HEAT

Heat plays an important role in our everyday life. Find several examples of your daily activities which are related to heat. Why does a vacuum flask can keep water hot in long time? Why do we feel warm when we stand near a bonfire? Those are examples of heat principles. So, what is a heat?

If you dip a hot iron into a glass of cold water, few minute later the water's temperature will increase, while the iron's temperature will decrease. Why does such a thing happen? Its happens because there is an energy transfer from the iron (hotter object) to the water (colder object) which is called heat. Thereby, heat is a form of energy transferred from the hotter object to the colder one.

A. The effect of heat on matter

What happen if a matter receives or releases heat? If a matter receives or releases then there will be change in the temperature or state of matter. When you are boiling water, after few minute later the water t urns hot and finally boils. The water turn hot because it receives heat. Thereby, if an object receives heat then temperature increases. An object cannot only receive heat but also release it. The temperature of an object decrease if it releases heat. The amount of heat transferred by an object depends on several aspect such as mass, materials type, and the amount of temperature change.

The same substance with different mass, the amount of heat which is needed to raise their temperature to the same point is different. It means that the greater the mass of a body is, the more heat is needed to raise its temperature. Thereby, the quantity of heat is proportional to the mass of matter.

If there are different materials with the same mass are heated, do they require an equal amount of heat to rise their temperature into the same point? The answer is "No, it don't". The amount of heat which is needed to raise their temperature to the same point is different. Thereby the quantity of heat depends of the nature of the materials. In this case, the nature of matter is represented by quantity called specific heat (*C*)

When a body is heated, then its temperature will rise. Do you think the amount of heat added to the body is proportional to the rise of the temperature? The answer is the quantity of heat transferred to a matter is proportional to the raise of the matter's temperature. It means that the greater the quantity of heat transferred to the matter, the greater the rise in the matter's temperature.

So the quantity of heat (Q) required to increase the temperature of a matter depends on the mass (m), specific heat (c), and the temperature change (ΔT). Putting all these relationship together, we have mathematical formula:

$Q = m\ c\ \Delta T$

Q = quantity of heat, joule(J)

m = mass of matter, kg

c = specific heat of matter, J/Kg˚C or J/Kg K

ΔT = the temperature change, ˚C or K

Heat Capacity

If the temperature of two different matters is raise, then the heat for changing their temperature in the same quantity will be different. Why does it happen? It happens because the heat capacities of two different matters are different. Heat capacity is defined as the quantity of heat needed to raise the temperature of a body by 1 ˚C or 1 K, which mathematically formulated as:

$$C = \frac{Q}{\Delta T}$$

Q = the quantity of heat (J)
C = heat capacity (J/ ˚C or J/ K)
ΔT = the temperature change, ˚C or K

B. The Changes of Matter

All matter can move from one state to another. It may require very low temperatures or very high pressures, but it can be done. Phase changes happen when certain points are reached.

1. Evaporation and Condensation
   Have you ever dropped methanol to your skin? After a while it will disappear. When does it go? Methanol evaporates into gas by taking heat from your skin, which makes your skin feel cold.
   Evaporation is a phase transition from liquid into gas. When a matter is evaporating, it requires some heat.
   The reverse process of evaporation is condensation. Condensation is the phase transition from gas into liquid. If you put a lid on a pan contains of hot water for a while, then when you open the lid you will find that some water grains cling on the lid. the water grains come out because the temperature of the lid is lower than that of the water steam. This makes the water steam is releasing heat to the lid, so the lid become hotter. As a consequence the water steam condensates into water grains and sticks on the lid. Thus, a body releases heat when it condensates.
2. Boiling
   If you boil water in a glass container, then a certain temperature, bubbles of vapor will appear. If the bubbles are formed in the whole of part of water, then it is called boiling. Boiling take places when the whole part of liquid is evaporating (not only the surface) and only in certain temperature. The temperature of a boiling liquid at a pressure of 1 atm is called boiling point.
3. Melting and Freezing
   When you burn a candle, you will see that the candle around the fire is melting. Heat from the fire causes the candle melt or turn on the liquid. The liquid candle

will fall to the floor and turn back on the solid candle. Solid is able to changes it states into liquid and vice versa. The phase transition from solid into liquid is called melting, while the phase change from liquid into solid is called freezing.

C. Black's Principles

If two liquids with different temperature are mixed, then the hotter liquid will have greater energy, while the cooler liquid will have smaller energy, for example hot and cold water. What happen with the energy of the mixture? Is it going to be higher or lower?

Joseph Black said that if two substance were mixed, then the heat possessed by the hotter substance would flow to the colder substance so that the equilibrium of energy by seeing the final temperature of the mixture which is equal. That phenomenon can be formulated as:

$$\mathbf{Q_{released} = Q_{received}}$$

The equation above is known as Black's principle

From the equation we can conclude the quantity of heat released by a hotter body is equal to that received by colder body.

D. Heat Transfer

Radiation, for example, is the only method by which internal energy can be transferred through a vacuum. So when a hot object is near a cold one in space, 100% of the heating is by radiation. All of the energy we receive from the Sun comes to us that way.

Convection heating involves the mixing of fluids (liquids and gasses) of different temperatures. No convection, therefore, occurs between or within solids. A hot copper cube in contact with a cold iron cube would, for example, heat it primarily by conduction (and some radiation).

Conduction occurs when the vibrating atoms of the copper transfer some of their energy to the iron atoms they come in contact with. The energy lost by the copper atoms results in a lower temperature, while the energy gained by the iron atoms translates to a higher temperature for that object.

All three heat transfer methods can occur simultaneously, or only one of the three might occur, depending on circumstances. A vacuum (Thermos) bottle is designed to minimized all three forms of heat transfer--a vacuum reduces conduction, mirrored sides minimize radiation, and a tight lid minimizes cooling of the air above the liquid's surface by convection.