THE PAPER FACTORY

Activity 1

Papermaking

Inquiries

- How is recycled paper made?
- How can energy be saved by using recycled paper?
- How can we identify energy saved when using recycled materials in a production process?

Content Domain

Math – Arithmetic (problem solving)

Science – General and physical science

Learning Outcomes

Math, Grade 4, #4, #5, #8, #24

Science, Grade 4, #1, #4, #6, #14

Duration

Part A: 45-60 minutes

Part B: 45-60 minutes

Materials

Part A: Blender, base paper (newspaper, colored construction, colored tissue, toilet tissue), warm water, two large bowls, candy molds, wire strainer, dish pans, screens (see instructions), **whisk, newspaper, tablespoons, 2-cup measure, Argo powdered laundry starch, yarn, potpourri**

Part B: Paint, glitter, yarn, markers, doilies, ribbon and **assorted materials for decoration**

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Objectives

Students will be able to: (a) identify the resources needed to produce a paper product and describe alternative resources that can be used to produce paper; (b) explain the role of energy in a production process; (c) make deductions about the effectiveness of recycling in saving money and energy; and (d) analyze the costs and benefits of alternative consumer choices.

Preparation

Part A: Gather materials. Read over instructions and papermaking tips on the handout, *How to Make Paper.* Cover work area with newspaper.

Part B: This needs to be done after the paper products have dried, approximately two days after papermaking. Gather materials. Cover tables for each group. Make an overhead of the handout, *Papermaking Cost-Analysis Sheet.*

Procedure

PART A

1. Explain how recycling paper requires a physical change, first by tearing and then by liquefying. Compare the physical change that paper goes through with other physical changes, like melting and freezing. Explain that each student will be a member of a group that will make paper products.

2. Divide students into five groups. Each group will have a different base and group procedure (see the teacher handout, *Papermaking Groups*). Make sure that at least one group has a base that is labeled "natural resource" (this correlates to using trees to make paper) and at least one group uses a base that is a "recycled resource."

3. Give each group their base material and have them shred their material until they have two cups.

NOTE: During papermaking it is usually easier if one group at a time works on making paper. The other groups can complete Activity 2, *What Sort of Trash is This Anyway?*

4. Have groups follow the directions on the handout, *How to Make Paper.* They will make a paper pulp using either a whisk or blender.

NOTE: Groups using the whisk may want to soak their paper in warm water.

5. Students may add items to their pulp as directed on their group sheet.

6. Students will then use their pulp to make paper. Each group should use all of their pulp to make as many paper products as they can. This is important when they do the comparisons in Part B.

7 Each group should save all of their waste products. Place them in a corner of the room labeled with their group number or give each group a bag.

PART B

1 Put students into their papermaking groups and have them gather their group's products and waste bag.

2 Allow students to decorate their paper products. Advise them that there will be a cost for decorations and that they need to keep track of what they use.

3 After students finish decorating their products, have them complete the handout, *Papermaking Cost-Analysis Sheet.* Each item students used during the papermaking process will have money and energy related to its use. These money and energy costs can be found on the handout, *Materials Cost Sheet.* Using an overhead of the handout, *Papermaking Cost-Analysis Sheet,* do an example for the class that includes some items from each cost category and show students how to record and add costs. When working on the example (on the overhead), compare costs of recycled and natural base materials to show how values for natural resources and recycled resources differ.

4 Have groups complete the handout, *Papermaking Cost-Analysis Sheet,* including all costs related to their products. Each group will need a copy of the handout, *Materials Cost Sheet,* to determine their costs. When the groups have listed all their costs, have them add the figures to find their total energy and total money costs. Then the groups will add their money and energy totals to calculate their total cost. They will list the number of products they made. Then have them divide to find the cost of each paper product. They may round and use estimation, if needed.

5 Have groups answer the last two questions on the handout, *Papermaking Cost-Analysis Sheet.*

6 Have each group report to the class the number of products they made, their total cost and the cost per product.

7 As a class, discuss the reports. Compare costs and products. As a class, answer the last two questions on the handout, *Papermaking Cost-Analysis Sheet.*

Questions for Discussion

- How did the groups using natural resource material compare to the recycled resource groups?
- How did their money total and energy total compare?
- Did using recycled materials save money and energy?
- Which group could make the most profit and how?
- Which product would seem the best?
- If natural resources have a value of one, could we make the statement that recycled materials save energy and resources?

Assessment

Assessment of this activity can be done in a variety of ways. Embedded assessment is provided with the student-produced paper product and student explanation of resources needed to produce a paper product.

By using the handout, *Steps in the Papermaking Process*, students can demonstrate their knowledge of the papermaking process.

ANSWERS to *Steps in the Papermaking Process:*

Handouts

Part A:

- *Papermaking Groups*
- *How to Make Paper*
- *Recycled Paper Jewelry*

Part B:

- *Papermaking Cost-Analysis Sheet*
- *Materials Cost Sheet*
- *Steps in the Papermaking Process*

(1) Bales of paper enter mill.
(2) Paper is shredded.
(3) Paper is mixed with water in a digester/hydropulper.
(4) Paper is poured onto a screen.
(5) Paper is dried and rolled.
(6) Paper is made into new products.

You may also ask students the question: Knowing what you do about the costs of producing a paper product, what changes will you make to increase productivity and reduce material costs for your final project? Evaluate their answers using a class-created rubric.

Extension

Have students graph information from the handout, *Papermaking Cost-Analysis Sheet.*

PAPERMAKING GROUPS

Group #1

Base ----------newspaper (recycled resource)
Tools ----------blender
Method ----------pour
Shaping----------screens
Additives ----------colored tissue, potpourri

Group #2

Base ----------colored scrap construction paper (recycled resource), combine colors (only slightly blended paper will show flecks)

Method ----------pour
Shaping----------screens
Additives ----------none

Group #3

Base ----------colored tissue paper (represents natural resource because it has not served another use)
Tools ----------whisk
Method ----------pour
Shaping----------screens
Additives ----------potpourri

Group #4

Base ----------toilet paper (natural resource)
Tools ----------whisk
Method ----------pour
Shaping----------screens
Additives ----------string, dryer lint, yarn, feathers

Group #5 (Follow instructions on the handout, Recycled Paper Jewelry)

Base ----------newspaper
Tools ----------blender
Method ----------hand filling
Shaping----------candy molds
Additives ----------starch

Student Handout

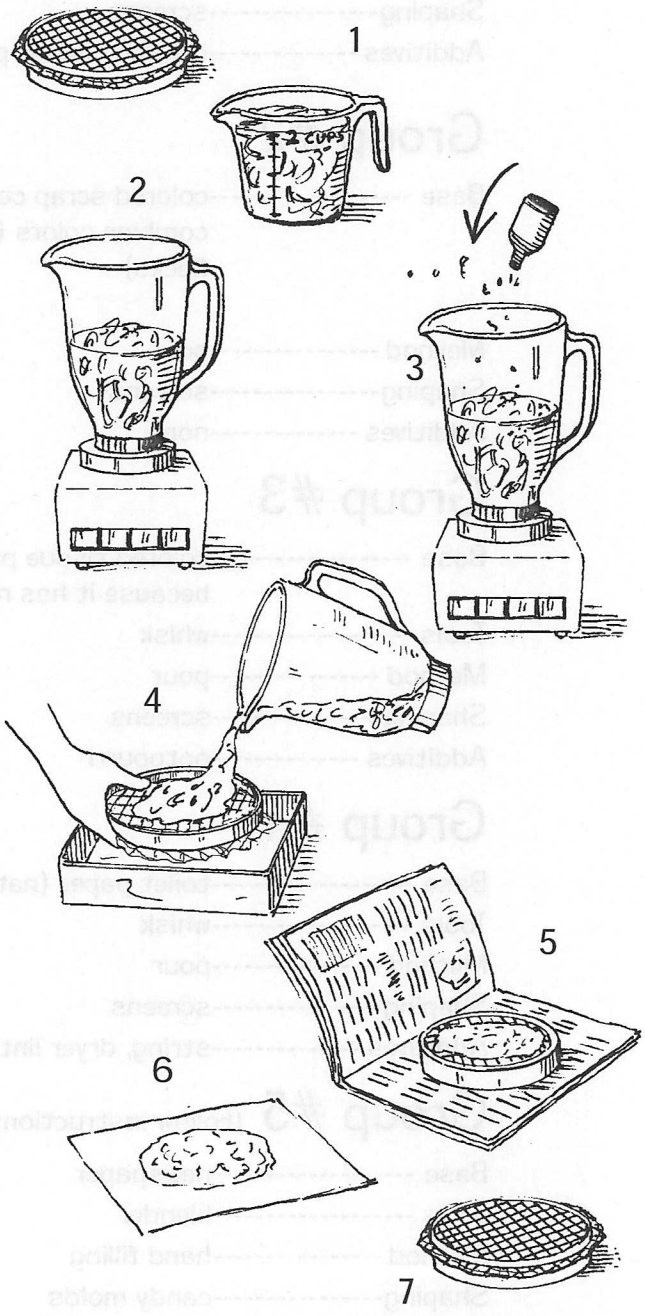
HOW TO MAKE PAPER

MATERIALS

base paper
warm water
2 large bowls
wire strainer
dish pans
screens (see instructions)
whisk
blender
plastic canvas
newspaper
2-cup measure
colored tissue
string, yarn, feathers, lint

INSTRUCTIONS FOR MAKING SCREENS:

Use wooden or plastic embroidery hoops. Cut polyester window screening to fit the hoops, leaving excess so the screens can be tightened if they loosen up. Cut plastic canvas to fit the opening in the hoop.



1. Tear the base paper into small pieces measuring about 2 cups.

2. TOOLS:
   - If using a whisk, put paper and 3 cups of warm water into a bowl. Let soak for at least 20 minutes. Stir with whisk.
   - If using a blender, fill blender half full of warm water. Add 2 cups of paper. Blend until the consistency of oatmeal.

3. ADDITIVES: If your group has an additive put it into the blender or bowl at this time. Additives add color, texture and smell.

4. SHAPING: You will be pouring your paper pulp onto screens. Make sure to do this over the dishpans so they will catch the extra water. Pour enough pulp onto the inside of your hoop to cover the screening. Take the piece of plastic canvas and press onto the pulp to remove the excess water.

5. With the excess water removed from the pulp, place the hoop, with the canvas still in it, onto a section of newspaper. Use the newspaper to blot the extra moisture out of your recycled paper. You are ready to take out your paper when you blot and no water comes out.

6. Take out the plastic canvas and turn the hoop over onto a scrap piece of paper. Tap on the back of the screening. If the paper doesn't come out, take the hoop apart. Leave the recycled paper on the piece of scrap paper to dry.

7. Put the hoop back together to make your next sheet of paper.

NOTE: Collect leftover pulp in a strainer. DO NOT POUR PULP DOWN A SINK DRAIN - it might block it.

Student Handout

RECYCLED PAPER JEWELRY

MATERIALS

blender
2 cups shredded paper
warm water
2 tbs. Argo laundry powder starch
candy or cookie molds
dishpans
pin backs
jewelry glue
acrylic paint
matte spray finish
2 mesh screens or metal strainers

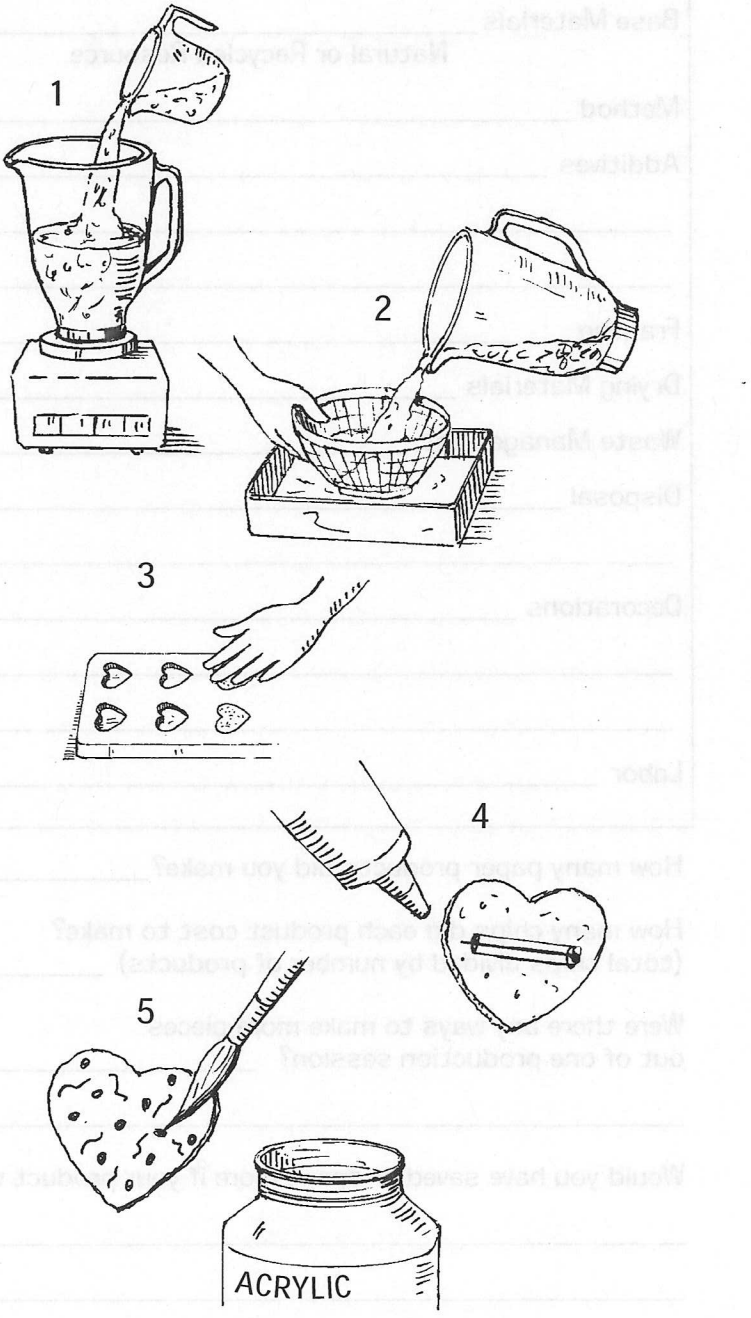
1. Fill blender half full of warm water. Add 2 cups of shredded paper to warm water and 2 tablespoons of Argo laundry powder starch. Blend well.This mixture should be thick but still pourable.

2. Pour mixture onto screen or into strainer over dishpan (to catch excess water). Take the other mesh screen and put it on top of the paper mixture and squeeze together to remove excess water. If using strainer, mix with hands until most of the water is out of the mixture.

3. Firmly press paper mixture into candy or cookie molds. Make sure the paper does not hang over the edge of the mold. Let molds dry for one to two days. The paper jewelry will easily come out of molds when completely dry.

4. When jewelry is dry, use glue to adhere pin back.

5. Paint your jewelry using an acrylic paint. After the paint has dried, spray your finished pin with a matte spray finish.



NOTE: Collect leftover pulp in a strainer. DO NOT POUR PULP DOWN A SINK DRAIN - it might block it.

Student Handout

PAPERMAKING COST-ANALYSIS SHEET

Name of company _____

Product produced _____

Students in company _____

SUPPLIES

Base Materials _____
Natural or Recycled Resource

Method _____

Additives _____

_____

_____

Framing _____

Drying Materials _____

Waste Management _____

Disposal _____

_____

Decorations _____

_____

_____

Labor _____

NUMBER OF CHIPS

Money	Energy
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
Total money	Total energy

_____
Total chips
(total money + total energy = total chips)

How many paper products did you make? _____

How many chips did each product cost to make?
(total chips divided by number of products) _____

Were there any ways to make more pieces
out of one production session? _____

_____

Would you have saved or spent more if your product was made from recycled materials? _____

_____

_____

Student Handout

MATERIALS COST SHEET

	MONEY	ENERGY
BASE MATERIALS		
Newspaper (recycled)	2	2
Toilet paper (natural)	3	3
Scrap construction paper (recycled)	2	2
Tissue paper (natural)	4	3
Water	1	1
METHOD		
Blender	4	3
Whisk	1	3
ADDITIVES		
Colored tissue	4	3
Potpourri	3	2
Argo starch	3	3
String	1	1
Yarn	1	1
Feathers	1	1
FRAMING		
Screens	3	3
Molds	3	3

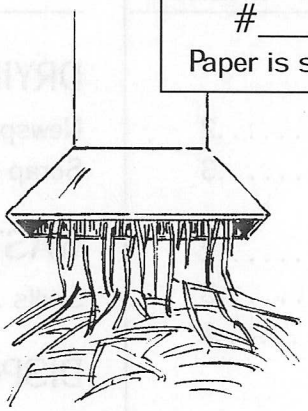
	MONEY	ENERGY
DRYING MATERIALS		
Newspaper	2	2
Scrap paper	2	2
WASTE MANAGEMENT		
Spills	2	2
DISPOSAL		
Waste newspaper	2	2
Waste water	2	4
Base paper	5	5
DECORATIONS		
Paint	5	3
Ribbon	3	3
Glitter	3	5
Glue	3	3
Doilies	3	3
LABOR		
One Worker	2	2

Student Handout

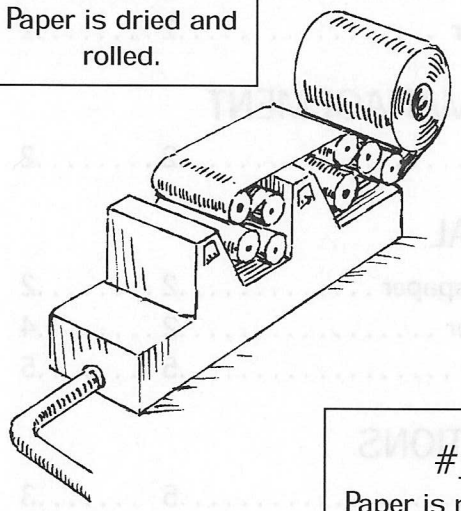
STEPS IN THE PAPERMAKING PROCESS

Directions: Put the papermaking process in the right order by numbering the pictures from 1 to 6.

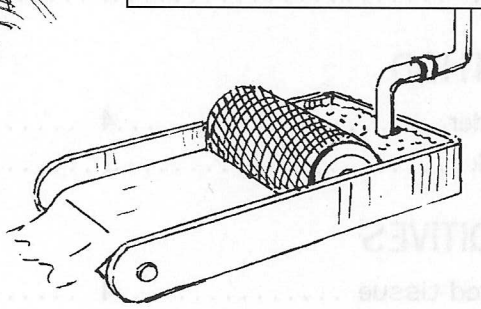
#_____
Paper is shredded.



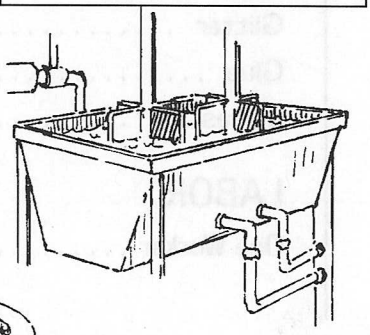
#_____
Paper is dried and rolled.



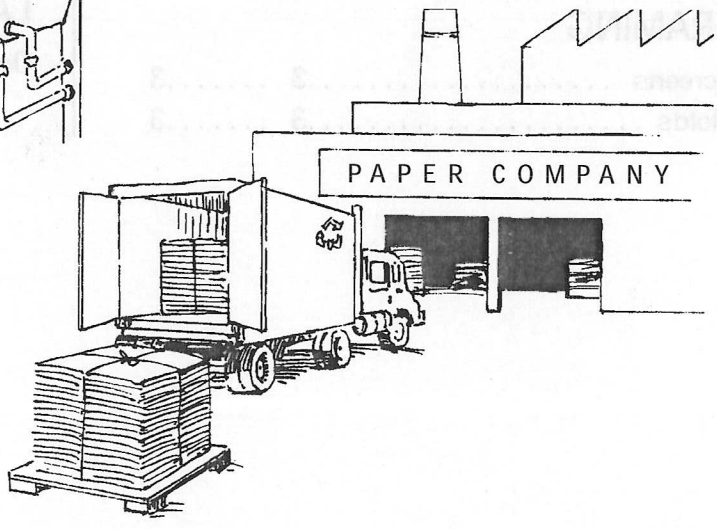
#_____
Paper is poured onto a screen.



#_____
Paper is mixed with water in a digester/hydropulper.



#_____
Bales of paper enter mill.



#_____
Paper is made into new products.