Acceleration/Deceleration

What changes? – both position and speed

- position = position + speed
- speed = speed + acceleration

To speed up, acceleration is in the same direction as speed (same sign).

To slow down, acceleration is in the opposite direction as speed (opposite sign).

Physically-Based Motion

Bouncing

Bouncing means doing different things at different times – sometimes you update the speed as usual (add the acceleration), sometimes you bounce (multiply the speed by -1 to change its direction).

- note: bouncing off a vertical surface affects the x speed, bouncing off a horizontal surface affects the y speed

Note: Since the simulation only works in discrete steps, it is likely that the object will have moved just beyond the edge of the window before the need to bounce is detected. Since air resistance and damping (see below) work to decrease the speed, it is possible that the object won't be moving fast enough after the bounce to get back into the window resulting in the object escaping. The mathematically correct solution for this situation is somewhat complicated, but a quick fix is to also adjust the position of the object to place it just at the edge of the window when a bounce occurs.

Gravity, Air Resistance, Damping

Gravity is acceleration downwards.

- yspeed = yspeed + g ($g > 0$)

Air resistance slows the speed proportional to the speed as the object moves through space; replace k by some very small (but positive) value.

- speed = speed – k*speed

Note: if both gravity and air resistance are being used, combine them into a single update for the y speed.

- yspeed = yspeed + g – k*speed

Damping slows the speed proportional to the speed when the object bounces, to model the effects of friction; replace k by a value close to (but smaller than) 1.

- speed = -k*speed

At the End of Class

Hand in whatever you have done during class, even if a sketch is incomplete.

- Make sure each sketch is named as directed and has a comment with the names of your group. Also be sure to save your sketches! (in Linux, this should be in your sketchbook **~/cs120/sketchbook**)
- Copy the entire directory for each sketch (not only the `.pde` file) into your handin directory (**/classes/cs120/handin/*username***). You only need to hand in one copy for the group. (If you are running Processing on your computer instead of using the Linux virtual desktop, you will need to use FileZilla to copy the sketches.)

Exercises

For all sketches, be sure to **include a comment with the names of your group at the beginning of the sketch.**

1. Create a sketch named **sketch_241004a** and copy-and-paste the contents of the "for #1" sketch posted on the schedule page into your sketch, then run it to see what it does.

   (a) Make the second circle (the green one) start from rest (speed is 0) and accelerate as it moves from left to right across the screen.

   (b) Make the third circle (the blue one) decelerate as it moves from left to right across the screen. Remember that deceleration can be thought of as acceleration in the opposite direction.

2. Create a sketch named **sketch_241004b** and copy-and-paste the contents of the "for #2" sketch posted on the schedule page into your sketch, then run it to see what it does.

   (a) Make the first circle (the black one) bounce whenever it hits the top or bottom of the drawing window. Also employ the fix which sets the circle's position to be just at the edge of the window when it bounces.

   (b) Make the second circle (the red one) start at rest and accelerate due to gravity. It should also bounce whenever it hits the bottom of the window.

   (c) Make the third circle (the green one) subject to gravity and air resistance, as well as bouncing whenever it hits the bottom of the window. Choose a value for k for the air resistance so that the effect is visible but not too drastic.

   (d) Make the fourth circle (the blue one) subject to gravity and air resistance, as well as bouncing whenever it hits the bottom of the window. Include damping when it bounces. Use the same k for air resistance as in (c) and choose a value for the k for damping so that the effect is visible but not too drastic.

If you have time –

- Save a copy of your sketch from #2 as **sketch_241004c**, then modify the copy so that the blue circle moves both horizontally and vertically, and can bounce off any side of the window. (Gravity still only applies to the y speed, but air resistance, bouncing, and damping can now affect both x and y.)
- Modify your sketch to include a rectangular obstacle which the blue circle also bounces off of. Bouncing off a rectangular obstacle is similar to bouncing off the side of the window – how do you determine if the circle has hit the rectangle?