Thermodynamics

Methods of Heat Transfer

Heat is the flow of energy due to a difference in temperature. Heat ALWAYS flows from higher temperature to lower temperature. Heat will cease to flow when thermal equilibrium (same temperature) has been reached. The variable for heat is **Q**.

Conduction is the flow of heat in the direction of increasing molecular agitation without any movement of the material(s).

- Individual object – One end of an object is at higher temperature than the other end of the object.
- Touching objects – Objects at different temperatures that are in direct contact with one another.

Question - Give examples of good and poor thermal conductors.

Convection is the flow of heat due to differences in the density of a fluid or gas. This results in the motion of the fluid or gas away from the heat source and the creation of convection currents.

- Let's review the Ideal Gas Law, PV = nRT. We live in an environment where the pressure remains constant (ignore the slight changes due to hot and cold weather fronts). Since n, R and P are constant, the Ideal Gas Law can be rewritten as, V **α** T, also known as Charles Law.
- Density equals mass divided by volume, $\frac{\text{mass}}{\text{volume}}$
- Combining the Ideal Gas Law and density gives a new equation for density, $\frac{\text{mass}}{\text{temperature}}$

Question - Circle the correct choice.

- As temperature increases the density *increases/decreases* resulting in an *upward/downward* motion of the fluid or gas.
- As temperature decreases the density *increases/decreases* resulting in an *upward/downward* motion of the fluid or gas.

Question – Give an example of convection.

Radiation is the emission of infrared radiation (heat waves). All objects emit infrared radiation; the greater the temperature the greater the emission.

Question – Give an example of radiation.

Heat vs. Temperature

Objects do not possess heat but they do have temperature. Heat is the energy that flows only when there is a difference in temperature (not in thermal equilibrium). Temperature is a measure of the atomic kinetic energy. This gives the relationship that kinetic energy is proportional to temperature, KE **α** T.

Question – Do different gases at the same temperature have the same atomic kinetic energy?

Question – Do different gases at the same temperature have the same atomic speed? Explain.

Internal Energy – is the sum of all atomic energies: translational kinetic energy, rotational kinetic energy, vibrational kinetic energy and potential energy. The variable for internal energy is **U**.

- Ideal Gases – The internal energy is found entirely as kinetic energy.
- Liquids and Solids – The internal energy in found as both kinetic and potential energy.

The potential energy is related to the specific heat of a material.

Question – Can different objects of equal mass at the same temperature have the same internal energy? Explain. HINT, $Q = mc\Delta T$.

Question – What do some objects at room temperature feel cool to the touch?

Laws of Thermodynamics

- Zeroth Law of Thermodynamics – If the temperature of object A equals the temperature of object B; the temperature of object B equals the temperature of object C; then the temperature of object A equals the temperature of object C.
- First Law of Thermodynamics – is an application of the conservation of energy. The change in the internal energy of a system is equal to the heat added plus the work done on the system. This is express mathematically as $\Delta U = Q + W$.
- Second Law of Thermodynamics – Any system free of external influences will become more disordered with time. This is also referred to as the Law of Entropy.
- Third Law of Thermodynamics – It is impossible to reach to absolute zero.

Physics and Art

You and a partner are to create a digital art piece that illustrates your understanding of thermodynamics. Using a digital device take 5 images that illustrates conduction, convection, radiation (the sun may not be used), first law of thermodynamics, and second law of thermodynamics.

- Requirements:
  - You or your partner's face must be in 3 out of the 5 photographs.
  - Each partner must be in at least one of the 3 photographs.
  - Each picture must be of a different object or situation.
  - The final piece of artwork must be **no less** than 40 in^2 and fit on an 8.5" X 11" piece of paper.
  - Images **MAY** be altered: color, orientation, distortion, etc. using photo-altering software (Microsoft Photo Editor, phone apps). This is not required.
- Submission
  - The final art piece may be colored printed using a computer or as a colored photograph.
  - Each member's name must be written on the back of the art piece.
  - On the back of the art piece identify which thermodynamic principle each picture represents.
- Evaluation
  - 10 points for each required thermodynamics element (50 points total). The sun may NOT be used as an example of radiation.
  - 10 points for each required face. (30 points total)
  - 10 points off for each 1 in^2 above or below the size requirement.
  - 10 points off if printed black and white.
- Due Date – The art piece is due the first Friday of the spring semester.