Heat

Classification of Hot and Cold Objects
An object is considered hot if its temperature rises from normal temperature. For example : fire,vessel on fire,burning coal, etc.
An object is considered cold if its temperature reduces or its very low.For example : Ice cubes and dry ice.
Definition
Temperature measuring instruments
Some instruments to measure temperature are thermometer, thermocouple, thermistor etc.
Definition
Temperature
Temperature is a quantity which tells the thermal state of a body (i.e. the degree of hotness or coldness of the body).
Its units are: Kelvin(K), degree celsius(oC) and degree fahrenheit(oF).
Definition
Specific heat capacity of water
Water has to absorb 4.184 Joules of heat for the temperature of one gram of water to increase 1oC.

Measuring specific heat capacity of a solid in calorimeter
Measurement of specific heat capacity of solid is done in a calorimeter.
$c=[(m2-m1)cw+m1cc](t-t1)m(t2-t)$
where
cw: specific heat capacity of water
cc: specific heat capacity of calorimeter
m2: mass of calorimeter + water
m1: mass of calorimeter
m: mass of solid
t2: temperature of solid
t1: initial temperature of water
t: temperature of mixture

Measuring specific heat capacity of a liquid in calorimeter
Measurement of specific heat capacity of liquid is done in a calorimeter.
$cL=mc(t2-t)-m1cc(t-t1)(m2-m1)(t-t1)$
where
c: specific heat capacity of known solid
cc: specific heat capacity of calorimeter
m2: mass of calorimeter + liquid
m1: mass of calorimeter
m: mass of solid
t2: temperature of solid
t1: initial temperature of liquid
t: temperature of mixture

Specific heat capacity

Specific heat capacity of a substance is defined as the amount of heat energy required to raise the temperature of unit mass of the substance by 1 K.

$c=Qm\Delta t$

Its SI unit is $Jkg-1K-1$

Note: $c=c'm$ where c' is the heat capacity.

Mixing of two bodies in same state

If 20g of water at 600C is mixed with 60g of water at 200C. The resultant temperature is

Heat lost by the hot water=Heat gained by the cold water

$m1c\Delta T1=m2c\Delta T2$

$20(60-T)=60(T-20)$

$60-T=3T-60$

$4T=120$

$T=30oC$

Mixing of two bodies in different states

5 g of steam at1000C is mixed with 5g of the ice at 00C. Find the final temperature of the mixture.

Latent heat of fusion is 336 J/g

Latent heat of vaporization is 2260 J/g

So, Heat released by 5g of steam to condense is $Q1=5\times10-3\times2260\times103$and,

Heat absorbed by 5g of ice to melt is $Q2=5\times10-3\times336\times103$

Heat require to increase temperature from 0oC to 100oC is $Q3=mc\Delta T=5\times10-3\times4200\times100=2100$ J

As, $Q1>Q2+Q3$hence final temperature is at 100oC.

Partial steam will condense.

Principle of calorimetry

The principle of calorimetry (or principle of mixtures) states that for an insulated system, heat energy lost by the hot body is equal to the heat energy gained by the cold body.

$m1c1(t1-t)=m2c2(t-t2)$

Note: Heat transfer occurs until both the bodies attain the same temperature(t).

Heat capacity equation

$Q=ms\Delta\theta$

where θ is the change in temperature, m is the mass of the body, Q is the heat supplied, and s is a constant for the given material under the given surrounding conditions called the specific heat capacity of the material.

The quantity ms is called the heat capacity of the material.

Describe the principle of method of mixtures

If two or more bodies at different temperatures are brought into thermal contact, the net heat is lost by the hot bodies is equal to net heat gained by the cold bodies until they attain thermal equilibrium. If heat is not lost by any other process to the surroundings,

i.e. Net heat lost= Net heat gain

This is called principle of method of mixtures.

Humidity, dew point and fog

Humidity is the amount of water vapor in the air. Water vapor is the gaseous state of water and is invisible.There are three main measurements of humidity: absolute, relative and specific. Absolute humidity is the water content of air at a given temperature expressed in gram per cubic meter.Relative humidity, expressed as a percent, measures the current absolute humidity relative to the maximum (highest point) for that temperature. Specific humidity is a ratio of the water vapor content of the mixture to the total air content on a mass basis.

Dew point is the highest temperature at which airborne water vapor will condense to form liquid dew. A higher dew point means there will be more moisture in the air.

Fog is a visible mass consisting of cloud water droplets or ice crystals suspended in the air at or near the Earth's surface. Fog can be considered a type of low-lying cloud and is heavily influenced by nearby bodies of water, topography, and wind conditions.

Definition

Relative Humidity

It is the ratio of the amount of water (moisture) present in air to the maximum amount of water which can be absorbed by air.

It is expressed as a percentage.It is a function of both moisture content and temperature.

Example

calculation of Relative Humidity

Q. If the actual vapor density is 10 g/m3 at 20oC while the saturation vapor density at the same temperature is 17.3 g/m3. Then find the relative humidity.

Solution :

Step 1 : Formula for Relative Humidity is given as

$$\text{Relative Humidity} = \frac{\text{actual vapor density}}{\text{saturation vapor density}} \times 100\%$$

Step 2 : Here we are given the following datas ,

actual vapor density = 10g/m3

saturation vapor density = 17.3g/m3

Putting these in the given formula, $\text{Relative Humidity} = \frac{10}{17.3} \times 100\%$

$= 57.8\%$

Result

Factors affecting rate of vaporisation

Rate of vaporisation is affected in the following ways:

It increases with increase in the temperature of the fluid.

It depends on the material of the fluid.

It increases with the increase in surface area of liquid.

It increases with increase in the speed of air flowing above the water.

It increases with the increase in the temperature of the surroundings.

It increases with the dryness of air above the water.

Definition

Latent heat of fusion

The heat absorbed when 1kg of solid converts into liquid state is called as latent heat of fusion.

Ex: For water,latent heat of fusion =80cal/g

Definition

Latent heat of fusion and vaporization

Amount of energy absorbed or released to change liquid into vapour or vapour into liquid without changing its temperature is known as Latent heat of vaporization

Boiling point

The boiling point of a substance is the temperature at which the vapor pressure of the liquid equals the pressure surrounding the liquid and the liquid changes into a vapor. The boiling point of a liquid varies depending upon the surrounding environmental pressure.

Definition

Specific latent heat

Latent heat is the amount of heat energy absorbed (or released) in change of phase of the material. Temperature is constant in the process.

Specific latent heat of a substance is the amount of heat energy absorbed (or released) to change the phase of unit mass of substance.

$L=Qm$

Definition

Latent heat of fusion

The amount of heat required for a solid-liquid state change is called the latent heat of fusion. Its units are J/g and cal/g.

Definition

Latent heat of vaporisation

The amount of heat required for a liquid-gas state change is called latent heat of vaporization. Values are usually quoted in J/mol or kJ/mol (molar enthalpy of vaporization), although kJ/kg or J/g (specific heat of vaporization), and older units like kcal/mol, cal/g and Btu/lb are sometimes still used, among others.

Example

Measurement of specific latent heat of ice

Measurement of specific latent heat of ice can be done by:

Electrical method: Energy is supplied for a known time by an electrical heater of known power.

Method of mixture: Mixing water and ice in a calorimeter.

Definition

Boiling point and normal boiling point

The boiling point of a substance is the temperature at which the vapour pressure of the liquid equals the pressure surrounding the liquid and the liquid changes into a vapour at STP.The normal boiling point (also called the atmospheric boiling point or the atmospheric pressure boiling point) of a liquid is the special case in which the vapour pressure of the liquid equals the defined atmospheric pressure at sea level, 1 atmosphere.

Factors affecting boiling point

Pressure: If the external pressure is higher than one atmosphere, the liquid will boil at a higher temperature than the normal boiling point.

Molecule Types: Types of molecules in the liquid affect the boiling point of the liquid. If the force of attraction between the molecules is relatively strong, the boiling point will be relatively high. If the force of attraction between molecules is relatively weak, the boiling point will be relatively low.

Melting point

The temperature at which a given material changes from a solid to a liquid, or melts is called as its melting point. Example : Ice melts at 32o Fahrenheit or 00 Celsius.

Freezing

Freezing, or solidification, is a phase transition in which a liquid turns into a solid when its temperature is lowered below its freezing point.Freezing point is the temperature at which liquid changes to solid

Liquid water turning to ice is an example of freezing.

Freezing point of water is 00C

Definition

Melting

Melting occurs when ore is melted at its desired temperature.

Definition

Freezing point of water

The freezing point of water is 32 degrees Fahrenheit, or zero degrees Celsius. The freezing temperature of water also equals the melting temperature of ice.

Definition

Melting point and normal melting point

The temperature at which the solid and liquid states of a substance is in thermal equilibrium with each other is called melting point. Normal melting point is the temperature at which a solid melts at 1 atmosphere of pressure.

Definition

Define freezing point

The freezing point is the temperature at which a liquid changes to a solid. The freezing point of a substance is not necessarily the same as its melting point. Example: Freezing point of water is 0oC

Melting

The change in solid to liquid phase at a constant temperature is called melting (or fusion). The temperature at which melting occurs is called melting point of the solid. Heat is released from the solid in this process.