Vectors and Kinematics Notes

**1 – Review**

Velocity is defined as the change in displacement with respect to time.

Note that this formula is only valid for finding **constant** velocity or **average** velocity. Also, if acceleration is constant:

Ex: A car traveling at 22 m/s slows down to 14 m/s in 3.00 s. What is its average velocity during this time?

Ex: A sprinter runs from the 50.0 m mark to the 100.0 m mark in 4.50 s, what is his velocity?

Whenever an object undergoes acceleration, we need to rely on our BIG - 3 kinematics equations. The variables for these are:

v :

vo :

a :

d :

t :

There are three kinematics equations that use these variables.

1)

2)

3)

Ex: A jet traveling at 65 m/s accelerates at 25 m/s2 for 8.00 s. What is its final velocity?

**Remember**: acceleration due to gravity *near the Earth’s surface* is the same for all objects regardless of mass!!!

g = \_\_\_\_\_\_\_\_\_\_

Note:

Ex: A textbook is dropped from a high cliff and hits the ground 3.5 s later. What is the book’s displacement?

**Note:** Displacements, velocities and accelerations can all be negative because they are *vectors*, which have both a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Ex: A student throws a ball straight up in the air at 14.2 m/s. What is its velocity when it is 6.0 m above its point of release?

Vector and Kinematics Notes

**3 - Graphs**

There is certain information that can be taken from position vs. time (d vs. t) and velocity vs. time (v vs. t) graphs.

**For Example:**

v vs. t graphs:

d vs. t graphs:

Given the information from the **v vs. t** graph we can complete the **x** and **a vs. t** graphs

In Physics 12 you will be expected to perform more advanced graphical analysis on tests and in labs. EVERY time you make a graph you should follow the following rules.

* Label the axis
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ variable on the x-axis
  + \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ variable on the y-axis
* Give the graph an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Scale each axis
  + Use…
  + Choose a scale that is…
* Plot the points and draw a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_.
* Determine if the curve is **\_\_\_\_\_\_\_\_\_\_\_\_\_\_** or not

Direct:

Quadratic :

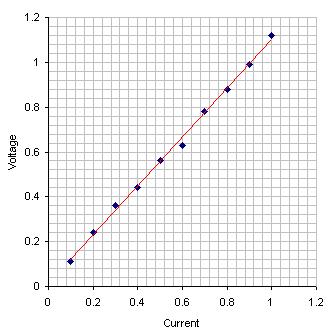
Inverse

Inverse Square

Square Root:



**Finding Slope**

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To find the slope of a straight line:

* Choose…
* Choose them as…
* Use only…

Remember the equation of a line is:

Determine the slope and y-intercept of the graph shown and write the equation describing this line.

**0.1**

**0.2**

**0.3**

**0.4**

**0.5**

**0.6**

Curve Straightening

Ex 2: An astronaut standing on an asteroid measures the force of gravity acting on a 10 kg mass at different distances from the center of the asteroid.

Ex 1: A car starts at a certain speed and accelerates uniformly. A student collects data of velocity at different displacements.

Ex 3: A student pushes a wooden block over a rough surface with different amounts of force and measures the acceleration each time.

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Vectors and Kinematics Notes

**4 – Vector Addition and Subtraction**

|  |  |
| --- | --- |
| SCALAR | VECTOR |
|  |  |

When we draw vectors we represent them as **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**.

Vector Addition

Whenever we add vectors we use...

To find the total or resultant vector, simply draw...

Ex: A student in a canoe is trying to cross a 45 m wide river that flows due East at 2.0 m/s. The student can paddle at 3.2 m/s.

a. If he points due North and paddles how long will it take him to cross the river?

b. What is his total velocity relative to his starting point in part a?

c. If he needs to end up directly North across the river from his starting point, what heading should he take?

d. How long will it take him to cross the river at this heading?

Vector Addition – Trig Method

In the previous example we added perpendicular vectors which gave us a nice simple right triangle.  
 In reality it’s not always going to be that easy.

Ex. A zeppelin flies at 15 km/h 30o N of E for 2.5 hr and then changes

heading and flies at 20 km/h 70o W of N for 1.5 hr. What was its final

displacement?

In order to solve non-right angle triangles, we will need to be familiar with the **Sine Law** and the **Cosine Law.**

**Sine Law:**

**Cosine Law:**

Vector Addition – The Component Method

There is another method that we can use when adding vectors. This method is a very precise, stepwise approach, however it is the only way we can add 3 or more vectors.

* **Draw** each vector
* **Resolve** each vector into x and y components
* Find the **total sum** of x and y vectors
* **Add** the x and y vectors
* **Solve** using trig

**REMEMBER:** When using x and y components…



Ex. An airplane heading at 450 km/h, 30° north of east encounters a 75 km/h wind blowing towards a direction 50° west of north. What is the resultant velocity of the airplane relative to the ground?

Airplane vector:

x-component:

y-component:

Wind vector:

x-component:

y-component:

Adding the two vectors:

x-components of resultant:

y-components of resultant:

Total resultant:

Vector Subtraction

With vectors a negative sign indicates…

When subtracting vectors we still draw them *tip to tail*, except…

We generally subtract vectors when dealing with a **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** in a vector quantity.

Recall:

Change =

Draw the Following

1) F1 + F2 2) d1 + d2 3) vf - vi 4) p2 – p1

p1

p2

vi

vf

d2

d1

F1

F2

Ex: A cyclist is traveling at 14 m/s west when he turns due north and continues at 10 m/s. If it takes him 4.0 s to complete the turn what is the magnitude and direction of his acceleration?

**5 - Projectile Motion Types 1, 2 and 3**

Y-components

In this case there is always a constant acceleration of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Because of this we need to use the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

X-components

There is no **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** working on the projectile in the X and the acceleration is always **\_\_\_\_\_\_\_\_\_\_\_\_\_**. Therefore the only equation we can ever use is:

The only value that can ever be used on both sides is **\_\_\_\_\_\_\_\_\_\_\_\_** because it is a **\_\_\_\_\_\_\_\_\_\_\_\_\_\_ .**

Problem Type 1:  
A student sits on the roof of their house which is 12 m high. She can launch water-balloons from a slingshot at 14.0 m/s. If she fires a water-balloon directly horizontally:

a. How long will it be airborne?  
*This depends on:*

b. How far forward will it travel?   
*This depends on:*

Example: A Cutlass Supreme drives straight out of a parking garage at 8.0 m/s and hits the water 3.4 s later.

a. How far did the car fall?

b. What was his **total** impact velocity? (magnitude and direction)

Problem Type 2: The Dukes of Hazzard are traveling at 85 km/h when they hit a jump that makes an angle of 25o above the horizontal.

a. How long are they airborne?   
b. How far forward do they fly through the air?  
c. What is their maximum height?

Example: A quarterback launches a ball to his wide receiver by throwing it at 12.0 m/s at 35o above horizontal.

a. How far downfield is the receiver?  
b. How high does the ball go?  
c. At what other angle could the quarterback have thrown the ball and reached the same displacement?

Problem Type 3:

Ex: A cannon is perched on a 48 m high cliff. It aims 30o above the horizontal and fires a shell at 52 m/s. Find:  
a) How long it takes for the sheel to hit the ground.  
b) The distance it lands from the base of the cliff.

Ex: A BMXer leaves a ramp traveling at 65 km/h at a trajectory of 40o above the horizontal. ***After*** reaching his max height he strikes the top of a building 5.8 m above the ground.  
a) What is the horizontal distance from the ramp to the building?  
b) What is his speed when he hits the building?