of which impurities are present. A price list of chemicals from one of the suppliers will usually list the following categories:

purity

"Spectrographic grade" or "Spec-Pure" — very, very pure
"Analar" — very pure
"Commercial grade" or "Industrial grade" — fairly pure.

Industrial grade is usually quite adequate for conservation purposes unless it is known that an unwanted reaction with one of the impurities can occur. With organic solvents such as acetone there is occasionally an undesirable residue after evaporation. Spectrographic grade is only needed in chemical analysis where it is important that no stray compounds interfere with the detection and measurement of very small quantities of material. Generally, because of the effort involved in removing the last traces of impurities, you will pay a lot more for a very nearly pure chemical than one where there is a higher proportion of impurities. Compare the price of supermarket washing soda with that of "Analar" sodium carbonate.

F Physical and chemical changes

Changes in the condition of materials are always important to the conservator. The deterioration of objects to a state where they need active conservation treatment is the result of change. You work to arrest those changes, at least, and sometimes to reverse them. The changes during both deterioration and conservation treatment can be classified as either **physical changes** or **chemical changes**.

physical changes
chemical changes

A *physical* change of condition involves a rearrangement of the molecules without any change in the structure of the individual molecules. *Chemical* changes involve rearrangements of atoms among molecules to create new molecular structures.

The components of a mixture can be separated by a physical change, whereas when the atoms in a molecule are permanently separated a chemical change has taken place.

A great deal of conservation treatment uses physical changes. If you blow the dust off a museum exhibit you have merely moved the dust from one place to another, you haven't wrought any chemical changes upon its molecules. Similarly when wax is used as a thermoplastic adhesive (for example, in attaching a lining canvas onto the back of an original canvas) it is melted by heat and flows into the two canvases. When it cools the molecules of wax cease to move and begin to hold the canvases together. This is a physical change. Another physical change occurs when a spirit varnish, like a solution of Ketone-N in white spirit, dries on a surface. The solvent, white spirit, evaporates, leaving a film of resin behind. The solvent molecules have left the surface and the resin molecules have remained; there has been no rearrangement *within* the molecules.

The tarnishing of silver, however, is a chemical change. Silver atoms combine with sulphur atoms to form black silver sulphide. The corrosion of bronze and the rusting of iron are also chemical changes.

It is not always easy to differentiate between physical and chemical changes. Cleaning processes involving solvents or washing with detergents are examples where the distinction between physical and chemical changes is more blurred since both may be involved. (Consideration of these processes will be left until Book II.)

G How chemical reactions happen

During the course of this chapter you will have come to think of the molecules of a compound as atoms bonded together into characteristic patterns. Chemical change has been explained as a rearrangement of atoms among molecules. To understand how these changes can happen you need to know what causes the atoms to break their bonds to form new patterns.

When a substance is heated the atoms and molecules move with increasing speed, and so, you can imagine, they run increasing risks of colliding, and with greater impact. As they collide with one another the particles may join together or knock parts off each other. These fragments may recombine to form new combinations of atoms. The more stable (strongly formed) a molecule is, the stronger the forces that are needed to break it up and cause it to react chemically, that is to make new combinations. This image of particles in constant movement, with the movement increasing with the increase of temperature, explains why chemical reactions tend to go faster at higher temperatures. As the collision speeds of particles get higher molecules may start to break at more points in their structure, creating a greater variety of pieces free to combine and form a range of fresh molecules. It is also likely that while parts of molecules are randomly moving and colliding together they may temporarily bond to form an unstable mass which easily falls apart to form yet other molecules which may be more stable (firmly bonded together).

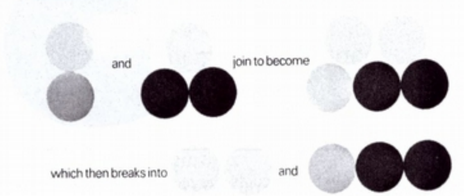

Figure 2.3 *One possible way in which molecules may collide, join, and then break up during a reaction.*

As a conservator, you will quickly understand from this that there are good reasons why, if the instructions for a chemical treatment of an object specify a temperature, you should keep to it. Otherwise the proposed reaction may go too fast to allow control or reactions different from those intended may occur.