TAP 601-2: Diffusion of bromine

A classic demonstration that is explained satisfactorily by a particulate model of gases. The students first observe relatively sluggish diffusion of bromine into air. This is followed by the much more rapid diffusion (i.e. expansion) into a vacuum

Almost all gases are transparent and so invisible. The following experiment uses bromine, which is brown; however, this is a dangerous, corrosive gas and great care must be taken.

You will need

- ✓ Vaseline
- ✓ one small brush for cleaning stopcocks
- ✓ vacuum pump
- ✓ pliers
- ✓ 500 ml 1 M (25%) sodium thiosulphate solution
- ✓ two bromine diffusion tubes with matched accessories, including the following:
- ✓ two large bore 8 mm stopcocks
- ✓ two lengths of rubber tubing (length 125 mm, internal diameter 12 mm)
- ✓ two borosilicate glass cap tubes, to hold ampoules
- ✓ two rubber bung no 25 with 11 / 12 mm hole
- ✓ two bromine ampoules

Safety

Wear Safety spectacles

Bromine gas is very toxic and must not be inhaled. The liquid is also corrosive. The teacher must have 500 ml of 1 M sodium thiosulfate solution in a wide beaker so that a hand with a splash of bromine liquid on it can be plunged in immediately. The rubber tubing must fit tightly otherwise the demonstration should be done in a fume cupboard.

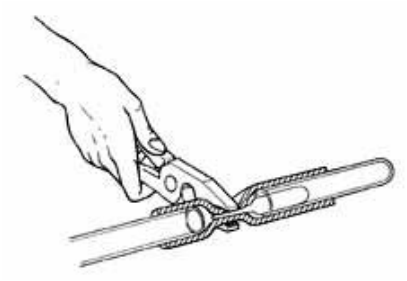
Use safety screens for the vacuum demonstration. Ensure the technician has been instructed in safe disposal and cleaning.

What to do:

Diffusion into air

Initially the bromine capsule is placed in the glass tube and the tap is closed. The diffusion tube is full of air.

1. Slide the capsule down from the glass tube into the rubber tubing.
2. Using square pliers, not side-cutters, break the capsule by squashing the rubber tubing. This will release liquid bromine and it will run towards the tap.



3. Watch carefully, as the tap is opened so that bromine moves into the diffusion tube.
4. Measure how far the average bromine molecule (average density of "brownness") moves in about 20 minutes. Calculate the average speed of a bromine molecule.

Diffusion into a vacuum

1. Initially only the bung and tap are attached to the diffusion tube.
2. With the tap open, use a vacuum pump to extract air from the diffusion tube.
3. Once the air has been extracted from the tube, close the tap then remove the vacuum pump.
4. Using rubber tubing, attach to the tap the glass tube with a bromine capsule inside.
5. Slide the capsule down from the glass tube into the rubber tubing.
6. Using pliers, break the capsule by squashing the rubber tubing. This will release liquid bromine and it will run towards the tap.
7. Watch carefully as the tap is opened so that bromine moves into the diffusion tube. It happens almost instantaneously!

Practical advice

The crucial point to these demonstrations is that the ‘actual’ speed of bromine molecules does not change from one demonstration to the next. Careful questioning of the class will highlight many common misunderstandings. These include the idea that the bromine is being ‘sucked' into the tube in the vacuum demonstration.

Alternative approaches

It may be best to discuss precisely what has been observed without any theoretical inferences. This can be followed up by developing a theoretical explanation of the observations based on the particulate picture of a gas.

Teacher and technician note

Bromine gas is very toxic and must not be inhaled. The liquid is also corrosive. The teacher must have 500 ml of 1 M sodium thiosulfate solution in a wide beaker so that a hand with a splash of bromine liquid on it can be plunged in immediately.

The main diffusion tube is a closed glass tube (45 cm long, 5 cm in diameter) with only one opening to a side tube. There is, therefore, no danger of an accident releasing bromine to the pump when diffusion into a vacuum is done. A rubber bung fits into the side tube and carries the glass tube of the stopcock. The glass tube from the stopcock extends through the rubber bung, thus ensuring that only bromine vapour and not liquid comes into contact with the bung. In any case, the bung can and should be replaced, after a few days' use.

The tube in the rubber bung leads to a stopcock with large bore. This should be of good quality, such as Interkey, with bore at least 8 mm. The tap of the stopcock must be spring-held for safety (but the stopcock may be of ordinary quality, not the special high-vacuum quality). The glass tube that leads out on the other side of the stopcock is joined to a closed glass cap by a short section of rubber tube, in which the bromine capsule is to be broken. That rubber tubing must have a fairly thin wall so that it can be squeezed with pliers to crush the capsule.

With this arrangement, the breaking of the capsule to release bromine is done separately, before the stopcock is opened to admit bromine to the main tube. This enables the experimenter to concentrate on the crushing of the capsule first and then pay full attention to the actual demonstration.

Note

The rubber tubing should not be very short; otherwise there is a danger of pulling it off the glass tube when squeezing it with pliers. Rubber tubing must, of course, have a bore large enough to let the capsule slide into it. The tube belonging to the stopcock and the cap tube must be still larger, so that the rubber tube fits tightly on them.)

If the apparatus meets the above criteria, the experiment may be done in the open laboratory using safety screens. If there is any doubt, the demonstration should be done in a fume cupboard.

External references

This activity is taken from http://www.practicalphysics.org and is based on Advancing Physics chapter 13 activity 160D