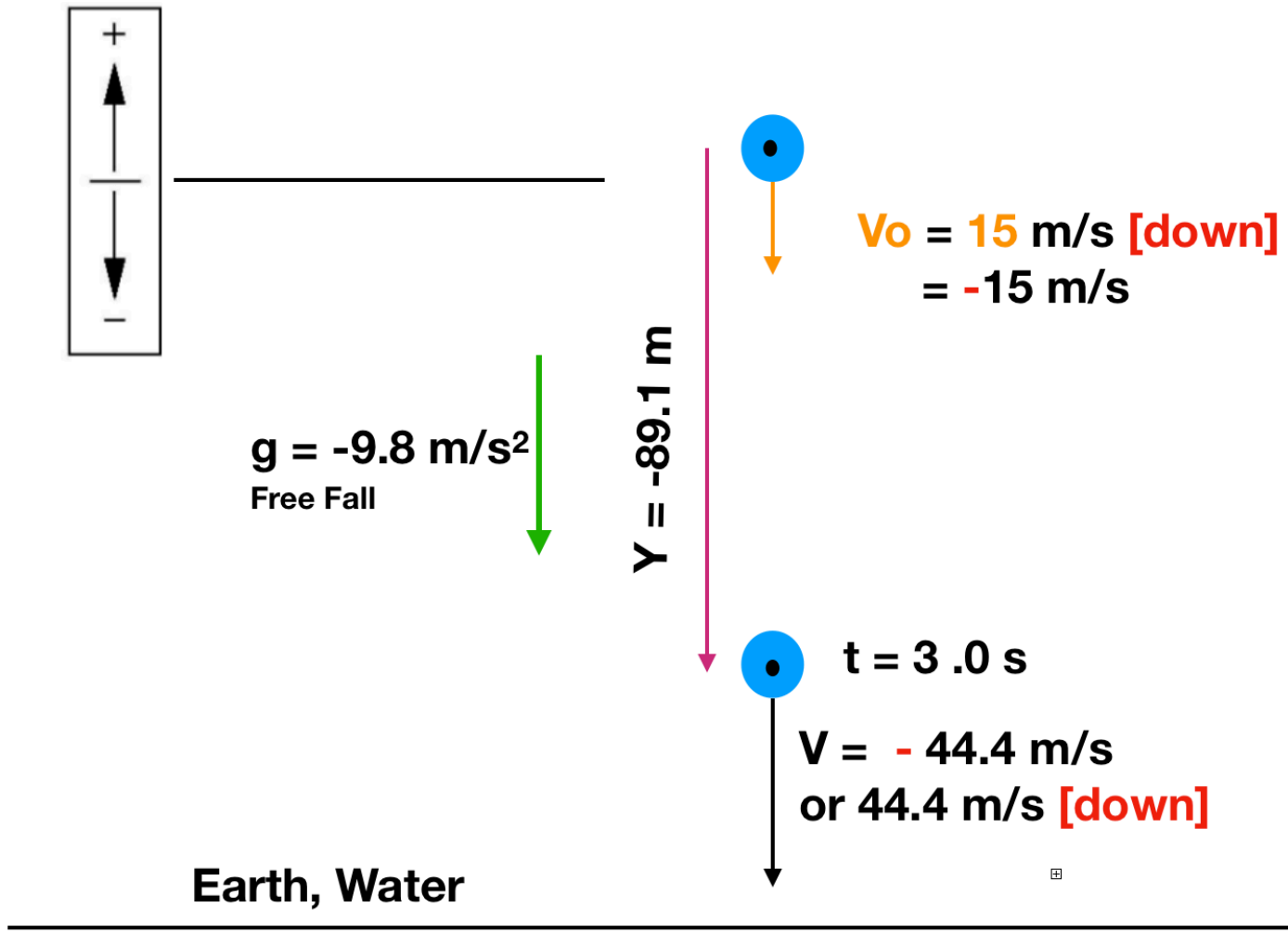
1. A girl throws a rock straight down form a bridge at 15 m/s. How fast is it going 3.0 s later?

It is a free fall a = g = -9.8 m/s²

Y Displacement	a = g acceleration	t time	Vo =Vi initial velocity	V = Vf Final velocity
	-9.8 m/s²	3.0 s	15 m/s [down] or -15 m/s	?

Kinematic Equations for Motion with Constant Acceleration (g) along the Y axis (Vertically)
$V = Vo + g\,t$
$Y = 1/2\,(Vo + V)\,t$
$V^2 = Vo^2 + 2\,g\,Y$
$Y = Vo\,t + 1/2\,g\,t^2$


+
−
Vo = 15 m/s [down]
= -15 m/s
g = -9.8 m/s²
Free Fall
Y = -89.1 m
t = 3 .0 s
V = - 44.4 m/s
or 44.4 m/s [down]
Earth, Water

$$V = V_o + g\,t$$

$$V = -15 + (-9.8)\,3$$

$$V = -15 + (-29.4)$$

$$V = -15 - 29.4$$

$$= -44.4 \text{ m/s}$$

$$Y = 1/2\ (Vo + V)\ t$$

$$= 1/2\ (\ -15 + -\ 44.4)x\ 3$$

$$= 1/2\ (-\ 59.4)\ x3$$

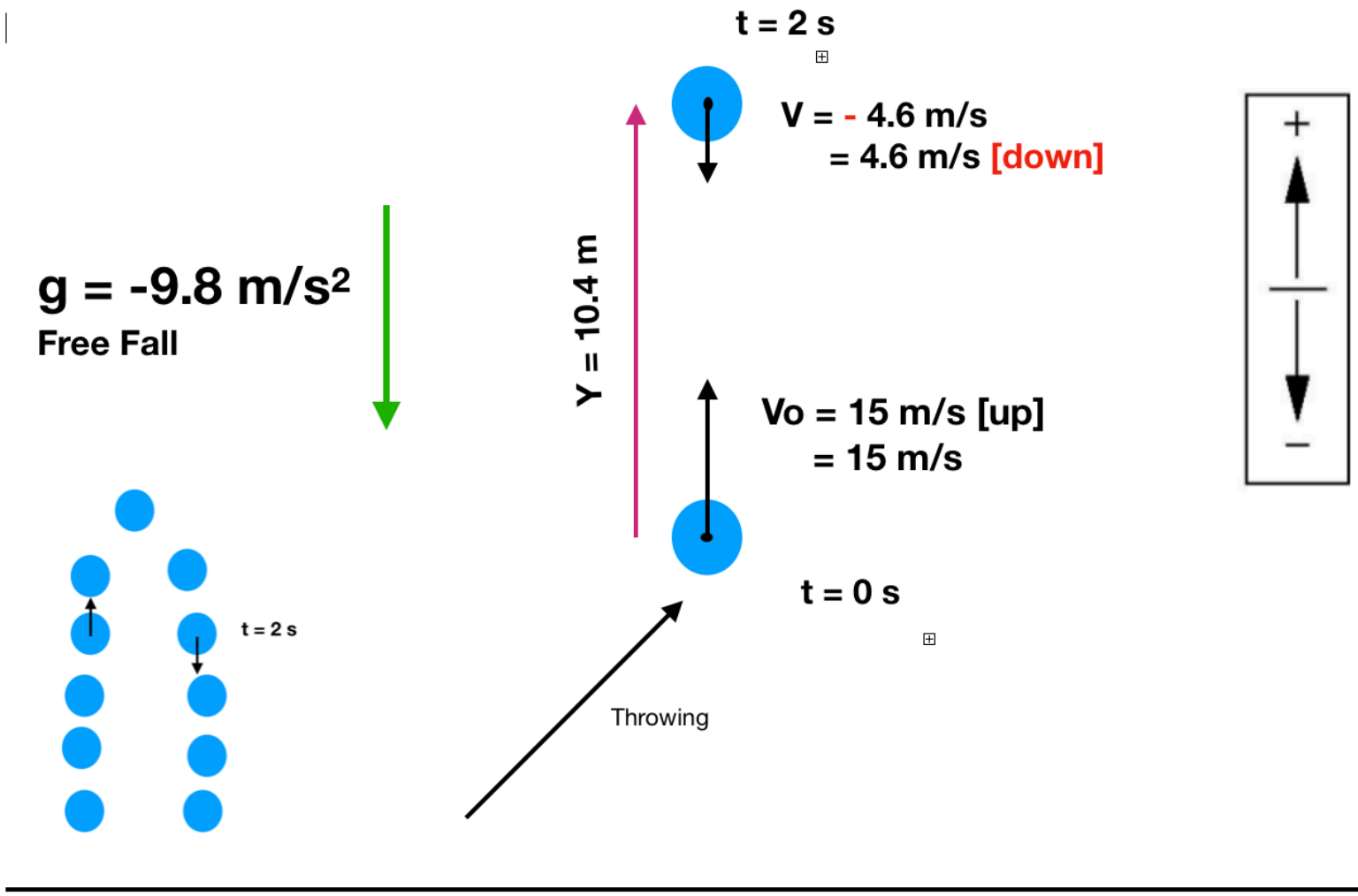
$$= 1/2\ (-178)$$

$$= -\ 89.2\ m$$

3. A girl throws a baseball straight up at 15 m/s. What is the ball's velocity 2.0 s later?

Y Displacement	**a = g** acceleration	**t** time	**Vo =Vi** initial velocity	**V = Vf** Final velocity
	-9.8 m/s²	**2 s**	**15 m/s**	**?**

Kinematic Equations for Motion with Constant Acceleration (g) along the Y axis (Vertically)
$V = Vo + g\,t$
$Y = 1/2\,(Vo + V)\,t$
$V^2 = Vo^2 + 2\,g\,Y$
$Y = Vo\,t + 1/2\,g\,t^2$


t = 2 s
V = - 4.6 m/s
= 4.6 m/s [down]
g = -9.8 m/s²
Free Fall
Y = 10.4 m
Vo = 15 m/s [up]
= 15 m/s
t = 0 s
t = 2 s
Throwing
+
–

$$V = Vo + g\ t$$

$$V = 15 + (-9.8)\ 2$$

$$V = 15 + (-19.6)$$

$$V = 15 - 19.6 = -4.6\ m/s$$

$$Y = 1/2\ (\ 15 + -\ 4.6\ )\ 2$$

$$Y = 1/2\ (15 - 4.6)\ 2$$

$$Y = 1/2\ (10.4)\ 2$$

$$Y = 1/2\ (20.8) = 10.4\ m$$

1. A prankster drops a water-filled balloon from the balcony of a high-rise. How long does it take for the balloon to fall 44.1 m?

Y **Displacement**	**a = g** **acceleration**	**t** **time**	**Vo =Vi** **initial velocity**	**V = Vf** **Final velocity**
- 44.1 m	**- 9.8 m/s²**	**? s**	**0 m/s**	

Kinematic Equations for Motion with Constant Acceleration (g) along the Y axis (Vertically)
$V = Vo + g\,t$
$Y = 1/2\,(Vo + V)\,t$
$V^2 = Vo^2 + 2\,g\,Y$
$Y = Vo\,t + 1/2\,g\,t^2$

$$Y = Vo\ t + 1/2\ g\ t^2$$

$$-44.1 = 0\ t + 1/2\ (-9.8)\ t^2$$

$$-44.1 = 0 + (-4.9)\ t^2$$

$$-44.1 = -4.9\ t^2$$

$$\frac{-44.1}{4.9} = \frac{-4.9\ t^2}{-4.9}$$

$$9 = t^2$$

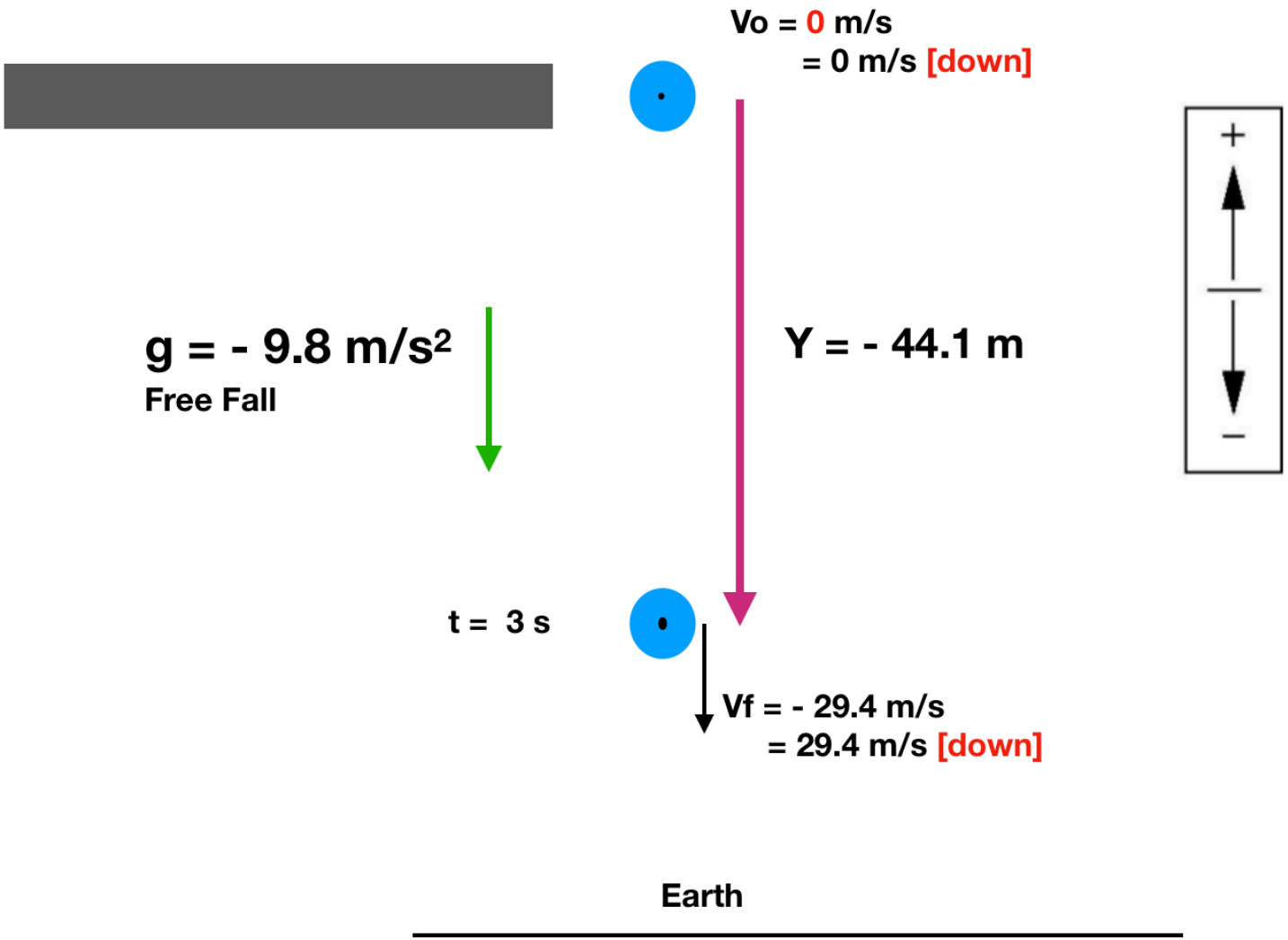
$$\sqrt{9} = \sqrt{\ } t^2$$

$$3\ s = t$$

$$V = V_o + g\,t$$

$$V = 0 - 9.8 \times 3$$

$$V = -29.4 \text{ m/s}$$


Vo = 0 m/s
= 0 m/s [down]
g = - 9.8 m/s²
Free Fall
Y = - 44.1 m
+
–
t = 3 s
Vf = - 29.4 m/s
= 29.4 m/s [down]
Earth

4. A girl uses a slingshot to fire a stone straight up at 24 m/s.

1) What is the stone's velocity 3.0 s later?

2) What is its displacement 3.0 s after it was fired?

Y **Displacement**	**a = g** **acceleration**	**t** **time**	**Vo =Vi** **initial velocity**	**V = Vf** **Final velocity**
?	**- 9.8 m/s²**	**3.0 s**	**24 m/s**	**? m/s**

Kinematic Equations for Motion with Constant Acceleration (g) along the Y axis (Vertically)
$V = Vo + g\,t$
$Y = 1/2\,(Vo + V)\,t$
$V^2 = Vo^2 + 2\,g\,Y$
$Y = Vo\,t + 1/2\,g\,t^2$

$$V = V_o + g\,t$$

$$V = 24 + (-9.8)\,3$$

$$V = 24 + (-29.4)$$

$$V = 24 - 29.4$$

$$V = -5.4 \text{ m/s}$$

$$Y = 1/2 \, (V0 + V) \, t$$

$$Y = 1/2 \, (24 + - \, 5.4) \, 3$$

$$Y = 1/2 \, (24 - 5.4 \,) \, 3$$

$$Y = 1/2 \, (55.8)$$

$$Y = 27.9 \text{ m}$$

What is the displacement of the ball at the top point?

At the top point, the final velocity is 0 m/s.

$$V^2 = Vo^2 + 2\,g\,Y$$

$$0 = (24)^2 + 2\,(-9.8)\,Y$$

$$0 = 576 - 19.6\,Y$$

$$-576 \quad -576$$

$$-576 = -19.6\,Y$$

$$\frac{-576}{-19.6} = \frac{-19.6\,Y}{-19.6}$$

$$29.4\ m = Y$$

Time to reach maximum height (V top = 0 m/s)

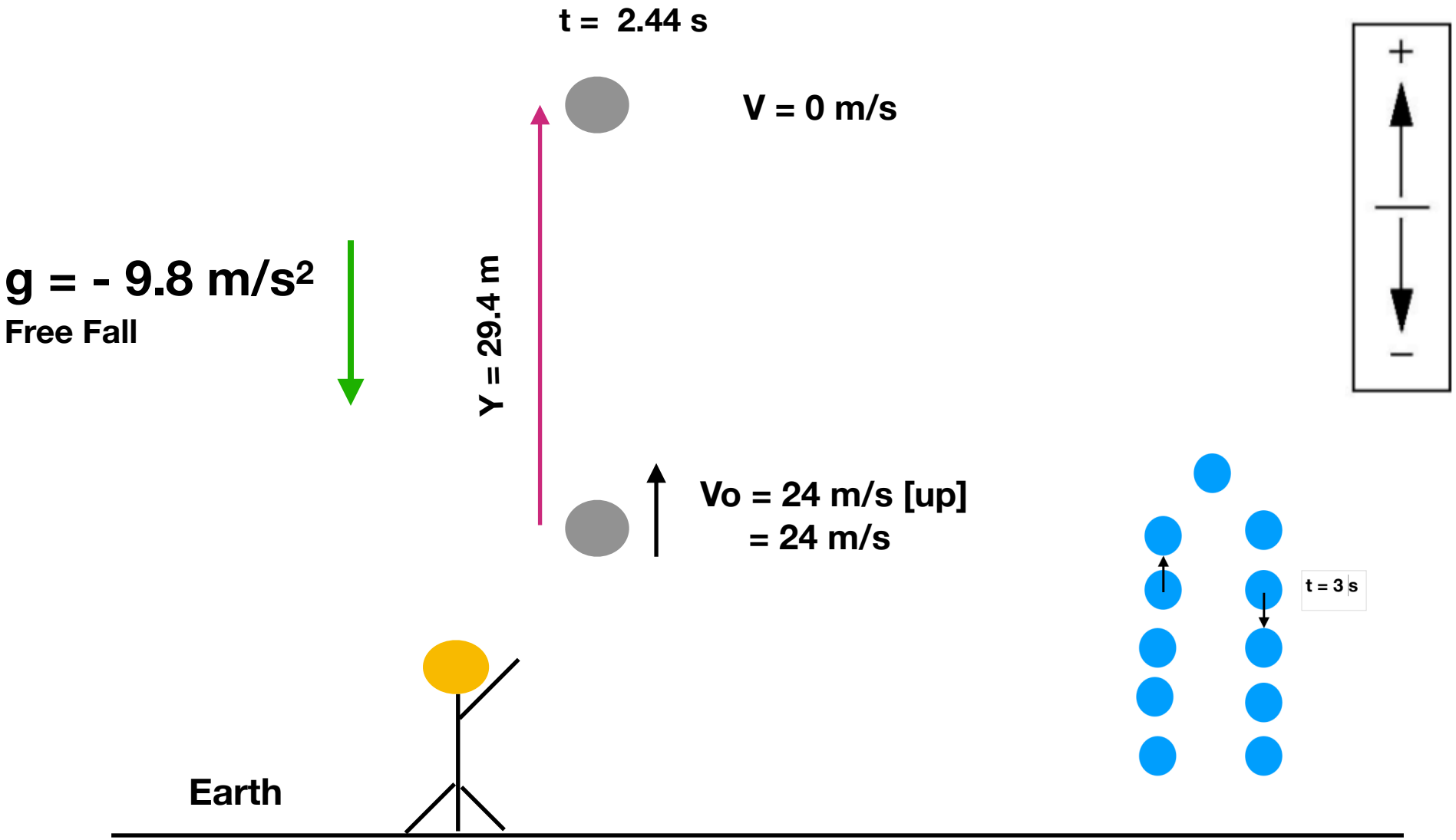
$$V = Vo + gt$$

$$0 = 24 + (-9.8)\, t$$
$$-24 \quad -24$$

$$-24 = -9.8\, t$$

$$\frac{-24}{-9.8} = \frac{-9.8\, t}{-9.8}$$

$$t = 2.44 \text{ s}$$


t = 2.44 s
V = 0 m/s
g = - 9.8 m/s²
Free Fall
Y = 29.4 m
Vo = 24 m/s [up]
= 24 m/s
+
−
t = 3 s
Earth

V after 0.5 s?

V= Vo + g t

V = 24 + (-9.8) 0.5

V = 24 **+ (-** 4.9)

V = 24 **-** 4.9 = 19.1 m/s = 19.1 m/s [UP]

V after 1 s?

$V = V_o + g\,t$

$V = 24 + (-9.8)\,1$

$V = 24 + (-9.8)$

$V = 24 - 9.8 = 14.2 \text{ m/s} = 14.2 \text{ m/s [UP]}$

V after 1.5 s?

$V = V_o + g\,t$

$V = 24 + (-9.8)\ 1.5$

$V = 24 + (-14.7)$

$V = 24 - 14.7 = 9.3\ m/s = 9.3\ m/s\ [UP]$

V after 2 s?

$V = V_o + g\,t$

$V = 24 + (-9.8)\,2$

$V = 24 + (-19.6)$

$V = 24 - 19.6 = m/s = 4.4\ m/s\ [UP]$

V at 2.9 s?

$V = V_o + g\,t$

$V = 24 + (-9.8)2.9$

$V = 24 + (- 28.42)$

$V = 24 - 28.42 = - 4.4 \text{ m/s} = 4.4 \text{ m/s [down]}$

V at 3.4 s?

$V = V_o + g\,t$

$V = 24 + (-9.8)3.4$

$V = 24 + (-\ 33.32)$

$V = 24 - 33.32 = 9.32$ m/s

V at 3.9 s?

$V = V_o + g\,t$

$V = 24 + (-9.8)3.9$

$V = 24 + (-)$

V = 24 = m/s = m/s []

V after 3 s?

$V = V_o + g\,t$

$V = 24 + (-9.8)\ 3$

$V = 24 + ()$

$V = 24 - = m/s = m/s$

$$V = V_o + g\,t$$

$$-4.4 = 24 + (-9.8)t$$

$$= -9.8\,t$$

V = 24 - = m/s = m/s