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 from \( x = a \) 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 $V_0$ to $V_1$, the work done is given by

$$W = \int_{V_0}^{V_1} \frac{k}{V} dV$$ (optional)