Heat

Heat is a form of energy that is embodied in the vibrational activity within an atom’s structure (primarily within its electron cloud)

I-P units are: British thermal units (Btu)
SI units are: Joules (J)

Heat is a near-basic energy form; solar radiation, light, sound, electricity—all these other forms of energy devolve into heat
Heat Flow

Heat flow is the movement or exchange of heat—always from a more energetic (hotter) to a less energetic (cooler) substance or area.

I-P units are: British thermal units per hour

** (Btu/h or Btuh) **

SI units are Watts

Entropy (as a principle of physics) says that heat cannot naturally flow uphill (from cold to hot); thus, entropy (energy un-usability) always increases unless an energy-using system of enhancement (such as a motor) intervenes.

** unfortunately, these two apparently contradictory unit statements are used interchangeably in building design

Temperature

Temperature is a measure of the density (not the absolute quantity) of heat in a substance.

I-P units are: degrees F

SI units are: degrees C

A 55-gallon drum of concrete at 85 deg F contains much more heat than a 55-gallon drum of air at 85 deg F (although they are at the exact same temperature)
Heat Capacity

Heat capacity is a measure of the possible energy content (quantity, not density) in a defined volume or weight of material.

I-P units are: Btu/cubic ft or Btu/pound
SI units are: Joules/cu meter or Joules/kilogram

The heat capacity of materials is a critical property in the design of passive climate control systems, where storing heat is often important to system success (see the previous example of the 55 gal drums).

Heat Descriptors (Types of Heat)

• **Sensible Heat**
  – Describes a situation or process where the addition or subtraction of heat results in a change in temperature
  – Measured with a dry-bulb thermometer

• **Latent Heat**
  – Describes a situation or process where the addition or subtraction of heat results in a change in moisture content (absolute humidity)
  – Measured with a wet-bulb thermometer or relative humidity sensor

Heat, from a purely scientific view, is just heat – but heat can cause different effects (and these effects are of particular concern to people and materials and thus architectural design).
Sensible and Latent Heat

- The energy from the electric burner increases the temperature of the room air;
- The energy from the gas burner increases air temperature, but also adds some moisture to the air from the combustion process;
- The energy from the burner with the boiling water adds a lot of moisture to the air (along with some sensible heat) – the stove’s heat output (Btu) may be the same in all three cases, but the effects on the room are not.

Heat Flow Mechanisms

4 ways that heat can flow from here to there and, applied to the human body, the potential directions of that flow.
Heat Flow Mechanisms

**Conduction** (a means of *sensible* heat flow)

**Convection** (a means of *sensible* heat flow)

**Radiation** (a means of *sensible* heat flow)

**Evaporation/Condensation**
*(a means of *latent* heat flow)*

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**Conduction**

The exchange of heat between two adjacent and touching objects (or from one part to another within a single object) by proximity contact between molecules—examples: the flow of heat from a metal stud to adjacent gypsum board; the flow of heat through a brick
Convection

The exchange of heat from a surface to/from a surrounding fluid (usually air) or heat exchange within a fluid itself; the ready motion of the molecules of the fluid is critical to promoting heat flow—examples: fanning yourself with a magazine; heat being swept away from a window during a blizzard.

Radiation

The exchange of heat between objects that are not in contact (but are within view of each other) via electromagnetic radiation; the objects may be a few inches or a million miles apart—examples: warming yourself in front of a fireplace; a closed car heating up on a cold but sunny day.
Evaporation

A flow of heat that occurs as a material changes state from a liquid to a gas; this involves the energy (called the latent heat of vaporization) required to break molecular bonds—examples: blowing on your coffee to cool it; feeling especially cool when coming out of a swimming pool on a windy day.

Modes of Heat Flow

*use and apply what you know even in the face of weirdness (see labels below)*

- **Conduction**: From molecule to molecule
- **Sensible Heat**: Fluid movement of heated air
- **Radiation**: Energy passing from one object to another without a connecting medium
- **Latent Heat**: Chemical energy due to water phase changes (evaporation, condensation, etc.) and water vapour transfer

www.fao.org/
yes,
1 Btu = 1 Btu
but →
all Btus are NOT
equal in their impact on the environment

Jim Augustyn: The Solar Cat Book