

### Fig 8.2 Changes of state

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# **8.15 Changes of States**

*Heat of fusion:* The quantity of heat required to completely melt a substance once it has reached its melting point.

*Heat of vaporization:* The quantity of heat required to completely vaporize a substance once it has reached its boiling point.



Fig 8.24 A heating curve for water, showing the temperature and state changes that occur when heat is added.

### **8.11 Intermolecular Forces**

Intermolecular Forces: The forces that acts between molecules and hold molecules close to one another.

- 3 major types of intermolecular forces are:
- dipole-dipole
- London dispersion
- > hydrogen bonding

*Dipole–Dipole Force*: Molecule containing polar covalent bond may have a net molecular polarity. In such cases, the positive and negative ends of different molecules are attracted to each other what is called a dipole–dipole force.



Fig 8.14 Attraction between dipoles in polar molecules

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*London dispersion force*: The short-lived attractive force due to constant motion of electrons within molecules.



Fig 8.15 London dispersion forces and the electron distribution in bromine

*Hydrogen bonds:* A hydrogen bond is an attractive interaction between an unshared electron pair on an electronegative O, N, and F and a positively polarized hydrogen atom bonded to another O, N, or F.



#### Hydrogen bonding in water and ammonia

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Hydrogen bonds can be quite strong, with energies up to 10 kcal/mol. Since NH<sub>3</sub>, H<sub>2</sub>O, and HF molecules are held tightly together by hydrogen bonds, an unusually large amount of energy must be added to separate them in the boiling process. As a result, the boiling points of NH<sub>3</sub>, H<sub>2</sub>O, and HF are much higher than the boiling points of their second row neighbors  $CH_4$  and of related third-row compounds, Table 8.2.

## 8.13 Water: A Unique Liquid

- Water covers nearly 71% of the earth's surface.
- Water accounts for 66% of the mass of an adult human body.
- The water in our blood forms the transport that circulates substances throughout our body.
- Water is the medium in which all biochemical reactions in our body are carried out.

- Water has the highest specific heat of any liquid

   absorb a large quantity of heat while
   changing the temperature slightly.
- Water has unusually high *heat of vaporization* it carries away large amount of heat when evaporates.