







- use baking soda to neutralize acids (e.g., aqua regia or piranha solution) until they stop fizzing.
  - use diluted vinegar to neutralize bases (e.g., concentrated KOH or NaOH solutions).
- Many metals will be corroded instantaneously upon contact with acids, generating H<sub>2</sub> gas, resulting in an explosive mixture with air.

## Alkali Metals

- Many metals and metal compounds are toxic. Alkali metals present an additional danger because of their high reactivity. In particular, many groups in JILA work with alkali metals (Li, Na, K, Rb, and Cs).
- You should always wear a face shield and protective goggles, gloves, and a lab coat when working with alkali metals.
- Alkali metals react spontaneously and violently with water as well as with short-chained alcohols (e.g. methanol or ethanol), generating H<sub>2</sub> gas (which can lead to explosions) and metal hydroxides (which are strong bases and highly corrosive). Never bring a piece of alkali metal or a part of your apparatus that is contaminated with alkali metals into contact with water or short-chained alcohols. Alkali metals can even react explosively with ambient humidity (even here in Boulder).
- Obviously, never try to extinguish an alkali metal fire with water, use the correct type of fire extinguisher!
- If you need to clean away alkali metals from equipment parts, use a long-chained alcohol bath (e.g., isopropanol) for a few hours. Remember that the isopropanol has now become a hazardous waste.

## Gas Cylinders

- Nearly all JILA labs use compressed gases. No matter the substance, gas cylinders are hazardous, because the main valve can be sheared off if they topple and strike a bench, laser table, or apparatus. A gas cylinder with a sheared-off valve is a rocket-propelled projectile that can break through concrete walls. Therefore, gas cylinders must always be secured, i.e., strapped to something like a wall that cannot move if the valve is sheared off.
- When you transport gas cylinders, always put on the cylinder's safety cap before you move it, and only use cylinder carts for transportation. Don't "roll" large cylinders on their bottom edge; this is an unstable way of moving gas cylinders.
- Always use the proper reducing valves, pump out the gas lines, and check for leaks before opening a container releasing gases or fumes. These safety precautions are especially important if you work with reactive, toxic, or corrosive gases such as NO, NO<sub>2</sub>, CO, or H<sub>2</sub>S (there are many others!). For some of these (e.g., CO), commercial detectors can be installed in the lab.
- Remember that even if the gases in question are nontoxic (e.g., rare gases or N<sub>2</sub>), they constitute a hazard, because they can suffocate you. Never leave flowing gases unattended. If the pumps fail (e.g., because of loss of electrical power), there can be a dangerous buildup of pressure in your apparatus.
- And, remember to keep flammable gases and oxygen or other oxidizing agents far apart in the lab.

## Fumes

Many of the liquids we use at JILA (and sometimes solids, too) have high vapor pressures at room temperature. Inhaling those vapors is often harmful or toxic, and many are flammable. Use a fume hood for work with such substances. Note that the hood will not work properly if the sash is too high up. Fume hoods have marks on the sides indicating the proper position of the sash for operation. Solvent fumes (e.g., diethyl ether) can make highly explosive mixtures with air, so do not leave bottles open. If you use the common fume hood in the X-Wing, please be aware that any storage must be approved by David Alchenberger (S120, x22389) first. All containers you store there (even for only a few minutes, even if they only contain water) must be marked with the content and with your name.

## Solvents

Many solvents are carcinogenic (e.g., benzene, toluene) or damage the liver (e.g., CCl<sub>4</sub>). Many are absorbed through the skin, and many (e.g., methanol, CCl<sub>4</sub>) are toxic. Most laser dyes are carcinogenic as well. Take care not to spill these solvents on your hands. In fact, all organic chemicals should be regarded as toxic unless you know otherwise (e.g., from reading the appropriate MSDS).

## Radioactive Materials

Some labs work with radioactive substances, especially metals. At JILA, these materials are usually only mildly radioactive, but that does not make them harmless. An example is thoriated tungsten, used for electron gun filaments. Do not grind or sand such materials to avoid generating dust. If you spot-weld thoriated-tungsten filaments, wear a breathing mask to avoid inhalation of dust. Also, take care not to ingest radioactive substances such as thorium. Lungs and other internal organs can be penetrated by alpha radiation, increasing the risk of cancers of the lung, pancreas, and blood. Exposure to thorium internally leads to increased risk of liver disease.

*After you have finished reviewing Chemical Safety Module please see Cindy Torres, JILA Reception to complete the chemical-safety quiz in the Quiz Packet.*