Problem 1. Consider the sentence 'Each year Americans consume a high percentage of the world’s energy’. How can energy be consumed if it is conserved? The current American administration appears to favor increasing American energy consumption. Discuss the implications of such an increase.

Problem 2. Look up the meanings of each of the English words derived from the Proto-Indo-European verb 'Werg' and discuss their relationships to the energy concept. Find words from other language families that are related to energy.

Problem 3. Design a reversible machine that exchanges gravitational and elastic potential energy and that uses an elastic band instead of a spring. Design an energy exchange machine that uses compressed air.

Problem 4. A solid object having a density that is uniformly distributed and half that of salt water is floated in the sea. Use the conservation of gravitational potential energy to determine the fraction of its volume that is submerged.

Problem 5. Learn the following SI systém international (or metric) units of measurements for the base quantities length, time, and mass.

1. The meter (m) is the length of the path travelled by light in a vacuum during a time interval of 1/299,792,458 of a second,

2. One second (s) is the time taken by 9,192,631,770 oscillations of the light (of a specified wavelength) emitted by a cesium-133 atom,

3. One kilogram (kg) is the inertial mass of the platinum-irridium cylinder kept at the International Bureau of Weights and Measures near Paris.

These definitions were obtained from Chapter 1 of Fundamentals of Physics by Halliday, Resnick and Walker. Consider the following definitions of units of measurement for the derived quantities energy and force:
1. One **joule** (J) is the kinetic **energy** of an object having inertial mass of 2 kg moving at 1 m/s.

2. One **newton** (N) is the weight, or gravitational **force** on an object that requires 1 J to lift 1 m.

Show that $1J = 1kgm^2/s^2$. The acceleration of gravity is $g = 9.8m/s^2$. Compute the gravitational mass and the inertial mass of an object that weighs 1 N.

**Problem 5.** Simultaneously a projectile is shot from and a bomb is dropped above the ground. Assuming that both objects strike the same ground target simultaneously, compute the ratio of their maximum heights.

**Problem 6.** At a time when many of his former classmates were thinking about such military problems, the young Albert Einstein’s thoughts were more speculatively engaged. He once said "I was ... in the patent office at Bern when all of a sudden a thought occurred to me: 'If a person falls freely, he will not feel his own weight.' I was startled. This simple thought made a deep impression on me. It impelled me toward a theory of gravitation.” (Halliday, Resnick and Walker, p312). Why did Einstein think *out of the box?*

**Problem 7.** Consider the elastic collision of two objects as illustrated on the last transparency of Lecture 1. How much energy is transferred between the objects as seen by a first observer, to whom the velocities of the objects prior to their collision are $V_1$ and $V_2$, and a second observer who moves with velocity $V$ relative to the first observer?