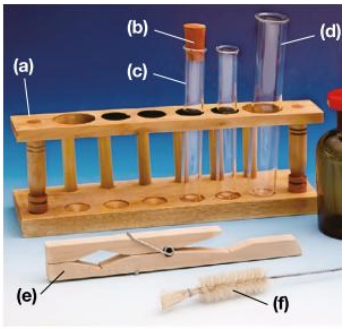
Intensive notes (Laboratory safety)

Common apparatus in the laboratory

A. Test tubes

- Test tubes are the most common tools in a chemistry laboratory. They are placed in a **test tube rack** when not in use.
- **Test tube holder** can be used to hold a test tube near its mouth
- Large test tubes are also called boiling tubes. They are used to boil a larger amount of liquid

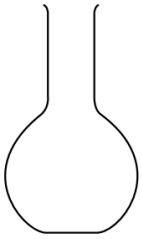


(a) Test tube rack
(b) Rubber stopper
(c) Test tube
(d) Boiling tube
(e) Test tube holder
(f) Test tube brush

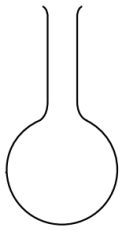
B. Beakers

- Different sizes are available. Beakers can be used for holding and heating a large volume of liquid.

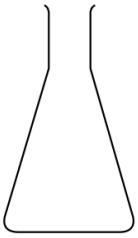
C. Flasks



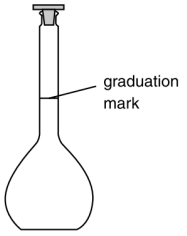
Flat-bottomed flask



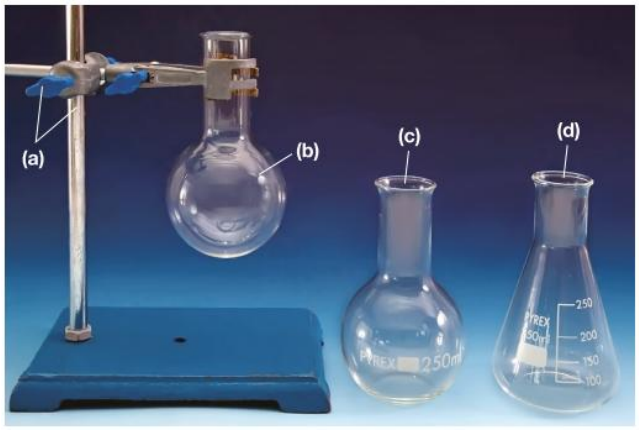
Round-bottomed flask



Conical flask



Volumetric flask

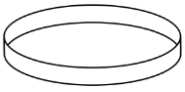


(a) Stand and clamp
(b) Round-bottomed flask
(c) Flat-bottomed flask
(d) Conical flask

D. Watch glass and Petri dish

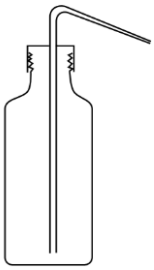
- They are used for temporary storage of solids and sometimes liquids.

Watch glass

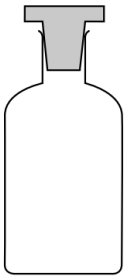


Petri dish

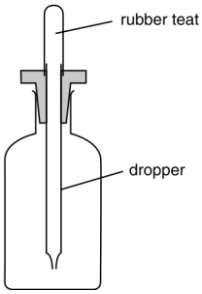
E. Bottles



plastic wash bottle



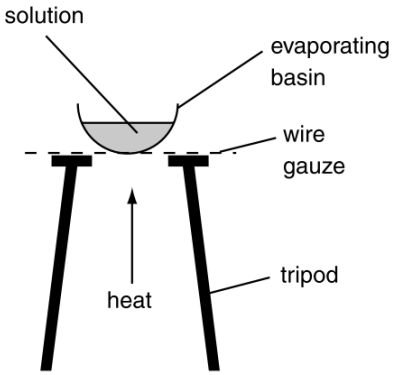
reagent bottle



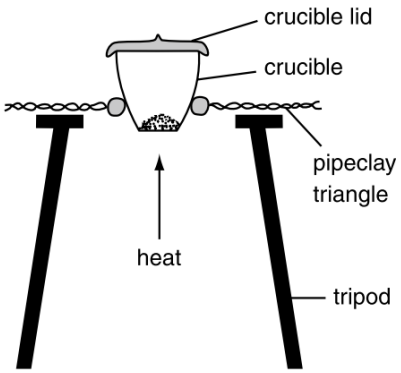
dropping bottle

F. Evaporating basins and crucibles

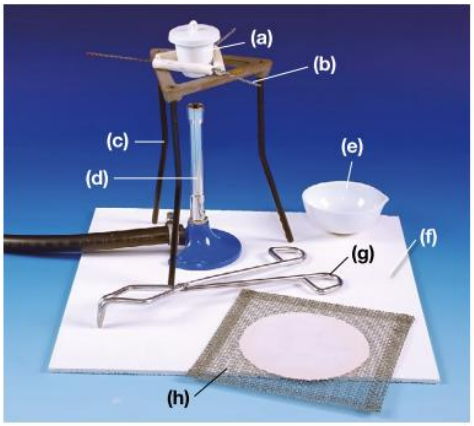
- Evaporating basins (or evaporating dishes) are used to **evaporate solutions**
- Crucibles are made of porcelain. They are used to hold substances for **very strong heating**. A pipeclay triangle is used to support a crucible on a tripod for heating. A hot crucible can be handled with crucible tongs



Evaporating a solution in an evaporating basin.



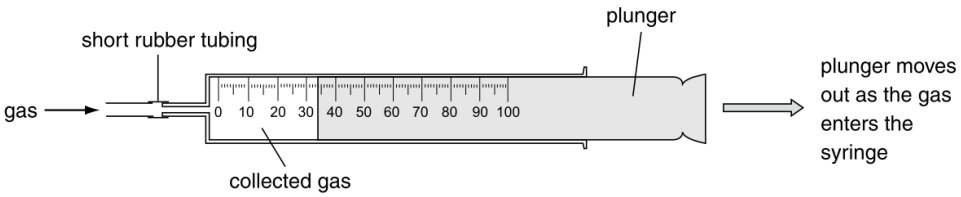
Very strong heating a solid in a crucible



(a) Crucible (with lid)
(b) Pipe-clay triangle
(c) Tripod
(d) Bunsen burner
(e) Evaporating dish
(f) Heat-resistant mat
(g) Crucible tongs
(h) Wire gauze

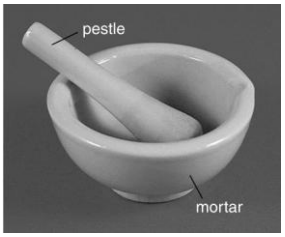
G. Gas syringe

A gas syringe is used to collect a gas or to measure the volume of a gas



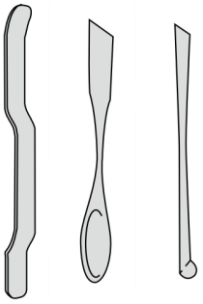
H. Mortar and pestle

- The mortar and pestle are used to grind a solid into a fine powder

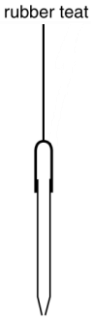


I. Spatulas, droppers, teat pipettes, glass rod and thermometer

- Spatulas are used to pick up small amounts of solids
- Droppers and teat pipettes are used to add drop quantities of a liquid
- A glass rod is used for stirring
- A thermometer is used to measure temperature



Different kinds of spatulas



Dropper

Teat pipette

Glass rod

Thermometer

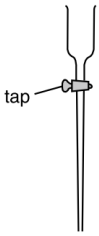
J. Funnels

Filter funnel

(For filtration and addition of liquid)

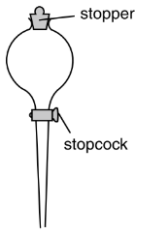
Thistle funnel

(For addition of liquid during gas preparation)



Tap funnel

(For controlled addition of liquid during gas preparation; escape of gas through the funnel can be prevented by closing the tap)

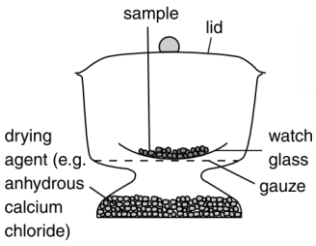


Separating funnel

(For separation of two immiscible liquids)

K. Desiccator

- Can keep solids or liquids out of contact with the moisture from the air by placing them in a desiccator
- A desiccator contains a drying agent such as anhydrous calcium chloride or silica gel



L. Balances

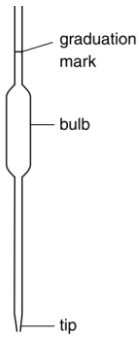
- For accurate weighing, you should use an electronic balance.
- You should place chemicals to be weighed on a filter paper or in a weighing bottle, not directly on the balance pan.

Analytical balances

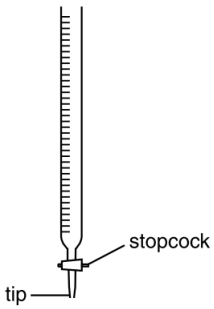
Top-loading balances

M. Pipette, burette, volumetric flask, measuring cylinder

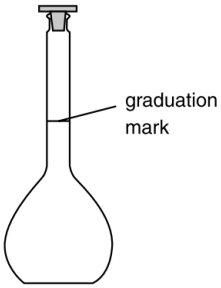
- For pipette, burette and volumetric flask, they are used to make **accurate** measurements of liquid volumes
- For measuring cylinder, it is used to make **rough** measurements of liquid volumes



Pipette



Burette

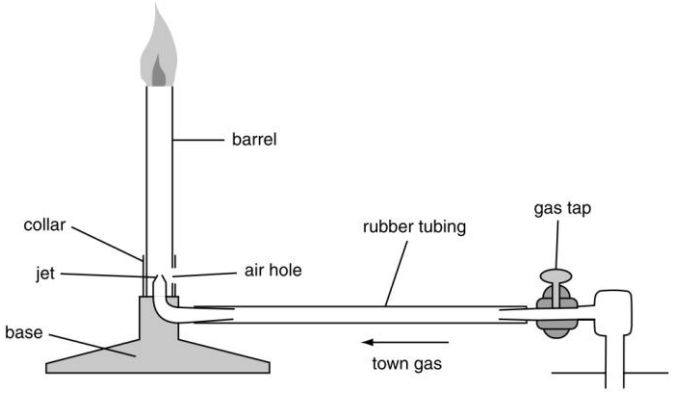


Volumetric flask

Measuring cylinder

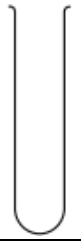
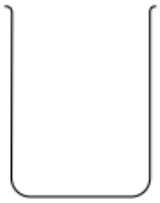
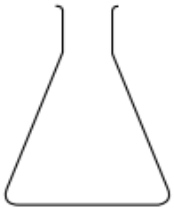
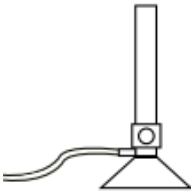
N. Bunsen burner

- It is the main heating source in the laboratory
- To light a Bunsen burner, close the air hole first. Put a lighted match near the top of the barrel. Then turn on the gas tap. Open the air hole slowly, until the flame changes from luminous to non-luminous.



- The gas tap controls the supply of gaseous fuel, hence the size of the flame.
- The air hole controls the air supply, hence the luminosity and temperature of the flame.
- When the air hole is open, a lot of air mixes with the gaseous fuel, thus burning is more complete. The flame is non-luminous and blue, with a high temperature
- When the air hole is closed, little air is mixed with the gaseous fuel. Burning is incomplete, resulting in a flame which is luminous and yellow, with a lower temperature

Vertical section diagrams of common laboratory apparatus

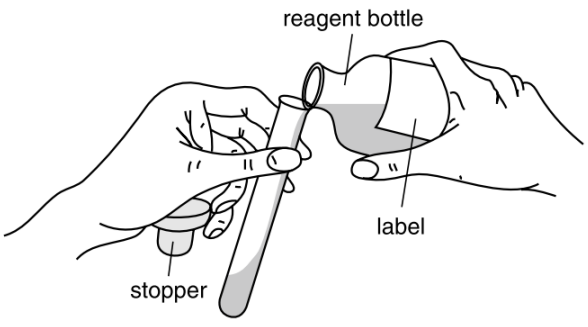
				
Test tube	**Beaker**	**Measuring cylinder**	**Filter funnel**	**Conical flask**
				
Round-bottomed flask	**Evaporating dish**	**Watch glass**	**Wire gauze**	**Bunsen burner**
				
Tripod	**Dropper**	**Glass rod**	**Thermometer**	**Crucible**

Laboratory techniques

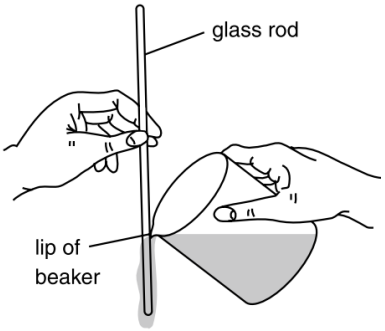
A. Transferring solids

- You can transfer a solid chemical into a test tube, using a clean dry **spatula**.
- Never put any chemicals back to the reagent bottle.

B. Transferring liquids



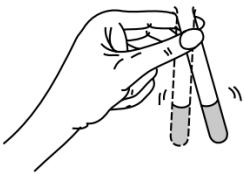
Transfer a liquid from a reagent bottle



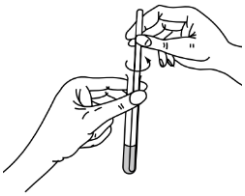
To pour a liquid from a beaker

C. Mixing substances in test tubes

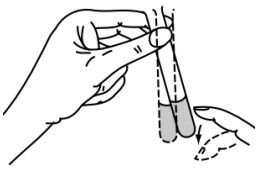
- There are 5 possible ways to do this.



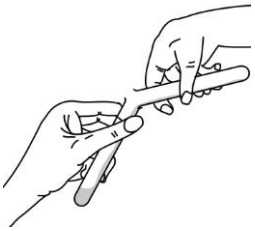
Shake the test tube gently.



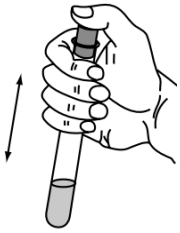
Stir with a glass rod.



Tap the bottom of the test tube with the index finger.



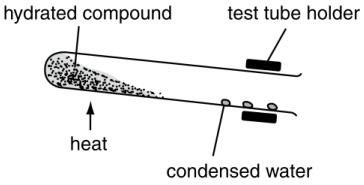
Pour the contents to and fro between two test tubes.



Stopper the test tube and shake (vigorous shaking is required).

D. Heating a solid

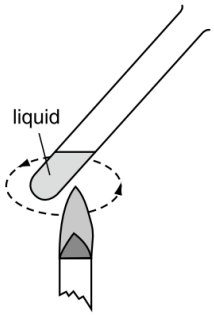
- For a solid which does not give off water during heating, hold the test tube horizontally, with the solid forming a shallow layer along the tube.
- For a solid which gives off water during heating, hold the test tube slightly sloping downwards. This prevents the condensed water (at the mouth of the tube) from running back and cracking the hot glass.
- To heat a solid very strongly, heat it in a crucible.



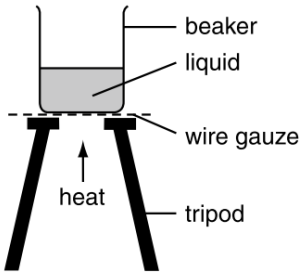
E. Heating a liquid

For heating a non-flammable liquid in a test tube:

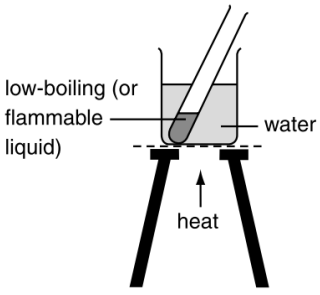
- Wear safety spectacles.
- Do not fill a tube with a liquid to more than one-third of its capacity.
- Hold the test tube near the top with a test tube holder
- Use a small non-luminous flame for heating.
- Never point the test tube to anyone during heating.
- Swirl the tube continuously during heating, so that the heating is uniform.



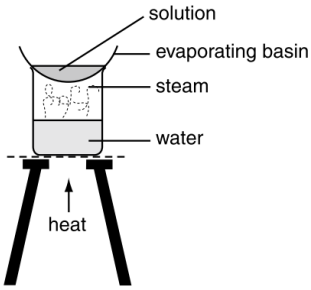
Other heating methods:



Heat the liquid (with a large quantity) in a beaker on a tripod and wire gauze

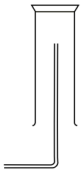
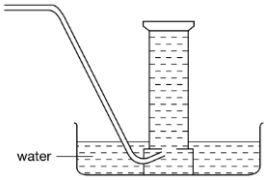
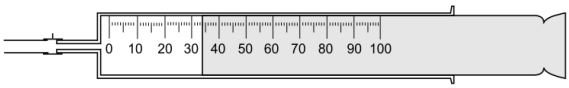


Heating a volatile or flammable liquid using a water-bath (us an oil-bath if a higher temperature is required.



Use a steam-bath to evaporate a solution quickly

F. Collecting gases

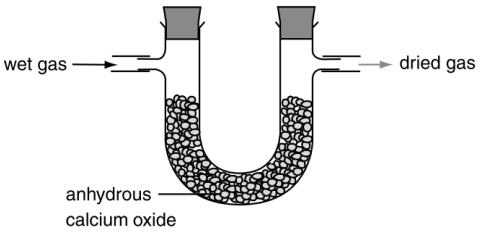
	
Upward delivery / Downward displacement Collect gases that are less dense than air (gases with molar mass << 28) Examples: Hydrogen, methane, ammonia	**Downward delivery / Upward displacement** Collect gases that are denser than air (gases with molar mass >> 28) Examples: Carbon dioxide, chlorine, sulphur dioxide
	
***Displacement of water** Collect water-insoluble gases. But the gas collected is wet	**Using gas syringe** Collect any gas

*If the gas being collected comes from a heated vessel, the delivery tube must be removed from water before heating is stopped. This is because once heating is stopped, water vapor condenses and the gas inside the vessel contracts due to a drop of temperature. A partial vacuum is thus created in the vessel. If the end of delivery tube had not been removed from under water, water would be sucked back via the delivery tube into the hot vessel. This 'sucking back' of water might crack the hot glass vessel

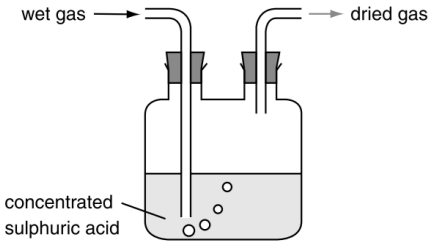
G. Drying solids

- You can use an oven to dry solids. (Note: To dry hydrated salts, the temperature of the oven should be set below 105°C. Otherwise, the water of crystallization would be removed.)
- For preparing dry crystals, they can also be dried using filter papers.

H. Drying gases



Anhydrous calcium oxide (Drying ammonia)



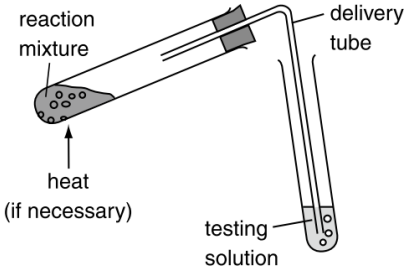
Concentrated sulphuric acid (Drying acidic gases)

I. Smelling gases

- In doing experiments, smell gases only if necessary. Also, do it with great caution. (Many gases are toxic!)
- Do not smell a gas by breathing in directly above the test tube. You should hold the tube about 15 cm away from the nose; then 'fan' a little of the gas towards your nose.

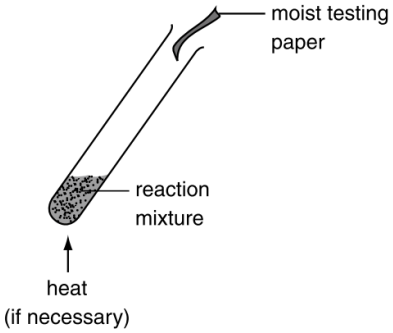
* Many gases and vapours are very poisonous. A person who has suffered from gas poisoning must be removed from the laboratory at once, to open areas. Smelling salt may be applied if he has fainted. After receiving first aid, he should be sent to the hospital by ambulance.

J. Testing gases



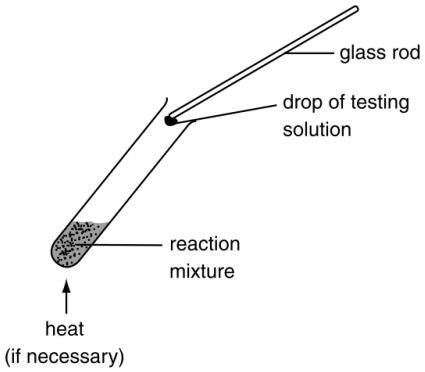
Using a delivery tube

Bubble the gas evolved through a testing solution



Using a testing paper

Test a gas by holding a moist testing paper in the mouth of the reaction vessel



Using a glass rod

Hold the rod (with 1 drop of testing solution) in the mouth of the reaction vessel. Observe carefully the drop of testing solution and look for any fumes produced.

*If the reaction mixture is being heated, always take out the delivery tube from the testing solution before removing the flame. This is to prevent sucking back of the solution.

Storage of chemicals

A. To prevent contact and reaction with air:
   - Potassium and sodium are kept under **paraffin oil**
   - Yellow phosphorus is kept under **water**.

B. Flammable and volatile liquids are stored in a **cool place, away from direct sunlight and heat source.** Their containers should **never be completely filled**.

C. Chemicals that absorb water are kept in **well-sealed containers**.
   - Examples include aluminium chloride, sodium hydroxide, potassium hydroxide, concentrated sulphuric acid

D. Chemicals that will decompose quickly in the presence of light are kept in **brown bottles**.
   - Examples include concentrated nitric acid, silver nitrate solution, hydrogen peroxide solution, chlorine water and bromine water.

Advantages of microscale experiments

- Reduce the amount of chemicals used
- Reduce chemical wastes produced
- Save the cost of chemicals used
- Complete the experiment in a shorter period of time
- Minimize chemical hazards

Intensive notes (Laboratory safety)

Hazardous chemicals

Hazardous nature	Examples	Safety precautions
 (A substance which may explode if ignited, exposed to heat or due to a shock or friction)	- Old stock of potassium and sodium - Ammonium dichromate - 2,4-dinitrophenylhydrazine	- Keep away from heat and naked flames - Avoid shock or friction - Make sure the container is properly stoppered
 (A substance which may start a highly exothermic reaction when in contact with easily oxidizable materials. It can create a fire risk)	- Concentrated sulphuric acid - Concentrated nitric acid - Potassium permanganate - Potassium dichromate - Potassium iodate	- Make sure the container is properly stoppered - Keep away from heat and naked flames - Keep away from metals, combustible and flammable chemicals - Avoid contact with the eyes and skin; if any concentrated acid is accidentally spilt into the eyes or onto the skin, wash the affected area with running water for at least 3 minutes and go for medical check-up
 (A substance which can catch fire easily under ordinary conditions.)	- Hydrogen, carbon monoxide, LPG, town gas - Methanol, ethanol - Yellow phosphorus, sulphur, potassium, sodium	- In case of solids or liquids, make sure the container is properly stoppered - In case of gases, make sure there is no leakage into the laboratory - Keep away from heat and naked flames
 CARCINOGENIC 致癌物 (A substance which would cause cancer or be suspected to cause cancer)	Known: Benzene, asbestos Suspected: Tetrachloromethane, trichloromethane, nitrobenzene	- Must wear a laboratory coat, safety spectacles and gloves - Perform the experiment in fume cupboard - Make sure the container is properly stoppered - Avoid breathing in their vapors / particles - Should avoid using carcinogens at schools

Hazardous nature	Examples	Safety precautions
 (A substance, which if breathed in / swallowed / absorbed through the skin, may involve serious health risk or even death)	- Chlorine, hydrogen sulphide, carbon monoxide, nitrogen dioxide, sulphur dioxide - Bromine, carbon disulphide, methanol - Cyanides, lead compounds, mercury and its compounds	- Perform the experiment in fume cupboard - In case of solids or liquids, make sure the container is properly stoppered - Avoid breathing in their gases / vapors / particles - Wear gloves (if gloves are not used, wash hands thoroughly after handling chemicals)
 (A substance, which if breathed in / swallowed / absorbed through the skin, may involve limited health risk)	- Trichloromethane - 1,1,1-trichloroethane - Iodine, oxalic acids, oxalates	- Avoid breathing in their vapors / particles - Avoid contact with the eyes and skin; if accidentally spilt into the eyes or onto the skin, wash the affected area with a lot of water - The laboratory should be well ventilated
 (A substance which would destroy living tissues upon contact)	- Hydrogen chloride - Bromine, concentrated mineral acids, concentrated ethanoic acid, concentrated ammonia, concentrated hydrogen peroxide - Potassium, sodium, sodium hydroxide, potassium hydroxide, silver nitrate	- Wear a laboratory coat, safety spectacles and gloves - Perform the experiment in fume cupboard - Handle them with care, especially when they are hot or being heated - Avoid contact with the eyes and skin; if any concentrated acid is accidentally spilt into the eyes or onto the skin, wash the affected area with running water for at least 3 minutes and go for medical check-up
 (A non-corrosive substance but can cause inflammation or reddening of the skin)	- Dilute mineral acids, - Aqueous ammonia - Ammonium dichromate, potassium dichromate	- Avoid contact with the eyes and skin; when accidentally spilt into the eyes or onto the skin, wash the affected area with a lot of water