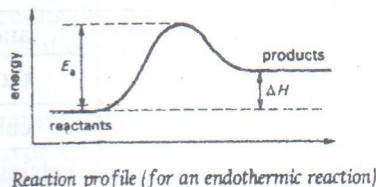


1. **activation energy** Symbol E_a . The minimum energy required for a chemical reaction to take place. In a reaction, the reactant molecules come together and chemical bonds are stretched, broken, and formed in producing the products. During this process the energy of the system increases to a maximum, then decreases to the energy of the products (see illustration). The activation energy is the difference between the maximum energy and the energy of the reactants, i.e. it is the energy barrier that has to be overcome for the reaction to proceed. The activation energy determines the way in which the rate of the reaction varies with temperature. It is usual to express activation energies in joules per mole of reactants. See also activated-complex theory.



2. **analysis** The determination of the components in a chemical sample. Qualitative analysis involves determining the nature of a pure unknown compound or the compounds present in a mixture. Various chemical tests exist for different elements or types of compound, and systematic analytical procedures can be used for mixtures. Quantitative analysis involves measuring the proportions of known components in a mixture. Chemical techniques for this fall into two main classes volumetric analysis and gravimetric analysis. In addition, there are numerous physical methods of qualitative and quantitative analysis, including spectroscopic techniques, mass spectrometry, polarography, chromatography, activation analysis, etc.
3. The boundaries of the chemical industry, then, are somewhat confused. Its main raw materials are the fossil fuels (coal, natural gas, and petroleum), air, water, salt, limestone, sulfur or an equivalent, and some specialized raw materials for special products, such as phosphates and the mineral fluorspar. The chemical industry converts these raw materials into primary, secondary, and tertiary products, a distinction based on the remoteness of the product from the consumer, the primary being remotest. The products are most often end products only as regards the chemical industry itself; a chief characteristic of the chemical industry is that its products nearly always require further processing before reaching the ultimate consumer. Thus, paradoxically, the chemical industry is its own best customer. An average chemical product is passed from factory to factory several times before it emerges from the chemical industry into the market.
4. Chemical engineering has to do with industrial processes in which raw materials are changed or separated into useful products. The chemical engineer must develop design, and engineer both the complete process and the equipment used in it. He must choose the proper raw materials; he must operate his plants efficiently, safely, and economically; and he must see to it that his products meet the requirements set by his customers. Consistent with engineering generally, chemical engineering is both an art and a science. Whenever science helps the engineer to solve his problems, he should use science. When, as is usually the case, science does not give him a complete answer, he must use experience and judgment. His professional stature depends on his skill in combining all sources of information to reach practical solutions to processing problems.
5. Research can be either basic or applied, a distinction that was established in the first half of the 20th century. Basic research is defined as the work of scientists and others who pursue their investigations without conscious goals, other than the desire to unravel the secrets of nature. In modern programs of industrial research and development, basic research (sometimes called pure research) is usually not entirely "pure"; it is commonly directed toward a generalized goal, such as the investigation of a frontier of technology that promises to address the problems of a given industry. An example of this is the research being done on gene splicing or cloning in pharmaceutical company laboratories. Applied research carries the findings of basic research to a point where they can be exploited to meet a specific need, while the development stage of research and development includes the steps necessary to bring a new or modified product or process into production.