

shews that increasing the concentration of the acid increases the rate of the reaction, although even in (ii) there is 300 times as much acid as is required by the equation.

The great influence of the temperature may be shewn by using the quantities of (i) but heating nearly to boiling before adding the *Pm*.

The solution

(iii) Ox 50cc, Ac 100cc, *Pm* 10cc, (total volume 160cc) in which the concentration of the permanganate is twice as great as in (i), is decolourized in nearly the same time, so that doubling the concentration (weight in a fixed volume) of the permanganate, has doubled the amount reduced in a fixed time, or has doubled the rate of the reaction. The rate is (nearly) proportional to the concentration of the potassium permanganate.

CATALYTIC AGENTS

If a second 5cc of *Pm* be added to solution (i) after the first portion has been reduced, the reduction takes place much more quickly than before; and a third portion is still more quickly decolourized. This is due to the manganous sulphate formed in the previous experiments; which, in some manner not completely understood, accelerates the reaction.

Substances like this which affect the rate without, apparently, taking part in the reaction, are termed "catalytic agents" or catalysers; the action of platinum in accelerating the union of hydrogen and oxygen, or of sulphur dioxide and oxygen, is a well known example of catalysis which has recently been turned to account in the "contact process" for the manufacture of sulphuric acid, and has long served as basis for innumerable "matchless" gas lighters. Copper in the hydrogen generator, and manganese dioxide in the preparation of oxygen from potassium chlorate also act "catalytically."

The enzymes, or unorganized ferments—rennet, for example—which play such a part in the chemistry of life, are catalytic agents; and many reactions which were formerly thought to be due to the life processes of micro-organisms are now referred to the catalytic action of chemicals generated by them. The fermentation of sugar, for instance, is caused by a "zymase" which can be obtained from yeast by killing the cells, grinding with sand, adding water, and filtering.

"Negative catalysers" retard instead of accelerating; some of the poisons seem to act in this manner.

The effect of concentrations, temperature, and catalysers may be illustrated by one more reaction, namely that between *Potassium iodide* and *chromic acid*. The following solutions are convenient :—Potassium bichromate 2½ g, water to make 1 litre; potassium iodide 8½ g, water