Section 3.3: Free Fall

How would you define a free-falling object?
What variables affect a free-falling object?

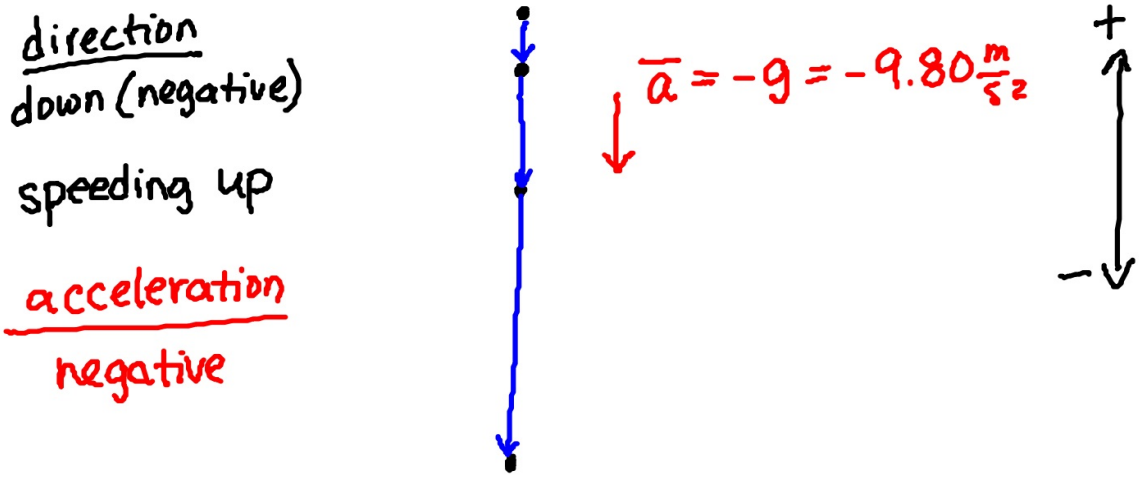
p. 72 ⇒ gravity

- air resistance
- weight / size / shape
- height
- velocity

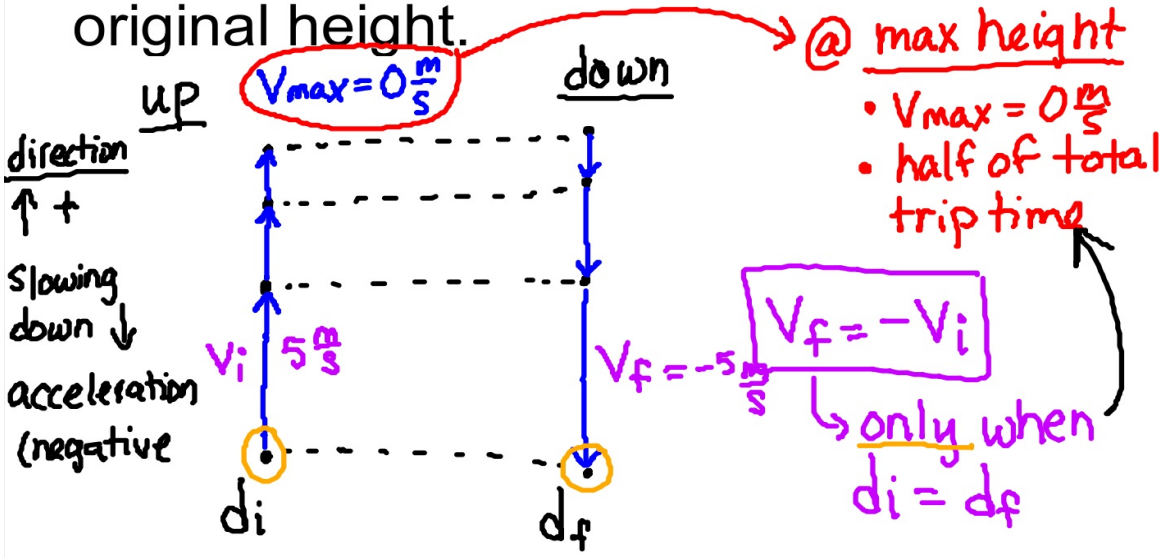
Section 3.3 Notes:

- acceleration due to gravity
  - ↳ $g = 9.80\ m/s^2$, downward
  - ↳ $\bar{a} = -g = -9.80\ \frac{m}{s^2}$ (for free-fall situations)

Draw a particle model to represent a ball dropping from rest.



Draw a particle model of a ball being thrown up in the air and falling back down to its original height.



Practice Problems (p. 74)

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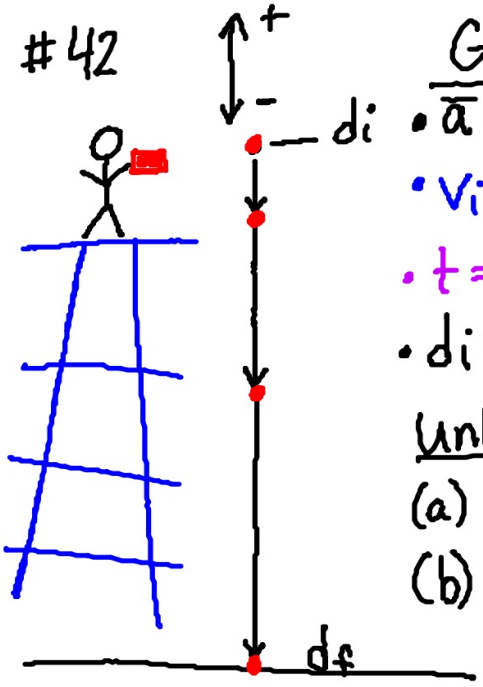

Given:

- $\bar{a} = -g = -9.80 \frac{m}{s^2}$
- $v_i = 0 \frac{m}{s}$ (brick was dropped from rest)
- $t = 4.0\,s$ (given)
- $d_i = 0\,m$

Unknown:

(a) $v_f =$ ____ m/s

(b) $d_f =$ ____ m

Equations

$$v_f = v_i + \bar{a}t$$

$$d_f = d_i + v_i t + \frac{1}{2}\bar{a}t^2$$

or

$$v_f^2 = v_i^2 + 2\bar{a}(d_f - d_i)$$

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Substitute & Solve

(a)

$$v_f = v_i + \bar{a}t$$

$$v_f = 0 \frac{m}{s} + \left(-9.80 \frac{m}{s^2}\right)(4.0\,s)$$

$$v_f = -39.2$$

2 sig figs

$$\boxed{v_f = -39 \frac{m}{s}}$$

(a)

(b)

$$d_f = d_i + v_i t + \frac{1}{2}\bar{a}t^2$$

$$d_f = 0\,m + 0 \frac{m}{s}(4.0\,s) + \frac{1}{2}\left(-9.80 \frac{m}{s^2}\right)(4.0\,s)^2$$

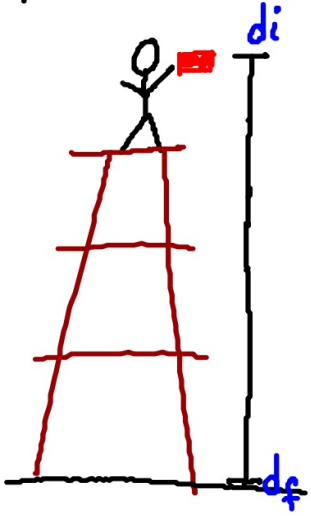
(0 and 0 struck through)

$$d_f = -78.4\,m_{2SF}$$

.5 × 9.80 × 4 ^ 2

$$\boxed{d_f = -78\,m}$$

p. 74 (#42)



Given:

$\bar{a} = -9.80 \frac{m}{s^2}$ (free-fall)

$t = 4.0\,s$ (stated)

$V_i = 0.0 \frac{m}{s}$

$d_i = 0.0\,m$

Unknown:

(a) $V_f = \_\_ \frac{m}{s}$

(b) $d_f = \_\_ m$

Equation:

② $V_f = V_i + \bar{a}t$

$V_f = 0 + -9.8(4)$

$V_f = -39.2 \frac{m}{s}$

$\boxed{V_f = -39 \frac{m}{s}}$

③ $d_f = d_i + V_i t + \frac{1}{2}\bar{a}t^2$

$d_f = 0\,m + 0\frac{m}{s}(4.5) + \frac{1}{2}\left(-9.80 \frac{m}{s^2}\right)(4s)^2$

$d_f = -78.4\,m$

$= \boxed{-78\,m}$

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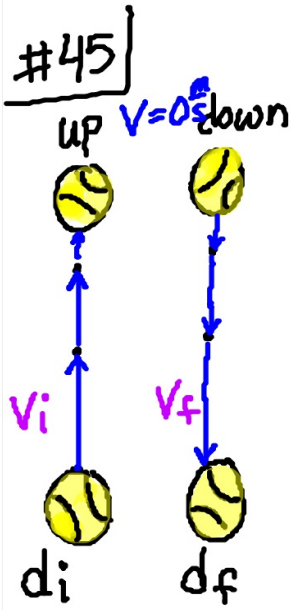

Given:

$V_i = 22.5 \frac{m}{s}$

$V_f = 0 \frac{m}{s}$ (up)

$V_f = -22.5 \frac{m}{s}$ (down)

$\bar{a} = -9.80 \frac{m}{s^2}$

V_i (down) $= 0 \frac{m}{s}$

$d_i = 0\,m$ (up)

$d_f = 0\,m$ (down)