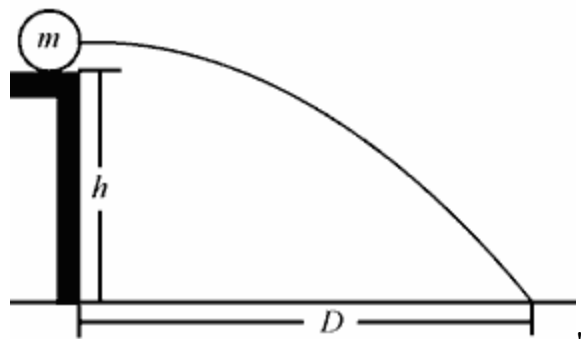


## Projectile Motion Review

1. Which of the following is **not** true about the path of a canon ball launched horizontally from the earth's surface if air resistance is neglected?
- A) The cannonball has a uniform horizontal velocity  
 B) The total velocity of the cannonball increases as a function of time  
 C) The vertical velocity of cannonball increases as a function of time  
 D) The distance the cannonball travels only depends upon the height it is shot from  
**E) The distance the cannonball travels is dependent on its mass**
2. A ball on a table of height  $h$  is rolled off a table traveling at velocity  $v$ , neglecting air resistance how much time does it take for the ball to hit the ground?
- A)  $\frac{h}{v}$     B)  $\frac{1h}{2v}$     C)  $\sqrt{\frac{h}{v}}$     D)  $\sqrt{\frac{h}{g}}$     E)  $\sqrt{\frac{2h}{g}}$
3. A basketball is thrown upwards on an arc at a 60 degree angle with the horizontal. If the velocity of the ball is 5 m/s how fast must the thrower run to catch the ball after it is released?
- A) **2.5 m/s**                      B) 4.3 m/s  
 C) 5.0 m/s                      D) 10 m/s  
 E) 20 m/s
4. A snowball is thrown out the window of a car moving at 20 m/s. The ball is thrown vertically to hit a snowman 20 meters away at window level. What speed would the snowball need to be thrown to hit the snowman?
- A) 2.5 m/s                      **B) 4.9 m/s**  
 C) 9.8 m/s                      D) 14.7 m/s  
 E) 19.6 m/s
5. Rocky the Flying Squirrel is carrying a nut of mass 0.5 kg while flying horizontally at a height of 15 m above the ground at a speed of 12 m/s. Bullwinkle is eagerly awaiting the delivery of the nut on the ground. Rocky releases the nut as he is directly above Bullwinkle. How far from Bullwinkle will the nut land if Bullwinkle does not move?
- A)  $3\sqrt{2}$  m                      B)  $3\sqrt{3}$  m  
 C)  $6\sqrt{2}$  m                      D)  $6\sqrt{3}$  m  
**E)  $12\sqrt{3}$  m**
6. A person throws a ball at an angle of  $30^\circ$  with the horizontal with a velocity of 32 m/s. As the ball is thrown, a second person is running past the thrower at a constant velocity. At what velocity must this second person run so that she may catch the ball as it hits the ground?
- A) 32 m/s                      B)  $32\sin 30^\circ$  m/s  
**C)  $32\cos 30^\circ$  m/s**                      D)  $32\tan 30^\circ$  m/s  
 E)  $64\cos 30^\circ$  m/s
- Base your answers to questions 7 and 8 on "the following diagram, in which a ball of mass  $m$  is rolled horizontally off a table of height  $h$  and lands a distance  $D$  from the edge of the table.



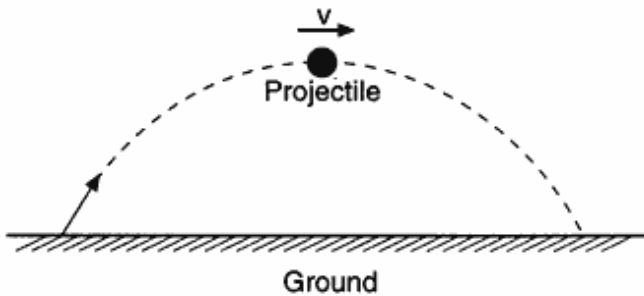
7. What is the initial horizontal velocity of the ball?
- A)  $\frac{D}{\sqrt{2h/g}}$                       B)  $D\sqrt{2h/g}$   
 C)  $2Dh/g$                       D)  $Dhg$   
 E)  $\frac{g}{Dh}$
8. How much time elapses between the time the ball leaves the edge of the table to when hits the ground?
- A)  $hD$                       B)  $h/D$   
 C)  $hD/g$                       D)  $2h/g$   
**E)  $\sqrt{2h/g}$**

## Multiple Choice

9. A baseball player throws a ball horizontally. Which statement best describes the ball's motion after it is thrown? [Neglect the effect of friction.]

- A) Its vertical speed remains the same, and its horizontal speed increases.
- B) Its vertical speed remains the same, and its horizontal speed remains the same.
- C) Its vertical speed increases, and its horizontal speed increases.
- D) Its vertical speed increases, and its horizontal speed remains the same.**
- E) Its vertical speed increases and its horizontal speed decreases.

10. The diagram below shows a projectile moving with speed  $v$  at the top of its trajectory.



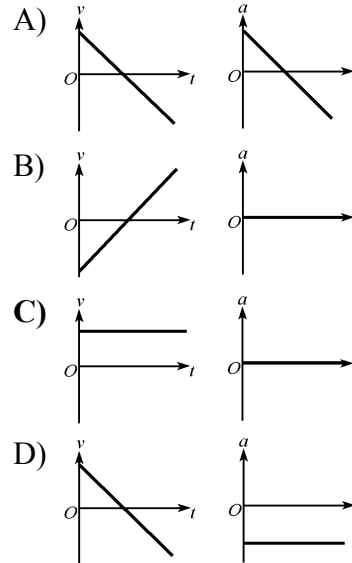
Which vector best represents the acceleration of the projectile in the position shown?

- A)
- B)
- C)
- D)

11. A bullet is fired horizontally at a velocity of 200 m/s at a height of 1 m. At the same time, another bullet is dropped 1 m from rest. The difference between  $t_1$ , the time it takes the fired bullet to hit the ground, and  $t_2$ , the time it takes the dropped bullet to hit the ground is

- A) 0 s    B) 1 s    C) 2 s    D) 4 s    E) 8 s

12. A projectile is fired with an initial velocity  $v_0$  at an initial angle  $\theta_0$  with the horizontal. Which of the following pairs of graphs below best represents the horizontal components of the velocity,  $v_x$ , and acceleration,  $a_x$ , of the projectile as functions of time?



## Multiple Choice

Base your answers to questions 13 and 14 on the information below.

A projectile is launched from ground level with an initial velocity of  $v$  at an angle  $\theta$  above the horizontal. Ignore air resistance.

13. The maximum horizontal displacement of the projectile is
- A)  $\frac{v \sin 2\theta}{g}$   
B)  $\frac{(v \sin \theta)^2}{g}$   
C)  $\frac{v \sin 2\theta}{2g}$   
D)  $\frac{(v \sin \theta)^2}{2g}$   
E)  $\frac{v^2 \sin 2\theta}{g}$
14. The maximum vertical displacement of the projectile is
- A)  $\frac{v \sin 2\theta}{g}$   
B)  $\frac{(v \sin \theta)^2}{g}$   
C)  $\frac{v \sin 2\theta}{2g}$   
D)  $\frac{(v \sin \theta)^2}{2g}$   
E)  $\frac{2v \sin 2\theta}{g}$

Base your answers to questions 15 and 16 on the following information.

A ball is thrown horizontally 20 m above the ground with a velocity of 5 m/s.

15. How far from the base of the cliff will the ball land?
- A) 5.6 m                      B) 9.2 m  
C) **10 m**                      D) 12 m  
E) 18.4 m
16. How much time will pass before the ball hits the ground?
- A) **2 s**    B) 2.8 s    C) 4.6 s    D) 6 s    E) 9.2 s

Base your answers to questions 17 and 18 on the following information.

From a cliff of height 28.8 m above the ground, a ball is thrown horizontally with an initial velocity of 7 m/s.

17. What is the range of the ball?
- A) 4.2 m                      B) 8.4 m  
C) 12.6 m                    D) **16.8 m**  
E) 22.4 m
18. The magnitude of the velocity of the ball when it strikes the ground is most nearly
- A) 15 m/s.                    B) 20 m/s.  
C) **25 m/s.**                    D) 30 m/s.  
E) 35 m/s.
- 
19. An object moving horizontally with speed  $v$  falls off the edge of a vertical cliff and lands a distance  $d$  from the base of the cliff. How far from the base of the cliff would the object land if the height of the cliff was doubled?
- A)  $d$                             B)  $\sqrt{2}d$   
C)  $2d$                         D)  $2\sqrt{2}d$   
E)  $4d$
20. An object moving horizontally with speed  $v$  falls off the edge of a vertical cliff and takes a time  $t$  to land. How long would it take for the object to land if it was moving with a horizontal velocity  $2v$ ?
- A)  $\frac{1}{2}t$   
B)  $\frac{1}{\sqrt{2}}t$   
C)  **$t$**   
D)  $2t$   
E) It could not be determined unless the height of the cliff was known

## Multiple Choice

21. Base your answer to the following question on the information below.

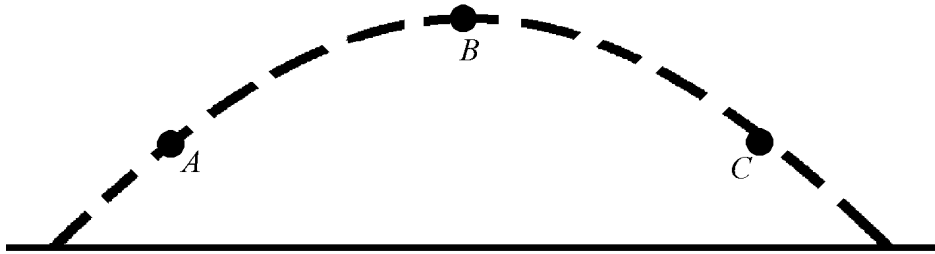
A 4.0 kg block rests at the edge of a platform that is 20 m above level ground. The block is launched horizontally with an initial velocity of 15 m/s.

The time it would take to reach the ground is most nearly

- A) 1.33 s                      B) 1.41 s  
C) 1.73 s                      D) **2.0 s**  
E) 2.5 s

Base your answers to questions 22 through 26 on the following information.

A cannonball is fired and follows the parabolic path shown below. Air resistance is negligible. Point *B* is the highest point on the path and points *A* and *C* are at the same height.



22. Which of the following best describes the direction of the net force on the ball at point *A*?
- A) up and to the right  
B) to the right  
C) down and to the right  
D) **down**  
E) There is no net force on the cannonball at point *A*
23. Which of the following best describes the direction of the velocity of the cannonball at point *B*?
- A) **to the right**                                      B) up and to the right  
C) down and to the right                                      D) up  
E) down
24. Which of the following best describes the direction of the acceleration of the ball at point *C*?
- A) to the right                                      B) down and to the right  
C) **down**    D) up and to the right  
E) up and to the left
25. How do the accelerations of the ball at the three points compare?
- A)  $a_A < a_B < a_C$     B)  $a_B < a_A < a_C$     C)  **$a_A = a_B = a_C$**     D)  $a_A = a_B < a_C$     E)  $a_B < a_A = a_C$
26. How do the speeds of the cannonball at the three points compare?
- A)  $v_A < v_B < v_C$     B)  $v_C < v_B < v_A$     C)  $v_B < v_A < v_C$     D)  $v_A < v_B = v_C$     E)  **$v_B < v_A = v_C$**

## Multiple Choice

27. A cannon fires a cannonball with an initial velocity of 30 m/s at an angle of  $60^\circ$  to the horizontal. If air resistance is negligible, the amount of time the cannonball remains in the air is  
A) 2.6 s B) 3.0 s **C) 5.2 s** D) 6.0 s E) 7.8 s
28. An object is thrown off of a cliff 320 m above level ground with an initial horizontal velocity of 20 m/s. The amount of time it takes to strike the ground is most nearly  
A) 2 s B) 4 s **C) 8 s** D) 12 s E) 16 s
29. A ball is launched from ground level with an initial upwards velocity of 20 m/s and an initial horizontal velocity of 30 m/s. How far from its starting position does the ball land assuming the ground is level?  
A) 30 m B) 60 m  
**C) 120 m** D) 150 m  
E) 180 m
30. A ball is thrown horizontally out of a hot air balloon at a height of 500 m above level ground with an initial velocity of 15 m/s. If air resistance is negligible, the time that it will take the ball to reach the ground is most nearly  
A) 3 s B) 5 s **C) 10 s** D) 15 s E) 33 s
31. A cannon fires a projectile with an initial speed  $v$  at an angle  $\theta$  above the horizon. What is the horizontal distance traveled by the projectile?  
A)  $\frac{v^2 \sin \theta}{g}$   
B)  $\frac{2v^2 \sin \theta}{g}$   
**C)  $\frac{v^2 \sin 2\theta}{g}$**   
D)  $\frac{2v^2 \sin 2\theta}{g}$   
E)  $\frac{2v^2 \sin^2 \theta}{g}$
32. A cannon fires a projectile with an initial speed  $v$  at an angle  $\theta$  above the horizon. What is the maximum height reached by the projectile?  
A)  $\frac{2v^2 \sin^2 \theta}{g}$   
**B)  $\frac{v^2 \sin^2 \theta}{2g}$**   
C)  $\frac{2v^2 \cos \theta \sin \theta}{g}$   
D)  $\frac{v^2 \cos \theta \sin \theta}{g}$   
E)  $\frac{v^2 \cos^2 \theta}{g}$
- Base your answers to questions **33** and **34** on the following information.
- An object is thrown with a horizontal velocity of 15 m/s off of a cliff that is 180 m above level ground.
33. If air resistance is negligible, the distance between the base of the cliff and the place where the object reaches the ground is most nearly  
A) 50 m B) 60 m  
C) 150 m D) 180 m  
**E) 90 m**
34. If air resistance is negligible, the time it takes the object to reach the ground is most nearly  
A) 4 s B) 5 s **C) 6 s** D) 7 s E) 8 s
35. An object is thrown horizontally off of a 125 m high cliff above level ground with an initial velocity of 15 m/s. If air resistance is negligible, the distance from the base of the cliff to the point where the object lands is most nearly  
A) 25 m B) 45 m  
**C) 75 m** D) 90 m  
E) 150 m

## Multiple Choice

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36. The ammunition fired from an M-16 rifle has a muzzle velocity of 1000 m/s. A sniper perched on a tower 50 meters high aims at a target and fires.

- (A) The sniper aims her rifle 53.1 degrees above the horizontal. How far away from the platform does the bullet hit the ground? Neglect air resistance.
- (B) With what speed would the bullet hit?
- (C) If the target is 500 meters away on a platform 50 meters high, what angle would the sniper have to make with her gun to hit the target?
- (D) What would be the speed of the bullet when it hits?

37. A cheetah is resting when a hare traveling in a straight path passes at its top speed of 25 m/s. It takes the cheetah 1.5 seconds to get up and begin running. The cheetah accelerates to its top speed of 45 m/s in 20 seconds. It can maintain this speed for 2 seconds before decelerating at  $4 \text{ m/s}^2$ .

- (A) What is the initial acceleration of the cheetah?
- (B) How long does the chase last?
- (C) How far has the cheetah traveled before catching the hare?
- (D) What is the cheetah's speed when it catches the hare?

38. A physicist drops a stone off the top of a cliff overlooking a lake. She hears the splash 4 seconds after releasing the stone.

- (A) Neglecting air resistance and assuming a speed of sound of 340. m/s, how long does it take for the stone to reach the lake?
  - (B) How long does it take for the sound to reach her ear?
  - (C) What is the velocity of the stone just before it hits the water?
  - (D) What is the height of the cliff?
-

**Answer Key**  
**proejct mot**

- |     |          |     |                           |
|-----|----------|-----|---------------------------|
| 1.  | <u>E</u> | 36. | (A) 98000 m               |
| 2.  | <u>E</u> |     | (B) 1000 m/s              |
| 3.  | <u>A</u> |     | (C) 44.9                  |
| 4.  | <u>B</u> |     | (D) 1000 m/s              |
| 5.  | <u>E</u> | 37. | (A) 2.25 m/s <sup>2</sup> |
| 6.  | <u>C</u> |     | (B) 25.88 seconds         |
| 7.  | <u>A</u> |     | (C) 684 m                 |
| 8.  | <u>E</u> |     | (D) 29.5 m/s              |
| 9.  | <u>D</u> | 38. | (A) 3.79 sec              |
| 10. | <u>D</u> |     | (B) 0.21 sec              |
| 11. | <u>A</u> |     | (C) 37.1 m/s              |
| 12. | <u>C</u> |     | (D) 70.5 m                |
| 13. | <u>E</u> |     |                           |
| 14. | <u>D</u> |     |                           |
| 15. | <u>C</u> |     |                           |
| 16. | <u>A</u> |     |                           |
| 17. | <u>D</u> |     |                           |
| 18. | <u>C</u> |     |                           |
| 19. | <u>B</u> |     |                           |
| 20. | <u>C</u> |     |                           |
| 21. | <u>D</u> |     |                           |
| 22. | <u>D</u> |     |                           |
| 23. | <u>A</u> |     |                           |
| 24. | <u>C</u> |     |                           |
| 25. | <u>C</u> |     |                           |
| 26. | <u>E</u> |     |                           |
| 27. | <u>C</u> |     |                           |
| 28. | <u>C</u> |     |                           |
| 29. | <u>C</u> |     |                           |
| 30. | <u>C</u> |     |                           |
| 31. | <u>C</u> |     |                           |
| 32. | <u>B</u> |     |                           |
| 33. | <u>E</u> |     |                           |
| 34. | <u>C</u> |     |                           |
| 35. | <u>C</u> |     |                           |
-