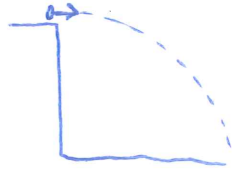


## AP Physics 1 - Test 04 - Projectile Motion

Score: \_\_\_\_\_

1. A stone thrown from the top of a tall building follows a path that is

- ☐ (A) circular  
☐ (B) made of two straight line segments  
☐ (C) hyperbolic  
☒ (D) parabolic  
☐ (E) a straight line



Focus of conceptual questions for the majority of the test.

2. Identical guns fire identical bullets horizontally at the same speed from the same height, one on the Earth and one on the Moon. Which of the following three statements is/are true?

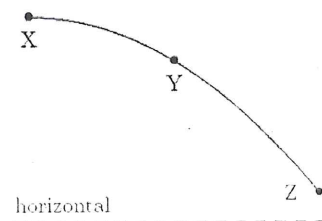
- I. The horizontal distance traveled by the bullet is greater for the Moon. *Yes, since it is in the air longer on the moon, it will go further.*  
 II. The flight time is less for the bullet on Earth. *Yes.*  
 III. The velocity of the bullets at impact are the same. *No, gravity is less on the moon, so  $V_f$  will be smaller.*

- ☐ (A) III only  
☒ (B) I and II only  
☐ (C) I and III only  
☐ (D) II and III only  
☐ (E) I, II, III

3. A stone is thrown horizontally and follows the path XYZ shown. The direction of the acceleration of the stone at point Y is

- ☒ (A) down  
☐ (B) right  
☐ (C) down and right  
☐ (D) down and left  
☐ (E) up and right

gravity only ever pulls objects to the center of Earth, which is down here.



4. A bullet shot horizontally from a gun

- ☐ (A) strikes the ground much later than one dropped from the same point at the same instant  
☐ (B) never strikes the ground  
☒ (C) strikes the ground at approximately the same time as one dropped vertically from the same point at the same instant *Bullet fired vs. bullet dropped*  
☐ (D) travels in a straight line  
☐ (E) strikes the ground much sooner than one dropped from the same point at the same instant

5. Starting from rest, object 1 falls freely for 4.0 seconds, and object 2 falls freely for 8.0 seconds. Compared to object 1, object 2 falls:

- (A) half as far  
(B) twice as far  
(C) three times as far  
(D) four times as far

Use Equation  
with  $v_i$ ,  $t$ ,  $a$ ,  $\Delta y$

$\Delta y = \cancel{v_i t} + \frac{1}{2} a t^2$  if you double  
 $\Delta y = \frac{1}{2} a t^2$   $t$ , you quadruple  $\Delta y$   
 $\Delta y \propto t^2$   
x4 (x2)<sup>2</sup>

6. The airplane shown is in level flight at an altitude of 0.50 km and a speed of 150 km/h.

$$\frac{150 \text{ km}}{\text{hr}} \times \frac{1 \text{ hr}}{3600 \text{ sec}} \times \frac{1000 \text{ m}}{1 \text{ km}} = 41.7 \text{ m/s}$$

If it were to release a heavy bomb, how much time would it take to hit the ground?

- (A) 50 s  
(B) 10000 s  
(C) 100 s  
(D) 24 s  
(E) 10 s

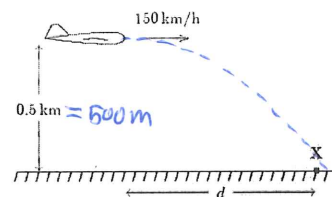
| x                        | y                           |
|--------------------------|-----------------------------|
| $\Delta x =$             | $\Delta y = -500 \text{ m}$ |
| $v_x = 41.7 \text{ m/s}$ | $v_{iy} = 0$                |
| $t =$                    | $v_{fy} =$                  |
|                          | $a = -9.8$                  |
|                          | $t = ?$                     |

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

$$-500 = -4.9 t^2$$

$$t = \sqrt{\frac{-500}{-4.9}}$$

$$t = 10.1 \text{ seconds}$$



7. The airplane shown is in level flight at an altitude of 0.50 km and a speed of 150 km/h.

How far (horizontal) does the package travel during its launch?

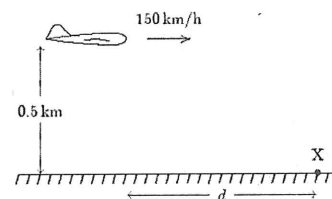
- (A) 150 m  
(B) 295 m  
(C) 420 m  
(D) 2550 m  
(E) 15,000 m

| x            | y                 |
|--------------|-------------------|
| $\Delta x =$ | $\Delta y = -500$ |
| $v_x = 41.7$ | $v_{iy} = 0$      |
| $t = 10$     | $v_{fy} =$        |
|              | $a = -9.8$        |
|              | $t = 10$          |

$$\Delta x = v_x \cdot t$$

$$= (41.7)(10)$$

$$\Delta x = 417 \text{ m}$$



8. The airplane shown is in level flight at an altitude of 0.50 km and a speed of 150 km/h.

At what magnitude of velocity does the package land with?

- (A) 41.1 m/s  
(B) -100 m/s  
(C) 100 m/s  
(D) 108 m/s  
(E) 141 m/s

| x                | y                 |
|------------------|-------------------|
| $\Delta x = 420$ | $\Delta y = -500$ |
| $v_x = 41.7$     | $v_{iy} = 0$      |
| $t = 10$         | $v_{fy} =$        |
|                  | $a = -9.8$        |
|                  | $t = 10$          |

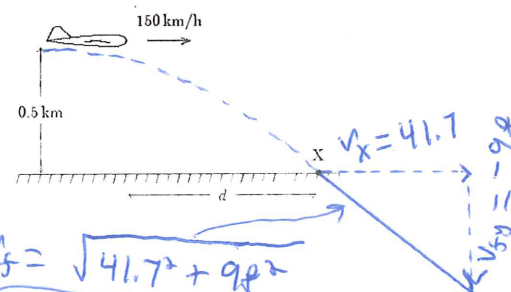
$$v_{fy} = v_{iy} + a t$$

$$= 0 + (-9.8)(10)$$

$$v_{fy} = -98$$

$$v_f = \sqrt{41.7^2 + 98^2}$$

$$v_f = 106.5$$

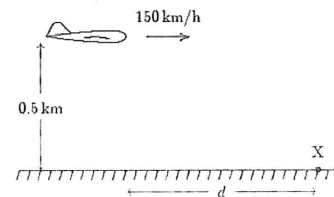
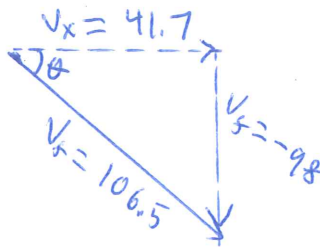


9. The airplane shown is in level flight at an altitude of 0.50 km and a speed of 150 km/h.

At what angle does the package land with?

- (A) 0 degrees
- (B) 45 degrees below x axis
- (C) 67.6 degrees below x axis
- (D) 72.3 degrees below x axis
- (E) 90 degrees below x axis

$$\theta = \tan^{-1}\left(\frac{9.8}{41.7}\right) = 66.9^\circ$$



10. A ball is thrown horizontally from the top of a 20-m high hill. It strikes the ground at an angle of 45° below the horizontal.

How long is the ball in the air once it is tossed?

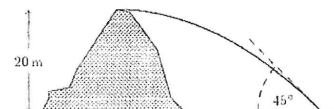
- (A) 2 seconds
- (B) 40 seconds
- (C) 5.2 seconds
- (D) 4 seconds
- (E) 10 seconds

| x            | y                |
|--------------|------------------|
| $\Delta x =$ | $\Delta y = -20$ |
| $v_x =$      | $v_{iy} = 0$     |
| $t =$        | $v_{fy} =$       |
|              | $a = -9.8$       |
|              | $t =$            |

$$\Delta y = v_{iy}t + \frac{1}{2}at^2$$

$$-20 = -4.9t^2$$

$$t = \sqrt{\frac{-20}{-4.9}} \approx 2$$



11. A ball is thrown horizontally from the top of a 20-m high hill. It strikes the ground at an angle of 45° below the horizontal.

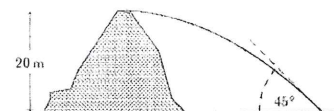
With what vertical velocity does the ball land with?

- (A) 0 m/s
- (B) 10 m/s
- (C) -10 m/s
- (D) 20 m/s
- (E) -20 m/s

$$v_f = v_i + at$$

$$= 0 + (-9.8)(2)$$

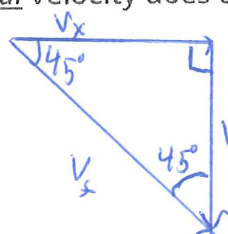
$$= -19.6 \text{ m/s}$$



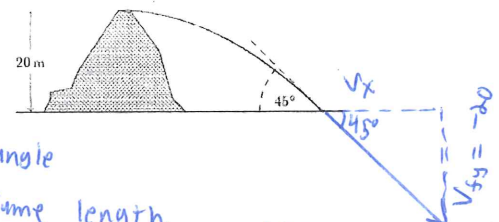
12. A ball is thrown horizontally from the top of a 20-m high hill. It strikes the ground at an angle of 45° below the horizontal.

With what horizontal velocity does the ball land with?

- (A) 0 m/s
- (B) 10 m/s
- (C) -10 m/s
- (D) 20 m/s



the two sides of a 45, 45, 90 triangle must be the same length, but  $v_x$  goes to the right, so  $v_x = +20$



(E) -20 m/s

13. A stone is thrown outward from the top of a 59.4-m high cliff with an upward velocity component of 19.5m/s. How long is stone in the air?

- (A) 4.00 s
- (B) 5.00 s
- (C) 6.00 s
- (D) 7.00 s
- (E) 8.00 s

Don't worry about this one.

14. A large cannon is fired from ground level over level ground at an angle of 30° above the horizontal. The muzzle speed is 980 m/s. Neglecting air resistance, the projectile will travel what horizontal distance before striking the ground?

- (A) 4.3 km
- (B) 8.5 km
- (C) 43 km
- (D) 85 km
- (E) 170 km

$\Delta x = v_x \cdot t = (848.7)(100)$   
 $\Delta x = 84870 \text{ m}$   
 $t = 100$

| x                         | y                                  |
|---------------------------|------------------------------------|
| $\Delta x = 848.7$        | $\Delta y = 0$                     |
| $v_x = 980 \cos 30^\circ$ | $v_{iy} = 980 \sin 30^\circ = 490$ |
| $= 848.7$                 | $a = -9.8$                         |
|                           | $v_f =$                            |
|                           | $t = 100$                          |

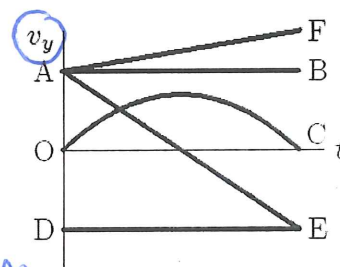
$\Delta y = v_{iy}t + \frac{1}{2}at^2$   
 $0 = 490t + \frac{1}{2}(-9.8)t^2$   
 $t = \frac{-490}{-4.9} = 100 \text{ s}$

15. Which of the curves on the graph below best represents the vertical component  $v_y$  of the velocity versus the time  $t$  for a projectile fired at an angle of 45° above the horizontal?

- (A) OC
- (B) DE
- (C) AB
- (D) AE
- (E) AF

acceleration is slope of a velocity graph. The acceleration is always  $-9.8 \frac{\text{m}}{\text{s}^2}$  in the y-direction.

Path AE is the only negative slope.



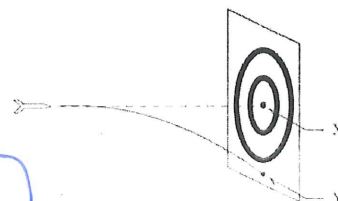
16. A dart is thrown horizontally toward X at 20m/s as shown. It hits Y 0.1 s later. The distance XY is:

- (A) 2 m
- (B) 1 m
- (C) 0.5 m
- (D) 0.1 m
- (E) 0.05 m

| x            | y              |
|--------------|----------------|
| $v_x = 20$   | $\Delta y = ?$ |
| $\Delta x =$ | $v_{iy} = 0$   |
| $t = 0.1$    | $v_{fy} =$     |
|              | $a = -9.8$     |
|              | $t = 0.1$      |

$\Delta y = v_{iy}t + \frac{1}{2}at^2$   
 $= \frac{1}{2}(-9.8)(0.1)^2$

$\Delta y = -0.049 \text{ m}$



17. A projectile is fired from ground level over level ground with an initial velocity that has a vertical component of 20m/s and a horizontal component of 30m/s. Using  $g = 10\text{m/s}^2$ , the distance from launching to landing points is:

- (A) 40 m
- (B) 60 m

| x            | y              |
|--------------|----------------|
| $\Delta x =$ | $\Delta y = 0$ |
| $v_x = 30$   | $v_i = 20$     |
| $t =$        | $v_f = -20$    |
|              | $a = -10$      |
|              | $t = ?$        |



- (C) 80 m  
(D) 120 m  
(E) 180 m

$$v_f = v_i + at$$

$$t = \frac{v_f - v_i}{a} = \frac{-20 - 20}{-10} = 4 \text{ seconds}$$

$$\Delta x = v_x \cdot t$$

$$= (30)(4) = 120 \text{ m}$$

18. Two projectiles of different mass are thrown in the air. Which one has a greater acceleration?

- (A) The one with more mass  
(B) The one with less mass  
(C) Both have the same acceleration  
(D) cannot tell without knowing the specific masses of each

19. A plane traveling at a constant horizontal velocity drops a package. If the package experiences no air resistance, describe the path of the package in relation to the position of the plane.

- (A) The package will always be directly below the plane, until the moment it strikes the ground. *both box and plane have the same  $v_x$  at all times.*  
(B) The package will gradually fall behind the horizontal position of the plane as it falls through the air.  
(C) The package will gradually surpass the horizontal position of the plane as it falls through the air.  
(D) It will depend on the mass of the package.

20. An object is thrown with a 30 degree angle above the horizontal. The acceleration at the top of its trajectory is zero.

- (A) True  
(B) False

*acceleration is ALWAYS -9.8 to the center of earth (down)*

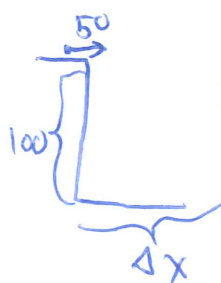
21. An object is thrown with a 30 degree angle above the horizontal. The velocity at the top of its trajectory is zero.

- (A) True  
(B) False

*still moving in the x-direction, just not in the y-direction.*

22. A model rocket flies off the edge of the cliff at a velocity of 50.0 m/s. If the canyon below is 100.0 m deep, how far off the edge of the cliff does the model rocket land?

- (A) 112 m  
(B) 225 m  
(C) 337 m  
(D) 400 m  
(E) 550 m



| x            | y                 |
|--------------|-------------------|
| $\Delta x =$ | $\Delta y = -100$ |
| $v_x = 50$   | $v_i = 0$         |
| $t =$        | $v_f =$           |
|              | $a = -10$         |
|              | $t =$             |

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

$$-100 = -5 t^2$$

$$\sqrt{t^2} = \sqrt{20}$$

23. A baseball is thrown by the center fielder (from shoulder level) to home plate where it is caught (on the fly at an equal shoulder level) by the catcher. At what point is the ball's speed at a minimum? (air resistance is negligible)

- (A) at the top of its trajectory

*Note the speed is minimum here but still not zero.*

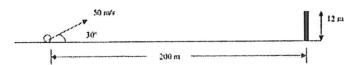
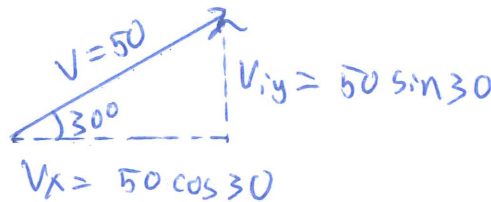
- (B) just before arriving at the catcher's mitt
- (C) just after leaving the center fielder's hand
- (D) speed is constant during the entire trajectory

24. A golf ball resting on the ground is struck by a golf club and given an initial velocity of 50 m/s at an angle of  $30^\circ$  above the horizontal. The ball heads toward a fence 12 meters high at the end of the golf course, which is 200 meters away from the point at which the golf ball was struck. Neglect any air resistance that may be acting on the golf ball.

What is the *vertical* component of velocity right after the gold ball is struck?

- (A) 0 m/s
- (B) 25 m/s
- (C) 43.3 m/s
- (D) 50 m/s
- (E) 68.3 m/s

$$V_y = 50 \sin 30 = 25 \text{ m/s}$$



25. A golf ball resting on the ground is struck by a golf club and given an initial velocity of 50 m/s at an angle of  $30^\circ$  above the horizontal. The ball heads toward a fence 12 meters high at the end of the golf course, which is 200 meters away from the point at which the golf ball was struck. Neglect any air resistance that may be acting on the golf ball.

What is the *horizontal* component of velocity right after the gold ball is struck?

- (A) 0 m/s
- (B) 25 m/s
- (C) 43.3 m/s
- (D) 50 m/s
- (E) 68.3 m/s

$$V_x = 50 \cos 30 = 43.3 \text{ m/s}$$



26. A golf ball resting on the ground is struck by a golf club and given an initial velocity of 50 m/s at an angle of  $30^\circ$  above the horizontal. The ball heads toward a fence 12 meters high at the end of the golf course, which is 200 meters away from the point at which the golf ball was struck. Neglect any air resistance that may be acting on the golf ball.

Calculate the time it takes for the ball to reach the plane of the fence.

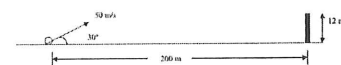
- (A) 11 s
- (B) 1.3 s
- (C) 3.5 s
- (D) 50 s
- (E) 4.6 s

| x                                           | y                                                                  |
|---------------------------------------------|--------------------------------------------------------------------|
| $\Delta x = 200$<br>$V_x = 43.3$<br>$t = ?$ | $\Delta y =$<br>$V_{iy} = 25$<br>$V_{fy} =$<br>$a = -9.8$<br>$t =$ |

$$V_x = \frac{\Delta x}{t}$$

$$t = \frac{\Delta x}{V_x} = \frac{200}{43.3} = 4.62 \text{ seconds}$$



27. A golf ball resting on the ground is struck by a golf club and given an initial velocity of 50 m/s at an angle of 30° above the horizontal. The ball heads toward a fence 12 meters high at the end of the golf course, which is 200 meters away from the point at which the golf ball was struck. Neglect any air resistance that may be acting on the golf ball.

What is the height of the ball when it reaches the plane of the fence?

- (A) 12 m
- (B) 8.8 m
- (C) 25 m
- (D) 3.2 m
- (E) it never makes it to the fence

Sorry,

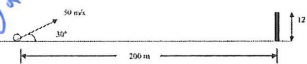
no correct

answer...

$$\Delta y = v_{iy}t + \frac{1}{2}at^2$$

$$\Delta y = (25)(4.62) + \frac{1}{2}(-9.8)(4.62)^2$$

$$\Delta y = 10.9 \text{ m}$$



28. A golf ball resting on the ground is struck by a golf club and given an initial velocity of 50 m/s at an angle of 30° above the horizontal. The ball heads toward a fence 12 meters high at the end of the golf course, which is 200 meters away from the point at which the golf ball was struck. Neglect any air resistance that may be acting on the golf ball.

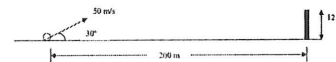
Does the ball pass over the fence, or strike it?

- (A) Passes over the fence
- (B) Strikes the fence

The fence is 12m

tall, so since the ball

is at a height 10.9m at the plane of the fence, it strikes the fence.



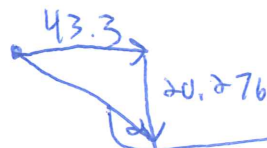
29. A golf ball resting on the ground is struck by a golf club and given an initial velocity of 50 m/s at an angle of 30° above the horizontal. The ball heads toward a fence 12 meters high at the end of the golf course, which is 200 meters away from the point at which the golf ball was struck. Neglect any air resistance that may be acting on the golf ball.

At what velocity does it strike the fence with?

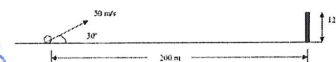
- (A) 0 m/s
- (B) 25 m/s
- (C) 43.3 m/s
- (D) 48.2 m/s
- (E) 21.2 m/s

$$V_x = 43.3$$

$$V_{sy} = v_{iy} + at = 25 + (-9.8)(4.62) = -20.276$$



$$\sqrt{43.3^2 + 20.276^2} = 47.8 \text{ m/s}$$



30. If a projectile is launched on a leveled surface, what angle would provide the largest range (horizontal displacement)?

- (A) An angle greater than 45 degrees above the horizontal
- (B) An angle equal to 45 degrees above the horizontal
- (C) An angle less than 45 degrees above the horizontal

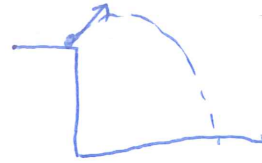


this one

31. If a projectile is launched off of cliff and onto a surface below the launch point, what angle would provide the largest range (horizontal displacement)?

- (A) An angle greater than 45 degrees above the horizontal

- ☐ B An angle equal to 45 degrees above the horizontal
- ☒ C An angle less than 45 degrees above the horizontal



32. The *horizontal* acceleration of a projectile is ALWAYS

- ☒ A zero
- ☐ B  $-9.8 \text{ m/s}^2$

33. The *vertical* acceleration of a projectile is ALWAYS

- ☐ A zero
- ☒ B  $-9.8 \text{ m/s}^2$

34. The *horizontal* velocity of a projectile in the air with no air resistance

- ☐ A Changes over time
- ☒ B Never changes

35. The *vertical* velocity of a projectile in the air with no air resistance

- ☒ A Changes over time
- ☐ B Never changes