Air Resistance and Terminal Velocity

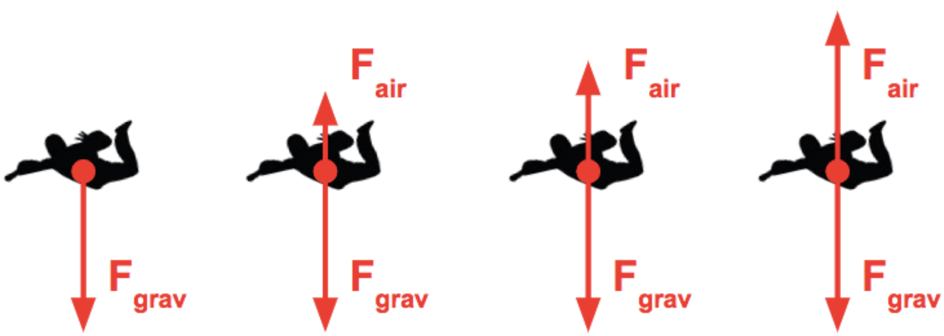
Lesson Notes

Three Factors Affecting Air Resistance

- Air Density
  As air density increases, air resistance increases; it's a linear relationship.
- Object speed
  As speed increases, air resistance increases; it's a quadratic relationship.
- Object cross-sectional area (*contour*)
  - == Air resistance depdends on the area of the leading edge of the object that is passing through air. Greater areas result in greater air resistance.
  - == Air resistance also depends upon a shape related variable known as drag coefficient; this provides a measure of the ease with which particles move around the objects leading edge. A smaller drag coefficient is representative of less air resistance.

Falling with Air Resistance

For skydivers, air resistance opposes the force of gravity. Its value increases as speed increases. Eventually, F_{air} balances the F_{grav} and the object stops accelerating. At this moment, **terminal velocity** is reached.



Terminal Velocity

The maximum velocity that an object attains.

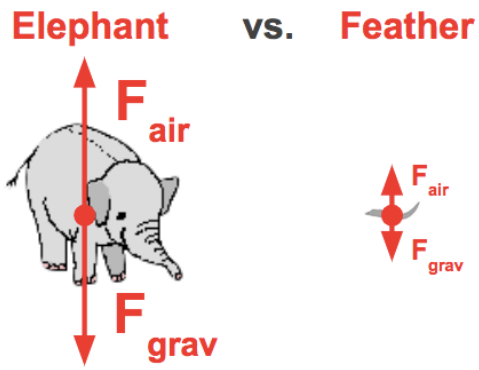
As an object falls under the influence of air resistance, …

- Speed increases.
- Air resistance increases.
- Net force decreases.
- Acceleration decreases.

… and eventually the two forces balance, at which point the net force is 0 N, the acceleration is 0 m/s/s, and **terminal velocity** is reached.

The Importance of Mass

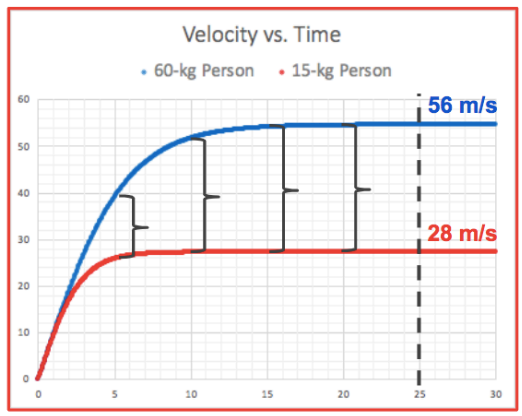
More massive objects have a larger downward gravity force. So they require a greater air resistance for balanced forces.



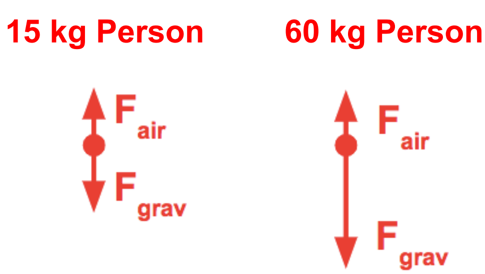
The feather reaches a terminal velocity almost immediately; it's **a very small v**.

The elephant requires a much larger terminal velocity for balanced forces; it's **a large v**.

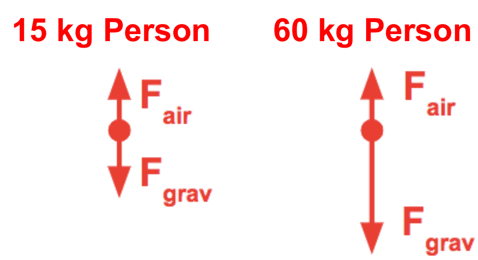
Analysis of the Falling Motion of a 15-kg and a 60-kg Person



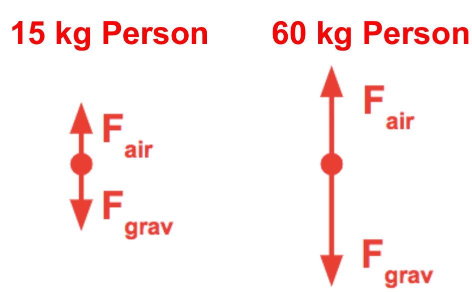
5 s Both persons are still accelerating. Neither has reached terminal velocity. The 60-kg person is moving 14 m/s faster.



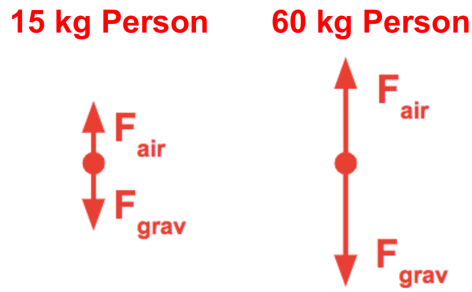
10 s Terminal velocity has been reached by the 15-kg person. The 60-kg person is still accelerating. The 60-kg person is moving 24 m/s faster.



15 s Terminal velocity was reached by the 15-kg person at 10 s. The 60-kg person is still accelerating. The 60-kg person is moving 26 m/s faster.



20 s Terminal velocity was reached by the 15-kg person at 10 s. The 60-kg person is still accelerating. The 60-kg person is moving 27 m/s faster.



25 s Terminal velocity has now been reached by both persons. The 60-kg person has twice the speed - 28 m/s faster.