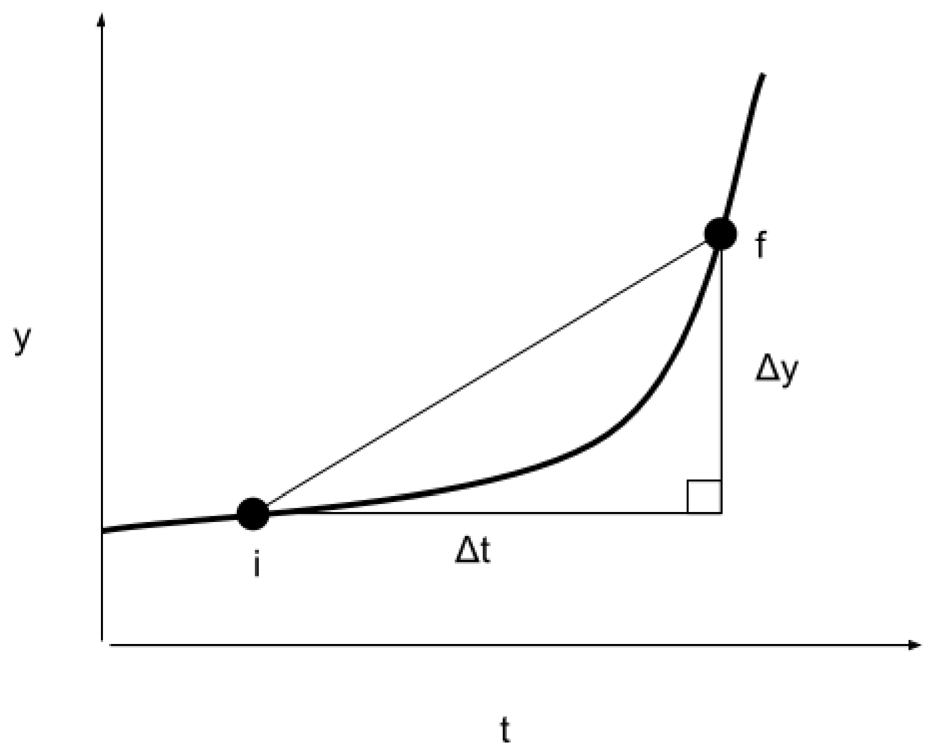
From 121, recall that :

$$v \equiv \frac{dy}{dt} \quad \text{and} \quad a \equiv \frac{dv}{dt}$$

Also recall that :

$$v_{ave} \equiv \frac{\Delta y}{\Delta t} = \frac{y_f - y_i}{t_f - t_i} \quad \text{and} \quad a_{ave} \equiv \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

Below is a plot of the position (y) of a particle plotted over time (t). Points i and f represent an arbitrary initial and final point along the trajectory.



1. In the plot above, what does the slope of the line between i and f represent in terms of the definitions provided? Explain.

2. Is the slope of the line greater, less than, or equal to v_f? Explain.

3. Would the slope of the line between points be closer to v_f if we considered a final point with a smaller Δt? Explain.

4. Using the definitions provided, express v_f in terms of v_i, Δt, and a_{ave}.

5. Similarly, express y_f in terms of y_i, Δt, and v_{ave}.

6. In computer code, the symbol '+=' is used to denote incrementation. For example :

   $y_f = y_i + dy$

   can be written in code as :

   y* += *dy;

   Express your answers to 4 and 5 using the syntax above and the symbols ***v***, ***y***, ***a***, and ***dt***.

   *(Let **a** represent* a_{ave} *and **dt** represent* Δt*)*

   v += ;

   y += ;

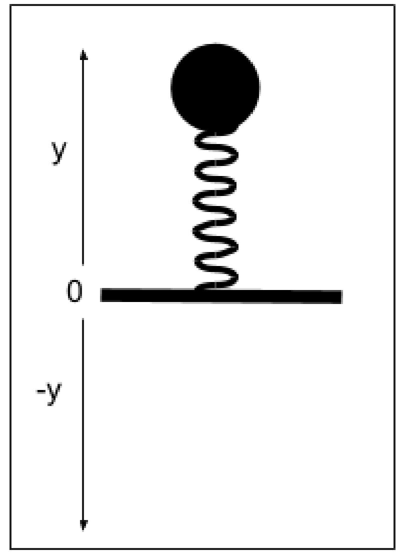
7. If ***v*** is initially v_i and ***y*** is initially y_i, what is ***v*** and ***y*** after each operation is performed?

8. In 5, the increment of **y** depends on v_{ave}. What must be true about the value of **dt** for v_f to approximate v_{ave} in your code? Explain.

9. If ***a*** (a_{ave}) is zero and ***v*** positive, what will happen to the value of ***y*** each time this operation is performed?

Now consider a spring with equilibrium at $y = 0$. Recall that :

$$F = ma = -ky$$



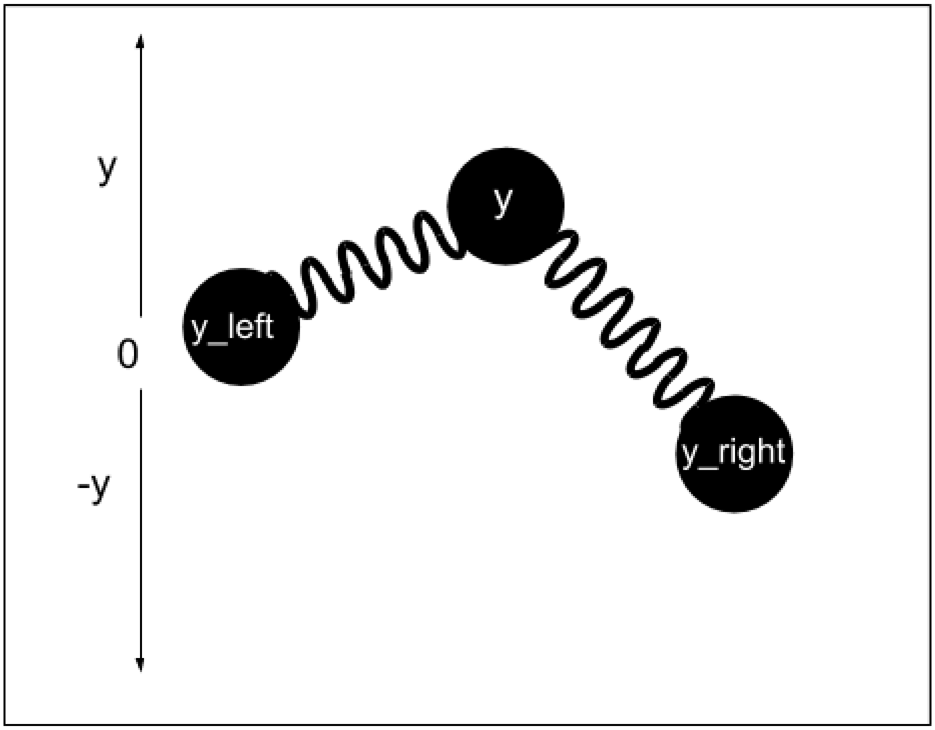
10. When released, what will happen to the ball over time? When $y = 0$, is the ball at rest?

11. Write $\boldsymbol{a}$ in terms of $\boldsymbol{m}$, $\boldsymbol{k}$, and $\boldsymbol{y}$.

12. Plug this value of $\boldsymbol{a}$ into your code from 6.

v += ;
y += ;

13. What will happen to the value ***v*** and ***y*** if a computer repeats this incrementation over time?



14. Assume that the balls are free to move up and down only and that the force only depends on the y component of the displacement between balls. Express the instantaneous acceleration (***a***) of the middle ball in terms of ***y***, ***y_left***, ***y_right***, ***k***, and ***m***. Simplify as needed.

15. Plug in the value of *a* from 10 into your code from 5.

v += ***;***

y += ***;***