Physics 161
Lecture 13 Summ
Thermal Physics
Temperature

October 17, 2017

Lecture 13: learning objectives

You will be able to define thermal contact, equilibrium and heat.

You will be able to state the zero-th law of thermodynamics and use it to define and measure temperature.

You will be able to distinguish heat and internal energy and define specific and latent heats and use them to calculate the energy changes associated with temperature and phase changes.

Thermal equilibrium

If two objects are in thermal contact with each other they will eventually come to thermal equilibrium.

Thermal contact:
The atoms or molecules of the two objects have a way of interacting with each other and exchanging energy.

Thermal equilibrium:
The average kinetic energy of the atoms or molecules of the two objects are the same.

How long you have to wait for the objects to reach equilibrium depends on how rapidly energy is transferred.

Zero-th law of thermodynamics

Zero-th law:
When two objects are in thermal contact, heat (thermal energy) is transferred from the body with higher temperature to that with lower temperature.

Zero-th law:
When two objects are at the same temperature, there is no net transfer of heat (thermal energy) from one to the other.

Temperature scales

The zero-th law allows us to define exactly what temperature is. This is not quite the same as choosing how to quantify it.

Celsius: (with "fixed" points)
Define T = 0° C to be the freezing temperature of water
Define T= 100° C to be the boiling temperature of water

Fahrenheit:
T = 32° F is the freezing temperature of water
T= 212° F is the boiling temperature of water

Kelvin:
T = 0 K is absolute zero
T = 273.16 K is the triple point of water

Internal energy and heat

Internal energy:
The energy associated with the atoms and molecules of the system.

Heat:
Thermal energy transferred from one (hotter) object to another (colder) object in thermal contact.

Specific heat

Specific heat:
If a quantity of energy, Q, is transferred to a substances of mass, m, changing its temperature by ΔT, the specific heat is defined by Q/(m ΔT).

$$c = \frac{Q}{m\Delta T}$$

Phase change:
A discontinuous change in the properties of a material.

Latent heat:
The heat transfer required to cause a change of phase (not temperature!) of 1 kg of a substance.

$$Q = \pm mL$$