

BALLOONS

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Balloons are commonly available in toy, novelty, card, and party shops. They are usually composed of rubber and come in a multitude of colors, shapes, and sizes. Natural rubber is a polymer of isoprene (2-methyl-1,3-butadiene) (See Figure 1) in the form of polymeric chains which are joined in a network structure and have a high degree of flexibility (See Figures 2 and 3). Upon application of a stress to the balloon material, such as inflating it, the polymer chain, which is randomly oriented, undergoes bond rotations allowing the chain to be extended or elongated. The fact that the chains are joined in a network allows for elastomeric recoverability since the cross-linked chains cannot irreversibly slide over one another. Also, the polymeric material that makes up the balloon is porous, as evidenced by the balloon deflating over a period of time.



Figure 1. Isoprene. Chemical formula (left) and ball and stick model (right)

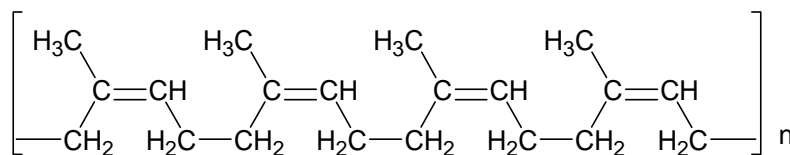


Figure 2. A rubber polymeric chain

An interesting demonstration of some of the properties of the rubber material that composes the balloon is the needle through the balloon trick. To do this, inflate the balloon to its maximum size, release a small amount of air to allow the molecules some recovery, and tie the end in a knot. Wipe the needle with a cloth containing a small amount of oil to lubricate the it making the needle slide through the rubber easier. (It looks like you are cleaning off the needle if you do not explain what is happening.) Starting at the end of the balloon, where the rubber is thicker and under less stress, slowly push the needle into the balloon using a twisting motion on the needle. If the needle does not slide easily, more lubrication is needed. If the needle is sufficiently sharp and smooth, it will not tear the rubber, but will slide between the polymer chains, allowing them to stretch around the needle. Continue to push the needle through the balloon until it comes through the other side of the balloon near the knotted end. The needle can then be withdrawn or pushed completely through the balloon leaving two small holes where the needle passed through the balloon. (The rubber does not make a perfect seal in those spots.) After showing that the balloon is

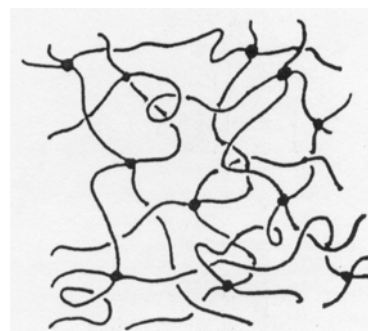


Figure 3. A schematic network of isoprene polymer chains. Dark dots indicate where chains are connected.

intact, the balloon is tossed into the air and popped with the needle to hide the small holes from the audience. With good quality latex balloons, the needle can also be passed through the balloon from side to side.

PROCEDURE

1. MATERIALS NEEDED:

- Balloons (helium quality latex) 9-inch round or larger
- Needle (35 to 50 cm long - Available from a Magic shop or an upholstery shop)
- Bamboo skewer (available at hardware stores, supermarkets, home centers)
- Oil (normal household lubricating oil or vegetable oil)
- Scotch tape (or equivalent)
- Crocus cloth or very fine sand paper (at least 400 grit or finer)
- Paper towel or cloth

2. SAFETY PRECAUTIONS:

Wear safety goggles or glasses as protection from flying particles in the event a balloon explodes.

Keep a cork on the tip of the needle when not in use to prevent accidental stabbing.

3. DISPOSAL:

All materials can be disposed of in the trash.

4. EXPERIMENTAL PROCEDURE:

Cleaning and sharpening the needle:

For best results, the needle must be kept clean. Clean the needle with crocus cloth or very fine sand paper to remove any surface oxidation. Wipe the needle with a cloth or paper towel containing a small amount of oil before storage.

Heavy oxidation can be removed by first cleaning the needle with fine emery cloth followed by polishing with crocus cloth. Wipe the needle with a cloth or paper towel containing a small amount of oil before storage.

If the needle becomes dull, sharpen it using fine emery cloth or sandpaper. Fold a piece of emery cloth around the tip of the needle and rotate the needle back and forth until the tip is sharp. If necessary, polish smooth with crocus cloth.

Put a needle through a balloon - Method 1:

This method uses Scotch tape to keep the balloon from breaking. Although the Scotch tape is not essential, it provides an extra margin of confidence to the experimenter.

1. Blow up the balloon to its full size. Release some of the air reducing the balloon to about 2/3 full. Tie the end of the balloon in a knot.



Figure 4. A needle through a balloon

2. Put a piece of scotch tape on each end of the balloon, where the rubber is thicker.
3. Insert the needle so it passes through both pieces of scotch tape. If the needle does not slide through easily, lubricate it with a small amount of oil.
4. Withdraw the needle from the balloon.
5. Throw the balloon into the air and pop it with the needle so nobody will be aware of the holes in the balloon.

Put a needle through a balloon - Method 2:

This is the method used by professional magicians.

1. Blow up the balloon to its full size. Release some of the air reducing the balloon to about 2/3 full. Tie the end of the balloon in a knot.
2. Use a cloth or paper towel to coat the needle with a small amount of oil.
3. Insert the needle through the end of the balloon where the rubber is thicker. The needle should come out of the balloon near the knot.
4. Withdraw the needle from the balloon.
5. Throw the balloon into the air and pop it with the needle so nobody will be aware of the holes in the balloon.

Put a bamboo (or wood) skewer through a balloon:

For safety considerations, it is not recommended to use metal needles with young students. An alternative is the use of a bamboo skewer which can be obtained in packages of 50 or 100 skewers at a hardware store, supermarket, or home center. A bamboo skewer would be less likely to cause serious injury if someone pokes themselves in the hand or arm by accident.

CAUTION: Bamboo skewers should not be given to youngsters to take home.

Bamboo skewers contain sufficient natural oil to slide easily through a balloon without additional lubrication. If desired, however, the skewer can be lubricated with a small amount of oil.

1. Blow up the balloon to its full size. Release some of the air reducing the balloon to about 2/3 full. Tie the end of the balloon in a knot.
2. Insert the skewer through the end of the balloon where the rubber is thicker. The skewer should come out of the balloon near the knot.
3. Withdraw the skewer from the balloon.
4. Use the skewer to pop the balloon so nobody will be aware of the holes in the balloon.

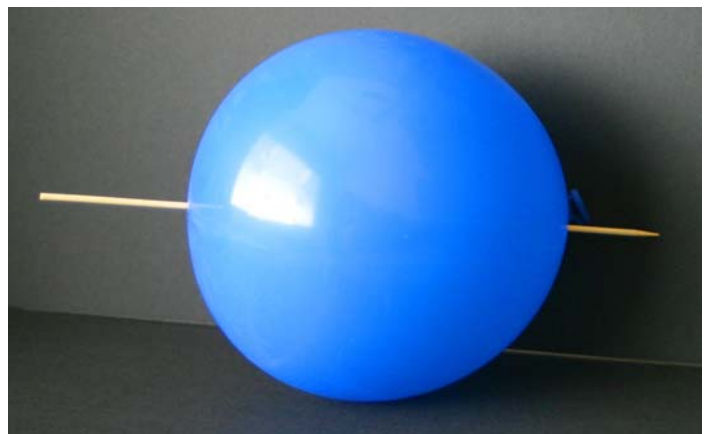


Figure 5. A wood skewer through a balloon.