Science Activities in Biomass

Curriculum: Biomass Power (organic chemistry, genetics, distillation, agriculture, chemical/carbon cycles, climatology, plants and energy resources/transformations)

Grade Level: Elementary School grades 4, 5, 6

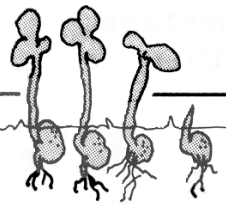
Whole class or small groups (3 to 4)

Time: Activities range from 2 to 15 class periods, depending on abilities of students.

Summary: Twelve activities concern plant growth and the environment, byproducts of biomass, and energy contained in different types of biomass.

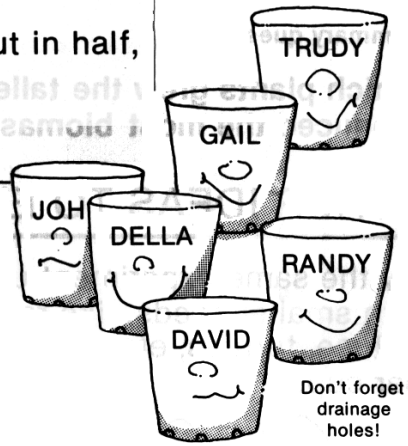
Provided by the Department of Energy's National Renewable Energy Laboratory and BP America Inc.

DO BEAN PLANTS GROW MORE IN THE DARK OR IN THE LIGHT?



MATERIALS:

Bean seeds; potting soil
Metric ruler; balance scale
Plastic cups or milk cartons, cut in half, for each student
Cardboard box or dark closet (must be light-tight)



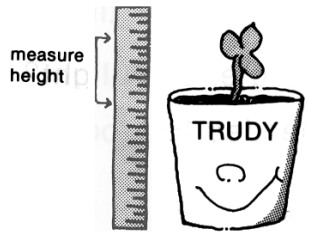
Don't forget drainage holes!

Plant three seeds in each cup.

Place half the cups in the sun and half in the dark. Keep moist.

DAY	1	2	3	4	5	6	7	8	9	10	11	12	13	14
TRUDY														
RANDY														
JOHN														
GAIL														
DAVID														
DELLA														

Height of plant



Record each bean plant's height for 14 days. You may have to support the plants as they get taller.

After 14 days remove the plants from the soil, wash, and dry with a paper towel. Weigh the plants and record.

Dry the plants in the sun until they are crisp and weigh again.

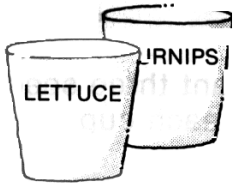
Weigh all the plants together!	
fresh weight	dry weight

Summary questions:

Which plants grew the tallest? Which plants produced the most biomass?

OTHER IDEAS TO EXPLORE:

Try the same experiment using plants with smaller seeds, like radishes, lettuce, turnips, etc. (Use 8–10 seeds per cup.)



What happens if the bean plants' growing conditions are reversed after two weeks

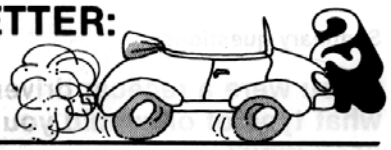
(Place the dark plants in the ligh and the light plants in the dark.)

Where did the bean plants in the dark get their energy to grow? Which set of plants would continue to gro for the longest time?

How can you tell if plants are getting enough light?

What's the most essential thing needed to produce biomas for energy production?

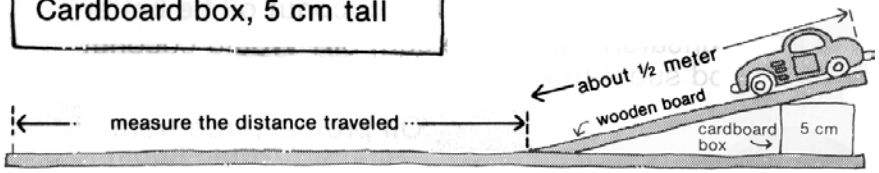
WHICH LUBRICATES BETTER: COOKING OIL OR AUTOMOBILE OIL?



MATERIALS:

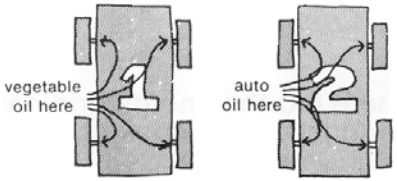
Vegetable oil (safflower, corn, peanut, etc.)
#20 or #30 Automobile oil
2 Small toy cars
Meter stick
Wooden board, about 12 cm wide
Cardboard box, 5 cm tall

Set up the inclined plane like the diagram below. Measure the distance traveled without oil.



Add oil to the wheels of each car. vegetable oil to one car, automobile oil to the other car.

	distance traveled	
	1	2
no oil		
	vegetable	auto oil
fresh oil		
1 week old		
2 weeks old		
3 weeks old		

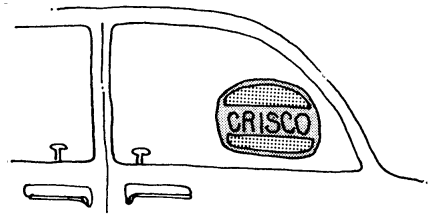


Test again and record the distance traveled. Store the cars in a clean place.

Test the cars each week for several weeks. Record the distance traveled without adding any extra oil.

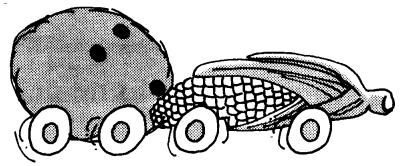
Summary questions:

If you were a racecar driver, what type of oil would you use? Why?



OTHER IDEAS TO EXPLORE:

Try using other cooking oils on one car and compare the results. Would a saturated oil like coconut oil be better than a polyunsaturated oil like corn oil? Would coconut oil be a good substitute for automobile oil?

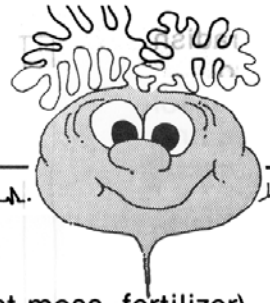


Oil protects iron from rusting. Would cooking oil do the same? What happens? Why?

Could machine oil be used in making paint?

Where did the energy originally come from that produced both cooking oil and automobile oil?

THE GREAT RADISH CONTEST!



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MATERIALS:

Radish seeds
Secret soil mix (soil, sand, peat moss, fertilizer)
2 Tongue depressors; balance scale; meter stick
Styrofoam cup or tin can for each student
Grow-type fluorescent lamp

The class may wish to set regulations for the race.

OFFICIAL REGULATIONS

What methods can be used to grow radishes?

How will the largest radish be decided?

How long will the contest last?

Must everyone use the same brand of radish seed? The same soil mix?

Prepare your own secret soil mix and plant six radish seeds in your cup. Be sure to punch drainage holes in the bottom of your cup.

HOW I GREW MY RADISH

secret soil formula _____

planting depth _____

watering record

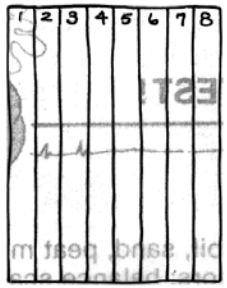
date							
amount							

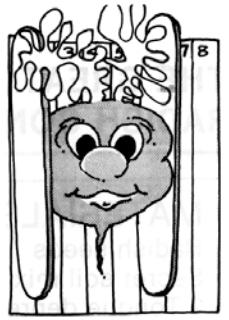
weight ____ length ____ width ____

The fluorescent light should be 7.5–10 cm above the top of the plants.

Keep accurate records during your experiment.

Place your radish between two tongue depressors and measure on this scale.





Award a badge to the winning radish!

Summary question:

Compare the growing notes for each radish.
What secret soil mix grew the best radish?

OTHER IDEAS TO EXPLORE:

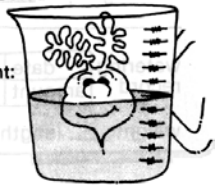
Try the best growing medium on a turnip or other root-crop plants. Try it on lettuce or legumes, too.

Did the largest top leaves always produce the largest radish?

Where did the energy in each plant come from?

How else might you measure the size of your radishes?

Hint:



WHICH GROWING MEDIUM PRODUCES MORE BIOMASS: PLAIN SOIL OR HYDROPONIC SOLUTION?

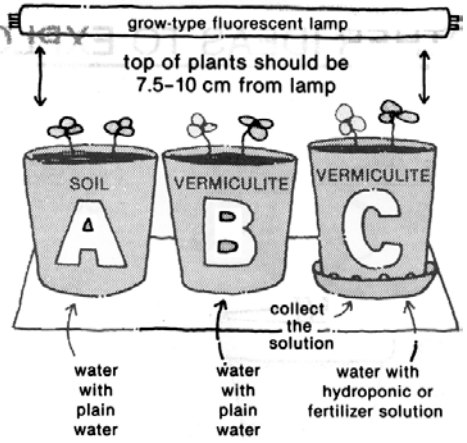
4

MATERIALS:

Potting soil; radish seeds
Vermiculite or coarse sand
Grow-type fluorescent lamp
Styrofoam cups or tin cans
Balance scale
Hydroponic chemicals
or concentrated complete plant fertilizer (garden center or hardware store)

Plant 6-8 radish seeds in each cup. Keep the soil moist. Select the two best seedlings and pull the others out.

Mix the hydroponic or fertilizer solution according to the package directions.



Keep cups A and B moist with plain water. Water cup C with your solution twice daily, collecting and reusing it for 1 week. Mix a fresh solution each week.

After 4 weeks remove the plants from the growing media, wash, and dry with a paper towel.

Weigh them and record.

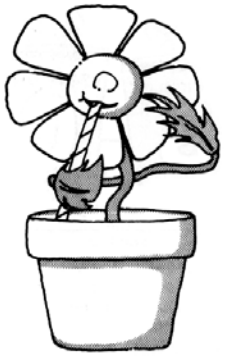
Dry the plants in the sun until they are crisp and weigh them.

growing media	compare the radish growth: fresh weight	compare the radish growth: dry weight
soil + water		
vermiculite + water		
vermiculite + hydroponics		

Summary questions:

How much better is one media than the other in producing biomass? Did you get any radishes?

OTHER IDEAS TO EXPLORE:



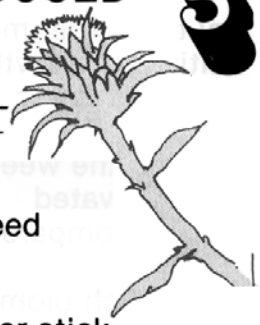
Try raising some other vegetable or flower the same way. Compare the results.

Find a hydroponic formula, and try making your own watering solution. Try raising a small garden outside or in a greenhouse

What other materials could be substituted for vermiculite? Could hydroponics be an advantage in producing biomass?

HOW MUCH BIOMASS IS PRODUCED BY 1 SQUARE METER OF A LOCAL WEED?

5



MATERIALS:

An area with a lush growth of a local weed
(kudzu, Johnson grass, honeysuckle, thistle, hyacinth, etc.)
Hoes; shovels; bags; balance scale; meter stick

Collect weeds (tops and roots) from one square meter of lush growth of a local weed.

plant used	biomass of wild plant crop	
	fresh weight	dry weight

Wash off the soil, dry them with a paper towel, and weigh

Dry the plants until they are crisp, then weigh again.

Summary questions:

Would the amount of weeds in your area be useful in solving the energy crisis?

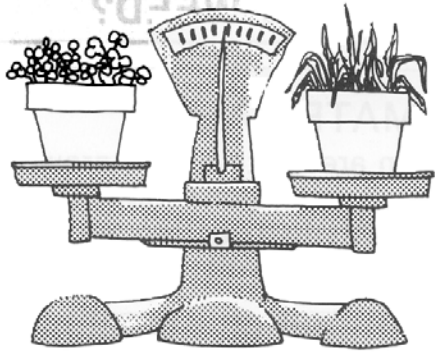
What normally is done with the weeds in your area? What are new uses of weeds grown in your area?

OTHER IDEAS TO EXPLORE:

Try this experiment using one square meter of cultivated growth like clover, barley, or grass.

How do the weed and cultivated growth compare?

How much biomass could be produced in an acre of weeds? In an acre of cultivated crops?



Try cultivating the weed. Does it grow better with additional fertilizer and water?

Try growing the weed with a hydroponic solution. (See Activity 4.)

What is the difference between a weed and a cultivated crop?

Which plants, wild or cultivated, do you think might survive best under unfavorable conditions like lack of rain, poor soil, or disease?

HOW LONG WILL GAS BURN THAT IS PRODUCED BY HEATING 10 GRAMS OF WOOD IN THE ABSENCE OF AIR?

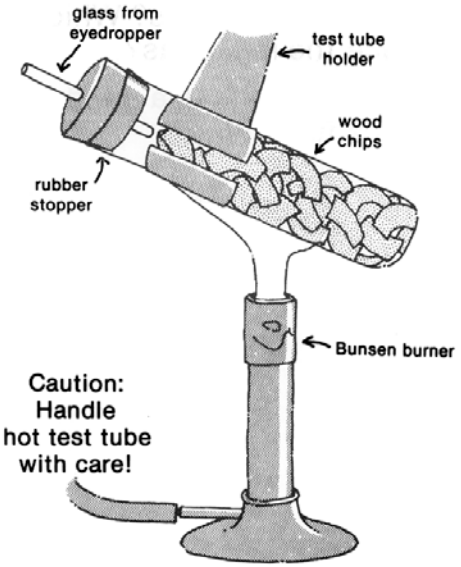
6

MATERIALS:

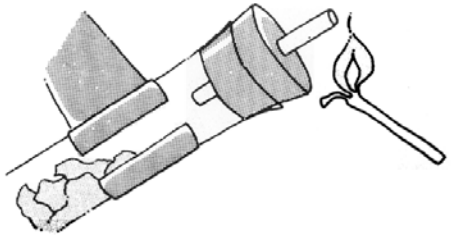
Wood splints or pencil shavings
Large pyrex test tube with 1-hole rubber stopper
Glass eyedropper; balance scale; tape
Teacher's Discretion → Matches; Bunsen burner
Clock; test tube holder

Weigh 10 grams of wood splints and place in the test tube. Add the rubber stopper and the glass from the eyedropper.

Move the test tube through the flame. Heat the wood until you see gas escaping from the test tube.

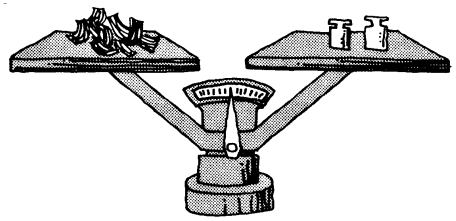


Caution: Handle hot test tube with care!



Summary question:

Light the gas while you continue to heat the wood. How long does it burn?

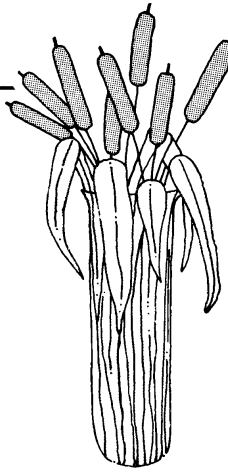


Weigh what remains in the test tube.

Has all the fuel value of the wood been used up in this process?

How can you find out?

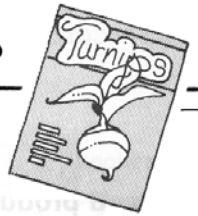
OTHER IDEAS TO EXPLORE:



What other substances could be used to make burnable gas? Which would produce the most gas?

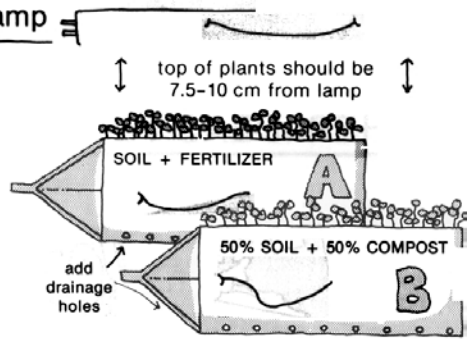
Do you think this is a good way to produce fuel? Why?

WHICH GROWS TURNIPS BETTER: COMPOST AND SOIL OR FERTILIZER AND SOIL?



MATERIALS:

2 Half-gallon milk cartons
Meter stick; balance scale
Chemical fertilizer, 10-10-10 (or equivalent)
Compost (garden centers or make your own!)
Turnip seeds
Grow-type fluorescent lamp



Plant 40 seeds in each container. Keep moist.

Select the 10 best seedlings in each container and pull the others out.

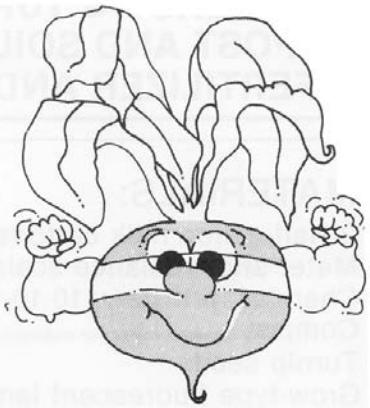
		A			B		
		Height	No. of leaves	Leaf size	Height	No. of leaves	Leaf size
week	1st						
	2nd						
	3rd						
	4th						
composite weight	fresh weight						
	dry weight						

Measure the growth of the turnips weekly after the seedlings appear. Count the number of leaves and measure the size of the largest leaf.

After 4 weeks pull the turnip plants. Wash off any dirt and dry with a paper towel.

Measure and record their weight.

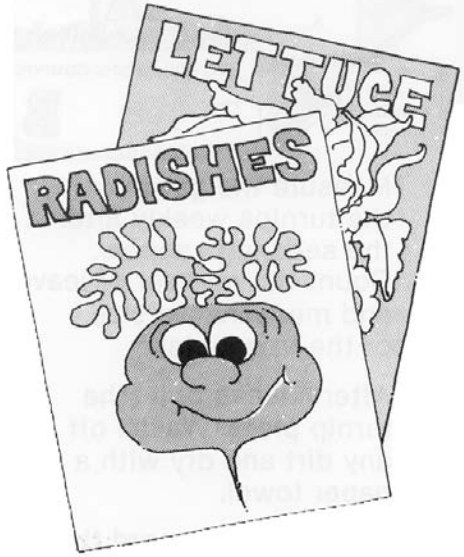
Dry the plants in the sun until they are crisp. Weigh and record.



Summary question:

Which method produces more biomass?

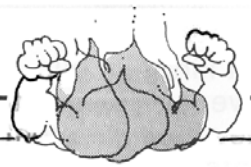
OTHER IDEAS TO EXPLORE:



Would you get the sam results with lettuce or radishes?

WHICH HAS MORE HEAT ENERGY: VEGETABLE OIL OR PETROLEUM OIL?

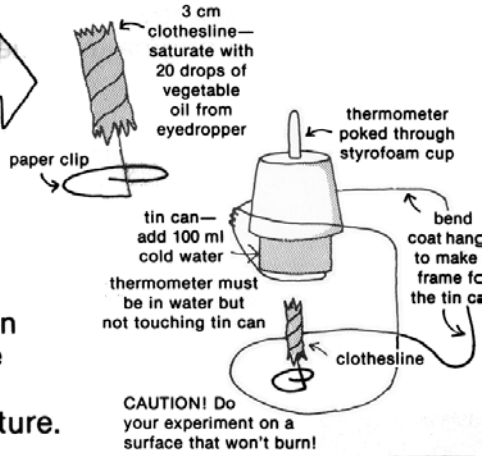
8



MATERIALS:

Vegetable oil; #20 or #30 automobile oil
2 Pieces cotton clothesline, 3 cm each
Glass eyedropper; thermometer
Teacher's Discretion
Matches; tin can; paper clips; metric measuring cup
Styrofoam cup; wire coat hanger or ring stand

Prepare your experiment like this.



Which do you guess has more heat energy?

Measure the temperature of the cold water and record. Light the oil on the clothesline and let the oil burn completely. Record the water temperature.

Run the experiment again using automobile oil. Record the water temperature and compare results.

oil tested	temperature of cold water	temperature after burning	difference in temperatures
VEGETABLE OIL			
AUTOMOBILE OIL			

Summary question:

Would vegetable oil be a good substitute for petroleum oil as fuel? Why?

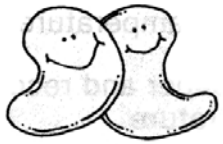
OTHER IDEAS TO EXPLORE:

Try different kinds of oils (peanut, olive, safflower, etc.) to see if they have different heat contents.

Is there a difference in the heat content of solid animal fats (such as lard) and vegetable oil?

Where does the energy stored in the oils originally come from?

WHICH HAS MORE HEAT ENERGY: PEANUTS OR PAPER?

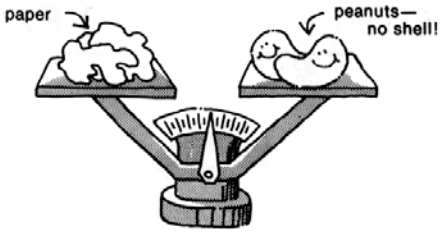


9

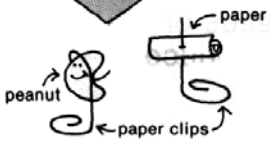
MATERIALS:

Peanuts; paper; paper clips
Tin can; styrofoam cup; metric measuring cup
Wire coat hanger or ring stand; matches (Teacher's Discretion)
Balance scale; thermometer

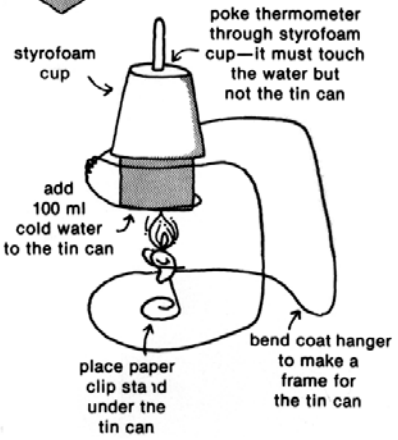
Weigh equal amounts of peanuts and paper.



Attach paper clip stands to each.



Set up your experiment like this.



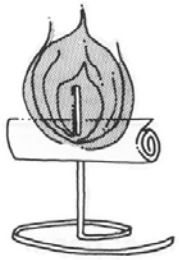
Read and record the temperature of the cold water.

energy source	temperature of cold water	temperature after burning	difference in temperature

Burn the peanut, then record the temperature again.

Refill the can with 100 ml cold water. Record the temperature.

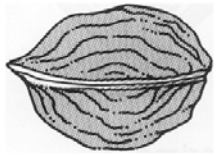
Burn the paper and record the temperature.



Summary questions:

How do you explain the results you obtain? Do you think your results would be exactly the same if you did the experiment again?

OTHER IDEAS TO EXPLORE:



Would a walnut produce more or less heat than a peanut?

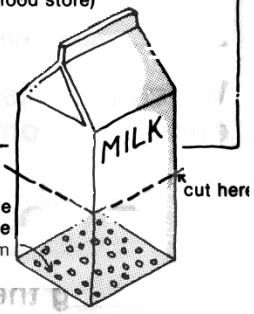
Would sesame seeds or sunflower seeds produce more or less heat than a peanut?

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

10

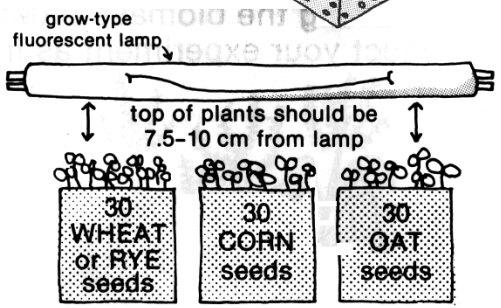
MATERIALS:

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 12.

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?

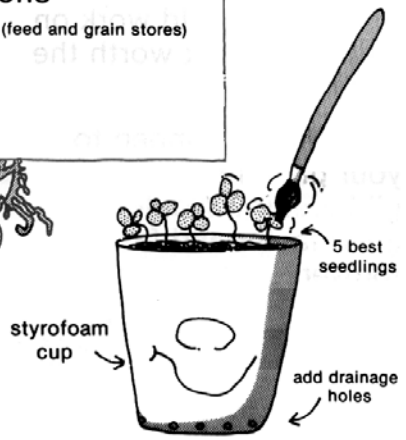
HOW MUCH CAN GIBBERELLIN INCREASE THE BIOMASS PRODUCED BY BARLEY?

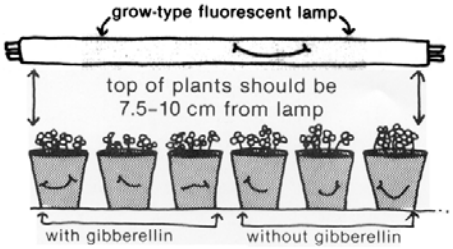
11

MATERIALS:

Gibberellin (garden centers; feed and grain stores)
Styrofoam cups or milk cartons
Barley seed or tomato seed (feed and grain stores)
Potting soil; balance scale
Grow-type fluorescent lamp
Small paint brush

Plant 8–10 seeds in each cup.
Keep moist.
When each plant has 3 leaves, thin to 5 plants per cup.





Paint gibberellin on the leaves and stems of half the plants once only
Keep the plants moist.

After 14 days pull the plants.
Wash the soil from the roots and dry with a paper towel. Weigh the plants and record.
Dry the plants in the sun until crisp and weigh again.

treatment		fresh weight	dry weight
	with gibberellin		
	without gibberellin		

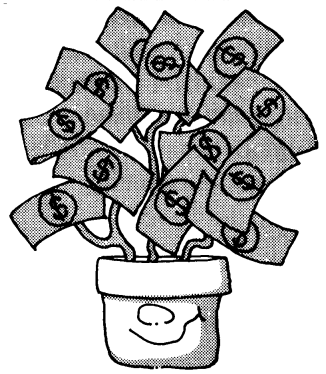
Summary question:

How can you be sure that the results you obtained in this experiment are correct?

OTHER IDEAS TO EXPLORE:

Do you think this chemical treatment would work on all plants? Is it worth the expense?

What might happen to your plants if you use more gibberellin? Would they grow faster and faster forever?



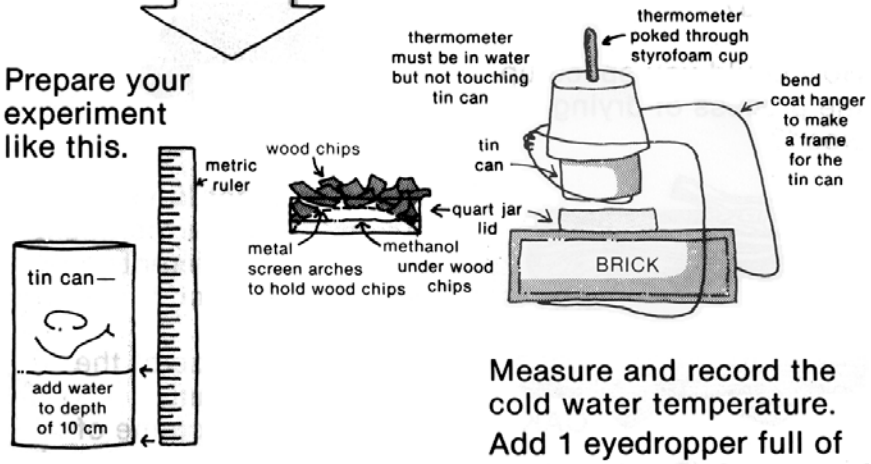
WHICH WILL GIVE MORE HEAT ENERGY: GREEN OR DRY WOOD?

12

MATERIALS:

Green and dry wood shavings (same variety)
Methanol (hardware or paint stores)
Large tin can; metric ruler; balance scale
Teacher's Discretion → Matches; thermometer; small piece metal screen
Quart jar lid (remove paper liner); styrofoam cup
Brick; eyedropper; metal coat hanger

Prepare your experiment like this.



	temperature of cold water	temperature after heating	difference in temperatures
DRY WOOD			
GREEN WOOD			

Measure and record the cold water temperature.

Add 1 eyedropper full of methanol and 10 grams of dry wood chips to the jar lid and ignite.

Measure and record the water temperature after burning.

Repeat using green wood and fresh water.

Summary questions:

How do you account for the results you obtain?

How do you make dry wood from green wood?

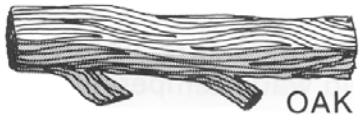
OTHER IDEAS TO EXPLORE:

Is green wood at one-half the price of dry wood a good buy for your fireplace?

How long does it take to change green wood to dry firewood?

How could you speed up the process of drying wood?


ASH


OAK


CEDAR

Would you get the same results in your experiment if you used different varieties of wood?

Measure the size of the can you used and calculate the volume of water heated by the wood. How many calories of heat are produced by burning 10 grams of wood?

$$\text{Volume} = \frac{3.14 \times \text{diameter of can}^2}{4}$$

$$\text{Calories} = \text{Volume} \times \text{change in temp.}$$