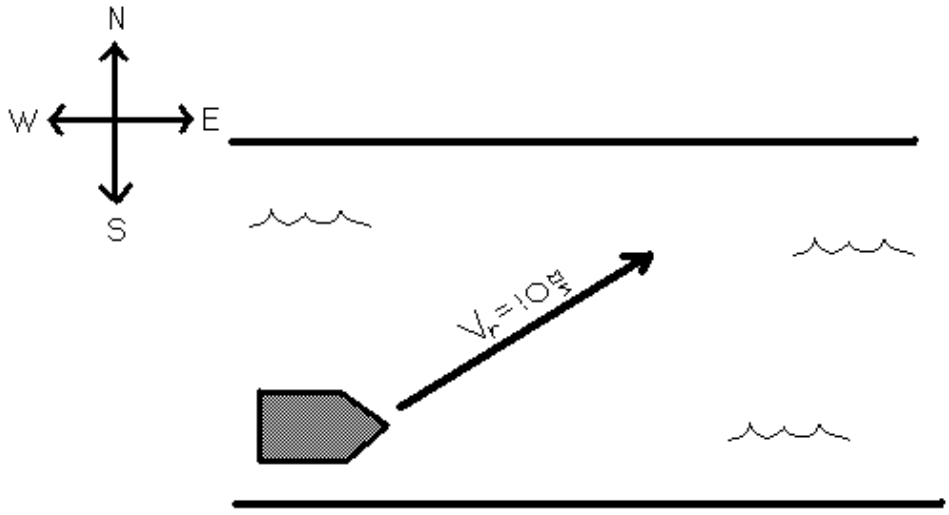
Two Dimensional Kinematics

Pre-Test

1. The following situation is given below. Suggest two reasonable (both magnitude and direction) component velocity vectors for the resultant velocity vector given below of the boat:

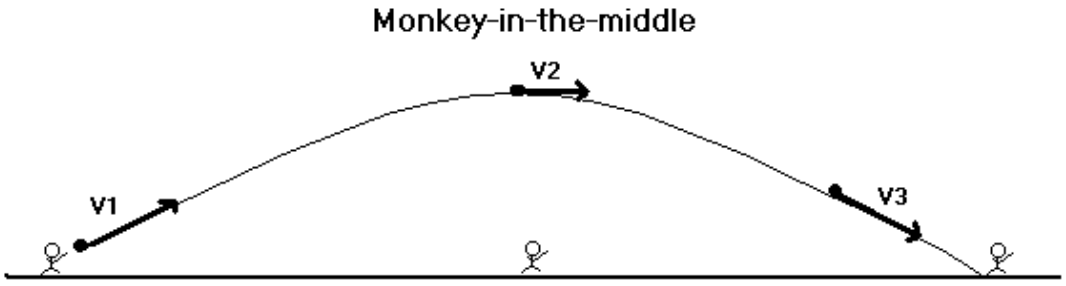


a) 15 m/s east, 5 m/s south.
b) 15 m/s east, 5 m/s north.
c) 10 m/s east, 10 m/s west.
d) 10 m/s northeast.
e) No sufficient answer is given above.

2. If a hang glider were traveling north at a velocity of 50 kilometers per hour, how would the plane's velocity (resultant) be affected if it encountered (1) a tailwind of 30 km/hr, (2) an eastward wind of velocity 30 km/hr?

a. 70 km/hr north, 50 km/hr northeast.
b. 70 km/hr south, 50 km/hr southeast.
c. 10 km/hr north, 70 km/hr east.
d. 10 km/hr south, 70 km/hr southeast.
e. 40 km/hr north, 30 km/hr east.
f. None of the above answers are correct.

3. Draw in the <u>component</u> velocity vectors for the three instances given below (Hint: think about "x- and y-component vectors"):



4. Access the second URL listed. This applet allows you to vary the following:
   - The gravitational acceleration of the planet
   - The kinetic energy of the projectile (muzzle velocity of cannon)
   - The angle of the cannon
   - The density of the projectile
   - The amount of drag the projectile experiences as it travels through an atmosphere

What you will be doing is performing an experiment. You will set one experimental variable (variable you will be testing) and hold all other control variables constant. You will analyze the motion of the projectile by observing (1) how far (horizontally) it goes simply by recording projectile's displacement from the cannon, and (2) how high (vertically) it goes by counting the number of blocks up the projectile has reached. Record your observations in the very last column of the table.

Notes:

1. *wrt*: "with respect to"
2. After each Trial reload the applet to restore the original configuration
3. Click on "Drag" to set air resistance

Trial	***g*** **(Gravity)** **m/s^2**	***v*** **(Velocity)** **m/s**	θ **(Angle of projectile w.r.t. ground)** °	ρ **(Density)** **g/cm^3**	**Air Resist-ance** **(kg•m)/s^2**	**Observations**
1	1. –9.8 2. –11.8 3. –13.8 4. –7.8 5. –6.8					
2		1. 52 2. 42 3. 12 4. 62 5. 82				
3			1. 52 2. 45 3. 12 4. 75 5. 90			
4				1. .01 2. .50 3. .75 4. 1.0 5. 1.2		
5					1. no drag 2. drag	

6. What did you notice about the projectile's motion when you (1) increased gravity, (2) decreased gravity? What can we say about how gravity affects the motion of this object?

7. What did you notice about the projectile's motion when you (1) increased the muzzle velocity, (2) decreased the muzzle velocity? What can we say about how muzzle velocity affects the motion of this object?

8. What did you notice about the projectile's motion when you (1) increased the angle, (2) decreased the angle? What can we say about how the angle affects the motion of this object? Which angle shot the object closest to the target? Why? Doesn't this seem counterintuitive?

9. What did you notice about the projectile's motion when you changed the object's density (and hence changing its mass)? How does mass affect the motion of this object?

10. What did you notice about the projectile's motion when you added the factor of a drag force? Did the object travel farther or shorter when the drag force was introduced? How did the drag force affect this object's motion?

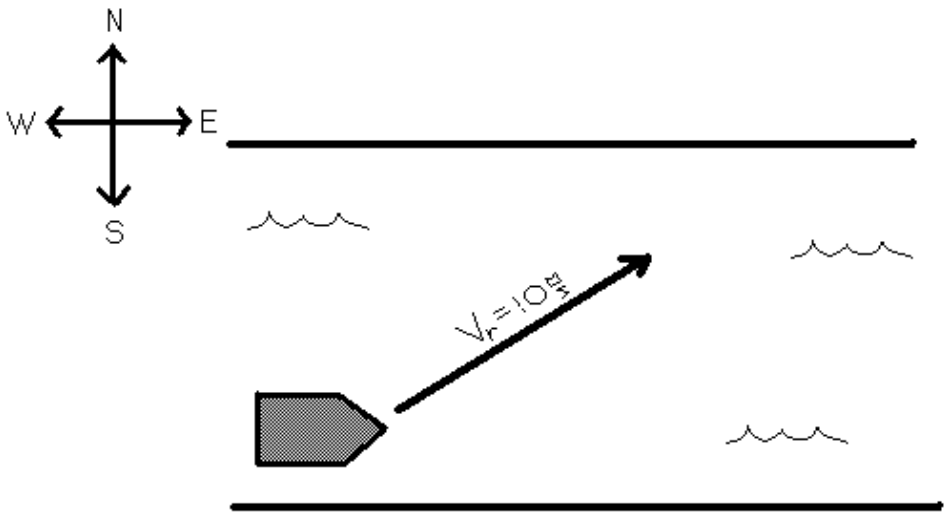
Web Site URL to learn the concepts:

1. **http://www.glenbrook.k12.il.us/gbssci/phys/Class/vectors/vectoc.html**
2. **http://zebu.uoregon.edu/nsf/cannon.html**
3. **http://www.hazelwood.k12.mo.us/~grichert/projectile/proj.html**

(Access the first URL and complete Lesson 1 through Lesson 2. The second and third URL's are an interactive animation (applet) based on projectile motion. It is designed for you to see how various factors affect (or do not affect) an object's during its trajectory.)

Post-Test

1. The following situation is given below. Suggest two reasonable (both magnitude and direction) component velocity vectors for the resultant velocity vector given below of the boat:



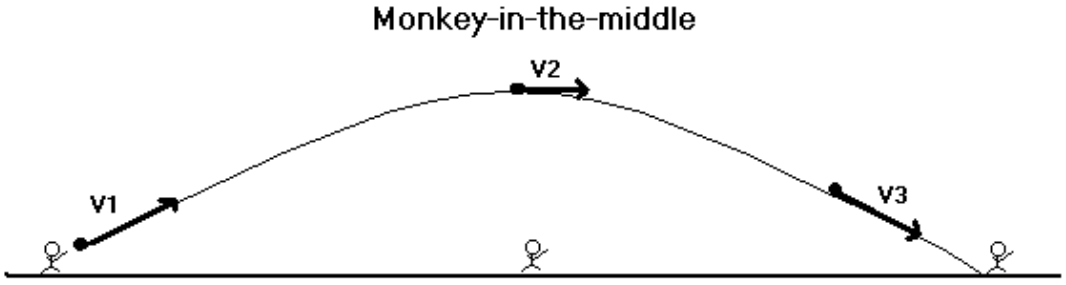
a) 15 m/s east, 5 m/s south.
b) 15 m/s east, 5 m/s north.
c) 10 m/s east, 10 m/s west.
d) 10 m/s northeast.
e) No sufficient answer is given above.

2. If a hang glider were traveling north at a velocity of 50 kilometers per hour, how would the plane's velocity (resultant) be affected if it encountered (1) a tailwind of 30 km/hr, (2) an eastward wind of velocity 30 km/hr?

a) 70 km/hr north, 50 km/hr northeast.

b) 70 km/hr south, 50 km/hr southeast.
c) 10 km/hr north, 70 km/hr east.
d) 10 km/hr south, 70 km/hr southeast.
e) 40 km/hr north, 30 km/hr east.
f) None of the above answers are correct.

3. Draw in the component velocity vectors for the three instances given below (Hint: think about "x- and y-component vectors"):



4. Access the second URL listed. This applet allows you to vary the following:

- The gravitational acceleration of the planet
- The kinetic energy of the projectile (muzzle velocity of cannon)
- The angle of the cannon
- The density of the projectile
- The amount of drag the projectile experiences as it travels through an atmosphere

What you will be doing is performing an experiment. You will set one experimental variable (variable you will be testing) and hold all other control variables constant. You will analyze the motion of the projectile by observing (1) how far (horizontally) it goes simply by recording projectile's displacement from the cannon, and (2) how high (vertically) it goes by counting the number of blocks up the projectile has reached. Record your observations in the very last column of the table.

Notes:

3. *wrt*: "with respect to"
4. After each Trial reload the applet to restore the original configuration

3. Click on "Drag" to set air resistance

Trial	***g*** **(Gravity)** **m/s^2**	***v*** **(Velocity)** **m/s**	θ **(Angle of projectile w.r.t. ground)** °	ρ **(Density)** **g/cm^3**	**Air Resist-ance** **(kg•m)/s^2**	**Observations**
1	5. –9.8 6. –11.8 7. –13.8 8. –7.8 5. –6.8					
2		6. 52 7. 42 8. 12 9. 62 10. 82				
3			11. 52 12. 45 13. 12 14. 75 15. 90			
4				6. .01 7. .50 8. .75 9. 1.0 10. 1.2		
5					5. no drag 6. drag	

5. What did you notice about the projectile's motion when you (1) increased gravity, (2) decreased gravity? What can we say about how gravity affects the motion of this object?

6. What did you notice about the projectile's motion when you (1) increased the muzzle velocity, (2) decreased the muzzle velocity? What can we say about how muzzle velocity affects the motion of this object?

7. What did you notice about the projectile's motion when you (1) increased the angle, (2) decreased the angle? What can we say about how the angle affects the motion of this object? Which angle shot the object closest to the target? Why? Doesn't this seem counterintuitive?

8. What did you notice about the projectile's motion when you changed the object's density (and hence changing its mass)? How does mass affect the motion of this object?

9. What did you notice about the projectile's motion when you added the factor of a drag force? Did the object travel farther or shorter when the drag force was introduced? How did the drag force affect this object's motion?