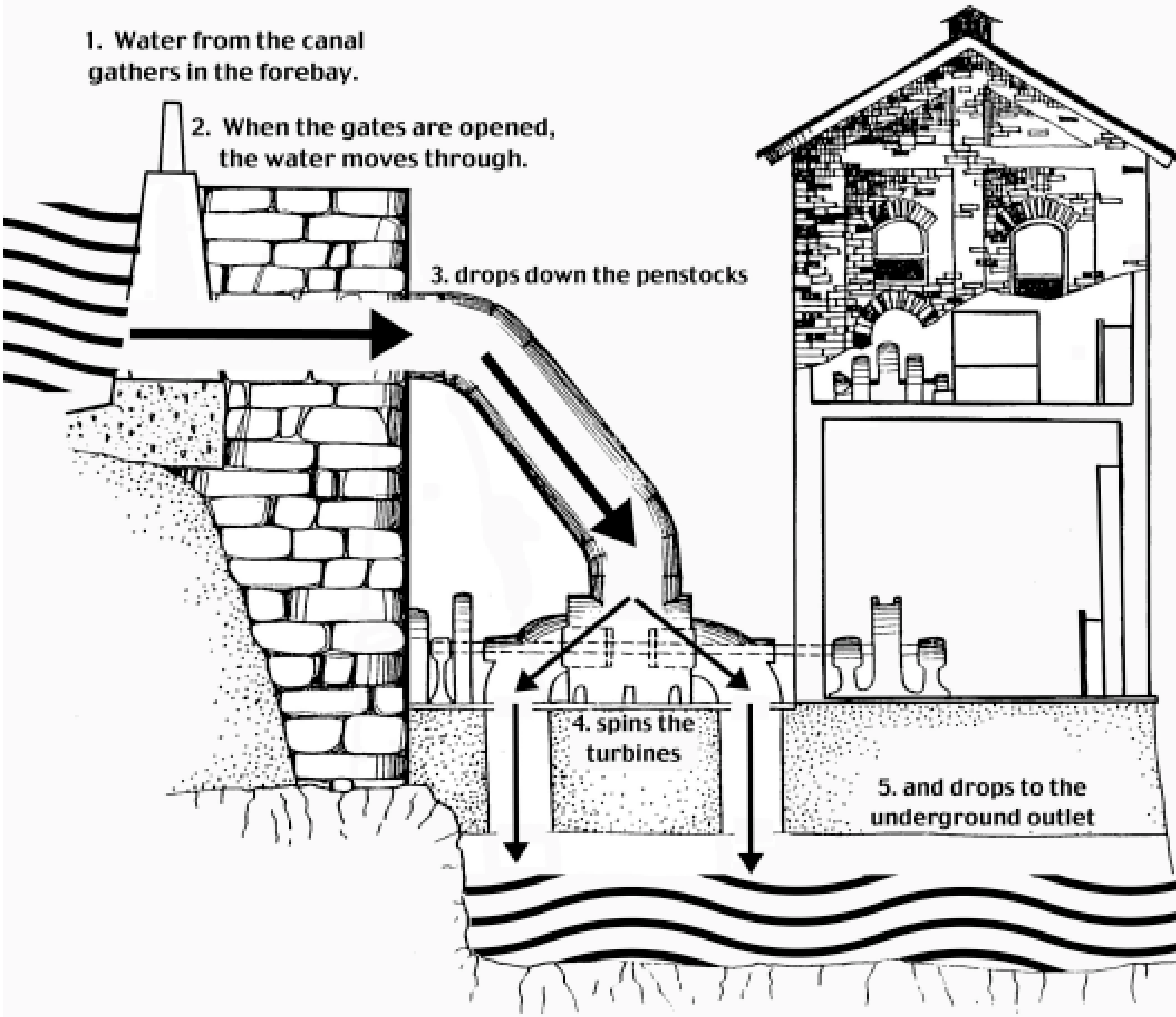
Make a drawing of your electromagnet. Draw a line that connects your nail with the iron core of the electromagnet in the picture. Draw a line that connects your coil of wire with the coil of wire in the picture.

Drawing of My Electromagnet



Moving Water at the Folsom Powerhouse

Handout for Lesson 11

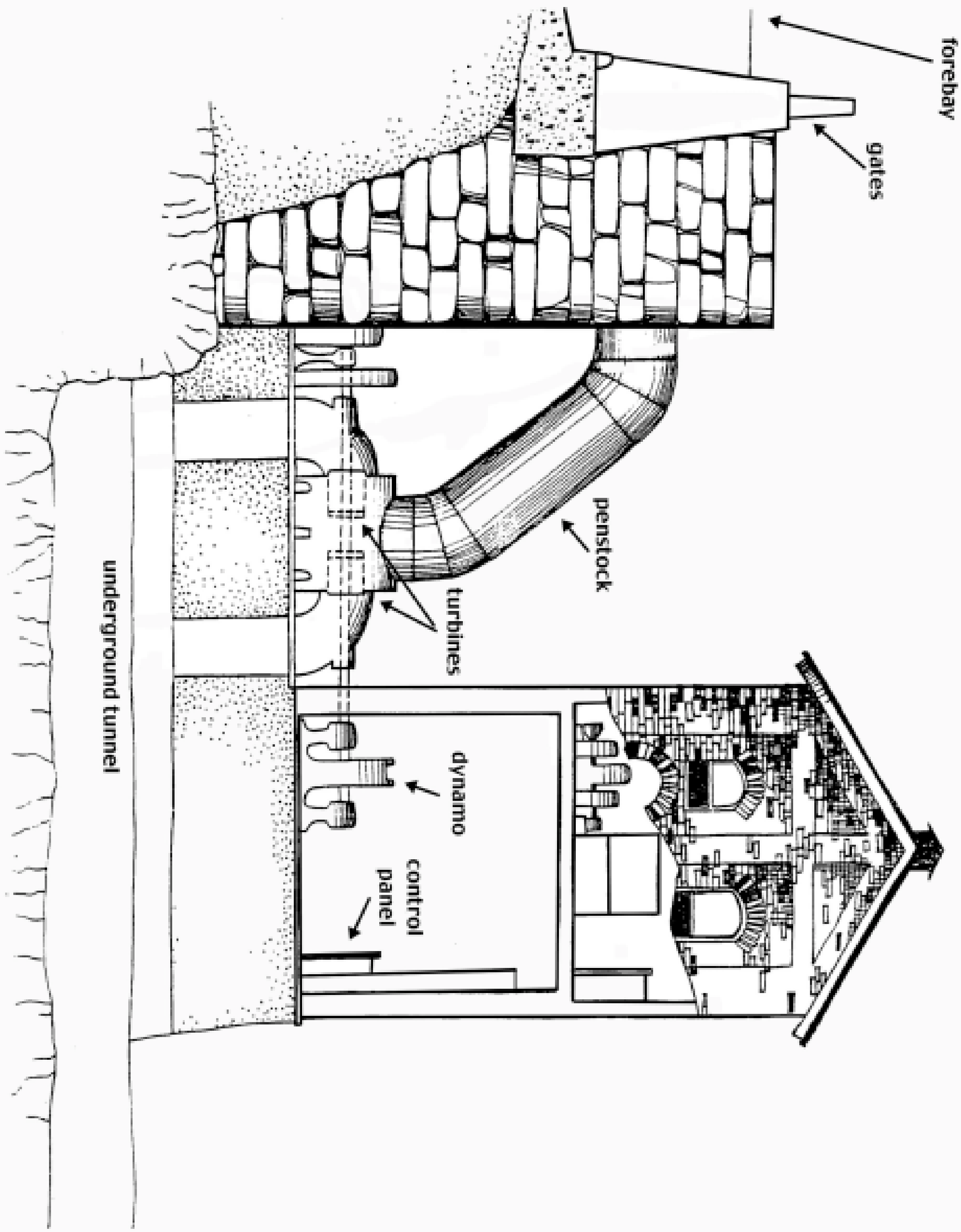


COLORING DIRECTIONS:

dirt = brown
water = blue
bricks = red
stones & cement = gray
metal = yellow

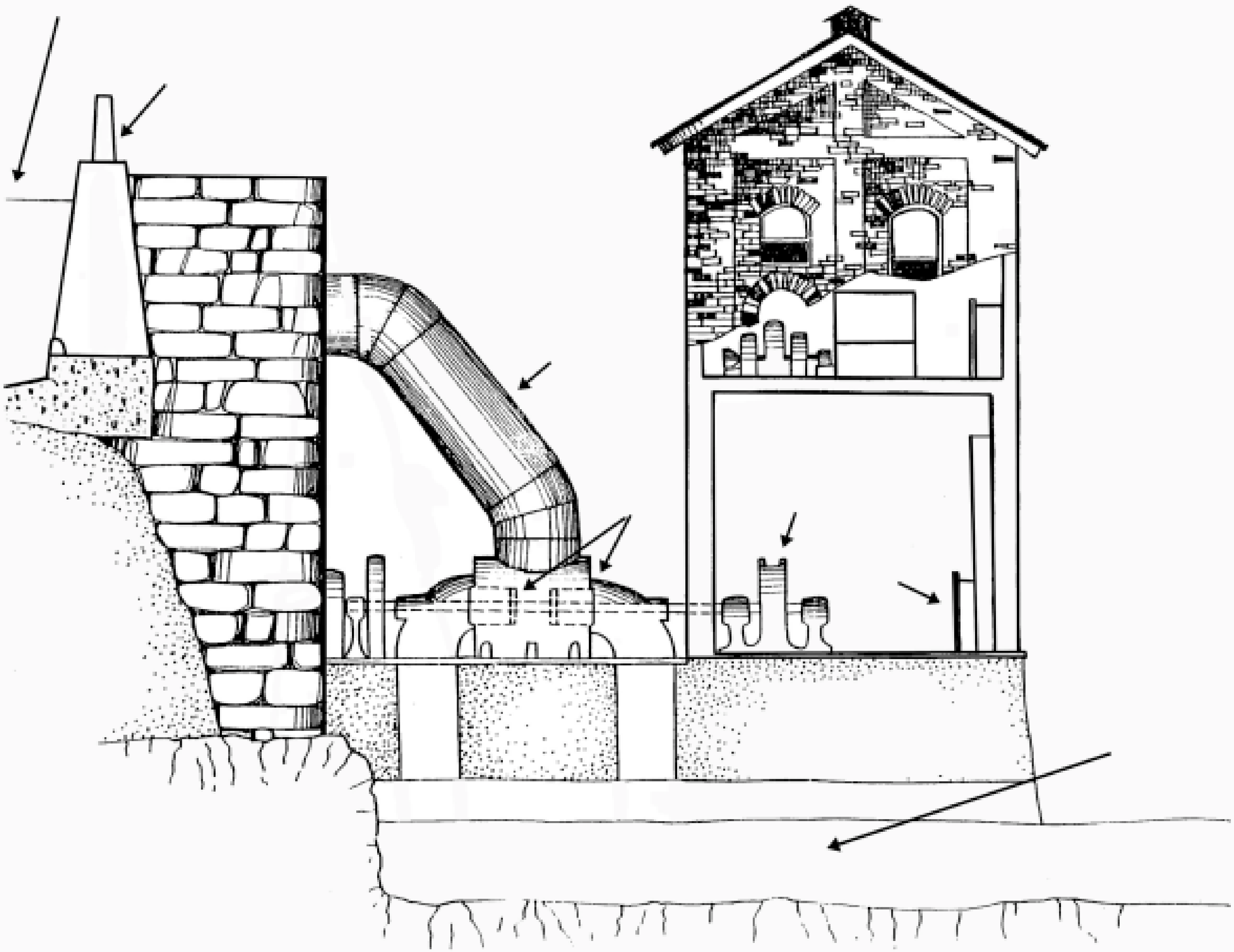
Features of the Folsom Powerhouse

Handout for Lesson 12— Labeled



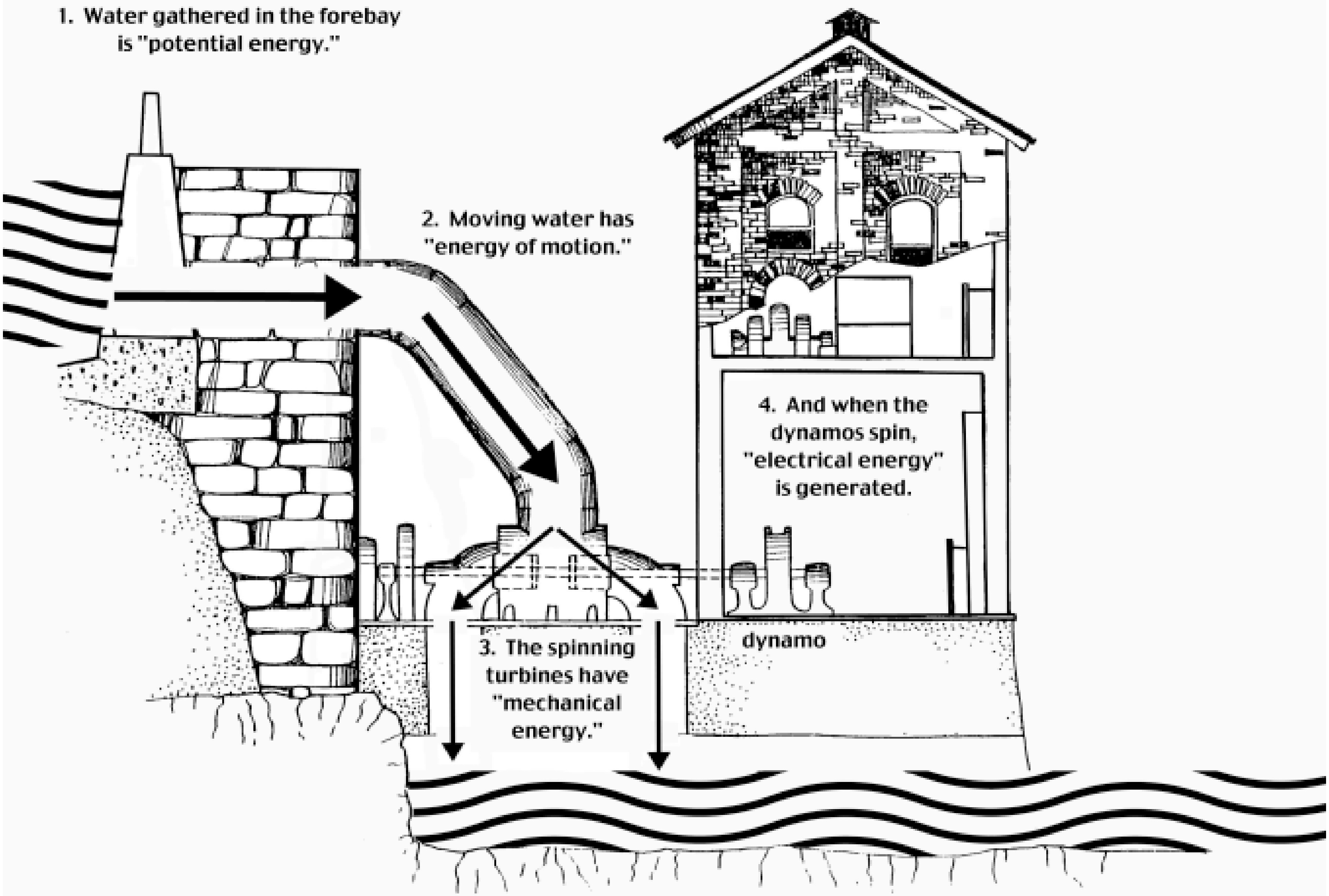
Features of the Folsom Powerhouse

Handout for Lesson 12 -- Unlabeled



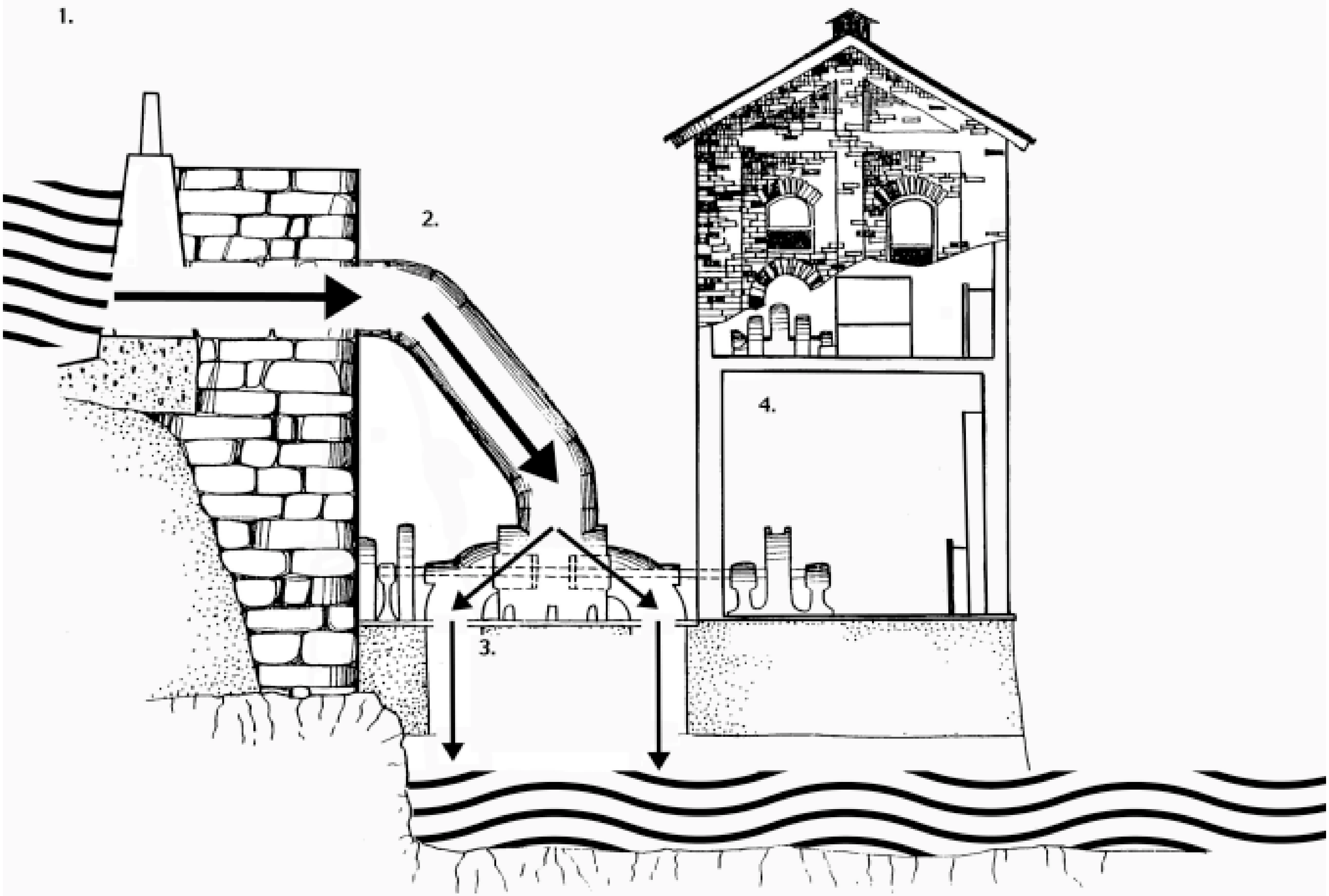
Forms of Energy at the Folsom Powerhouse

Handout for Lesson 13 -- Labeled



Forms of Energy at the Folsom Powerhouse

Handout for Lesson 13 -- Unlabeled



Quiz Question A

Handout for Lesson 14

Directions: Choose at least 3 parts of the Folsom Powerhouse shown in the handout on the next page. Give its part number, its name and explain what it does.

PART NO. NAME EXPLANATION

_____ ____________________ ____

PART NO. NAME EXPLANATION

_____ ____________________ ____

PART NO. NAME EXPLANATION

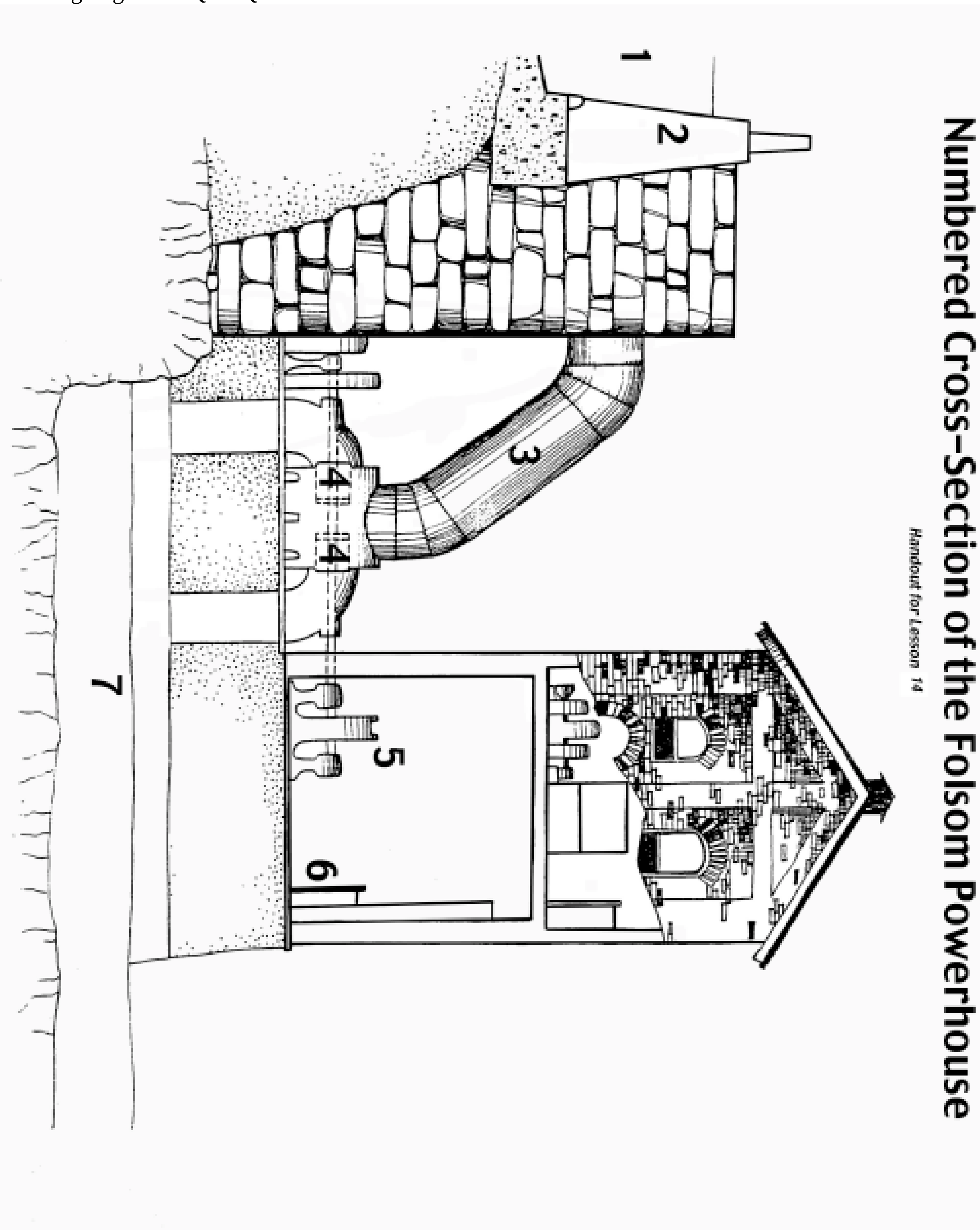
_____ ____________________ ____

PART NO. NAME EXPLANATION

_____ ____________________ ____

If you can explain more parts, write about them on the back of this page.

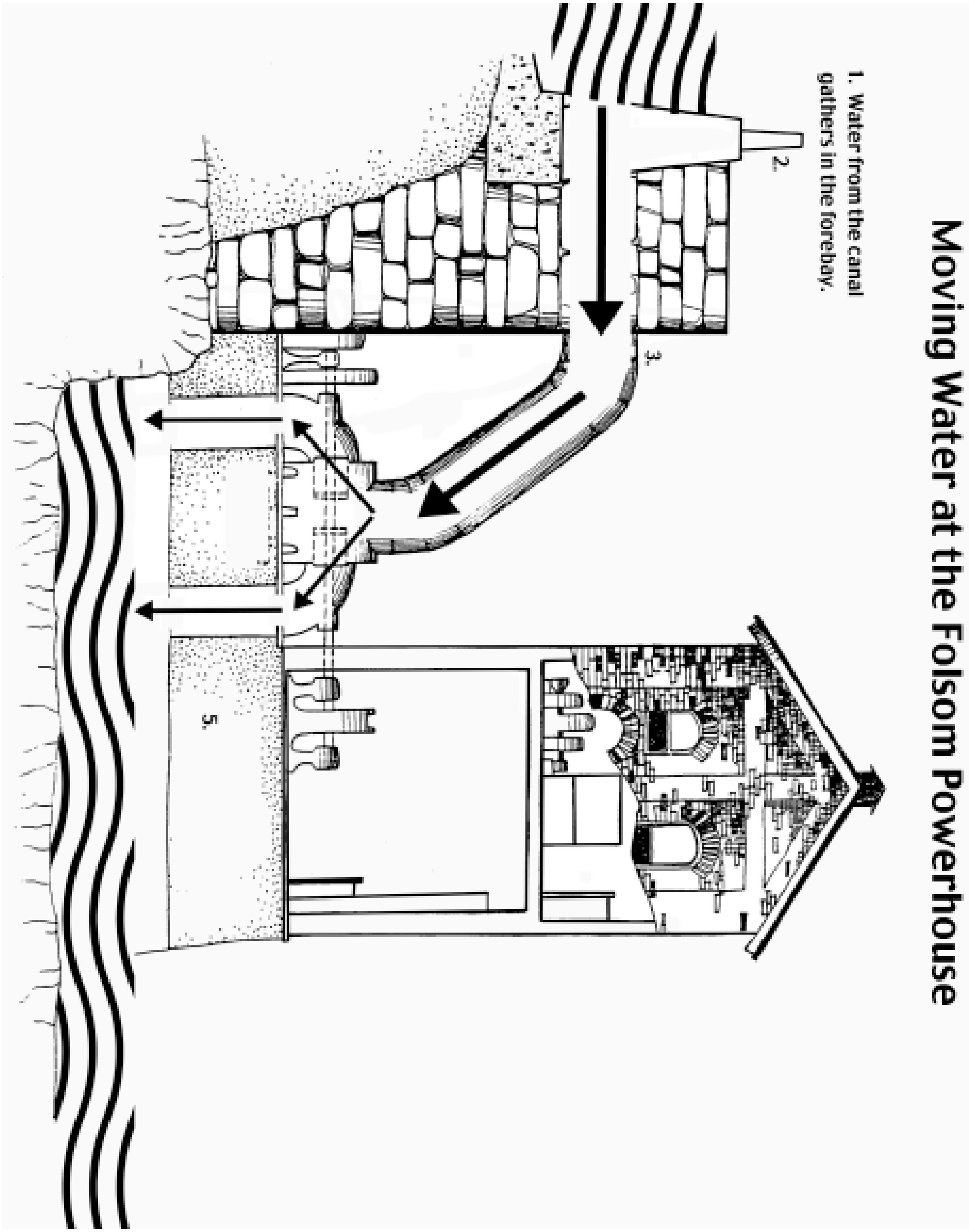
Drawing to go with Quiz Question A



Quiz Question B

Handout for Lesson 14

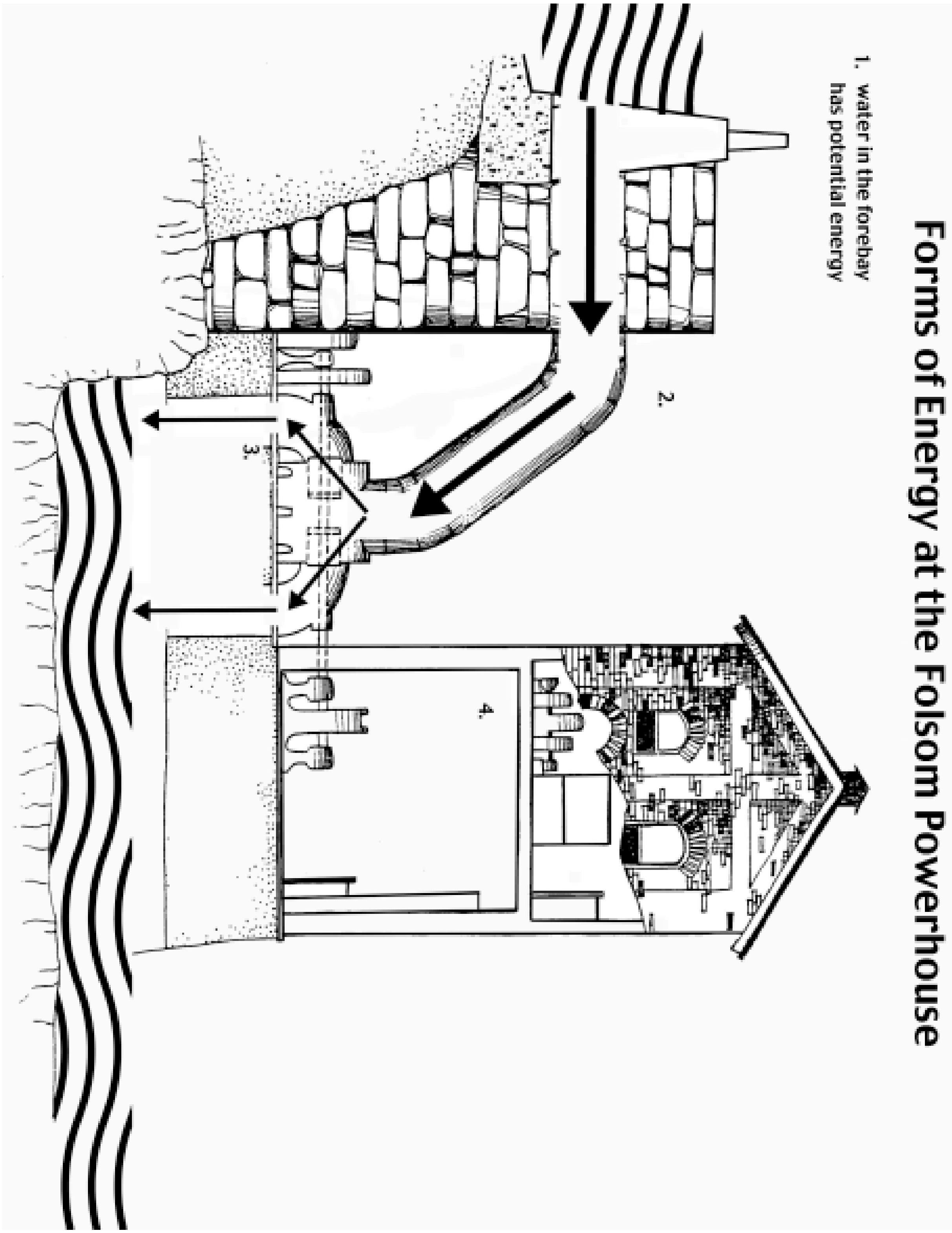
In the Drawing below, explain how water moves through the Folsom Powerhouse. Number 1 is completed as an example.



Quiz Question C

Handout for Lesson 14

In the drawing below, identify each part tell what form energy takes in that part. Part 1 is completed as an example.



Quiz Question D

Handout for Lesson 14

Make a drawing of a light bulb in a circuit with a battery and a switch. Use arrows to show the path of electricity traveling through the circuit. Label these parts: battery, bulb, switch.

Make a drawing of an electromagnet in a circuit with a battery and a switch. Use arrows to show the path of electricity traveling through the circuit. Label these parts: battery, electromagnet, switch.

Check-Off List for Scientific Problem-Solving Skills

Teacher Check-Off Form

________________________________ is able to:

child's name:

1. Differentiate an observation from an inference ☐
2. Measure weight of objects ☐
3. Measure length of objects ☐
4. Measure volume of objects ☐
5. Estimate weight of objects ☐
6. Estimate length of objects ☐
7. Estimate volume of objects ☐
8. Differentiate an observation from an inference ☐
9. Formulate predictions based on cause and effect ☐
10. Justify predictions based on cause and effect ☐
11. Conduct multiple trials to justify a prediction ☐
12. Draw conclusions about relationships between predictions and results ☐
13. Construct graphs from measurements ☐
14. Interpret graphs made from measurements ☐
15. Follow instructions for a scientific investigation ☐