

Unit 3 Review: Projectile Motion

Concept:

Fill in the table with the following phrases.

- horizontal constant velocity
- ~~horizontal motion~~
- ~~$a = 9.8 \text{ m/s}^2$~~
- ~~vertical distance~~
- ~~$v = 0 \text{ m/s}$~~
- ~~time is same,  $t_x = t_y$~~
- ~~$a = 0 \text{ m/s}$~~
- horizontal distance
- ~~vertical motion~~

Projectile Motion	
x: horizontal motion	y: vertical motion
$\Delta d$ : horizontal distance	$\Delta d$ : vertical distance
v: horizontal <u>constant</u> velocity	v: $v_i = 0 \text{ m/s}$
a: $a = 0 \text{ m/s}^2$ <small>no gravity in horizontal direction</small>	a: $a = 9.8 \text{ m/s}^2$ <small>due to gravity</small>
t: time is same	t: time is same

Free-fall Problems

1. A flowerpot falls from a windowsill  $52.5 \text{ m}$  above the sidewalk. How long does it take the flowerpot to strike the ground?



$v_i = 0 \text{ m/s}$   
 $a = 9.8 \text{ m/s}^2$   
 $\Delta d = 52.5 \text{ m}$   
 $t = ?$

$$\Delta d = v_i t + \frac{1}{2} a t^2$$

$$52.5 \text{ m} = (0 \text{ m/s})t + \frac{1}{2}(9.8 \text{ m/s}^2)t^2$$

$$\frac{52.5 \text{ m}}{4.9 \text{ m/s}^2} = \frac{(4.9 \text{ m/s}^2)t^2}{4.9 \text{ m/s}^2}$$

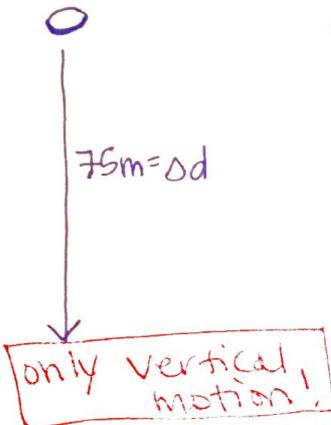
$$\sqrt{10.71 \text{ s}^2} = \sqrt{t^2}$$

$3.27 \text{ s} = t$

2. A penny <sup>falls</sup> is ~~thrown~~ down a wishing well that is 75 m deep.  <sup>$\Delta d$</sup>   <sup>$t$</sup>  How long will it take for the penny to hit the ground?

$v_i = 0 \text{ m/s}$   
 $a = 9.8 \text{ m/s}^2$   
 $\Delta d = 75 \text{ m}$   
 $t = ?$

$\Delta d = v_i t + \frac{1}{2} a t^2$   
 $75 \text{ m} = (0 \text{ m/s}) t + \frac{1}{2} (9.8 \text{ m/s}^2) t^2$   
 $75 \text{ m} = \frac{(4.9 \text{ m/s}^2) t^2}{4.9 \text{ m/s}^2}$   
 $\sqrt{15.31 \text{ s}^2} = \sqrt{t^2}$   
 $3.91 \text{ s} = t$



Projectile Problems

3. A pelican flying with a speed of 20 m/s along a horizontal path drops a fish from a height of 5.4 m. How far does the fish travel horizontally before it hits the water below?

horizontal x	vertical y
$\Delta d = ?$	$\Delta d = 5.4 \text{ m}$
$v_i = 20 \text{ m/s}$	$v_i = 0 \text{ m/s}$
$a = 0 \text{ m/s}^2$	$a = 9.8 \text{ m/s}^2$
$t = ?$	$t = ?$

You have to find  $t$  first!

$\Delta d = v_i t + \frac{1}{2} a t^2$   
 $\Delta d = \frac{1}{2} a t^2$   
 $5.4 \text{ m} = \frac{1}{2} (9.8 \text{ m/s}^2) t^2$   
 $5.4 \text{ m} = \frac{(4.9 \text{ m/s}^2) t^2}{4.9 \text{ m/s}^2}$   
 $\sqrt{1.1 \text{ s}^2} = \sqrt{t^2}$   
 $1.04 \text{ s} = t$

$\Delta d = v_i t + \frac{1}{2} a t^2$   
 $\Delta d = v_i t$   
 $\Delta d = (20 \text{ m/s})(1.04 \text{ s})$   
 $\Delta d = 20.8 \text{ m/s}$   
 horizontal  $\Delta d$ !  
 Answer!

4. A cat chases a mouse across a 1m high table. The mouse steps out of the way and the cat slides off the table and strikes the floor 2.2 m from the edge of the table. When the cat slid off the table, what was his speed?  $v_i$

x	y
$\Delta d = 2.2 \text{ m}$	$\Delta d = 1 \text{ m}$
$v_i = ?$	$v_i = 0 \text{ m/s}$
$a = 0 \text{ m/s}^2$	$a = 9.8 \text{ m/s}^2$
$t = ?$	$t = ?$

You have to find  $t$  first!

$\Delta d = v_i t + \frac{1}{2} a t^2$   
 $\Delta d = \frac{1}{2} a t^2$   
 $1 \text{ m} = \frac{1}{2} (9.8 \text{ m/s}^2) t^2$   
 $1 \text{ m} = \frac{(4.9 \text{ m/s}^2) t^2}{4.9 \text{ m/s}^2}$   
 $\sqrt{0.204 \text{ s}^2} = \sqrt{t^2}$   
 $0.45 \text{ s} = t$

$\Delta d = v_i t + \frac{1}{2} a t^2$   
 $2.2 \text{ m} = \frac{v_i (0.45 \text{ s})}{0.45 \text{ s}}$   
 $4.89 \text{ m/s} = v_i$   
 horizontal  $v_i$  →  
 final answer

5. A dog runs down a pier that is  $4\text{ m}$  above the surface of the water. If its horizontal speed is  $15\text{ m/s}$  as it jumps off, how long will the dog be in the air? How far from the edge of the pier will the dog travel at the point it strikes the water?

horizontal X	vertical Y
$\Delta d = ?$	$\Delta d = 4\text{ m}$
$v_i = 15\text{ m/s}$	$v_i = 0\text{ m/s}$
$a = 0\text{ m/s}^2$	$a = 9.8\text{ m/s}^2$
$t = ?$	$t = ?$

① vertical (y)

$$\Delta d = v_i t + \frac{1}{2} a t^2$$

$0\text{ m/s}$

$$\Delta d = \frac{1}{2} a t^2$$

$$4\text{ m} = \frac{1}{2} (9.8\text{ m/s}^2) t^2$$

$$4\text{ m} = (4.9\text{ m/s}^2) t^2$$

$$\frac{4\text{ m}}{4.9\text{ m/s}^2} = \frac{4.9\text{ m/s}^2}{4.9\text{ m/s}^2} t^2$$

$$\sqrt{0.816\text{ s}^2} = \sqrt{t^2}$$

$$\boxed{0.90\text{ s} = t}$$

② horizontal (x)

$$\Delta d = v_i t + \frac{1}{2} a t^2$$

$0\text{ m/s}^2$

$$\Delta d = v_i t$$

$$\Delta d = (15\text{ m/s})(0.90\text{ s})$$

$$\boxed{\Delta d_x = 13.5\text{ m}}$$

6. A speeding train engine derailed from its tracks due to the bridge missing a section ahead. If the train goes off the rails horizontally falling down into a river valley  $80\text{ m}$  deep and  $150\text{ m}$  away  $\Delta d_x$  from the edge of the tracks. How long was the train engine in the air? How fast was the train traveling as it left the track?

horizontal X	vertical Y
$\Delta d = 150\text{ m}$	$\Delta d = 80\text{ m}$
$v_i = ?$	$v_i = 0\text{ m/s}$
$a = 0\text{ m/s}^2$	$a = 9.8\text{ m/s}^2$
$t = ?$	$t = ?$

① vertical (y)

$$\Delta d = v_i t + \frac{1}{2} a t^2$$

$0\text{ m/s}$

$$\Delta d = \frac{1}{2} a t^2$$

$$80\text{ m} = \frac{1}{2} (9.8\text{ m/s}^2) t^2$$

$$80\text{ m} = (4.9\text{ m/s}^2) t^2$$

$$\frac{80\text{ m}}{4.9\text{ m/s}^2} = \frac{4.9\text{ m/s}^2}{4.9\text{ m/s}^2} t^2$$

$$\sqrt{16.33\text{ s}^2} = \sqrt{t^2}$$

$$\boxed{4.04\text{ s} = t}$$

② horizontal (x)

$$\Delta d = v_i t + \frac{1}{2} a t^2$$

$0\text{ m/s}^2$

$$\Delta d = v_i t$$

$$\frac{150\text{ m}}{4.04\text{ s}} = \frac{v_i (4.04\text{ s})}{4.04\text{ s}}$$

$$\boxed{37.1\text{ m/s} = v_i}$$