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[B.Sc (Prog.) Physical Science (Sec-A)-IV Semester]—Physical Chemistry

Factors that Affect On Reaction Rate

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- When the concentrations of the reactants are raised, the reaction proceeds more quickly. This is due to an increase in the number of molecules that have the minimum required energy. For gases, increasing pressure has the same effect as increasing concentration.
- When solids and liquids react, increasing the surface area of the solid will increase the reaction rate. A decrease in particle size causes an increase in the solid's total surface area.
- Raising the reaction temperature by 10 °C can double or triple the reaction rate. This is due to an increase in the number of particles that have the minimum energy required. The reaction rate decreases with a decrease in temperature.
- Catalysts can lower the activation energy and increase the reaction rate without being consumed in the reaction.
- Differences in the inherent structures of reactants can lead to differences in reaction rates. Molecules joined by stronger bonds will have lower reaction rates than will molecules joined by weaker bonds, due to the increased amount of energy required to break the stronger bonds

Effect of Temperature

It has been observed experimentally that a rise of 10 °C in temperature usually doubles or triples the speed of a reaction between molecules. The minimum energy needed for a reaction to proceed, known as the activation energy, stays the same with increasing temperature. However, the average increase in particle kinetic energy caused by the absorbed heat means that a greater proportion of the reactant molecules now have the minimum energy necessary to collide and react. An increase in temperature causes a rise

in the energy levels of the molecules involved in the reaction, so the rate of the reaction increases. Similarly, the rate of reaction will decrease with a decrease in temperature.

Interactive: Temperature and Reaction Rate

Explore the role of temperature on reaction rate. Note: In this model any heat generated by the reaction itself is removed, keeping the temperature constant in order to isolate the effect of environmental temperature on the rate of reaction.

Effect of Pressure

Increasing the pressure for a reaction involving gases will increase the rate of reaction. As you increase the pressure of a gas, you decrease its volume (PV=nRT; P and V are inversely related), while the number of particles (*n*) remains unchanged. Therefore, increasing pressure increases the concentration of the gas (*n/V*), and ensures that the gas molecules collide more frequently. Keep in mind this logic only works for gases, which are highly compressible; changing the pressure for a reaction that involves only solids or liquids has no effect on the reaction rate.

Effect of Presence or Absence of a Catalyst

Catalysts are substances that increase reaction rate by lowering the activation energy needed for the reaction to occur. A catalyst is not destroyed or changed during a reaction, so it can be used again. For example, at ordinary conditions, H_2 and O_2 do not combine. However, they do combine in the presence of a small quantity of platinum, which acts as a catalyst, and the reaction then occurs rapidly.

Effect of Reactant Concentrations

Raising the concentrations of reactants makes the reaction happen at a faster rate. For a chemical reaction to occur, there must be a certain number of molecules with energies equal to or greater than the activation energy. With an increase in concentration, the number of molecules with the minimum required energy will increase, and therefore the rate of the reaction will increase. For example, if one in a million particles has sufficient

activation energy, then out of 100 million particles, only 100 will react. However, if you have 200 million of those particles within the same volume, then 200 of them react. By doubling the concentration, the rate of reaction has doubled as well.

Interactive: Concentration and Reaction Rate

In this model, two atoms can form a bond to make a molecule. Experiment with changing the concentration of the atoms in order to see how this affects the reaction rate (the speed at which the reaction occurs).

Effect of Surface Area

In a reaction between a solid and a liquid, the surface area of the solid will ultimately impact how fast the reaction occurs. This is because the liquid and the solid can bump into each other only at the liquid-solid interface, which is on the surface of the solid. The solid molecules trapped within the body of the solid cannot react. Therefore, increasing the surface area of the solid will expose more solid molecules to the liquid, which allows for a faster reaction.

This shows that the total exposed surface area will increase when a larger body is divided into smaller pieces. Therefore, since a reaction takes place on the surface of a substance, increasing the surface area should increase the quantity of the substance that is available to react, and will thus increase the rate of the reaction as well

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