Acceleration

Questions?

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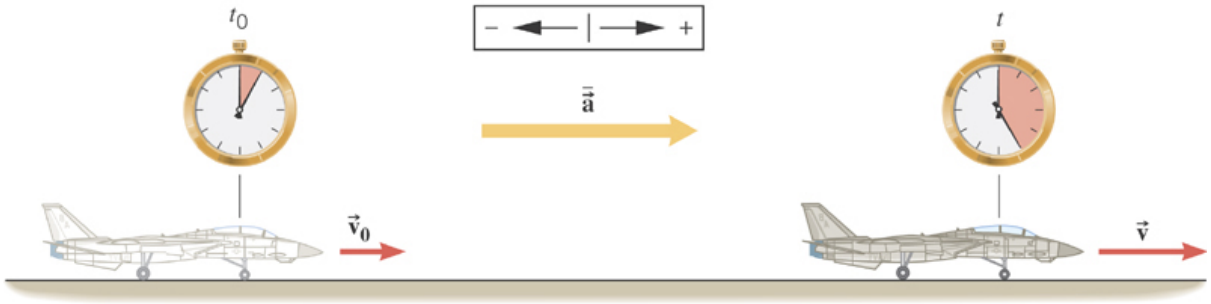
P2.1B Represent the velocities for linear and circular motion using motion diagrams (arrows on strobe pictures).

P2.1C Create line graphs using measured values of position and elapsed time.

When an object's velocity changes, it accelerates. **Acceleration** shows the change in velocity in a unit time.

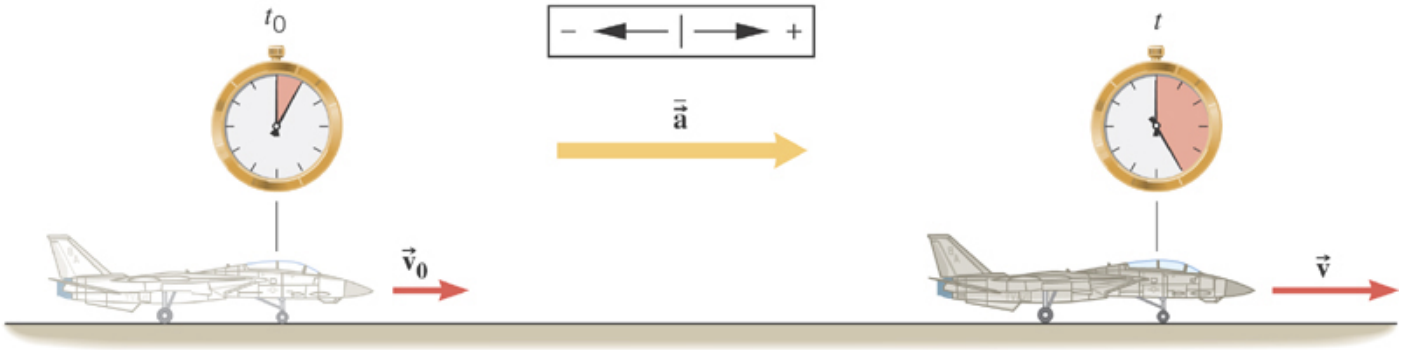
The picture below shows a plane during a takeoff. The plane accelerates from an initial velocity v_0 to a final velocity v during the time interval $\Delta t = t - t_0$



Average Acceleration Definition

$$\vec{\bar{a}} = \frac{\vec{v} - \vec{v}_o}{t - t_o} = \frac{\Delta \vec{v}}{\Delta t}$$

Example 1: Acceleration and Increasing Velocity



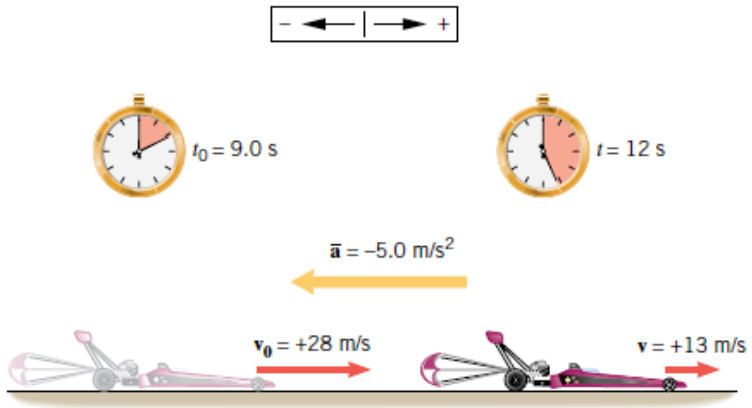
Suppose the plane starts from rest (v_0 = 0 m/s) when t_0 = 0 s. The plane accelerates down the runway and at t = 29 s attains a velocity of v 260 km/h, where the plus sign indicates that the velocity points to the right. Determine the average acceleration of the plane.

$$\vec{\mathbf{v}}_o = 0\,\text{m/s} \qquad \vec{\mathbf{v}} = 260\,\text{km/h} \qquad t_o = 0\,\text{s} \qquad t = 29\,\text{s}$$

$$\bar{\vec{\mathbf{a}}} = \frac{\vec{\mathbf{v}} - \vec{\mathbf{v}}_o}{t - t_o} = \frac{260\,\text{km/h} - 0\,\text{km/h}}{29\,\text{s} - 0\,\text{s}} = +9.0\,\frac{\text{km/h}}{\text{s}}$$

Example 2: Acceleration and Decreasing Velocity (deceleration $a < 0$)

(a)



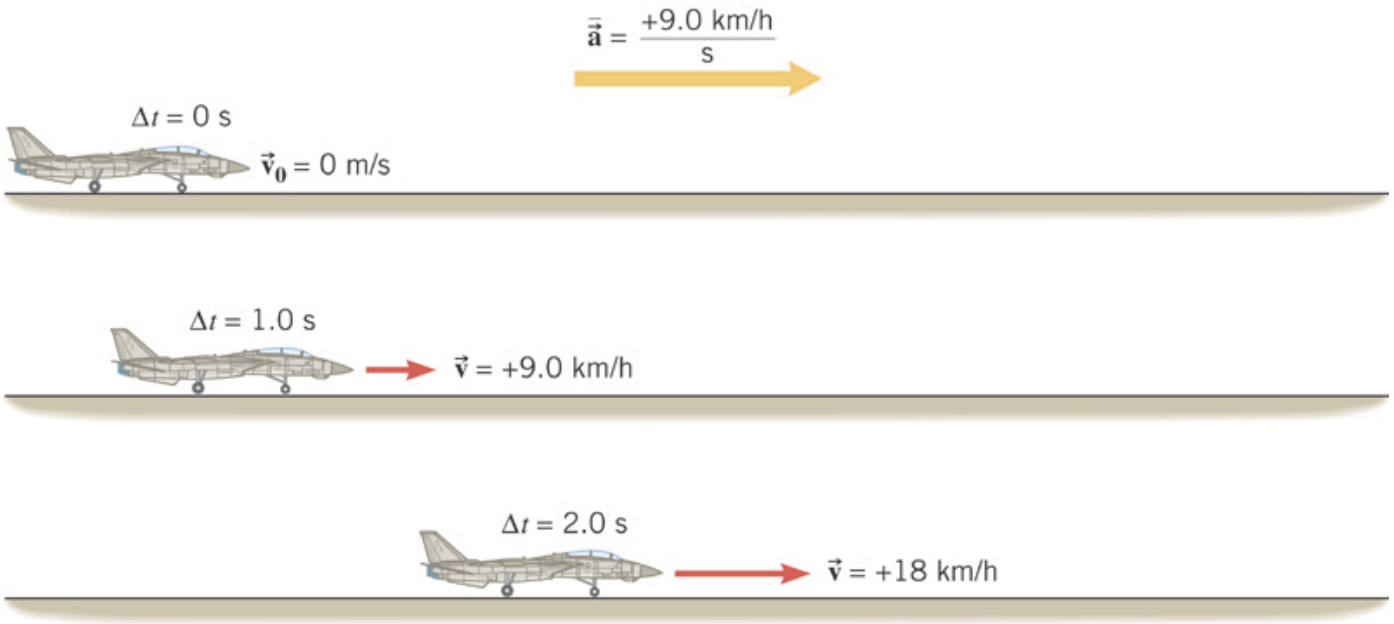
(b)

(a) To slow down, a drag racer deploys a parachute and applies the brakes. (b) The velocity of the car is decreasing, causing an average acceleration "a" that points opposite to the velocity. The driver begins slowing down when the $t_0 = 9.0$ s. The car's velocity is $v_0 = 28$ m/s. When $t = 12.0$ s, the velocity has been reduced to v = 13 m/s. What is the average acceleration of the dragster?

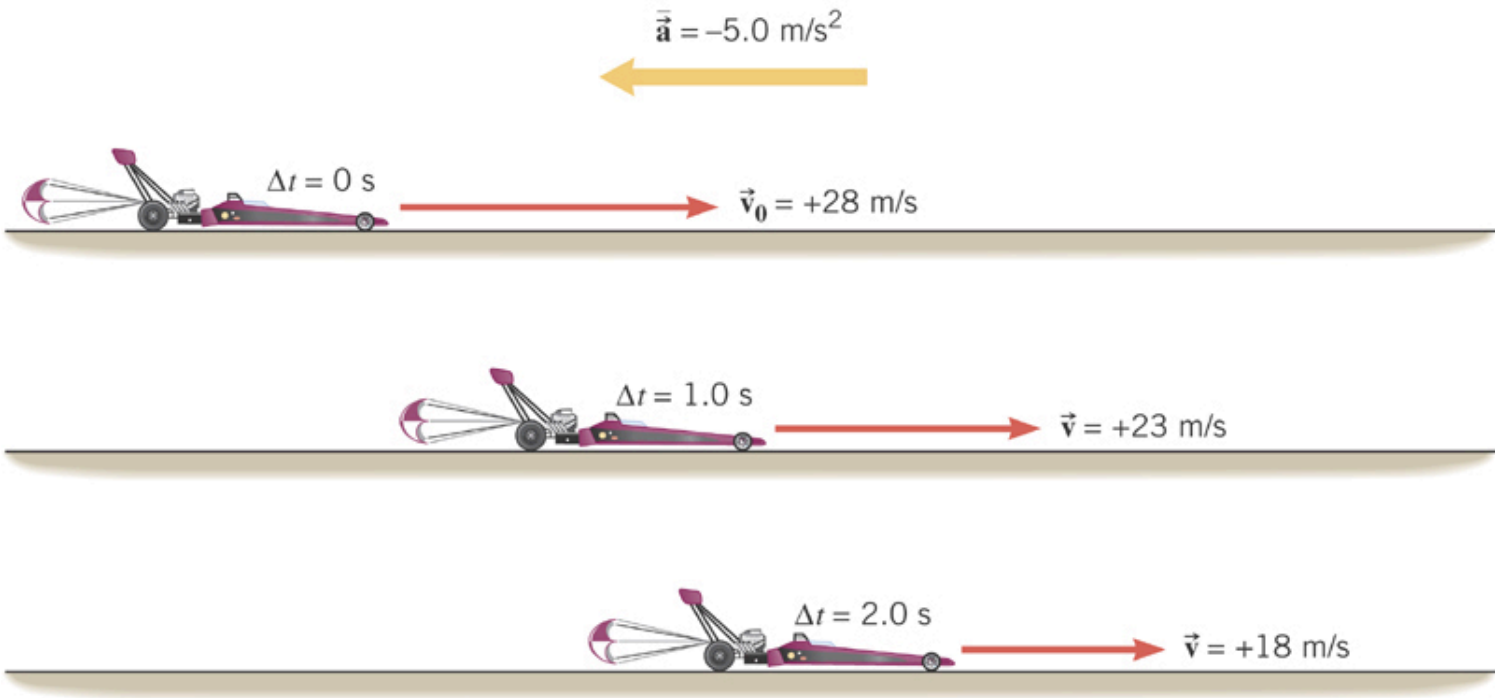
$$\bar{\mathbf{a}} = \frac{\bar{\mathbf{v}} - \bar{\mathbf{v}}_o}{t - t_o} = \frac{13\,\text{m/s} - 28\,\text{m/s}}{12\,\text{s} - 9\,\text{s}} = -5.0\,\text{m/s}^2$$

Practice Problems: Answer questions 1,2 and 3

1. An acceleration of +9.0 km/h/s means that the velocity of the plane changes by 9.0 km/h during each second of the motion. The "+" direction for a and v is to the right. During the first second, the velocity increases from 0 to 9.0 km/h; during the next second, the velocity increases to 18 km/h, and so on. Explain why the velocity changed to 18 km/h. What is the velocity by the end of the 29 th second?



2. The picture below shows how the velocity of the dragster changes during the braking, assuming that the acceleration is constant throughout the motion. The acceleration and velocity point in opposite direction. Here, an acceleration of 5.0 m/s means the velocity decreases by 5.0 m/s each second of elapsed time. Explain the change in velocity after 1.0 s and after 2.0 s. In, approximately, how many second the dragster will come to a complete stop?



3. A cyclist accelerate from 5.0 m/s [S] to 15 m/s [S] in 4.0 s. What is his acceleration?