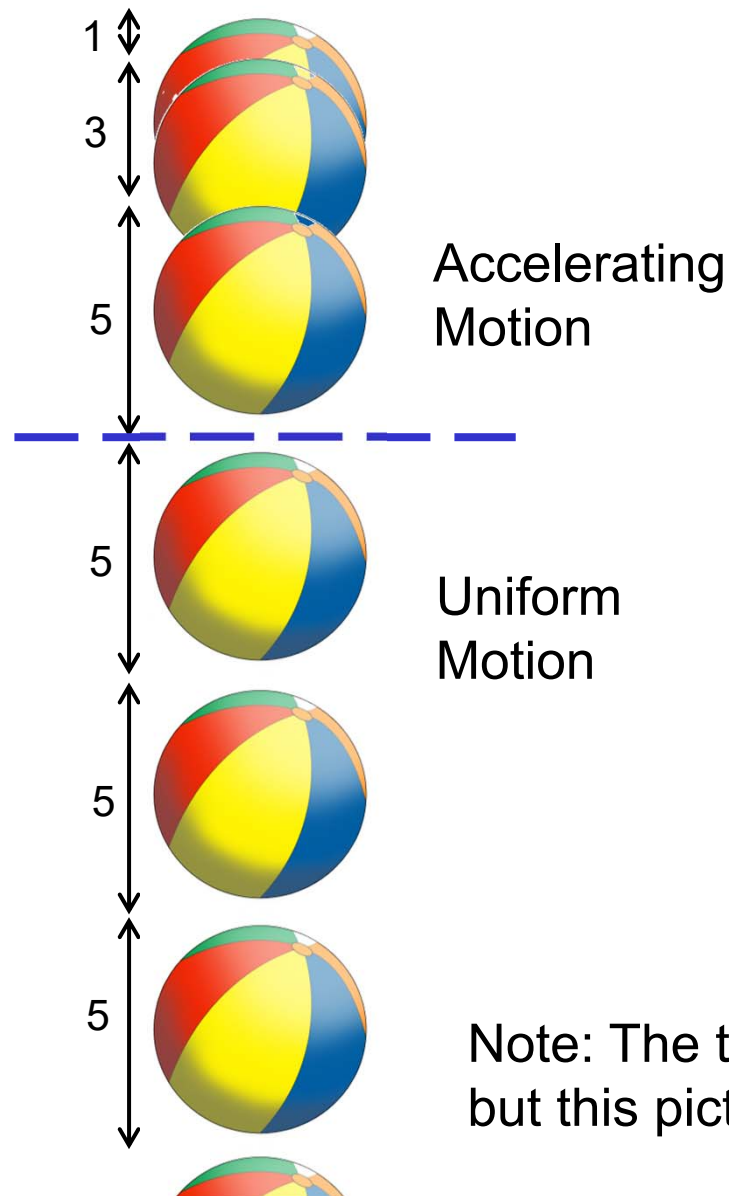


Terminal Velocity



National Science Foundation
WHERE DISCOVERIES BEGIN

Falling with Air Resistance



Light objects, such as a beach ball, initially fall with accelerating motion.

Due to air resistance, the motion transitions to uniform motion after falling a certain distance.

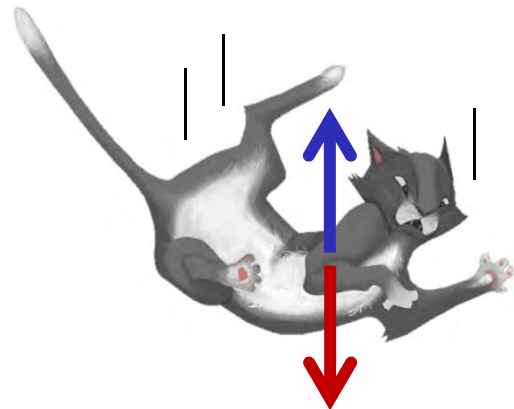
Note: The transition occurs rapidly but this picture is a bit simplified.

Terminal Velocity

Speed of falling objects increases until the air resistance force balances the force of gravity (i.e., the weight).

When forces balance, zero acceleration so constant speed.

This is the **terminal velocity**, which is the maximum speed when falling.

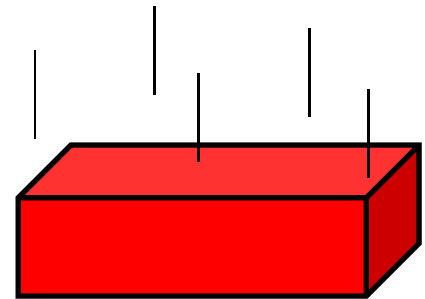
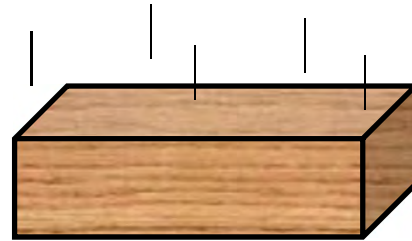


Net force is sum of:
Resistance (upward)
Weight (downward)

Terminal Velocity & Weight

For a given size and shape, the object that weighs more has a higher terminal velocity since more air resistance force is needed to balance the weight.

Terminal velocity of a brick is higher than that of a wooden board of the same size and shape.



Terminal Velocity & Area

For a given weight, the object with a larger surface area has a slower terminal velocity.



<http://www.flickr.com/photos/funksoup/>

Skydiver's terminal velocity is slower with an open parachute.



<http://www.flickr.com/photos/impuls-f/>

Falling Coffee Filter



Department of Physics

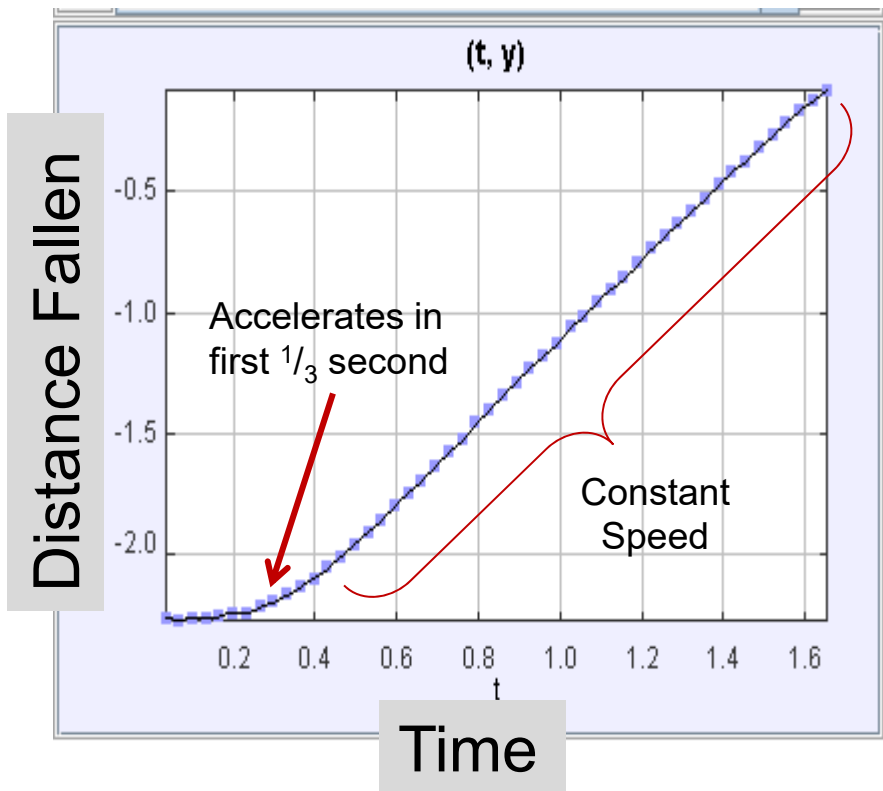
Doane College

Crete, NE

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Click

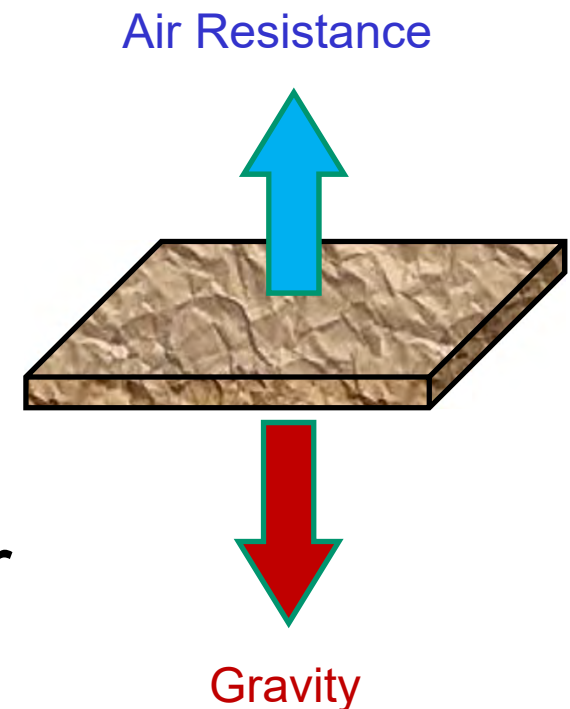
Tracked falling of a coffee filter.



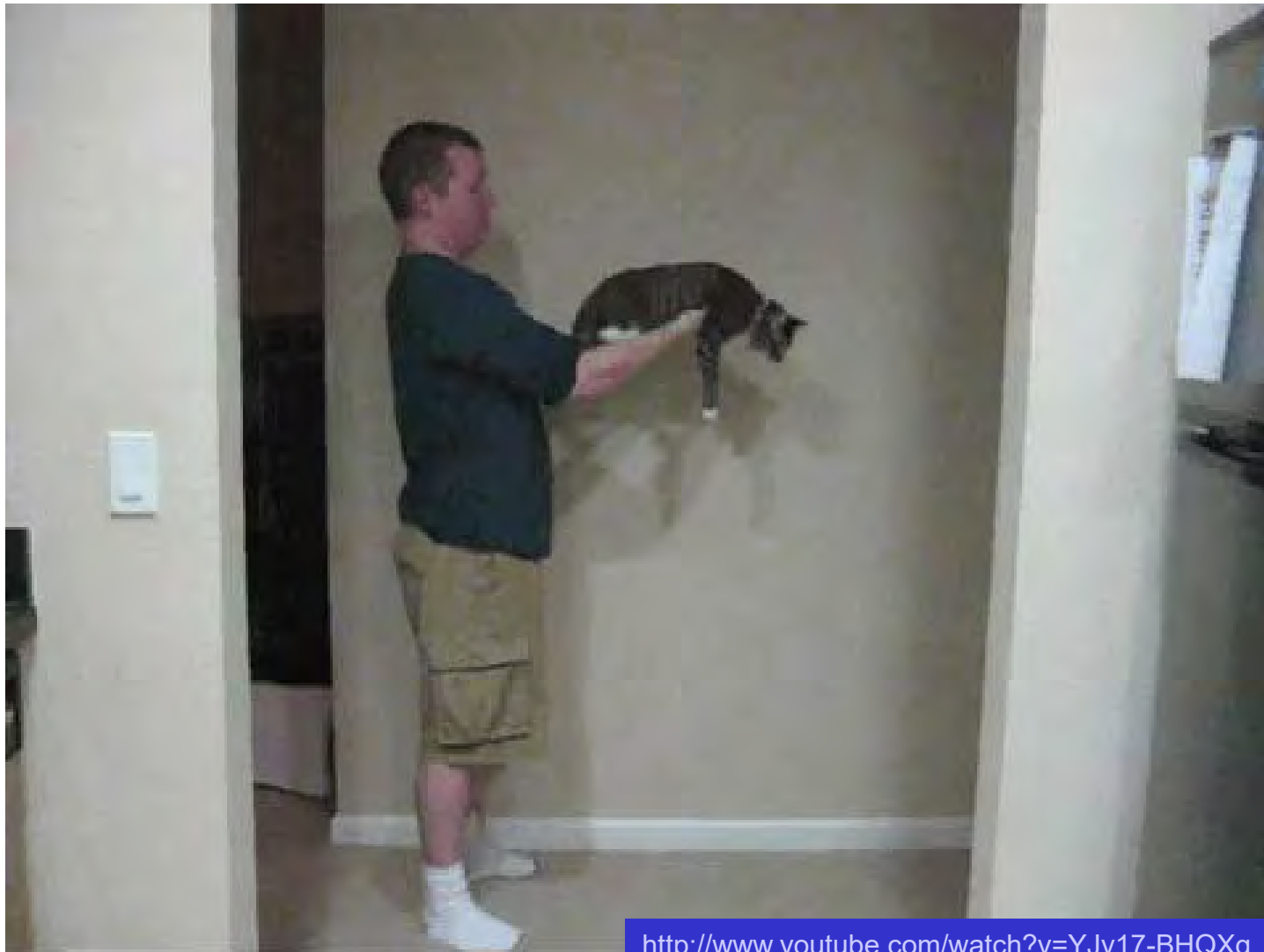
Leaf/Paper Terminal Speed

The terminal speed of a leaf or sheet of paper is about 5 feet per second, which is about $3\frac{1}{2}$ miles per hour (or 2-3 inches per frame).

Terminal speed is reached after falling about 4 frames (flat orientation).

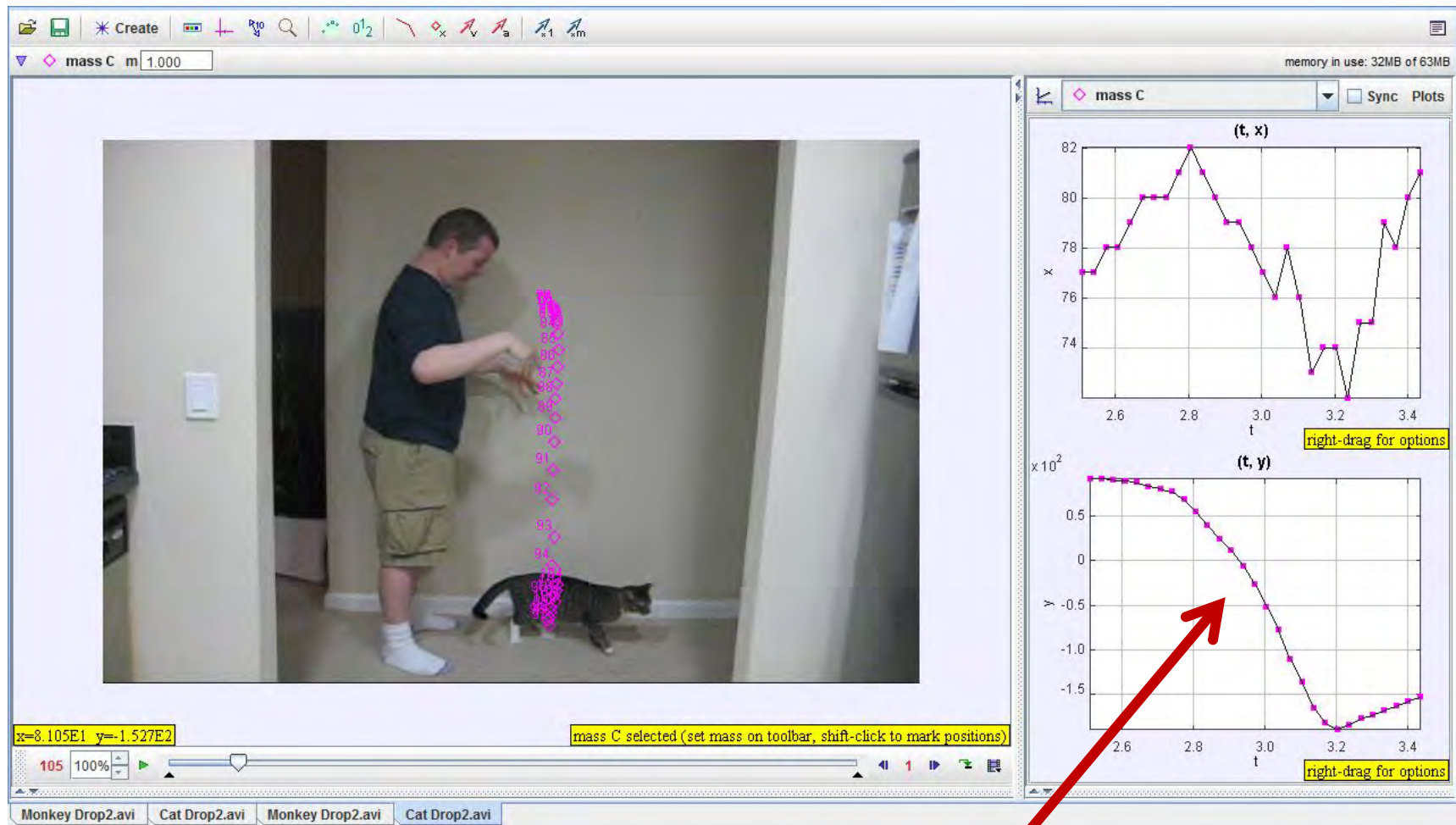


Cat Drop Video Reference



<http://www.youtube.com/watch?v=YJy17-BHQXg>

Cat Drop Motion Graph

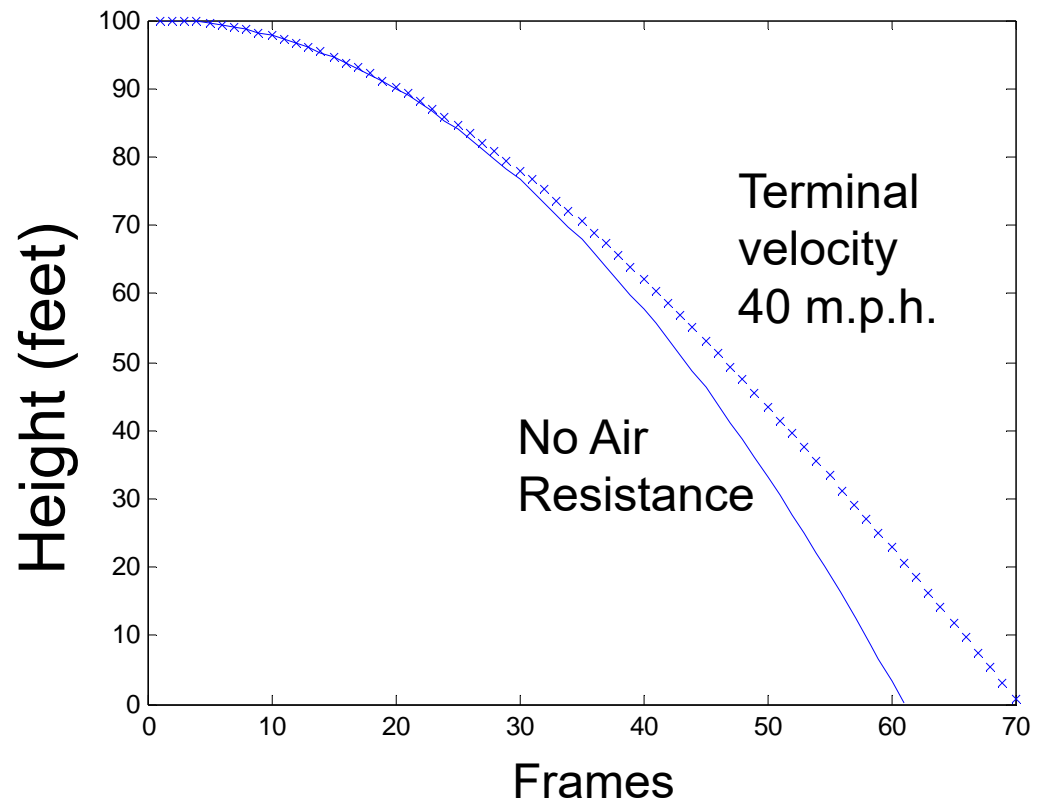
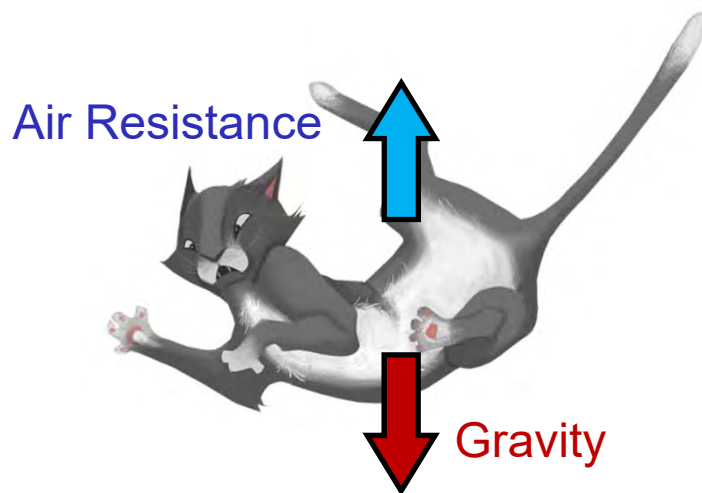


Good parabolic arc; no noticeable air resistance

Cat Drop from Building

Dropping a cat from a height of 100 ft (about 8th floor) it reaches terminal velocity about half-way down.

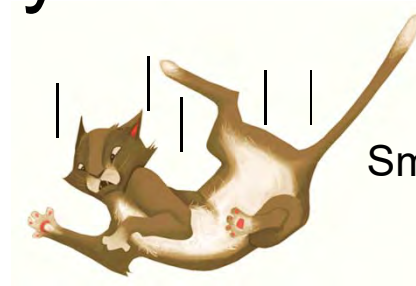
For cats, falling four stories is same as forty.



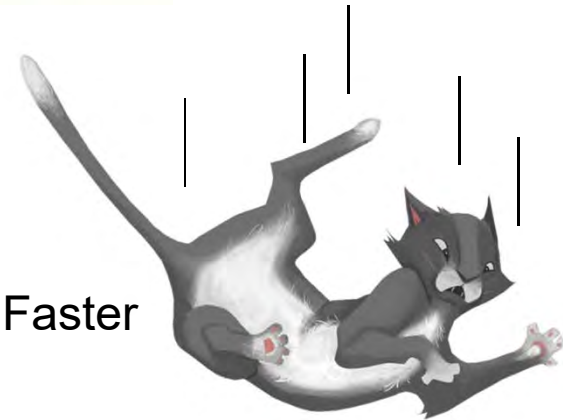
Terminal Velocity & Size

For two things of similar shape and composition, the larger one has a higher terminal velocity.

Terminal velocity of a small cat is slower than that of a large cat.



Small cat -- Slower



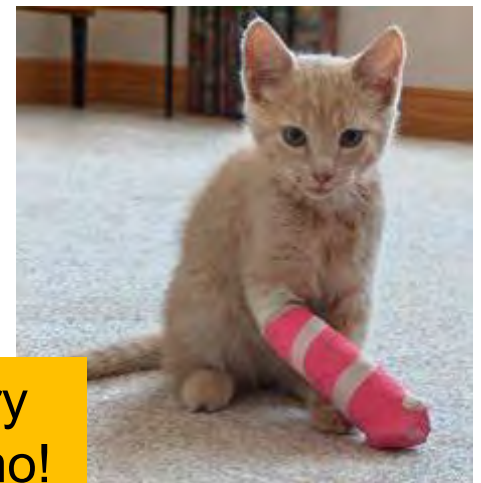
Large cat -- Faster

Surviving Falls from Heights

Small animals, like squirrels, cannot die from falls since their terminal velocity is normally not fast enough to be fatal.



Cats survive high falls about half of the time while humans rarely survive since our terminal velocity is 120-140 m.p.h.



Don't try
this demo!

Estimating Terminal Velocity

Can estimate the terminal velocity as the wind speed needed to support the weight of an object.



Estimating Terminal Velocity

Terminal velocity of ping pong ball is about the speed of air coming out of a hair dryer.



Indoor Skydiving

With a big fan (blowing 120-140 mph), you can experience terminal velocity by skydiving indoors.



Summary

- When the force of air resistance on a falling object balances the object's weight the object falls at a constant speed, i.e., terminal velocity.
- For a given size and shape, the object that weighs more has a higher terminal velocity.
- For a given weight, the object with the smaller surface area has a higher terminal velocity.
- For two things of similar composition and shape, the larger has a higher terminal velocity.
- Can estimate the terminal velocity as the wind speed needed to support an object's weight.