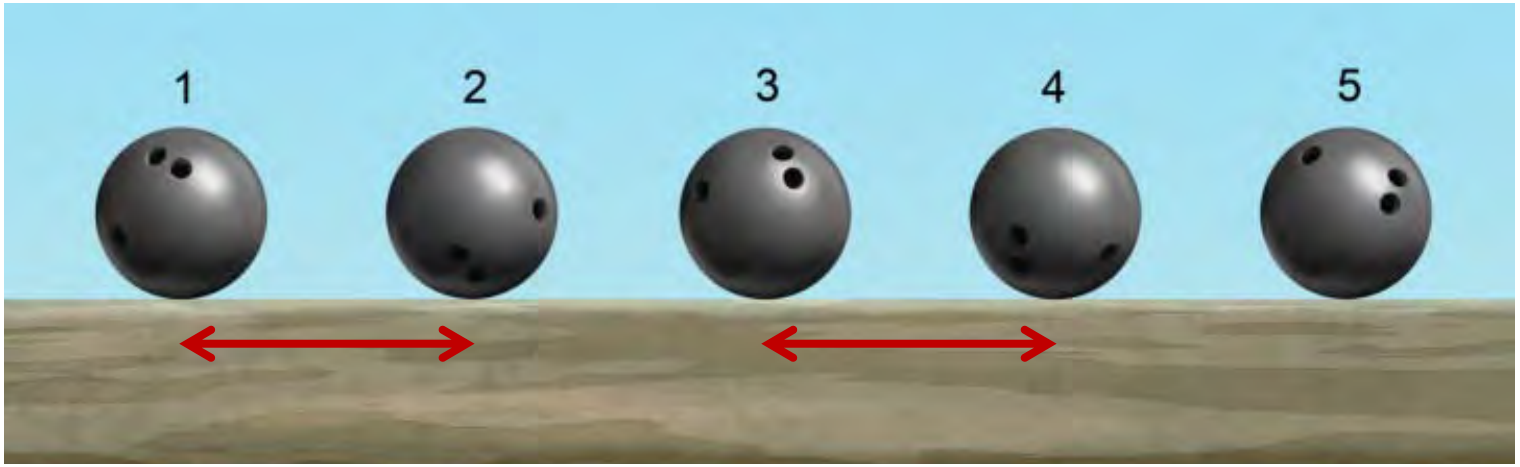
Basic Motion

Animation
Physics

Uniform Motion

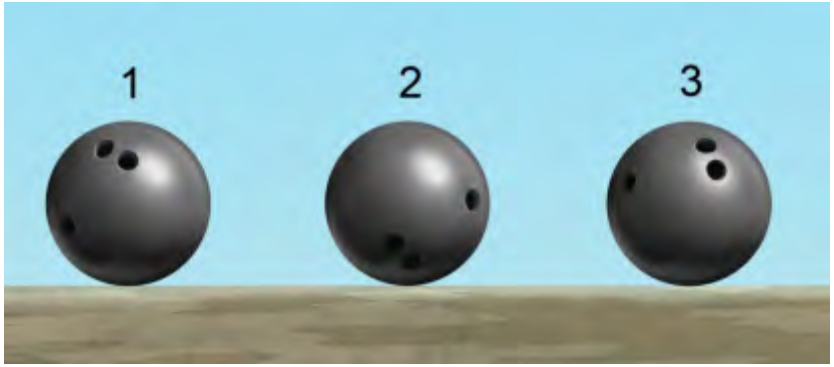
The simplest type of motion is uniform motion; a heavy ball rolling on the floor is a good example.



- An object in uniform motion goes in a straight line.
- In uniform motion, the velocity is constant so the spacing from frame to frame is always the same.
- The larger the spacing, the faster the speed of the motion.

Timing, Spacing & Speed

The timing and spacing determine speed.



This bowling ball is 12 inches in diameter with two frames per drawing (shooting on twos). What is the speed of the bowling ball?

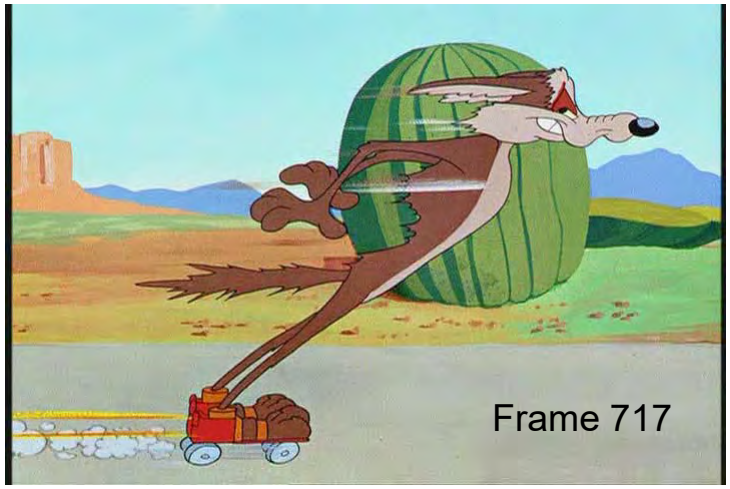
10 miles per hour	7 inches per frame
20 miles per hour	15 inches per frame
30 miles per hour	22 inches per frame
40 miles per hour	29 inches per frame
50 miles per hour	37 inches per frame
60 miles per hour	44 inches per frame
90 miles per hour	66 inches per frame

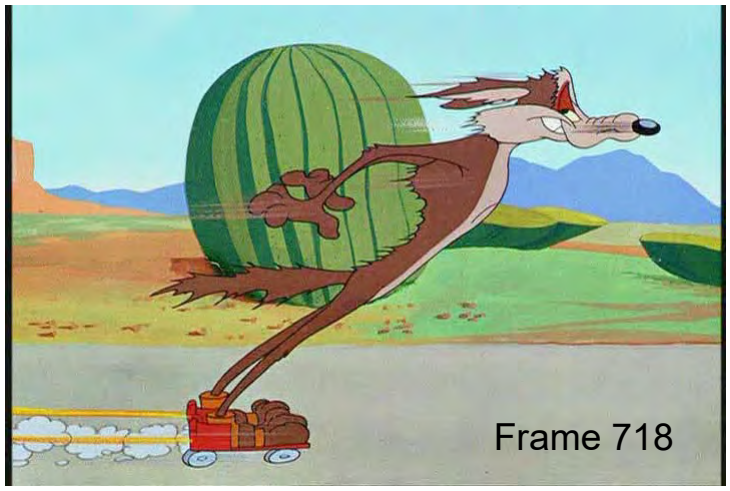
The ball rolls about 20 inches per drawing so 10 inches per frame which is about 15 m.p.h.

Wile E. Coyote on Rocket Skates

Let’s estimate Wile’s speed in this scene from “Beep Beep”

Estimating Wile's Speed





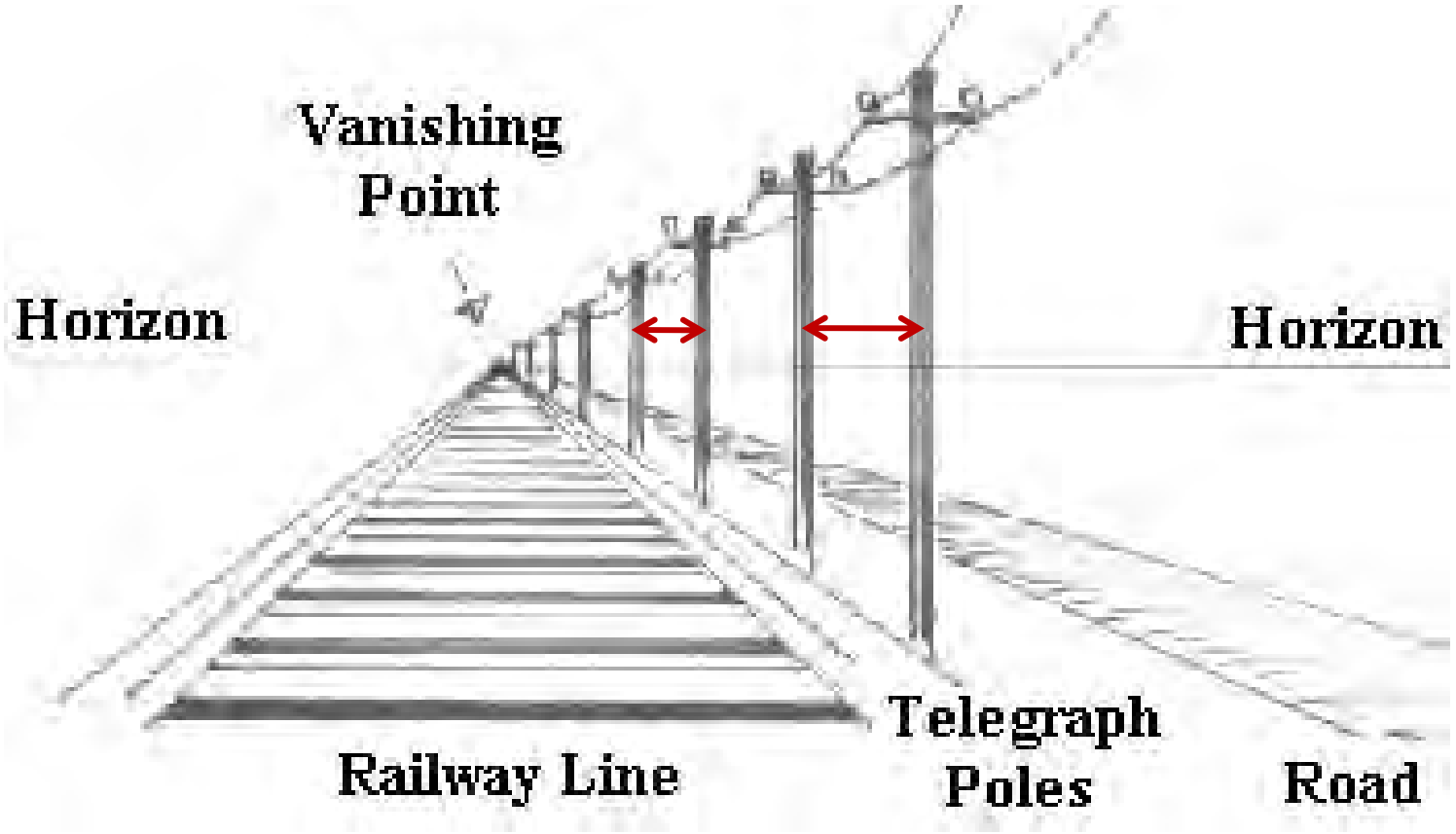
He travels about the length of his ears (say 15 inches) per frame so he's only going about 20 m.p.h.

10 miles per hour	7 inches per frame
20 miles per hour	15 inches per frame
30 miles per hour	22 inches per frame
40 miles per hour	29 inches per frame
50 miles per hour	37 inches per frame
60 miles per hour	44 inches per frame
90 miles per hour	66 inches per frame

*Correction of 20% since movie is 30 fps instead of 24 fps; going 24 m.p.h.

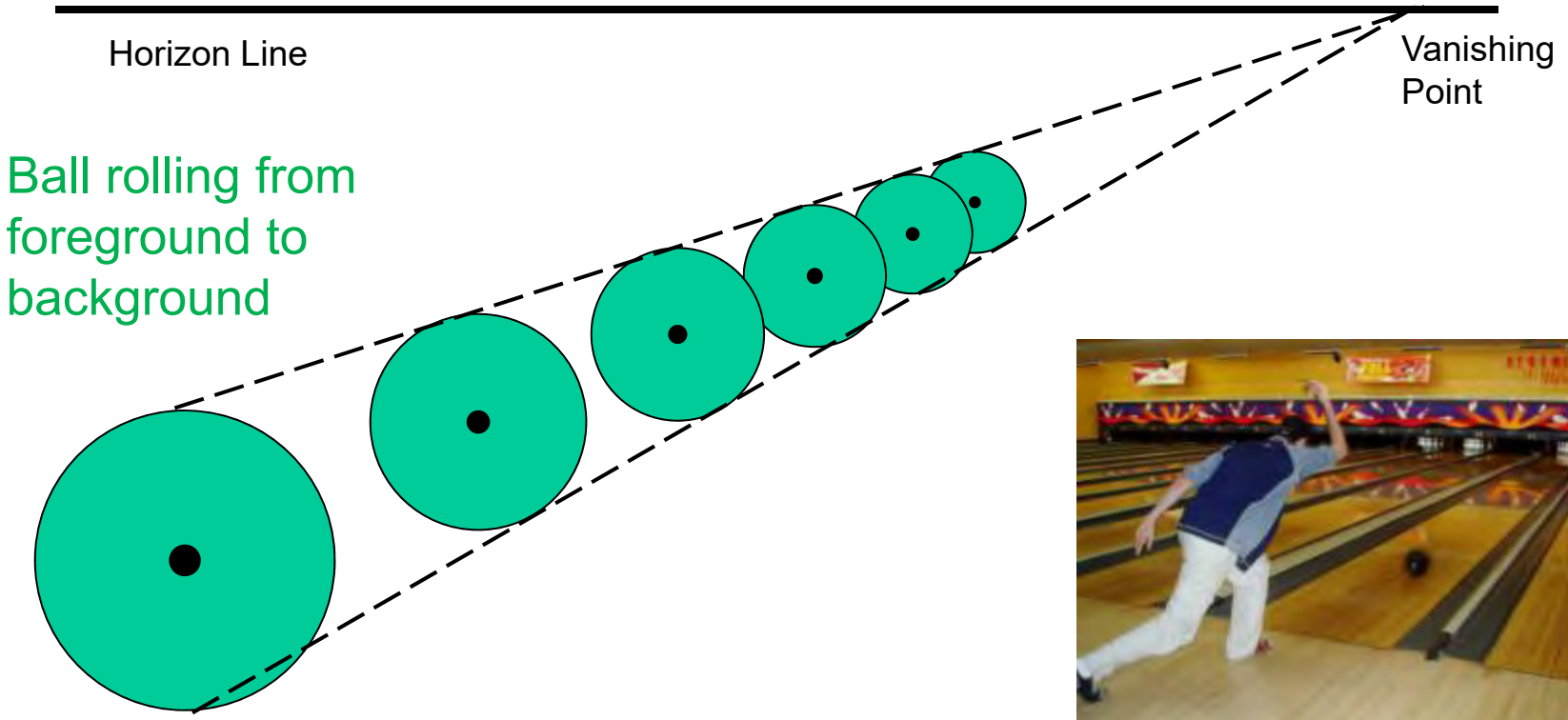
Perspective

Uniform spacings are not visually uniform when viewed in perspective.



Uniform Motion in Perspective

Uniform motion may not seem uniform due to the distortion of scale when shown in perspective.



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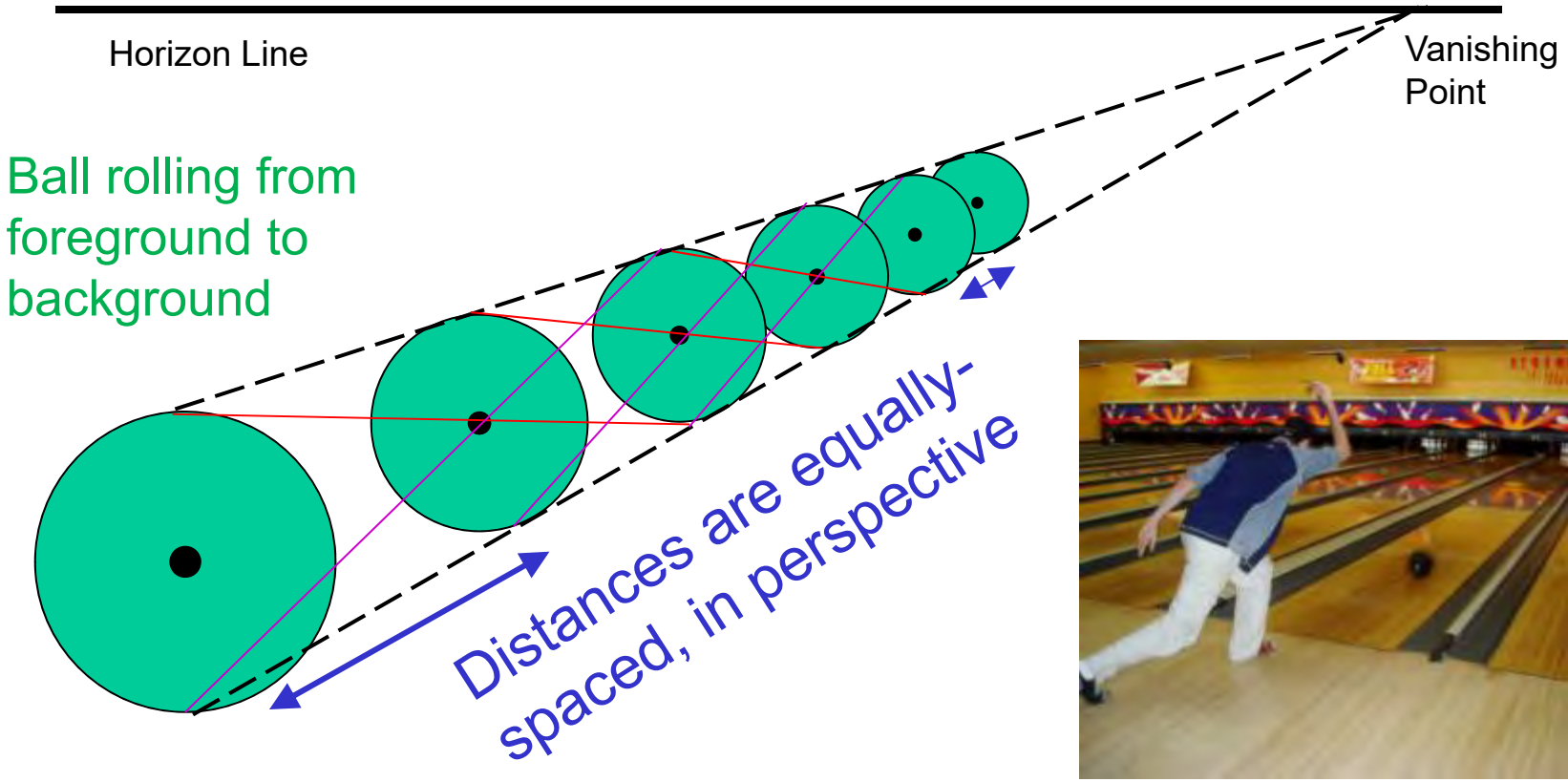


Ball Drop Video Reference

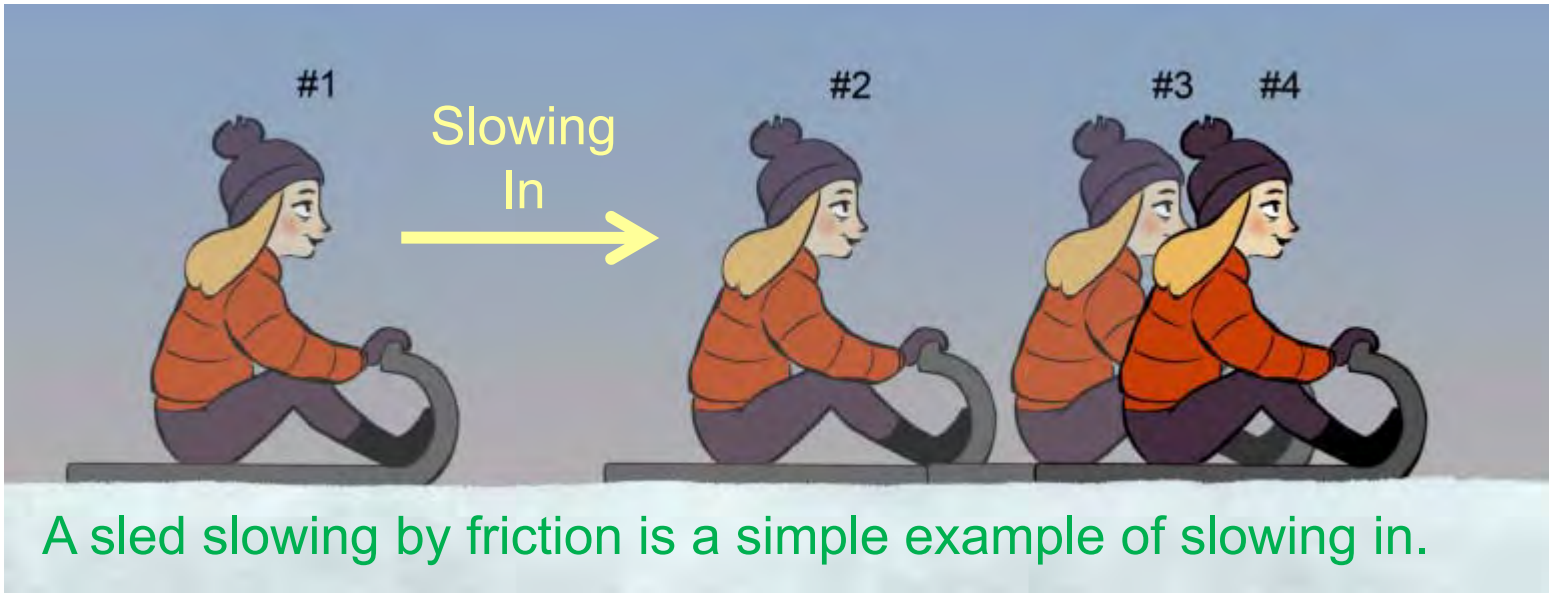
This is in slow-motion, at one-quarter the normal speed.

http://www.youtube.com/watch?v=vHYuAz6sY4k

Slowing In (or Easing In)

If an object's motion is *not* uniform then the object is either speeding up, slowing down, or changing direction.

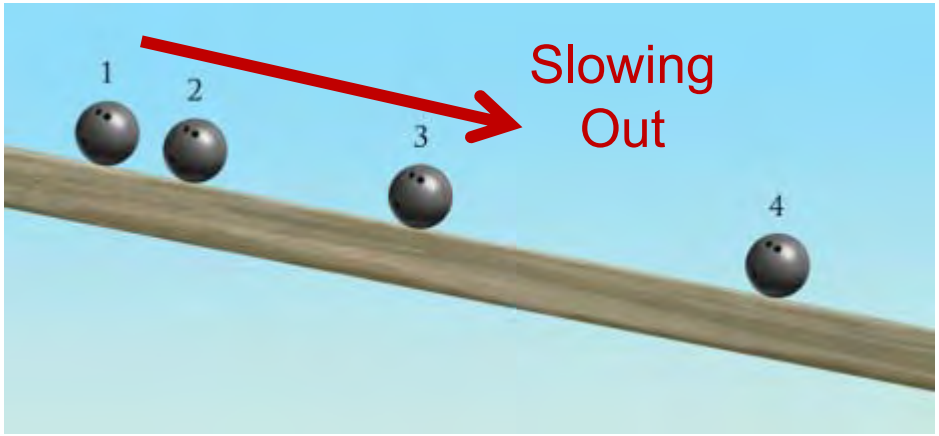
If the speed is decreasing then the spacing between drawings decreases, which in animation is called "slowing in" (or "easing in").



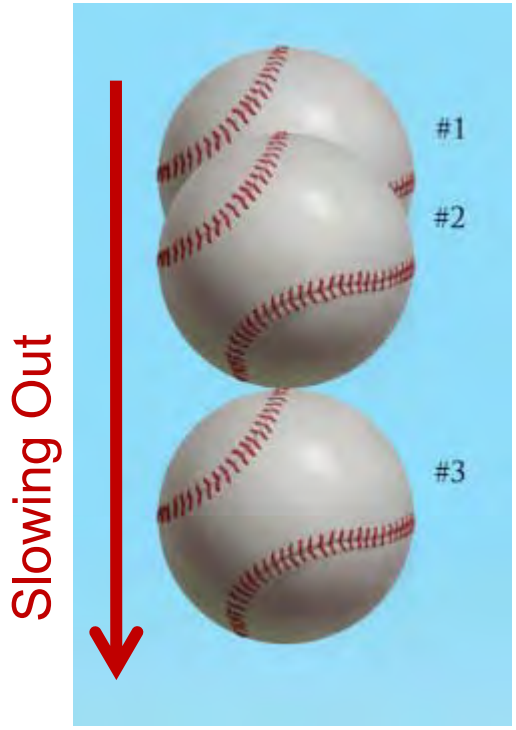
A sled slowing by friction is a simple example of slowing in.

Slowing Out (or Easing Out)

If the speed is increasing then the spacing between drawings increases, which in animation is called “slowing out” (or “easing out”).

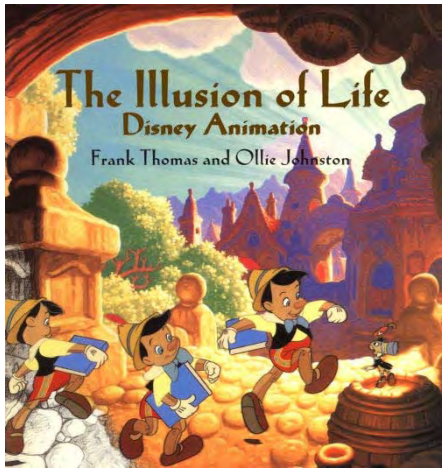


A ball rolling down an incline is an example of slowing out.



A ball falling downward is another example of slowing out.

Principles of Animation

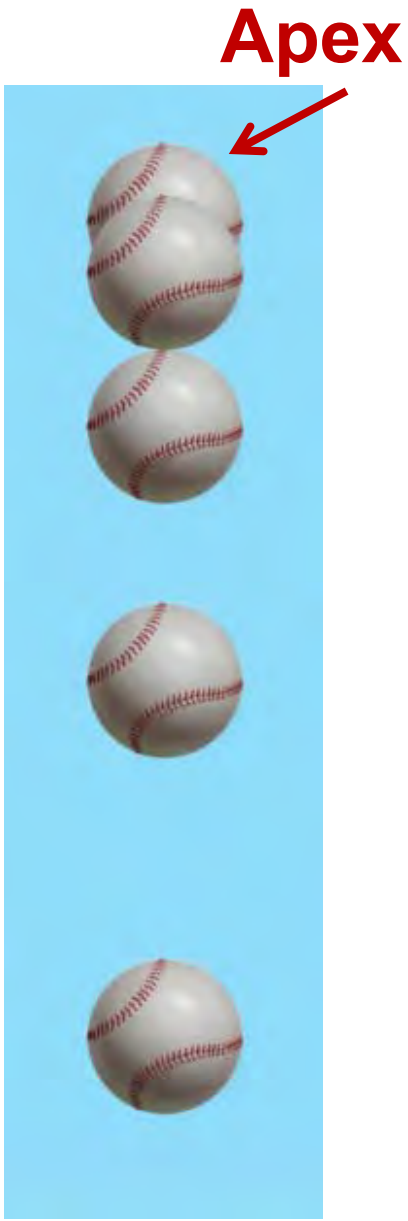


Slowing in and out is yet another one of the Principles of Animation.

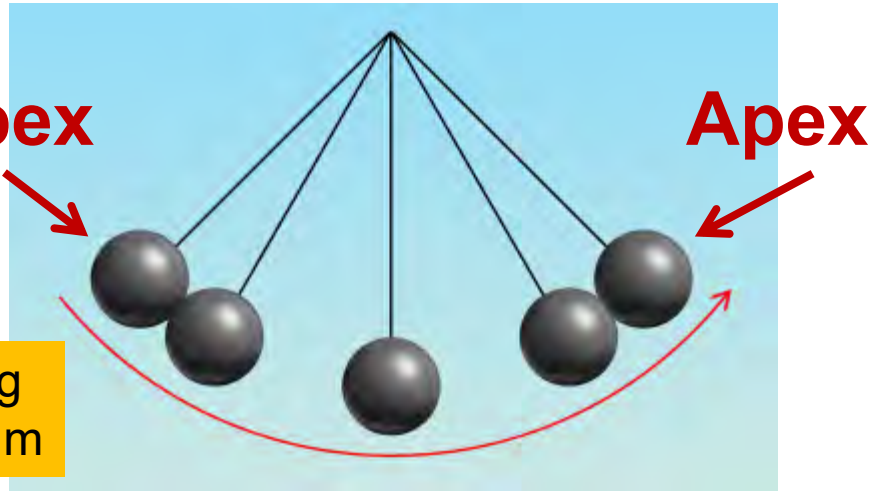
1. Squash & Stretch
2. Timing
3. Anticipation
4. Staging
5. Follow Through & Overlapping Action
6. Straight Ahead & Pose-to-Pose Action
7. Slow In and Slow Out
8. Arcs
9. Exaggeration
10. Secondary Action
11. Appeal
12. Solid Drawing

Apex & Extremes

A ball that's thrown straight upward slows in to and then slows out from the *apex* (i.e., the highest point).



An apex is an example of an *extreme*, a pose from which slowing out starts or slowing in finishes.

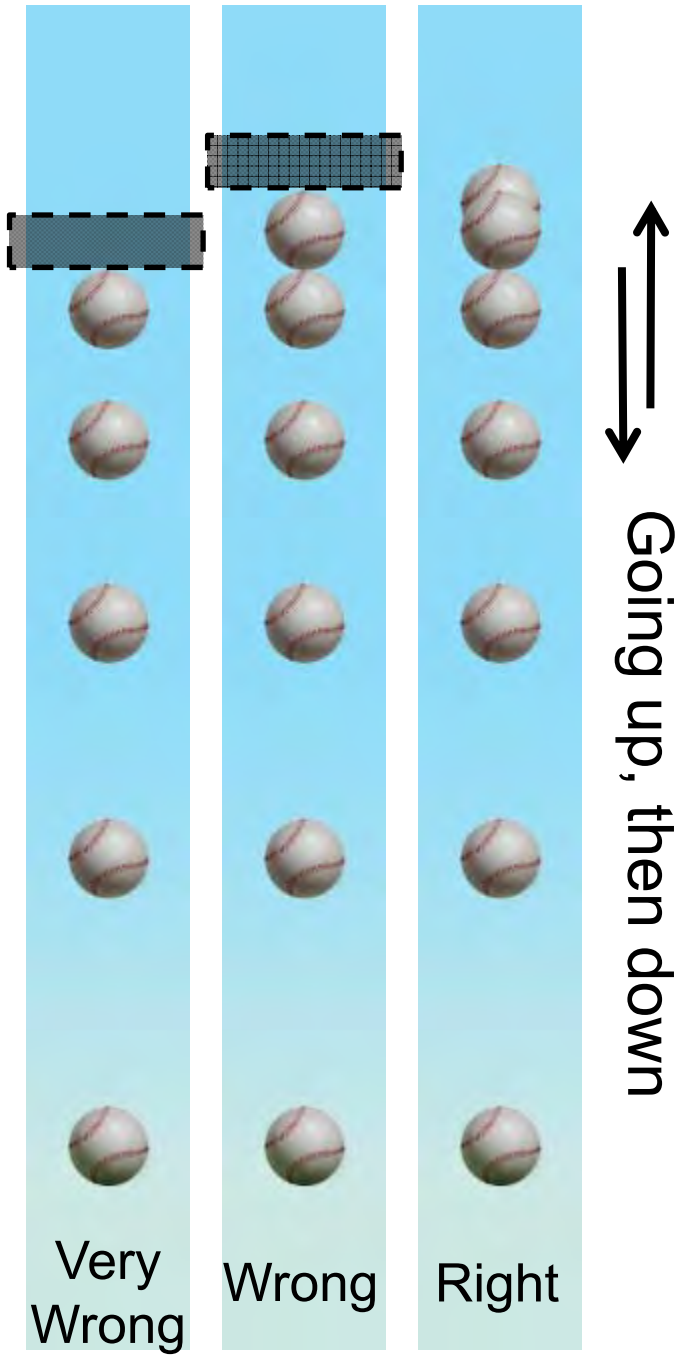


“Hitting the Ceiling”

Animating a ball that slows into an apex and then slows out as it falls is challenging.

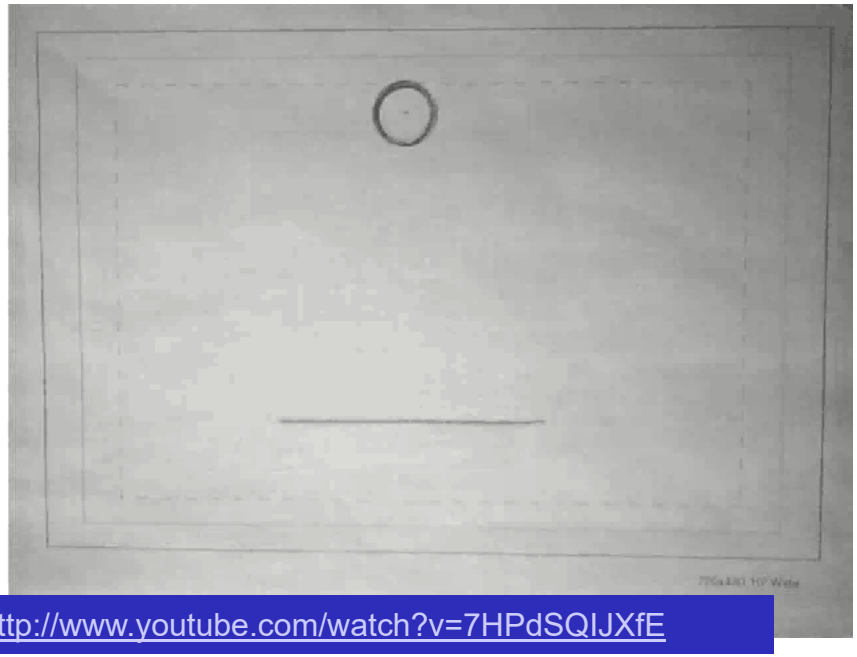
If the spacings near the apex aren’t quite right then the ball reverses direction at the top in an unnatural way.

The ball may appear as if it is hitting an invisible ceiling.



“Hitting the Ceiling” Example

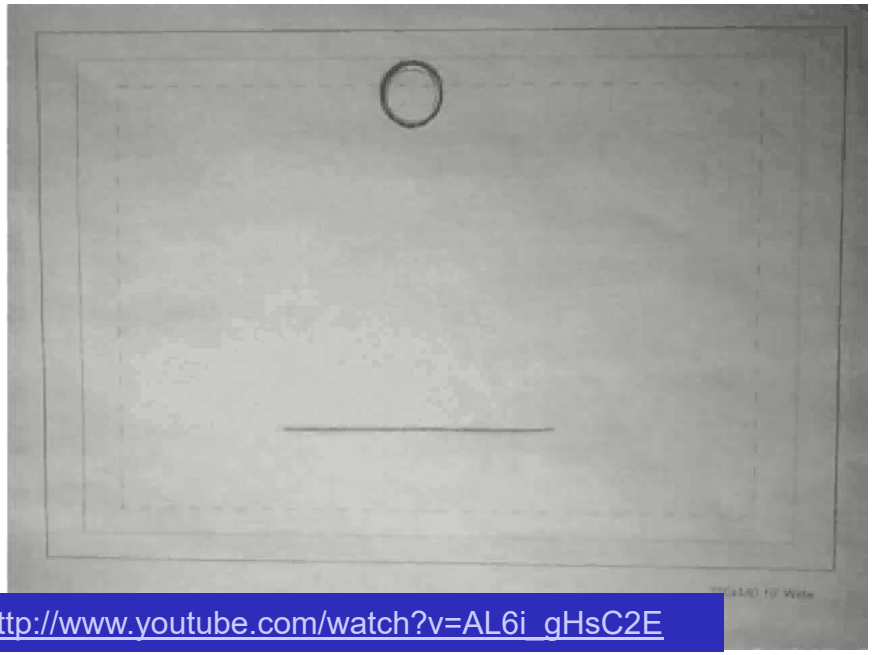
Wrong



http://www.youtube.com/watch?v=7HPdSQIJXfE

This ball seems to hit an invisible ceiling near the apex.

Right



http://www.youtube.com/watch?v=AL6i_gHsC2E

Here the slowing in and out of the apex is pretty good.

Summary

- Uniform motion is motion with constant speed in a straight line.
- The larger the spacings, the higher the speed of the motion.
- Slowing in & slowing out are important examples of non-uniform motion.
- The apex is an example of an extreme.
- The spacings into and out of the apex are critical to creating believable falling motion.