Answer on Question #63311, Physics / Molecular Physics | Thermodynamics

Q The specific latent heat of fusion of ice is 334000 j/kg. What does this mean?

Answer:

The specific latent heat of fusion of a substance is the amount of heat required to convert unit mass of the solid into the liquid without a change in temperature.

I case of ice we need 334000 J of heat to convert 1 kg of ice into water.

Q At 100c water has a specific latent heat of vaporization of 2260 000 j/kg. What does this mean? How much thermal energy would be needed to change 2 kg of water at 100c into steam at the same temperature? How much thermal energy would be needed to change 10 kg?

Solution:

The energy required in joules to completely convert one kg of water to steam without increasing the temperature is called the latent heat of vaporization.

The thermal energy needed to change 2 kg of water at 100°C into steam at the same temperature is

$$Q_1 = H_v m = \left(2260000\ \frac{\text{J}}{\text{kg}}\right)(2\ \text{kg}) = 4520000\ \text{J}$$

The thermal energy needed to change 10 kg of water at 100°C into steam at the same temperature is

$$Q_1 = H_v m = \left(2260000\ \frac{\text{J}}{\text{kg}}\right)(10\ \text{kg}) = 22600000\ \text{J}$$

Answer: $4520000\ \text{J}; 22600000\ \text{J}.$

Q Explain the terms of Kinetic theory why

a) Thermal energy is needed to turn a liquid into a gas.

b) Evaporation produces cooling.

Answer:

a) If heat energy is supplied by heating a liquid, the particles eventually move fast enough to break all the attractions between them, and the liquid boils.

b) The average energy of the particles in a liquid is governed by the temperature. The higher the temperature, the higher the average energy. But within that average, some particles have energies higher than the average, and others have energies lower than the average. Some of the more energetic particles on the surface of the liquid can be moving fast enough to escape from the attractive forces holding the liquid together. They evaporate.

As the faster-moving molecules escape, the remaining molecules have lower average kinetic energy, and the temperature of the liquid thus decreases. This phenomenon is called evaporative cooling.

Q An electric kettle has a power rating of 2.1 kw. The kettle is filled with 1.5kg of water at a temperature of 20c. How long after the kettle is switched on will the water start to boil?

Solution:

The warming to the final temperature 100 degrees Celsius need heat

$$Q = c_{water} m \Delta T = 4200 \cdot 1.5 \cdot (100 - 20) = 504000 \text{ J}$$

The power is

$$P = \frac{Q}{t}$$

Thus, the time is

$$t = \frac{Q}{P} = \frac{504000 \text{ J}}{2100 \text{ W}} = 240 \text{ s}$$

Answer: 240 s.