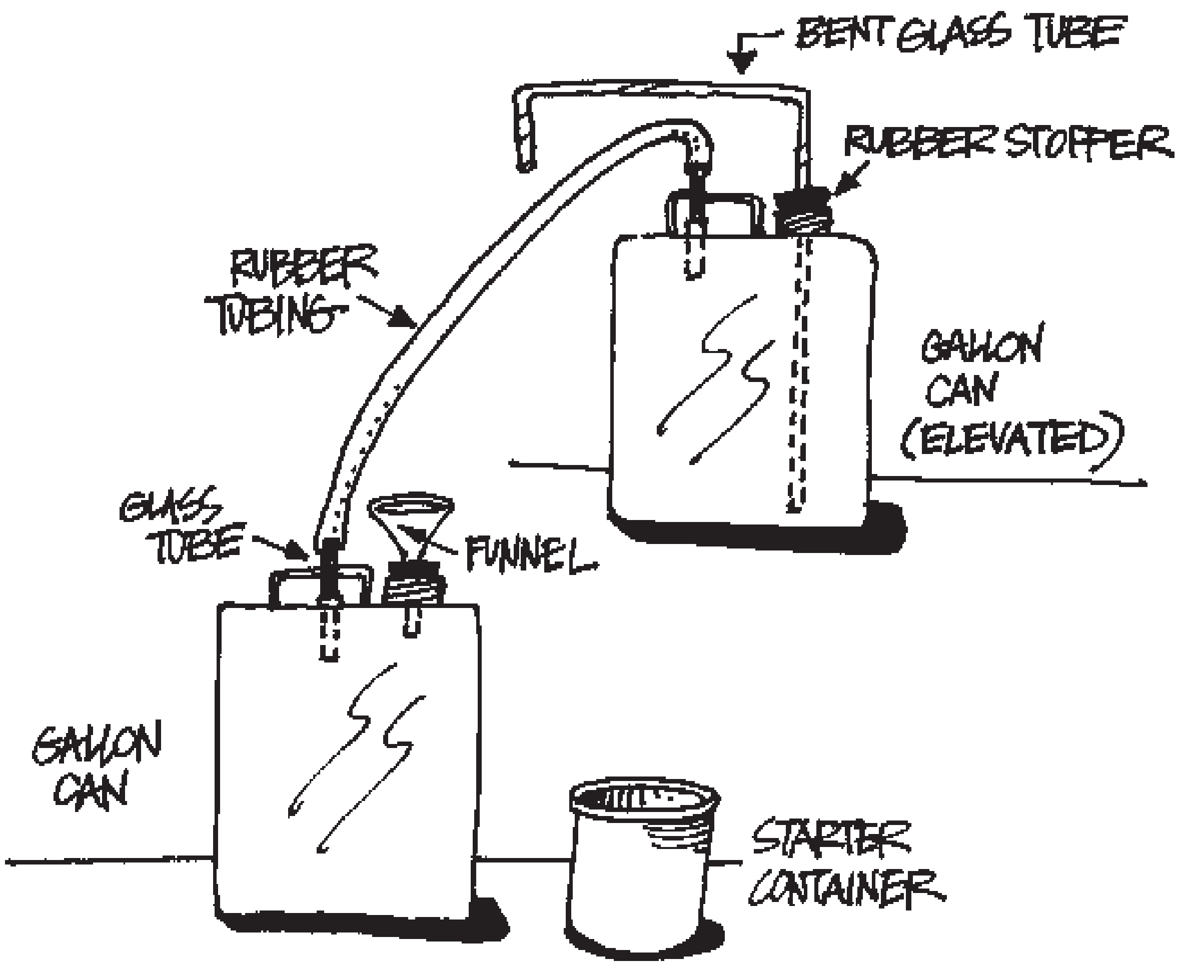
Perpetual Flow Diagram



Introductory Exercise
Using "Perpetual Flow" to Construct Good Questioning

Introduction

The importance of good questioning techniques in teaching cannot be undervalued. Effective teachers use questioning to ignite student curiosity and focus student attention on the identified problem.

This introductory activity provides an opportunity to develop student inquiry skills. One of the most important skills is the ability to formulate questions in seeking answers in science.

The "Perpetual Flow" experiment lends itself well for students to formulate both deductive (convergent) and inductive (divergent) questions. Deductive (convergent) questions are ones that ask the student to explain, interpret, give examples, or summarize concepts in his or her own words. Inductive (divergent) questions are analysis type questions that require the student to use existing knowledge and synthesize new knowledge.

Examples of inductive (divergent) questions are:

Why is it necessary to regulate the volume of the river or stream flow, during hydropower production?

What energy problems might exist if hydro power would stop all production?

How does the availability of electricity influence your life style?

Examples of deductive (convergent) questions are:

How does hydropower affect the natural flow of a stream or river?

What are the benefits of hydropower over other forms of electrical energy production?

Questions often asked by teachers are simple recall and this type of questioning seldom motivates further student interest to investigate the topic. Research indicates that 90% of questions asked by teachers are recall questions.

Purpose

Students engaged in this model system will improve their questioning skills which will become evident as they progress through the Nature of Water Power units.

The students will observe the demonstration which provides opportunities to predict, ask questions and make observations. This will lead to a better understanding of science systems.

Student teams will diagram the setup and develop a prediction about the working of the demonstration consistent with their observations.

Student teams will observe and formulate questions.

Scientific Learning Goals and Objectives for this Activity:

(Currently aligned with Washington Grade Level Expectations (GLE's): 1.1.4; 2.1.1 and 2.1.3)

Goals

- Students will engage in questioning skills.
- Students will practice using inquiry process skills, including variables.
- Students will engage in higher order critical thinking.
- Students will identify and discuss a closed system.

Objectives

- Students will use process skills to help analyze a problem.
- Students will use convergent and divergent questioning skills in analysis.
- Students will relate predictions, observations, and questioning to make a final analysis using the scientific process.

Teacher Preparation

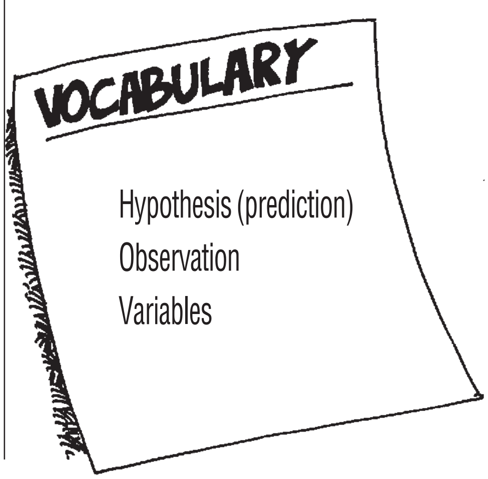
Preparation Time:
15 minutes

Materials:
Prepare one set up demonstration for the entire class:

- 2 one-gallon containers
- 1 container (approx. 250 ml capacity)
- 1 bottle each: red and green food coloring

The following items are pre-assembled:

- 1 piece glass tubing, bent with 2-90 degree angles (see diagram) with a straight extension about 10" long
- 1 piece glass tubing (approx. 4" long)
- 2 two hole stoppers (to fit in gallon container)
- 1 funnel (spout sized to fit into stopper)
- 1 piece rubber tubing (approx. 12 - 20" long)



Set up

Day One:

- Have demonstration materials connected and apparatus tested before class according to diagram.

Day Two:

- Color the water in the startup container with red food coloring, and color the water in the top can with green food coloring. This will produce green color from the top can when you pour the red water in the funnel of the bottom can on day 2.

Prepare for Each Student:

- copy of student journal pages

Activity Time:
Day One—
40 minutes
Day Two—
30 minutes

Activity Processes:
Day One: (System not started)

Divide class up into teams of about 4 students. Using the journal pages in this guide, each student begins a journal labeled with student and members of team.

Student Involvement

1. Each team observes the apparatus from a distance. The student teams illustrate and label the demonstration observed.

*Although students will want to suggest guesses about the outcome of the demonstration, it is recommended they wait until a final hypothesis is made.

(Start the System)

*Begin the demonstration by pouring the water into the funnel until the flow starts.

*Consistently refer to the apparatus as a "system."

*Continue the demonstration for around 5 minutes, and then temporarily stop the flow by pinching the rubber tube.

*Student teams will be making observations and formulating questions during the operation of the system.

*Students may ask questions about the system that can be answered with either yes or no.

Teacher Note: What did they observe that would help them to formulate good questions?

2. Have student teams list all observations and formulate written questions from their observations.

*Groups should not share observations with other groups until later.

3. Each student team writes a hypothesis in their journal, as to how the system works. They are to use illustrations with their explanation.

Day Two:

(Start the System)

Pre-set the system with red colored water startup container, and green colored water in the upper container. Note: green water will appear in the flow from the upper container, as they observe you pouring red water into the funnel of the lower container.

1. Student teams will record any new observations about the system. Students will also formulate new questions during the operation of the system.

Teacher Note: Do not give clues or answers, let the students develop their own.

2. Student teams will explain what they would like to do in the future to gain additional information about this demonstration.

Teacher Note: Best if you do not open the cans at the end of the activity or tell the students how the system works. If students want to know, have them set up their interpretation of the system. Remember the goal of this activity is formulating questions, not to find out how the system works." Questioning is at the "heart" of science and science is the process of formulating questions to seek answers.."

Student Involvement

APPLICATION
Compare and contrast the system you observed (cans) with a hydroelectric facility (in other words what are the similarities and differences between these two systems.

*Note to the teacher: a suggestion is to have students in groups of 3 to four listing all of the similarities and differences, followed by a class discussion.

*Note to the teacher: Background information: What are some of the similarities and what are some of the differences?

Examples;
1) both systems have flowing water;
2) flowing water has potential energy;
3) both systems have input and output;
4) both systems rely upon height of water (flow from high to low) or stored water;
5) the hydroelectric system transforms potential energy to electrical energy;
6) the transformation of energy with the can system is only from potential to energy of motion;
7) the ongoing supply of water from a river to the hydroelectric system allows a more continuous energy transformation;
8) the limited water supply in the can system limits the time of energy transformation;
9) others

* This discussion should help provide student focus on the subsequent activities.

Journal - Introductory Exercise
Good Questioning Techniques

Student Name ______________________________

Team Names ______________________________

Day One:

1. Draw and describe the system you and your team are observing.

2. As a team, list your observations and formulate questions relating to those observations.

3. As a team hypothesize how the system functions. (Use illustrations with your explanation; include possible variables).

Day Two:

4. As a team, record new observations regarding the system and formulate questions relating to your new observations.

5. After having observed the demonstration for both days, record any additional information you would like to gather to help answer questions you have.

6. New level of questioning: Have teams develop and record convergent and divergent questions.