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ABSTRACT

This guide, one component of the Resource Recovery Education Kit (See SO 007 866 for a description), contains ideas and activities for teaching about solid waste disposal in secondary level industrial arts classes. Among the course objectives are the following: (1) to understand that litter represents a small but highly visible portion of our municipal solid waste load; (2) to be aware of what happens to trash after it is hauled away; (3) to learn about improved methods for reducing waste volume and disposing of the residue; (4) to understand that through resource recovery we can utilize materials from solid waste. Teaching strategies include studies of the local community and having students prepare models, charts, diagrams, exhibits for local displays, research, and classroom discussion. The guide consists of five major study units: (1) Solid Waste: A Growing Problem; (2) Collection and Transportation; (3) Disposal; (4) Resource Recovery; and (5) Solid Waste Management Systems. Objectives, student activities, questions for discussion and research, basic understandings to be developed, and instructional resources are provided for each unit. A special projects section provides visual and print instructions for constructing a can crusher, a paper recycling system, a glass bottle cutter, and a magnetic separator. (Author/RM)

Teaching resource recovery in INDUSTRIAL ARTS

RESOURCE RECOVERY EDUCATION PROGRAM

National Association of Secondary School Principals
1904 Association Drive, Reston, Virginia 22091

National Center for Resource Recovery, Inc.
1211 Connecticut Avenue, N. W Washington, D. C. 20036

I. SOLID WASTE: A GROWING PROBLEM

A. OBJECTIVE

5. To understand that litter, which occurs outside the solid waste collection system, represents a small but highly visible portion of our municipal solid waste load.

B. STUDENT ACTIVITIES

1. Think of ways in which your industrial arts class can sponsor an antilitter campaign in your school or town. In planning such a positive action program, the essential first step is to evaluate the extent of the litter problem you are about to attack.

With your students, make a walking-tour survey of present litter conditions in your school building, playground, and neighborhood. The information gleaned from the tour should be summarized, and priorities should be assigned to those areas where the problem seems worst. A floor plan of the school and a map of the vicinity make effective visual aids for marking the key littering spots and for planning and carrying through the clean-up campaign.

2. Once you have sized up the problem, your next step is to get people involved. Are there civic clubs interested in conducting an antilitter project? If so, perhaps one group could run a slogan contest. Since many copies of the winning slogan will be needed in the campaign, students could design some appropriate posters and screen-print them.

3. Sponsor a contest among students for the design of a symbol or cartoon figure to represent a litterer, just as Smokey Bear represents conservation. The character or emblem should be made from paper litter picked up in school. To make a three-dimensional design, wet paper and paste should be applied over a clay model or a wire frame. When the mold is dry, the surface should be shellacked. Use the symbol in your litter drive.

4. Encourage students to undertake other found-art projects that creatively communicate an antilitter message. Some suggested ideas are: can sculptures (using acrylic paints); assemblages made of various pieces of litter or waste packing materials; mosaics and mobiles utilizing old coat hangers, cans, or wrappers; and a life-size litter monster consisting of junk parts.

5. Include photography as part of the visual display for your antilitter education campaign. There are many ways of using pictures, including prints, enlargements, slides, and even movies. In taking pictures, a student might construct an attachment for his camera to permit shooting at right angles so that subjects will be caught in candid poses. A small mirror set at 45 degrees to the lens would do it.

Before the student decides how to organize his presentation, he should show the pictures to a small group of classmates, friends, or family and ask which ones carry the strongest message. (Editing pictures is as much of a problem as editing stories for the school newspaper, and the process really requires an objective second party.) The student then arranges the best photographs in a storytelling sequence and writes the necessary titles and captions. He can now design a display that arouses maximum public awareness.

6. Since litter is costly as well as ugly, have your class spend an hour collecting trash in school or on the school grounds. Construct a wooden box (possibly a frame with wire mesh or glass sides) to display the collected litter. As an antilitter alert, add a plaque that tells how much litter was collected, how many students were required to gather it, and how much its removal would have cost the community's sanitation department had it performed the service. The last item can be calculated by multiplying student man-hours by the hourly wage rate of local street-cleaning employees.

7. In the constant battle against litter, the design of trash receptacles is a major problem. City officials across the country are still looking for the ideal trash basket for sidewalks and street corners. Similarly, park and highway authorities continue to search for the best litter receptacles for camping and highway debris. Baskets made of wire mesh are inexpensive, but they are constantly being damaged or stolen. Concrete containers are both vandalproof and theftproof, but they cost much more than lightweight containers.

Have your industrial arts class design and develop several different durable and attractive trash boxes for streets and public places. Students should keep in mind function, cost, eye appeal, and ease of maintenance and servicing. Public service messages can be included on each side of the receptacle to help increase deposits in the new containers.

Set up a contest in which faculty or students rate the trash boxes on attractiveness of design, durability, and ease of servicing and maintaining.

8. Have your students design litterbags or litterboxes for cars. A litterbag can easily be made from a piece of cloth 11" × 28". Make a hem of 1" or 1½" and then sew up the sides and one end. Add one or two handles to attach to a dashboard knob or window winder.

A litterbox can be made from a half-gallon milk carton. Cut off the top, fold down the flaps, and attach a loop of string or yarn for the handle.

Use other boxes, materials, and designs to create interesting "litter-gobblers."

9. Students may make antilittering signs for parks and overnight camping areas. The signs should be attractive and completely weatherproof so that they don't become litter themselves.

C. QUESTIONS FOR DISCUSSION AND RESEARCH

1. What is litter? Where does it come from, and why is it a problem?
2. Have any effective methods been devised for eliminating litter? How do they work?
3. Why does the threat of severe penalty not seem to work?
4. Are there any signs of litter in your school? In your industrial arts laboratory? How do you account for this? If there is litter, how can it be prevented?
5. What are some mechanical means of curbing and controlling litter? How does a mechanical street cleaner operate?

D. BASIC UNDERSTANDINGS TO BE DEVELOPED

1. Litter consists of materials discarded in the wrong place. It is the trash and debris heedlessly deposited on streets, highways, and waterways by pedestrians, motorists, and boaters. Litter contains many of the things that are found in solid waste; they have simply escaped the normal collection process. These materials are unsightly and, unlike most solid wastes, highly visible.

Litter is less a threat to the environment than a national disgrace. It is unsightly, annoying, and avoidable. Almost all of us are involved. Thoughtless and lazy people discard their trash without regard for others.

2. Nearly all of us, at one time or another, have been litterbugs. But if we can change attitudes—our own first, then those of others—we can solve the litter problem and begin to meet the pollution challenge. This is how the problem must be solved.

3. Most antilitter groups, such as the nationally active organization Keep America Beautiful, Inc., agree that there are three basic ways to reduce litter. KAB's programs concentrate on three *E*'s—Education, Equipment, and Enforcement.

Public education programs alert people to the harm of littering. It is bad manners, bad economics, bad for the environment, and bad for the people who must look at and live with other people's discarded rubbish.

Proper equipment is also important. There must be enough conveniently located litter receptacles. Today, new kinds of equipment with names like "Whirlwind," "Litter Hawk," "Billy Goat," "Litter Gulper," and "Can Gobbler" are helping to dispose of the thousands of tons of litter discarded by Americans annually. Some of these machines are self-propelled; others work like vacuum cleaners. A total of 17 types of modern equipment are described in the booklet "Guide to Mechanical Litter Removal Equipment," produced and distributed by KAB.

Equally urgent is enforcement of the antilittering laws. For these laws to be strictly enforced, the penalties must be severe enough to discourage a potential litterer but not so severe that communities will be reluctant to impose them.

E. INSTRUCTIONAL RESOURCES

1. Read Topic I on solid waste in the section "A Survey of Resource Recovery" in the students' booklet.
2. Read the publication "Guide to Mechanical Litter Removal Equipment," listed in Instructional Resources.
3. Read the pamphlet "Litter Laws," listed in Instructional Resources.

II. COLLECTION AND TRANSPORTATION

A. OBJECTIVES

1. To be aware of how trash and garbage are handled after they have been left to be hauled away. To know how they are conveyed and what becomes of them.
4. To examine recent technological and managerial developments that make it possible to reduce the problems and costs of refuse collection.

B. STUDENT ACTIVITIES

1. Design a can crusher for household use. Make certain that it is portable, compact, and safe to operate. Consider various possibilities for powering the crusher. Make the necessary drawings for specifications and design. Then build a prototype, test it, and make any needed improvements. (See the Project Section.)
2. Holding a bag while filling it with leaves or grass is hard work for one person. Design and construct a portable bag holder. The bag should be held open for filling and the holder should be easily maneuverable—perhaps set on wheels.
3. You can perform a valuable service to families in your community by informing them of the dangers of handling solid waste improperly. Print a card or pamphlet listing the recommended safety

steps for preventing accidents and sickness resulting from careless waste disposal. Then conduct a door-to-door distribution of the copies.

4. Many communities have found that one way to boost the morale of sanitation workers is to make sure they are dressed as well as policemen and firemen. Design a functional but good-looking sanitation employee uniform (from hat to boots) for cold and warm weather. The uniform should be dirt-resistant and easily repairable.

5. Let's assume that your community needs a mechanical system of solid waste collection. The problem is to choose the right system. Since collection requirements are different from region to region (and sometimes from community to community), analyze the requirements of your community or area and then figure out the best system for meeting them. For example, should the new system accommodate all types of solid waste? Will worn-out appliances and weekend yard clippings be included in the same pickup? Does your system call for combined garbage and trash collection or for separate pickup of each type of refuse? Also, how should the waste be containerized, and what type of vehicle should transport it to the disposal site? Trucks? Continuous conveyors? Pneumatic tubes?

After selecting the means of collection, plan a routing to show how homes, schools, and factories might be connected to a central recovery and disposal center. Make a wall-chart diagram to illustrate your idea.

6. An important improvement in collection has been made through the design of better collection vehicles. A dramatic departure from the standard compactor truck is the articulated "mechanical arm" for curbside and alley pickup. Such vehicles are already in use in Scottsdale, Arizona, and Bellaire, Texas. Since one man can drive the truck and also operate the arm, labor costs for the use of these vehicles are sharply reduced.

Old-style collection trucks, being large and unwieldy, often have difficulty getting into narrow alleys and onto unpaved roads. In winter, garbage trucks often get stuck in alleys and damage backyard fences. Would a small, easily maneuvered truck be part of the solution to this problem? If so, should it be electrically driven, with a mechanical arm for reaching over car hoods and fences? Make sketches of several types of small trucks and construct a scale model of the one best suited to your town's requirements.

7. Perhaps the most ambitious new method for improving the mechanics of solid waste collection is a variation of the old pneumatic tube that once shuttled money and receipts around department stores. Sweden pioneered the concept of using large tubes to collect wastes by vacuum suction. One such system is in operation at Disney World in Florida.

Draw up a plan for the installation of a pneumatic-tube waste-collection system in your community. Study a street map of your town or city and determine the best layout of pipelines to a central recovery center. Illustrate the system on an overlay of acetate or tracing paper, or with an actual scale model. Where should the vacuum pumps be located? Should the pipelines service the entire community or only commercial and industrial sections?

8. After completing your plan for a pneumatic-tube system, set up a demonstration apparatus using a mailing tube and a fan. Is this model able to move dust and paper clippings? How can the vacuum be measured? If vacuum removal of waste is possible, what air pressure is required to make the system work efficiently?

C. QUESTIONS FOR DISCUSSION AND RESEARCH

1. What different systems of solid waste collection are presently in use in this country and elsewhere? What are the major differences in the various systems? Can any of these systems be considered automatic?

2. Are there better ways of collecting and transporting municipal waste in your community than those presently in use? If so, identify several of these ways and explain the advantage of each.

3. Would trash collection in your community be more efficient if large containers were provided for single-family residences and then serviced mechanically?

4. How can the problem of storing municipal refuse preparatory to collection be handled best in your community?

5. What problems are caused by the use of poor systems for transporting municipal waste?

6. Could a water pipeline like that used in a sanitary sewer be used for the transporting of solid wastes? Investigate the pumping system used in gasoline and oil pipelines to see whether such a system might be used for waste collection.

7. What are some hazards involved in handling trash at home and on the job?

8. By how much does compacting reduce the volume of solid waste?

9. What is the function of transfer stations in waste collection?

10. How might computers be used in a collection and transportation system to increase efficiency and cut costs? How might they have helped in any of your designs for waste collection?

D. BASIC UNDERSTANDINGS TO BE DEVELOPED

1. The collection of municipal waste has become a major national industry, in both cost and size. And the problems related to collection are getting bigger each year. Our nation spends close to $4 billion a year for waste collection alone. And even though collection accounts for 85 percent of all waste management costs, it remains the least developed aspect of the solid waste challenge. Solid waste disposal may be the greatest pollution problem, but collection is by far the biggest financial problem in waste management.

2. In the majority of American communities, trash is still collected by the old-fashioned and costly truck-and-workers method. Although most towns and cities have so far made little use of new collection methods, enough proven technology already exists to revolutionize trash collection. Although using this technology to best advantage requires considerable capital investment, these improvements in collection can pay for themselves, as a few forward-looking cities are proving.

3. Several new technological systems offer special improvements in collection. The best of these appear to be the totally automated collection truck system, the vacuum-tube system, and the transfer-station system. One collection system includes compactor trucks that grind, crush, or chop refuse as it is loaded, increasing the vehicle's hauling capacity and reducing the number of trips required. Another compactor truck innovation incorporates a mechanical arm that is operated by the driver from the cab of the truck. This system offers major savings in both collection time and employees' wages.

One of the more promising recent advancements in waste collection has been the vacuum pipeline. Pioneered in Sweden, this system has been installed in apartment buildings, hospitals, and amusement parks to whisk away trash and garbage to remote collection and transfer sites.

In many areas throughout the country, dumps have been outlawed or filled up, and incinerators and open burning have been ruled illegal. Thus communities have had to find new ways of getting large amounts of solid waste to distant sites. Because it is impractical to have a collection truck do long-distance hauling, the answer for many of these cities has been to establish transfer stations. In a transfer station some form of compaction device is used to reduce the volume of the waste. The load is then put on a larger vehicle, such as a huge trailer truck, for transport to the disposal site (usually a sanitary landfill or an incinerator).

4. Antiquated collection methods add to the problems of protecting public health and preventing fire and rodent damage and air and water pollution. Another problem is the need for safety standards for collection workers. Garbage collection is one of the most hazardous occupations in America today—nine times more dangerous than the average industrial job.

E. INSTRUCTIONAL RESOURCES

1. Read Topic II on collection and transportation in the section "A Survey of Resource Recovery" in the students' booklet.
2. Refer to the publication "Refuse Collection Practice," listed in Instructional Resources.
3. Read the article "Whisking the Garbage," listed in Instructional Resources.
4. View and discuss the film "In the Bag," listed under Audiovisual Materials.
View and discuss the film "The Green Box," listed under Audiovisual Materials.
View and discuss the film "The Stuff We Throw Away," listed under Audiovisual Materials.

III. DISPOSAL

A. OBJECTIVES

1. To emphasize how in most cases the two primary methods of disposal (open dumping and burning; substandard incineration) cause pollution, add to the costs of health and environmental protection, and waste valuable resources.

3. To learn about improved methods for reducing waste volume and disposing of the residue (sanitary landfill, controlled incineration, pyrolysis, etc.).

B. STUDENT ACTIVITIES

1. Put together a schematic drawing and picture story of your community's waste management system. Photograph the steps of collection and disposal in careful detail. Make photo enlargements and mount them on your drawing to complete the description of the incineration process.

2. Make a wall-size cross-sectional drawing of an incinerator to explain its operation. If there is such an incinerator in your town, perhaps you could borrow a set of blueprints of its construction to help you.

3. Construct a tabletop model showing the operation of a sanitary landfill.

4. Construct a tabletop model of a city dump.

5. Arrange the three foregoing projects in a display. Prepare charts and diagrams on the comparative hazards, advantages and disadvantages,

costs, and space requirements of the projects. The exhibit should emphasize how all three methods waste valuable material and energy resources.
6. Design and prepare a booklet or brochure to accompany the exhibit. Arrange to display the exhibit in a high-traffic location, such as a school lobby, the local public library, or a shopping-center mall.
7. Collect and analyze some residue from a municipal incinerator. What materials can you identify? Are there any evidences of metals melting together? How could the different materials that have survived the heat be sorted? At what temperatures might these remaining materials have been affected? Make a bulletin-board chart showing the critical temperatures and the melting points of the materials commonly found in solid wastes.

C. QUESTIONS FOR DISCUSSION AND RESEARCH

1. What kinds of materials do archaeologists search for in their effort to discover the nature of past civilizations? What do archaeological deposits tell about ancient styles of living? What might America's dumps reveal to some future-day archaeologist about today's life-styles?
2. What were probably man's first disposal methods?
3. What are the most common ways of disposing of municipal solid wastes today?
4. Why is dumping the most common method of waste disposal? What problems does it create?
5. What is incineration? What are the advantages and disadvantages of this method of disposal?
6. What important consideration is missing when wastes are disposed of by traditional methods?
7. What are several improved methods for waste disposal?
8. What hazards have been eliminated by these improved methods? Have new or different hazards been created?
9. Why have methods to recover valuable materials from waste been slow to win acceptance?
10. Is America's solid waste problem only a matter of waste disposal, or is it more complicated than that?

D. BASIC UNDERSTANDINGS TO BE DEVELOPED

1. To the average citizen, the problems of solid waste disappear down the street with the local collection vehicle. For the city, however, the problems are just beginning. In most cities, the whole solid waste program has been to collect waste, haul it away, and burn or bury it. Disposal methods as well as collection methods have remained essentially the same over the years. Open dumping —disposing of waste in one selected location— has been the most common disposal method. Such dumps, now illegal in many areas, are unsightly and unsafe. A breeding ground for rodents and other disease-carrying animals, they can cause pollution of land, air, and water.
2. One solution to the problem of open dumping is sanitary land-filling, a method in which solid waste is brought to a dump, where it is compacted in layers and covered with dirt. A proper sanitary landfill not only eliminates health hazards but later can easily be converted into useful land for recreational grounds and building sites. This disposal method works well only if land is available and not too costly.
3. Incineration, another method for refuse disposal, might at first seem to be the solution to many solid waste disposal problems. Without question, an improved incinerator system can reduce the volume of municipal waste by some 80 percent; if appropriately designed, it can convert the heat generated into useful steam or electricity. But such an incinerator is costly, and it is acceptable only if it is built as a nonpollutant.
4. Although sanitary landfilling and incineration can be employed effectively in municipal solid waste management programs, neither provides for the recovery of the increasingly valuable materials present in each community's waste stream.

E. INSTRUCTIONAL RESOURCES

1. Read Topic III on disposal in the section "A Survey of Resource Recovery" in the students' booklet.
2. Refer to the publication "Municipal Refuse Disposal," listed in Instructional Resources.
3. View and discuss the film "Sanitary Landfill: One Part Earth to Four Parts Refuse," listed under Audiovisual Materials.

IV. RESOURCE RECOVERY

A. OBJECTIVES

1. To develop the understanding that through resource recovery we can utilize materials from solid waste and thus conserve depletable resources for the future.
2. To understand that municipal solid waste is a vast national resource of materials and energy and that sufficient technology already exists to recover a much greater segment of these precious resources than we are now extracting.
3. To be familiar with the most significant resource recovery techniques and systems that are now available or in development.

4. To understand that, although proper solid waste management can turn a national problem into an economic opportunity, lasting resource recovery is possible only if the value derived from its use exceeds the cost of separation or processing. The challenge is largely economic, and therein lies both the problem and the solution.

B. STUDENT ACTIVITIES

1. Visit the historical glass section of a local museum. Look for pictures and articles about early glass in encyclopedias or in books about glass in your local library. Make a map to show the spread of glassmaking from Egypt to Rome to Venice to western Europe to England to America. Make a time line showing the history and development of glassmaking through the centuries.

2. Bottle glass usually melts at 1500–1800 F. Place several bottles in a ceramic kiln, setting one horizontally, one vertically, and one at an angle. Gradually heat them to a molten state. Watch the shape of each bottle change, and see what happens to it as it cools. Compare the shapes and decide what you can make from each form. (Be sure to wear eye safety protection.)

3. Make a paper recycling system. (See the Project Section.)

4. Make a glass bottle and jug cutter. (See the Project Section.)

5. Design and construct a simple machine to crush glass and rock. For ideas applicable to glass, study the operation of machines (for example, a jaw crusher, hammer mill, tumble mill, and roll crusher) used to crush other materials.

6. Prepare a sample of concrete, using crushed glass as the aggregate. Compare the compression strength of this sample with that of concrete made with gravel.

7. Make some cullet from a glass bottle and use the fragments in a ceramic glaze. Note how cullet from a blue bottle, for example, will produce a blue glaze. *Cullet* is crushed glass.

8. Make a collection of discarded containers of various types, shapes, and materials. Prepare an exhibit illustrating the possibilities for reuse, with emphasis on creative solutions.

9. Conduct several experiments to find new uses for old plastic materials. For example, cut sheet strips into strips for laminating and use liquid plastics as the adhesive. What do these experiments show about possible ways to reuse plastics?

10. Construct a wall chart, using bar graphs to show the quantities of reusable materials that can be obtained from a single junked car. Add bars to show the dollar value of each. (See Item 10 under "Questions for Discussion and Research.")

11. Conduct an experiment to find out how many aluminum beverage cans are required to make a one-pound ingot. Cut the cans into small pieces for melting, or use the can crusher described in II–B.

12. Using the compactor you have constructed (see II–B), reduce the volume of an aluminum beverage can as much as possible. Compare the before-and-after volumes of the can to see by how much the volume is reduced.

13. Design a small souvenir that can be cast in a sand mold from discarded aluminum cans. If other students want these souvenirs, how could you set up a system for producing them in quantity?

14. Construct a model to illustrate the conversion of waste for use as fuel to produce heat or to provide steam for producing electricity. Explain the various processes involved. How much power can a ton of mixed waste produce? A ton of organic waste?

15. Construct a model showing a cross section of a furnace for pyrolysis. Include an explanation of how recoverable gases, oils, and char are produced in the furnace.

16. Using data on resource recovery found in the students' booklet in the section "A Survey of Resource Recovery," Topic IV, construct a miniature resource recovery plant. Build models and include explanations of the different processes involved in recovery. (See the Project Section.)

C. QUESTIONS FOR DISCUSSION AND RESEARCH

1. What is the meaning of the term *recycle*? Contrast this meaning with that of the term *biodegradable*. Does recycling of materials ever occur naturally in the environment?

2. What materials are used in making glass? What are the sources of these ingredients?

3. How readily can old glass be broken down into its original components? Is it recyclable? If so, how does it affect the quality of the newly manufactured glass?

4. What is the earliest archaeological evidence of man-made glass? Where was it found?

5. What processes are used in color-sorting glass? Explain the theory and practice involved in these processes.

6. How are colors in glass and glazes obtained?

7. What uses can be made of the slag produced in the process of steelmaking?

8. What possible uses can be made of old concrete? Of discarded brick and clay tile? Of asphalt? Can plaster of paris molds be reclaimed? What new building materials can be made from solid waste?

9. Which highway material, concrete or asphalt, is more economical of materials? How satisfactory are highway paving materials made of old tires and old glass?

10. How can the common scrap metals—such as steel, cast iron, aluminum, copper, brass, bronze, zinc, and lead—be easily identified?

11. How is paper made? Why is it possible to make paper from fibers? How can wastepaper be broken down into fibers?

12. Make a report to the class on the processes involved in recycling one of the following materials: paper, glass, steel, and aluminum. Use encyclopedias and other reference books for helpful information. If there is a recycling operation of any kind in your area, make arrangements to visit it as a class field trip.

13. The scrap metal (or secondary materials) industry plays a vital role in the economy of the United States. Find out how this industry is organized and make a report on the scrap cycle. What are the sources of scrap? How is scrap prepared for recovery? What are the major kinds of scrap-handling and -processing equipment? What are some of the finished products in which scrap metals are used?

14. Compare the price of a new car with the junk value of an old one. How many pounds of reusable materials are contained in a junked car? How much could you get for them at a salvage yard?

15. What are the main kinds of materials found in solid waste? Is their recovery important? Why?

16. Why is it more difficult to recover resources from mixed municipal wastes than from unmixed industrial scrap?

17. Why is it necessary to find additional sources of energy-producing fuels?

18. What are some specific methods for recovering heat and energy from mixed municipal refuse? (See the material on resource recovery in the Students' Manual in the section "A Survey of Resource Recovery," Topic IV.)

19. What commercial uses can be made of the heat resulting from the burning of wastes?

20. How are gases, oils, and char produced from solid wastes? What kind of gas is produced when organic material decomposes? What use can be made of recovered gases?

D. BASIC UNDERSTANDINGS TO BE DEVELOPED

1. Contrary to the dictionary definition, trash today is not something worth little or nothing. Nearly everything we throw away has some use left. Buried in the waste streams of our towns and cities are "resources out of place"—glass, metals, paper, plastics, and rubber—waiting to be recovered as materials for reuse, for new products, or for energy and fuel value.

2. Several basic facts and figures point to the need for resource recovery.

In addition to the direct costs of disposal, there are often hidden social costs, mainly due to improper disposal practices. These include health hazards, property damage, and environmental degradation. The greatest social cost is the permanent loss of depletable or irreplaceable resources. According to a study published by the National Center for Resource Recovery, we are annually throwing away materials and energy worth over $1 billion.

3. Waste materials can be put to work in many ways. Valuable resources, otherwise destined for burning or burial, can be mechanically extracted from mixed municipal refuse for recycling and reuse. The kind of processing center needed to make recovery possible is one capable of separating discarded materials by type. This would be a complicated operation but by no means an impossible one.

A total waste recovery system would probably begin with the extraction of bulk items—such objects as suitcases, toasters, and old auto tires—and breaking up of the remaining material into pieces of manageable size.

Once the material is broken up, a selective process of segregation would begin, each step involving a particular property of the material. Iron and steel could be extracted by magnets; paper and plastic by air classification, blowing the materials into separate chambers; nonferrous metals, glass, and garbage could be further separated by screens or liquid baths; and types of glass could be sorted by color. These methods are not new. Industry has been employing them for years in various processes: mechanical separation; optical separation; ballistic (hurling) separation; and the use of electromagnets, fluids, chemicals, or air to separate one type of material from another.

Each separated material would have its own destination: ferrous metals to mills and foundries; nonferrous metals to smelters; and glass to glass plants, by type, color, etc. Practically none of our solid waste is completely without value, and some of it has a variety of applications.

Paper can be processed into sheet building material or reused as paper. Glass can be processed into insulation as glass wool, made into bricks, used as a decorative substance, and even employed as chicken grit. Research shows that ground-up bottles can replace gravel in asphalt highways. And ground-up rubber tires mixed with asphalt make a crack-resistant road that lasts longer than conventional roads.

4. The materials remaining after separation can also become a valuable resource through careful planning and application of technology. Organic materials—food wastes, grass, and leaves—can go to compost pits and ultimately be reused as fertilizer and soil conditioner. Paper, plastics, and rubber can be used as fuel to power furnaces to make steam for heat or to turn turbines to generate electricity. The residue from this process can be used as landfill.

5. The pyrolysis form of incineration may be another part of the answer to waste recovery. This process, which can efficiently reduce waste, involves heating in the absence of air. Organic solids are converted to acids, alcohols, and condensable gases. These materials can be recovered. Pyrolysis and other noncombustion methods also produce materials that can serve as fuel.

6. Although the idea of recovering and reusing municipal waste is relatively new, the idea is not unfamiliar to industry. For years salvaged, or secondary, materials have served as sources of raw materials in many industries.

Why, then, has resource recovery not been used with garbage and trash? One reason is that until recently recovery has not been able to compete economically with conventional means of disposal. That situation, however, is changing as the costs of land and of incinerator construction, as well as of resources, are going up. Also, new techniques and equipment are making resource recovery a more attractive alternative to traditional disposal systems.

7. Recycling technology as it now exists is fragmented, but it remains for these fragments to be pulled together into one complete system. When that is done, a total resource recovery plant can separate and process waste materials into reusable resources.

8. Solid waste, the third pollution, has only recently become an environmental concern. It is fortunate that this age-old problem is now being recognized, because there is a growing need to conserve natural resources, protect the environment, and improve the efficiency of solid waste management.

E. INSTRUCTIONAL RESOURCES

1. Read Topic IV on resource recovery in the section "A Survey of Resource Recovery" in the students' booklet.
2. Read the article "Bottlenecks, Part 1," listed in Instructional Resources.
3. Read the article "Machinery for Trash Mining, Part II," listed in Instructional Resources
4. Read the article "Tackling Resource Recovery on a National Scale," listed in Instructional Resources.
5. View and discuss the film "Recycling," listed under Audiovisual Materials.
View and discuss the film "Things Worth Saving," listed under Audiovisual Materials.
View and discuss the film "Wealth of the Wasteland," listed under Audiovisual Materials.

V. SOLID WASTE MANAGEMENT SYSTEMS

A. OBJECTIVES

1. To understand that solid waste management must be dealt with through a total systems approach comprising the steps of home collection, separation, recovery, and conversion and that several promising systems are already in operation, in addition to those in development.

2. To understand that although new systems are emerging, no single solution is likely to be adaptable to every situation.

B. STUDENT ACTIVITIES

1. Compare the technological principles and processes of several waste-handling systems for collection, disposal, and resource recovery. Using the Students' Manual and other references identify the most effective applications of each system. Are the processes involved mechanical, thermal, electrical, or chemical?

2. Using some elements of these systems and some of your own invention, construct a tabletop model of an ideal waste-collection/disposal/resource-recovery system. Plan its location within your community, and show how homes, schools, stores, and industries could be linked to it.

3. Construct a chart showing a proportional comparison of the volume of refuse brought in to the volume of the resources recovered from one of the new systems.

4. Imagine that a volunteer group has asked the industrial arts class to design a collection and recycling center for the community. Before plunging into such an undertaking, students should answer several basic questions: Is there a need for such a center? Should the public be paid for returned containers? Should the center be staffed by employees or volunteers or a combination of both groups? What would be the cost of operating the center?

5. When these important factors have been considered, design and build a tabletop model of the collection center. Requirements to be met include location and layout, equipment, transportation, operational schedule, manpower, and markets.

C. QUESTIONS FOR DISCUSSION AND RESEARCH

1. What is the most desirable solution to the problem of solid waste?

2. How do the several systems for resource recovery compare in their technology? How efficiently does each system recover resources?

3. Are all hazards eliminated by these advanced systems, or are new or different hazards created by them?

D. BASIC UNDERSTANDINGS TO BE DEVELOPED

1. Resource recovery can be profitable. We not only conserve our natural resources, which are far from inexhaustible, but we also gain new revenue for our cities. Instead of mining this abundance, we have until now accepted it as a massive and continued financial burden. We currently spend an estimated $5 billion annually to collect and dispose of solid waste.

Many of our municipal waste systems are far less advanced than some systems already in use in Europe. Milan will soon be running all its streetcars and subways by electricity generated from burning refuse. And in Paris a substantial portion of the city's steam heat in winter is derived from the same fuel source—the city's refuse.

2. In the United States there are still many barriers to the intelligent and efficient use of waste resources. For this reason the value of the municipal trash heap is still largely potential. In order to realize this value, materials must be recovered on a major economic scale. Before this can happen, however, answers must be found to the complex questions of cost and technology. The government can encourage new markets and can exercise its purchasing power to provide incentives. Most of all, an informed public must work with local, state, and federal representatives so that modern solid waste management becomes a major issue.

3. There are some encouraging signs of new thinking in relation to resource recovery. In 1970 Congress passed the Resource Recovery Act, which promotes the study of ways to stimulate the market for secondary resources, provides funds for demonstration projects, and helps develop a new national policy for recovering and reusing materials from solid waste resources. This shift in perspective represents a major breakthrough in expanding the recycling potential in our national economy.

In the meantime, private industry has made an extensive commitment to developing the technology needed for resource recovery. Today there are more than 20 different systems being built privately, and some of these are already in use.

4. Recycling is not the preferred method of recovery in every case. Waste-heat recovery, chemical conversion, land reclamation, and other forms of resource recovery are among the options that must be considered in any specific situation. But only a total systems approach, taking into consideration economic, social, scientific, and technical factors, can provide an adequate solution to the solid waste challenge.

5. Communities and volunteer groups planning to develop facilities for recycling should know in advance who will be the customers for the metal, paper, glass, and compost their recycling operations will produce. Along with the obvious need to develop new and larger markets for recycled materials, it is usually necessary to attract customers close at hand to the treatment plant to minimize shipping charges.

6. The technology needed to transform our solid waste stream into an inexhaustible resource already exists. What we lack is a broad public understanding of the various methods to achieve this transformation, the foresight to choose wisely among them, and the will to make the necessary changes.

Solid waste disposal is a way of getting rid of trash. The way we now do this is archaic, pollution-causing, and inefficient. With a little forethought on the part of managers of waste-disposal systems and with some public help and financial support, we can make our disposal system more modern, less polluting, and more efficient in a short time. With adequate planning and wholehearted, well-informed public support, we can eliminate the phrase *solid waste* from the national vocabulary and turn our waste stream into a rich and growing asset.

E. INSTRUCTIONAL RESOURCES

1. Read Topic V on solid waste management systems in the section "A Survey of Resource Recovery" in the students' booklet.
2. Read the article "Resource Recovery: A Positive Approach to the Solid Waste Problem," listed in Instructional Resources.
3. Study and discuss the wall chart "Resource Recovery: Worth from Waste."

PROJECTS SECTION

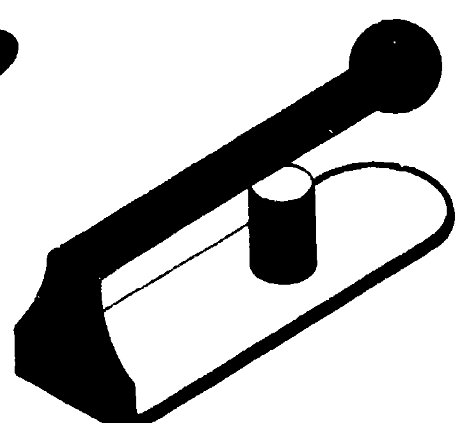
II. COLLECTION AND TRANSPORTATION

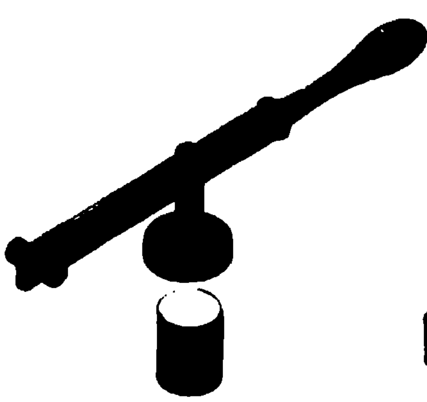
B.1 Design a can crusher for home use.

Solid waste management systems begin with storage containers - the trash can under the Kitchen sink, the refuse bin behind the school cafeteria, etc. Home storage requirements may be reduced significantly if metal containers are collapsed. Such compaction may also help keep the storage area sanitary.

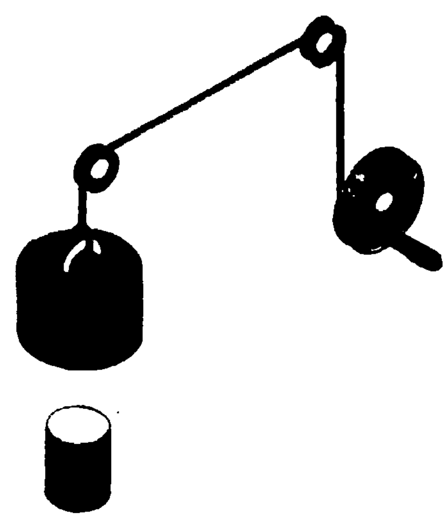
A can crusher for home use might be handy for your household. Can you design one that will be simple to build and easy to operate? Since a compaction action is necessary, the problem is finding the best means of accomplishing it. The following are suggestion starters:

Nut cracker





Hand lever



Heavy weight

Foot pedal

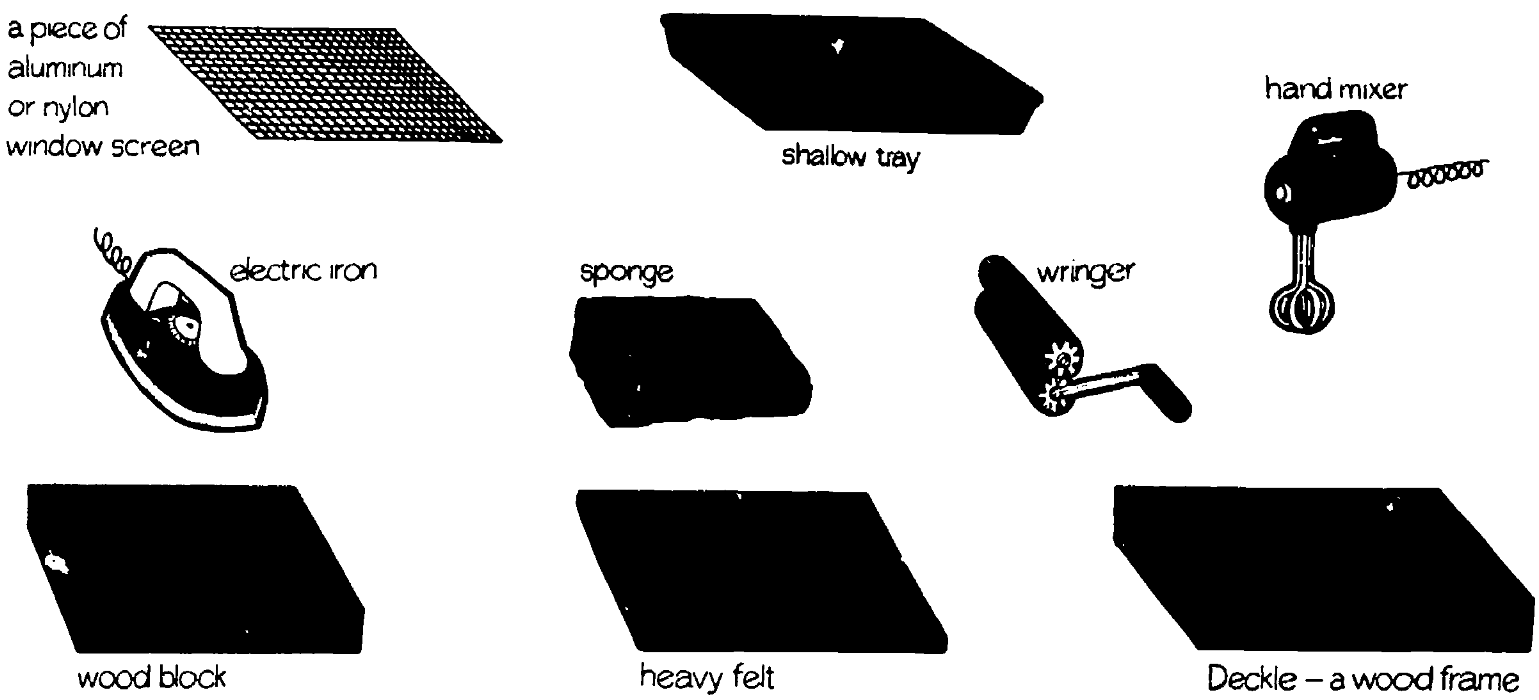
Screw press

IV. RESOURCE RECOVERY

B.3 Make a paper recycling system.

Recycling paper means to make new paper from old. Newspapers and magazines are commonly recycled into wrapping paper and cardboard.

Equipment for recycling paper



The Process

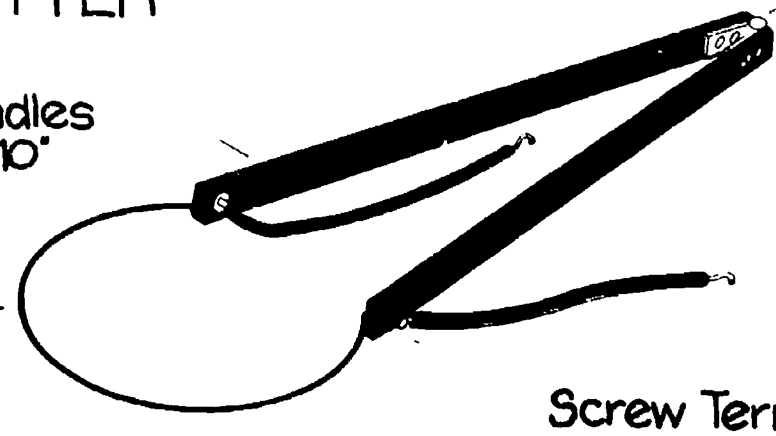
1. Shred a couple of handfuls of newspaper and cook it slowly in a pan of water. When it becomes mushy, beat it into a pulp with the mixer.
2. Add water to thin the mix and separate the fibers. The mix should be about 99 percent water. Beat it thoroughly and pour it into the tray.
3. Slide the screen under the mixture and place the deckle on it. Fill the deckle; then remove both it and the screen at the same time. The water drains out leaving a deposit of fibers. This is the sheet of paper.
4. Place the screen on the sponge and press out more water with the block. Place the screen on a piece of felt, paper side down. Carefully remove the screen, leaving the paper on the felt. Cover the paper with a piece of coarse cloth and press it with the hot iron to dry and strengthen the paper.
5. Remove the cloth and piece of felt and you have a piece of paper.

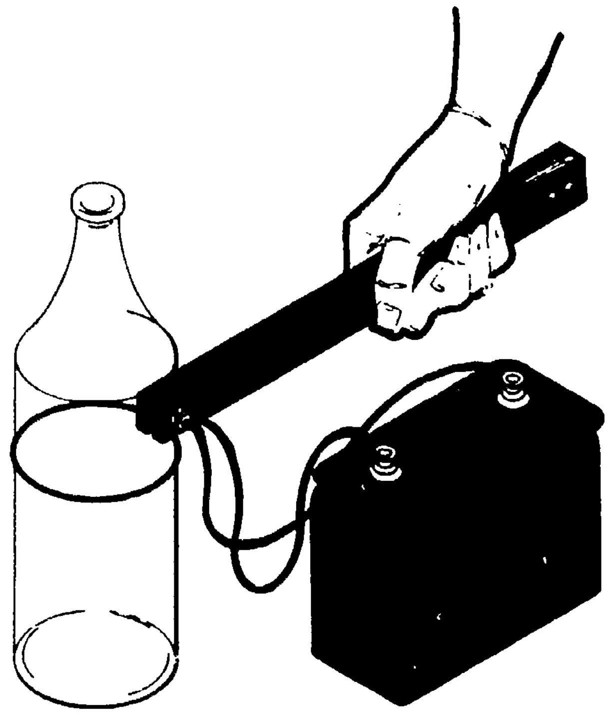
For You to Find Out:

1. How could you make a thicker, heavier paper?
2. Why is it gray in color?
3. How can the printing ink be removed? Experiment with common household bleaches.
4. What is the process of paper manufacturing? How is the sheet formed from tiny individual fibers?
5. What is "sizing" as used in writing paper? Why is it used?
6. Could you make colored paper? Try vegetable coloring.
7. What is Fourdrinier process for papermaking? How is the method you used like this?

B4. Make a glass bottle cutter

1. ELECTRIC CUTTER





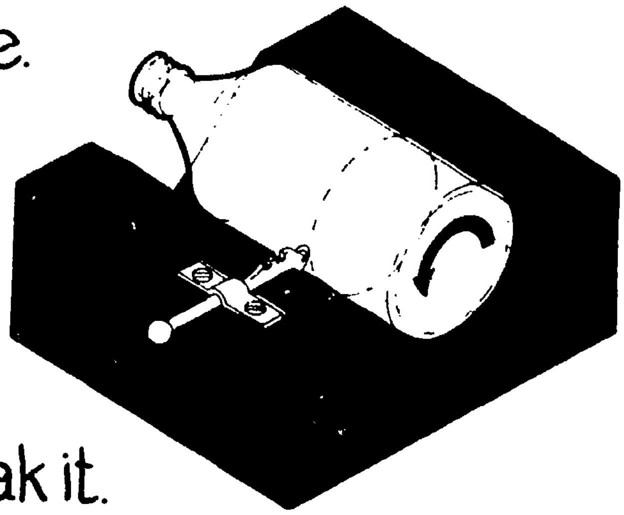
Adjust the resistance wire loop to fit snugly around the bottle.

Turn on the current for 2-3 minutes.

The wire heats only a line around the bottle.

Remove the loop and plunge the bottle into cold water.

2. MECHANICAL CUTTER



Make a V-block to hold the bottle.

Mount a glass cutter so that it makes contact with the bottle.

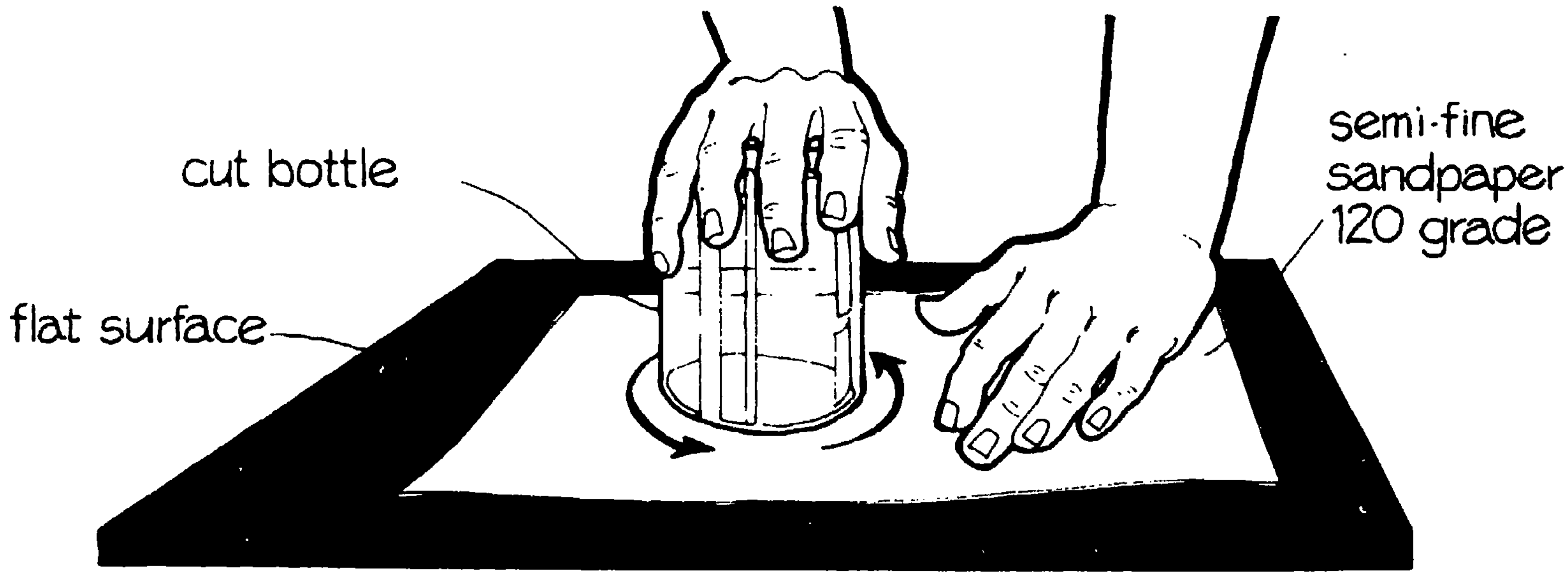
Turn the bottle into the cutter.

Tap the bottle at the cut to break it.

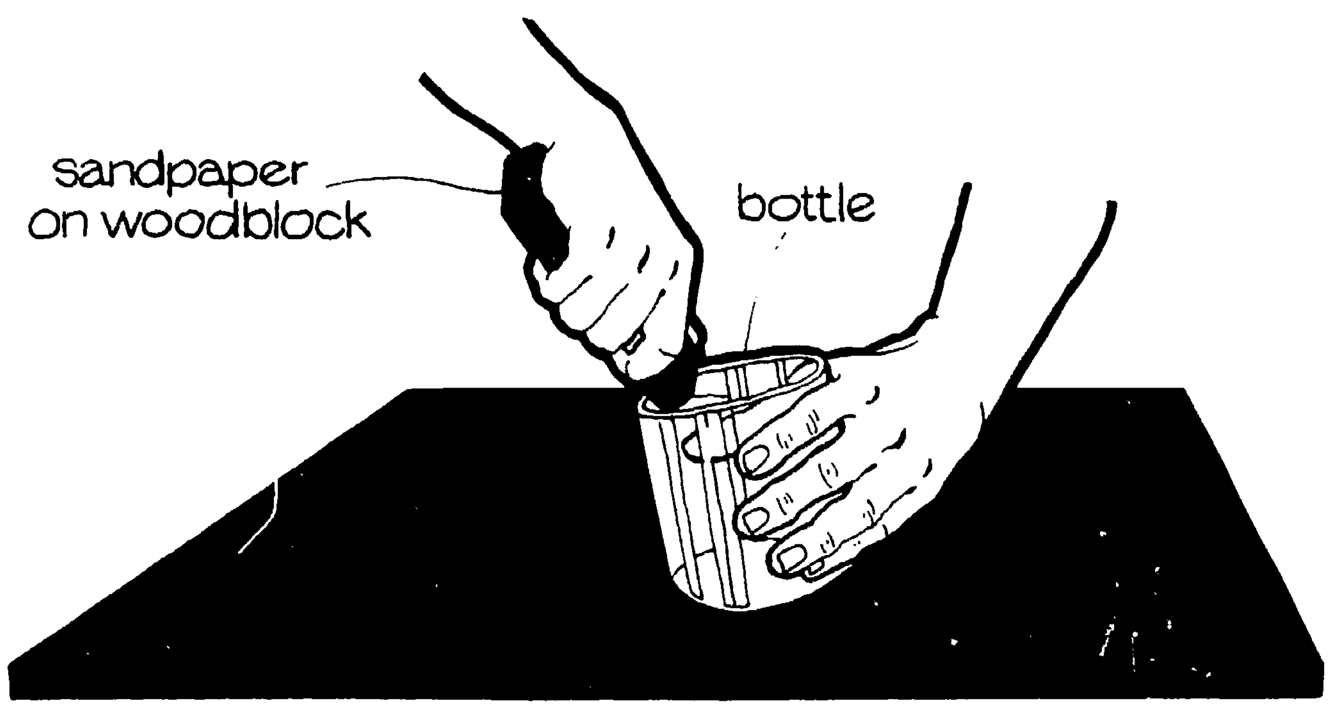
3. BEFORE USING

BEST COPY AVAILABLE

Before you use the cut pieces, their edges must be sanded to avoid cutting yourself.



Rub in circular motion to sand outer edge.

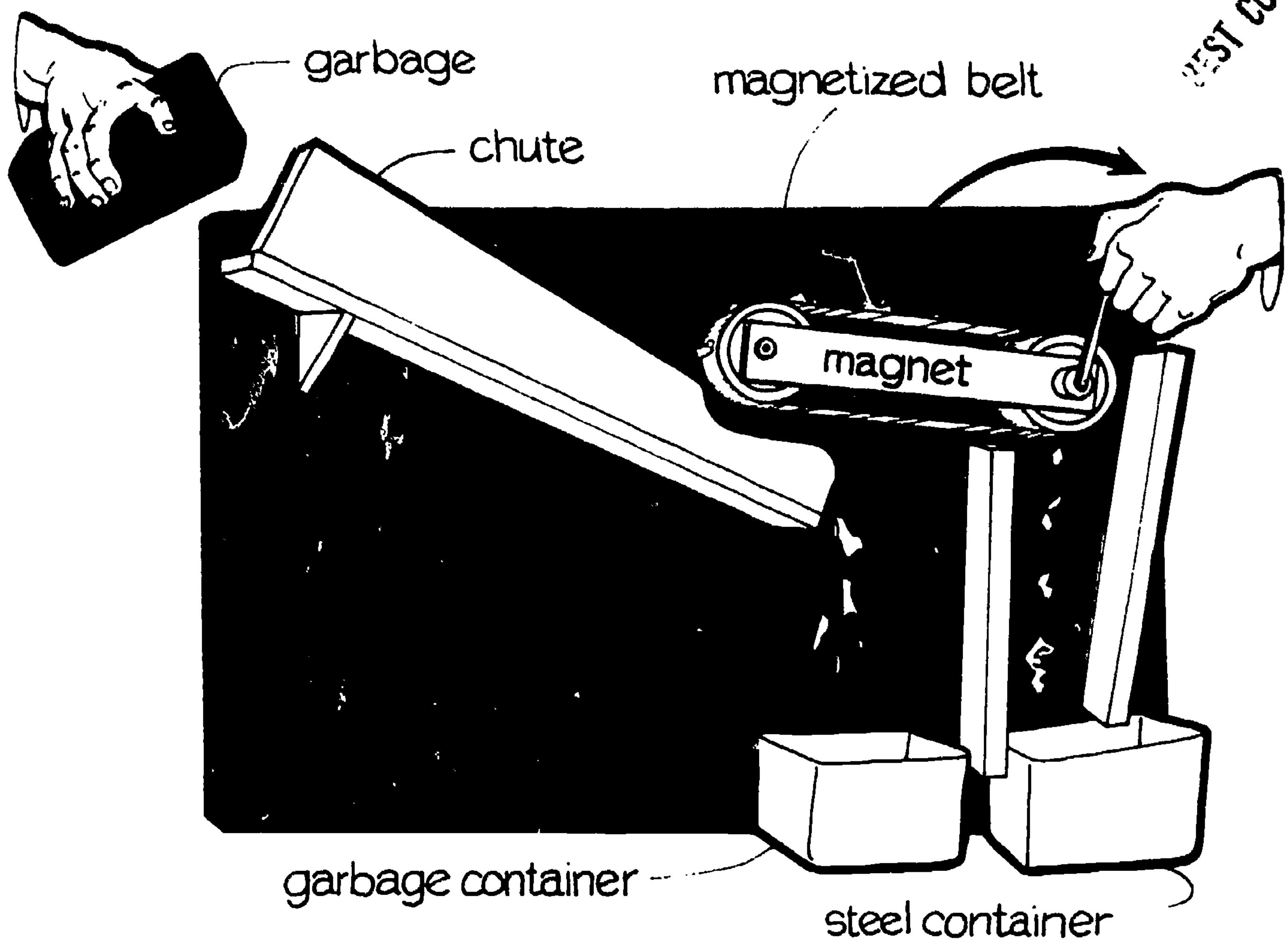


Sand inside and outside edges.

IV. B.16 Make your own Magnetic Separator

Mindy Lambert and Steve Derse, students from Hamilton High School, Milwaukee, Wisconsin, developed a demonstration of magnetic separation.

The model works like this. Can you duplicate it?



A stream of pulverized (pre-sized) solid waste is released down a chute which passes directly under a magnetic belt/separator. (The separator is actually a horseshoe magnet mounted between two rollers.) A belt, which is turned by a handle hooked onto one of the rollers, revolves counter-clockwise around the magnet. As the ferrous approaches the magnet it is attracted to the belt which carries it to the bin on the right hand side where it drops off. The garbage is not attracted to the magnet and falls into the bin on the left hand side.