# Chapter N4: Motion from Forces

Physics I

College of the Atlantic

### N4.1: The Reverse Kinematic Chain

As we saw in the last chapter, velocity is the time derivative of position. And acceleration is the time derivative of velocity:

$$v(t) = \frac{dx(t)}{dt} \text{ and } a(t) = \frac{dv(t)}{dt} . \tag{1}$$

This tells us how to go from position $x(t)$ to acceleration $a(t)$. And Newton's second law ($\vec{F} = m\vec{a}$) lets us figure out what force caused the motion.

This chapter is about "working backwards." Given a force, we can figure out an object's acceleration. We can then take anti-derivatives to go from acceleration to velocity, and velocity to position.

### N4.2: Graphical Anti-Derivatives

**Example:**

1. A cat runs at a constant speed of 3 m/s. Sketch its speed and position as a function of time.
2. A physics textbook falls straight down at a constant acceleration of 10 m/s$^2$. Sketch its acceleration, velocity, and position as a function of time.

### N4.3: Free Fall in One Dimension

If an object is acted on only by gravity near the surface of the earth (i.e., we ignore drag), then its z-position and velocity as a function of time are given by:

$$v(t) = v_0 + gt . \tag{2}$$

$$x(t) = x_0 + v_0 t + \frac{1}{2} g t^2 . \tag{3}$$