Chapter N4: Forces from Motion

N4.2: The Kinematic Chain & N4.7: Graphs of 1D Motion

Velocity is the time derivative of position. And acceleration is the time derivative of velocity:

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

In english, this means that the velocity tells you how fast your position x is changing, and the acceleration tells you how fast your velocity is changing.

You should understand this relationship well enough to be able to make qualitatively correct graphs.

Example: For the following scenario, sketch separate plots of x, v, and a vs. t.

- I was driving fast and then I saw a cop and quickly slowed down.

N4.3: Net Force Diagrams & N4.4: Examples

To make a free body diagram, simply make a diagram of all the forces acting on a single object. The net force diagram is then obtained by rearranging the force arrows so that it's clear how the forces add together.

Examples:

1. A .3kg object hangs from a string.
2. A .3kg object is hung from a string and is spun in a horizontal circle at a constant speed.
3. If the speed is 2 m/s and the radius of the circle in which the object is spun is 30 cm, what is the tension in the string, and what angle does the string make with the horizontal?

N4.5: Third-Law Pairs

Pairs of forces linked by Newton's third law *always* act on different objects.

Practice, Practice, Practice:

Free Body Diagrams: For each of the following scenarios, draw a free-body diagram and a net-force diagram, and answer any additional quantitative questions.

1. I give a block a shove. It slides for a while and then stops. Draw the force diagram for the block while it's sliding after I've shoved it.
2. A 50 kg box of tofu rests on the back of a pick-up truck. The truck accelerates at 2 m/s^2. What are the magnitudes of all the forces acting on the box?

Kinematics: For the following scenarios, sketch separate plots of x, v, and a vs. t.

1. I was walking to class slowly and then I realized I was late so I started running.
2. I drove up slowly to the red light. I waited a while. Then I sped off.
3. I was driving quickly and then stopped suddenly at a red light. I was a little in the intersection so I drove backwards and got out of the intersection. I then waited a while for the light to change. When it changed, I drove off.
4. A mass on the end of a spring oscillates up and down.