Vocabulary: Mass-Energy Equivalence

- Binding energy – the energy required to separate a nucleus into individual *nucleons*.
  - The binding energy is also equal to the energy released when individual nucleons are bound together to form a nucleus.
  - The greater the binding energy of a nucleus is, the greater its stability.
  - The binding energy of a nucleus is proportional to its *mass defect*.
- Fission – a *nuclear reaction* in which a nucleus splits into two or more smaller nuclei.
  - The fission of large nuclei releases energy.
  - Fission occurs in nuclear reactors and nuclear bombs.
- Fusion – a nuclear reaction in which two nuclei merge together to form a larger nucleus.
  - The fusion of small nuclei releases energy.
  - Fusion occurs in stars and in hydrogen bombs.
- Length contraction – the apparent shortening of moving objects as measured from a stationary frame of reference.
- Mass defect – the difference between the mass of a nucleus and the mass of an equivalent number of unbound nucleons.
  - Because unbound nucleons have greater potential energy than bound nucleons, they have greater mass as well.
- Mass-energy equivalence – the theory that mass is a form of energy.
  - Mass energy is described by Einstein's equation: $E = mc^2$. In the equation, E is energy, m is mass, and c is the speed of light.
  - As energy is added to an object, its mass increases. For example, a heated brick has greater mass than a cold brick.
  - In most cases, mass cannot be destroyed to produce energy. Instead, the mass of an object or particle changes as its energy changes.
- Nuclear reaction – a process that changes the energy, structure, or composition of atomic nuclei.
  - Examples of nuclear reactions include fission, fusion, and nuclear decay.
- Nucleon – a particle found in an atomic nucleus, e.g. a proton or neutron.

- Relativistic mass – the mass of a moving object, as measured by a stationary observer.
    - The symbol for relativistic mass is *m'*.
    - The relativistic mass of an object increases as the object's speed relative to the observer increases.

- Rest mass – the mass of a stationary object.
    - The symbol for rest mass is *m*.

- Special relativity – a theory that assumes the speed of light in a vacuum is constant in all inertial reference frames and that all inertial reference frames are equally valid.
    - According to the theory of special relativity, a moving object will contract and increase in mass as measured from a stationary frame of reference. In addition, clocks will run more slowly on the moving object than on the stationary object.

- Time dilation – the slowing of time on moving objects relative to a stationary observer.