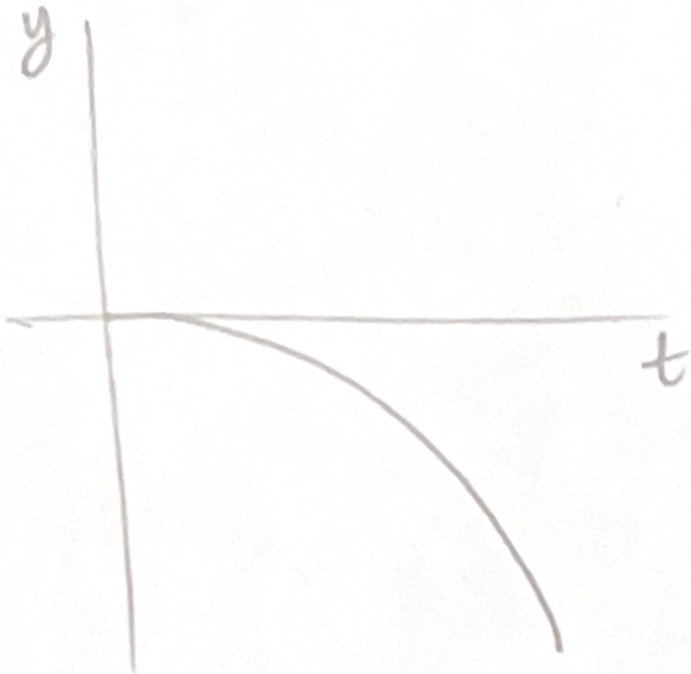
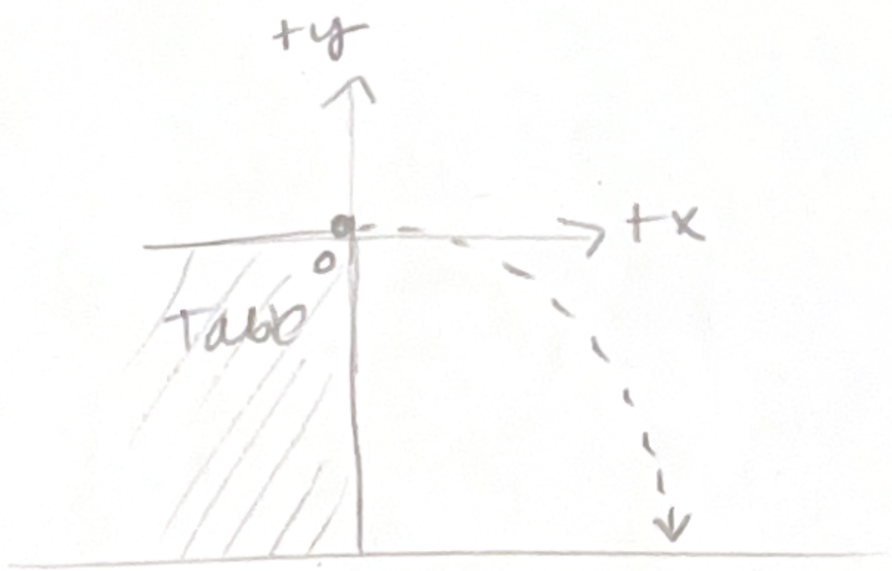
Kinematics Equations: Derivatives and Antiderivatives





① General equation for position when motion can be modeled as constant acceleration:

$$\Delta y = V_{iy}\Delta t + \frac{1}{2}a_y\Delta t^2$$

Assuming $t_i = 0$, we get:

$$y = y_i + V_{iy}t + \frac{1}{2}a_y t^2$$

② Taking the derivative with respect to time, we get the y-component of the velocity:

$$y' = V_y = V_{iy} + a_y t$$

③ Taking the derivative again, we get the y-component of acceleration:

$$y'' = a_y = a_y$$

④ To go the other direction, we take the antiderivative and add a constant:

$$y'' = a_y = a_y$$

$$y' = V_y = a_y t + C$$

Now we evaluate the constant using the fact that at $t=0$, $V_y = V_{iy}$:

$$V_y = a_y t + C$$
$$V_{iy} = a_y(0) + C$$
$$V_{iy} = C$$

So, the equation for y' becomes $\boxed{y' = V_y = V_{iy} + a_y t}$

⑤ To find an equation for position, take the antiderivative of ↑, and add constant. Evaluate the constant using the fact that $y = y_i$ at $t=0$, and you will get: $y = y_i + V_{iy}t + \frac{1}{2}a_y t^2$