Topic 2C: Skill 16 - Horizontal Launched Projectiles

101. The only force acting on a projectile (falling, launched upward, horizontally or at angle) is gravity. This means the acceleration on any projectile is $9.8 m/s^2$ directed downward.

102. What is the horizontal acceleration of a projectile? Why does a horizontal projectile move forward? Zero. It was pushed forward without anything stopping the inertia

103. What equation is used to analyze the horizontal motion of a projectile?

$$v_x = \frac{d_x}{t}$$

104. What equations can be used to analyze the vertical motion of a projectile?

$d_y = v_{iy} t + \frac{1}{2} a_y t^2$

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

$v_f^2 = v_i^2 + 2ad$

105. An object is launched horizontally with a horizontal velocity of v_x from a height of 2m. If the launch velocity were doubled to $2v_x$, the time of the fall would

a. double
b. quadruple
c. halved
d. remain the same

V_x and V_y are independent

Changing V_x doesn't change vertical variables

if d_y doesn't change V_{fy} doesn't change

106. How would the horizontal range (d_x) change for two objects launched from the same height if the velocity were doubled? (As an example find the range object A launched horizontally at 10m/s and object B launched horizontally at 20m/s both from a height of 2m).

$d_x = v_x t$

$d_x = 2v_x t$

range would be double

107. A cannon ball is launched with a horizontal velocity of 20m/s from a height of 50m. What is the range (dx) of the cannon ball?

v_{iy} (m/s)	v_{fy} (m/s)	$v_{y\text{-}avg}$ (m/s)	d_y (m)	a_y (m/s^2)	t (s)
0			50m	9.81	3.2s

$$t = \sqrt{\frac{2d}{a}}$$

$$t = \sqrt{\frac{2(50m)}{9.81 m/s^2}} = 3.2s$$

v_x (m/s)	d_x (m)	t (s)
20	64m	3.2s

108. A rock is thrown horizontally off a bridge with a speed of 15m/s. It lands a horizontal range of 55m from the base of the bridge. What is the height of the bridge?

v_{iy} (m/s)	v_{fy} (m/s)	$v_{y\text{-}avg}$ (m/s)	d_y (m)	a_y (m/s^2)	t (s)
0			?	9.81	3.7s

$$d = \frac{1}{2}at^2$$

$$d = \frac{1}{2}(9.81 m/s^2)(3.7s)^2 = 67.1m$$

v_x (m/s)	d_x (m)	t (s)
15	55	3.7s

$$t = \frac{d_x}{v_x} = \frac{55m}{15 m/s} = 3.7s$$

109. Mathew has found an unusual way to measure the height of the school building. He throws a baseball from the top of the building with a horizontal velocity of 16 m/s. The ball lands 72 meters from the base of the building. Calculate the height of the school.

$v_x = 16 m/s$

$d_x = 72m$

$$t = \frac{d_x}{v_x} = \frac{72m}{16 m/s} = 4.5s$$

$$d_y = \frac{1}{2}at^2 = \frac{1}{2}(9.81 m/s)(4.5s)^2 = 99.3m$$

110. Daredevil Dora hopes to ride her motorcycle off the top of Buzzard Bluff and over the Snake River at the base of the bluff. The bluff is 13 meters high and the river is 24 meters wide at the base of the bluff. At what horizontal speed will Dora have to drive her bike off the bluff in order to just clear the river?

$d_y = 13m$ $d_x = 24m$ $v_x = ?$

$$t = \sqrt{\frac{2d_y}{a}} = \sqrt{\frac{2(13m)}{9.81 m/s^2}} = 1.62s$$

$$v_x = \frac{d_x}{t} = \frac{24m}{1.62s} = 14.8 m/s$$

111. The movie "The Gods Must Be Crazy" begins with a pilot dropping a bottle out of an airplane. It is recovered by a surprised native below, who thinks it is a message from the gods. If the plane from which the bottle was dropped was flying at a height of 500m, and the bottle lands 400m horizontally from the initial dropping point, how fast was the plane flying when the bottle was released?

$d_y = 500m$ $d_x = 400m$ $t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(500m)}{9.81 m/s^2}} = 10.1s$

$V_{iy} = 0$ $V_x = \frac{dx}{t} = \frac{400m}{10.1s} = 39.6 m/s$

112. Suppose that an airplane flying 60 m/s, at a height of 300m, dropped a sack of flour. How far from the point of release would the sack have traveled when it struck the ground?

$V_x = 60 m/s$ $d_y = 300m$ $t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(300m)}{9.81 m/s^2}} = 7.82s$

$t = ?$

$V_{iy} = 0$

$a = 9.81 m/s^2$

$d_x = V_x t$

$d_x = (60 m/s)(7.82s)$

$= 469.2m$

113. In many locations, old abandoned stone quarries have become filled with water once excavating has been completed. While standing on a quarry wall, a boy tosses a piece of granite into the water below. If he throws the ball horizontally with a velocity of 3.0 m/s, and it strikes the water 4.5 m away, how high above the water is the wall?

$V_x = 3 m/s$ $d_y = ?$ $t = \frac{dx}{V_x} = \frac{4.5m}{3 m/s} = 1.5s$

$d_x = 4.5m$ $V_{iy} = 0$

$t = ?$ $a = 9.81 m/s^2$

$d_y = V_{iy} t + \frac{1}{2} a t^2$

$d_y = 0 + \frac{1}{2}(9.81 m/s^2)(1.5s)^2 = 11m$

114. Tad drops his bowling ball out the car window 1.0 m above the ground while traveling down the road at 18 m/s. How far, horizontally, from the initial dropping point will the ball hit the ground? If the car continues to travel at the same speed, where will the car be in relation to the ball when it lands?

$d_y = 1m$ $V_x = 18 m/s$ $t = \sqrt{\frac{2d}{a_y}} = \sqrt{\frac{2(1m)}{9.81 m/s^2}} = .447s$

$a_y = 9.81 m/s^2$ $d_x = ?$

$V_{iy} = 0$

$t = ?$

$d_x = V_x t$

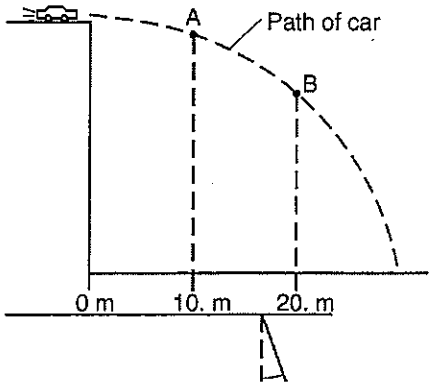
$= (18 m/s)(.447s)$

$= 8.05m$

Topic 2C - Skill 16
Horizontal Projectiles

115. **Note that the question below only has three choices.**

The diagram below represents the path of a stunt car that is driven off a cliff, neglecting friction.



Compared to the horizontal component of the car's velocity at point A, the horizontal component of the car's velocity at point B is

A) smaller B) greater
C) the same

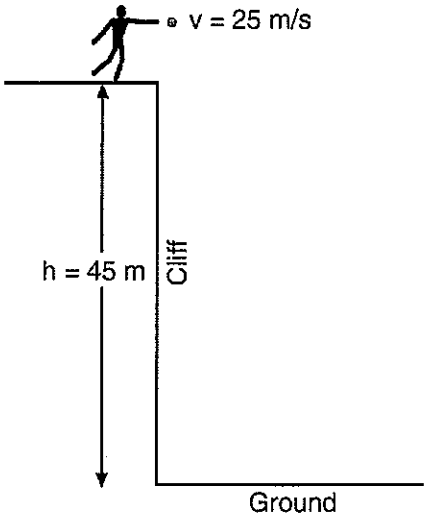
116. A plane flying horizontally above Earth's surface at 100. meters per second drops a crate. The crate strikes the ground 30.0 seconds later. What is the magnitude of the horizontal component of the crate's velocity just before it strikes the ground? [Neglect friction.]

A) 0 m/s B) 100. m/s
C) 294 m/s D) 394 m/s

$v_x = 100\ m/s$

$t = 30s$

117. The diagram below shows a student throwing a baseball horizontally at 25 meters per second from a cliff 45 meters above the level ground.



Approximately how far from the base of the cliff does the ball hit the ground? [Neglect air resistance.]

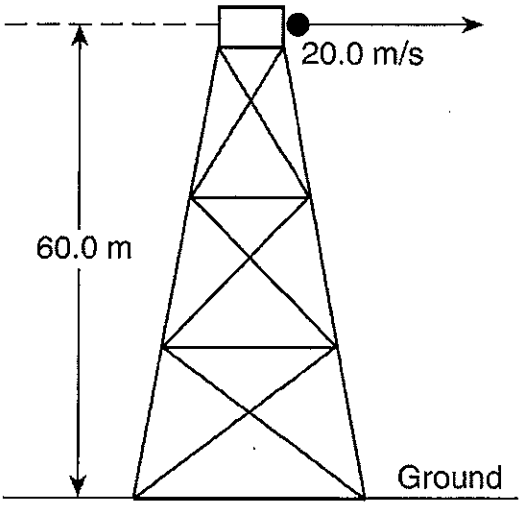
A) 45 m B) 75 m
C) 140 m D) 230 m

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(45m)}{9.81 m/s^2}} = 3s$

$d_x = v_x t = (25 m/s)(3s) = 75m$

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

A ball is thrown horizontally with an initial velocity of 20.0 meters per second from the top of a tower 60.0 meters high.



What is the horizontal velocity of the ball just before it reaches the ground? [Neglect air resistance.]

A) 9.81 m/s
B) 20.0 m/s
C) 34.3 m/s
D) 68.6 m/s

$V_x = 20\ m/s$ →

does not change

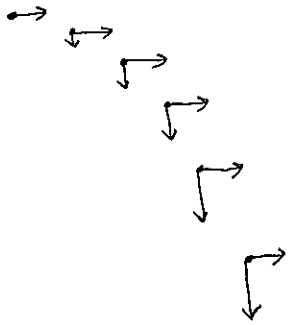
$d_y = 60\ m$

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(60\ m)}{9.81\ m/s^2}}$

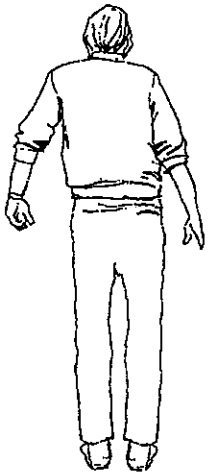
$t = 3.5\ s$

119. 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.



120. In the diagram below, a stationary observer on the ground watches as a seagull flying horizontally to the right drops a clamshell.



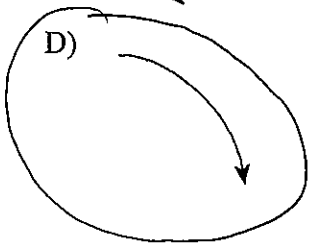
Which diagram best represents the path of the falling clamshell as seen by the observer? [Neglect air resistance.]

A)

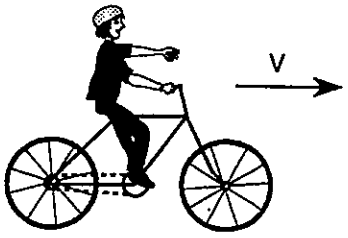
B)

C)

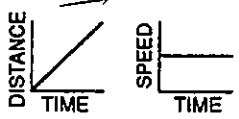
D)



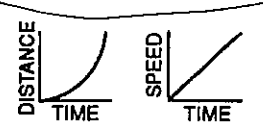
121. The diagram represents a bicycle and rider traveling to the right at a constant speed. A ball is dropped from the hand of the cyclist.

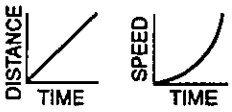


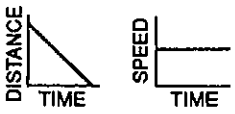
Which set of graphs best represents the horizontal motion of the ball relative to the ground? [Neglect air resistance.]

A) 

equilibrium

B) 

C) 

D) 

122. A 0.2-kilogram red ball is thrown horizontally at a speed of 4 meters per second from a height of 3 meters. A 0.4-kilogram green ball is thrown horizontally from the same height at a speed of 8 meters per second. Compared to the time it takes the red ball to reach the ground, the time it takes the green ball to reach the ground is

A) one-half as great
B) twice as great
C) the same
D) four times as great

red	green
$m = .2kg$	$.4kg$
$V_x = 4m/s$	$V_x = 8m/s$
$d_y = 3m$	$d_y = 3m$
$t = t$	

if h doesn't change
t doesn't change

Base your answers to questions **123** and **124** on the information below.

Projectile *A* is launched horizontally at a speed of 20. meters per second from the top of a cliff and strikes a level surface below, 3.0 seconds later. Projectile *B* is launched horizontally from the same location at a speed of 30. meters per second.

123. Approximately how high is the cliff?

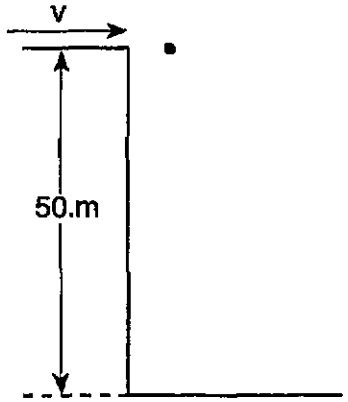
A) 29 m
B) 44 m
C) 60. m
D) 104 m

$d = \frac{1}{2}at^2$
$d = \frac{1}{2}(9.81 m/s^2)3s^2$
$d = (4.9 m/s^2)(9s^2)$
$d = 44.1m$

124. The time it takes projectile *B* to reach the level surface is

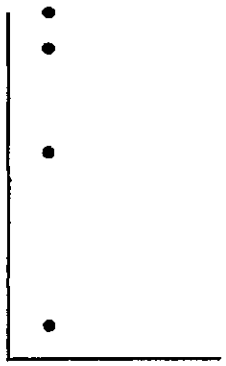
A) 4.5 s
B) 2.0 s
C) 3.0 s
D) 10. s

125. A ball is projected horizontally to the right from a height of 50. meters, as shown in the diagram below.

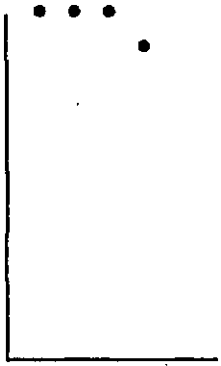


Which diagram best represents the position of the ball at 1.0-second intervals? [Neglect air resistance.]

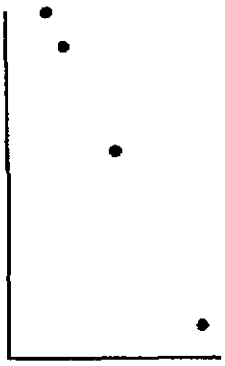
A)



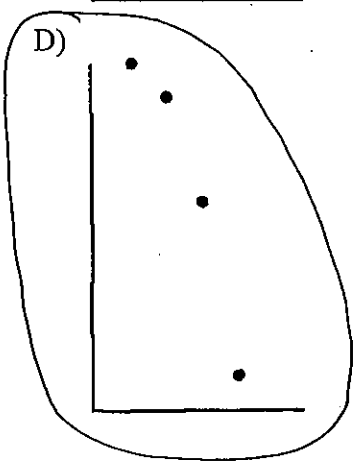
B)



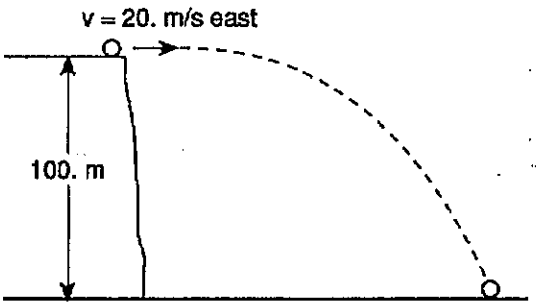
C)



D)



Base your answers to questions **126** and **127** on the diagram below which shows a ball projected horizontally with an initial velocity of 20. meters per second east, off a cliff 100. meters high. [Neglect air resistance.]



126. During the flight of the ball, what is the direction of its acceleration?

A) downward
B) upward
C) westward
D) eastward

127. How many seconds does the ball take to reach the ground?

A) 4.5 s
B) 20. s
C) 9.8 s
D) 2.0 s

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(100m)}{9.81 m/s^2}}$

$t = 4.5$

128. A book is pushed with an initial horizontal velocity of 5.0 meters per second off the top of a desk. What is the initial vertical velocity of the book?

A) 0 m/s
B) 2.5 m/s
C) 5.0 m/s
D) 10. m/s

$V_x = 5 m/s$

$V_{iy} = 0$

129. A ball is thrown horizontally at a speed of 20. meters per second from the top of a cliff. How long does the ball take to fall 19.6 meters to the ground?

A) 1.0 s
B) 2.0 s
C) 9.8 s
D) 4.0 s

$d_y = 19.6m$ $V_x = 20 m/s$

$t = \sqrt{\frac{2d_y}{a}}$

$t = \sqrt{\frac{2(19.6m)}{9.81 m/s^2}}$

$t = 2s$