AP PHYSICS

Name: _____

Period: _____ Date: _____

DEVIL PHYSICS

BADDEST CLASS ON CAMPUS

AP EXAM		CHAPTER TEST	
50 Multiple Choice • 45 Single Response • 5 Multi-Response	90 min, 1 point each	25 Multiple Choice • 22 Single Response • 3 Multi-Response	45 min
Free Response • 3 Short Free Response • 2 Long Free Response	90 min • 13 min ea, 7 pts ea • 25 min ea, 12 pts ea	Free Response • 2 Short Free Response • 1 Long Free Response	45 min • 12 min ea, 7 pts ea • 20 min ea, 12 pts ea

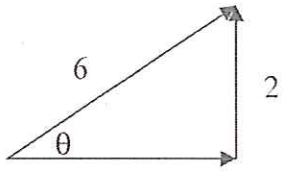
CHAPTER 3 TEST REVIEW

Note: For all calculations use 10.0 m/s^2 as the value for the acceleration due to gravity (g).

MULTIPLE CHOICE

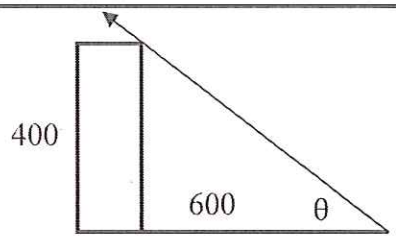
1. If the acceleration vector of an object is directed anti-parallel to the velocity vector,
   a. the object is turning
   b. the object is speeding up
   c. the object is slowing down
   d. the object is moving in the negative x-direction
2. If you walk 6.0 km in a straight line in a direction north of east and you end up 2.0 km north and several kilometers east. How many degrees north of east have you walked?
   a. 19°
   b. 45°
   c. 60°
   d. 71°

$$\sin\theta = \frac{2}{6}$$
$$\theta = \sin^{-1}\frac{2}{6}$$
$$\theta = 19°$$



3. A 400-m tall tower casts a 600-m long shadow over a level ground. At what angle is the Sun elevated above the horizon?
   a. 34°
   b. 26°
   c. 42°
   d. 48°
   e. can't be found; not enough information

$$\tan\theta = \frac{400}{600}$$
$$\theta = \tan^{-1}\frac{400}{600}$$
$$\theta = 33.6°$$



For questions 4-5, three vectors, expressed in Cartesian coordinates, are

	x-comp	y-comp
$\vec{S}$	-3.5	+4.5

$\vec{T}$	0	-6.5
$\vec{U}$	+5.5	-2.5

4. What is the magnitude of the resultant vector $\vec{S}+\vec{T}+\vec{U}$?

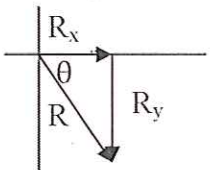
   a. 4.9
   b. 24
   c. 16
   d. 18
   e. can't be found; not enough information

$$R_x = S_x + T_x + U_x = -3.5 + 0 + 5.5 = 2$$
$$R_y = S_y + T_y + U_y = 4.5 + (-6.5) + (-2.5) = -4.5$$
$$R_x^2 + R_y^2 = R^2$$
$$R = \sqrt{R_x^2 + R_y^2} = \sqrt{2^2 + (-4.5)^2} = 4.9$$

5. What is the angle of the resultant vector $\vec{S}+\vec{T}+\vec{U}$ measured from the positive x-axis?

   a. 24° above
   b. 24° below
   c. 66° above
   d. 66° below
   e. can't be found; not enough information

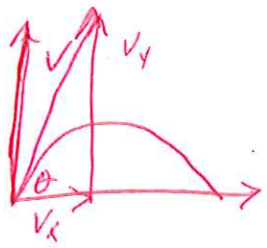
$$R_x = S_x + T_x + U_x = -3.5 + 0 + 5.5 = 2$$
$$R_y = S_y + T_y + U_y = 4.5 + (-6.5) + (-2.5) = -4.5$$
$$\tan\theta = \frac{R_y}{R_x}$$
$$\theta = \tan^{-1}\frac{R_y}{R_x}$$
$$\theta = \tan^{-1}\frac{-4.5}{2} = 66°$$



6. A projectile is launched with an initial velocity of 60.0 m/s at an angle of 30.0° above the horizontal. What is the maximum height reached by the projectile?

   a. 23 m
   b. 46 m
   c. 69 m
   d. 92 m
   e. can't be found; not enough information

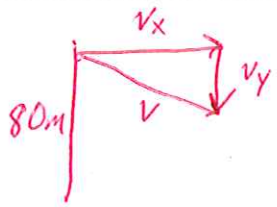
$$\sin\theta = \frac{v_{y0}}{V}$$
$$V\sin\theta = v_{y0} = 30\text{m/s}$$
$$v_y^2 = v_{y0}^2 + 2gy$$
$$0 = v_{y0}^2 + 2gy$$
$$-2gy = v_{y0}^2$$
$$y = \frac{v_{y0}^2}{-2g} = \frac{30^2}{(-2)(-10)} = 45$$



7. A rifle bullet is fired at an angle of 30° below the horizontal with an initial velocity of 800 m/s from the top of a cliff 80 m high. How far from the base of the cliff does it strike the level ground below

   a. 130 m
   b. 140 m
   c. 150 m
   d. 160 m
   e. 170 m

$$\sin\theta = \frac{v_{y0}}{V}$$
$$V\sin\theta = v_{y0} = 400\text{m/s}$$
$$v_y^2 = v_{y0}^2 + 2gy$$
$$v_y = \sqrt{v_{y0}^2 + 2gy}$$
$$v_y = \sqrt{400^2 + 2(10)(80)} = 402m/s$$
$$v_y = v_{y0} + gt$$
$$\frac{v_y - v_{y0}}{g} = t = \frac{402 - 400}{10} = 0.2s$$
$$\cos\theta = \frac{v_{x0}}{V}$$
$$V\cos\theta = v_{x0} = 693\text{m/s}$$
$$(v_x)(t) = x = (693)(0.2) = 139$$



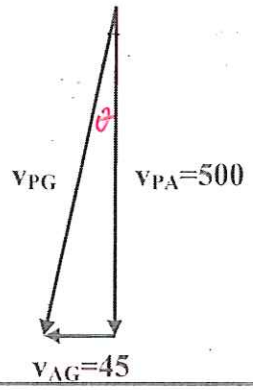
8. A plane is flying due South (270° Cartesian, not compass) at 500 km/h. A wind blows from East to West (180°) at 45.0 km/h. Find the plane's velocity with respect to the ground.

a. 502 km/h at 265°
b. 502 km/h at 85°
c. 520 km/h at 5°
d. 545 km/h at 265°

$$v_{AG}^2 + v_{PA}^2 = v_{PG}^2$$
$$v_{PG} = \sqrt{v_{AG}^2 + v_{PA}^2} = \sqrt{45^2 + 500^2} = 502$$
$$\tan\theta = \frac{v_{AG}}{v_{PA}} = \frac{45}{500}$$
$$\theta = \tan^{-1}\frac{45}{500} = 5°$$

Angles in Cartesian coordinate plane measured counter-clockwise from positive x-axis so,

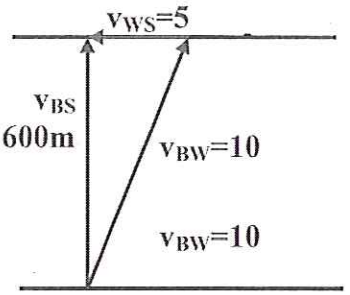
$$\theta = 270 - 5 = 265°$$



9. The driver of a motorboat that can move at 10 m/s in still water wishes to travel directly across a river 1.6 km wide in which the current flows at 5.0 m/s. How long will it take to cross the river?

a. 5.3 min
b. 2.7 min
c. 2.4 min
d. 1.8 min
e. ~~1.8 min~~ 3.1

$$v_{BS}^2 + v_{WS}^2 = v_{BW}^2$$
$$v_{BS}^2 = v_{BW}^2 - v_{WS}^2$$
$$v_{BS} = \sqrt{v_{BW}^2 + v_{WS}^2} = \sqrt{10^2 - 5^2} = 8.66\ m/s$$
$$(v_x)(t) = x$$
$$t = \frac{x}{v_x} = \frac{1600}{8.66} = 185s = 3.1\ min$$



10. A swimmer heading directly across a river 200 m wide reaches the opposite bank in 6 min, 40 s. She is swept downstream 480 m. What is the speed of the current?

360s

a. 0.50 m/s
b. 1.2 m/s
c. 1.4 m/s
d. 1.8 m/s

$\tan\theta = \frac{480}{200} = \frac{48}{20} = 2.4$

$\theta = \tan^{-1}(2.4) = 67°$

$x^2 = \sqrt{200^2 + 480^2}$

$x = 520\ m$

$V_{ss} \times t = x$

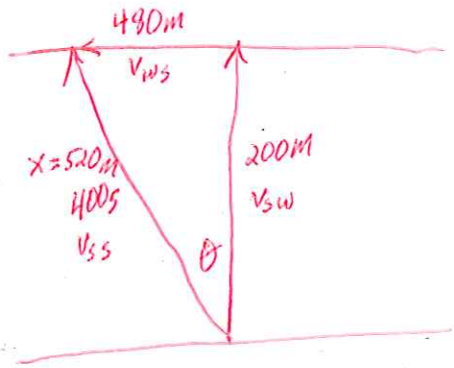
$V_{ss} = \frac{x}{t} = \frac{520}{400s}$ 1.3 m/s

$\sin\theta = \frac{V_{ws}}{V_{ss}}$

$V_{ws} = V_{ss}\sin\theta$

$V_{ws} = (1.3)\sin(67)$

$V_{ws} = 1.20$



-1 inconsequential

11. A ball is projected horizontally off the roof of a building with a speed of 14.0 m/s. If the height of the roof is 80.0 m and air resistance is negligible, what is the approximate time the ball is airborne?

a. 16.0 s
b. 3.0 s
c. 9.0 s
d. 81.0 s
e. 4.0 s

$$y = y_0 + v_{y_0}t + 1/2\,gt^2$$
$$-80 = 1/2\,gt^2$$
$$\frac{2(-80)}{-9.81} = t^2$$
$$\sqrt{\frac{2(-80)}{-10.0}} = t = 4s$$

12. 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. If a second ball lands a distance 2D from the base of the cliff, how fast was it moving? Assume air resistance is negligible.

a. V
b. $\sqrt{2}$ V
c. 2V
d. 4V
e. It cannot be determined unless the height of the cliff is known.

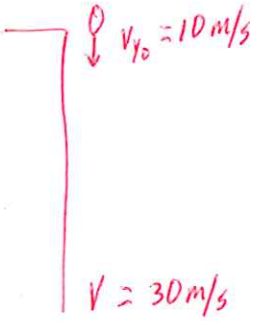
Time to fall vertically doesn't change.

$V_x \times t = x$

$2V_x \times t = 2x$

13. A physics student standing on the edge of a cliff throws a stone vertically downward with an initial speed of 10.0 m/s. The instant before the stone hits the ground below, it is traveling at a speed of 30.0 m/s. If the physics student were to throw the stone horizontally outward from the cliff instead, with the same initial speed of 10 m/s, give the total velocity of the stone just before it hits the ground.

a. 10.0 m/s
b. 20.0 m/s
c. 30.0 m/s
d. 40.0 m/s
e. It cannot be determined unless the height of the cliff is known



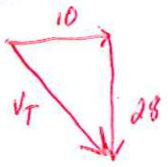
Thrown Horizontally

$V_x = 10$ m/s

$V_f^2 = V_0^2 + 2gy$

$V_f = \sqrt{0 + (2)(10)(40)}$

$V_f = 28$



$V_T = \sqrt{10^2 + 28^2}$

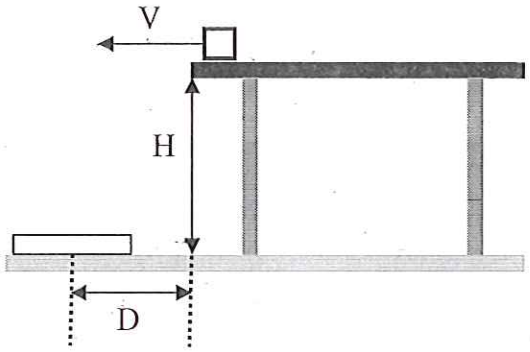
$= 30$ m/s

Thrown Down

$V_f^2 = V_0^2 + 2gy$

$y = \frac{V_f^2 - V_0^2}{2g}$

$y = 40$ m



14. A block of mass M is moving horizontally with constant speed V on a frictionless tabletop as shown. A short pan, whose center is a distance D from the table edge, is placed on the level floor. Which of the following equations best represents an expression for the height H that the table must be so that the mass lands directly at the center of the pan? Assume air resistance is negligible.

a. $H = \frac{2D^2}{gV}$

b. $H = \frac{1}{2}g\left(\frac{D}{V}\right)^2$

c. $H = \frac{gD^2}{V^2}$

d. $H = \sqrt{gV}\left(\frac{D^2}{V^3}\right)$

e. $H = \sqrt{2gV}$

$V_x t = D$

$t = \frac{D}{V}$

$y = y_0 + v_0 t + \frac{1}{2} g t^2$

$H = \frac{1}{2} g t^2$

$H = \frac{g}{2}\left(\frac{D}{V}\right)^2$

$= \frac{1}{2} g \left(\frac{D}{V}\right)^2$

15. A bullet is shot vertically upward from a pistol while on the bed of a pickup truck that is moving in a straight line on a level, horizontal roadway at a speed of 20.0 m/s. If air resistance is negligible, what is the bullet's landing point.

a. It lands in front of the truck, ahead of where it was launched.

b. It lands behind the truck, behind where it was launched

c. It lands in the bed of the truck, close to the point from which it was launched

d. Its landing point is dependent on the bullet's mass

e. It imbeds itself in the head of the person stupid enough to do this

- Bullet has same velocity in x-direction as truck
- Bullet x-velocity does not decrease

16. A projectile is fired from a gun and has initial horizontal and vertical components of velocity equal to 30.0 m/s and 40.0 m/s respectively. Assuming air resistance is negligible, approximately how long does it take the projectile to reach the highest point in its trajectory?

a. 1.0 s

b. 2.0 s

c. 4.0 s

d. 8.0 s

e. 16.0 s

Horizontal velocity inconsequential. $V_{y_0} = 40 m/s$

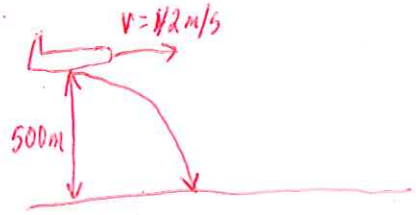
$0 = V_{y_0} + gt$

$V_{y_0} = -gt$

$\frac{V_{y_0}}{-(-g)} = t = \frac{40}{10} = 4s$

17. An unmanned drone owned by Amazon.com is trying to deliver a 900.0 kg package to the doorstep of a particular house. The drone is in level flight at an altitude of 500.0 m and is moving horizontally with a speed of 42.0 m/s. At what distance prior to the target should the drone release the package? Assume there is no awning over the doorstep and air resistance is negligible.

a. 150.0 m
b. 295.0 m
c. 424.0 m
d. 2.55×10^3 m
e. 1.50×10^4 m



$y = y_0 + v_{y0}t + \frac{1}{2}gt^2$

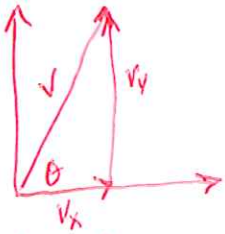
$\sqrt{\frac{2y}{g}} = t = 10\,s$

$x = v_x \times t = 42 \times 10$

$= 420$ (424 for $g = 9.81$)

18. A projectile is fired with an initial speed of 30.0 m/s at an angle of 60° above the horizontal. What is the magnitude of the horizontal component of the projectile's displacement at the end of 2.0 s? Assume air resistance is negligible.

a. 30.0 m
b. 50.0 m
c. 15.0 m
d. 26.0 m
e. 60.0 m



$\theta = 60°$

$V = 30\,m/s$

$\sin\theta = \frac{V_y}{V}$

$V\sin\theta = V_y = 26$

$\cos\theta = \frac{V_x}{V}$

$V\cos\theta = V_x = 15$

$V_x \times t = x$

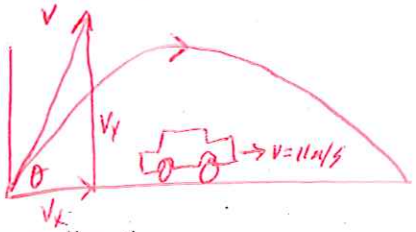
$15 \times 2 = x = 30m$

19. A spring-loaded gun is aimed horizontally and is used to launch identical balls with different initial speeds. The gun is at a fixed position above the floor. If the second projectile is fired with two times the speed as that of the first projectile, how would the horizontal range be affected?

a. The range for both projectiles would be the same. $V_x \times t = x$ Time is based on time to fall vertically and is unaffected by V_x, therefore it is the same for both.
b. The range of the second projectile would be half as much as that of the first projectile
c. The range of the second projectile would be about 1.4 times larger than that of the first projectile
d. The range of the second projectile would be smaller that of the first by a factor of 1.4 $2(V_x) \times t = 2x$
e. The range of the second projectile would be twice as large as that of the first projectile

20. A football is kicked with a speed of 22.0 m/s at an angle of 60° relative to the positive x-direction. At that instant, an observer rides past the football in a car that moves horizontally on a level roadway with a constant speed of 11.0 m/s in the positive x-direction. According to the observer in the car, what will happen to the ball? Assume air resistance is negligible.

a. It will follow a path that is straight up and down in the y-direction.
b. It will follow a path that is straight across in the positive x-direction.
c. It will follow a hyperbolic path.
d. It will follow a parabolic path.
e. It will follow a straight line that is angled (less than 90°) with respect to the x-direction.



$V = 22\,m/s,\ \theta = 60°$

$\cos\theta = \frac{V_x}{V}$

$V_x = V\cos\theta = 11\,m/s$

Horizontal speed of ball is the same as horizontal speed of car. Ball will be in same horizontal position in window of car and go up and down

21. A dart is thrown horizontally directly at the center of a target with a velocity of 20.0 m/s. The dart hits the target 0.1 s later and, predictably, below the center. How far below the center did it land?

a. 2.0 m
b. 1.0 m
c. 0.5 m
d. 0.1 m
e. 5×10^{-2} m

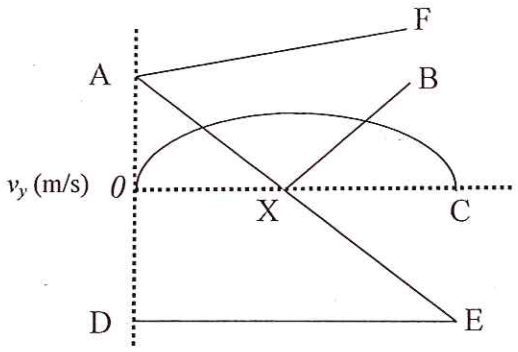
inconsequential!

$\rightarrow V_x = 20 m/s$ (+)

$t = 0.1 s$

$y = \cancel{y_0}^{0} + \cancel{v_{y0}}^{0} t + \frac{1}{2} g t^2$

$y = \frac{1}{2} g t^2 = 0.05 m = 5 \times 10^{-2} m$

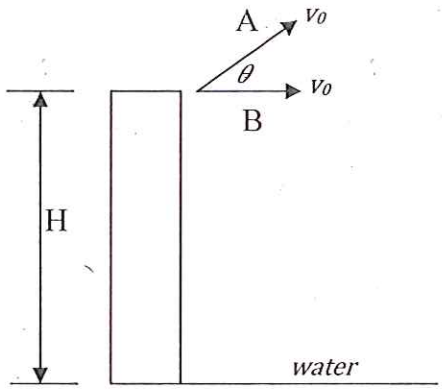


22. Which of the lettered segments on the graph above best represents a graph of the velocity (~~vy~~ v_y) versus time (t) for a projectile shot at an angle of 45° above the horizontal?

a. OC
b. DE
c. AXB
d. AXE
e. AF

Acceleration is a constant 10 m/s² so slope ($\frac{\Delta v}{\Delta t}$) will be a straight line. Since g is negative, slope will be negative. Velocity is initially positive, decreases to zero, then increases in negative value. AXE is only correct choice

23. As depicted above, person A throws a stone of mass M with initial velocity v0 at an angle θ (relative to the horizontal) from a bridge that is a height H above the water level. At the same instant, person B throws a stone of mass 2M with the same initial velocity but in the horizontal direction. Which of the following statements is correct concerning the speeds of each stone (vA and vB thrown by persons A and B, respectively), and the times (tA and tB) at which the stones impact the water; assuming air resistance is negligible?



a. $v_A < v_B$ and $t_A > t_B$
b. $v_A > v_B$ and $t_A < t_B$
c. $v_A < v_B$ and $t_A = t_B$
d. $v_A = v_B$ and $t_A > t_B$
e. $v_A = v_B$ and $t_A = t_B$

Mass is inconsequential.

$v_y^2 = v_{y_0}^2 + 2gy$

$v_y = \sqrt{v_{y_0}^2 + 2gy}$

For B, $v_{y_0} = 0$ $v_y = \sqrt{2gy}$

For A, v_{y_0} will be equal to the initial velocity's y-component

$v_y = \sqrt{(v\sin\theta)^2 + 2gy}$

$= \sqrt{v\sin\theta)^2 + 2gy}$

For B $v_x = v_0$

For A $v_x = v_0\cos\theta$

$R_B = \sqrt{2gy + v_0^2}$

$R_A = \sqrt{(v_0\sin\theta)^2 + 2gy + (v_0\cos\theta)^2}$

$= \sqrt{2gy + v_0^2}$

Time for A to hit the water is equal to time for the parabola + time to fall. Time for B is just time to fall.

24. Two steel balls, one of mass 1.0 kg and the other of mass 2.0 kg, simultaneously roll off the edge of the same horizontal table, each leaving with the same velocity. Which of the following statements is correct?

a. Both balls will hit the floor at approximately the same horizontal distance from the base of the table.
b. The less massive ball will travel twice the horizontal distance from the base of the table than does the more massive ball
c. The more massive ball will travel twice the horizontal distance from the base of the table than does the less massive ball
d. The less massive ball travels $\sqrt{2}$ times farther from the base of the table than does the more massive ball.
e. The more massive ball travels $\sqrt{2}$ times farther from the base of the table than does the less massive ball.

25. A stone is thrown horizontally with a speed v off a hillside cliff. Which vector best represents the direction of the acceleration of the stone midway along the stone's path? The same the entire path

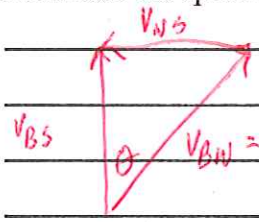
a.
b.
c.
d.

e. 

FREE RESPONSE

1. A boat, whose speed in still water is 1.75 m/s, must aim upstream at an angle of 26.3° (with respect to a line perpendicular to the shore) in order to travel directly across the stream.

   a. Determine the speed of the current.

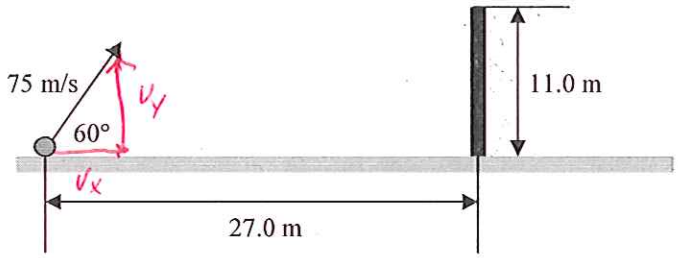


$\theta = 26.3$ $\quad V_{BW} \sin\theta = V_{WS} = 0.77\ m/s$

$\sin\theta = \frac{V_{WS}}{V_{BW}}$

   b. Determine the resultant speed of the boat with respect to the shore.

$\cos\theta = \frac{V_{BS}}{V_{BW}}$ $\quad V_{BS} = V_{BW}\cos\theta = 1.57\ m/s$



2. A ball of mass 0.3 kg, initially at rest, is projected from ground level toward a wall that is 27.0 m away. The ball's velocity at the moment it is projected is 75.0 m/s at 60° relative to the horizontal as shown, and the wall is 11.0 m high. During its flight, the ball impacts nothing else and is not subjected to air resistance.

   a. Determine the magnitude of the vertical and horizontal components of the ball's velocity.

$\sin\theta = \frac{V_y}{V}$

$V_y = V\sin\theta = 65\ m/s$

$\cos\theta = \frac{V_x}{V}$

$V_x = V\cos\theta = 37.5\ m/s$

   b. Determine the time it takes the ball to reach the plane of the wall.

~~$V_y = V_{y_0} + gt$~~ $\quad V_{y_0} = gt \quad \frac{V_{y_0}}{g} = t = 6.5\ s$

$V_x \times t = x \quad t = \frac{x}{V_x} = 0.72\ s$

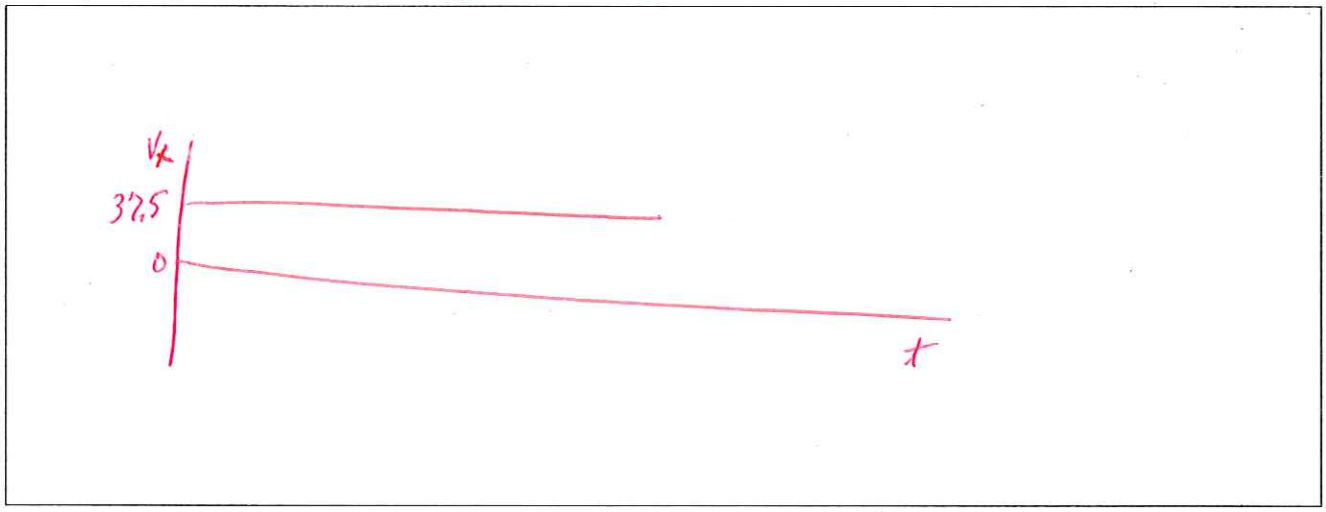
c. The ball passes over the wall. Determine the ball's distance above the wall the moment the ball passes over the wall.

$y = y_0 + V_{y0}\,t + \frac{1}{2}gt^2$ $\quad \Delta h = 44 - 11 = 33$

$y = (6.5)(0.72) - \frac{1}{2}(10)(0.72)^2$

$y = 44$ m

d. In the space below, make an appropriate sketch of the horizontal velocity component of the ball during its flight until it reaches the plane of the wall

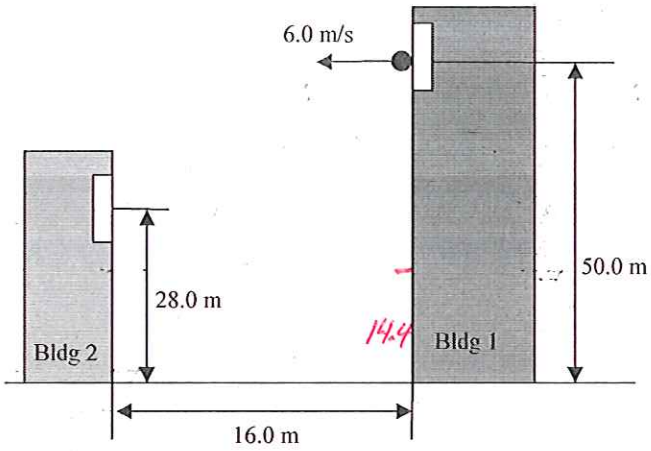


e. Has the ball passed over the wall before, after, or at the highest point of its trajectory? Defend your answer with appropriate calculations.

$V_y^2 = V_{y0}^2 + 2gy$ $\quad V_x = V_{x0} + at$ ($V_x = 0$)

$y = \frac{V_{y0}^2}{2g} = 21$ $\quad t = 6.5$

Both time and height of apex are greater than time/height at wall so it must have passed over wall before reaching apex



3. A person in apartment building 1 throws a ball horizontally at a speed of 6.0 m/s out a window toward nearby apartment building 2, which is 16.0 m away, as shown. The location of the window from which the ball leaves is 50 m above the street, and the center of the second window in building 2 is 28.0 m above the street as shown. The entire height of the window in building 2 is 1.5 m.

   a. Determine the amount of time it takes the ball to reach apartment building 2.

   $V_x \times t = d$ $\quad d = 16m$ $\quad t = \frac{d}{V_x} = \frac{16}{6} = 2.67s$

   $V_x = 6m/s$

   b. Using appropriate calculations to defend your answer, determine whether or not the ball goes into the window in building 2. If it does not, how far above or below the window center does it pass?

   $y = \cancel{V_{iy}^{0}} + \cancel{V_{iy}^{0}} t + \frac{1}{2} g t^2$ $\quad y = \frac{1}{2}(-10)(2.67)^2$

   Hits 13.6m below bldg 2 window

   $y = \frac{1}{2} g t^2$ $\quad y = -35.6$

   c. Determine the final speed of the ball the moment it reaches the closest plane (not necessarily pane) of the wall of building 2.

   $V_x = 6m/s$ $\quad V_y = \cancel{V_{iy}^{0}} + gt = (10)(2.67)$ $\quad V_f = \sqrt{6^2 + (26.7)^2}$

   $= 26.7$ $\quad = 27.4 m/s$

   d. Explain why your answer to part (c) is larger than the initial speed (6.0 m/s) of the ball.

   Gravity – not just a good idea, it's the law.

e. Estimate the replacement cost of the window in building 1 which was, unfortunately, closed the first time he tried to throw it. ***(Note: assume this is the same guy who shot the gun vertically from the bed of his pickup).***

Any reasonable answer

4. Naomi wants to launch a spitball through a straw such that it lands in Ben's left eye, approximately 5.8 meters away. Since it is the beginning of the period and Naomi is still recovering from climbing the stairs, she can only muster a velocity of 9.6 m/s. Ben is also suffering from the effects of the stairs and is somewhat slumped over such that his eye is at the same level as Naomi's straw.

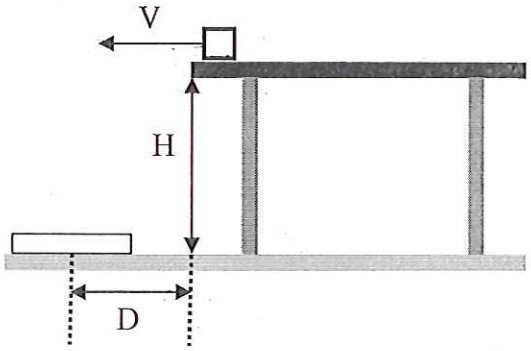
a. Using the range formula, $R = \frac{v_0^2 \sin 2\theta_0}{g}$, at what angle should Naomi launch her spitball? Assume air resistance is negligible and her spittle is of uniform density.

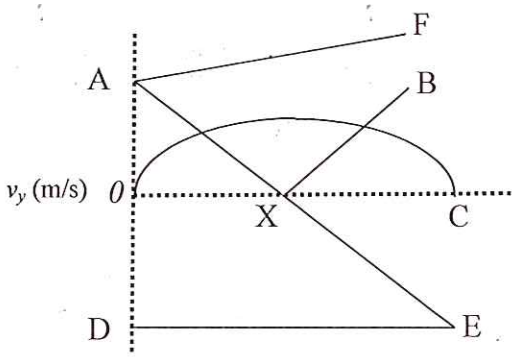
$\frac{Rg}{v_0^2} = \sin 2\theta \quad 2\theta = \sin^{-1}\left(\frac{Rg}{v_0^2}\right) = 0.39$

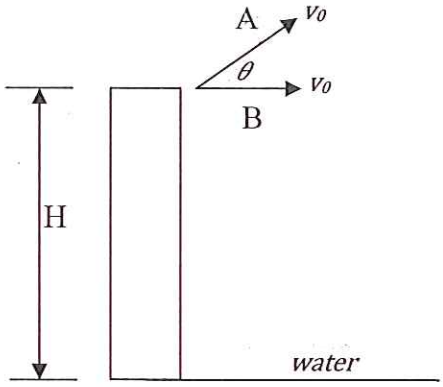
$\theta = \frac{0.39}{2} = 19.5^\circ$

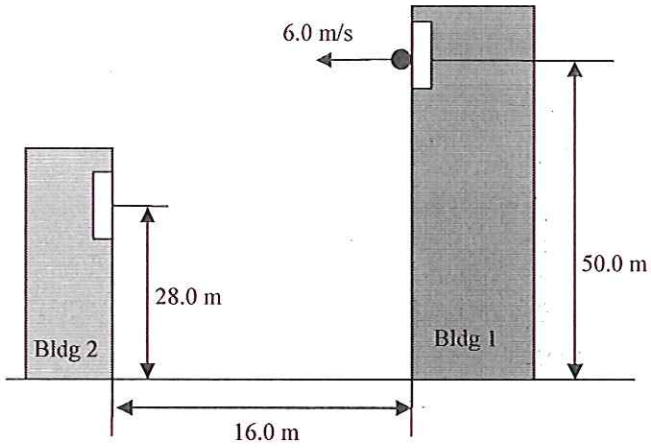
b. How would your answer differ if Ann were doing the shooting instead of Naomi?

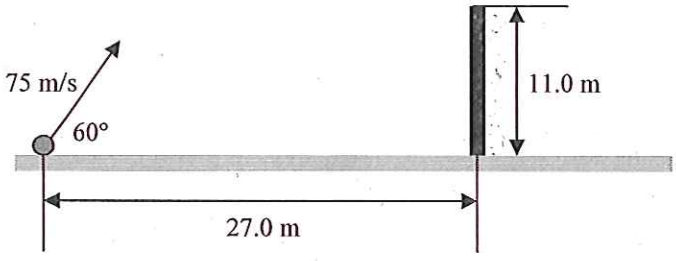
Though Ann is slightly farther away from Ben, she is taller and we can assume from this that she has a greater lung capacity and can produce a higher velocity than that of Naomi. Since velocity is squared and in the denominator of the equation, we can assume that Ann would need to shoot at a slightly lower angle.


V
H
D


F
A
B
v_y (m/s)
0
X
C
D
E


A
v_0
θ
v_0
B
H
water


6.0 m/s
28.0 m
50.0 m
Bldg 2
Bldg 1
16.0 m


75 m/s
60°
11.0 m
27.0 m