PH141
Fall 2009
HW 2
Ch 3, Conceptual: 1, 3, 6, 9
Ch 3, Problems: 4, 9, 19, 21, 29, 30, 52, 53, 67, 69

**Conceptual**

**1. (a)** $V_1 > V_3 > V_2$

There is no acceleration in the x-direction so the velocity in the x-direction stays constant. The total velocity therefore depends on the vertical component only. The higher the ball is, the slower its vertical velocity component (until it reaches the top where $V_y = 0$). Therefore the largest velocity is associated with the lowest position, the top ball has Vy = 0, and the middle balls velocity is in between.

**3. (c) Both Balls have the same acceleration**

If an object is freely in the air, the acceleration in the vertical direction is **always** g = 9.8 m/s$^2$ downward towards the center of the earth. The acceleration due to gravity is independent of velocity or position. Therefore ball 1 and ball 2 will accelerate at the same rate of 9.8 m/s$^2$ downward until they hit the ground.

**6. (c) Both balls hit the grounds at the same time**

Horizontal and vertical velocities do not influence each other, the fact that ball 1 has a velocity in the horizontal direction is irrelevant as one should look at the vertical component to determine the balls hang time. Both balls fall from the same height with the same initial velocity (in the vertical direction). Therefore each ball will hit the ground at the same time.

**9. (a) Projectile 1, because it travels higher then Projectile 2.**

Only the vertical velocity component will influence the hang time. The ball with the initial velocity in the vertical direction will spend more time in the air. The fact that ball 1 reaches a higher position is proof that it had a larger initial velocity in the y-direction and therefore will spend more time in the air.

## Problems

### Problem 4

(See Attached)

### Problem 9

The vertical component of the velocity $v_y = 6.8$ m/s and the horizontal component $v_x = 15.8$ m/s. Components can be combined using Pythagorean relation:

$$v = \sqrt{v_x^2 + v_y^2}$$
$$v = 16.9 \text{ m/s}$$

This is only the magnitude of the velocity. If one wishes to report the entire velocity vector quantity (magnitude and direction) we need the direction of this velocity.

$$\tan\theta = \frac{v_y}{v_x} \quad \text{so} \quad \theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) = 23.7° \quad \text{above the horizon}$$

### Problem 19

Maximum height would be achieved if the jump was completely vertical meaning all of the velocity will be a part of the vertical component. Using the free fall equation:

From Eq 2.8
With $v_o = 0$

$$x = v_o t + \frac{1}{2}at^2$$

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

A basket ball player will have to leave the ground, reach the apex (top), and fall back down. Through symmetry the time going up is equal to time it will take to fall from that max height. Therefore we can assume that the basketball player is at the max vertical height and will take 1 second to fall, meaning the total air time will be twice that (2 seconds). For 1 second fall using the equation above:

$$x = 4.9 \text{ m}$$

### Problem 21

(See Attached)

**Problem 29**

The pitcher throws the ball horizontally which means all of the initial velocity is in the horizontal direction. We are neglecting air drag so there is no acceleration in the horizontal direction, $v_{ox} = v_x$. If this velocity is know along with the distance, we can find the time the ball is in the air.

In the x direction (given): $x = 17.0$ m, $a = 0$, $v_o = 41.0$ m/s, $t = ?$

$$x = v_o t + \frac{1}{2}at^2 \qquad \text{with } a = 0$$

$$t = \frac{x}{v_o}$$

$$t = 0.415 \text{ s}$$

In the y direction (given): $a = 9.8$ m/s, $t = 0.415$ s, $v_{oy} = 0$, $y = ?$

Using Free Fall equation:

$$y = 4.9t^2$$

$$\mathbf{y = 0.844 \text{ m}}$$

**Problem 30**

One can split this problem into 2 smaller problems (ascending and descending) by first splitting the initial velocity into its vertical and horizontal components and finding the hang time using the vertical component and gravitation acceleration to determine 2 expressions with a common initial velocity term. By subbing one equation into the other one can solve for the hang time in terms of initial velocity. Then sub out the time term by using the appropriate kinematic equation tat related time to initial velocity and solve for initial velocity.

Or use the range equation from class:

$$R = \frac{v_o^2}{g}\sin(2\theta)$$

If only the range is to be determined, knowing only magnitude of initial velocity and release angle above the horizon, one can use this time independent equation.

$$v_o = \sqrt{\frac{R \cdot g}{\sin(2\theta)}}$$

$$\mathbf{v_o = 45.5 \text{ m/s}}$$

**Problem 52**

(See Attached)

**Problem 53**

(See Attached)

**Problem 67**

If we use a reference frame that is positive upward and positive rightward we see that the initial velocity of the volley ball has a positive horizontal component and a negative vertical component. Using the component equations:

$$v_x = (v)\cos\theta = 8.6(m/s)$$

and

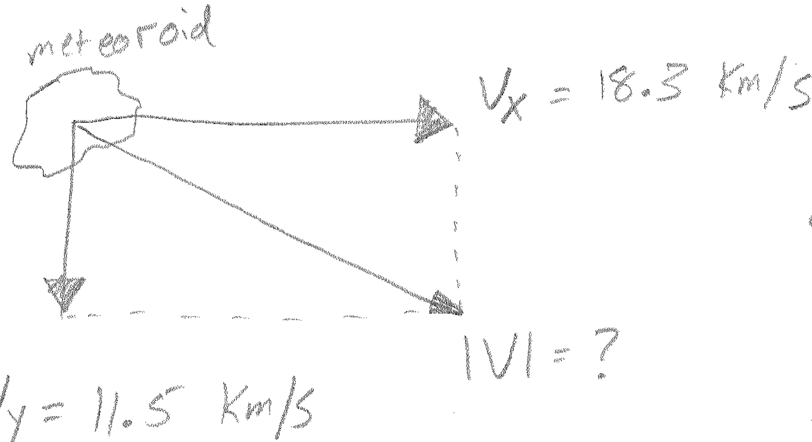
$$v_y = (v)\sin\theta = 12.3(m/s)$$

The question asks for the x-component, which is 8.6 m/s

**Problem 69**

(See Attached)

(4)




• Looking for "speed" only need to know magnitude of velocity

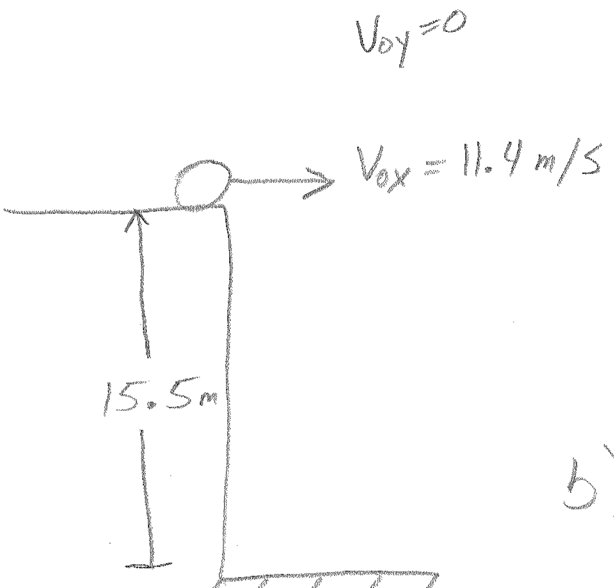
Combine Components

$$|V| = \sqrt{V_x^2 + V_y^2}$$

$$|V| = \sqrt{(18.3)^2 + (11.5)^2} = \sqrt{467.14}$$

$$\boxed{|V| = 21.6 \text{ km/s}}$$

(21)




a) only look at y-direction
Free fall Eq (with $V_{oy} = 0$)

$$y = 4.9t^2$$

$$15.5 = 4.9t^2$$

$$t = \sqrt{\frac{15.5}{4.9}} \rightarrow \boxed{t = 1.78}$$

b) $a_x = 0$, so $V_{ox} = V_x \rightarrow$ constant

must find $\boxed{V_y}$ knowing $V_{yo} = 0$

$\longrightarrow$

21. b) cont.

$$V_y^2 = V_{oy}^2 + 2ay$$

$$V_y^2 = 0 + 2(9.8)(15.5)$$

$$V_y^2 = 303.8$$

$$V_y = 17.4 \text{ m/s}$$

using

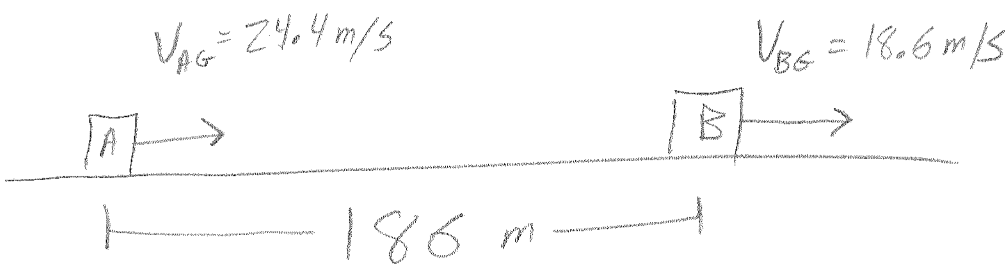
$V_y = 17.4$ m/s and $V_x = 11.4$ m/s

$$|V| = \sqrt{V_x^2 + V_y^2} = \sqrt{17.4^2 + 11.4^2}$$

$$\boxed{|V| = 20.8 \text{ m/s}}$$ only magnitude is asked for so direction is not needed

---

52

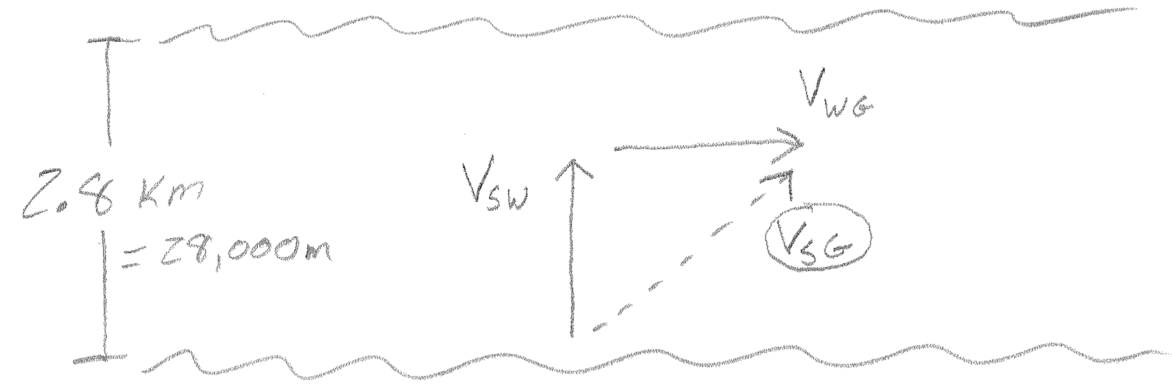



Relitive Velocity $\boxed{V_{AB} = V_{AG} - V_{BG}}$

$V_{AB} = 5.8$ m/s $\longrightarrow$ $V = \frac{x}{t}$ $\rightarrow$ $\boxed{t = \frac{x}{v}}$

$$t = \frac{186}{5.8} \rightarrow \boxed{t = 32.1 \text{ s}}$$ *

53




$V_{SW}$ = velocity of swimmer relitive to the water

$V_{WG}$ = velocity of water relitive to shore

* $V_{SG}$ = Velocity of swimmer relitive to shore

Must add vectors $\boxed{\vec{V}_{SG} = \vec{V}_{SW} + \vec{V}_{WG}}$

Because vectors are 90° apart, we can treat them seperate.

a) $V = \frac{X}{t} \rightarrow \boxed{t_{\text{to cross}} = \frac{X}{V_{SW}}} = \frac{28{,}000}{1.4} \rightarrow \boxed{t = 2000\,s}$

use in b)

b) $V = \frac{X}{t} \rightarrow \boxed{X = V_{WG}\, t_{\text{to cross}}} = (0.91)(2000)$

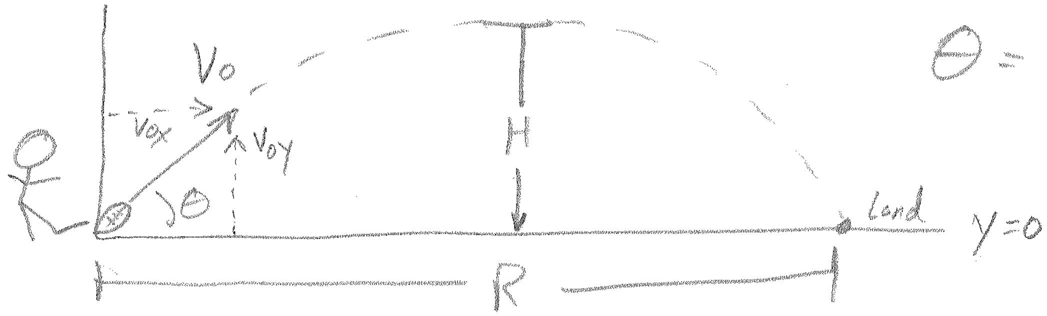
$\rightarrow \boxed{X = 1820\text{ m}}$

* down streem

(69)

$V_o = 22\ m/s$

$\theta = 40°$




$$V_x = V_o \cos\theta = \boxed{16.8\ m/s}$$

$$V_y = V_o \sin\theta = \boxed{14.1\ m/s}$$

Only difference in this problem is the value of acceleration, $\boxed{|a_{moon}| = 1.62\ m/s^2}$

a) (From Pg.69)

$$y = H = \frac{V_y^2 - V_{oy}^2}{2a_y} = \frac{0^2 - 14.1^2}{2(1.62)} \longrightarrow \boxed{H = 61.3\ m}$$

$\approx 60m$

b) Must Find Hang time first (PG.69)

$$y = V_{oy}t + \tfrac{1}{2}a_y t^2$$

$$0 = 14.1t + (-1.62)t^2 \longrightarrow \boxed{0.81t^2 + 14.1t + 0 = 0}$$

$\cancel{t=0}$, $\boxed{t = 17.4s}$

use t

(PG 70)

$$x = R = V_{ox}t$$

$$R = (16.8)(17.4) \longrightarrow \boxed{R = 292\ m} *$$

accept 289 → 295 m