

## Physics 11 U1 Worksheet 5 – Projectile Motion

Solutions

Name: \_\_\_\_\_

Date: \_\_\_\_\_

1. A ball is dropped off an 11 m cliff. How long will it take to hit the ground?

(if  $V_{iy} = 0$  then use drop time formula)

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2 \times 11}{9.8}} = 1.50 \text{ sec}$$

2. What did Galileo demonstrate from the top of the Leaning Tower of Pisa?

that mass does not affect the rate of drop  
ie, large + small objects fall @ the same rate.

3. What were we trying to demonstrate when we shot a potato horizontally off the gym roof and at the same instant dropped another potato?

That  $V_x$  does not affect drop time. Both  
potatoes fall @ roughly the same time.

4. A car traveling at 25 m/s drives off a 73 m high cliff. How far away from the cliff does the car land?

- find drop time first
- then calculate horizontal distance

$$\textcircled{1} \downarrow t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2 \times 73}{9.8}} = 3.8598 \text{ sec}$$

Keep 5 sig figs

$$\textcircled{2} \leftrightarrow d = v \cdot t = (25)(3.8598) = 96.5 \text{ m}$$

$$\text{accel} = 0$$

5. Imagine a ball is thrown straight up and is later caught by the same hand.

a) What is the direction of the acceleration due to gravity when a ball is travelling up?

down

b) What is the direction of the acceleration due to gravity when a ball is travelling down/

down


c) What is 1 g in meters per second squared? 9.8 m/s<sup>2</sup>

d) What is the acceleration of the ball at the very top of its flight? 9.8 m/s<sup>2</sup>.

e) What is the velocity of the ball at the very top of its flight?

zero

6. A ball is thrown straight up at 16.8 m/s. Find the maximum height of the ball.


 $V_i = 16.8 \quad V_f = 0 \text{ @ top} \quad a = -9.8 \quad d = ?$

$$V_f^2 = V_i^2 + 2ad.$$

$$0 = 16.8^2 + 2(-9.8)d$$

$$d = 14.4 \text{ m}$$

7. A car drives off a 50 m cliff at 20.0 m/s.

a) How long until it hits the ground?

$$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{100}{9.8}} = 3.194 \text{ sec.}$$

b) What is its horizontal speed when it hits the ground?



$$\text{accel} = 0 \quad v = 20 \text{ m/s}$$

c) How far from the base of the cliff does the car hit?

$$d = v_x t = (20)(3.194) = 63.88$$

d) What is the vertical velocity when it hits the ground?



$$v_i = 0$$

$$a = 9.8$$

$$t = 3.194 \text{ sec.}$$

$$v_f = ?$$

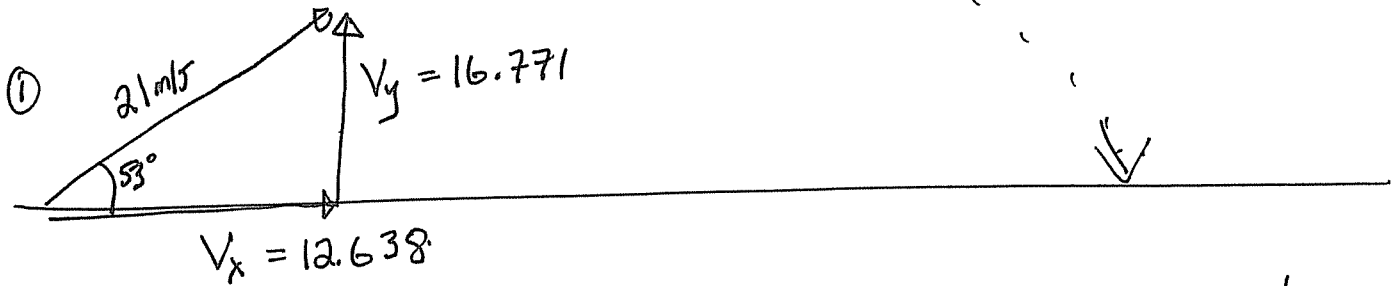
$$v_f = v_i + at$$

$$= 0 + (9.8)(3.194)$$

$$= 31.3 \text{ m/s}$$

8. a) A football is kicked at 21 m/s at an angle of 53 degrees from the horizontal. Find how far away it lands.

- ① • find  $V_x$  and  $V_y$  first
- ② • then use  $V_y$  and calculate flight time
- ③ • then use flight time and  $V_x$  to calculate  $d$



②

$V_i = 16.771$      $V_f = -16.771$      $a = -9.8$      $t = ?$

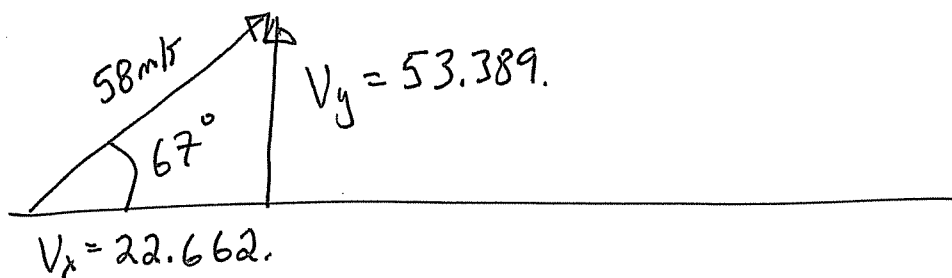
*— always  $-V_i$  if it comes back down to the same level.*

$$V_f = V_i + at =$$
$$-16.771 = 16.771 + -9.8(t)$$
$$t = 3.42 \text{ sec}$$

③

$$d = V_x t = (12.638)(3.42) = 43.3 \text{ m}$$

9. An arrow is shot at 58 m/s at an angle of 67 degrees above the horizontal.



a) Find the maximum height of the arrow.

$V_i = 53.389$     $V_f = 0$     $a = -9.8$     $d = ?$   
 $V_f^2 = V_i^2 + 2ad \rightarrow 0^2 = (53.389)^2 + 2(-9.8)(d)$

b) Find the range of the arrow (←-----→).

$d = 145 \text{ m}$

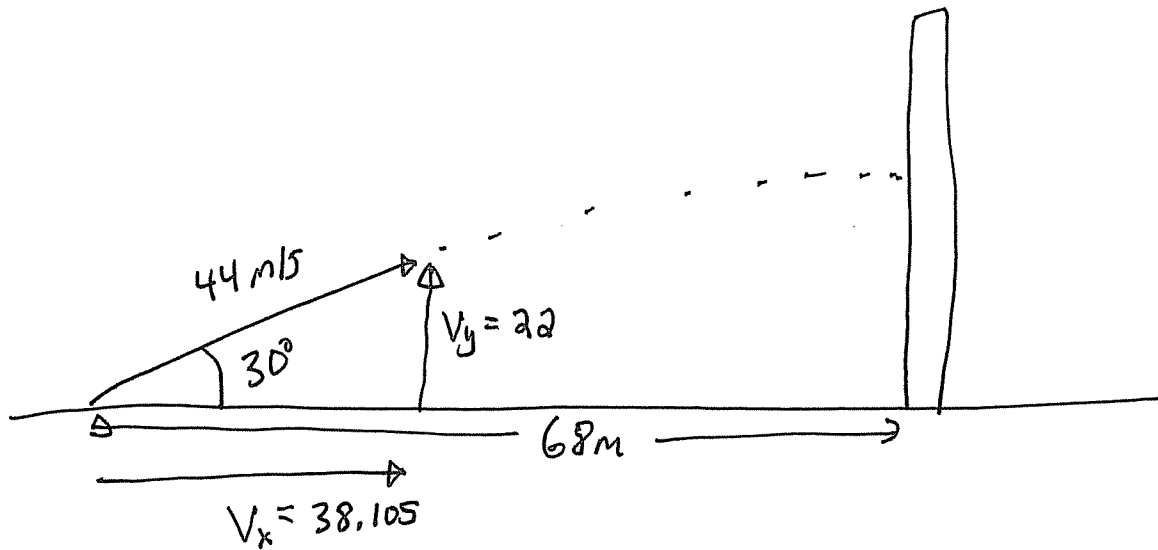
$d = V_x t$   
 $22.662$

$V_f = V_i + at$   
 $-53.389 = 53.389 + (-9.8)t$   
 $t = 10.896$

$d = (22.662)(10.896) = 247 \text{ m}$

10. Challenge problem.

A projectile is shot at 44 m/s 30 degrees above the horizon. A very tall wall is 68 m away. At what height does the projectile strike the wall?



① time to hit wall = ?  $\rightarrow$

$\rightarrow d = vt \rightarrow t = \frac{d}{v} = \frac{68}{38.105} = 1.7845 \text{ sec}$

② height =  $d = V_i t + \frac{1}{2} a t^2$ .



$$d = (22)(1.7845) + \frac{1}{2}(-9.8)(1.7845)^2$$

$$d = 23.7 \text{ m}$$