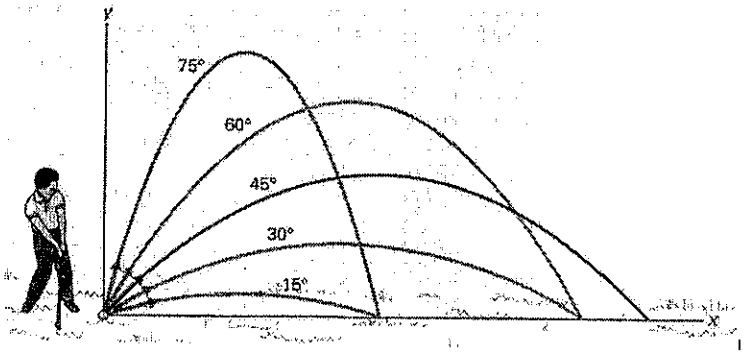
Relationship between launch angle and horizontal range.

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° 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° the vertical and horizontal motions are balanced**. The angle that results in maximum range (dx) is 45°. 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.



135. 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

136. 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

if 45° isn't an option, choose the angle closest to 45°

137. 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

V_{iy} is greatest for largest angles

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

138. A baseball is thrown at an angle of 40.0° 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

Options are all Bad

$\theta = 40°$ $V_{ix} = V_i \cos\theta$
$V_{ix} = 12\ m/s$ $12\ m/s = V_i \cos 40°$
$V_i = ?$ $V_i = 14.8\ m/s$

139. 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?

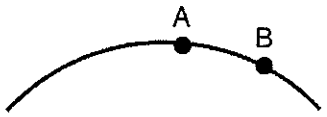
A) 248 m B) 9.8 m
C) 49 m D) 0 m

140. 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

falling down $V_f^2 = V_i^2 + 2ad$
$(30\ m/s)^2 = 2(9.8\ m/s^2)d$

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



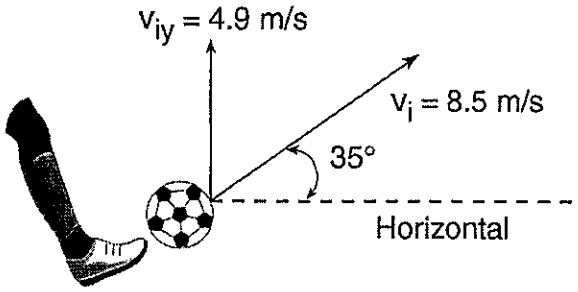
What happens to the object's acceleration as it travels from *A* to *B*? [Neglect friction.]

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

a is only in vertical $9.81\ m/s^2$

142. 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° 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

$V_f^2 = V_i^2 + 2ad$
$(4.9\ m/s)^2 = 0 + 2(9.81\ m/s^2)d$
$d = 1.2\ m$

Topic 2C - Skill 17 and 18

143. 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

$t = \frac{2v_i}{a} = \frac{2(15\ m/s)}{9.8\ m/s^2} = 3s$

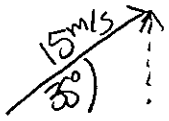
144. A golf ball is hit at an angle of 45° above the horizontal. What is the acceleration of the golf ball at the highest point in its trajectory? [Neglect friction.]

A) 9.8 m/s^2 upward
B) 9.8 m/s^2 downward
C) 6.9 m/s^2 horizontal
D) 0.0 m/s^2

pulled by gravity

145. 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



146. 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

147. A ball is thrown at an angle of 38° 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.

148. A vector makes an angle, θ, with the horizontal. The horizontal and vertical components of the vector will be equal in magnitude if angle θ is

A) 30° B) 45° C) 60° D) 90°

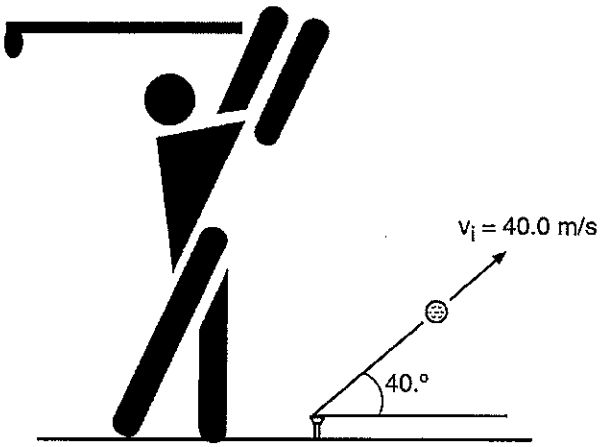
149. An archer uses a bow to fire two similar arrows with the same string force. One arrow is fired at an angle of 60.° with the horizontal, and the other is fired at an angle of 45° with the horizontal. Compared to the arrow fired at 60.°, the arrow fired at 45° has a

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

- High angle equals high V_{iy} equal great time of flight
- 45° equals max range

150. 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° 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

151. A football player kicks a ball with an initial velocity of 25 meters per second at an angle of 53° above the horizontal. The vertical component of the initial velocity of the ball is

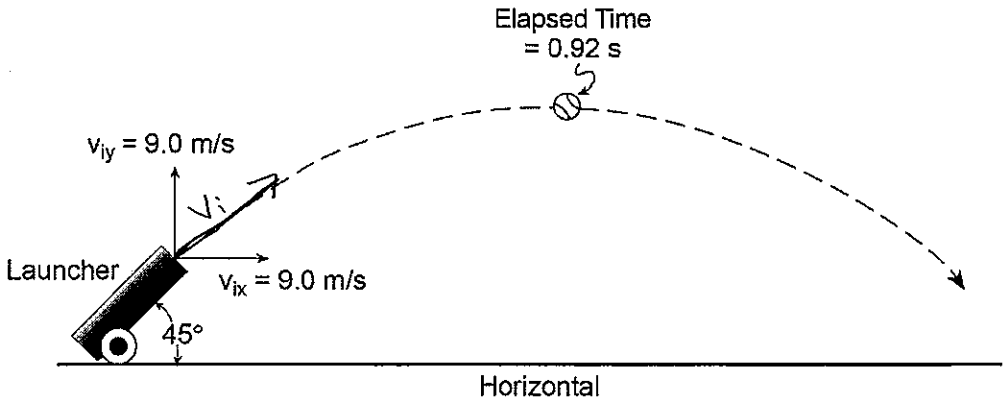
A) 25 m/s
B) 20. m/s
C) 15 m/s
D) 10. m/s

152. The path of a projectile fired at a 30° angle to the horizontal is best described as

A) parabolic B) linear
C) circular D) hyperbolic

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

A machine launches a tennis ball at an angle of 45° 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

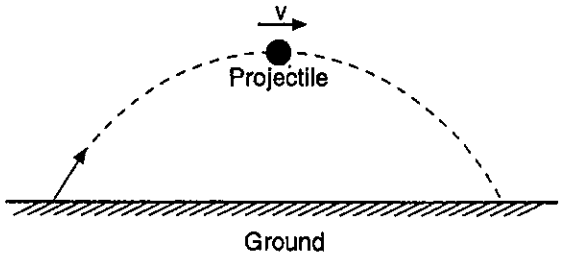
~~A) 4.5 m/s~~ ~~B) 8.3 m/s~~ C) 13 m/s ~~D) 18 m/s~~

must be longer than longest side

Can't be sum of perpendicular sides

$V_i = \sqrt{V_{ix}^2 + V_{iy}^2}$

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



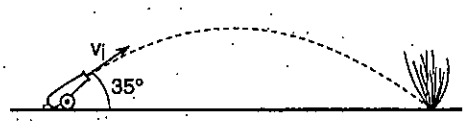
Which vector best represents the acceleration of the projectile in the position shown?

A) ← B) → C) ↑ D) ↓

A is constant negative only on "y" axis

Base your answers to questions **155** and **156** on the information and diagram below.

A cannon elevated at an angle of 35° 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.]



155. If the angle of elevation of the cannon is decreased from 35° to 30.°, 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

$V_{iy} = V_i \sin\theta$

$V_{ix} = V_i \cos\theta$

156. 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

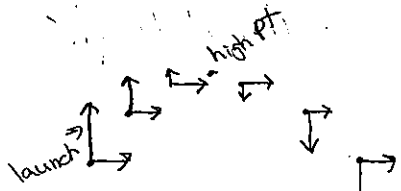
$t = \frac{2V_{iy}}{a}$

$10s = \frac{2V_{iy}}{10\ m/s^2}$ $V_{iy} = 50\ m/s$

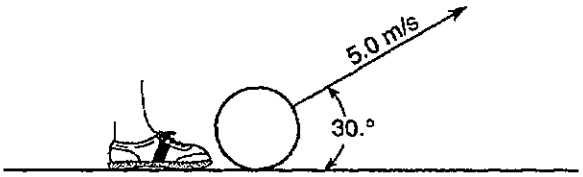
estimated

157. A projectile is launched at an angle of 60° 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



158. 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.° 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

159. A projectile is fired at an angle of 53° 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

$V_{iy} = V_i \sin\theta$

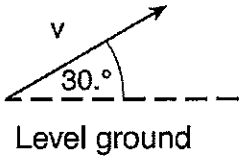
$V_{iy} = 80\,m/s \sin 53^\circ$

$V_i = 80\,m/s\ @\ 53^\circ$

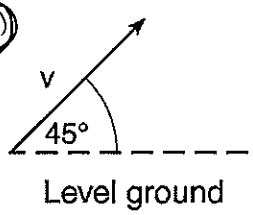
Topic 2C - Skill 17 and 18

160. 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.]

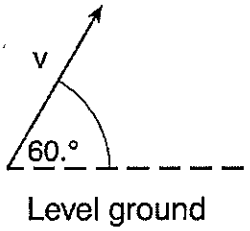
A)



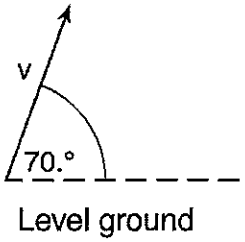
B)



C)



D)



161. 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

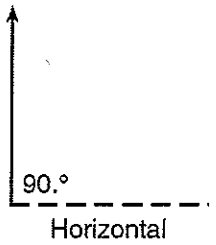
240 m
240 m
250 m
320 m

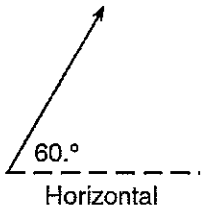
Which projectile traveled the greatest horizontal distance? [Neglect friction.]

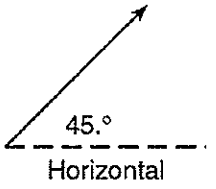
A) A B) B C) C D) D

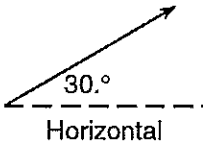
$d_x = v_x t$

162. 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?

A)


B)


C)


D)


163. A machine launches a tennis ball at an angle of 25° 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