HOMEWORK #1
SOLUTIONS

1)   Energy is the ability to do work on some form of matter. Kinetic energy (KE) is the energy of an object based upon its *mass* and the *square of its velocity* (KE = $(1/2)MV^2$. In this problem, the object that is doing the work on the water is the WIND, which is air. Since the wave height on the first day is only half the wave height on the second day, the KE on the first day is also only half the KE on the second day. If we call the KE on the first day, KE_1, and the KE on the second day, KE_2, then,
$$2 \; x \; KE_1 = KE_2$$
This can be written as
$$2 \; x \; [(1/2)M_a(15)^2] = (1/2) \; M_a \; (V)^2$$
Since the mass of the air (Ma) is not very different from one day to the next, then this reduces to
$$(15)^2 = (1/2) \; (V)^2 \text{ or } 450 = V^2$$
and therefore V = 21.2 m/s. A small increase in the wind speed translates to a HUGE increase in the kinetic energy!

2)   a) Photosynthesis added oxygen (O_2) to the atmosphere for the first time. One important by-product of the presence of O_2 was the production of ozone (O_3). Ozone in the stratosphere absorbed lethal ultra-violet (UV) radiation thus shielding the surface of the Earth. This allowed life to move to dry land. Secondly, oxygen breathing animals could evolve. Because of the efficiency of O_2 as an energy source, such animals were able to attain large sizes.

3)   This problem involves thinking about the definition of pressure. The weight of the car is a constant and is evenly distributed over each of the 4 tires. Thus, each tire supports 480 lbs. If the tire is pressurized to 30 lbs/in^2 then the definition of pressure can be used to calculate the footprint.
$$\text{Pressure} = (\text{Force} / \text{Area})$$
We can rearrange this to find an expression of Area;
$$\text{Area} = (\text{Force} / \text{Pressure})$$
Thus, the area of each tire that makes contact with the ground (its footprint) is
$$\text{Area} = (480 \text{ lbs} / 30 \text{ lbs/in}^2) \; = \; 16 \text{ in}^2.$$

In January, the air inside the tire is colder yet the number of molecules inside is the same. A tire behaves rather like a balloon so it corresponds to case 2 in class. Since the air is colder, the average KE of the molecules of air is lower. This means the molecules move more slowly and exert less force on the inside walls of the tire in January. Consequently, the tire pressure decreases. If the tire pressure has decreased and yet the car still weighs down on the tires, the tires have to have a bigger footprint to support the weight of the car. Thus, more of your tire makes contact with the ground and this reduces the mileage your car will get.