

The nitrogen oxide story

Teachers' notes

Objectives

- For students to become familiar with handling information on the student safety sheets.

Outline

This activity has been included as an exemplar of how student safety sheets can be used and it is hoped that the approach will be adopted and used with other chemicals.

Teaching topics

This activity is suitable for 11–14 year olds. It can be used as a stand-alone piece of work. Some teachers may wish to use this to introduce the idea of concentration, stressing that the more concentrated samples of nitrogen oxide will do more damage than less concentrated samples. It could also be used when teaching about elements and compounds.

Teaching tips

This activity could be introduced by discussing some of the material on the student worksheet, such as the meaning of the hazard symbols and the difference between the oxides of nitrogen. This could lead into further discussion about the contexts mentioned on the student sheets. The following points should be noted:

- Many students suffer from asthma and will know that things that irritate the respiratory system have the potential to trigger an asthma attack.
- Not all students will have heard about Alzheimer's disease or Parkinson's disease.
- Not all students will know that nitroglycerine is an explosive.

After a discussion, the student sheets could be set as a homework exercise.

Timing

60 minutes




Answers

1. Toxic – skull and cross bones symbol.
2. Initially it would irritate mouth, throat, and respiratory system. If too much (more than 44 mg m^{-3}) was breathed in the person would be poisoned.
3. (b) a girl who has asthma.
4. Evacuate the laboratory, and open the windows to allow good ventilation.
5. N_2O (laughing gas) is safe to breathe in. It is used as an anaesthetic.
6. $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$ or word equation.
7. NO is a contributor to acid rain and photochemical smog.
8. Use of a catalytic converter, so the engine can run at lower temperatures, reducing the formation of NO.
9. Not very good, a toxin and polluter.
10. Nitroglycerine is an explosive. It has been used to make bombs.
11. During the treatment of heart disease, nitroglycerine releases small amounts of NO into the body. At last NO is being used for something good.

The nitrogen oxide story

Carefully study the safety information for nitrogen oxides to find out what sort of reputation nitrogen oxide really has.

Nitrogen oxides

| Substance | Hazard | Comment |
|--|--|--|
| Nitrogen (mon)oxide (NO) gas |  VERY TOXIC | Very toxic if breathed in. Irritates eyes and respiratory system. For 15-minute exposure, concentration should not exceed 44 mg m^{-3} . Reacts with oxygen in atmosphere to form nitrogen dioxide (see below). May form by the reaction between oxygen and nitrogen in air, especially in car engines. This is a major contributor to acid rain and photochemical smog. The mixture of NO and NO_2 formed in this way is often referred to as NO_x . |
| Nitrogen dioxide (NO_2) and dinitrogen tetroxide (N_2O_4) gas |  VERY TOXIC  CORROSIVE | Very toxic if breathed in. May cause dizziness, headaches and coldness. Irritates eyes and respiratory system. Serious effects may be delayed until after apparent recovery. May trigger asthma attack. For 15-minute exposure, concentration should not exceed 10 mg m^{-3} . Formed as air pollutant from nitrogen monoxide (see above). Formed in laboratory by action of heat on many nitrates, and by nitric acid on some metals. Very soluble in water – risk of suck-back. |
| Dinitrogen oxide (N_2O) “Laughing gas” | LOW HAZARD | Anaesthetic in large amounts. Used as general anaesthetic eg by dentists. |

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Questions

1. Which safety symbol would you use to describe nitrogen oxide (NO) gas?
2. What would happen to you, if you breathed in NO?
3. Which person would be affected the most by a leak of NO gas into the air: (a) a boy with a broken leg, (b) a girl who has asthma, or (c) a girl who has measles?
4. What action should be taken if there was a NO leak in the laboratory?
5. Is it safe to breathe in any of the oxides of nitrogen? Give a reason for your answer.
6. Write an equation for the formation of nitrogen oxide in car engines.
7. Why do you think NO is considered to be a major pollutant?
8. What could be done to reduce the amount of NO given out by vehicle exhausts?
9. What sort of reputation do you think the small gaseous NO molecule has?



In 1977, things started to look up for NO... an announcement was made by Ferid Murad of the University of West Virginia...

Nitroglycerin (another molecule, that used to suffer from bad image problems), commonly used to treat heart disease, releases nitrogen oxide in the body.

10. Find out why nitroglycerine suffered from bad image problems.

11. Why was Ferid Murad's announcement good news for NO?

What happened during the next 20 years?

After the announcement was made by Ferid Murad, scientists were a bit confused and excited at the same time. They had many questions to ask such as:

- What does NO do in the body?
- Could it be the answer to heart problems?
- How much is released?
- Why is it not killing the cells?
- Could NO be the answer to some medical conditions.

A big investigation was carried out and here are some of the results:

- NO instructs blood vessels to relax as they respond to nerve messengers.
- White blood cells use NO to kill bacteria and other disease causing organisms.
- Sometimes the white blood cells get over active and produce too much NO which causes the blood vessels to dilate too much and the patient suffers shock.
- NO is active in the brain and could be responsible for memory. This could help scientists find a cure for Alzheimer's and Parkinson's diseases.
- Viagra, the drug that cures some impotent men, owes its performance to NO.

In 1998, the Nobel Prize for Medicine was awarded to three men, Louis Ignarro, Ferid Murad and Robert Furchgott for the research done into the role of NO in living organisms.

During the 1980s and 1990s scientists discovered the good side of the NO molecule. NO is really a medical wonder molecule. However, most people still regard it as a health hazard. Well, in fact they are right. When you have enough NO around, it is still a pollutant.

12. The NO molecule wants to improve its image. Your job is to design a flyer to market NO and help NO lose its bad reputation.