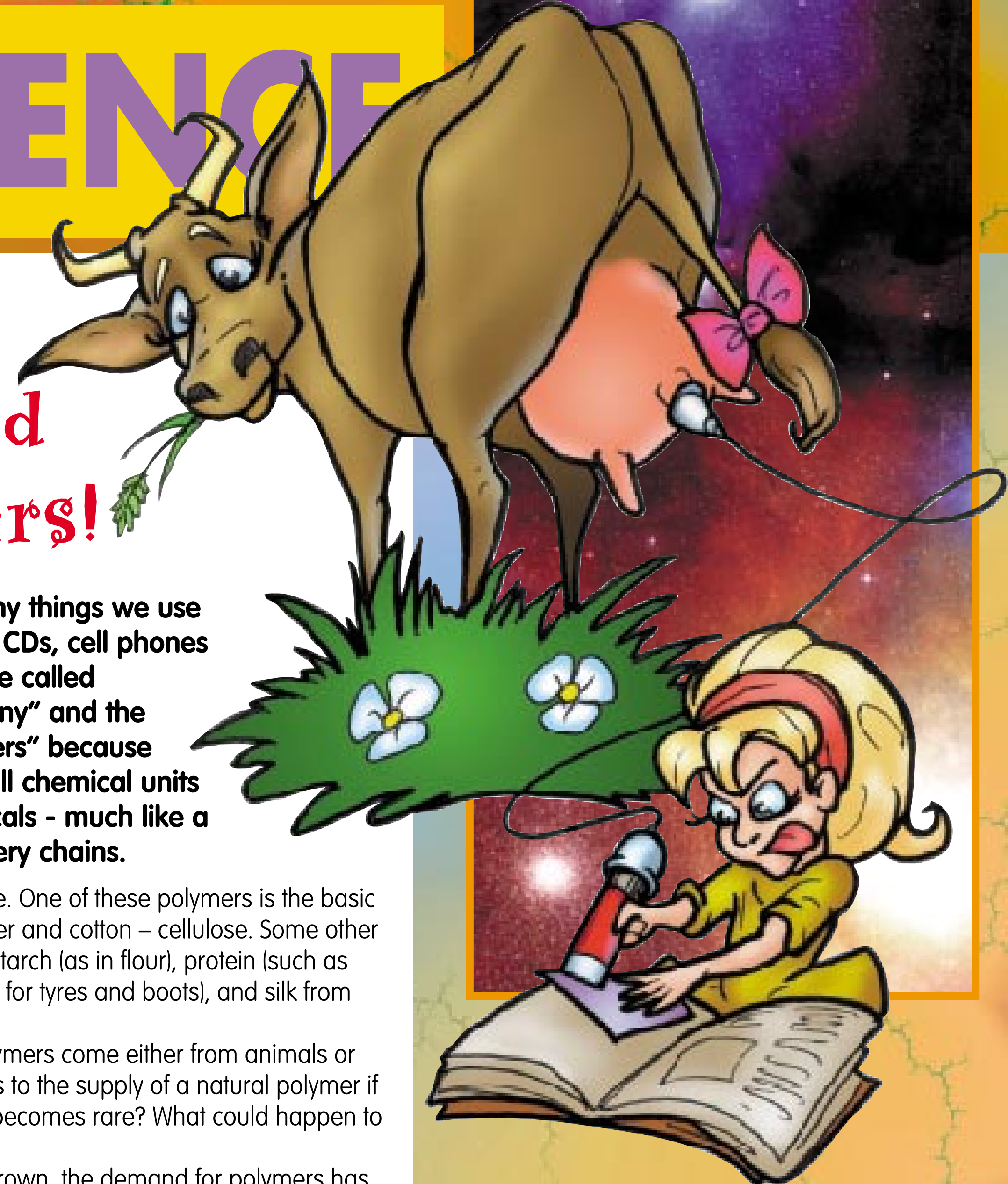
EASY SCIENCE



You are surrounded by polymers!

Chemicals that make up many things we use every day - like plastic bags, CDs, cell phones and even artificial bones - are called polymers. "Poly" means "many" and the chemicals are called "polymers" because they are chains of many small chemical units linked to make larger chemicals - much like a box full of jumbled up jewellery chains.

Many polymers occur in nature. One of these polymers is the basic building block of wood, paper and cotton – cellulose. Some other polymers that occur in nature are starch (as in flour), protein (such as egg white and meat), rubber (used for tyres and boots), and silk from silk worms (used for clothing).

Did you notice that all these polymers come either from animals or plants? What do you think happens to the supply of a natural polymer if the plant or animal it comes from becomes rare? What could happen to the cost of the natural polymer?

As the human population has grown, the demand for polymers has also grown. The need for rubber became critical during World War II and led to the development of artificial rubber. To make artificial rubber, polymer chemists first had to understand what smaller chemical units made up the polymer rubber. They used tests and instruments to tell which different chemicals made up the polymer rubber. Using this knowledge, they then experimented with the best ways to make artificial rubber. Artificial rubber does not depend on the supply of rubber plants (which are only found in certain parts of the world) because it could be made from raw materials that are more easily available. Artificial rubber could then be made cheaply and in large amounts.

Other artificial polymers that have changed the way we live are nylon (a substitute for silk), polyethylene (the most common plastic), Teflon (for non-stick surfaces in cookware), Dacron (a fabric), and the first plastic, Bakelite (a hard material used for billiard balls and telephones).

Did you know?

In the 1870s, J. W. Hyatt invented billiard balls which were made from a semi-synthetic plastic. The problem was that one of the ingredients was flammable and sometimes when two balls would hit each other there would be a small explosion!

In the rather dangerous pool halls of the American Wild West, this gunshot-like explosion would be enough to make all the men draw their guns!

Modern balls are made from phenolic resin which is an old-fashioned plastic – but it is stable and has a lovely shine.

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SAASTA

In the bag

In this activity you can compare the properties of two polymers, one natural and the other artificial.

You will need:

- Two paper bags
- Two plastic freezer bags
- Measuring cup
- Mixing bowl
- Water
- Vegetable oil

First just look and feel a plastic bag and a paper bag. Next, hold both bags open over the sink while your partner pours 1/8 cup of water in each one. Look what happens to the bags for one minute. Now, hold the bags closed and gently shake them for four minutes. What happens? Would you choose to carry a goldfish home from the pet shop in a paper bag?

Now see what will happen when you use two fresh bags to hold another liquid - oil. While you hold the fresh bags open, let your partner pour 1/8 cup of oil into each bag. Look what happens to the bags for three minutes.

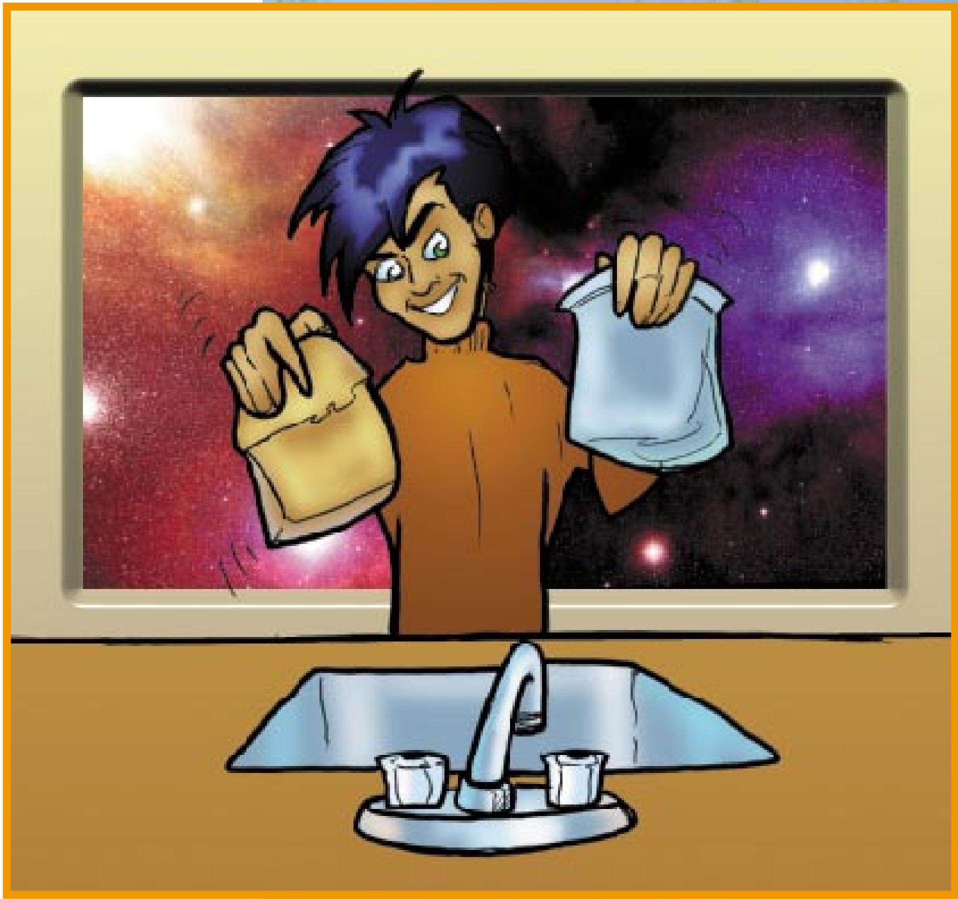
Carefully pour the oil from the paper bag into the measuring cup and record the amount. Discard this oil and wash the cup. Now measure the oil left in the plastic bag and compare it with what was left in the paper bag.

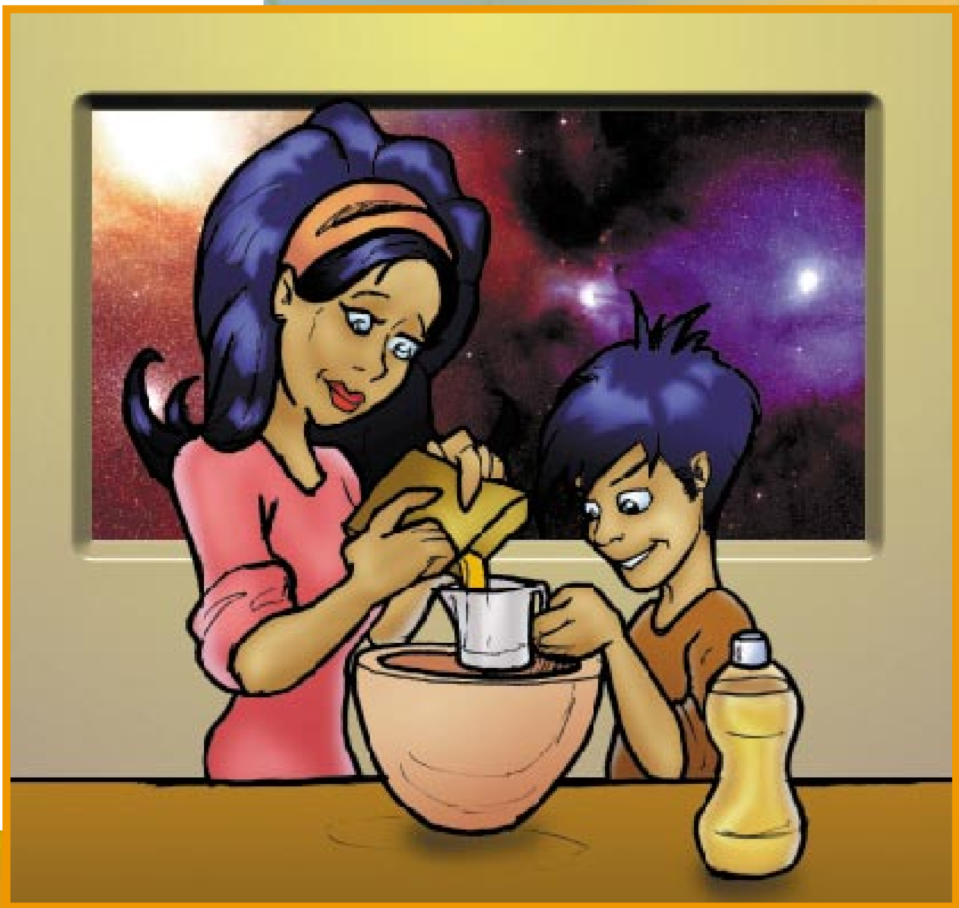
Hold the bags up to the light and see what effect the oil had on them. Can you explain any difference in the amounts of oil left behind in the bags?

From what you have seen, try to answer the following questions:

- What are the advantages in using paper bags to carry groceries? What are the advantages of using plastic bags for groceries?
- Which bag looks like it would disintegrate (break up) more easily when thrown away?

Can you see that polymers such as plastic have their advantages, but that natural materials, such as paper, also have their place in the world?





From moo to glue

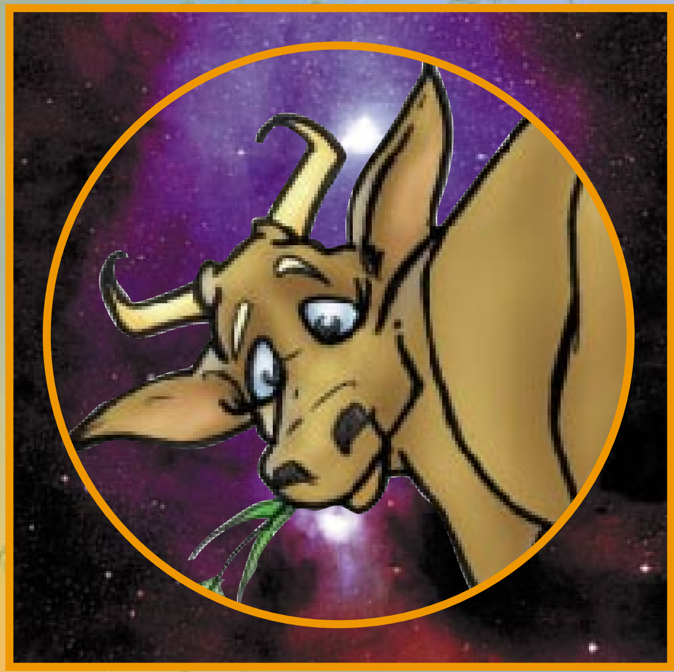
Glue can be made from a polymer (a protein) found in milk. To get the protein out of the milk, you need to curdle the milk by adding a mild acid, vinegar.

You will need:

- Two tablespoons (30 ml) of vinegar
- 1/2 cup (125 ml) of non-fat milk made from non-fat milk powder and hot tap water (follow the package instructions)
- 1/4 teaspoon of baking powder
- Teaspoon for stirring
- Two cups
- Funnel
- Coffee filter or paper towel
- Paper and ice-cream sticks
- Blunt scissors

Pour the vinegar into one of the cups, and stir in the hot milk. Let the mixture sit until the solids are separated from the liquid (about three minutes). Carefully pour the liquid from the mixture down the sink drain and save the solids.

Line the funnel with coffee filter paper or a circle of paper towel folded into a cone that will fit the funnel. Put the funnel in the second cup. Carefully pour the solids into the funnel. Pour any liquid that collects in the mug down the sink, but save the solids in the funnel. Wash both cups.

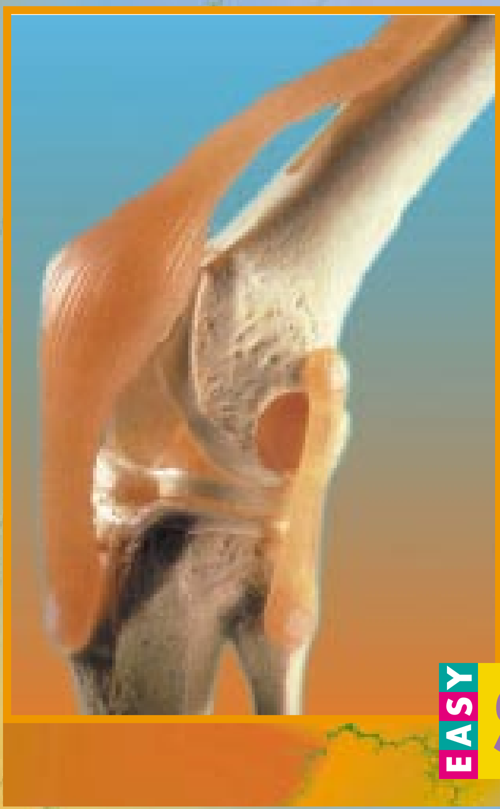


Scrape the solids from the funnel into one of your clean cups, and stir in the baking powder and 1 1/2 teaspoons (8 ml) of water. The mixture in the cup is your glue.

Cut a sheet of drawing paper in two and then cut each half into four pieces. Decorate one side of each paper square with fancy shapes (hearts, stars, flowers). Brush a thin layer of glue on the top part of an ice-cream stick and press the blank side of a decorated piece of paper onto the gluey stick. Does your glue work?

Two other "glues" you can compare with the milk glue are:

- One slightly beaten egg white mixed with one tablespoon (15 ml) of water
- 60 ml white flour mixed with 60 ml water



Plastic parts

Plastic is used extensively in the world of medicine. Plastic joints are made from non-toxic (non-poisonous), high density plastics, which have been especially treated to encourage bonding to the bodys' tissues.

Knee joints like this one are often replaced in people who suffer from acute arthritis.

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Slime Alert!

I bet you would love to make some gooey slime. First things first – make sure you've got some old clothes on and that you prepare your work space. Maybe you should lay down an old sheet or some newspapers to protect rugs or floors.

You will need:

- 25 ml clear glue gel (not white glue)
- Distilled water
- A microwave oven
- 30 ml borax, a mineral used for cleaning - it's sold alongside laundry detergents
- Food colouring (make sure you have green!)
- Wooden mixing sticks — find them at arts and crafts stores, or hardware stores
- Three mixing bowls
- Rubber gloves (recommended)
- Waxed paper

Check with a grown-up before you begin. Use a wooden mixing stick to stir together 1/2 cup (125 ml) of glue with 1/2 cup (125 ml) of water in one of the bowls. Microwave the mixture on high for one minute. Stir the mixture again. Microwave it on high for one more minute. Stir it until it is smooth, then put it aside.

Measure 2 tablespoons (30 ml) of borax and add it to 1 cup of water in another bowl. Stir until all of the borax is dissolved.

Mix 1/2 cup (125 ml) of the glue mixture with 1/2 cup (125 ml) of the borax mixture in a third bowl. Add 5 or 6 drops of food colouring (no more!). Mix the whole yucky mess together.

Pull on those rubber gloves! Put your slime on some waxed paper and knead it like bread dough. Don't rub your eyes before you have taken off the gloves and washed your hands, since the borax can irritate your eyes.

Congratulations! You've got slime. You can save it in a plastic bag in the refrigerator – just make sure you label it so no one eats it!

The borax connects the glue molecules, resulting in long connected chains of molecules. Did someone say "polymers"?

Tip: Knowing just how much borax solution to add is the trick to this experiment. If you add too little, your slime will be sticky. If you add too much, your slime will be very wet. Touch your slime with your hands when it doesn't look like a liquid anymore. If your slime feels sticky, try adding a little borax solution. If your slime feels very wet and slippery (but is not still runny), remove it from the container and kneed it in your hands. In a few minutes, any extra borax solution will evaporate or be absorbed.

Here's a variation — make a bouncy, rubbery type of slime:

Follow instructions for the slime-making activity above, but use white (latex) glue instead of glue gel. Test to see if it's different from the other slime. Does it bounce more? Stretch more?

Brainstorm how you could use this slime and why it would be a good material for your applications (examples: plug up holes in walls, use as a shock-absorbing material within sole of shoe, glob to hold pins or paper clips, etc.)

"Melt" styrofoam

You will need:

- A small dish
- A container of acetone (available at home supply stores) or fingernail polish remover (contains acetone)
- Styrofoam pellets or a styrofoam plate or cup

Ask your parents or teacher cover your work surface with a plastic tablecloth or dropcloth. Acetone will remove paint or finish from furniture! Also, make sure that nobody smokes while trying this experiment—acetone is flammable.

If you don't have pellets, shred the styrofoam plate or cup into small pieces. Place the pieces in the dish and pour the acetone or fingernail polish remover over them and see the styrofoam "melt" to a blob.

Styrofoam containers are 'pumped up' with a lot of air. Placing them in acetone causes a chemical reaction that releases the air. The plastic material that is left is the polystyrene - a polymer.

Play with plumber's putty

For this experiment, all you need is a tube of plumber's putty (available at a hardware store) and your hands!

Squeeze out a small amount of the plumber's putty and begin warming it with your hands. Once it starts feeling warm, start shaping it. Work fast, because once the putty cools, it will harden and will not soften even if you heat it up again.

Why won't the putty soften if you heat it up again?

Plumber's putty is an example of a thermoset plastic. When the chemicals get hot, a chemical reaction makes a special kind of polymer chain form. The polymer chains in thermoset plastic are a different material than the one you used in the slime experiment. When the thermoset plastic cools, the chains are set - permanently.

Polymers all around us

Artificial polymers are so much part of our lives now it is difficult to imagine not having them around. Just look around in the kitchen and see how many natural and artificial polymers you can find.

Now, imagine that artificial polymers had never been discovered. Make a list of the natural polymers that would be used in the place of the artificial polymers. For example, if there were no plastic, what would a milk container be made of?

Can you imagine what the kitchen would look like if there were no more natural polymers available? Make a list of the artificial polymers that could be used to replace the natural ones.

Here's a job for you!

The artificial polymer industry relies on the talents of chemist inventors. Every day, people find uses for more sophisticated plastic materials, so there will always be work for people who can invent these materials. One such inventor, Dr Philip Landis, a chemist who has more than 70 patents to his credit, has some advice for young inventors:

- Be patient and understanding.
- Read a great deal to find out what other people are doing.
- Practice using laboratory equipment.
- Concentrate on science and maths courses.
- Trade ideas with friends.
- Get involved with science fair (expo) contests.
- Get a broad background of knowledge.

Some careers associated with polymers are: auto engineers; chemical engineers; chemists; fabric designers; filter makers; furniture makers; furniture restorers; material designers; materials engineers; and physicists.