Friday warm-up: vectors, displacement, velocity, time, and acceleration

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1 Memory Bank

1. $\vec{v} = v_x\hat{i} + v_y\hat{j}$ ... Definition of a vector in terms of $\hat{i}$ and $\hat{j}$ components (representing the x-direction and y-direction).
2. $\vec{v} + \vec{w} = (v_x + w_x)\hat{i} + (v_y + w_y)\hat{j}$ ... Vector addition: the $\hat{i}$-components add with each other, and the $\hat{j}$-components add with each other.
3. $|\vec{v}| = \sqrt{v_x^2 + v_y^2}$ ... The magnitude of the vector
4. $v_x = |\vec{v}|\cos\phi$, $v_y = |\vec{v}|\sin\phi$ ... The x and y-components of the vector, assuming ϕ is the angle between $\vec{v}$ and the x-axis.
5. $\Delta\vec{x} = \vec{x}_f - \vec{x}_i$ ... Definition of displacement
6. $\Delta t = t_f - t_i$ ... Definition of time-duration
7. $\vec{v} = \Delta\vec{x}/\Delta t$ ... Definition of velocity
8. $\vec{a} = \Delta\vec{v}/\Delta t$ ... Definition of acceleration

2 Chapter 2 - Kinematics I

1. If $\vec{v} = -3\hat{i} + 3\hat{j}$ km/hr, (a) what is the *magnitude* of $\vec{v}$? (b) Graph $\vec{v}$ in a 2D coordinate system. (c) What is the angle between $\vec{v}$ and the positive x-axis?

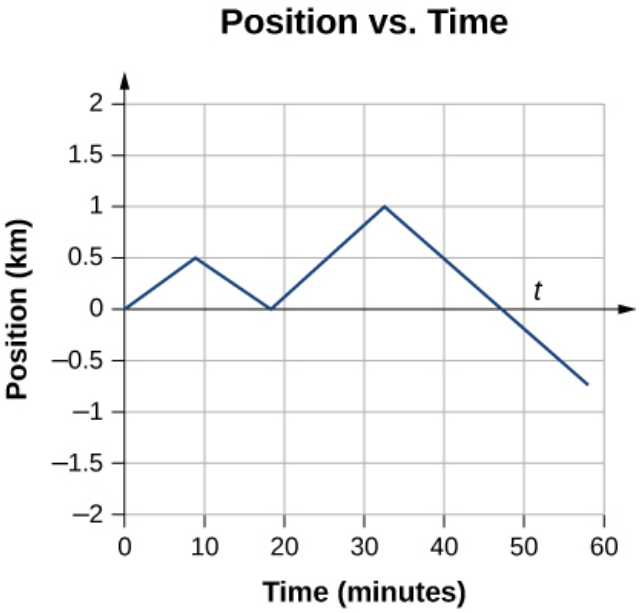

Figure 1: A system moves in one dimension with displacement $\vec{x}$ (km) versus time t (min).

2. Suppose a system is moving with the velocity in the previous exercise. If the system is at the origin of a 2D coordinate system at time $t_i = 0$, where will the system be at $t_f = 60$ seconds?
3. Suppose a spacecraft is touching down on the Moon, and it is descending with a constant velocity $\vec{v}_i = -10\hat{j}$ m s^{-1}. A additional booster is ignited such that, after 10 seconds, the velocity is $\vec{v}_f = -2\hat{j}$ m s^{-1}. (a) What is the acceleration, $\vec{a}$? (b) Explain why the acceleration should be positive or negative, vertically.
4. A worker is searching for cracks along a stretch of road that is 4 km long (Fig. 1). First, he moves +0.5 km in 9 minutes. Second, he moves -0.5 km in 9 minutes. Third, he +1 km in 14 minutes. Finally, he moves -1.75 km in 26 minutes. (a) What total distance did he travel? (b) What is his *displacement* over 58 minutes? (c) Find the average velocity of the worker.