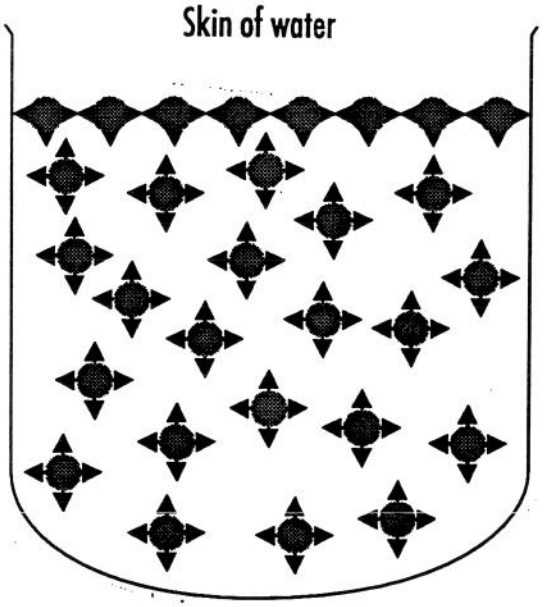
Although the cohesive forces (forces of attraction) between particles in liquids are relatively weak, the strength of these forces vary from one liquid to another. In water they are quite strong, giving water some unique properties not seen in other liquids. Because water molecules are attracted to each other, water beads when a drop is placed on wax paper or one glass. In a container of water, the surface molecules strongly attract each other generating surface tension which forms a *skin* that is relatively difficult to break through. This *skin* can support razor blades, stick pins, paper clips, and other objects much more dense than water and which normally should sink.



Matter, in whatever state, can generally be mixed. Particles of solids can be mixed with other particles of solids, solids with liquids, gases with liquids, and gases with gases. A mixture results when the particles of one substance are mixed with those of another substance in any proportion. Lots of natural and man-made substances are mixtures including soil, air, rocks, wood, steel, fresh and salt water, paints, and even blood.

When one substance is mixed in another so that it is uniformly dispersed throughout, the mixture is called a *homogenous* mixture. If one substance is unevenly mixed with the other, the mixture is said to be a *heterogeneous* mixture. A *solution* is a special homogeneous mixture formed when one substance is dissolved in another. *Dissolving* is a process by which the particles of one substance become completely intermingled with those of another and remain that way indefinitely. Skimmed milk and tea are both of solutions, consisting mainly of water.

We are most familiar with solutions in which a solid substance is dissolved in a liquid. Solutions will also form when a liquid is dissolved in another liquid, or a gas in a gas. Liquid metals can be mixed to form solutions and when they solidify form a kind of solid solution. In solutions, the substance being dissolved (usually the substance of smaller quantity) is called the *solute*, and the substance doing the dissolving (substance of larger quantity), is the *solvent.*

Mixtures can be separated, some more easily than others. The techniques that can be used depend upon the kind of mixture one is dealing with and the properties of the substances making up the mixture.

1. Mixture of solid and solid:

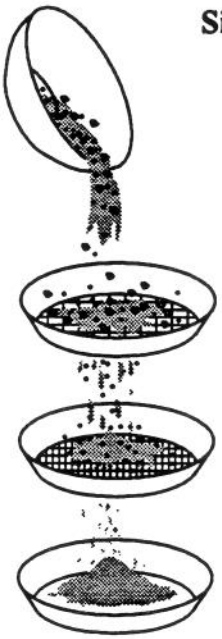
   a) Sieves - various gauges of sieves can be used to separate different sizes of solid particles.

   b) Magnets - magnetic substances can be separated from non-magnetic substances.

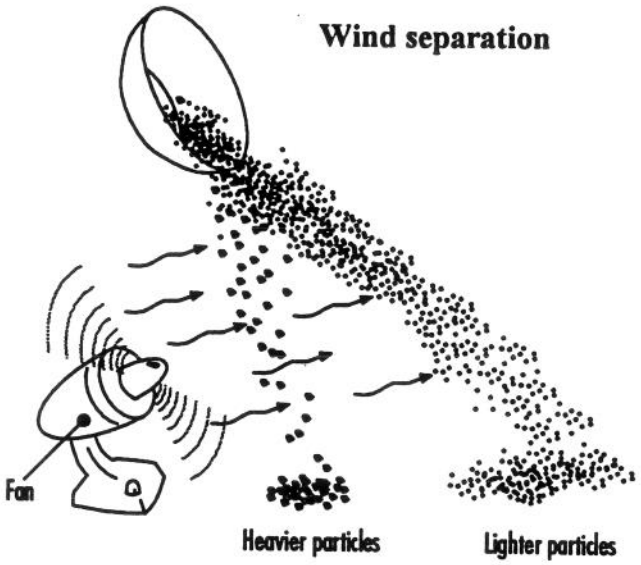
   c) Wind - lighter substances that can be moved by a light breeze can be separated from heavier substances that fall straight down in the breeze.

   d) Water - floating materials can be separated from materials that sink in water.

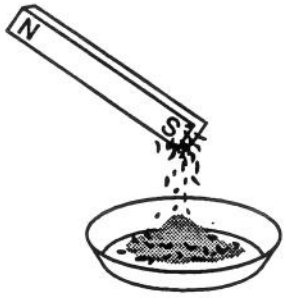
Sieving



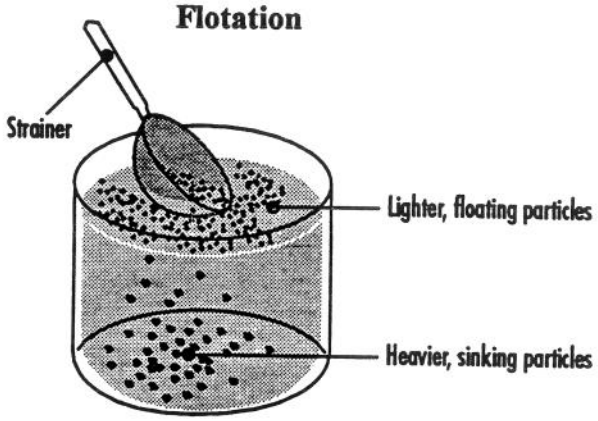
Wind separation



Magnetic Separation



Flotation

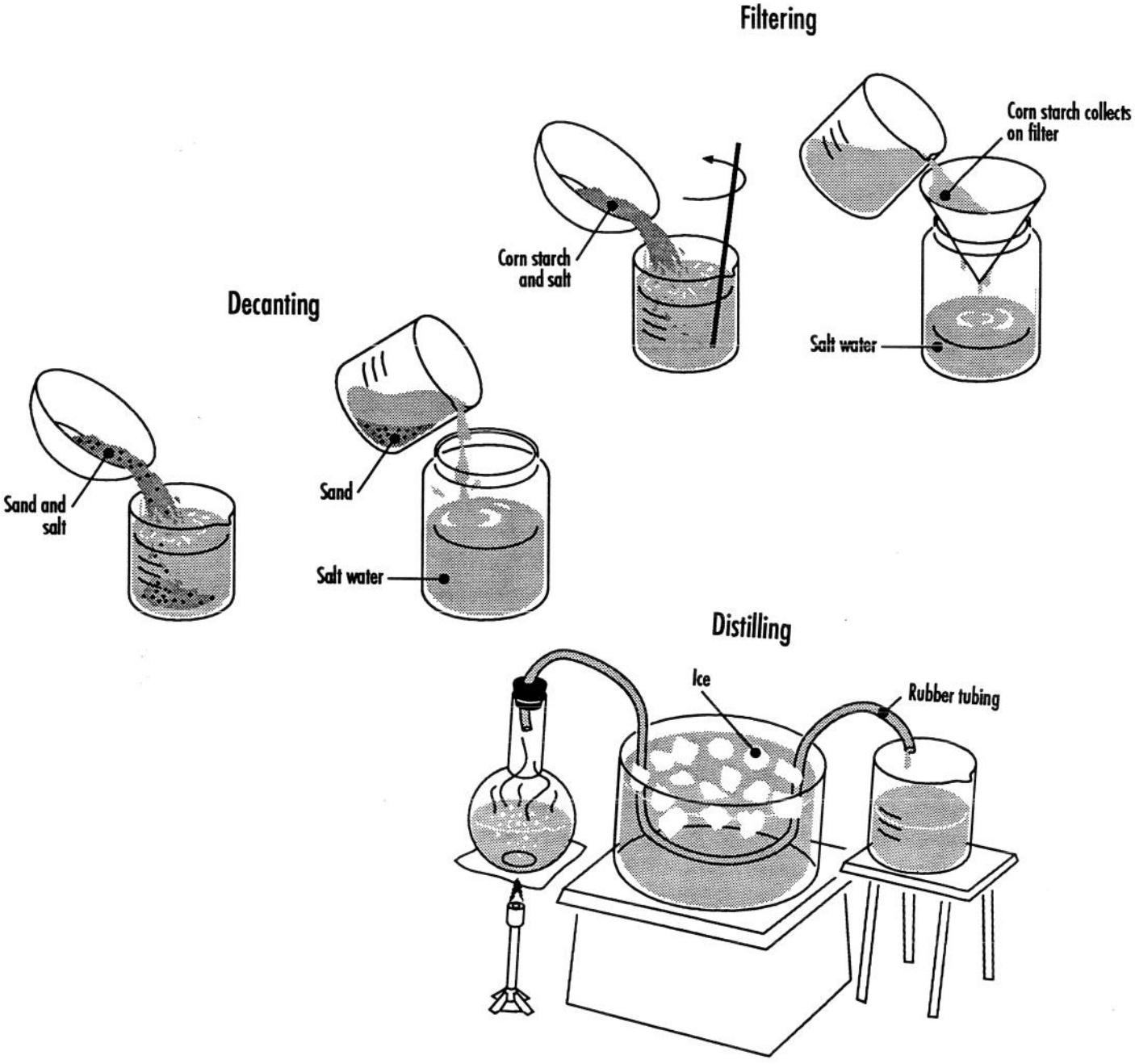


2. Mixture of solid and liquid:

a) Evaporating - soluble or insoluble solids can be recovered by evaporating the water. The water is lost into the air as it evaporates while the solid, whether dissolved or not, remains behind forming a residue.

b) Decanting - insoluble solids that settle out in water can be recovered by pouring off the water and letting the wet residue dry out.

c) Filtering - insoluble solids can be stirred up to form a suspension which can then be poured into a filtering system. The water will pass through the filter but the insoluble substance will collect on the filter.



3. Mixture of a liquid and liquid:

a) Decanting - where two liquids do not mix, the top liquid is paired off or removed with an eyedropper.

b) Distilling - heat the mixture of liquids in a distilling apparatus. The temperature will rise to, and remain at, the boiling temperature of one liquid until all of it boils off. Then, it will rise to the boiling temperature of the next liquid and so on. The vapors of each substance are collected in a tube which passes through a cooling system condensing the vapors back to a liquid in a container.

4. Mixture of a liquid and a gas:

a) Heating - cold liquids including water will dissolve more gas than warm liquids. Heating the liquid drives the gas out of solution.

5. Mixture of a gas and a gas:

a) Liquefying - cool the mixture of gases down until one becomes a liquid. This requires cooling to a very low temperatures (-200°C). The liquid can easily be separated from the gas.

If a soluble solid is stirred into water until the water cannot dissolve anymore of that substance, then the solution formed is said to be saturated at that temperature. If the solution is then cooled, the water will be able to hold less dissolved solute, so some of the substance will come out of solution. If the particles coming out of solution fit together in a crystalline structure, much like building blocks, a crystal will begin to form. Crystalline shape and colour is different for different substances. The largest crystals will form when a hot saturated solution is cooled slowly giving the first crystals to appear, time to grow.

Matter does not always remain the same; it will undergo change depending upon conditions. Some of these changes are reversible, others are not. For example, dissolving a substance, changing its state, mixing it with other substances, or even changing the shape of a substance in many cases, are all examples of a *reversible* change because the substance can be brought back to its original form. *Irreversible* change, or change that is very difficult to reverse, occurs in a chemical reaction where one or more substances interact to form new substances with different chemical and physical properties. In a chemical reaction the atoms of the elements involved are not altered, but instead they are rearranged to form new molecules thus new substances. A familiar example of a chemical reaction is rusting. The iron in the nail combines with oxygen from the air to form rust (iron oxide). Getting the iron back in pure form is possible but difficult to do. A colour change is associated with rusting and with many other chemical reactions. In other cases, bubbles of gas might indicate a chemical reaction, if one of the new substances formed in the reaction is a gas. This is what happens when vinegar and baking soda are mixed. This, however, is not what happens in boiling. The bubbles that rise off the bottom in a pot of boiling water are bubbles of steam (water vapor), a physical change