

HEAT AND THERMODYNAMICS

Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat.

STANDARDS¹

- Students know* heat flow and work are two forms of energy transfer between systems.
- Students know* that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature first law of thermodynamics and that this is an example of the law of conservation of energy.
- Students know* the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as *thermal energy*. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.
- Students know* that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.
- Students know* that entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.

FRAMEWORK EQUATIONS²

- $Q = cm\Delta T$
 - $\Delta U = Q + W$
 $W = Q_L - Q_H$
 - $KE = (3/2)kT$
 - $\Delta S = Q/T$
- Q heat
 c specific heat
 m mass
 T temperature
 U internal energy
 W work done **on gas***
 Q_L heat removed from gas
 Q_H heat added to gas
 KE kinetic energy
 k 1.38×10^{-23} J/K
 S entropy

*per ETS/The College Board as of 2002

1. *Science Content Standards for California Public Schools, Kindergarten Through Grade Twelve*. This sheet does not include starred, "opportunities to learn" standards.

2. *California Science Framework for K 12 Public Schools*. Some equations were modified for this sheet to better align with conventional notation.

This sheet was prepared by Dean Baird www.phyz.org and is not a publication of the California Department of Education.