A conserved quantity is constant in time. There are several conserved quantities, but today we will only look at energy. You’ll have to read your book for the others.

**Forms of Energy**

1. Kinetic Energy – energy of motion  
   \[ \text{K.E.} = \frac{1}{2} \times \text{mass} \times \text{speed}^2 \]
2. Gravitational Potential Energy  
   \[ \text{G.P.E.} = \text{weight} \times \text{height} \]
3. Internal Energy - stored inside an object  
   - temperature
   - physical state (gas, solid, …)
   - chemical state (TNT, gasoline, …)
   - shape (spring)
4. Electrical Potential Energy  
   depends on sign of electric charge (positive or negative)
5. Radiant Energy → such as from the Sun.

Energy can change from one form to another

1. Throw a ball upwards. It’s energy changes.  
   - purely kinetic energy at the beginning
   - purely gravitational potential energy at the top of its travel
   - purely kinetic energy at the end.
2. Put a mass on a spring, stretch it out, and let it oscillate.  
   - stretch: no kinetic, no grav., ALL internal energy
   - normal: a lot of kinetic, some gravitational, and NO internal energy
   - compress: no kinetic, max grav., some internal energy.
   - and back and forth, etc.

It is the sum of energy (in all its forms) that is conserved.

Energy is transferred in several ways:

1. Work = force \times distance moved along the direction of applied force.
2. heat conduction. Heat flows between two objects in contact.
3. radiation (like the sun)
4. convection. Heat up a volume of air, move it to some other place where it warms up a room
5. chemical reaction

In practice, it is impossible to measure every kind of energy loss. The idea of “conservation of energy” made sense to a lot of people, and it was accepted. But for many years, a mathematical proof – an underlying “why” – was missing. Emmy Noether (1882 – 1935) proved the conservation of energy, and showed the general method of determining conserved quantities. Of her it is said,

“...Before Noether's theorem the principle of conservation of energy was shrouded in mystery, leading to the obscure physical systems of Mach and Ostwald. Noether's simple and profound mathematical formulation did much to demystify physics.”

For more information on 20th century women in science, visit the WWW page:  
http://www.physics.ucla.edu/~cwp/