

Explain why water in a glass cup is quickly warmed in a microwave oven, but the glass cup warms much more slowly, if at all.?

Solution:

Microwaves are a form of electromagnetic radiation with frequencies from 0.3 GHz to 300 GHz. It means that they are waves of electrical and magnetic energy moving together through space. Microwaves fall into the radio frequency band of electromagnetic radiation.

For water molecules is typical dipole moment. As oxygen atom are more electronegative than hydrogen atoms and they retracted over the electron density of covalent bonds in water molecules. Because of this, an oxygen atom has a partial negative charge ($2\delta^-$) and the hydrogen atom less than half the value of the positive charge (δ^+).

In the absence of an electric field molecules are arranged randomly. In an electric field the water molecules are arranged strictly in the field lines δ^+ in one direction and δ^- to another. If the field changes direction opposite to the molecules immediately return on 180 degrees.

Magnetron is in every microwave oven and it converts electrical energy into microwave electric field which interacts with water molecules. Microwaves "bombing" the water molecules and cause them to rotate with a frequency millions of times per second. This creates molecular friction and heats that water.

The electromagnetic waves are absorbed by glass weakly in this range of frequencies (0.3 GHz to 300 GHz). That's why the water in a glass cup is quickly warmed in a microwave oven and the glass cup remain cold.