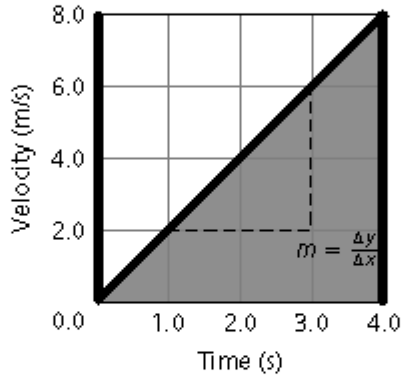
Date _____ Period _____ Name _____

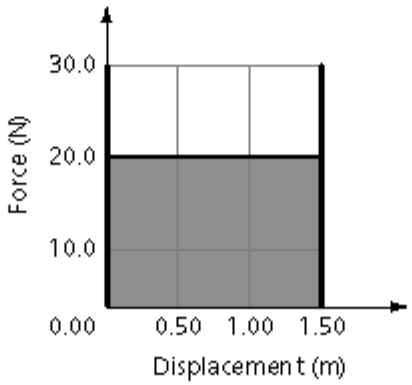
ACTIVITY
11 Connecting Math to Physics

The Area Under a Graph

Graphs are used throughout your textbook to visualize the relationships between variables. An important attribute of a graphed curve is the area under the curve. In calculus, this area is called an integral. Areas above the *x*-axis are positive, and areas below the *x*-axis are negative. Usually, we are concerned with the area under a curve and between two vertical lines. Those vertical lines may or may not be grid lines on the graph.

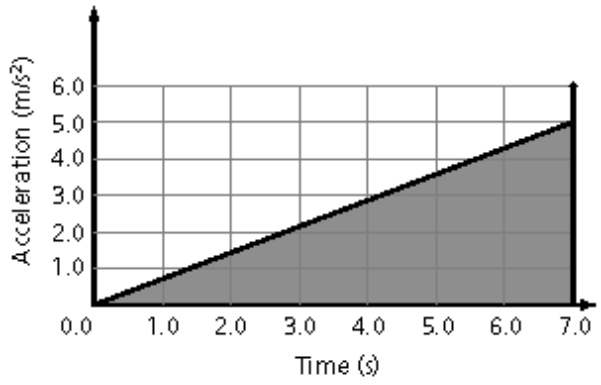


In the figure above, the shape is a triange where $A = (1/2)bh$ = 1/2 x 4.0 s x 8.0 m/s = 16 m. Notice that the unit for *vt* is the meter. Therefore, the integral of a *v*-*t* graph is always equal to the displacement, *d*. The unit that results from the multiplication of the *x*-axis value and the *y*-axis value indicates the variable that the integral is equal to. In the figure below showing an *F*-*d* graph, the integral of the graph is the area of the rectangle $A = bh$ = 1.5 m x 20 N = 30 N m = 30 J. The unit for *Fd* is the joule. Therefore, the integral of the *F*-*d* graph is equal to the amount of work done.



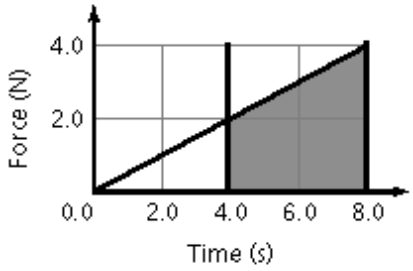
For each of the following exercises, find the integral and indicate the variable it is equal to based on the units.

1.



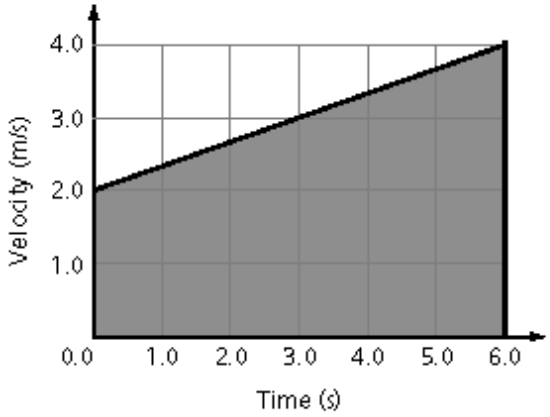
The integral is 18 m/s. The variable is change in velocity. The variable is not simply velocity because we cannot know the initial velocity of the accelerating object from the graph.

2.



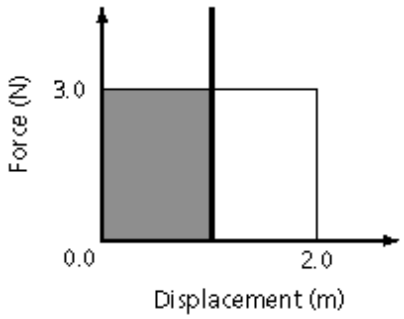
The integral is 16 N·s – 4 N·s = 12 N·s. The variable is impulse or change in momentum.

3.



The integral is 12 m + 6.0 m = 18 m. The variable is displacement.

4.



The integral is 3.0 J. The variable is work.