Motion Problem Practice

Name

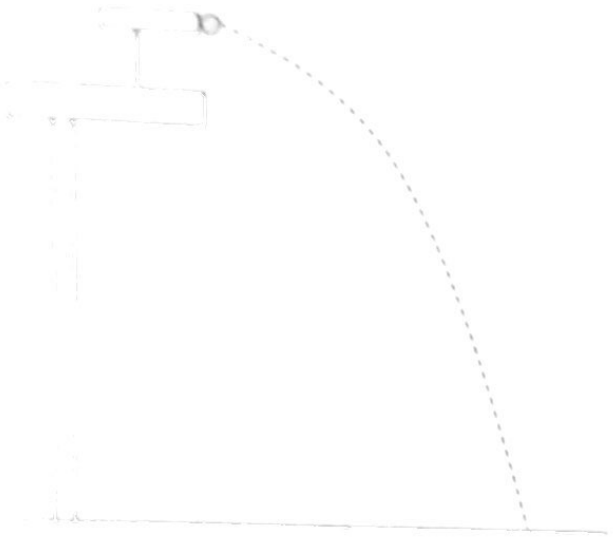
1 2 3 4 5 6 7 8

Part I. Determining the velocity of the ball

a) With what velocity does the ball (two clicks) come out of the shooter?

4.58 m/s

Part II. An Object Shot Horizontally from a Cliff



a) How far from the base of the table does the ball hit the ground?
b) What are the horizontal and vertical components of the ball' velocity when it hits the ground?

x	y

Practice: Horizontal off a Cliff

1) A ball rolls off a 15m cliff and hits the ground 3m from the base of the cliff. a) How fast was the ball rolling when it rolled off the cliff? b) What are the horizontal and vertical components of the ball when it hits the ground?

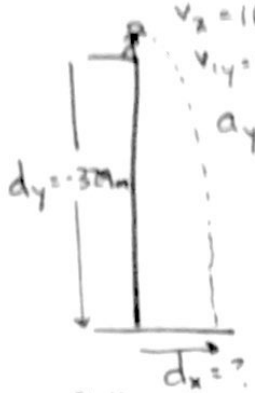
v_{fx} v_{fy} of the velocity

x	y
G: $d_x = 3m$, $t = \sqrt{3}\ s$	G: $d_y = -15m$, $a_y = -10 m/s^2$, $v_{iy} = 0 m/s$
U: $v_x = ?$	U: $t = ?$
E: $v_x = \frac{d_x}{t}$	E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
S/S: $v_x = \frac{3m}{\sqrt{3}s}$	S/S: $-15 = 0t + \frac{1}{2}(-10)t^2$, $-15 = -5t^2$, $3 = t^2$, $t = \sqrt{3}$
$v_x = 1.7 \frac{m}{s}$	

x	y
$v_{fx} = v_x$	G: $v_{iy} = 0 m/s$, $a_y = -10 m/s^2$, $t = \sqrt{3}\ s$
$v_{fx} = 1.7 \frac{m}{s}$	U: $v_{fy} = ?$
	E: $v_{fy} = v_{iy} + a_y t$
	S/S: $v_{fy} = 0 + (-10)(\sqrt{3})$
	$v_{fy} = -17 \frac{m}{s}$

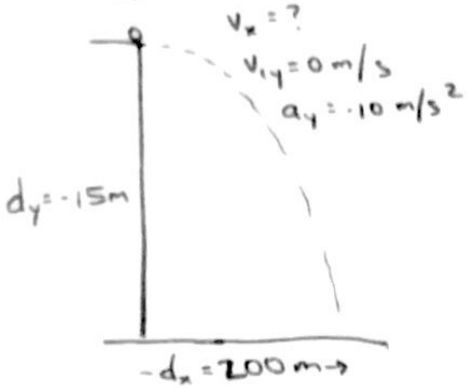
2

2) You stand on the Sears Tower (329 m) and spit off the edge. The spit leaves your mouth at 16 m/s and you spit horizontal to the ground below. How far does the spit land from the base of the Sears Tower?



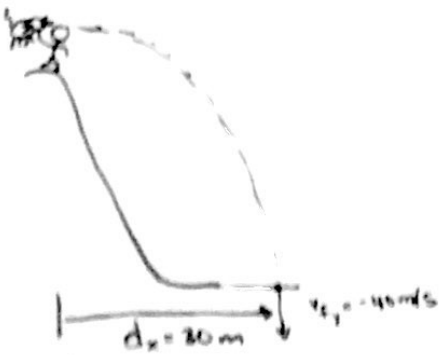
x	y
G: $v_x = 16$ m/s, $t = 8.1$ s	G: $v_{iy} = 0$ m/s, $a_y = -10$ m/s^2, $d_y = -329$ m
U: $d_x = ?$	U: $t = ?$
E: $v_x = \frac{d_x}{t}$	E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
S/S: $16 = \frac{d_x}{8.1}$	S/S: $-329 = 0t + \frac{1}{2}(-10)t^2$, $-329 = -5t^2$, $t^2 = 65.8$, $t = 8.1$ s
$d_x = 130$ m	

3) If an object lands 200 m from a 15 m building after it was launched horizontally, with what velocity was it launched at?



x	y
G: $d_x = 200$ m, $t = \sqrt{3}$ s	G: $d_y = -15$ m, $a_y = -10$ m/s^2, $v_{iy} = 0$ m/s
U: $v_x = ?$	U: $t = ?$
E: $v_x = \frac{d_x}{t}$	E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
S/S: $v_x = \frac{200}{\sqrt{3}}$	S/S: $-15 = 0t + \frac{1}{2}(-10)t^2$, $-15 = -5t^2$, $t^2 = 3$, $t = \sqrt{3}$
$v_x = 115 \frac{m}{s}$	

4) Lew Creedus, The Meanest Man in the World, throws a kitten horizontally from the top of Centennial Hill. If the kitten strikes the ground with a final vertical velocity of 40 m/s, and the kitten traveled 30 meters horizontally: a) How fast did Lew throw the kitten? b) How tall is the hill?



a.

x	y
G: $d_x = 30$ m, $t = 4$ s	G: $v_{iy} = 0$ m/s, $a_y = -10$ m/s^2, $v_{fy} = -40$ m/s
U: $v_x = ?$	U: $t = ?$
E: $v_x = \frac{d_x}{t}$	E: $v_{fy} = v_{iy} + a_y t$
S/S: $v_x = \frac{30}{4}$	S/S: $-40 = 0 + (-10)t$, $t = 4$ s
$v_x = 7.5$ m/s	

b.

y
G: $v_{iy} = 0$ m/s, $a_y = -10$ m/s^2, $t = 4$ s
U: $d_y = ?$
E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
S/S: $d_y = 0.4 + \frac{1}{2}(-10)(4)^2$, $d_y = -80$ m
Height = 80 m

5) A roller skate strikes the ground after rolling horizontally off of a table. If the horizontal component of the skate's velocity when it strikes is 6 m/s and the table is 2.5 meters high: a) With what speed was the skate moving when it left the table? b) How far did the skate travel horizontally?

a.

x	y
G: $v_x = 6$ m/s	G:
$V_x = 6$ m/s	

b.

x	y
G: $v_x = 6$ m/s, $t = ? = 0.707$ s	G: $v_{iy} = 0$ m/s, $a_y = -10$ m/s^2, $d_y = -2.5$ m
U: $d_x = ?$	U: $t = ?$
E: $v_x = \frac{d_x}{t}$	E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
S/S: $6 = \frac{d_x}{0.707}$	S/S: $-2.5 = 0t + \frac{1}{2}(-10)t^2$, $-2.5 = -5t^2$, $t = 0.707$ s
$d_x = 4.24$ m	

Part III: An Object Shot at an Angle

1) With what velocity does the ball come out the cannon? 4.8 m/s

2) If we shoot the cannon at a 30° angle what are the initial horizontal and vertical velocities of the ball? $v_x = 4.2\ m/s$, $v_{iy} = 2.4\ m/s$

3) How far does the ball land horizontally from the cannon? 2.02 m

4) How high does the ball travel at its maximum height?

5) What are the horizontal and vertical components of the balls velocity when it strikes the ground?

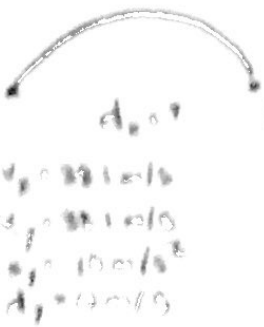
Practice:

Disregard this!

6) ~~As the legend states, Dave Szwed and his brother Mike, once shot a lime 250 yards (290.2 m) using a "Winger".~~ If they shot the lime at a 45° angle and with an initial velocity of 53.9 m/s a) What was the total time the lime was in flight? b) How high did it go? c) How far did it go?

x	y
G: $v_x = 38.1\ m/s$	G: $v_{iy} = 38.1\ m/s$
$t = 7.62\ s$	$a_y = -10\ m/s^2$
U: $d_x = ?$	$d_y = 0\ m$
E: $v_x = \frac{d_x}{t}$	U: $t = ?$
S/S:	E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
$38.1 = \frac{d_x}{7.62}$	S/S:
	$0 = 38.1t + \frac{1}{2}(-10)t^2$
	$0 = 38.1t - 5t^2$
	$0 = t(38.1 - 5t)$
	$[t = 7.62\ s]$

a) TIME



b) $[d_x = 290\ m]$

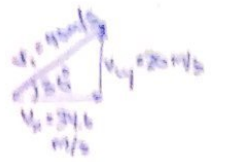
How far?

y
G: $a_y = -10\ m/s^2$
$v_{iy} = 38.1\ m/s$
$t = 3.81\ s$
U: $d_y = ?$
E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
S/S:
$d_y = (38.1)(3.81) + \frac{1}{2}(-10)(3.81)^2$

b) $[d_y = 72.6\ m]$

How high?

3) Mr. Bruce kicks a soccer ball with a velocity of 40 m/s at and angle of 30° above the horizontal. a) How long is it in the air? b) How far did it go? c) How high did it go? d) Half way, what are the vertical and horizontal components of the ball's velocity?



x	y
G: $v_x = 34.6$ m/s	G: $v_{iy} = 20$ m/s, $a_y = -10$ m/s^2, $d_y = 0$ m
$t = 4$ s	U: $t = ?$
U: $d_x = ?$	E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
E: $v_x = \frac{d_x}{t}$	S/S: $0 = 20t + \frac{1}{2}(-10)t^2$
S/S:	$t = 4$ s a)
$d_x = 139$ m b)	

$d_x = ?$

E.C.

4) Coach Kulak can drive a golf ball about 300 yards (274.3 m) into trees with his one wood which lofts the ball at an angle of 10° above the horizontal. What must be the initial velocity of the ball to go that far?

x	y
G: $d_x = 274.3$ m	G: $d_y = 0$ m, $a_y = -10$ m/s^2
U: $t = ?$, $v_x = ?$	U:
E: $v_x = \frac{d_x}{t}$	E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
S/S:	S/S:

$\tan\theta = \frac{v_{iy}}{v_x}$

$v_x \tan\theta = v_{iy}$

$d_y = v_x \tan\theta\, t + \frac{1}{2}a_y t^2$

$0 = v_x(\tan 10°)t + \frac{1}{2}(-10)t^2$

$0 = \frac{d_x}{t}(\tan 10°)t - 5t^2$

$0 = (274.3)(\tan 10°) - 5t^2$

$0 = 48.4 - 5t^2$

$t^2 = 9.67$

$t = 3.11$ s

$v_x = \frac{274.3}{3.11} = 88.2$ m/s

$\cos\theta = \frac{v_x}{v_i}$

$v_i = \frac{v_x}{\cos\theta}$

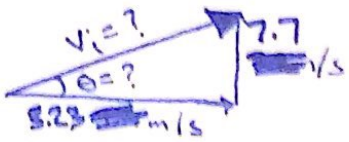
$v_i = \frac{88.2}{\cos 10°}$

$v_i = 89.6$ m/s

5) A grasshopper (not kind with wings that sort of fly) hops and reaches a vertical height of 3 meters and jumps a distance of 5 meters. a) What was of the initial vertical velocity of the grasshopper? b) What was the horizontal velocity of the grasshopper? c) Add these vectorally to get the initial velocity and angle the grasshopper hopped at.

y
G: $a_y = -10$ m/s^2
$v_{fy} = 0$ m/s
$d_y = 3$ m
U: $v_{iy} = ?$
E: $v_{fy}^2 = v_{iy}^2 + 2a_y d_y$
S/S: $0^2 + v_{iy}^2 + 2(-10)(3)$
$0 = v_{iy}^2 - 60$
a) $v_{iy} = 7.7$ m/s

x	y
G: $d_x = 5$ m	G: $d_y = 0$ m
$t = 1.55$	$a_y = -10$ m/s^2
U: $v_x = ?$	$v_{iy} = 7.75$ m/s
E: $v_x = \frac{d_x}{t}$	U: $t = ?$
$v_x = \frac{5}{1.55}$	E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
b) $v_x = 3.23$ m/s	S/S: $0 = (7.75)t + \frac{1}{2}(-10)t^2$
	$0 = t(7.75 - 5t)$
	$t = 1.55$ s



$v_i = \sqrt{3.2^2 + 7.7^2} = 8.3$ m/s

$\tan\theta = \frac{7.7}{3.2}$

$\theta = 67°$

c) $v_i = 8.3$ m/s @ 67°

6) Wearing really short shorts, a long jumper jumps with an initial velocity of 8 m/s at an angle of 40° above the horizontal. a) How far is the jumper's jump? b) What height does he reach?

a)

x	y
G: $v_x = 6.13$ m/s	G: $d_y = 0$ m, $a_y = -10$ m/s^2, $v_{iy} = 5.14$ m/s
$t = 1.05$ s	U: $t = ?$
U: $d_x = ?$	E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
E: $v_x = \frac{d_x}{t}$	S/S: $0 = 5.14t + \frac{1}{2}(-10)t^2$
S/S:	$t = 1.05$ s
$d_x =$ [illegible] m	

b)

y
G: $v_{iy} = 5.14$ m/s
$a_y = -10$ m/s^2
$t = 0.51$ s
U: $d_y = ?$
E: $d_y = v_{iy}t + \frac{1}{2}a_y t^2$
S/S: $d_y = (5.14)(0.51) + \frac{1}{2}(-10)(0.51)^2$
$d_y = 1.3$ m