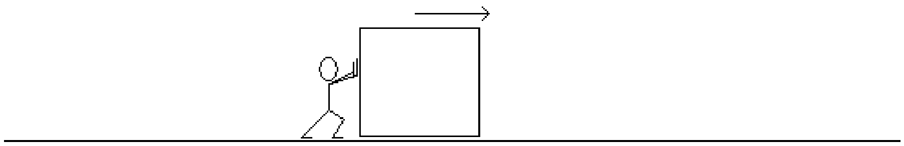
Impulse and momentum



Suppose a crate has a mass of *m* and begins at rest on a frictionless surface. You push on it with a force *F* over a time of Δt.

By Newton's second law, F = m·a

By definition, a = $\frac{\Delta v}{\Delta t}$, therefore F = m·$\frac{\Delta v}{\Delta t}$

Rearranging this equation yields

$F \cdot \Delta t = m \cdot \Delta v$

Answer Webassign Question 1

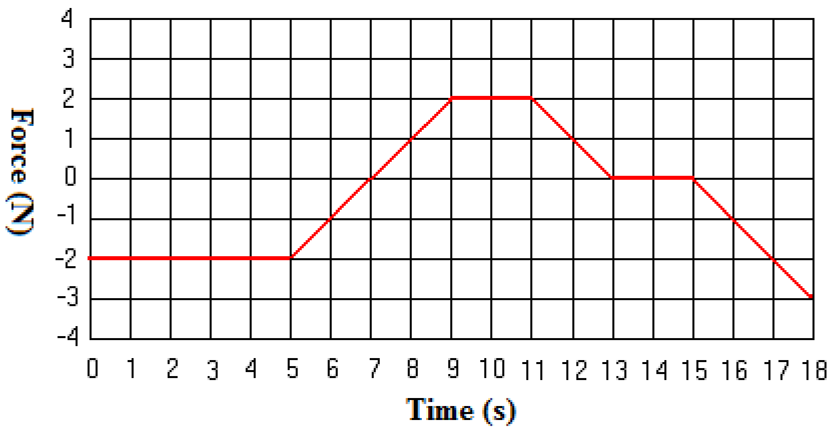
Answer Webassign Question 2

If we define impulse (J) as the product of force and time span and also define momentum (p) as mass times velocity, then this equation becomes:

$J = \Delta mv = \Delta p$ read as "Impulse equals change in momentum"

Answer Webassign Question 3

If there was a graph of force versus time, the area under that curve would equal the impulse.



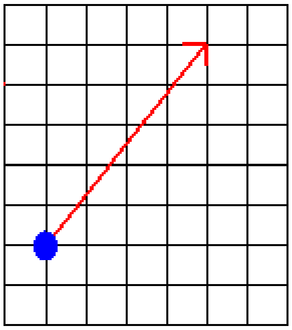
For instance, the impulse from 0s to 7s would be the area trapped to the x-axis, which is -12N·s. This would cause a change in momentum of -12kg·$\frac{m}{s}$. These two quantities are the same by the equivalence of impulse and change in momentum. Even the units are the same if you expand 1N out into 1kg·m/s^2.

Answer Webassign Question 4

The simple situation described at the beginning had motion in only one dimension, but the little derivation works just as well in two and three dimensions, making the impulse equation a vector equation.

$\vec{J} = \Delta\vec{p}$ where $\vec{J} = \vec{F}\cdot\Delta t$ and $\vec{p} = m\cdot\vec{v}$

Momentum ($\vec{p}$) is often seen as a vector in two dimensions.



For example, if the above diagram had units of kg$\cdot\frac{m}{s}$, the little blue puck would have a momentum of 4kg$\cdot\frac{m}{s}$ in the x-dimension and 5kg$\cdot\frac{m}{s}$ in the y-dimension. In polar coordinates, this would be a momentum of (6.4kg$\cdot\frac{m}{s}$, 51.34º).

Answer Webassign Question 5

To review:

J = **F**·Δt Impulse equals force applied over a time span

The area under a force-time function is also the impulse imparted.

J = Δ**p** Impulse equals change in momentum

p = m·**v** Momentum equals mass times velocity

Because force and velocity are vectors, impulse and momentum are also vectors (in bold-face), quantities often analyzed in two dimensions.