move away from its original position after the disruptive force is removed. If an airplane with negative static stability has the nose pitch up because of wake turbulence, the tendency will be for the nose to continue to pitch up even after the turbulence goes away. If an airplane tends to remain in a displaced position after the force is removed, but does not continue to move toward even greater displacement, its static stability is described as being neutral.

### *Dynamic Stability*

The dynamic stability of an airplane involves the amount of time it takes for it to react to its static stability after it has been displaced from a condition of equilibrium. Dynamic stability involves the oscillations that typically occur as the airplane tries to return to its original position or attitude. Even though an airplane may have positive static stability, it may have dynamic stability which is positive, neutral, or negative.

Imagine that an airplane in straight-and-level flight is disturbed and pitches nose up. If the airplane has positive static stability, the nose will pitch back down after the disturbance is removed. If it immediately returns to straight-and-level flight, it is also said to have positive dynamic stability. The airplane, however, may pass through level flight and remain pitched down, and then continue the recovery process by pitching back up. This pitching up and then down is known as an oscillation. If the oscillations lessen over time, the airplane is still classified as having positive dynamic stability. If the oscillations increase over time, the airplane is classified as having negative dynamic stability. If the oscillations remain the same over time, the airplane is classified as having neutral dynamic stability.

*Figure 5-61* shows the concept of dynamic stability. In view A, the displacement from equilibrium goes through three oscillations and then returns to equilibrium. In view B, the displacement from equilibrium is increasing after two oscillations, and will not return to equilibrium. In view C, the displacement from equilibrium is staying the same with each oscillation.

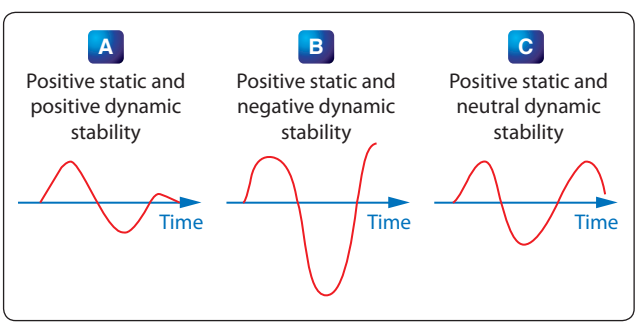


**Figure 5-61.** *Dynamic stability.*

### *Longitudinal Stability*

Longitudinal stability for an airplane involves the tendency for the nose to pitch up or pitch down, rotating around the lateral axis, which is measured from wingtip to wingtip. If an airplane is longitudinally stable, it will return to a properly trimmed angle of attack after the force that upset its flight path is removed.

The weight and balance of an airplane, which is based on both the design characteristics of the airplane and the way it is loaded, is a major factor in determining longitudinal stability. There is a point on the wing of an airplane, called the center of pressure or center of lift, where all the lifting forces concentrate. In flight, the airplane acts like it is being lifted from or supported by this point. This center of lift runs from wingtip to wingtip. There is also a point on the airplane, called the center of gravity, where the mass or weight of the airplane is concentrated. For an airplane to have good longitudinal stability, the center of gravity is typically located forward of the center of lift. This gives the airplane a nose-down pitching tendency, which is balanced out by the force generated at the horizontal stabilizer and elevator. The center of gravity has limits within which it must fall. If it is too far forward, the forces at the tail might not be able to compensate and it may not be possible to keep the nose of the airplane from pitching down.

In *Figure 5-62*, the center of lift, center of gravity, and center of gravity limits are shown. It can be seen that the center of gravity is not only forward of the center of lift, it is also forward of the center of gravity limit. At the back of the airplane, the elevator trailing edge is deflected upward to create a downward force on the tail, to try and keep the nose of the airplane up. This airplane would be highly unstable longitudinally, especially at low speed when trying to land. It is especially dangerous if the center of gravity is behind the aft limit. The airplane will now have a tendency to pitch nose up, which can lead to the wing stalling and possible loss of control of the airplane.

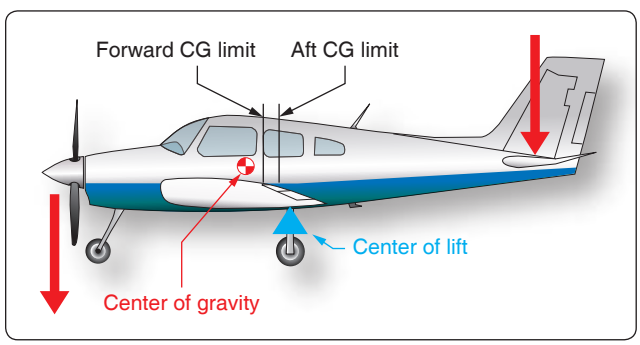


**Figure 5-62.** *Longitudinal stability and balance.*