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

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?

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

v :
v_o :
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/s^2 for 8.00 s. What is its final velocity?

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

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

g = ___________

Note:

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?

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

<u>Vector and Kinematics Notes</u>

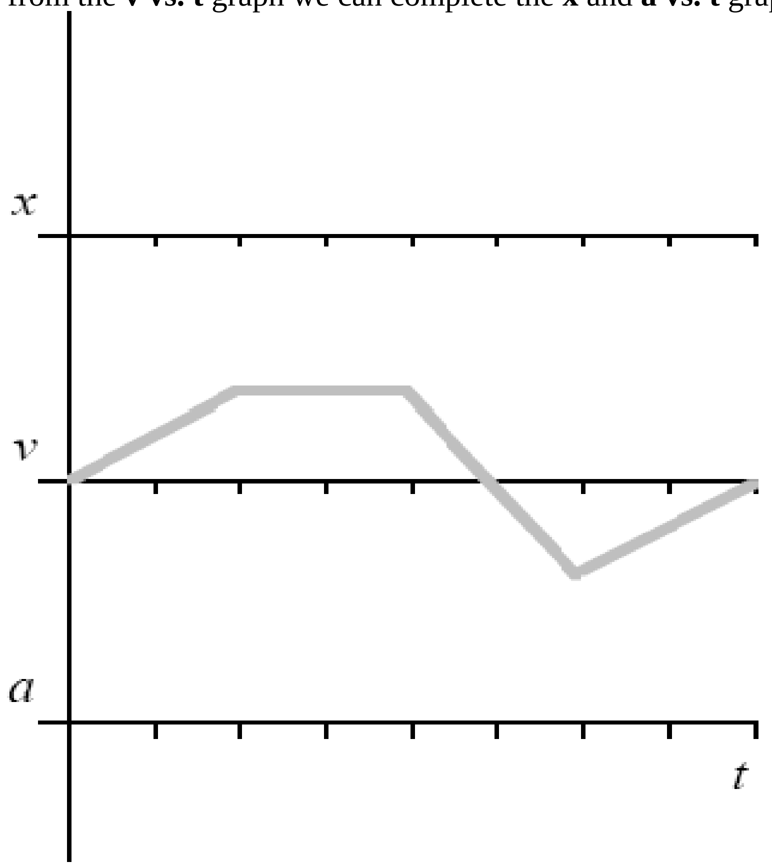
2 - Graphs

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:

<u>d vs. t graphs</u>:	<u>v vs. t graphs</u>:

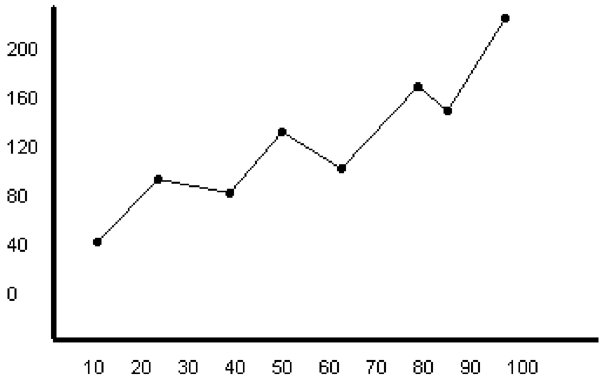
Given the information from the **v vs. t** graph we can complete the **x** and **a vs. t** graphs

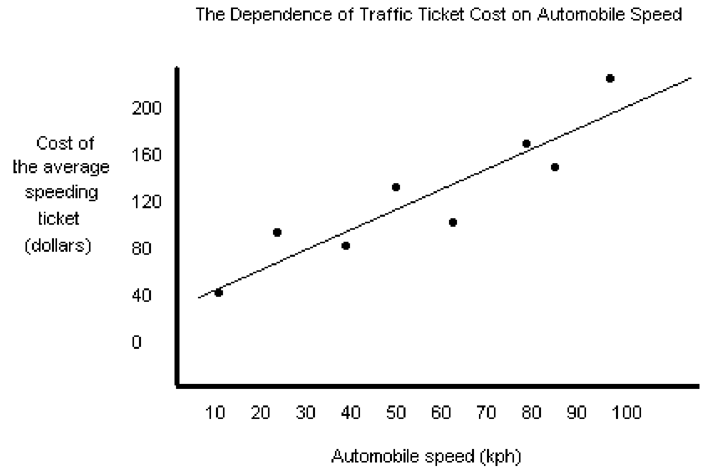


In Physics 12 you will be expected to perform more advanced graphical analysis on tests and in labs. EVERY time you make a graph you should follow the following rules.

- 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

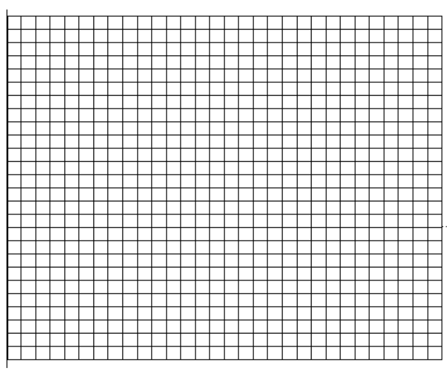
What's wrong with the graph on the left?



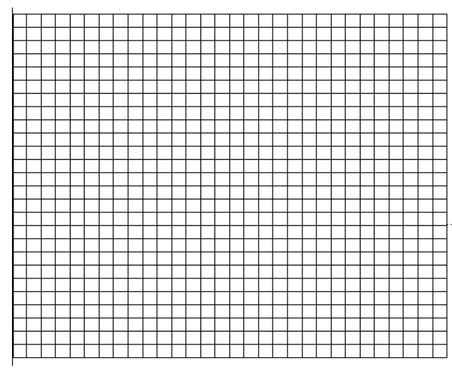


There are a 4 types of curve that you will be expected to recognize and manipulate

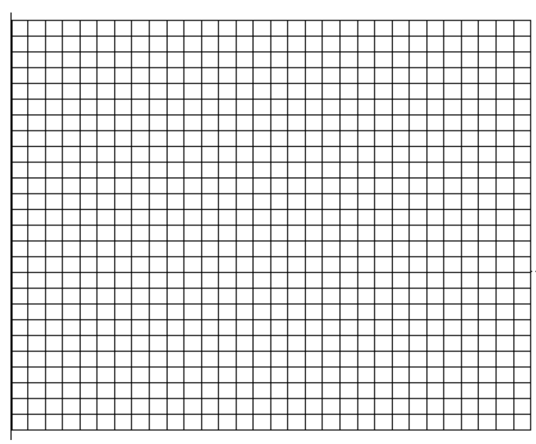
Direct Relationship:



Quadratic Relationship:



Inverse Relationship:



Inverse Square Relationship:

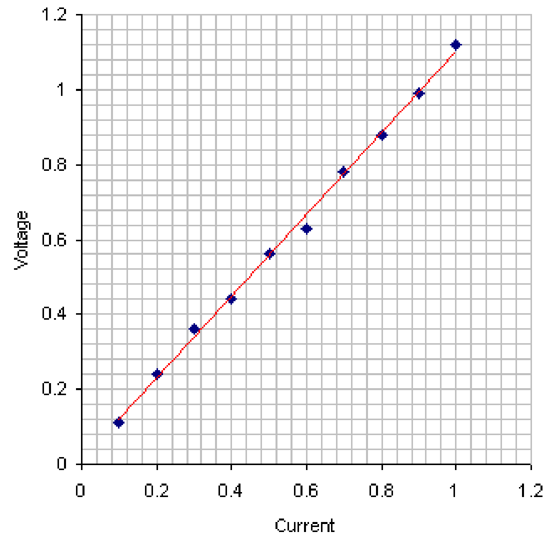
Finding Slope

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.



Curve Straightening

An astronaut on a Planet X drops his hammer and notes how far it falls each second. Plot a graph using the following data:

d (m)	t (s)
1.9	1
9.2	2
17.1	3
33.2	4
48.4	5

a. What relationship is this?

d (m)	$t^2 (s^2)$
1.9	
9.2	
17.1	
33.2	
48.4	

b. What relationship is this?

c. Calculate the slope.

d..What does the slope represent?

Vectors and Kinematics Notes

3 – Vectors and Navigation

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 block of wood sits on a desk. Student A pushes it with 10.0 N north and Student B pushes with 20.0 N west. What is the total force exerted on the block?

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 30^{o} N of E for 2.5 hr and then changes heading and flies at 20 km/h 70^{o} 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:

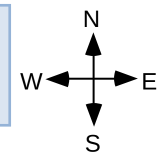
Vector Addition – The Component Method

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.

When adding two vectors using the component method, start with a vector diagram. Then resolve each vector to be added into its x and y components (the x and y are arbitrary – but more useful since they relate to a coordinate plane). **Trigonometry can be used to determine the horizontal and vertical components of vectors.**

REMEMBER:

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 that…

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

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?

Vectors and Kinematics Notes

4 – Relative Velocity and Navigation

Whenever we talk about displacement or velocity, we must specify the reference point or reference frame from which it is measured, to avoid confusion about the values of the d or v.

For example, suppose a person is traveling on a train at 50 km/h. The person walks in the direction of the train's motion with a speed of 5 km/h. Then a person outside of the train will see the person walking at a speed of ______. How can two people see different values for the same person?
When inside the train, our measurement of the speed is “relative to” or “with respect to” the train, while outside, our measurement of the speed is “relative to” or “with respect to” Earth.

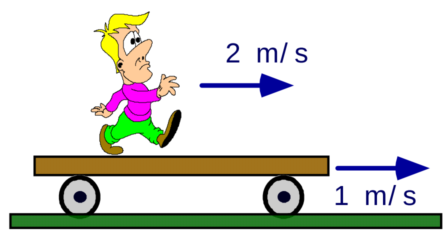
Calculating Relative Velocity with Reference Frames

A man walks to the right with a velocity of 2 m/s on a platform that moves with a velocity of 1 m/s to the right.

a) What is his velocity relative to the platform?

Reference frame: __________

$v_{person\text{-}platform}$ = __________ m/s



b) What is the person's velocity relative to the ground?

Reference frame: __________

$v_{person\text{-}ground} = v_{platform} + v_{person\text{-}platform}$

$v_{person\text{-}ground}$ = __________ m/s + __________ m/s

$v_{person\text{-}ground}$ = __________ m/s

Ex: A student in a canoe is trying to cross a 40.0 m wide river that flows to the east at 8.0 m/s. The student can paddle at 14.0 m/s.

a) If he points due north and paddles, how long will it take him to cross?
NOTE:

b) What will be his velocity (relative to his starting point) in part a?
NOTE:

c) If he needs to end up directly across from his starting point, what direction should he head?
NOTE:

d) In part c, how long will it take to cross the river?

Vector and Kinematics Notes

5 – Projectile Motion

Projectiles in 1-D
Ahh when life was simpler…

Ex: A hiker stands on the edge of a 25 m cliff and throws his backpack straight up at 15 m/s. Calculate its velocity just before it hits the bottom of the cliff.

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Projectiles in 2-D
They grow up so fast…☹

There are a few common variations on these old classics. Just remember that the x and y-components are ______________ and therefore _______________. For this reason we will **always** separate their data and calculations.

X-components	Nothing crosses this line or there will be trouble…	Y-components

The only value that can ever be used on both sides is _________________ because it is
____

Ex 1: A student sits on the roof of their house which is 12 m high. She can launch water-balloons from a slingshot at 25 m/s. If she fires a water-balloon directly horizontally:
a. How long will it be airborne?
b. How far will it travel?

** How long it is airborne only depends on:* ______________

** How far it travels in the x-direction depends only on:* ____________ *and* ____________

Ex 2: A quarterback launches a ball to his wide receiver by throwing it at 22.0 m/s at 35^o 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?

Ex 3: A cannon sits on a 65 m high cliff (typical Trask…so typical…). A cannonball is fired at 42 m/s 55^o above the horizontal.

a. How long is it airborne?

b. What is its final velocity?

c. What is its maximum height relative to the ground below?