Example Projectile Motion Test Name: Answer Key

1. At the same moment a ball is projected horizontally (level with the ground) another ball (identical to the first) is dropped from the same height. Which reaches the ground first? More importantly, why?

They reach the ground at the same time.
why? Vertical & Horizontal motion are independent.

2. To a physicist, what is considered to be a *projectile*? In other words, how is the term *projectile* defined?

↳ object moving only under the influence of gravity

3. Consider a projectile "in flight." Using the words *constant* and *changes*, fill out the following chart indicating whether or not the specific aspect of the projectile's motion is constant or changes:

Aspect of the projectile's motion	***Constant*** **or** ***Changes***
x-horizontal position	Changes
y-vertical position	Changes
v_x-horizontal velocity	constant
v_y-vertical velocity	Changes
a_x-horizontal acceleration	constant (& zero)
a_y-vertical acceleration	constant ($-9.80 m/s^2$)

4. In the previous question you specified whether or not a projectile's horizontal and vertical acceleration changed during flight or was constant. Now you need to specify values (or ranges of values in the case of a changing acceleration) for each. Make sure to note which value is for horizontal and which is for vertical acceleration.

$a_x = 0$ $a_y = 9.80 m/s^2$ down

5. After reading a projectile motion problem you should make a sketch of the *trajectory* of the projectile. What is meant by the word *trajectory*?

path the projectile takes

6. On your trajectory sketch you are also supposed to label quantities that you know or you are asked to find. List a few of those quantities that should be labeled.

Δx v_{AVE_x} a_x

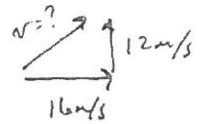
Δy v_{o_y} a_y

7. If you are given a launch speed, ***v***, and angle of launch, θ (with the horizontal), how would you calculate the initial horizontal and vertical velocities (v_x & v_y)? You may simply write an equation for each.

$v_x = v\cos\theta$

$v_y = v\sin\theta$

8. A projectile is launched with a *horizontal* velocity of 16 m/s and a *vertical* velocity of 12 m/s. What is the projectile's resultant (combined) velocity? Show all calculations.



$16^2 + 12^2 = v^2$

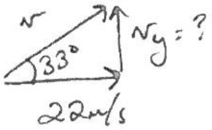
$256 + 144 = 400 = v^2$

$\sqrt{400} = v^2$

$v = 20 m/s$

Don't worry about s.f. on this one.

9. A projectile is launched with a *horizontal* speed of 22 m/s. If the projectile was launched at an angle of 33 degrees above the horizontal, find the projectile's *vertical* speed. Show all calculations.



$\tan 33° = \frac{v_y}{22m/s}$

$22m/s \tan 33° = v_y$

$v_y = 14.286967$

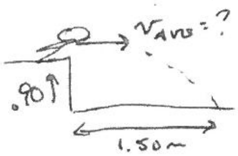
14m/s

10. "A projectile is launched at angle of 35 degrees above the horizontal and at a speed of 24 m/s." Is the speed mentioned in the statement preceding this question a *horizontal speed, resultant (combined) speed,* or *vertical speed*? What words are present (or absent) in the sentence that lets you know which speed it is?

It's the resultant (or combined velocity) velocity. I know this because the question gives an angle which would not be necessary if it ~~were~~ was a horiz. or vert. velo. Also the words horizontal & vertical are absent.

For these questions let g = 9.80 m/s² down. Employ the projectile ~~problem~~ puzzle solving techniques used in class to answer the following:

11. A cat leaps horizontally from the top of a couch 0.90 meters above the floor toward a toy on the floor 1.50 meters away. With what speed must the cat leap to land directly on the toy?



x	y
$\Delta x = 1.5m$	$\Delta y = -.90m$
$v_{AVE} = ?$	$a = -9.80 m/s^2$
$t = ?$	$v_0 = 0$
	$t = ?$

$\Delta y = v_0 t + \frac{1}{2} a t^2$

$-.9m = 0 + \frac{1}{2}(-9.8)(t^2$

$-.9 = -4.9 t^2$

$\frac{-.9}{-4.9} = t^2$

$\sqrt{.18367...} = \sqrt{t^2}$

$t = 0.42857...s$

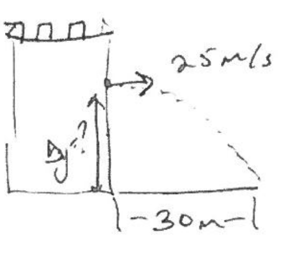
$v_{AVE} = \frac{\Delta x}{t}$

$v_{AVE} = \frac{1.5m}{.42857...}$

$v_{AVE} = 3.5 m/s$ 2s.f.

$v_{ave} = 3.5 m/s$

12. A certain type of longbow fires arrows horizontally out a castle tower's arrow slit at 25 m/s. If the arrow is found embedded in the ground a mere 30.0 meters away from the base of the tower, from what height was the arrow launched?



x	y
$v_{AVE} = 25 m/s$	$v_0 = 0$
$\Delta x = 30.0m$	$\Delta y = ?$
$t = ?$	$a = 9.80 m/s^2$
	$t = ?$

$v_{AVE} = \frac{\Delta x}{t}$

$25 m/s = \frac{30.0m}{t}$

$t(25) = 30$

$t = 30/25$

$t = 1.2s$

$\Delta y = v_0 t + \frac{1}{2} a t^2$

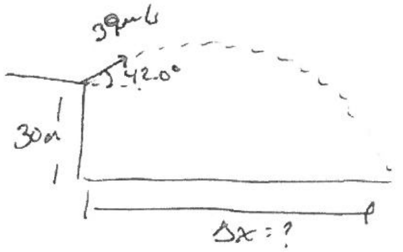
$\Delta y = (0) + \frac{1}{2}(9.8)(1.2)^2$

$\Delta y = 7.056$

7.1 2s.f.

$\Delta y = 7.1m$

13. A famous German football player kicks a soccer ball ~~of~~ off the roof of a 30.0 m tall building for an Adidas commercial. If the launch velocity of the ball is 39 m/s at 42.0° above the horizontal, at what distance from the base of the building does the ball land?



x	y
$v_{AVE} = 39\cos 42°$	$v_0 = 39\sin 42°$
$\Delta x = ?$	$a = -9.80$
$t = ?$	$\Delta y = -30$
	$t = ?$

$\Delta y = v_0 t + \frac{1}{2}at^2$

$-30 = (39\sin 42)t + \frac{1}{2}(-9.8)t^2$

→ Quadratic Eqn Solver

$-4.9t^2 + (39\sin 42°)t + 30 = 0$

$t = 6.297878$ or $-.972144...$

$v_{AVE} = \frac{\Delta x}{t}$

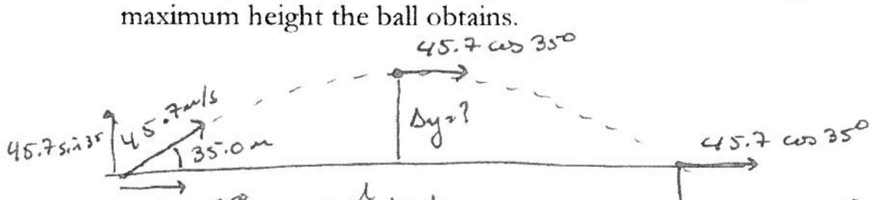
$39\cos 42° = \frac{\Delta x}{6.297878...}$

182.527

2 s.f.

Δx = 180 m

14. Casey clubs a golf ball at speed of 45.7 m/s at an angle of 35.0° above the ground. Calculate the maximum height the ball obtains.



ground to top

x	y
	$v_0 = 45.7\sin 35°$
	$v_f = 0$
	$a = -9.80\ m/s^2$
	$\Delta y = ?$

$\vec{v}_f^{\,2} = \vec{v}_0^{\,2} + 2\vec{a}\Delta\vec{y}$

$0^2 = (45.7\sin 35°)^2 + 2(-9.8)(\Delta y)$

$0 = 687.092175433 - 19.6\Delta y$

$-687.092175433 = -19.6\Delta y$

35.0557 m

3 s.f.

Δy = 35.1 m

Find the total time the ball is in the air.

ground to ground

x	y
	$\vec{v}_0 = 45.7\sin 35°$
	$\vec{v}_f = -45.7\sin 35°$
	$\vec{a} = -9.80$
	$t = ?$
	$\Delta\vec{y} = 0$

$\vec{a} = \frac{\vec{v}_f - \vec{v}_0}{t}$

$-9.8 = \frac{-45.7\sin 35° - 45.7\sin 35°}{t}$

$-9.8 = \frac{\cancel{-64.6275598}}{t}$ 5.3494782

$t = \cancel{6.59485}$ 5.3494...

$t = \cancel{6.59}$ s 5.35 s

3 s.f.

t = ~~6.59 s~~ 5.35 s

Calculate the horizontal range of the ball.

x	
$v_{AVE} = 45.7\cos 35°$	
$t =$	

$v_{AVE} = \frac{\Delta x}{t}$

$(v_{AVE})(t) = \Delta x$ 5.3494...

$(45.7\cos 35°)(\cancel{6.5948...})$

$\cancel{172.86721}$ 200.259

3 s.f.

Δx = ~~173 m~~ 2.00×10^2 m