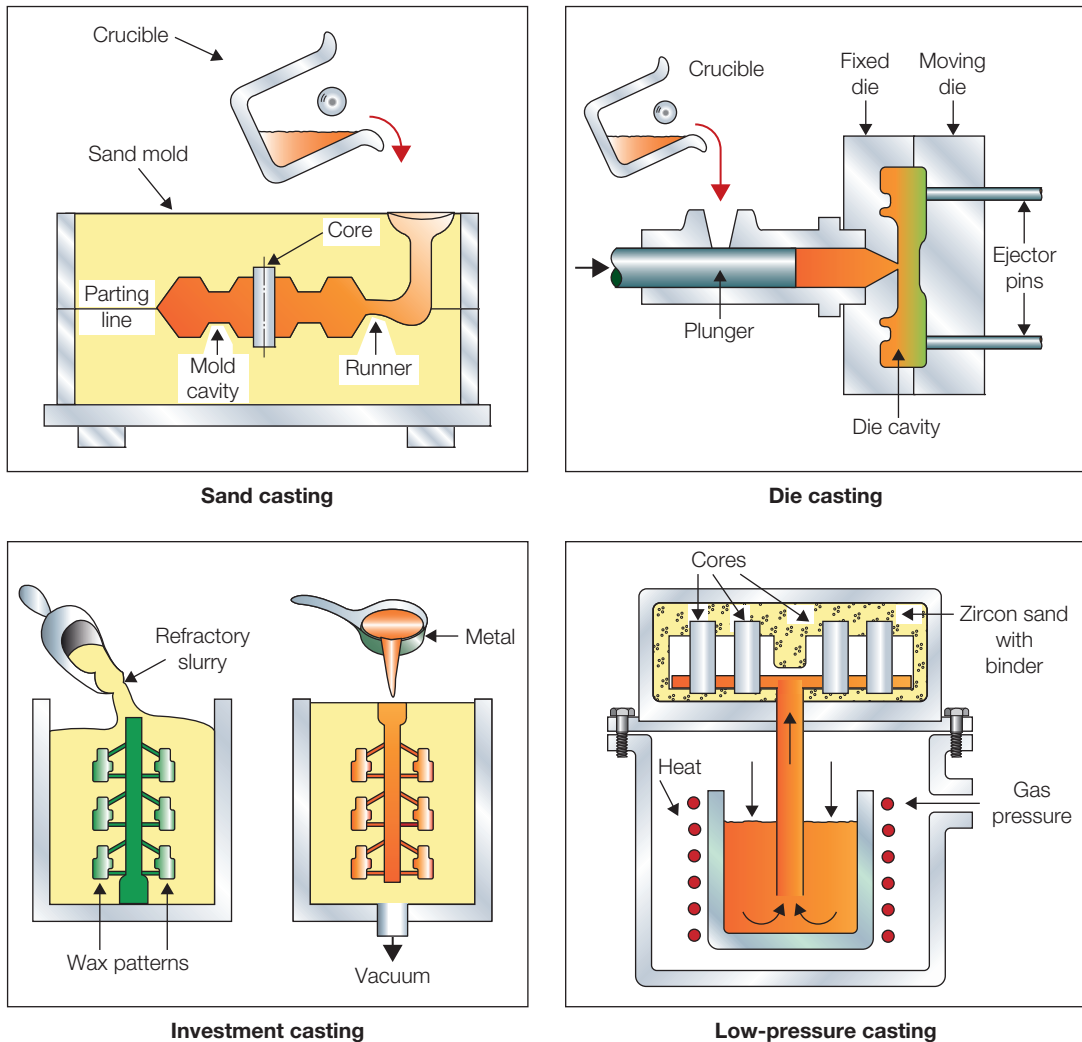


13.3 THE PROCESSES: SHAPING, JOINING, FINISHING

Shaping processes

In *casting* (Figure 13.5), a liquid is poured or forced into a mold where it solidifies by cooling. Casting is distinguished from molding, which comes next, by the low viscosity of the liquid: It fills the mold by flow under its own weight (as in gravity sand and investment casting) or under a modest pressure (as in die casting and pressure sand casting). Sand molds for one-off castings are cheap; metal dies for die casting large batches can be expensive. Between these extremes lie a number of other casting methods: shell, investment, plaster mold, and so forth.

**FIGURE 13.5**

Casting processes. In *sand casting*, liquid metal is poured into a split sand mold. In *die casting*, liquid is forced under pressure into a metal mold. In *investment casting*, a wax pattern is embedded in a refractory, melted out, and the cavity filled with metal. In *pressure casting*, a die is filled from below, giving control of atmosphere and of the flow of metal into the die.

Cast shapes must be designed for easy flow of liquid to all parts of the mold, and for progressive solidification that does not trap pockets of liquid in a solid shell, giving shrinkage cavities. Whenever possible, section thicknesses are made uniform (the thickness of adjoining sections should not

differ by more than a factor of 2). The shape is designed so that the pattern and the finished casting can be removed from the mold. Keyed-in shapes are avoided because they lead to “hot tearing” (a tensile creep fracture) as the solid cools and shrinks. The tolerance and surface finish of a casting vary from poor for sand casting to excellent for precision die castings; they are quantified in [Section 13.6](#).

When metal is poured into a mold, the flow is turbulent, trapping surface oxide and debris within the casting, giving casting defects. These are avoided by filling the mold from below in such a way that flow is laminar, driven by a vacuum or gas pressure, as shown in [Figure 13.5](#).