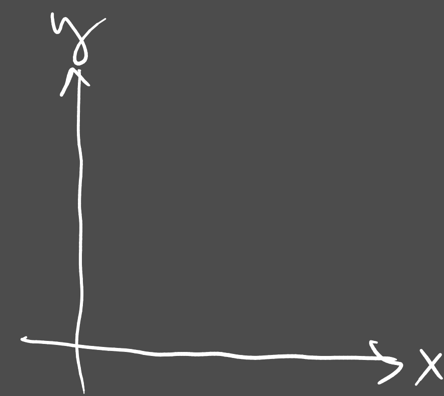
Chapter 3

Chapter 3 - Free-fall and Projectile Motion

Free-fall
* constant acceleration -> g = 9.8 m/s^2
  10 m/s^2 is close enough in most cases
* can be positive or negative depending on
  your perspective
* otherwise use the constant acceleration
  equations we have.

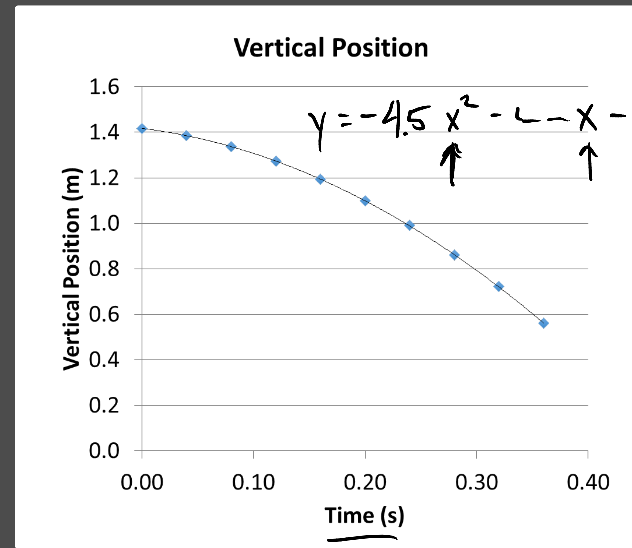


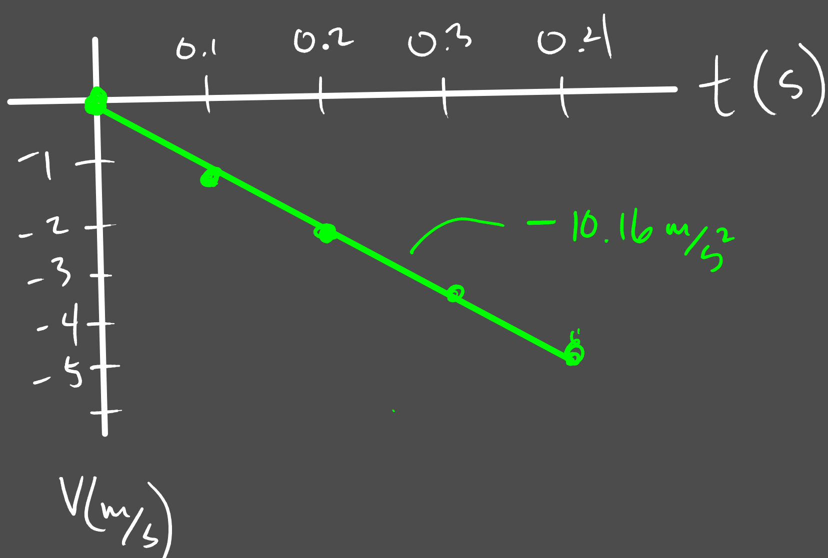
$$\rightarrow V_f = V_i + \underset{\substack{\uparrow \\ g = (\pm 9.8\, m/s^2)}}{a} \cdot t$$

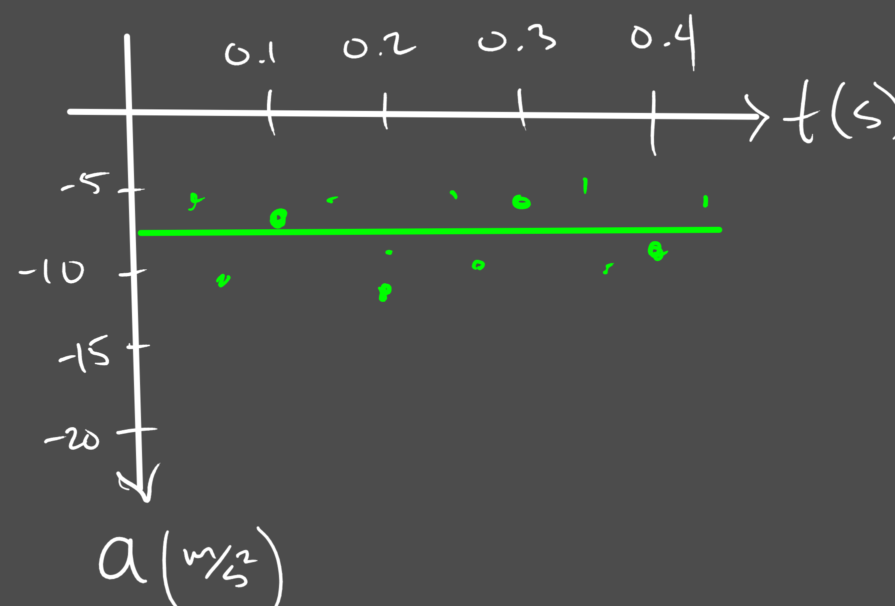
$$y_f = \underline{y_i + v_i \cdot t} + \frac{1}{2} \underset{\substack{\uparrow \\ g}}{a} \cdot t^2$$

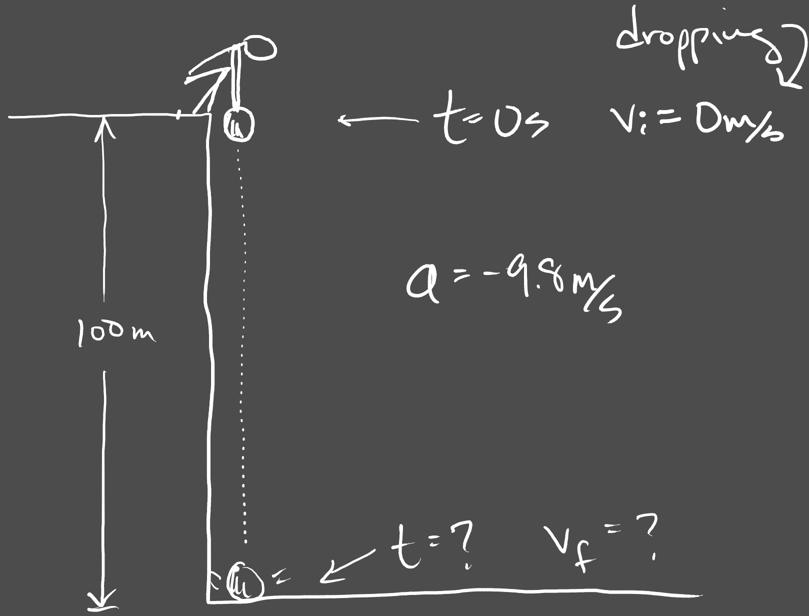
Vertical Motion of Free-Fall Object

Time (s)	Vertical Position, y (cm)	Vertical Position, y (m)	Delta y (m)	Vertical Velocity (m/s)	Vertical Acceleration (m/s²)
0.00	15.80	1.417			
0.04	15.45	1.386	-0.031	-0.78	
0.08	14.90	1.336	-0.049	-1.23	-11.21
0.12	14.20	1.274	-0.063	-1.57	-8.41
0.16	13.30	1.193	-0.081	-2.02	-11.21
0.20	12.25	1.099	-0.094	-2.35	-8.41
0.24	11.05	0.991	-0.108	-2.69	-8.41
0.28	9.60	0.861	-0.130	-3.25	-14.01
0.32	8.05	0.722	-0.139	-3.48	-5.61
0.36	6.25	0.561	-0.161	-4.04	-14.01
				Average Acceleration	-10.16









$$y_f = y_i + v_i \cdot t + \tfrac{1}{2} a \cdot t^2$$

$$0 = +100\,m + \cancel{0 \cdot t} + \tfrac{1}{2}(-9.8\,m/s^2)t^2$$

$$0 = 100\,m + (-4.9\,m/s^2)t^2$$

$$-100 \qquad -100$$

$$\frac{-100\,m}{-4.9\,m/s^2} = \frac{-4.9\,m/s^2 \cdot t^2}{-4.9\,m/s^2}$$

$$\sqrt{20.4\,s^2} = \sqrt{t^2}$$

$$\boxed{4.52\,s = t}$$

$$v_f = v_i + at \quad (t = 4.52\,s)$$

$$v_f: ? \qquad v_i: 0 \qquad a: -9.8\,m/s^2$$

$$v_f = 0 - 9.8\,m/s^2 \cdot 4.52\,s$$

$$v_f = -44.296\,m/s$$

$$\boxed{v_f = -44.3\,m/s}$$

$$y_f = y_i + v_i \cdot t + \tfrac{1}{2} a t^2$$

$$y_f: 100\,m \qquad y_i: 0\,m \qquad v_i: 0\,m/s \qquad a: 10\,m/s^2$$

$$100\,m = \cancel{0} + \cancel{0 \cdot t} + \tfrac{1}{2}(10\,m/s^2)t^2$$

$$100\,m = 5\,m/s^2\,t^2$$

$$\sqrt{20\,s^2} = \sqrt{t^2}$$

$$4.47\,s = t$$

$$v_f = \cancel{v_i} + a \cdot t$$

$$v_f = 10\,m/s^2 \cdot (4.47\,s)$$

$$v_f = +44.7\,m/s$$

* A person drops a ball off a 100 m cliff, and it falls ~~with an acceleration of 9.8 m/s/s,~~ find the final time and final velocity of the ball when it hits the ground.

How could I word the description of the problem above?

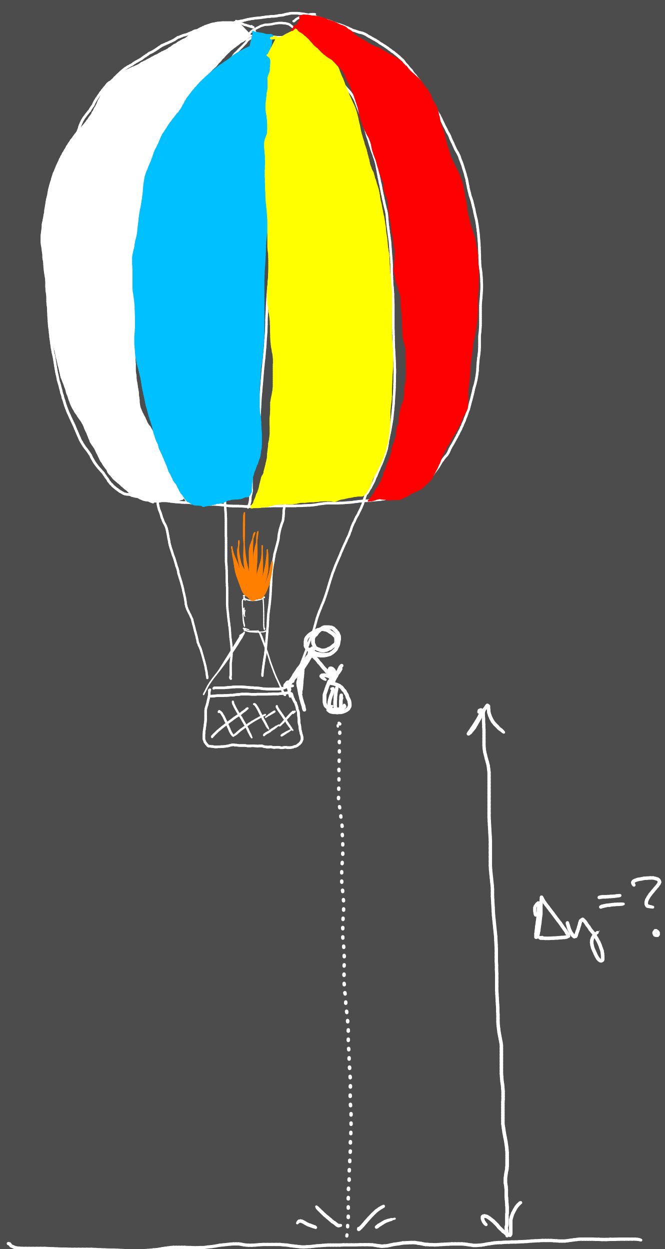
* If I drop a ball from a 100 m high cliff, how long is it in the air? And how fast is it travelling when it hits the ground?

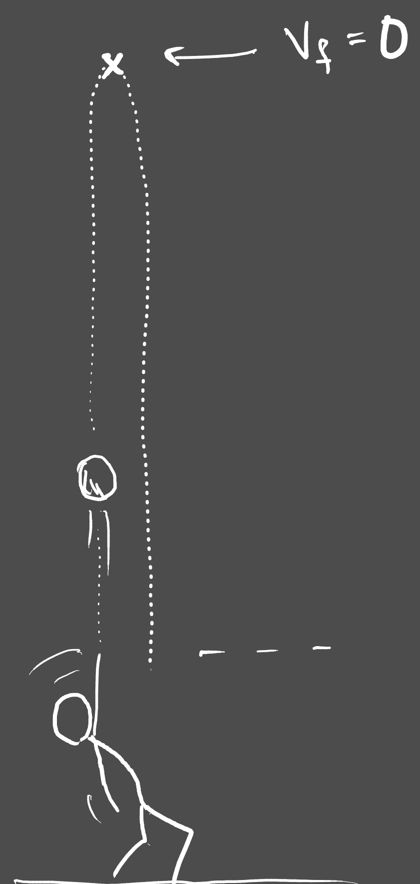
* How long would it take for a ball to drop 100 m with no resistance starting from stand still (rest) and how fast is it traveling when it hits the ground?

What if I threw the object down to start with at 10 m/s initially?

quadratic equation → more math → more bad

Recall Quiz: If it takes 3.5 seconds for an object you drop to hit the ground, then how high are you above the ground?




$V_f = 0$

Two dimensional projectile motion

Paths are in the shape of parabolas