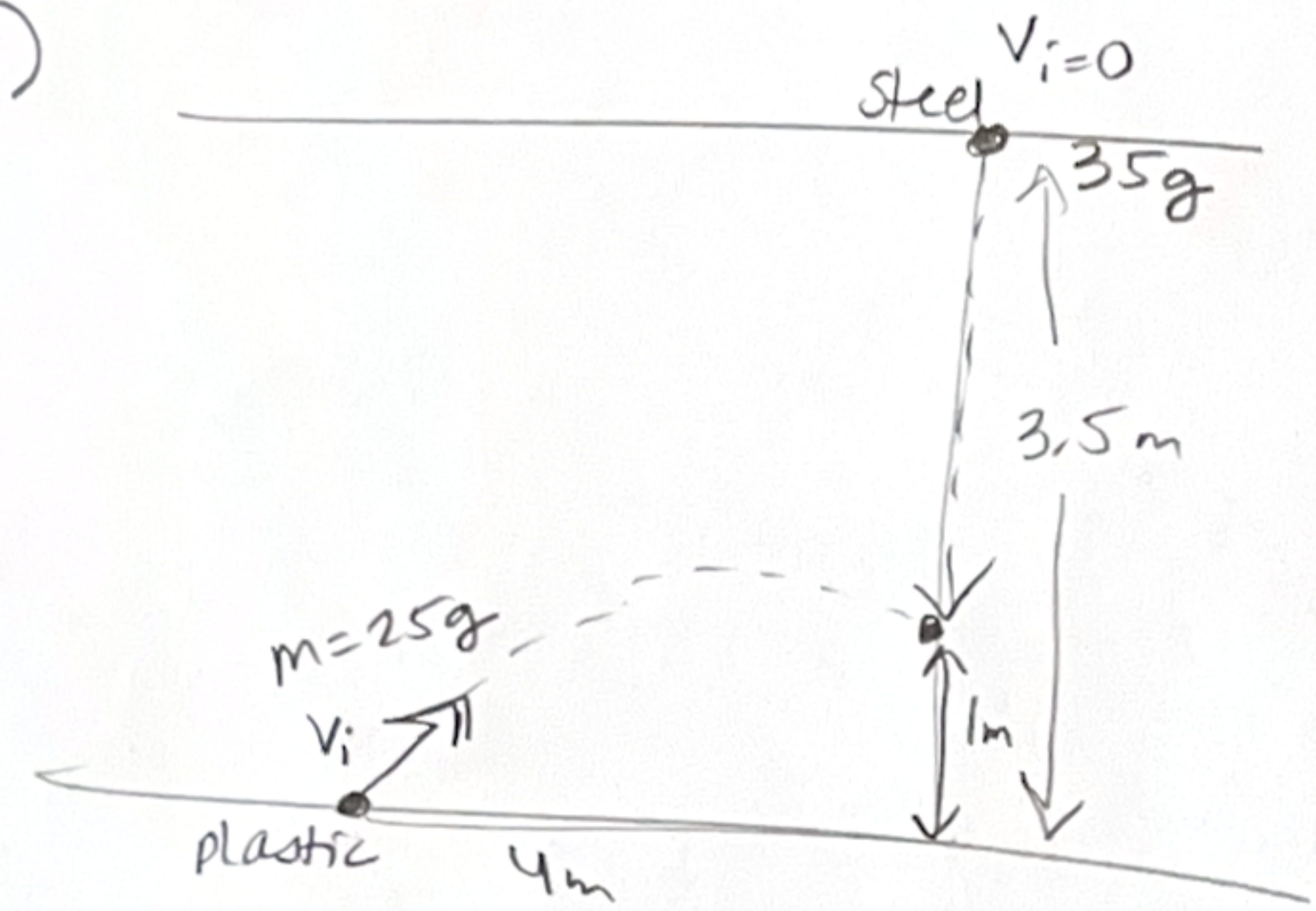
Ch4 p. 108 #53

53)




Notice that both balls are moving for the same amount of time, so they have the same $\Delta t$ from launch/release to collision.

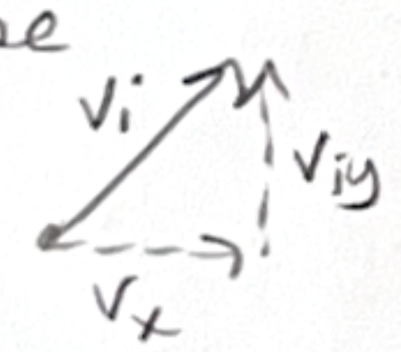
**cannonball (plastic)**
Interval: Launch to collision

| Horiz | Vert |
|---|---|
| $\Delta x = 4m$ | $\Delta y = +1m$ |
| $V_x = ?$ | $V_{iy} = ?$ |
| $\Delta t = ?$ | $V_{fy} = ?$ |
| | $a_y = -9.8 m/s^2$ |
| | $\Delta t =$ |

**falling ball (steel)**
Interval: Release to collision

$\Delta y = -2.5m$
$V_{iy} = 0$
$V_{fy} = ?$
$a = -9.8 m/s^2$
$\Delta t =$

I need both $V_x$ and $V_{iy}$ to find the launch speed because




$\vec{V}_i$ is the vector sum of $\vec{V}_x$ and $\vec{V}_{iy}$.

① I can find the time the steel ball is at the collision point.

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

$$-2.5m = 0(\Delta t) + \frac{1}{2}(-9.8 m/s^2)\Delta t^2$$

$$-2.5 = -4.9\Delta t^2$$

$$.714s = \Delta t$$

② Now that I know the time of the collision, what can I find for the plastic ball that came out of the cannon?

Now I can find $V_{iy}$ and $V_x$!

using my Horizontal variables, $\Delta x = V_x \Delta t$

$$4m = V_x(.714s)$$

$$5.6 m/s = V_x$$

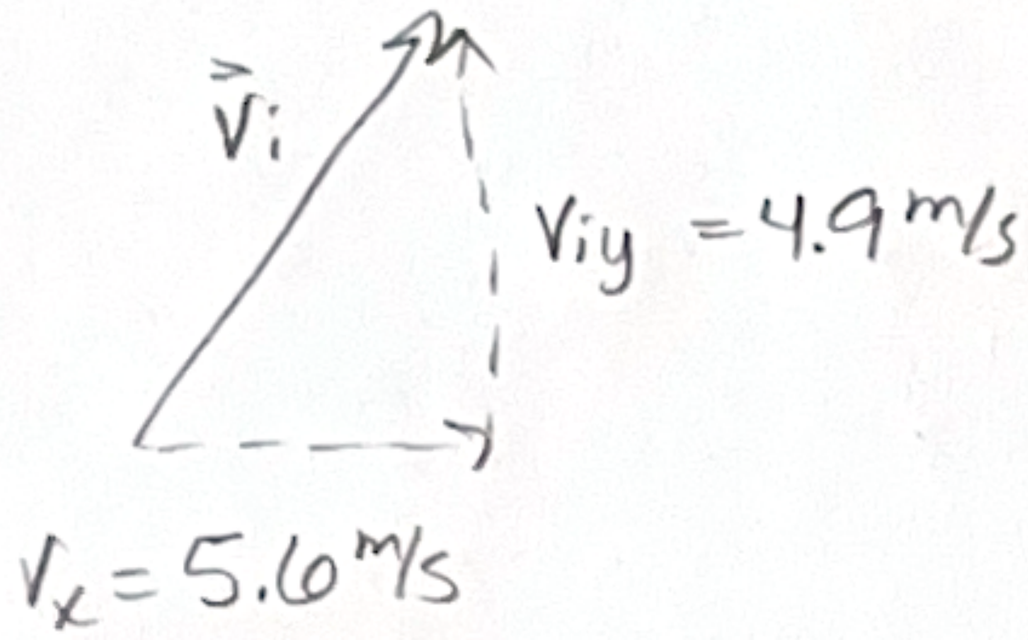
using my Vertical variables, $\Delta y = V_{iy}\Delta t + \frac{1}{2}a_y\Delta t^2$

$$1m = V_{iy}(0.714s) + \frac{1}{2}(-9.8 m/s^2)(0.714s)^2$$

$$1 = 0.714V_{iy} - 2.5$$

$$4.9 m/s = V_{iy}$$

③ Now I know both components of the initial velocity, $\vec{v}_i$, So I can find its magnitude, which is the speed.




$$v_i^2 = v_x^2 + v_{fy}^2$$

$$v_i^2 = (5.6\, m/s)^2 + (4.9\, m/s)^2$$

$$v_i^2 = 55.37$$

$$v_i = \boxed{7.4\, m/s}$$

The plastic ball came out of the cannon at a speed of 7.4 m/s.