Wednesday warm-up: displacement, velocity, and acceleration vectors

Prof. Jordan C. Hanson

September 4, 2024

1 Memory Bank

1. $\Delta x = \vec{x}_f - \vec{x}_i$ ... Definition of displacement
2. $\Delta t = t_f - t_i$ ... Definition of time duration
3. $\vec{v} = \Delta\vec{x}/\Delta t$ ... Definition of vector velocity
4. $\vec{a} = \Delta\vec{v}/\Delta t$ ... Definition of vector acceleration

2 Velocity as a vector

1. Suppose the location of an aircraft is described by a 2D coordinate system in which East corresponds to the postive x-axis, and North corresponds to the positive y-axis. An aircraft takes off from the origin in a direction 60 degrees above the x-axis (60 degrees North of East), with a speed of 200 km/hr.

   (a) Determine the components of the velocity vector, v_x and v_y, and build the velocity vector $\vec{v} = v_x\hat{i} + v_y\hat{j}$.

   (b) What is the location of the aircraft after 12 minutes?

   (c) The pilot turns the aircraft due East, and travels at the same *speed* of 200 km/hr for another 6 minutes. What is the final location?

3 Acceleration

1. A vehicle with different velocity and *acceleration* vectors is shown in Fig. 1. Match the pictures to the following statements. (1) The vehicle is moving to the right and speeding up. (2) The vehicle is moving to the right and slowing down. (3) The vehicle is moving to the left and speeding up. (4) The vehicle is moving to the left and slowing down.

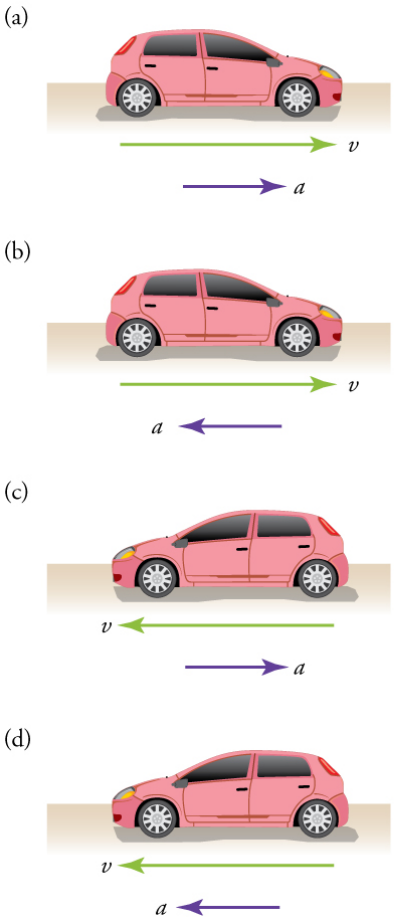

Figure 1: Four cases of velocity and acceleration in one dimension.

2. Suppose the velocity of the vehicle in Fig. 1 is 40 km hr^{-1} at $t = 0$ seconds, and 80 km hr^{-1} at $t = 5$ seconds. (a) What is the acceleration in km hr^{-1} s^{-1}? (b) What is the acceleration in m s^{-2}?