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idea packet

To Harness the Wind

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To Harness the Wind

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Goals / Objectives

SC.7.N.1.1 Define a problem from the seventh grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

SC.7.N.1.2 Differentiate replication (by others) and repetition (multiple trials)

SC.7.N.1.3 Distinguish between an experiment (which must involve the identification and control of variables) and other forms of scientific investigation and explain that not all scientific knowledge is derived from experimentation

SC.7.N.1.4 Identify test variables (independent variables) and outcome variables (dependent variables) in an experiment.

SC.7.P.11.2 Investigate and describe the transformation of energy from one form to another.

SC.7.P.11.3 Cite evidence to explain that energy cannot be created nor destroyed, only changed from one form to another.

SC.912.P.10.1 Differentiate among the various forms of energy and recognize that they can be transformed from one form to others

SC.7.E.6.6 Identify the impact that humans have had on Earth, such as deforestation, urbanization, desertification, erosion, air and water quality, changing the flow of water (Renewable and Non Renewable resources)

LAFS.68.RST1.1. Cite specific textual evidence to support analysis of Science and technical texts.

Activities

- **Energy**
  - *Activity: Energy Detective*
- **Energy Sources**
  - *Activity: Mini Lab - Appliance Energy Use*
- **Solar Energy**
  - *Activity: Engineering Design – Build a Solar Water Heater Model*
- **Wind Energy**
  - Activity: Engineering Design – Wind Turbines
- **Hydro Energy**
  - *Activity: Engineering Design - Water Powered Turbines*
- **Biomass Energy**
  - *Activity: Mini Lab – Which Grass Produces more Biomass in the same amount of time?*
- **Additional Teacher Resources**

Energy is around us every day. Have students look around the classroom and/or outside the room for evidence of energy

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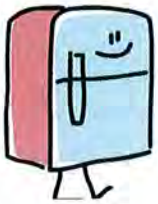
Detective Data Sheet

We know the energy was here because..... (evidence)	Source of Energy (wind, sun, electrical, etc)

Mini Labs



Mini Lab #1: Appliance Energy Use

Materials:
Home Appliances

Procedure: knowing the amount of energy (watts it takes to operate different appliances in your home can help you invest in more energy efficient appliances. Choose five appliances found in your home. Record the appliance and wattage in a data table. You can usually find the wattage of most appliances stamped on the bottom or back of the appliance or on its nameplate.

Mini Lab #2: Energy Cost

Procedure: The Department of Energy reported that the average cost of residential electricity in 2009 was \$0.12/kWh. You can calculate the amount of energy and the cost of energy used by difference appliances in your home by using the formulas below. Complete the data table below. Calculate the cost for operating each appliance for two hours. Round to the nearest cent.

Step#1: How much energy does a 100-watt light bulb use in two hours?

Formula: $\frac{\text{POWER (watts) x TIME (hr)}}{\text{1,000 (watt x hr/kWh)}}$ Example: $\frac{\text{100 watts x 2 hours}}{\text{1,000 watt x hr/kWh}} = 0.2 \text{ kWh}$

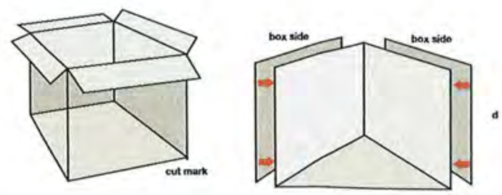
Step#2: What is the cost of operating a 100 watt light bulb for 2 hours? Use \$0.12/kWh as the average cost of electricity.

Formula: (kWh) x (\$/kWh) Example (0.2 kWh) x (\$0.12/kWh) = \$0.024

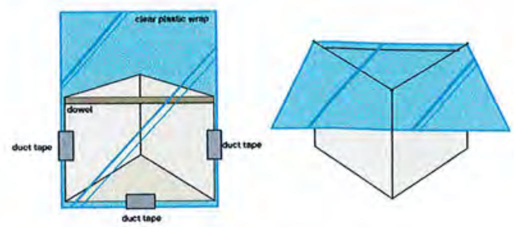
Appliance	Power (Watt)	Cost for Operating (2 hours)
Ceiling Fan	75	
Freezer	100	
Portable heater	1500	
Television	250	
Clothes dryer	2500	
Computer	360	
Water heater	3200	

Build a Solar Water Heater Model

1. Cut the cardboard box in half diagonally. Cut off the top flaps. Cut the left-over half's 2 sides off and glue or rubber cement them to the outside of your box half. This adds strength and insulation.

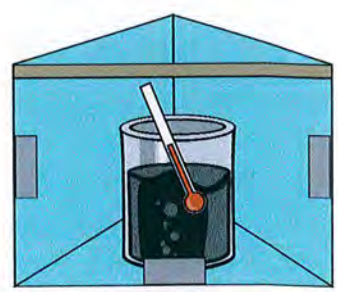


2. Glue aluminum foil shiny side out to the inside *(sides and bottom)* of the box. Secure a small dowel across the top of the opening *(from corner to corner)* with silver duct tape to serve as a brace.



3. Cut a piece of clear plastic or vinyl large enough to tape to the underside of the box and to cover the opening and the top of the box.

4. Tape the plastic wrap securely to the underside of the box. This plastic serves as both the cover and the *"door"* for the heater. When you use the solar heater, pull the plastic up over the top of the box and tape it tightly in place.



5. Fill the can with tap water. Measure and record the initial temperature of the water. Cover the top of the can with plastic wrap and secure it with a rubber band. Make a small slit in the plastic, insert the thermometer, and leave it in the water except when you are reading it.

6. Set up the model solar water heater outside so the opening of the box faces the sun; make sure it is not shaded. The direction the box must face will vary depending on the time of day.

7. Place the water-filled can inside the box and seal the box with the clear plastic cover.

8. Check the changes in water temperature as directed by your teacher. Two groups will measure and record the temperature every 10 minutes for 40 minutes. The other two groups will measure and record the temperature only at the beginning and the end of 40 minutes.

Effectiveness of Insulation

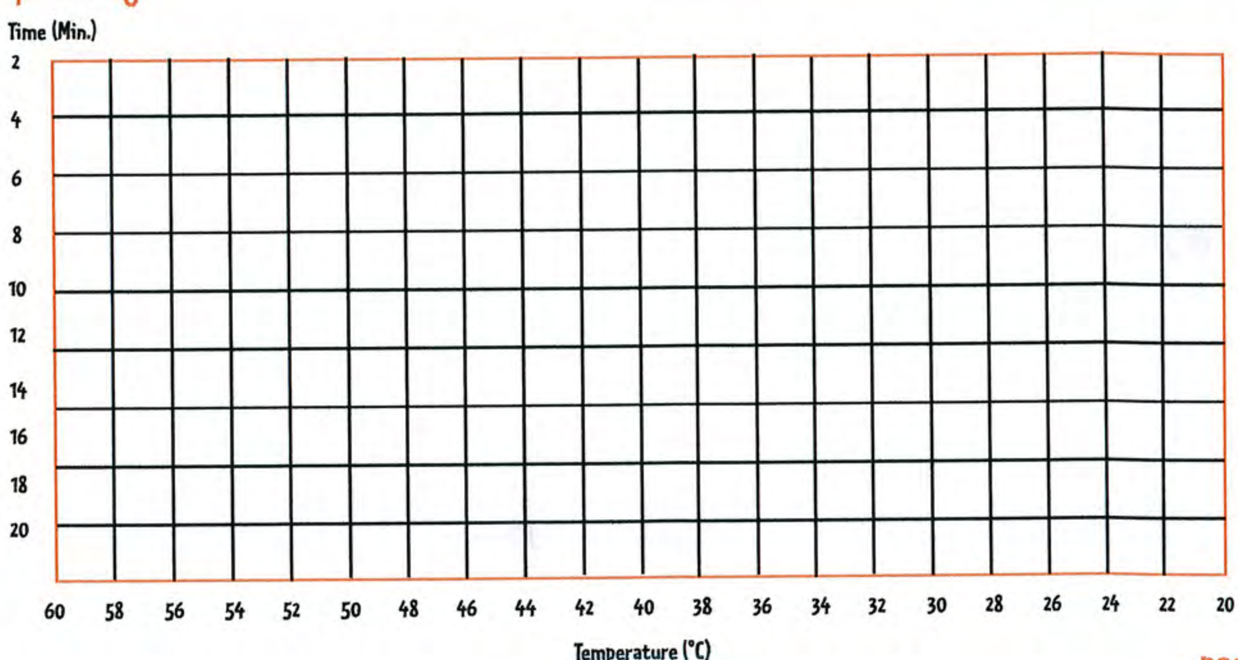
Data Table: Warming

	Can #1	Can #2	Can #3	Can #4
Beginning temp. (°C)				
Temp. after 20 min. (°C)				
Temp. difference (°C)				

Data Table: Cooling

Can	Insulation	Temperature (°C) after elapsed time (min.)										Temp. difference (°C)
		2	4	6	8	10	12	14	16	18	20	
#1	Foil											
#2	Newspaper											
#3	Styrofoam											
#4	(None)											

Graph: Cooling



To Harness the Wind

As an introduction, students working groups create a flow chart showing how wind energy is turned into electricity that powers our homes and schools. Students then draw the flowchart as a class with input from each group. The flowchart emphasizes how the form of energy changes in the process.

Sun (electromagnetic energy) - differentially warms the **Earth** (thermal energy) - **wind** (mechanical energy) - turns **turbine rotor** (mechanical energy) - turbine turns **metal coil** inside **generator** (mechanical energy) - metal coil moving in a magnetic field creates **electricity** (electric energy).

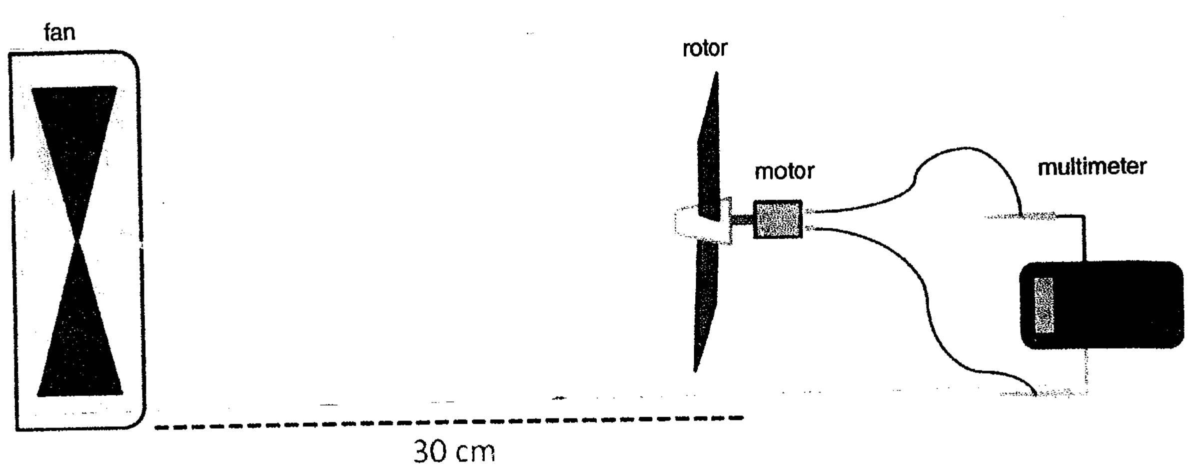
The Design Challenge

Students will design, build and test turbine rotors. The team whose turbine generates the most electricity will win a prize!

Materials

Safety goggles, cork (for each team), cardstock, construction paper, craft foam, cardboard, paper, bamboo skewers, tape or glue, small DC toy motor, strong fan, and multimeter that can measure in both volts and amps.

Testing Table Setup



Experimental Design

1. Spend the first 5-10 minutes brainstorming ideas for wind turbine blade designs.

Decide together what will be tested: number of blades, shape of blades, different materials for the blades. *This must be decided on before beginning. Only one variable is tested.

2. Show the design to your instructor and collect materials to start building.

3. Once wind turbine rotors are complete, draw a diagram of the turbine design. Please label the drawing with the type of material used and sizes (such as height and width of a blade in centimeters).

4. When the turbine and diagram are complete, bring it to the testing station to measure how many volts and amps the turbine produces. Volts are the electric potential (amount of energy per charge) and amps are a measure of the electrical current (amount of electrons passing a point per unit of time).

	Trial 1	Trial 2	Trial 3
Volts			
Amps			

5. The average household in the United States uses 30 kilowatt hours (kWh) of electricity per day. How many of your wind turbines would you need to power a house?

First, calculate the amount of power in watts your wind turbine produces using the equation below:

$$\text{Power (in watts)} = \text{volts} \times \text{amps}$$

Second, find out how many kilowatt hours of electricity your turbine produces in one hour using the equation below:

$$\text{kWh} = \frac{\text{power (in watts)}}{1{,}000} \times 1 \text{ hour}$$

Third, multiply the amount of kWh your turbine produces in an hour by 24 hours to get the amount of kWh produced in a day.

Lastly, divide the average household electricity use per day (30 kWh) by the kWh your turbine produces in a day to find out how many of your turbines are needed to power your house.

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Hydroelectric
Workshop Activity

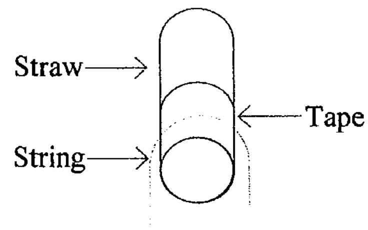


Figure 1: Wrap string around straw and secure with tape

Materials

Foam Cup	Spoons	Scissors
Metric Ruler	Pens	
Drinking Straw	Tape	

Procedure

You have 30 minutes to complete this activity.

1. Find a partner.
2. Create a waterwheel around a straw axle using any combination of the available materials. The straw will rotate within loops of tape attached to the test tank. Do not cut the straw.
3. Wrap the end of a piece of string around the end of the straw. Secure the string with tape. See Figure 1.
4. Cut the string so that 1 ft of the string hangs from the straw.
5. Attach the paper clip to the end of the string with tape.
6. Read the test tank procedure and then conduct a trial run at the test tank.
7. Report the length of time that it takes for the string to be completely wound around the straw. If it does not completely lift the paper clip, report the time and distance the paper clip was lifted.
8. Make adjustments and repeat trial runs until time is called.
9. Have fun!

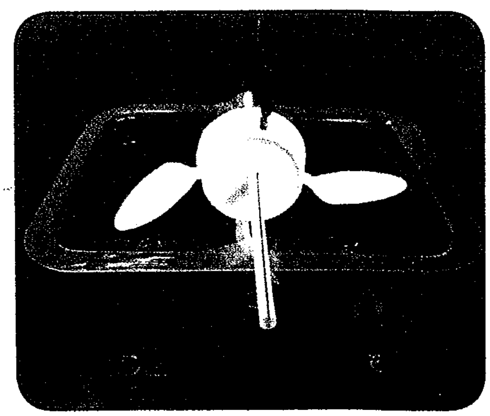


Figure 2: Assembled waterwheel

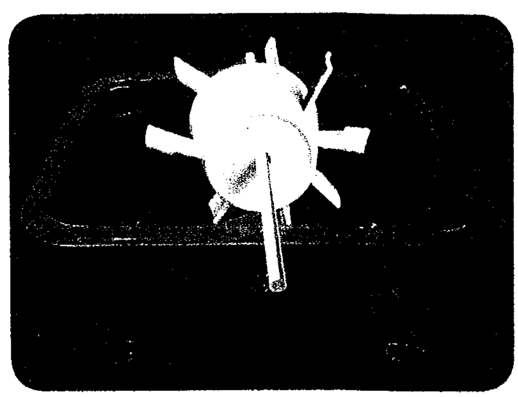
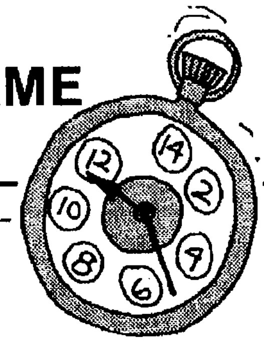


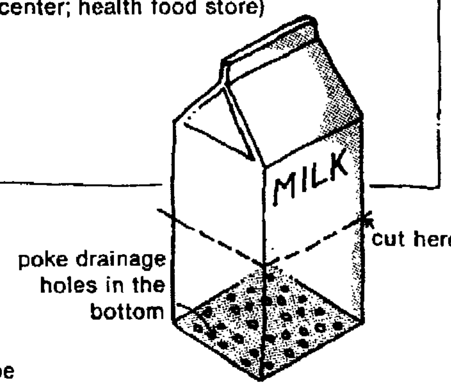
Figure 3: Experiment in progress

WHICH GRASS PRODUCES MORE BIOMASS IN THE SAME AMOUNT OF TIME?



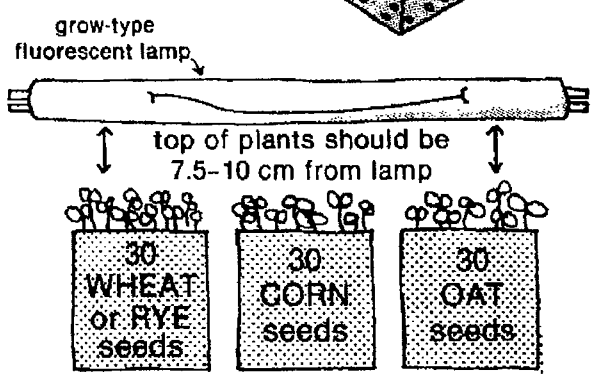
MATERIALS:

Wheat or rye seed (garden center; health food store)
Corn seed (garden center; feed and grain store)
Oats (whole only, not milled) (garden center; health food store)
Potting soil; balance scale
3 Half-gallon milk cartons
Grow-type fluorescent lamp



Cut the milk cartons in half. Fill with potting soil, and plant the seeds. Keep moist.

Grow the plants under a grow-type lamp. Record your results.



		Plant growth and development									
		germination			average height						
Plant	date planted	date of 1st sprout	date of 10th sprout	date of 20th sprout	2 days	4 days	6 days	8 days	10 days	12 days	14 days
WHEAT or RYE											
CORN											
OATS											

After 14 days pull the plants. Wash off the dirt and dry with a paper towel.

Weigh the plants and record. Dry the plants in the sun until they're crisp, and weigh them again.

		Weight	
		fresh weight	dry weight
Test plant	WHEAT or RYE		
	CORN		
	OATS		

Summary question:

Which plant is the best converter of light energy to biomass?

OTHER IDEAS TO EXPLORE:

Try burning the biomass produced. Set up and conduct your experiment as in Activity 8.

Would the results be better if your plants were allowed to mature?

Do other grasses produce more biomass? (Try using barley, triticale, rice, etc.)

What is done with most of the corn and wheat grown in this country? What might happen if a major portion of our grain was used to produce energy?

Steps of the Scientific Method

1. Choose a problem.
State the problem as a question.

2. Research your problem.
Read, get advice, and make observations.

3. Develop a hypothesis.
Make a prediction about what will happen.

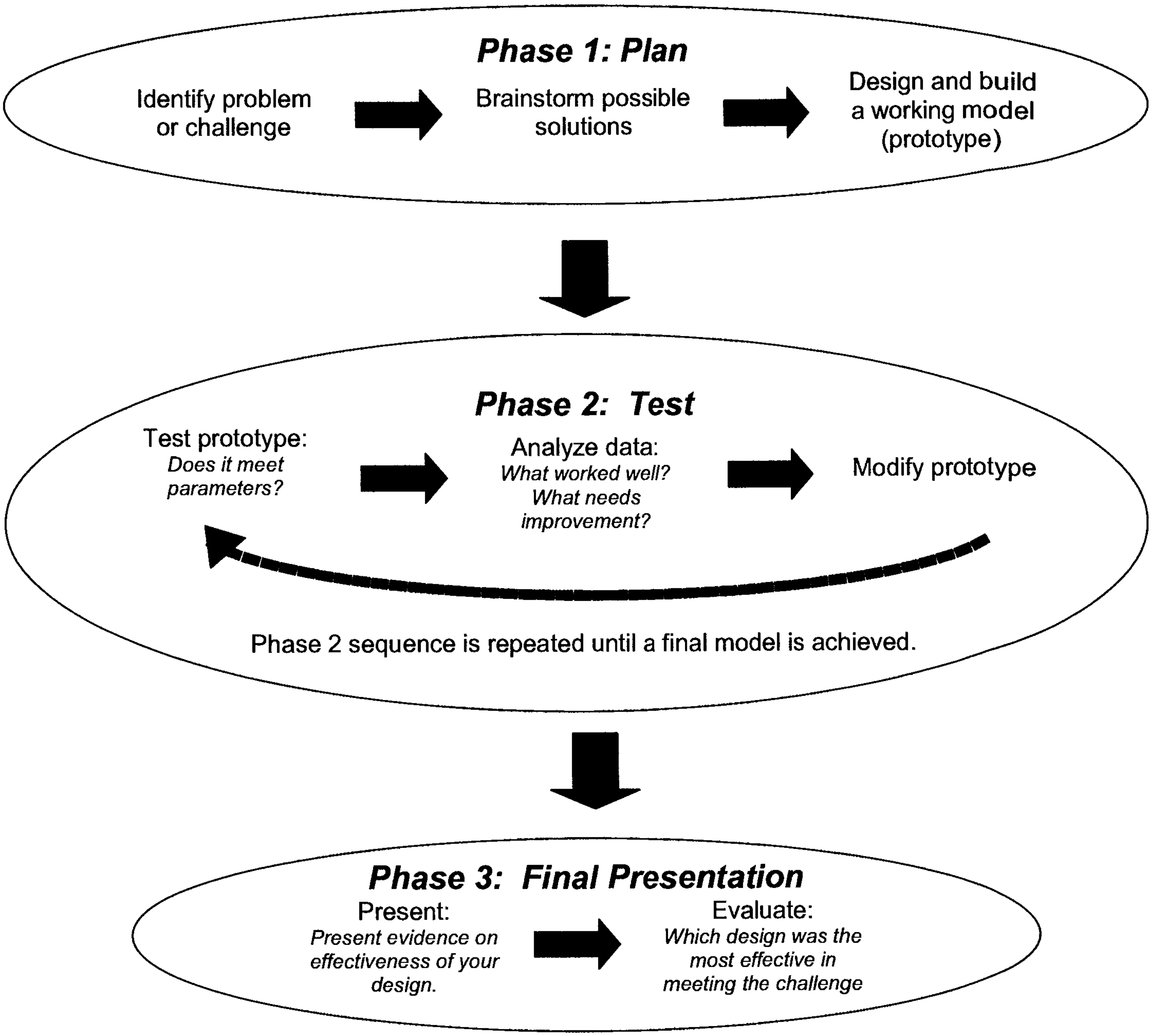
4. Design an experiment.
Plan how you will test your hypothesis.

5. Test your hypothesis.
Conduct the experiment and record the data.

6. Organize your data.
Create a chart or graph of your data.

7. Draw conclusions.
Analyze your data and summarize your findings.

Engineer/Design Challenge Process



Energy Transformation Worksheet

Identify the different types of energy transformation in each of the pictures

Windmill

Energy Transformation:

Flashlight

Energy Transformation:

Microwave

Energy Transformation:

Firecracker

Energy Transformation:

Bicycle

Energy Transformation:

Battery

Energy Transformation:

Give an example where the following energy changes would take place:

Electrical to Thermal

Chemical to Thermal

Electrical to Mechanical

Teacher Resources

The Boy Who Harnessed the Wind: Picture Book Edition by William Kamkwamba, Bryan Mealer and Elizabeth Zunon (Jan 19, 2012)

The Boy Who Harnessed the Wind: Creating Currents of Electricity and Hope (P.S.) by William Kamkwamba and Bryan Mealer (Jul 27, 2010)

Alternative Energy Experiments, Grades 5 - 8 (Science Activity Books) by Schyrlet Cameron and Carolyn Craig (Jan 4, 2010)

NSTA – National Science Teachers Association – Articles and lessons for teachers

Interactive Resources

Energy Kids
Energy facts about various forms of renewable and nonrenewable energy sources
http://www.eia.gov/kids/index.cfm

Explore Learning
www.explorelearning.com

Play: Hungry mice - Science Museum
http://www.sciencemuseum.org.uk/energy/site/EIZGame4.asp
On planet Earth humans. are dangerously reliant on non-renewable energy.

Power Up! - Science NetLinks
http://sciencenetlinks.com/esheets/power-up/
Help power up a city with different energy sources

Renewable and Non-Renewable - The Children's University of **...**
http://www.childrensuniversity.manchester.ac.uk/interactives/science/energy/renewable/
Electricity can be made from **renewable** or **non-renewable energy sources**

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