Wednesday 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. $|\vec{v}| = \sqrt{v_x^2 + v_y^2}$ ... The magnitude of the vector
3. $v_x = |\vec{v}|\cos\phi$, $v_y = |\vec{v}|\sin\phi$ ... The x and y-components of the vector, assuming ϕ is the angle between $\vec{v}$ and the x-axis.
4. $\Delta\vec{x} = \vec{x}_f - \vec{x}_i$ ... Definition of displacement
5. $\Delta t = t_f - t_i$ ... Definition of time-duration
6. $\vec{v} = \Delta\vec{x}/\Delta t$ ... Definition of velocity
7. $\vec{a} = \Delta\vec{v}/\Delta t$ ... 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? (d) If the system is at the origin at $t = 0$, where will the system be at $t_f = 60$ seconds?

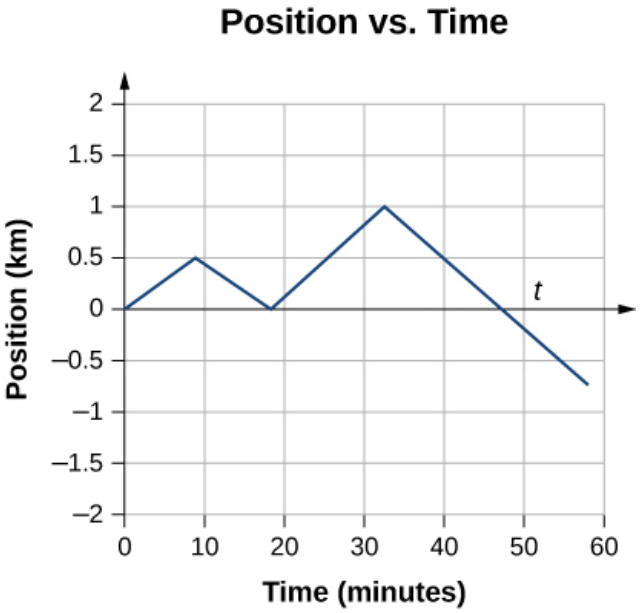

Figure 1: A system moves in one dimension with displacement $\vec{x}$ (km) versus time t (min).

2. Consider Fig. 1. (a) At $t = 32$ seconds, what is the total distance traveled by the system? (b) What is the total displacement at that time? (c) Is the velocity positive or negative between 20 and 30 seconds? (d) Is the velocity positive or negative between 40 and 50 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 (Fig. 1). First, he moves +0.5 km in 9 minutes. Second, he moves -0.5 km in 9 minutes. Third, he moves +1 km in 14 minutes. Finally, he moves -1.75 km in 26 minutes. (a) What is his total *displacement* over 58 minutes? (b) What is his average velocity?