# Section 6.5: Work

## A. Definition of Work Done by a Constant Force

If an object is moved a distance D in the direction of an applied constant force F, then the **work** W done by the force is defined as **W = FD.**

- *A force can be thought of as a push or a pull; a force changes the state of rest or state of motion of a body*
- *For gravitational forces on earth, it is common to use units of measure corresponding to the weight of an object.*

## B. Definition of Work Done by a Variable Force

If an object is moved along a straight line by a continuously varying force F(x), then the **work** W done by the force as the object is moved form x = a to x = b is

$$W = \lim_{\|\Delta\| \to 0} \sum_{i=1}^{n} \Delta W_i = \int_a^b F(x)dx$$

- $\Delta$W = increment of work = (force increment)(distance)
  = ($\Delta$F)(x)
  = (force)(distance increment)
  = (F)($\Delta$x)
- $\Delta$F = (weight) = (force increment)

Examples: 2, 4, 23, 28, (38)

## C. Three Laws of Physics

1. **Hooke's Law:** The force F required to compress or stretch a spring is proportional to the distance d that the spring is compressed or stretched from its original length. That is

$$F = kd$$ Example: 16

2. Newton's Law of Universal Gravitation: The force F of attraction between two particles of masses, $m_1$ and $m_2$ is proportional to the product of the masses and inversely proportional to the square of the distance d between the two particles.

$$F = k\frac{m_1 m_2}{d^2}$$ (optional)

3. Coulomb's Law: The force between two charges $q_1$ and $q_2$ in a vacuum is proportional to the product of the charges and inversely proportional to the square of the distance d between the two charges. This is

$$F = k\frac{q_1 q_2}{d^2}$$ (optional)

4. **Boyle's Law:** If the temperature of a gas remains constant, its pressure is inversely proportional to its volume.

$$p = \frac{k}{V}$$ (optional)

- As the volume of the gas expands from Vo to V1, the work done is given by $W = \int_{V_o}^{V_1} \frac{k}{V} dV$ (optional)