

### **Topic 2C: Skills 17 and 18 – Projectiles Launched at an Angle**

151. Determine the initial horizontal and vertical velocity for a dart launched with a velocity of 4m/s at an angle of 30 degrees.

152. A toad leaps with a velocity of 2m/s at an angle of 40 degrees. What is the toad's "air-time" (total time of flight)? (What variable must be found in order to determine total time of flight?)

153. A cannon ball is launched vertically upward from the bed of a pick-up truck moving east at 10m/s. The ball returns to the launch height in 2 seconds.

- a. What is the vertical launch velocity of the cannon ball?
- b. What is the resultant direction (angle) of the cannon ball (relative to a fixed frame)?
- c. What is the resultant velocity of the cannon ball?
- d. Sketch the path of the projectile in this scenario after launch.

154. A paintball is launched with a velocity of 30m/s at an angle of 40°. What is the horizontal range of the paintball? (assume it lands on someone or something at the same height from which it was launched). [Since  $v_{iy} \neq 0$  the  $\Delta v$  is in the grid]

$\Delta v$ (m/s)	$v_{iy}$ (m/s)	$v_{fy}$ (m/s)	$v_{y-avg}$ (m/s)	$d_y$ (m)	$a_y$ (m/s <sup>2</sup> )	$t$ (s)

$v_x =$

$d_x =$

$t =$

155. A stream of water leaves a sprinkler with a velocity of 10m/s at an angle of 60 degrees. What is the horizontal distance reached by the water?

$\Delta v$ (m/s)	$v_{iy}$ (m/s)	$v_{fy}$ (m/s)	$v_{y-avg}$ (m/s)	$d_y$ (m)	$a_y$ (m/s <sup>2</sup> )	$t$ (s)

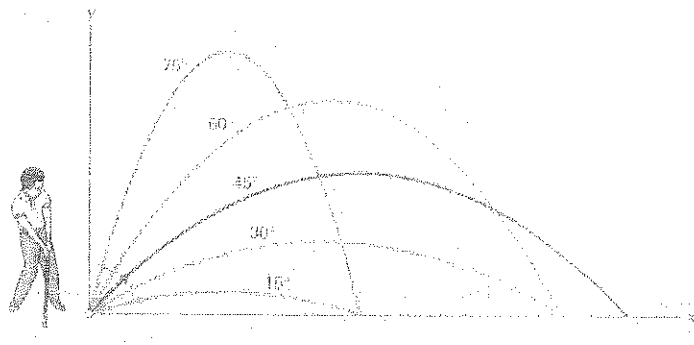
$v_x =$

$d_x =$

$t =$

### Relationship between launch angle and horizontal range.

When playing sports people making decisions about the optimal launch angle all the time. For example if a volleyball player wants to give another player time to get into position to spike a ball they launch the ball upward at  $90^\circ$  to give the maximum time of flight. If a football player wants to this they throw the ball at a high angle with more upward motion than forward motion. If you want to get a ball down field fast you put all the emphasis on horizontal motion and minimal vertical motion. This is because the vertical motion determines the time in the air. At  $45^\circ$  the vertical and horizontal motions are balanced. The angle that results in maximum range ( $dx$ ) is  $45^\circ$ . 45 degrees or the angle closest to 45 will result in the greatest horizontal distance traveled. 90 degrees or the highest angle will result in the greatest maximum height reached and the greatest time in the air.



156. Which of the following launch angles would result in the greatest horizontal range for a constant launch velocity?
- a. 30 degrees      b. 45 degrees      c. 60 degrees      d. 80 degrees
157. Which of the following launch angles would result in the greatest horizontal range if the magnitude of the initial velocity is held constant?
- a. 40 degrees      b. 55 degrees      c. 60 degrees      d. 25 degrees
158. Which of the following launch angles would result in the greatest time of flight if the magnitude of the initial velocity is held constant?
- a. 60 degrees      b. 45 degrees      c. 80 degrees      d. 30 degrees

**Topic 2C-Skill 17 and 18**  
**Projectiles launched at an angle**

159. A baseball is thrown at an angle of  $40.0^\circ$  above the horizontal. The horizontal component of the baseball's initial velocity is 12.0 meters per second. What is the magnitude of the ball's initial velocity?

A) 7.71 m/s                      B) 9.20 m/s  
C) 15.7 m/s                     D) 18.7 m/s

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

A ball is projected vertically upward from the surface of the Earth with an initial speed of +49 meters per second. The ball reaches its maximum height in 5.0 seconds. (Disregard air resistance.)

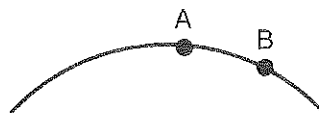
What is the total displacement of the ball from the time it is thrown until it returns to the point from which it was thrown?

A) 248 m                      B) 9.8 m  
C) 49 m                        D) 0 m

161. A 0.25-kilogram baseball is thrown upward with a speed of 30. meters per second. Neglecting friction, the maximum height reached by the baseball is approximately

A) 15 m                        B) 46 m  
C) 74 m                        D) 92 m

162. The diagram below represents the path of an object after it was thrown.

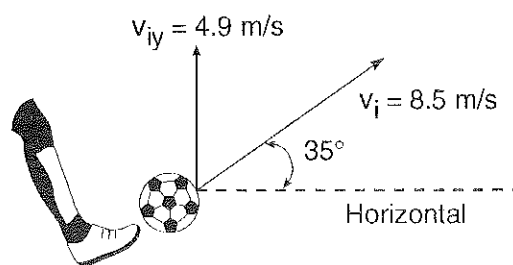


What happens to the object's acceleration as it travels from A to B? [Neglect friction.]

A) It decreases.  
B) It increases.  
C) It remains the same.

163. Base your answer to the following question on the information and diagram below.

A child kicks a ball with an initial velocity of 8.5 meters per second at an angle of  $35^\circ$  with the horizontal, as shown. The ball has an initial vertical velocity of 4.9 meters per second and a total time of flight of 1.0 second. [Neglect air resistance.]



The maximum height reached by the ball is approximately

A) 1.2 m                      B) 2.5 m  
C) 4.9 m                      D) 8.5 m

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164. A soccer ball kicked on a level field has an initial vertical velocity component of 15.0 meters per second. Assuming the ball lands at the same height from which it was kicked, what is the total time the ball is in the air? [Neglect friction.]
- A) 0.654 s                      B) 1.53 s  
C) 3.06 s                      D) 6.12
165. A golf ball is hit at an angle of  $45^\circ$  above the horizontal. What is the acceleration of the golf ball at the highest point in its trajectory? [Neglect friction.]
- A)  $9.8 \text{ m/s}^2$  upward  
B)  $9.8 \text{ m/s}^2$  downward  
C)  $6.9 \text{ m/s}^2$  horizontal  
D)  $0.0 \text{ m/s}^2$
166. A golf ball is hit with an initial velocity of 15 meters per second at an angle of 35 degrees above the horizontal. What is the vertical component of the golf ball's initial velocity?
- A) 8.6 m/s                      B) 9.8 m/s  
C) 12 m/s                      D) 15 m/s
167. A ball thrown vertically upward reaches a maximum height of 30. meters above the surface of Earth. At its maximum height, the speed of the ball is
- A) 0.0 m/s                      B) 9.8 m/s  
C) 3.1 m/s                      D) 24 m/s
168. A ball is thrown at an angle of  $38^\circ$  to the horizontal. What happens to the magnitude of the ball's vertical acceleration during the total time interval that the ball is in the air?
- A) It decreases, then increases.  
B) It decreases, then remains the same.  
C) It increases, then decreases.  
D) It remains the same.
169. A vector makes an angle,  $\theta$ , with the horizontal. The horizontal and vertical components of the vector will be equal in magnitude if angle  $\theta$  is
- A)  $30^\circ$    B)  $45^\circ$    C)  $60^\circ$    D)  $90^\circ$

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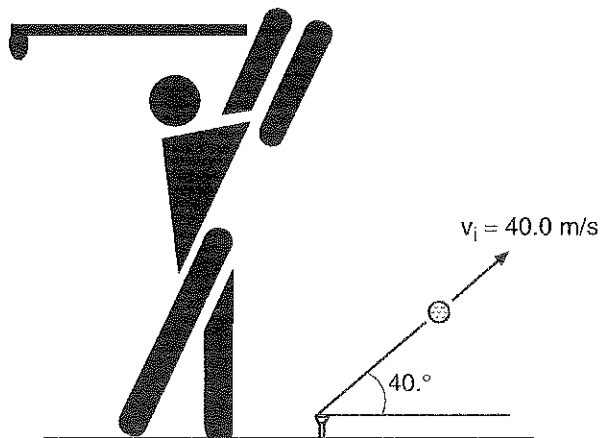
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170. An archer uses a bow to fire two similar arrows with the same string force. One arrow is fired at an angle of  $60.^{\circ}$  with the horizontal, and the other is fired at an angle of  $45^{\circ}$  with the horizontal. Compared to the arrow fired at  $60.^{\circ}$ , the arrow fired at  $45^{\circ}$  has a

- A) longer flight time and longer horizontal range
- B) longer flight time and shorter horizontal range
- C) shorter flight time and longer horizontal range
- D) shorter flight time and shorter horizontal range

171. Base your answer to the following question on the information and diagram below

A golf ball leaves a golf club with an initial velocity of 40.0 meters per second at an angle of  $40^{\circ}$  with the horizontal.



What is the vertical component of the golf ball's initial velocity?

- A) 25.7 m/s      B) 30.6 m/s      C) 40.0 m/s      D) 61.3 m/s
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172. A football player kicks a ball with an initial velocity of 25 meters per second at an angle of  $53^\circ$  above the horizontal. The vertical component of the initial velocity of the ball is

- A) 25 m/s
- B) 20. m/s
- C) 15 m/s
- D) 10. m/s

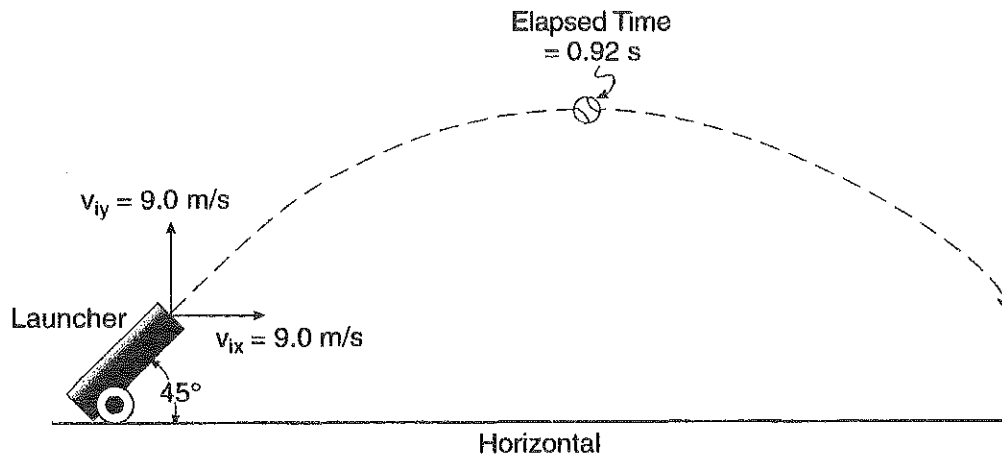
173. The path of a projectile fired at a  $30^\circ$  angle to the horizontal is best described as

- A) parabolic
  - B) linear
  - C) circular
  - D) hyperbolic
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174. Base your answer to the following question on the diagram and information below.

A machine launches a tennis ball at an angle of  $45^\circ$  with the horizontal, as shown. The ball has an initial vertical velocity of 9.0 meters per second and an initial horizontal velocity of 9.0 meters per second. The ball reaches its maximum height 0.92 second after its launch. [Neglect air resistance and assume the ball lands at the same height above the ground from which it was launched.]



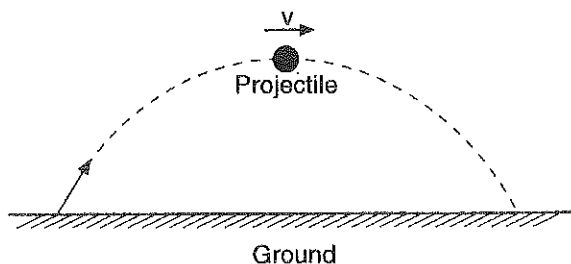
The speed of the tennis ball as it leaves the launcher is approximately

- A) 4.5 m/s      B) 8.3 m/s      C) 13 m/s      D) 18 m/s



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175. 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)  $\leftarrow$
- B)  $\rightarrow$
- C)  $\uparrow$
- D)  $\downarrow$

Base your answers to questions 176 and 177 on the information and diagram below.

A cannon elevated at an angle of  $35^\circ$  to the horizontal fires a cannonball, which travels the path shown in the diagram below. [Neglect air resistance and assume the ball lands at the same height above the ground from which it was launched.]



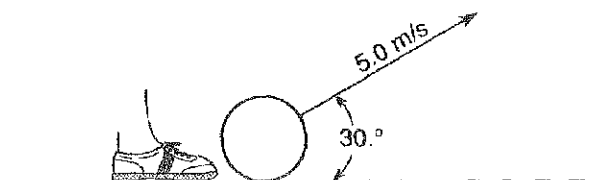
176. If the angle of elevation of the cannon is decreased from  $35^\circ$  to  $30^\circ$ , the vertical component of the ball's initial velocity will
- A) decrease and its horizontal component will decrease
  - B) decrease and its horizontal component will increase
  - C) increase and its horizontal component will decrease
  - D) increase and its horizontal component will increase
177. If the ball's time of flight is 10. seconds, what is the vertical component of its initial velocity?
- A) 9.8 m/s
  - B) 49 m/s
  - C) 70. m/s
  - D) 98 m/s

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178. A projectile is launched at an angle of  $60^\circ$  above the horizontal. Compared to the vertical component of the initial velocity of the projectile, the vertical component of the projectile's velocity when it has reached its maximum height is

- A) less
- B) greater
- C) the same

179. Base your answer to the following question on the diagram below which represents a ball being kicked by a foot and rising at an angle of  $30^\circ$  from the horizontal. The ball has an initial velocity of 5.0 meters per second. [Neglect friction.]



As the ball rises, the vertical component of its velocity

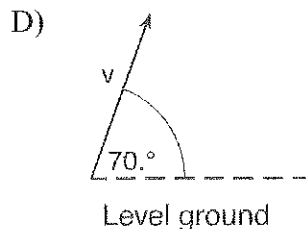
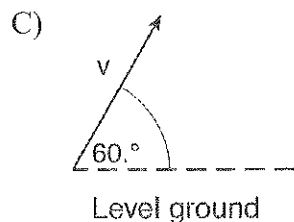
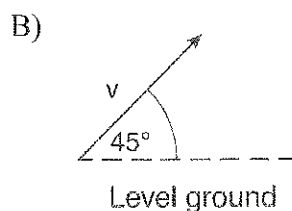
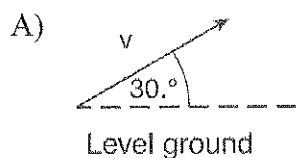
- A) decreases
- B) increases
- C) remains the same

180. A projectile is fired at an angle of  $53^\circ$  to the horizontal with a speed of 80. meters per second. What is the vertical component of the project initial velocity?

- A) 130 m/s
- B) 100 m/s
- C) 64 m/s
- D) 48 m/s

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181. Four identical projectiles are launched with the same initial speed,  $v$ , but at various angles above the level ground. Which diagram represents the initial velocity of the projectile that will have the largest total horizontal displacement? [Neglect air resistance.]



182. Four projectiles,  $A$ ,  $B$ ,  $C$ , and  $D$ , were launched from, and returned to, level ground. The data table below show the initial horizontal speed, initial vertical speed, and time of flight for each projectile.

Data Table

Projectile	Initial Horizontal Speed (m/s)	Initial Vertical Speed (m/s)	Time of Flight (s)
A	40.0	29.4	6.00
B	60.0	19.6	4.00
C	50.0	24.5	5.00
D	80.0	19.6	4.00

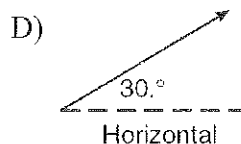
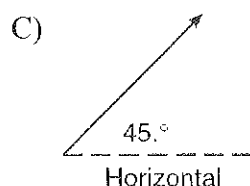
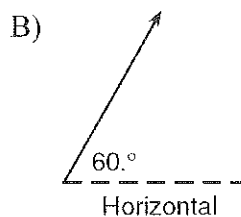
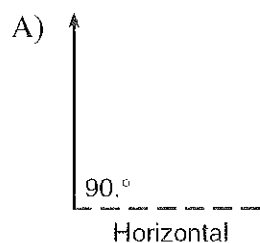
Which projectile traveled the greatest horizontal distance? [Neglect friction.]

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

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183. A volleyball hit into the air has an initial speed of 10. meters per second. Which vector best represents the angle above the horizontal that the ball should be hit to remain in the air for the greatest amount of time?



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184. A machine launches a tennis ball at an angle of  $25^\circ$  above the horizontal at a speed of 14 meters per second. The ball returns to level ground. Which combination of changes *must* produce an increase in time of flight of a second launch?

- A) decrease the launch angle and decrease the ball's initial speed
  - B) decrease the launch angle and increase the ball's initial speed
  - C) increase the launch angle and decrease the ball's initial speed
  - D) increase the launch angle and increase the ball's initial speed
-