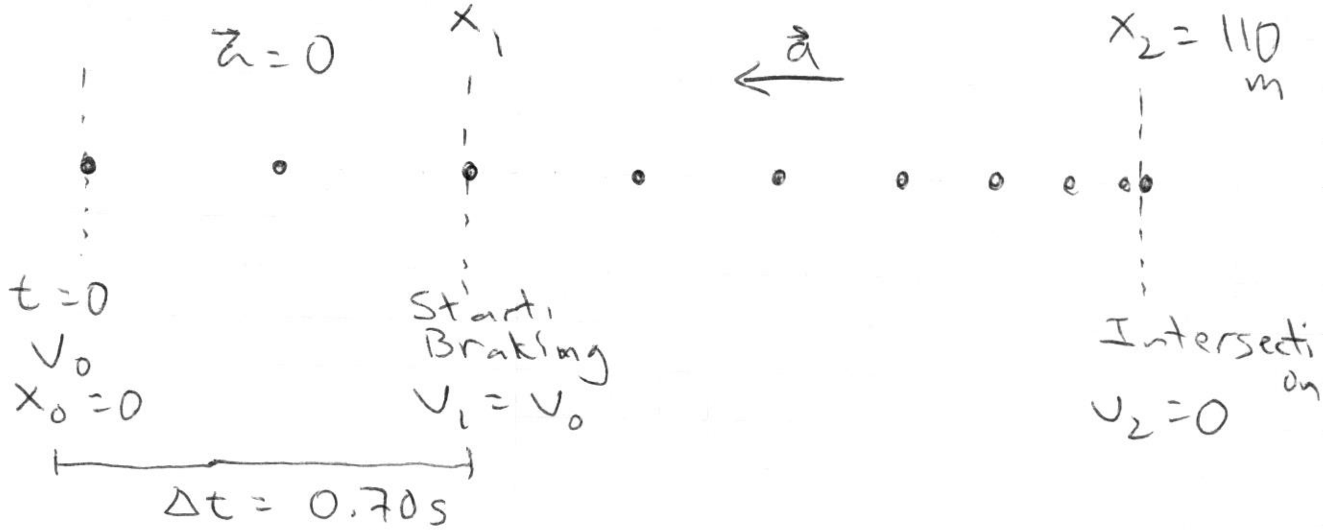
2.60



During reaction time, travel

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$
$$x = 0 \quad (20 \text{ m/s})(0.7 \text{ s}) + 0$$
$$x = 14 \text{ m}$$

Start braking:

$$v_2^2 = v_1^2 + 2a\Delta x$$
$$0 = (20 \text{ m/s})^2 + 2a(110 - 14 \text{ m})$$

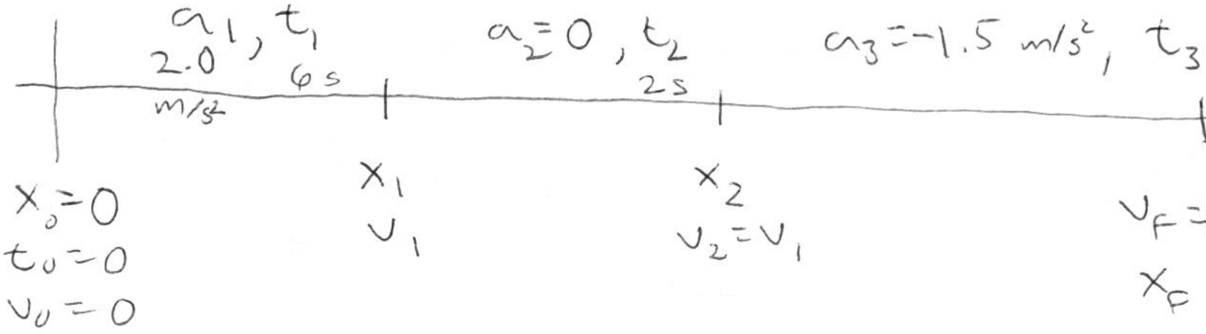
this is Δx covered while braking

$$a = -2.08 \text{ m/s}^2 = -2.1 \text{ m/s}^2$$

Stopping time:

$$v_2 = v_1 + a\Delta t$$
$$0 = 20 \text{ m/s} + -2.08\,\Delta t$$
$$\Delta t = 9.6 \text{ s}$$

2-69



1st Segment: $v_f = v_0 + at$

$$v_1 = 0 + (2.0\ m/s^2)(6s) = 12.\ m/s$$

$$x_1 = x_0 + v_0 t + \frac{1}{2} a_1 t^2$$
$$x_1 = 0 + 0 + \frac{1}{2}(2.0\ m/s^2)(6s)^2$$
$$x_1 = 36\ m$$

2nd Segment: $v = \text{constant} = 12\ m/s$

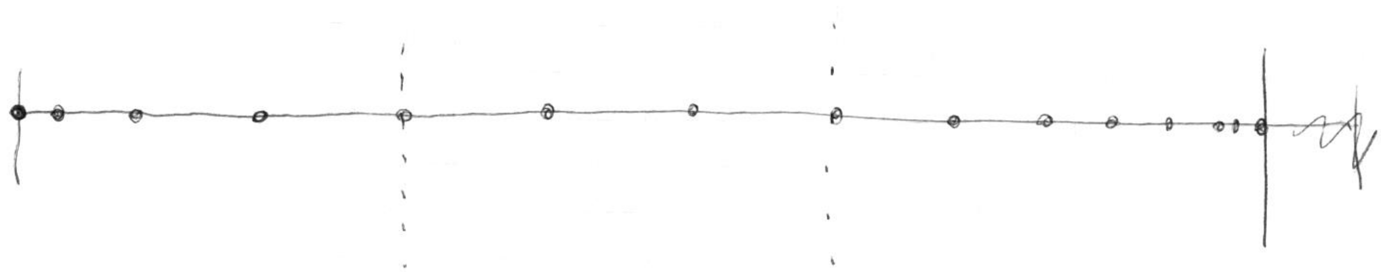
$$x_2 = x_1 + v_1 t + \frac{1}{2} a_2 t^2$$
$$x_2 = 36\ m + (12\ m/s)(2.0s) + 0$$
$$x_2 = 60\ m$$

3rd Segment: $v_f = v_2 + a_3 t_3$

$$0\ m/s = 12\ m/s + (-1.5\ m/s^2)t_3$$
$$t_3 = 8.0\ s$$

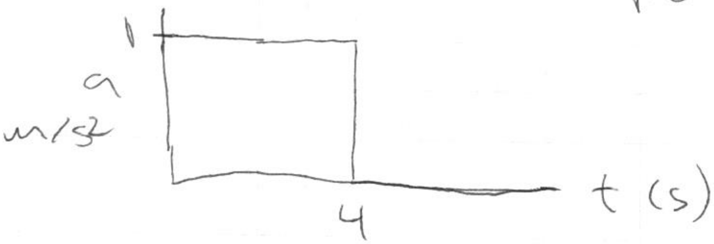
$$x_3 = x_2 + v_2 t + \frac{1}{2} a_3 t^2$$
$$x_3 = 60 + (12\ m/s)(8.0\ s) + \frac{1}{2}(-1.5\ \frac{m}{s^2})(8.0s)^2$$
$$x_3 = 108\ m$$

Motion Diagram:



2-20 Graphically:

read a from slope of v, t:



$a = \frac{\Delta v}{\Delta t} = 1.0$ m/s

Δx as area under v, t graph

0 - 2 s: $\Delta x = \frac{1}{2}(2\text{ s})(-2\text{ m/s}) = -2$ m

$\therefore x = -2$ m at 2 s

2 - 4 s: $\Delta x = \frac{1}{2}(2\text{ s})(+2\text{ m/s}) = +2$ m

$\therefore x = 2$ m past where it was at 2s, so $x = 0$ at 4s

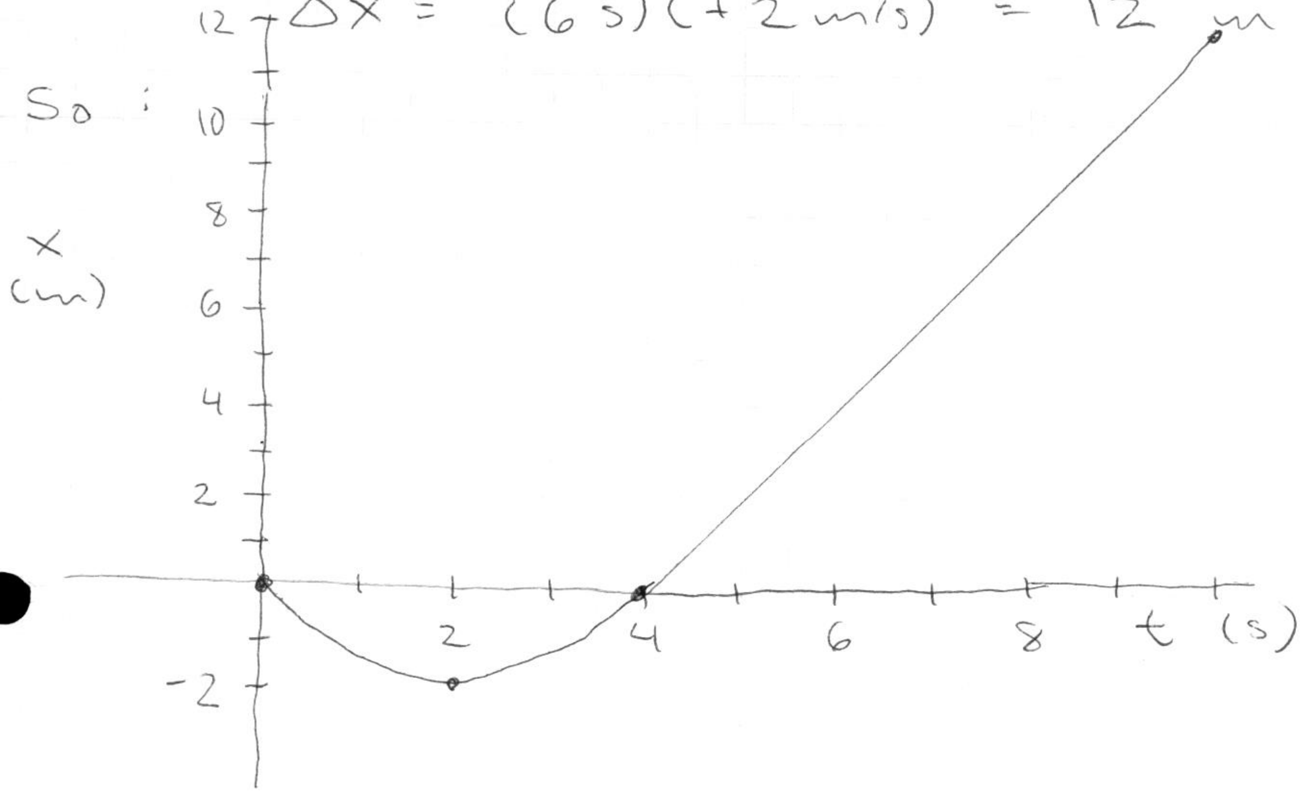
Note a is positive during this time, so lines are curved + showing positive a

From 4 - 10 s, line is straight.

Δx from 4 → 10 s is

$\Delta x = (6\text{ s})(+2\text{ m/s}) = 12$ m

So:



OR →

OR using kinematic eqs

- from vel graph, $a = +1.0$ m/s ~~to~~ from $0 \rightarrow 4$ sec
  $a = 0$ from $4 \rightarrow 10$ s
  and $v_0 = -2$ m/s ~~to~~ at $t = 0$

$0 \rightarrow 1$ s:

$$x_1 = x_0 + v_0 t + \tfrac{1}{2} a t^2$$
$$x_1 = 0 + (-2 \text{ m/s})(1 \text{ s}) + \tfrac{1}{2}(1 \text{ m/s}^2)(1 \text{ s})^2$$
$$x_1 = -1.5 \text{ m} \quad \text{at } 1 \text{ s}$$

$$x_2 = 0 + (-2 \text{ m/s})(2 \text{ s}) + \tfrac{1}{2}(1 \text{ m/s}^2)(2 \text{ s})^2$$
$$x_2 = -2.0 \text{ m} \quad \text{at } 2 \text{ s}$$

$$x_3 = 0 + (-2 \text{ m/s})(3 \text{ s}) + \tfrac{1}{2}(1 \text{ m/s}^2)(3 \text{ s})^2$$
$$x_3 = -1.5 \text{ m} \quad \text{at } 3 \text{ s}$$

$$x_4 = 0 + (-2 \text{ m/s})(4 \text{ s}) + \tfrac{1}{2}(1 \text{ m/s}^2)(4 \text{ s})^2$$
$$x_4 = 0.0 \text{ m}$$

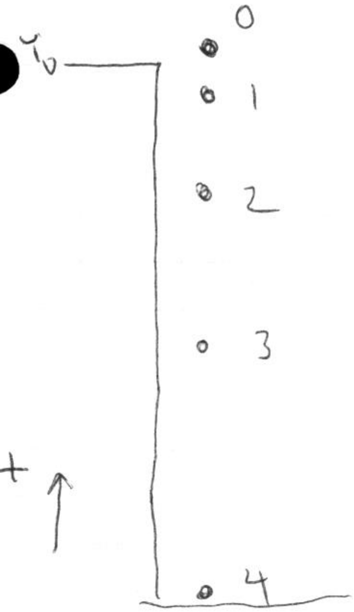
- Now $a = 0$, so straight line.

$$x_f = x_0 + v_0 t + \tfrac{1}{2} a t^2$$
$$x_{10} = x_4 + v_4 t + \tfrac{1}{2} a t^2$$

$$x_{10} = 0 + (2 \text{ m/s})(10 - 4 \text{ s}) + 0$$
$$x_{10} = 12 \text{ m}$$

b. From acc vs t graph, $a = +1.0$ m/s^2 at $t = 3.0$ s

2-42



$y_f = 0$

What do you think v_0 is?

$$y_f = y_0 + v_{0y}\Delta t + \tfrac{1}{2} a_y \Delta t^2$$

$$0 = y_0 + 0 + \tfrac{1}{2}(-9.8\ \tfrac{m}{s^2})(4.0\,s)^2$$

$$y_0 = 78.4\ m = 78\ m$$

$$v_{fy} = v_{0y} + a_y \Delta t$$

$$v_{fy} = 0 + (-9.8\ m/s^2)(4.0\,s)$$

$$v_f = 39\ m/s$$

<u>or</u>

$$v_f^2 = v_0^2 + 2 a_y \Delta y$$

$$v_f^2 = 0 + 2(-9.8\ m/s^2)(-78.4\ m)$$

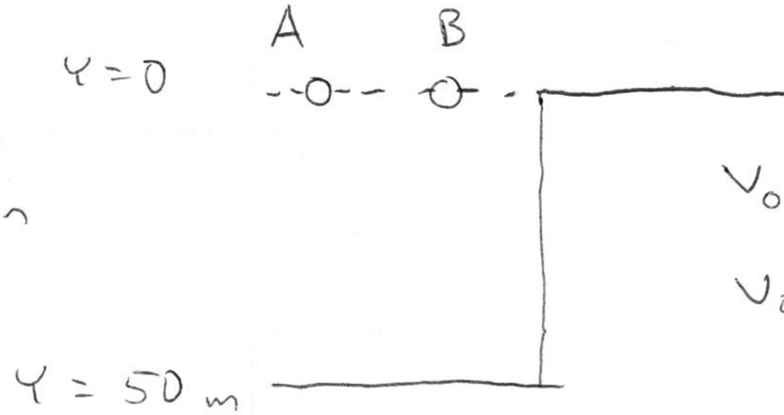
$$\Delta y = y_f - y_0$$

$$v_f = 39\ m/s$$

2-51

$x \downarrow$

I choose Down ~~pros~~ positive



$v_{0A} = 2.0$ m/s

$v_{0B} = ?$

hit water at same time, but B was thrown 1.0 s after stone A. So B has travel time 1.0 s less than A:

$$\Delta t_B = \Delta t_A - 1.0 \text{ s}$$

A: $y = y_0 + v_0 t + \frac{1}{2}at^2$

$$50 = 0 + (2.0 \text{ m/s})t + \frac{1}{2}(9.8 \text{ m/s})t^2$$

$$0 = 4.9t^2 + 2t + {}^-50$$

$$\Delta t = \frac{-2 \pm \sqrt{2.0^2 - 4(4.9)(-50)}}{2(4.9)}$$

(a) $\Delta t_A = 3.0$ s

$\therefore \Delta t_B = 2.0$ s

B: $y = y_0 + v_0 t + \frac{1}{2}at^2$

$$50 = 0 + v_0(2.0 \text{ s}) + \frac{1}{2}(9.8 \text{ m/s}^2)(2.0 \text{ s})^2$$

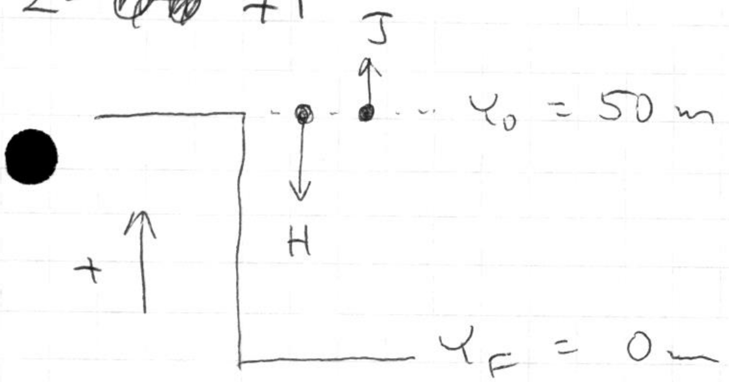
(b) $v_0 = 15.2$ m/s

Final velocities: $v_F = v_0 + at$

A: $v_F = 2.0 \text{ m/s} + (9.8 \text{ m/s}^2)(3.0 \text{ s})$
$= 31.4$ m/s
$= 31$ m/s

B: $v_F = 15.2 \text{ m/s} + (9.8 \text{ m/s}^2)(2.0 \text{ s})$
$= 34.8$ m/s
$= 35$ m/s

2-71



$$ax^2 + bx + c = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

H : $V_0 = -20$ m/s.

$$Y_F = Y_0 + V_0 \Delta t + \tfrac{1}{2} g \Delta t^2$$

$$0 = 50\text{ m} + (-20\text{ m/s})\,\Delta t + \tfrac{1}{2}(-9.8\text{ m/s}^2)\,\Delta t^2$$

$$4.9\Delta t^2 + 20\,\Delta t + -50 = 0$$

$$\Delta t = \frac{-20 \pm \sqrt{(20)^2 - 4(4.9)(-50)}}{2(4.9)}$$

$$\Delta t = 1.75\text{ s}$$

$$V_F = V_0 + g\Delta t = -20\text{ m/s} + (-9.8\text{ m/s}^2)\,(1.75\text{ s})$$

$$V_F = -37\text{ m/s}$$

J : $V_0 = +20$ m/s.

$$Y_F = Y_0 + V_0 \Delta t + \tfrac{1}{2} g \Delta t^2$$

$$0 = 50\text{ m} + (20\text{ m/s})\,\Delta t + \tfrac{1}{2}(-9.8\text{ m/s}^2)\,\Delta t^2$$

$$4.9\,\Delta t^2 + -20\,\Delta t + -50 = 0$$

$$\Delta t = \frac{+20 \pm \sqrt{(-20)^2 - 4(4.9)(-50)}}{2(4.9)}$$

$$\Delta t = 5.83\text{ s}$$

$$V_F = V_0 + g\Delta t = 20\text{ m/s} + (-9.8\text{ m/s}^2)(5.83\text{ s})$$

$$V_F = -37\text{ m/s}$$

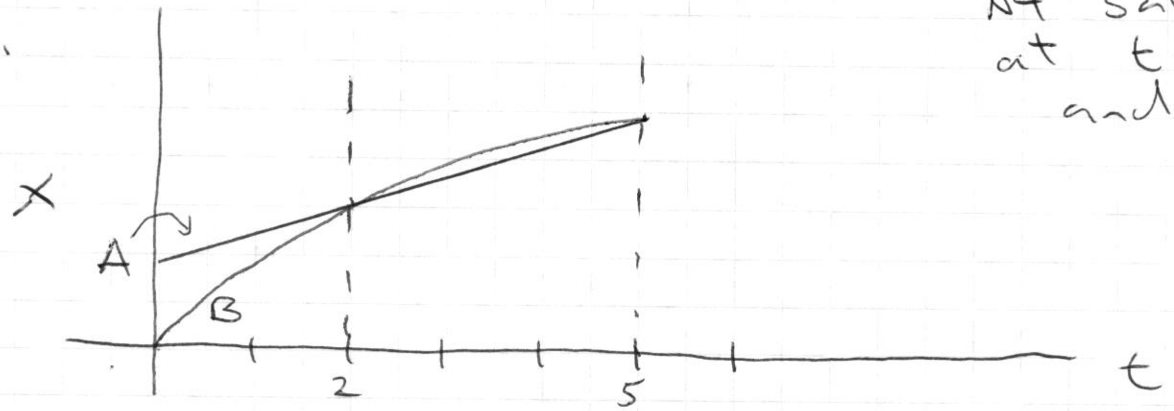
Time between splashes $= 5.83 - 1.75 = 4.1$ s

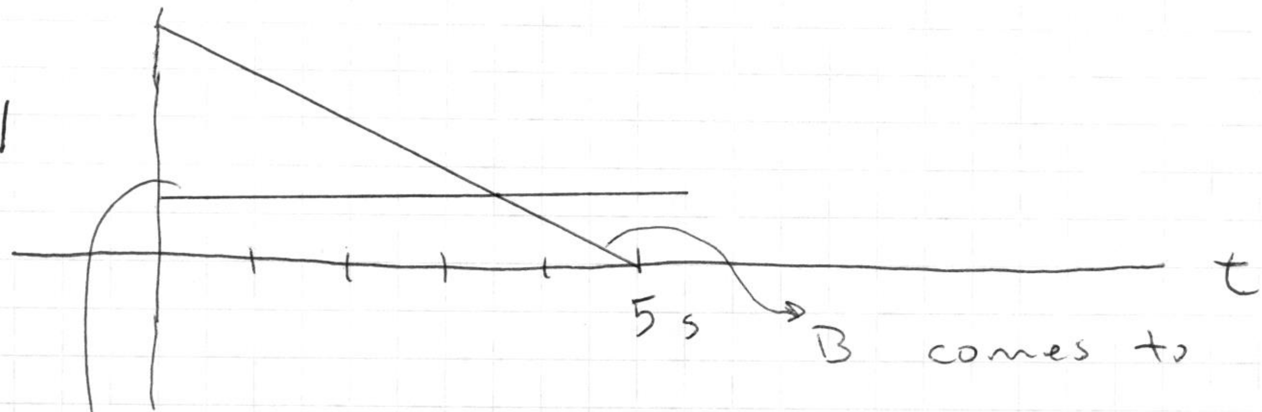
Both hit with same speed!

WB Ch 2

13.

A + B are At same x at t = 2 s and t = 5 s



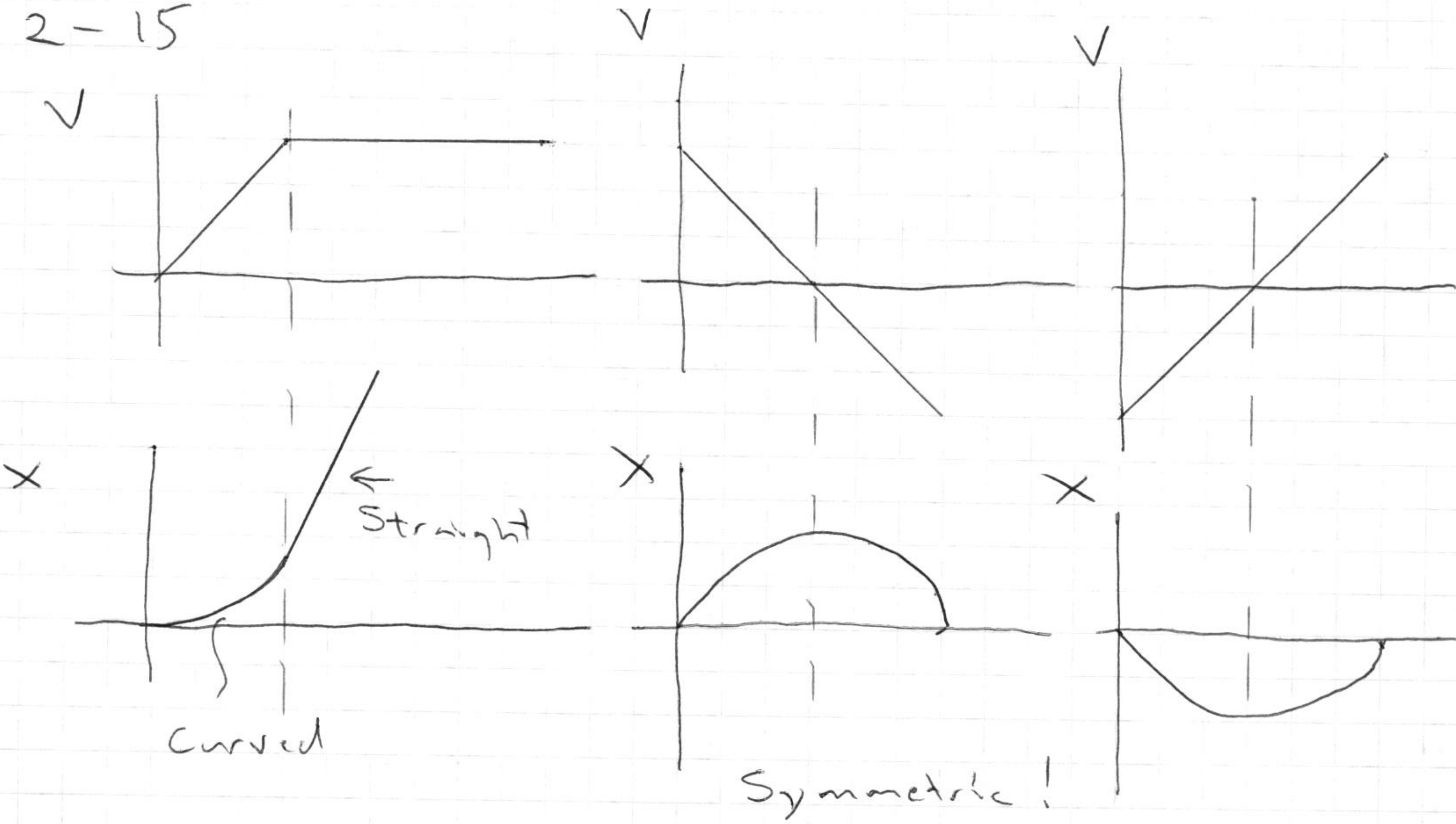


B comes to halt

A has constant v

A + B have same vel ≈ between 3 + 4 seconds

2-15



2-24 a. Accel is g. Only gravity is acting on it. Gravity does not depend on initial velocity

b. Still = g.