Lesson 38: Graphing Work

Like many other concepts in physics, it is often easier to interpret information or come to conclusions if the data is presented as a graph.

- This does sometimes make it harder when you are first learning physics, since we make you learn a bunch of rules for each type of graph.
- You should try to see beyond the rules… if you can do this, and understand each graph for what it truly represents, you will be on the road to understanding physics.

In the case of Work, the graph that we are most interested in is Force vs. Displacement and the area underneath (or sometimes above) the line.

- Imagine a really boring situation where a constant force is applied to an object that causes it to move a displacement. The graph would look something like...

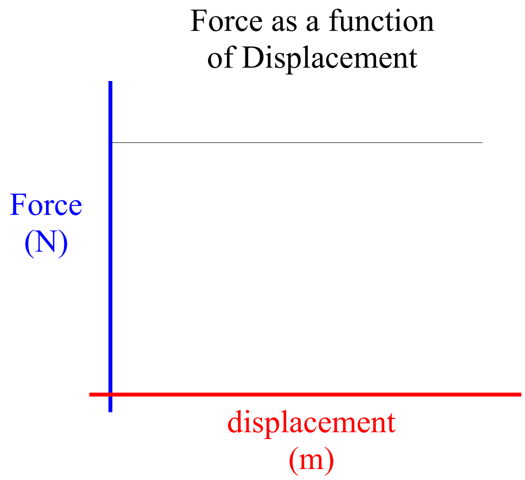

Illustration 1: Force vs Displacement graph.

- If you were asked to calculate the area under the line of the graph, what would you do?
  - Since it is a rectangular shape, you'd probably say Area = base X height
  - But wait a second… the base is a displacement and the height is a force…

$$A = b\ h$$

$$A = F\ d \qquad W = F\ d$$

$$\therefore \text{ Area under the line = Work!}$$

This is really handy for doing calculations of work if the force is ***not*** constant.

- As long as we can calculate the area under the line, we will have the work that has been done.
  - Watch out that you use the appropriate area formula for the graph you are looking at.
- We can ***not*** just run in and use the formula $W = Fd$ in these situations since force is not a constant.

Example 1: A rocket engine is going through a series of tests. It is ignited and data is measured as it builds up thrust. If the initial force was zero as it was switched on, and it increases constantly up to 1.6e5 N as the rocket moves 112 m along the test track, **determine** how much work was done.

First, we'll graph the information (shown at right).

Second, we calculate the area under the line (which is a basic triangle) to find out how much work was done.

$A = \frac{1}{2} b (h)$
$= \frac{1}{2} 112m (1.6e5N)$
$A = 8\ 960\ 000 =$ **9.0e6 J = W**

The rocket did 9.0e6 J of work.

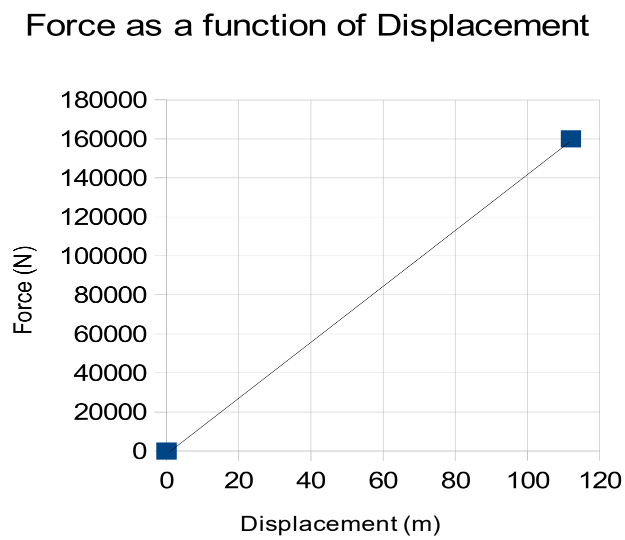

Illustration 2: Graph for Example 1.