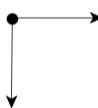
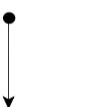
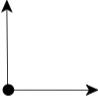


1. A rock is thrown horizontally off the roof of a building at 18 m/s. What is the horizontal component of the velocity just before the rock hits the ground?
- (A) -18 m/s
(B) -9.8 m/s
(C) 9.8 m/s
(D) 18 m/s
2. A juggler throws a ball at 0.22 m/s at an angle of 60.0° above the horizontal. What is the y-component of the velocity of the ball?
- (A) 0.11 m/s
(B) 0.19 m/s
(C) 0.25 m/s
(D) 0.44 m/s
3. How much time does it take a soccer ball to travel 50.0 m horizontally if it is kicked with a velocity of 18.4 m/s at an angle of 30.0° above the horizontal?
- (A) 0.184 s
(B) 0.319 s
(C) 3.14 s
(D) 5.43 s
4. A ball is thrown horizontally with a speed of 10.0 m/s. If it hits the ground 4.0 s later, what is the magnitude of the y-component of its velocity just before it hits the ground?
- (A) 0 m/s
(B) 39 m/s
(C) 49 m/s
(D) 98 m/s
5. Which expression represents the time it takes for a projectile, with initial velocity v_1 , at angle θ above the horizontal, to reach its maximum height?
- (A) $v_1 g \cos \theta$
(B) $v_1 g \sin \theta$
(C) $\frac{v_1 \cos \theta}{g}$
(D) $\frac{v_1 \sin \theta}{g}$
7. Which movement is an example of projectile motion?
- (A) climbing a wall
(B) running around a track
(C) throwing a ball off a cliff
(D) walking at a constant velocity
7. An egg is thrown in the air with a velocity of 15 m/s at 45° above the horizontal. What is its horizontal velocity and vertical acceleration when it reaches the maximum height?

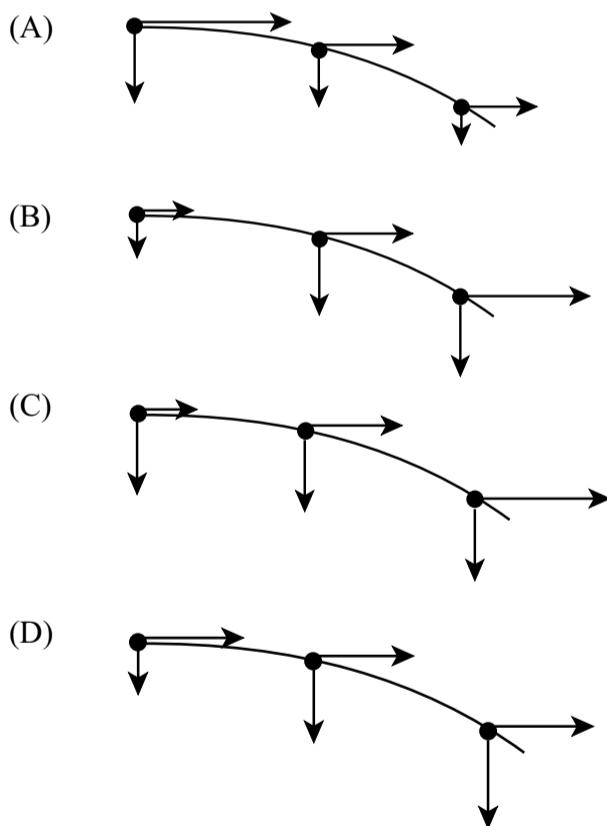
horizontal velocity (m/s)	vertical acceleration (m/s ²)
(A) 0	0
(B) 0	-9.8
(C) 11	0
(D) 11	-9.8

8. A projectile is launched at a 30.0° angle above the horizontal with a speed of 20.0 m/s. What is the vertical displacement after 3.0 s?
- (A) - 74 m
(B) - 14 m
(C) + 12 m
(D) + 31 m
9. If a coin is pushed horizontally from a 1.2 m high table and lands 0.68 m from the base, what was the speed at which it left the table?
- (A) 1.4 m/s
(B) 1.9 m/s
(C) 2.8 m/s
(D) 5.7 m/s
10. What is the vertical speed component of a projectile that is launched at an angle of 20.0° to the horizontal with an initial speed of 30.0 m/s?
- (A) $30.0 (\cos 20.0^\circ)$
(B) $30.0 (\sin 20.0^\circ)$
(C) $\frac{30.0}{\sin 20.0^\circ}$
(D) $\frac{30.0}{\cos 20.0^\circ}$
11. Which best represents the velocity components of a projectile at its maximum height?
- (A) 
(B) 
(C) 
(D) 
12. A projectile is shot horizontally at 40.0 m/s from a cannon located on a cliff 155 m high. How many seconds is the projectile in the air?
- (A) 0.258 s
(B) 5.62 s
(C) 11.0 s
(D) 31.6 s
13. A ball thrown into the air has a horizontal velocity component of 12 m/s. What is the range of the ball if it lands after 3.0 s?
- (A) 4.0 m
(B) 36 m
(C) 51 m
(D) 80 m
14. An arrow is fired at 45.5 m/s from a 5.75 m high tree branch, at an angle of 60° above the horizontal. What maximum height, above the ground, will the arrow reach?
- (A) 32.1 m
(B) 73.4 m
(C) 79.1 m
(D) 84.9 m

15. A ball is thrown at a 60° angle to the horizontal. As soon as the ball is released, the thrower runs along level ground, below the ball, and catches it 3.0 s later. If the thrower ran 12 m, what was the magnitude of the initial velocity?
- (A) 2.3 m/s
 (B) 4.0 m/s
 (C) 4.6 m/s
 (D) 8.0 m/s
16. If a ball is thrown at an initial speed of 8.0 m/s at an angle of 35° above the ground, what is the speed of the ball when it returns to its original height?
- (A) 4.6 m/s
 (B) 6.6 m/s
 (C) 8.0 m/s
 (D) 9.8 m/s
17. A rock is thrown horizontally from the top of a hill. If air friction is negligible, which best represents the horizontal and vertical accelerations?

horizontal acceleration (m/s^2)	vertical acceleration (m/s^2)
(A) 0	-9.8
(B) 0	0
(C) 9.8	-9.8
(D) 9.8	0

18. Which diagram best represents the vertical and horizontal velocity components shortly after a ball is kicked from a cliff?



19. Which is constant for all projectiles?
- (A) horizontal displacement
 (B) horizontal velocity
 (C) vertical displacement
 (D) vertical velocity
20. If a coin is tossed horizontally from a 1.2 m high table and lands 0.68 m from the base, what was the speed at which it left the table?
- (A) 1.4 m/s
 (B) 1.9 m/s
 (C) 2.8 m/s
 (D) 5.7 m/s

21. What is the vertical speed component of a projectile that is launched at an angle of 20.0° to the horizontal with an initial speed of 30.0 m/s?

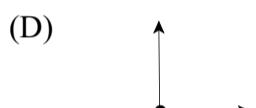
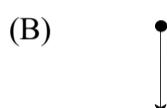
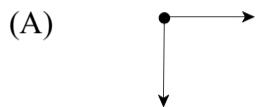
(A) $30.0 (\cos 20.0^\circ)$

(B) $30.0 (\sin 20.0^\circ)$

(C) $\frac{30.0}{\sin 20.0^\circ}$

(D) $\frac{30.0}{\cos 20.0^\circ}$

22. Which best represents the velocity components of a projectile at its maximum height?



23. A projectile is shot horizontally at 40.0 m/s from a cannon located on a cliff 155 m high. How many seconds is the projectile in the air?

(A) 0.258 s

(B) 5.62 s

(C) 11.0 s

(D) 31.6 s

24. A ball thrown into the air has a horizontal velocity component of 12 m/s. What is the range of the ball if it lands after 3.0 s?

(A) 4.0 m

(B) 36 m

(C) 51 m

(D) 80 m

25. An arrow is fired at 45.5 m/s from a 5.75 m high tree branch, at an angle of 60° above the horizontal. What maximum height, above the ground, will the arrow reach?

(A) 32.1 m

(B) 73.4 m

(C) 79.1 m

(D) 84.9 m

26. A ball is thrown at a 60° angle to the horizontal. As soon as the ball is released, the thrower runs along level ground, below the ball, and catches it 3.0 s later. If the thrower ran 12 m, what was the magnitude of the initial velocity?

(A) 2.3 m/s

(B) 4.0 m/s

(C) 4.6 m/s

(D) 8.0 m/s

27. Which is constant for any given projectile?

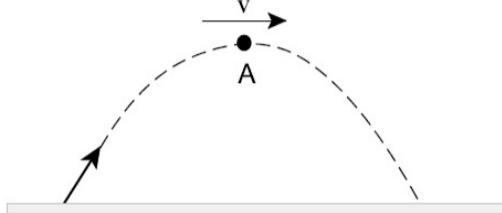
(A) horizontal displacement

(B) horizontal velocity

(C) vertical displacement

(D) vertical velocity

28. Which demonstrates projectile motion?
(A) ball rolling up a hill
(B) car driving down a street
(C) horse galloping around an oval track
(D) rock rolling off the edge of a cliff
29. If a projectile is launched at an angle of 65° from the horizontal at a speed of 2.1 m/s, what is the maximum height reached by the object?
(A) 0.040 m
(B) 0.097 m
(C) 0.18 m
(D) 0.23 m
30. The diagram below shows a projectile moving with speed, v , at the top of its path.



Which vector best represents the acceleration of the projectile at position A?

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

31. If a steel ball was launched horizontally from a height of 90.0 cm and lands 1.3 m from the base, what was the initial velocity?
(A) 0.30 m/s
(B) 2.7 m/s
(C) 3.0 m/s
(D) 7.1 m/s
31. Which illustrates projectile motion?
(A) driving a car around a banked curve
(B) dropping a rock from a building
(C) juggling
(D) running
32. A ball kicked from the ground at 12.0 m/s and 28° from the horizontal, returns to the ground in 5.0 s. What is the ball's speed just before it hits the ground?
(A) 0 m/s
(B) 5.6 m/s
(C) 11 m/s
(D) 12 m/s
33. If a ball is thrown at an angle of 35° from the ground, at a speed of 8.0 m/s, what is the magnitude of the vertical component of the initial velocity?
(A) 4.6 m/s
(B) 5.6 m/s
(C) 6.6 m/s
(D) 8.0 m/s

34. A ball is thrown horizontally at 10.0 m/s. If it hits the ground 2.00 s later, what is the magnitude of the x-component of its velocity just before it hits the ground?
- (A) 0 m/s
 (B) 10.0 m/s
 (C) 20.0 m/s
 (D) 30.0 m/s
35. If a coin is pushed horizontally from a 1.2 m high table and lands 0.75 m from the base, what was the speed at which it left the table?
- (A) 0.38 m/s
 (B) 1.5 m/s
 (C) 1.9 m/s
 (D) 3.0 m/s
36. Which represents the range for a projectile launched horizontally with velocity, v , from height, h ?

(A)

$$v \sin \theta \sqrt{\frac{h}{4.9}}$$

(B)

$$-v \cos \theta \sqrt{\frac{h}{4.9}}$$

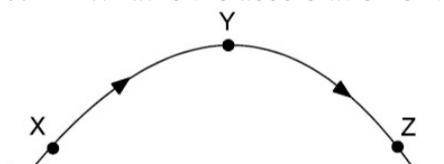
(C)

$$v \sqrt{\frac{h}{4.9}}$$

(D)

$$v \left(\frac{h}{4.9} \right)$$

37. What is the acceleration of the projectile at each point in the diagram below?



Acceleration (m/s ²)		
X	Y	Z
(A) -9.8	-9.8	-9.8
(B) -9.8	0	9.8
(C) 9.8	9.8	-9.8
(D) 9.8	0	-9.8

38. If a projectile is launched from ground level with an initial velocity of 65 m/s at 30.0° above the horizontal, what is its total time in the air?
- (A) 3.3 s
 (B) 6.6 s
 (C) 12 s
 (D) 13 s
39. An object is projected horizontally from a 0.95 m high table at a velocity of 12 m/s. How far from the base of the table will the object hit the floor?
- (A) 2.3 m
 (B) 5.3 m
 (C) 11 m
 (D) 27 m

40. Two arrows are launched at the same time with the same initial velocity. Arrow X is fired at an angle of 60° to the horizontal, and arrow Y is fired at an angle of 45° to the horizontal. Which best describes the motion of arrow X compared to the motion of arrow Y?
- (A) Arrow X has a longer flight time and longer horizontal range.
 (B) Arrow X has a longer flight time and shorter horizontal range.
 (C) Arrow X has a shorter flight time and longer horizontal range.
 (D) Arrow X has a shorter flight time and shorter horizontal range.
41. What is the direction of acceleration for any projectile?
- (A) up
 (B) down
 (C) left
 (D) right
42. What is the range of a projectile launched horizontally at 15 m/s with a flight time of 4.5 s?
- (A) 3.3 m
 (B) 59 m
 (C) 68 m
 (D) 99 m
43. A rock is launched with a horizontal velocity of 3.0 m/s and a vertical velocity of 4.0 m/s. What is the magnitude of the velocity of the rock at its maximum height?
- (A) 0 m/s
 (B) 3.0 m/s
 (C) 4.0 m/s
 (D) 5.0 m/s
44. A projectile is launched from ground level with an initial velocity of 65 m/s at an angle of 60.0° above the horizontal. How much time does it take to return to ground level?
- (A) 2.4 s
 (B) 3.4 s
 (C) 5.6 s
 (D) 11 s
45. What is the maximum height of a projectile launched at 120 m/s at an angle of 30.0° above the horizontal.
- (A) 3.1 m
 (B) 5.3 m
 (C) 180 m
 (D) 550 m
46. A golfer hits a golf ball with a velocity of 75 m/s at an angle of 15° to the horizontal. What are the horizontal and vertical components of the initial velocity?

horizontal velocity (m/s)	vertical acceleration (m/s^2)
(A) 0	75
(B) 19	72
(C) 72	19
(D) 75	0

47. A stone is thrown horizontally from the edge of a cliff and lands in the water below. If the stone is in the air for 2.8 s, how high is the cliff?
- (A) 14 m
 (B) 27 m
 (C) 38 m
 (D) 77 m

48. A swimmer runs horizontally off the end of a wharf at 1.2 m/s and lands in the water 2.4 s later. How far does she have to swim to get back to the wharf?

(A) 0.50 m
(B) 2.0 m
(C) 2.9 m
(D) 5.8 m

49. A football is kicked and follows a parabolic path. Which represents the velocity of the football at its maximum height?

(A)



(B)



(C)



(D)



50. A plane flying horizontally with a speed of 50.0 m/s at a height of 161 m, drops a package when it is directly over a tent. How far from the tent will the package land?

(A) 161 m
(B) 169 m
(C) 287 m
(D) 1640 m

51. A stone is thrown upward from the top of a building at an angle of 30.0° to the horizontal with an initial speed of 20.0 m/s. If the stone lands on the ground 4.22 s later, how tall is the building?

(A) 14.2 m
(B) 21.5 m
(C) 45.1 m
(D) 129 m

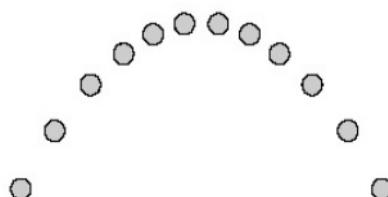
52. A person runs horizontally off the end of a cliff and lands in the water 1.3 s later. How high is the cliff?

(A) 1.6 m
(B) 6.4 m
(C) 8.3 m
(D) 13 m

53. A marble is launched horizontally from a table at 12 m/s and lands on the floor 0.25 s later. What is the range of the marble?

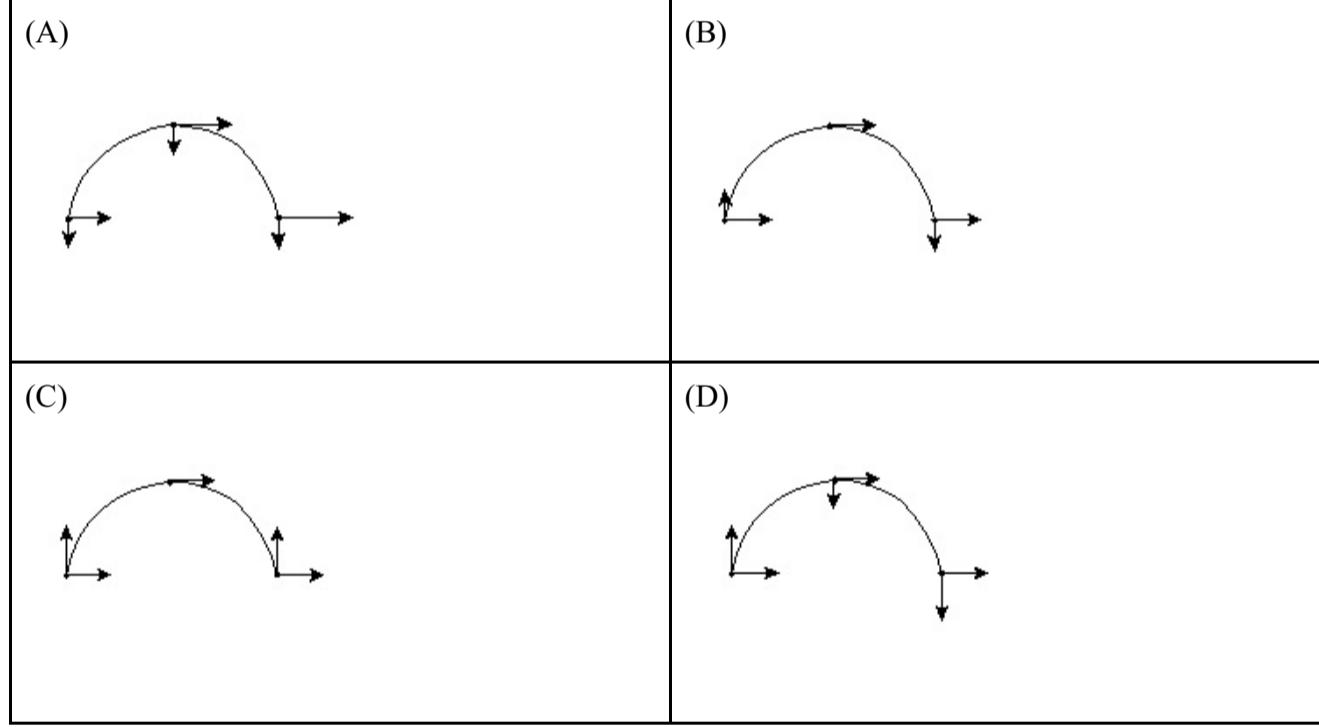
(A) 0.021 m
(B) 0.31 m
(C) 3.0 m
(D) 48 m

54. Which describes a ball thrown in the air that traces the path shown?



- (A) The acceleration of the ball at the top of its motion is zero.
 (B) The acceleration of the ball keeps changing.
 (C) The velocity of the ball at the top of its motion is zero.
 (D) The velocity of the ball keeps changing.
55. A projectile is launched with an initial velocity of 14 m/s at an angle of 25° above the horizontal. What is the speed of the projectile at its maximum height?
 (A) 0 m/s
 (B) 5.9 m/s
 (C) 13 m/s
 (D) 14 m/s
56. A golf ball is hit from ground level with an initial velocity of 63 m/s at an angle of 31° above the horizontal. How long will it take the ball to hit the ground?
 (A) 3.3 s
 (B) 5.5 s
 (C) 6.6 s
 (D) 11 s
57. A marble is launched horizontally from the top of a building. How far has the marble fallen when the vertical component of its velocity is 16 m/s [down]?
 (A) 0.82 m
 (B) 1.6 m
 (C) 13 m
 (D) 26 m

58. Which represents the velocity components of a projectile?



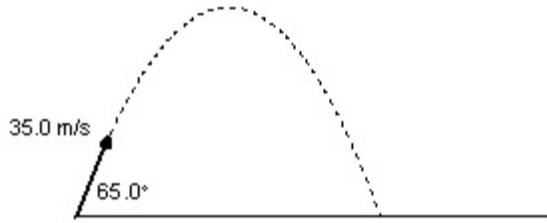
59. An arrow is shot horizontally with a velocity of 12 m/s. If the range is 24 m, how long is the arrow in the air?
 (A) 0.50 s
 (B) 2.0 s
 (C) 12 s
 (D) 24 s
60. What are the horizontal and vertical components of a projectile launched with a velocity of 16.0 m/s at an angle of 40.0° above the horizontal?

	v_x (m/s)	v_y (m/s)
(A)	10.3	12.3
(B)	12.3	10.3
(C)	12.3	16.0
(D)	16.0	12.3

61. A soccer ball is kicked with a speed of 15.0 m/s at 30.0° above the ground. What is its height at 0.60 s?

- (A) 1.6 m
(B) 2.7 m
(C) 6.0 m
(D) 6.3 m

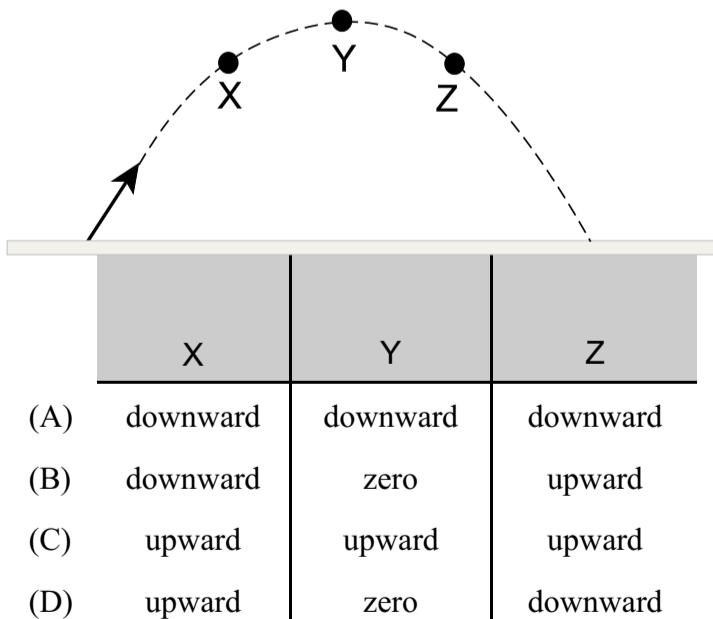
62. A catapult fires a large stone as shown. What is the maximum height reached by the stone?



- (A) 1.62 m
(B) 11.2 m
(C) 51.3 m
(D) 103 m
63. A golf ball is launched with an initial velocity, v_o , at an angle θ above the ground. Which expression describes the time required for the golf ball to land on the ground?

- (A) $\frac{-2v_o}{a}$
(B) $\frac{-2v_o \cos \theta}{a}$
(C) $\frac{-2v_o \sin \theta}{a}$
(D) $\frac{-v_o \sin \theta}{a}$

64. Which represents the vertical component of the velocity at points X, Y and Z for the object following the parabolic path shown below?



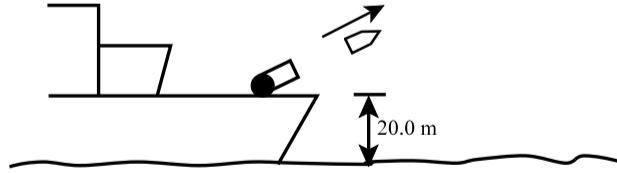
- | | | |
|--------------|----------|----------|
| X | Y | Z |
| (A) downward | downward | downward |
| (B) downward | zero | upward |
| (C) upward | upward | upward |
| (D) upward | zero | downward |

65. What is the range of a ball thrown horizontally at 12 m/s if its time of flight is 3.0 s?
- (A) 0.25 m
 (B) 4.0 m
 (C) 12 m
 (D) 36 m
66. An arrow is fired from a bow with an initial velocity of 18.0 m/s at an angle of 35.0° above the horizontal. How far, horizontally, has the arrow travelled in 1.45 s?
- (A) 12.4 m
 (B) 15.0 m
 (C) 21.4 m
 (D) 26.1 m
67. A ball is launched with an initial velocity of 28.0 m/s at 40.0° above the horizontal. How long does it take for the ball to reach its maximum height?
- (A) 1.68 s
 (B) 1.84 s
 (C) 2.19 s
 (D) 2.86 s
68. A golf ball is launched at an angle of 15.0° from the ground. What was the initial speed of the ball if it lands on the ground 3.42 s later?
- (A) 16.8 m/s
 (B) 17.3 m/s
 (C) 64.7 m/s
 (D) 129 m/s

69. A cannonball is fired on Earth at an angle of 45° above the ground and has a range of 125 m. If the same cannonball is fired on Jupiter where $g = 24.6 \text{ m/s}^2$, which combination of changes would have to occur so that the cannonball still has a range of 125 m?

Launch Angle	Launch Speed
(A) decrease	same
(B) increase	same
(C) same	decrease
(D) same	increase

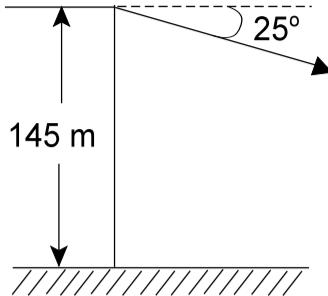
1. If a rock is thrown horizontally from a 45.0 m high cliff with a velocity of 20.0 m/s, how far from the base of the cliff does the rock hit the ground? **JUNE 2004**
2. In the diagram below, a shell is shot from a cannon, with an initial speed of $4.4 \times 10^2 \text{ m/s}$, at 30.0° from the deck of a ship. If the ship is at rest and the shell is launched 20.0 m above sea level, how far will the shell travel horizontally from its original position into the sea? Assume friction is negligible. **JUNE 2004**



3. (a) As a plane flies horizontally at 65.0 m/s, it releases a package from a height of $1.20 \times 10^3 \text{ m}$. **JUNE 2005**
4. (i) What is the horizontal distance the package travels after it is released?
 (ii) What is the final velocity of the package? **AUGUST 2005**

5. The diagram below represents a cannon located on a 145 m high cliff. If the cannon fires a cannonball at a 25° angle below the horizontal, with an initial velocity of 75.0 m/s, how far will the cannonball travel in the horizontal direction before it hits the ground?

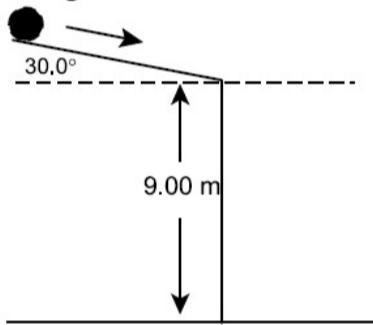
AUGUST 2005



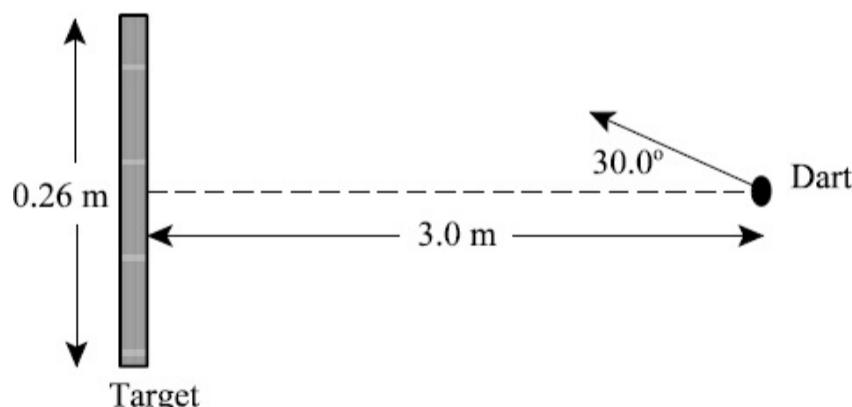
6. A parcel is dropped from a plane flying overhead with a constant horizontal speed of 75 m/s. If the range is 1.2×10^3 m, from what height was the parcel dropped? Assume air resistance is negligible. Show workings. **JUNE 2006**

7. A strike in baseball occurs between 0.50 m and 1.0 m directly above home plate. A pitcher, 18.0 m from home plate, throws a ball with an initial velocity of 17.0 m/s at 15° above the horizontal. If the ball is released 2.0 m above the ground, will the pitch be a strike? Show workings. **JUNE 2006**

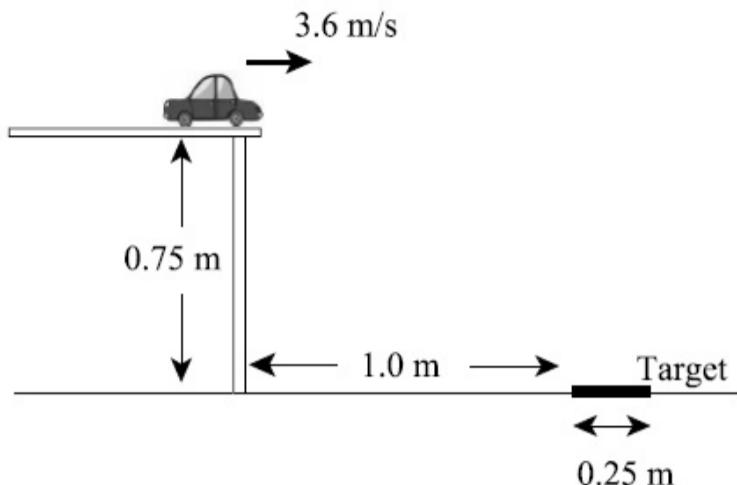
8. A ball rolls off an incline at 20.0 m/s, as shown in the diagram below. At what horizontal distance from the wall will the ball hit the ground? **AUGUST 2006**



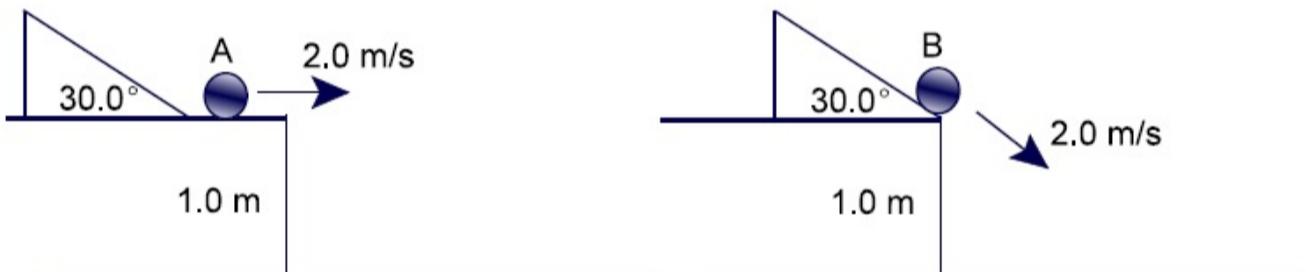
9. A juggler throws a ball upward at an angle of 65° to the horizontal, with an initial speed of 3.2 m/s. How far apart should the juggler hold her hands in order to catch the ball at the same level from which it was thrown? **JUNE 2007**
10. In the diagram below a dart that is in line with the midpoint of a 0.26 m high target, is thrown toward the target with a speed of 6.0 m/s at a 30.0° angle. Determine whether the dart will hit the target if it is 3.0 m away.



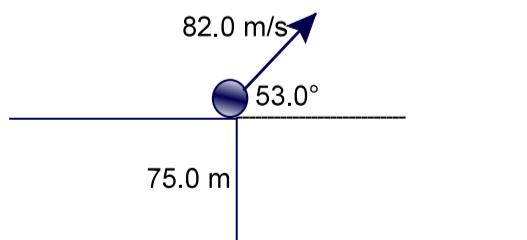
11. In a laboratory activity, students launch a toy car horizontally off a table with a speed of 3.6 m/s as shown. If a 0.25 m wide target is placed 1.0 m from the base of the table, determine whether the car will hit the target. **AUGUST 2007**



12. Explain why beginning jugglers prefer large dwell ratios, while professional jugglers prefer smaller dwell ratios. **AUGUST 2007**
13. Ball A is rolled down a 30.0° ramp on a 1.0 m high table, and exits the table horizontally at 2.0 m/s. A second identical ball B, is rolled down the same ramp but exits the table with a speed of 2.0 m/s at a 30.0° angle. Calculate which ball will travel the greatest horizontal distance from the base of the table. **JUNE 2008**



14. A fish sees a bug on a tree branch that is 4.1 m above the water, and tries to knock it down by shooting a jet of water with an initial velocity of 11.7 m/s at an angle of 35° to the surface of the water. With the aid of a diagram, calculate whether it is possible for the angler fish to hit the bug. **JUNE 2008**
15. A golfer hits a golf ball from ground level with a speed of 25 m/s at 35° above the horizontal. Calculate the magnitude of the velocity of the ball when it has travelled a horizontal distance of 42 m. **AUGUST 2008**
16. A ball is thrown from a 75.0 m high cliff, with an initial velocity of 82.0 m/s , at an angle of 53.0° above the horizontal. Calculate the range of the ball when it hits the ground below. **JUNE 2009**



17. A ball is thrown with an initial velocity of 82.0 m/s at an angle of 53.0° below the horizontal as shown. Calculate the range of the ball if it is thrown from a height of 10.0 m . **AUGUST 2009**