

SECTION I

1

Basic Chemistry Lab Equipment

Here are the some basic lab equipment which find applications in various operations in medicinal chemistry practicals.

Beaker: A beaker is a glass container with a flat bottom and a small spout for pouring. It is used in the chemistry laboratory for mixing, heating, and stirring liquids. Beakers come in various sizes and are shaped like a cylinder.

Crucible: Crucibles are containers used for heating substances to very high temperatures. They are generally made from materials such as porcelain, nickel, and alumina.

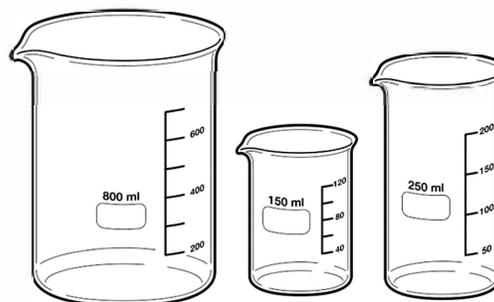
Erlenmeyer flask: This is a type of chemistry flask with a conical shaped body, a cylindrically shaped neck, and a flat bottom. It generally has measurement marks on the side. It is similar to a beaker, but has the cone shaped body. The cone shape reduces losses from evaporation and helps to prevent spills when stirring/shaking the liquid.

Florence flask: It is a round bottom borosilicate glass container with thick walls, capable of withstanding temperature changes.

Volumetric flasks: A volumetric flask is a round flask with a long neck and flat bottom. It is used to measure an exact volume of liquid. There is a small line on the neck that indicates how far to fill the bottle (use the bottom of the meniscus). They come with special caps that will not let anything in or out. Remember that temperature affects volume; therefore avoid using liquids that will fluctuate in temperature (hot water that will cool, for example).

Funnel: A funnel is a pipe with a wide mouth that helps to pour substances into a container without spilling. In a chemistry laboratory, funnels are often used together with filters to separate a mixture.

Gloves: Laboratory gloves are important to wear in order to protect the skin from chemical substances. Always listen to your teacher and make sure to wear gloves when performing experiments.



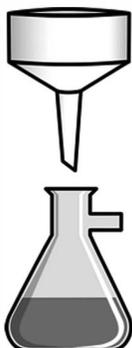
Beaker



Erlenmeyer flask



Volumetric flask



Funnel and buchner flask



Always wear gloves

Goggles: Goggles are very important when performing experiments of any kind. They can keep dangerous chemicals and other substances from damaging your eyes. Always wear your goggles in the lab!

Graduated cylinder: It is a tall skinny cylinder used to measure volumes. It is generally a more accurate way to measure volume than a typical beaker or flask.

Mortar and pestle: A mortar and pestle are used to crush and grind solids into a powder. The mortar is a bowl and the pestle is a small club-shaped tool. They are typically made from ceramic or stone. Mortar and pestle

Pipette: It is a narrow glass tube used to transfer liquids from one place to another. Pipettes sometimes are used for measurement. The accuracy of different pipettes varies widely.

Scoopula: A scoopula is a metal spatula-type utensil used to scoop up solids such as powders in a chemistry lab.

Stirring rod: It is a skinny solid glass rod used in chemistry to mix chemicals and liquids. A stirring rod is typically about the length of a long straw and has rounded ends.



Always wear goggles



Graduated cylinder



Mortar and pestle



Pipette

Test tube: A test tube is a glass or plastic tube used for holding, mixing, and heating small quantities of liquid chemicals. Test tubes often have a flared top to help with pouring. They come in a variety of sizes.

Test tube holder: A stand built for holding multiple test tubes.

Test tube brush: A brush designed to help clean out test tubes.

Test tube clamps: Clamps that hold test tubes while using them to heat up chemicals during a lab experiment.

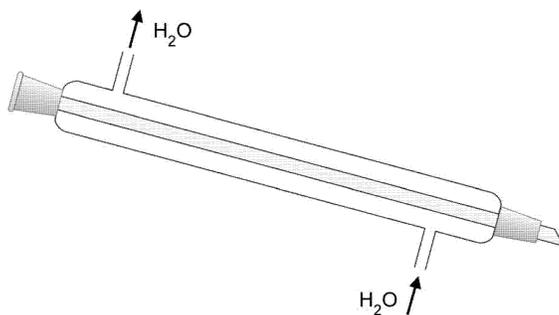
Thermometer: A device used for measuring the temperature of a substance.

Triangle: A triangle made of clay pipes and wire that can withstand high temperatures. It is often used to hold a crucible.

Wire gauze: A wire gauze is used to support a beaker or flask when heating. The wire gauze helps to spread the heat evenly.

Dropper: It is ideal for simple liquid handling for pharmaceutical, laboratory chemical, cosmetic, aroma therapy and herbal uses.

Condenser: It is used to cool hot vapors or liquids. A simple condenser, Liebig condenser, usually consists of a large glass tube containing a smaller glass tube running its entire length, within which the hot fluids pass. The inner tube is cooled with water that passes in the outer tube (shell around the centre tube) in the opposite direction than the one of hot vapour.

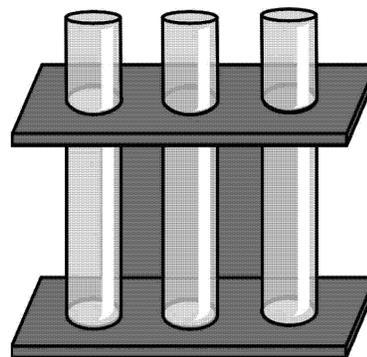


Condenser

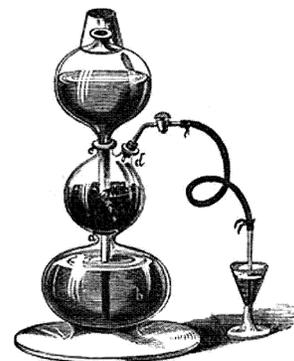
Kipp's Apparatus: It is a laboratory apparatus for producing gas by the action of a liquid on a solid without heating.

Separator Funnel: It is used to separate (*partition*) the components of a mixture into two *immiscible solvent* phases of different *densities*. Typically, one of the phases will be aqueous, and the other a non-polar *lipophilic organic solvent* such as *ether*, *dichloromethane*, *chloroform*, or *ethyl acetate*. All of these solvents form a clear delineation between the two liquids. The two layers formed are usually known as the organic and aqueous phases. Most organic solvents float on top of an aqueous phase, though important exceptions are most *halogenated solvents*. Separator funnel sizes range from 250 ml to 1000 ml

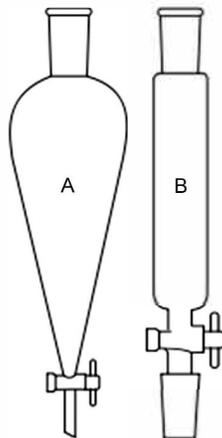
Desiccators: These are used to store dried samples in a dry atmosphere. It is a short glass jar fitted with an air-tight cover, containing some



Test tubes in a holder

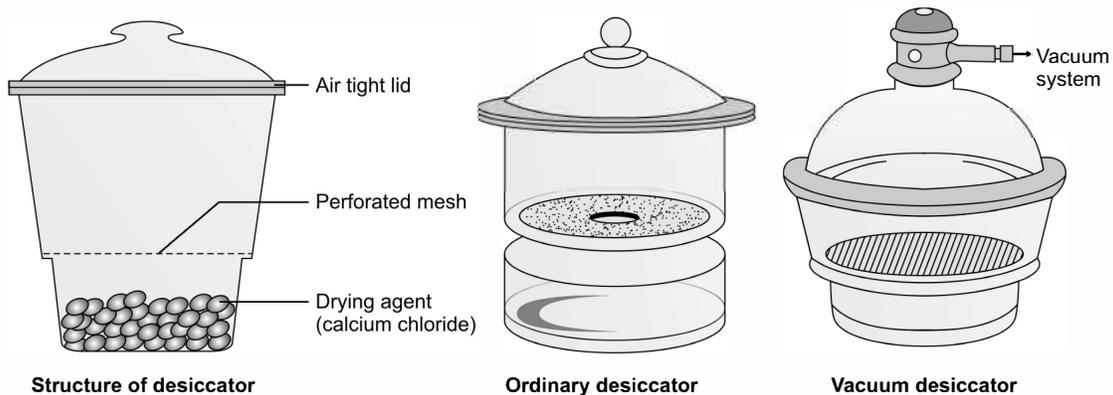


Kipp's apparatus



Separator funnel

desiccating agent such as anhydrous calcium chloride, above which the material is suspended to be dried, or preserved from moisture. It is of two types: (a) ordinary desiccators, (b) Vacuum desiccators. In the vacuum desiccators, there is provision of applying vacuum to provide inert atmosphere.



Structure of desiccator

Ordinary desiccator

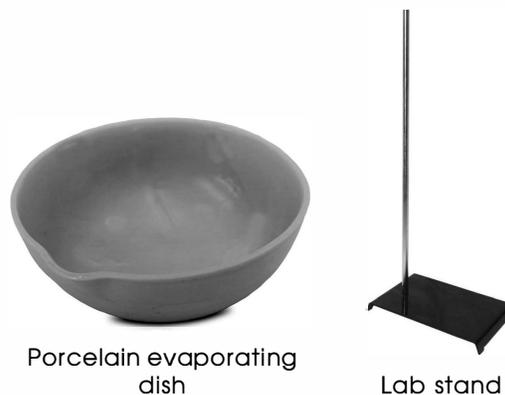
Vacuum desiccator

Desiccators

Porcelain evaporating dishes: It allow separation of solute from a solution, often by applying heat.

Clay Triangles: These are placed on a ring attached to a ring stand as a support for a funnel, crucible, or evaporating dish.

Lab stands: These also come in many different styles: wire stands, tripods, or heavy support stands. Wire stands and tripods can hold beakers or flasks over a burner. Support stands (pictured) are much more versatile and can have various clamps or rings mounted to them to hold several pieces of equipment at once.



Porcelain evaporating dish

Lab stand

Wash bottles: These are plastic bottles with a nozzle at the top for rinsing glassware, cleaning/disinfecting, or applying solutions. They can be filled with a variety of reagents, such as water or alcohol.

Balances: A balance is used to weigh chemicals. The chemicals are always in some form of container and never placed directly on the balance. It is important not to move a balance because they have been calibrated for the exact position they are in. Some balances have plastic housing with small doors to keep air currents from affecting the measurement. Close these doors whenever the balance is in use.

To use a balance to determine the weight of a chemical, first put the empty container that the chemical will be in on the balance. Once you have a reading, press the “tare” or “zero” button on the balance. Remove the container from the balance and add the chemical (never add chemicals to a container while it is on the balance). Reweigh after adding the chemical to find the weight of only the chemical. It is important to keep the balance clean.

Buret: It is used to very accurately dispense volumes of liquid and dispense small measurable amount of liquids.

Watch glass: It is used to hold a small amount of solid, such as product of a reaction. Can also be used as a cover for an evaporating dish or beaker.



Wash bottle



Electronic balance

Heating Devices

Temperature is one of the most important physical variables that is used to control physical, biological and chemical experiments. A common requirement in a laboratory experiment is the need to heat a sample. Several pieces of equipment can do this, including the Bunsen burner, laboratory oven, hot plate, heating mantle and microwave oven.

Bunsen burner: The Bunsen burner is one of the most well-known pieces of laboratory equipment found within school science labs. It consists of a mixing tube which is used to generate a mixture of gas and air. Once lit, the intensity of the flame can be varied by opening or closing an adjustable air hole.

Bunsen burners are typically used to heat beakers of liquid in order to induce chemical reactions. Bunsen burners also pose disadvantages: They cannot control the temperature as accurately as electronic heaters and using an open flame can be dangerous.

Heating mantles: One of the most popular and safest methods to heat a reaction mixture is a **heating mantle**, a resistively heated flexible fiberglass shell that conforms to the shape of the reaction flask. Most heating mantles are hemispherical in design and come in a variety of sizes designed to fit round bottom flasks from 50 ml up to 5000 ml or more. Shown below are three examples of heating mantles. The one on the left has a shell that supports the flask, the middle one has a hemispherical outer aluminum shell and the one on the right has a flexible all-fiberglass design. Most chemists prefer the latter two types because these are easiest to use in combination with a magnetic stir plate. Combination heating/stirring mantles are also available, but are somewhat



Bunsen burner



Heating mantles

more expensive. In a common arrangement in heating mantle, electric wires are embedded within a strip of fabric that can be wrapped around a flask. The current is supplied to the device, and hence, the temperature achieved, is regulated by a thermostat. Heating mantles are commonly used for heating round-bottomed flasks, reaction kettles and related reaction vessels.

Remember that heating mantles are electrical appliances, so follow the appropriate precautions. To prolong the life of your heating mantle, clean up spills (solid or liquid) right away. Except for the cord, mantles are not generally repairable. If the fiberglass becomes brittle or cracked or if any wires are exposed, then discard the heating mantle. Never immerse a heating mantle in water or other liquids (or place these in the mantle) and always use a properly grounded outlet. Do not allow the cords to dangle down the front of the lab bench or hood, a snag/trip danger.

Hot plates: The hot plate is one of the most essential pieces of **laboratory equipment**, used on a daily basis. **Hot plates** are generally used to heat laboratory samples when the desired temperature is 100°C or higher and are preferred because they are the safest heating device since they produce no open flame, and rarely produce sparking. An important part of a **hot plate** is the heating top, which is the flat surface on which the sample to be heated is placed. Most modern heating tops are made out of ceramic, aluminum, or enamel. When choosing a **hot plate**, it is important to pay special attention to what material the heating top is constructed because each material has various performance assets as well as notable liabilities. For example, aluminum **heating plates** distribute heat very well, and very quickly and they are perfect when conducting an experiment that needs to be performed fast and efficiently. They are extremely easy to clean up, and when used correctly, have an outstanding life span often outlasting alternatives by years. One disadvantage of the aluminum-heating top is its sensitivity if it should come in contact with harsh chemicals that can damage the aluminum layer. If the heating top comes in contact with a chemical such as this, it can severely damage the **heating plates** performance. This means that when using an aluminum **hot plate**, care must be taken when using corrosive chemicals.

While ceramic and enamel **heating plates** do not heat up quite as fast as aluminum **heating plates**, ceramic and enamel **hot plates** are extremely durable when it comes to temperature and strong chemicals. Their resistant **heating plate** will allow users to utilize



Hot plates

them for much longer periods than other **heat plate** alternatives without worrying about damaging them with chemicals. They are relatively easy to clean and also rarely conduct heat on the sides of the plate, which could cause injury to the user. The tint of ceramic and enamel **heating plates** is also perfect when using in stirring a sample during which one will be monitoring color change as the color change is much more notable than when one is using an aluminum **heating plate**.

Heating baths: For temperatures up to 100°C, a **water bath** or steam bath is generally employed, although water condensing can be a problem if it is necessary to ensure anhydrous conditions within the reaction.

Water is placed in the vessel, which is heated by means of the flame. For this reason it may be used for nonflammable liquids or for refluxing of low-boiling-point products, but in this case the presence of a naked flame introduces considerable risks of fire. These baths are normally equipped with a series of overlapping concentric rings, which can be removed to give the right size of support for the particular vessel being heated.



Heating baths

If the laboratory is equipped with a steam service, it is convenient to have a series of steam baths. Alternatively, if the laboratory has no external steam service, to avoid naked flames, an electrically heated bath may be utilized and fitted with a constant level device. A resistance connected to a temperature regulator heats water in the bath.

For temperatures above 100°C, **oil baths** are generally used. The bath can be heated with a heating element or on a hotplate. Medical paraffin, glycerol, silicon oil, and cottonseed oil may be employed; it depends on the work temperature. Silicon oils carry a low risk of inflammation, do not give off unpleasant odors, and have a long service life. Synthetic thermal liquids are mainly produced on a hydrocarbon basis and exhibit a low viscosity within the recommended working temperature range. Mineral oil is mainly used for the high temperature range.



Sand bath

Unpleasant odors are kept to a minimum. The silicon fluids are probably the best liquids for oil baths, but they are very expensive for general use. On the other hand, these fluids can be heated to up to 250°C without loss or discoloration.

The sand bath is heating device in the form of container filled with heated sand. It is used to provide even heating for another container, most often during a chemical reaction. It is generally used when more than 100°C temperature is required. It is chemically inert to organic materials, easy to clean up and reuse and does not degrade.

Hot air baths and tube furnaces: Hot air baths are used in the lab as heating devices. Nitrogen is preferred for reactions involving flammable materials. Electrically heated air baths are frequently used to heat small or irregularly shaped vessels. One drawback of the hot air bath is that they have a low heat capacity. As a result, these baths normally have to be heated to 100°C or more above the target temperature. Tube furnaces are often used for high-temperature reactions under pressure.

Heat guns: Laboratory heat guns are constructed with a motor-driven fan that blows air over an electrically heated filament. They are frequently used to dry glassware or to heat the upper parts of a distillation apparatus during distillation of high-boiling materials.

Ovens: Electrically heated ovens are commonly used in the laboratory to remove water or other solvents from chemical samples and to dry laboratory glassware. *Never use laboratory ovens for human food preparation.*

- Laboratory ovens are constructed such that their heating elements and their temperature controls are physically separated from their interior atmospheres.
- Laboratory ovens rarely have a provision for preventing the discharge of the substances volatilized in them. Connecting the oven vent directly to an exhaust system can reduce the possibility of substances escaping into the laboratory or an explosive concentration developing within the oven.
- Do not use ovens to dry any chemical sample that might pose a hazard because of acute or chronic toxicity unless special precautions have been taken to ensure continuous venting of the atmosphere inside the oven.
- To avoid explosion, rinse glassware with distilled water after rinsing with organic solvents before being dried in an oven.
- Do not dry glassware containing organic compounds in an unvented oven.
- Bimetallic strip thermometers are preferred for monitoring oven temperatures. Do not mount mercury thermometers through holes in the top of ovens so that the bulb hangs into the oven. If a mercury thermometer is broken in an oven of any type, turn off and close the oven immediately. Keep it closed until cool. Remove all mercury from the cold oven with the use of appropriate cleaning equipment and procedures in order to avoid mercury exposure.

Microwave ovens: Use microwave ovens specifically designed for laboratory use. Domestic microwave ovens are not appropriate. Microwave heating presents several potential hazards not commonly encountered with other heating methods: extremely rapid temperature and pressure rise, liquid superheating, arcing, and microwave leakage. Microwave ovens designed for the laboratory have built-in safety features and operation procedures to mitigate or eliminate these hazards. Microwave ovens used in the laboratory may pose several different types of hazards:

- There is a risk of generating sparks that can ignite flammable vapours.
- Material placed inside microwave may overheat and ignite.

Magnetic stirrer: It is a laboratory device that employs a rotating magnetic field to cause a stir bar immersed in a liquid to spin very quickly, thus stirring it. The rotating field may be created either by a rotating magnet or a set of stationary electromagnets, placed beneath the vessel with the liquid. It may contain a heating element, fixed in the magnetic stirrer. Speed of magnetic stirrer and heating are controlled by separate knob.

Fumehood: It is a laboratory equipment designed to limit exposure to dangerous fumes. The air inside the fume is either vented to the outside or else filtered to the outside and re-circulated.



Magnetic stirrer