NAME: Key

Vector & Projectile Motion Review

Concepts:

I) What is the difference between the path of Type 1 and Type 2 projectiles?

II) Explain why V_{oy} is zero for Type 1 projectiles.

III) Explain why a_x is zero for all projectiles?

IV) After drawing the picture what should be the first step in solving a Type 2 projectile?

V) What formula is used to find time for all Type I projectiles?

VI) What conditions are necessary to use the horizontal components to find time for a Type 1 projectile?

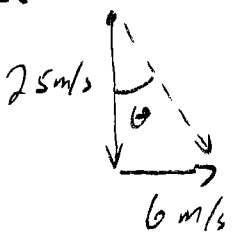
VII) What is the relation between v_{ox} and v_{fx}, explain why this is.

VIII) How are v_{fy} and v_{fx} used to find the final velocity of any object?

IX) When should [$v_f^2 = v_o^2 + 2ad$] be used and when should [$v_f = v_o + at$] be used to find the final vertical velocity?

Problems:

1. A golfer hits a golf ball with an initial velocity of 25 m/s due south. A crosswind blows at 6 m/s due ~~west~~ east. Find the resultant velocity of the golf ball immediately after it has been hit.

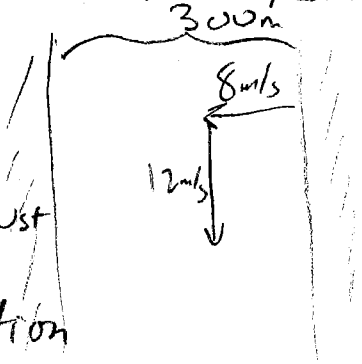


$6^2 + 25^2 = x^2$

$x = 25.8\ m/s \ @\ 13.5°\ [W\ of\ S]$

$\theta = \tan^{-1}\left(\frac{6}{25}\right) = 13.5°$

2. A 300 m wide river flows South at 12.0 m/s. A turtle points himself directly ~~East~~ west and swims at 8.0 m/s.



a) How long will it take to cross the river?

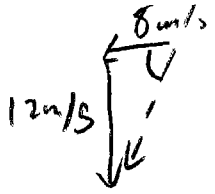
$V = \frac{d}{t}, \quad t = \frac{d}{V} = \frac{300m}{8\ m/s} = 37.5\ s$ ← both values must be in same direction

b) How far down river does he end up?

$d = V \cdot t$

$= (12\ m/s)(37.5\ s) = 450\ m$

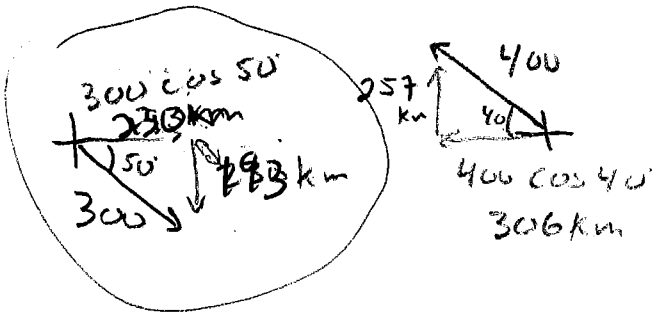
c) What is his resultant velocity as he crosses the river? (include a vector diagram)



$X^2 = 12^2 + 8^2$, $X = 14.4$ m/s @ 56° [S of W]

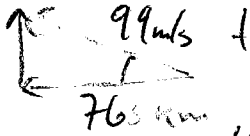
$\theta = \tan^{-1}\left(\frac{12}{8}\right) = 56°$

3. A ship starts its journey at point A and travels for 300 km on a bearing of 50° [E of S] to a point B. The ship then changes direction and travels for 400 km on a bearing of 40° [N of W] to a point C. Calculate the resultant displacement vector.



x dir 306 km − 230 km = 76 km W

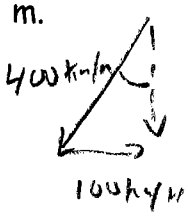
y dir 257 km − 193 km = 64 km N



$X^2 = 27^2 + 113^2$, $X = 116$ km @ 13° [N of W]

4. A plane can fly at 400 km/h in still air. The plane needs to travel due south to an airport 900 km away and there is a crosswind blowing at 100 km/h East.

a) What heading should he take in order to head directly south? Include a vector diagram.



$\theta = \sin^{-1}\left(\frac{100}{400}\right)$

$= 14.5°$ [W of S]

b) How long will it take the plane to reach the airport at this heading?

$X^2 = 400^2 - 100^2$

$= 387$ km/H

$v = \frac{d}{t}$, $t = \frac{d}{v} = \frac{900 \text{ km}}{387 \text{ km/hr}}$

$t = 2.32$ Hr.

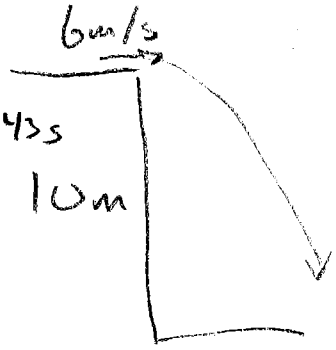
5. A physics student runs at 6.0 m/s horizontally off a 10.0 m high diving board.

a) How long will it take to reach the water?

X	Y
$v = 6$ m/s	$a = 9.8$ m/s²
	$d = 10$ m
	$v_0 = 0$

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

$10 = \frac{1}{2}(9.8) t^2$, $t = 1.43$ s



b) How far from the diving board will she land?

$d_x = v_x \cdot t$

$= (6)(1.43) = 8.57$ m

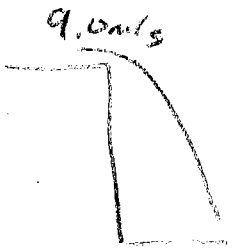
c) What are her final vertical and horizontal velocities?

$V_{f_y}^2 = V_0^2 + 2ad$

$= 0 + 2(9.8)(10)$

$V_{f_y} = 14 m/s$, $V_x = 6 m/s$

6. A rock is tossed off a bridge horizontally at 9.0 m/s and strikes the ground below 3.2 s later. How high is the bridge and what was the range of the throw?



X	Y
$V = 9.0 m/s$	$V_0 = 0$
$t = 3.2s$	$a = 9.8 m/s$
	$t = 3.2s$

$d_y = V_0 t + \frac{1}{2} a t^2$

$= \frac{1}{2}(9.8)(3.2)^2$

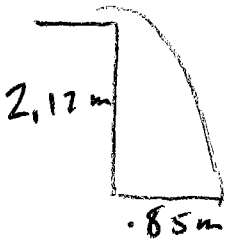
$= 50.2 m$

$d_x = V_x \cdot t$

$= (9)(3.2)$

$= 28.8 m$

7. Water sprays horizontally out of a shower head which is 2.12 m above the ground. If the water hits the shower floor 0.85 m from the wall of the shower how fast was the water coming out the showerhead?



X	Y
$d = .85m$	$V_0 = 0 m/s$
	$a = 9.8 m/s$
	$d = 2.12 m$

$d_y = V_0 t + \frac{1}{2} a t^2$

$2.12 = \frac{1}{2}(9.8) t^2$

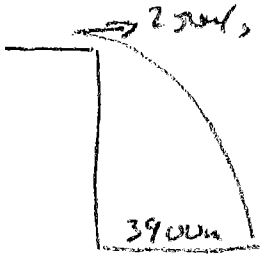
$t = .66s$

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

$= \frac{.85m}{.66s}$

$= 1.29 m/s$

8. A supply plane flying at 250 m/s releases supplies 3900 m in front of survivors of a shipwreck. How high is the plane?



X	Y
$V = 250 m/s$	$V = 0 m/s$
$d = 3900m$	$a = 9.8 m/s^2$

$t = \frac{d}{v}$

$= \frac{3900}{250}$

$= 15.6s$

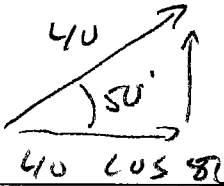
$d_y = V_0 t + \frac{1}{2} a t^2$

$= \frac{1}{2}(9.8)(15.6)^2$

$= 1190 m$

9. A football kickoff is moving with an initial velocity of 40 m/s at 50° above the field.

a) What is the range of the football?



$40 \sin 50° = 30.6 m/s$

$40 \cos 50° = 25.7 m/s$

$V_f = V_0 + at$

$0 = 30.6 + (-9.8)t$

$t = 3.1 \times 2 = 6.24s$

$d_x = V_x \cdot t$

$= (25.7)(6.24)$

$= 160 m$

b) What is the velocity of the football at the maximum height?

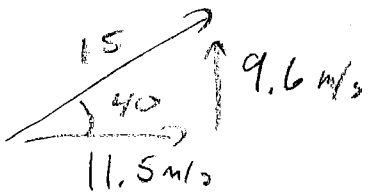
$V_y = 0$ $V_x = 25.7\ m/s$ so $V = 25.7\ m/s$

c) What is the maximum height of the football?

$V_f^2 = V_o^2 + 2ad$ $\quad -936 = -19.6d$

$0 = (30.6)^2 + 2(-9.8)d$ $\quad d = 47.8\ m$

10. A football is kicked at 40° with a velocity of 15 m/s, find its total air time, vertical velocity at 1.3 s, and velocity at 2.5 m high.



$V_f = V_o + at$

$0 = 9.6 + (-9.8)t$

$t = .98 \times 2 =$

$t = 1.96\ s$

$V_f = V_o + at$

$= 9.6 + (-9.8)(1.3)$

$= -3.14\ m/s$

coming down

$V_f^2 = V_o^2 + 2ad$

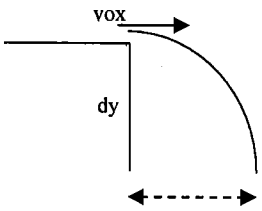
$= (9.6)^2 + 2(-9.8)(2.5)$

$= 43.16$

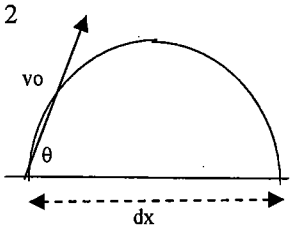
$V_f = \pm 6.57\ m/s$

Answers

I) type 1



type 2



II) because the projectile is launched horizontally
III) zero
IV) find v_{ox} and v_{oy}
V) $d = v_o t + \frac{1}{2} a t^2$
VI) must be given v_{ox} and dx
VII) they are the same because there is no acceleration in the x direction
VIII) pythagoras' theorem
IX) use $v_f^2 = v_o^2 + 2ad$ when given dy, use $v_f = v_o + at$ when given time

1) dx = 8.57 m
2) dy = 50.2 m, dx = 28.8 m
3) dx = 182 m
4) 1.29 m/s
5) dy = 1.19×10^3 m
6) dx = 90.4 m
7) dx = 1.64 m
8) dx = 36.7 m
9) yes
10) 6.46 m/s
11) vf = 15.3 m/s
12) vf = 300 m/s (still)
13) vf = 10.6 m/s
14) dy = 14.7 m
15) 5.35 m/s
16) 2.02 s, 30m. 20 m/s down, 15m/s
17) 1.5 m/s
18) Misses by 25 cm
19) 1.97 s, 23m, 4….m