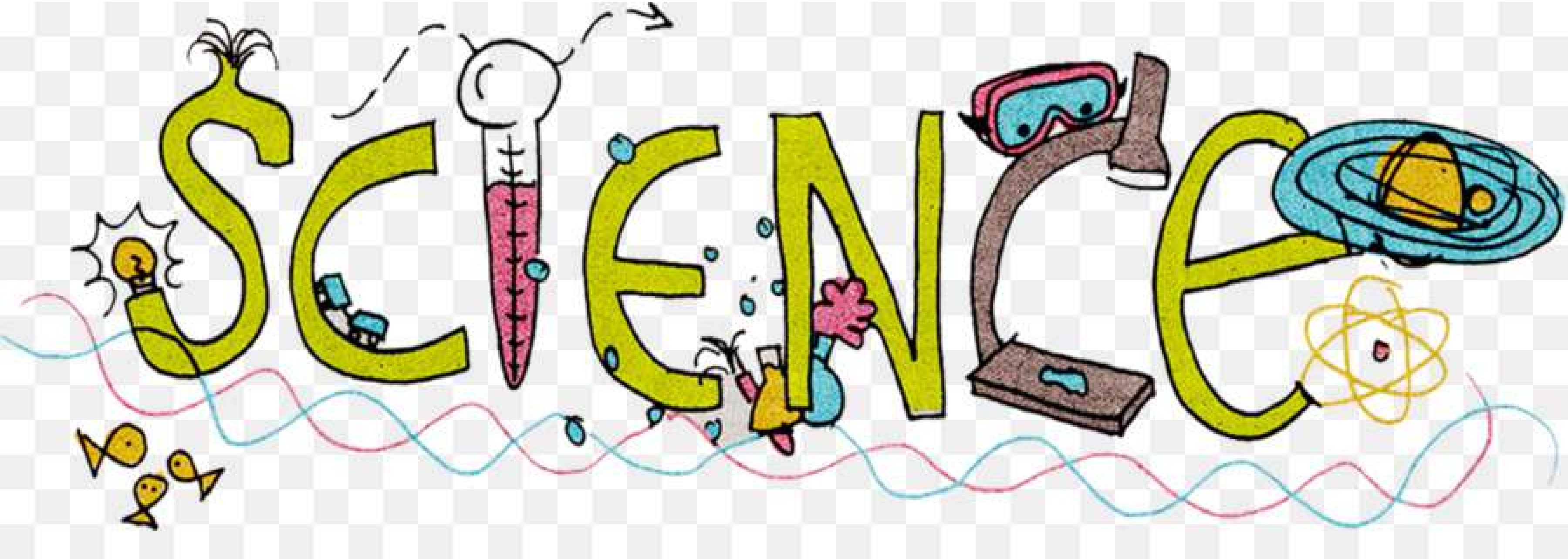
Teacher’s Notes - Reference

Physics

Ms. Givinsky and Ms. Hill

CLAIM - EVIDENCE - REASONING



- Divide your whiteboard into 3 sections
- Brainstorm about and describe “claim” “evidence” and “reasoning”

In science, the CLAIM always

- Directly answers the question
- Is a complete sentence
- Is brief/straightforward and doesn’t explain

In science, the EVIDENCE always is written in complete sentences and...

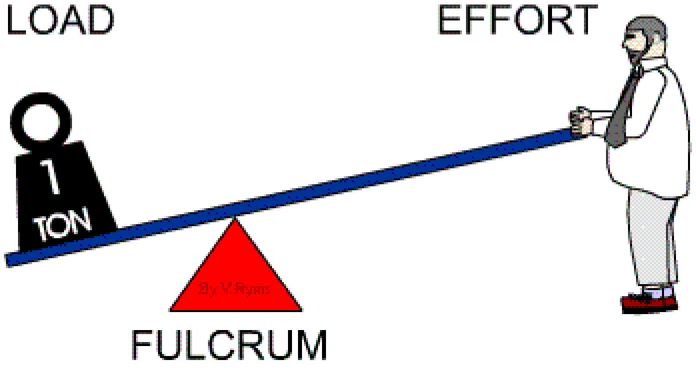
- Includes data (numbers)
- Is related to the claim
- Shows change or comparison

In science, the REASONING always is written in complete sentences and...

- Explains how the evidence supports the claim
- Uses scientific terminology and definitions
- Avoids the word “it”

Write a claim that answers the question: Does using levers make work easier?

Give evidence from the data table to support your claim.



Load distance from fulcrum	Effort distance from fulcrum	Force required to lift object
5 cm	10 cm	0.8 N
20 cm	10 cm	4.3 N
10 cm	5 cm	5.3 N
10 cm	20 cm	1.3 N

Control - when no lever was used, the force required to lift the object was 2.2 N

Check your work:

CLAIM

- Is a complete sentence?
- Answers the question?
- Is brief?
- Does not attempt to explain?

EVIDENCE

- Includes data/numbers?
- Relates to the claim (same variables)?
- Shows change or comparison?

Write a claim that answers the question: Which body part is the most painful place for a bee sting?

Give evidence from the data table to support your claim.

Body part	Pain rating (scale of 1-10)
Nostril	9
Back	4.8
Upper lip	8.7
Arm	5
Leg	6.2
Hand	7.5

Check your work:

CLAIM

- Is a complete sentence?
- Answers the question?
- Is brief?
- Does not attempt to explain?

EVIDENCE

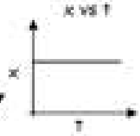
- Includes data/numbers?
- Relates to the claim (same variables)?
- Shows change or comparison?

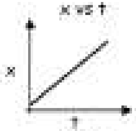
MOTION GRAPH SUMMARY

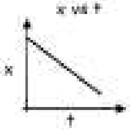
X vs t Graphs

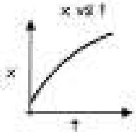
Some quick rules

- The slope of the x vs t graph gives the value for the v vs t graph
- No slope (slope = zero) means object is not moving, velocity = 0.
- **Upward (+) slope** means velocity is positive
- **Downward (-) slope** means velocity is negative
- **Constant slope** means velocity is constant AND acceleration is ZERO
- **Increasing slope** (curved, getting steeper) means Increasing velocity AND + acceleration
- **Decreasing slope** (curved, flattening out) means Decreasing velocity AND – acceleration
- **Steeper slope means higher velocity**





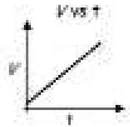


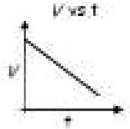


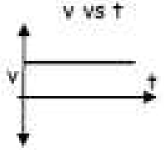
V vs t Graphs

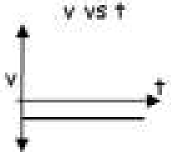
Some quick rules

- V vs t graphs will always be straight lines (not necessarily horizontal)
- The slope of the v vs t graph gives the value for the a vs t graph
- **Upward (+) slope** means velocity is increasing and acceleration is positive
- **Downward (-) slope** means velocity is decreasing acceleration is negative
- **A Constant** means velocity is constant AND acceleration is ZERO
    - **Positive Velocity** – above the independent (horizontal) axis
    - **Negative Velocity** – below the independent (horizontal) axis









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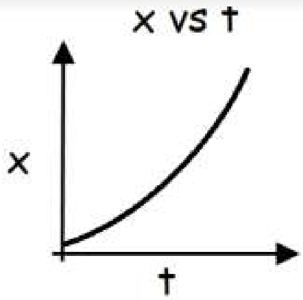
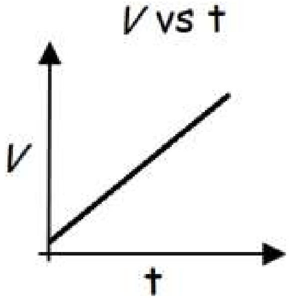
Here we start with the x vs t graph shown and determine the shape of the V vs t graph and the a vs t graph.



Describe the x vs t graph:

1) Is the graph going up (increasing), down (decreasing) or staying the same (constant)?
2) If increasing or decreasing, is the **slope** increasing (getting steeper) , decreasing (becoming less steep), or constant?

[✓ Increasing] Decreasing Constant	AT A(N)	[✓ Increasing] Decreasing Constant	RATE



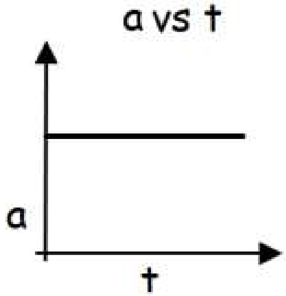
The words chosen above describe the V vs t graph.

FIRST: Increasing means the V vs t graph is positive (above the horizontal axis)

SECOND: Increasing means the slope is positive (going up)

Now describe the V vs t graph with the same questions as above:

[✓ Increasing] Decreasing Constant	AT A(N)	Increasing Decreasing [✓ Constant]	RATE



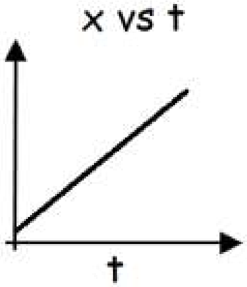
The words chosen above describe the a vs t graph.

FIRST: Increasing means the a vs t graph is positive (above the horizontal axis)

SECOND: Constant means the graph has a slope of zero (all a vs t graph will have a slope of zero)

EXAMPLE 2

Here we start with the x vs t graph shown and determine the shape of the V vs t graph and the a vs t graph.

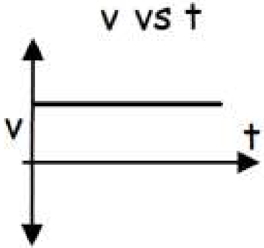


Describe the x vs t graph:

1) Is the graph going up (increasing), down (decreasing) or staying the same (constant)?

2) If increasing or decreasing, is the **slope** increasing (getting steeper) , decreasing (becoming less steep), or constant?

[✓ Increasing] Decreasing Constant	AT A(N)	Increasing Decreasing [✓ Constant]	RATE



The words chosen above describe the V vs t graph.

FIRST: Increasing means the V vs t graph is positive (above the horizontal axis)

SECOND: Constant means the slope is constant (not changing)

Now describe the V vs t graph with the same questions as above:

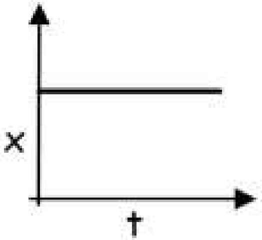
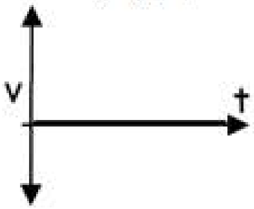
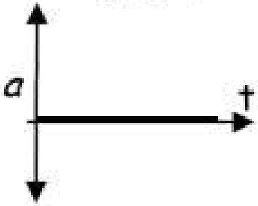
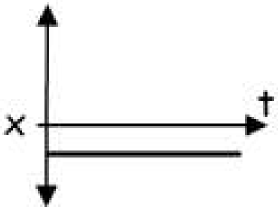
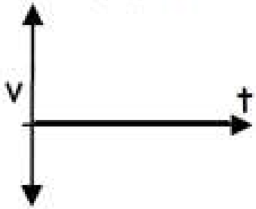
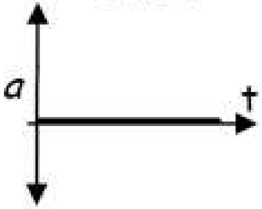
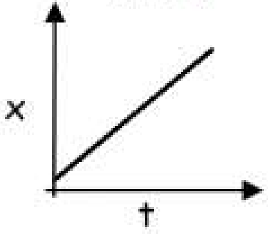
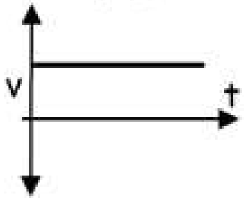
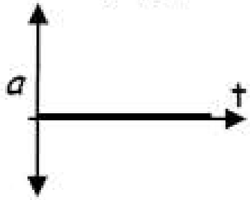
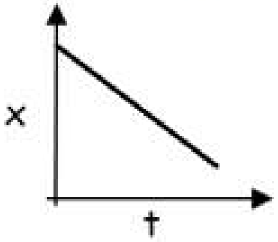
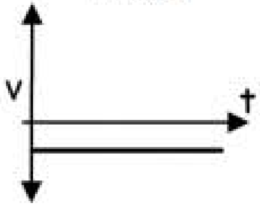
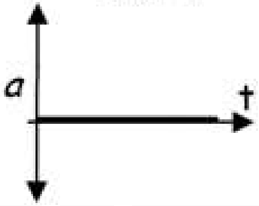
Increasing Decreasing [✓ Constant]	AT A(N)	Increasing Decreasing Constant	RATE

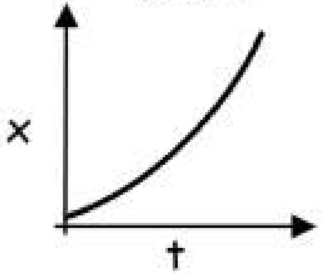
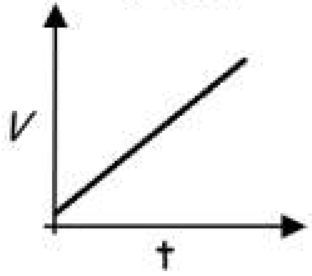
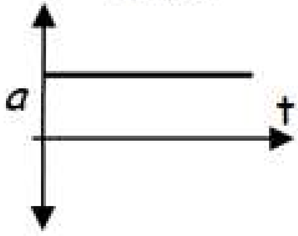
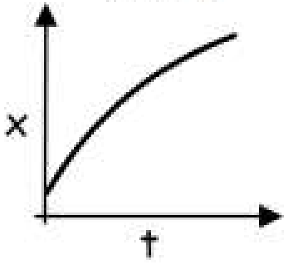
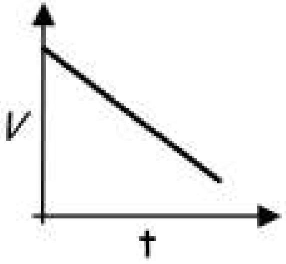
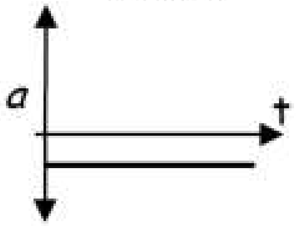
The words chosen above describe the a vs t graph.

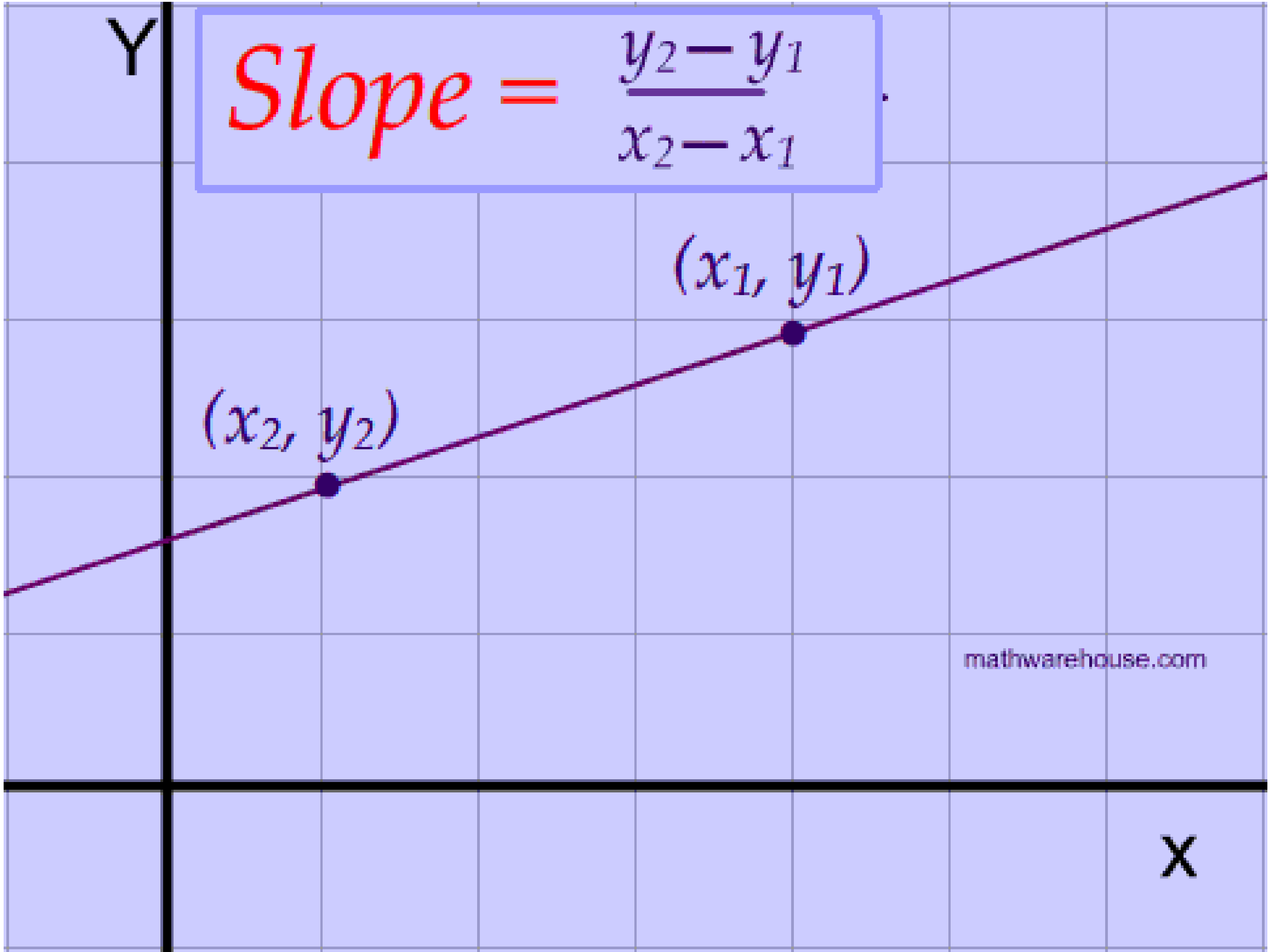
FIRST: CONSTANT this means acceleration is ZERO

SECOND:

SUMMARY OF VARIOUS SCENERIOS

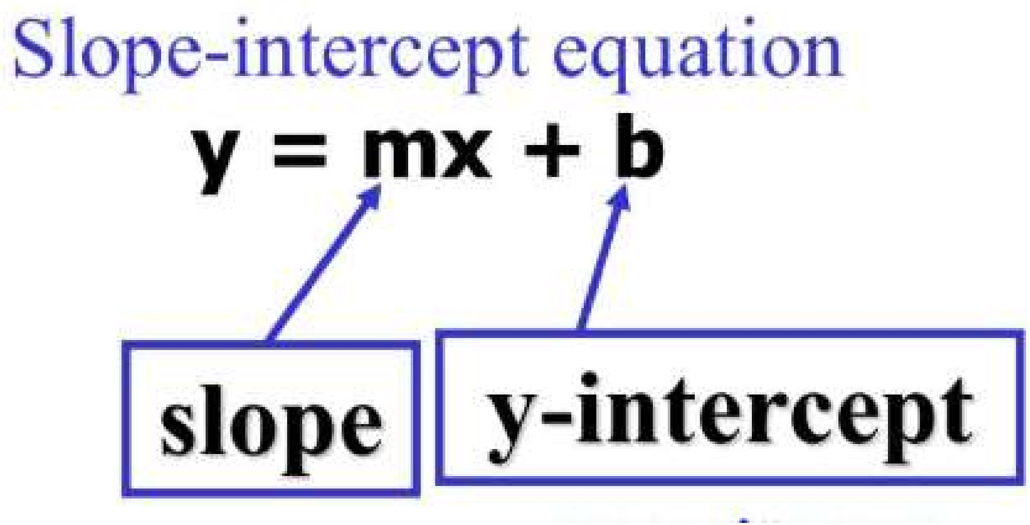
Stationary Object at a positive location	Stationary Object at a negative location	Object moving with a positive constant velocity	Object moving with a negative constant velocity
x vs t  v vs t  a vs t  	x vs t  v vs t  a vs t  	x vs t  v vs t  a vs t  	x vs t  v vs t  a vs t 

Accelerating Object	Decelerating Object	Some quick observations:
x vs t  V vs t  a vs t  	x vs t  V vs t  a vs t  	Only _____ vs t graphs are curved. They are curved when the velocity is ________ing. Curving up is a positive _____________ion. Curving down is a ____________ acceleration. V vs t graph will always be ___________ lines but not always horizontal. a vs t graphs will always be straight _____________al lines.


Y
$Slope = \frac{y_2 - y_1}{x_2 - x_1}$
(x_1, y_1)
(x_2, y_2)
mathwarehouse.com
X

There are three steps in calculating the slope of a straight line when you are not given its equation.

1. **Step One:** Identify two points on the line.
2. **Step Two:** Select one to be (x_1, y_1) and the other to be (x_2, y_2).
3. **Step Three:** Use the slope equation to calculate slope.

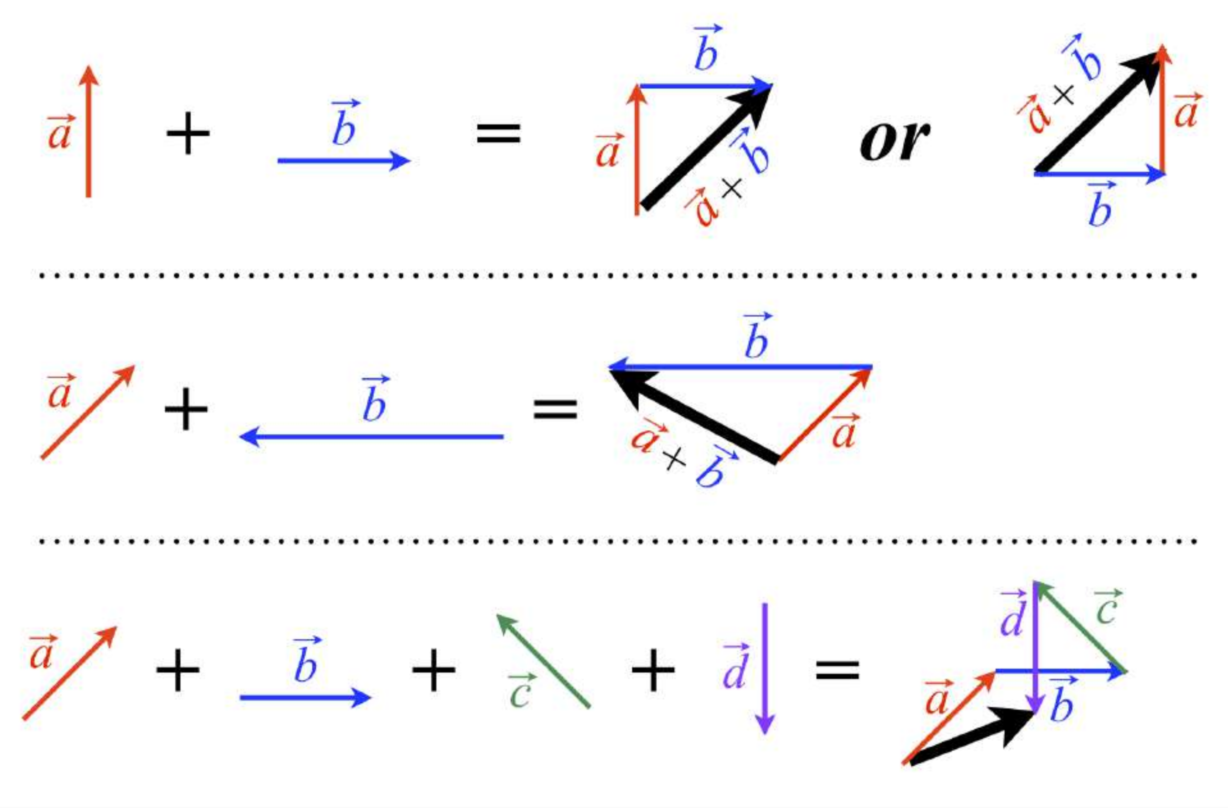


Vectors

Brainstorm

Think back to the bowling ball lab- what did you have to do to make the bowling ball stop? To turn left sharply? Describe and draw both on your board.

The diagrams below are called "vector diagrams". We use them when we study forces.



What do you think the rules are for drawing vector diagrams?

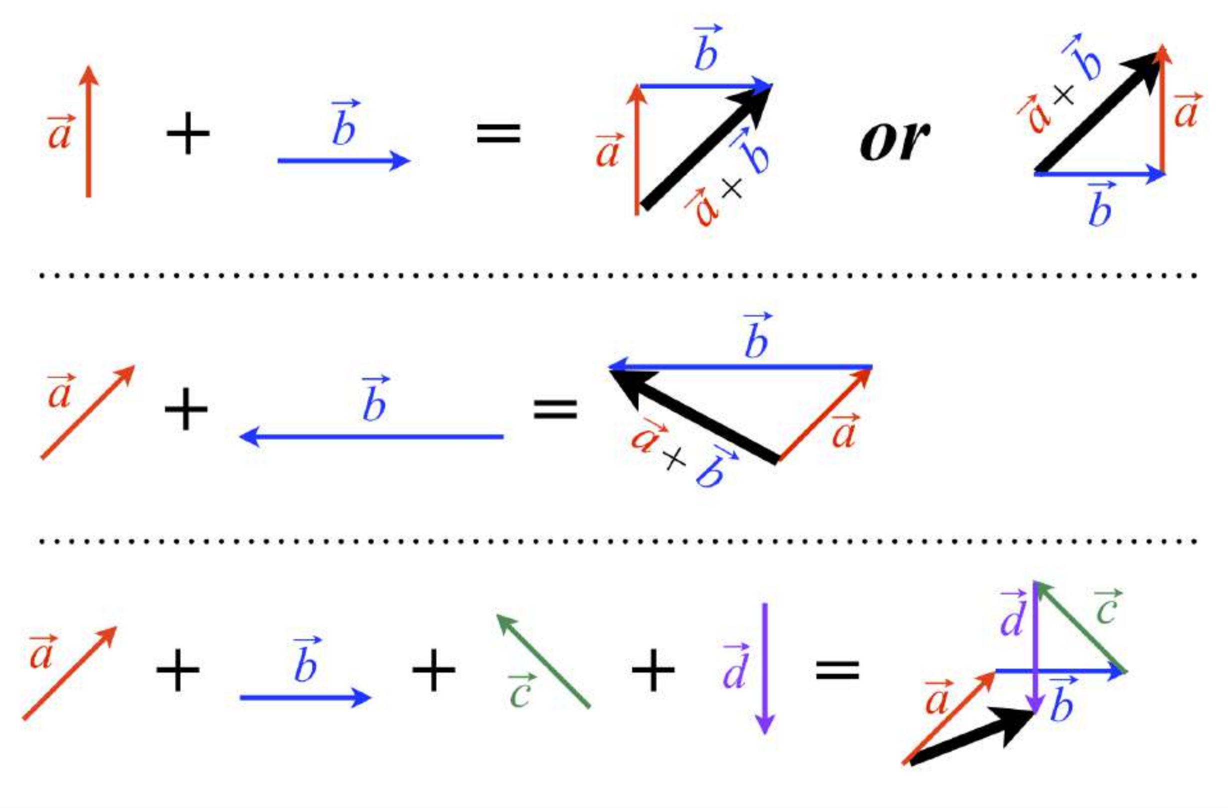


Diagram Rules

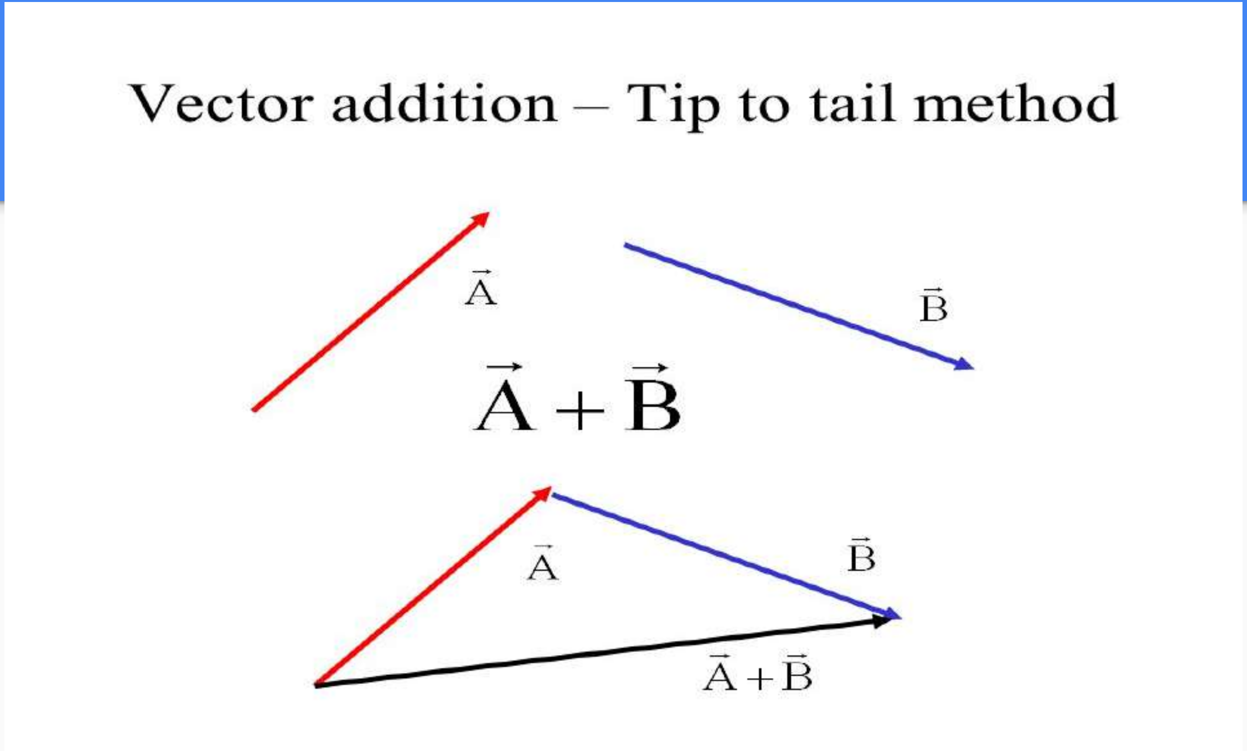
1. Draw all vectors as arrows. The size of the arrow should match the size of the quantity (small arrows for small quantities and larger arrows for large quantities).

Diagram Rules

2. Draw all component vectors from head to tail. Some problems are very complex with more than two vectors. Just keep drawing the vectors according to the directions.

Diagram Rules

3. Draw the resultant from the tail of the first vector drawn to the head of the last vector drawn.



Vector addition – Tip to tail method

$$\vec{A} + \vec{B}$$

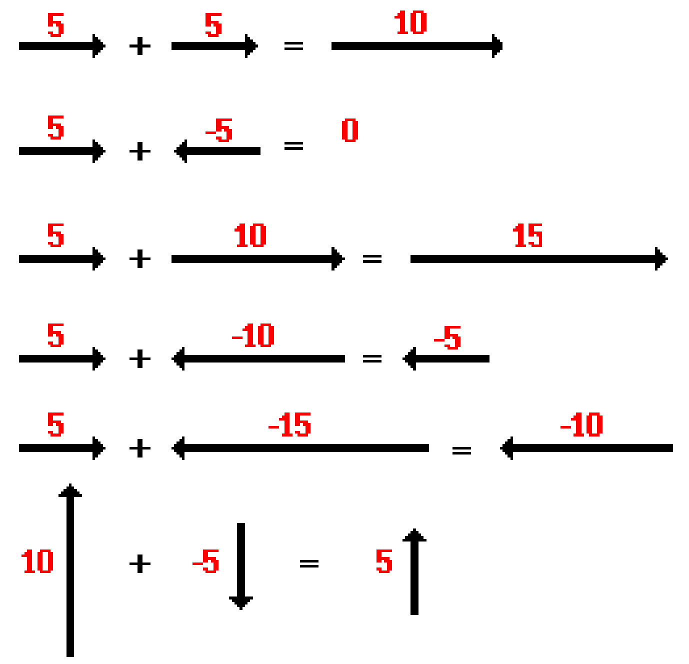
Math Rules

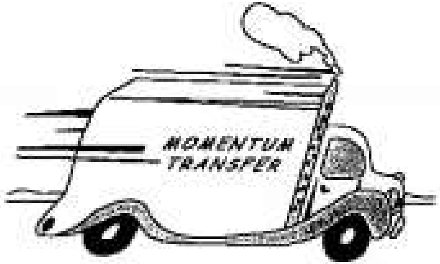
1) When the component vectors go in the same direction, you simply ADD them together to get the resultant. The direction is the same (south components mean a south resultant).

Math Rules

2. When the component vectors are in the opposite direction, you SUBTRACT them to get the resultant. The direction of the larger vector is the direction of the resultant.

Examples





"CRASH COURSE" ACTIVITY

"Understanding Car Crashes
It's Basics Physics"

Video Discussion Questions

Teacher
Post-Video
Answers

Directions:

After viewing the video, answer the following questions in the space provided. Be prepared to discuss your responses with your classmates while in small groups or as an entire class.

Post-Video "Crash" Questions

1. Ever tried to stop a 150 pound (68 kg) cannonball fired towards you at 30 mph (48 km/hr.)? No, probably not. But you may have tried to brace yourself in a car collision. How are the two situations similar?

   Both you and the cannonball have momentum based upon mass and velocity. If you are traveling 30 mph and weigh 150 pounds your momentum would equal the cannonball's. In a major collision, it is impossible to prevent injuries by bracing yourself. No matter how strong you think you are, you are not strong enough to stop your inertia during a collision.

2. Show mathematically why an 80,000 pound (36,000 kg) big rig traveling 2 mph (0.89 m/s) has the SAME MOMENTUM as a 4,000 pound (1,800 kg) sport utility vehicle traveling 40 mph (18 m/s).

   Momentum is the product of an object's mass and velocity. The formula is p = mv. The product of each is equivalent.

   The SI unit for momentum is the kilogram x meter/second (kg x m/s).

   Truck momentum = (36,000 kg)(0.89 m/s) = 32,000 kg x m/s

   SUV momentum= (1,800 kg)(18 m/s) = 32,000 kg x m/s

3. During the Egg-Throwing Demonstration, which egg experienced the greater impulse, the egg that hit the wall or the bed sheet? (Be careful here!) Which egg experienced the greater force of impact? Which egg experienced the greater time of impact?

   If their momenta are equal before the collisions (same mass and velocity), both eggs experience identical impulses because both are stopped by the collision.

   The egg that hit the crash barrier experienced the greater impact force due to the shorter impact time.

   The egg that collided with the bed sheet experienced the greater time of impact, thereby experiencing a smaller stopping force over a longer time interval.

4. Explain how the fortunate race car drivers survived their high speed accidents.

   The impulse that the wall applied to both cars was identical BUT remember impulse is the force of impact multiplied by the time of impact. With the fortunate driver, the identical impulse was a product of a small force extended over a long period of time.

5. Describe other examples where momentum is reduced by applying a smaller collision force over a longer impact time (or where things "give way" during a collision to lessen the impact force)?

   Answers will vary. Some examples: Bungee jumping; trampolines; trapeze safety nets; falling on grass compared to concrete; many football players prefer the "give" of natural grass to the harder artificial turf.

6. Which would be more damaging to your car: having a head-on collision with an identical car traveling at an identical speed or driving head on into the Vehicle Research Center's 320,000 pound (145,455 kg) deformable crash barrier? Explain.

   Both crashes produce the same result. Either way the car rapidly decelerates to a stop. In a head-on crash of identical cars traveling at equal speeds, the result is equal impact forces and impact times (according to Newton's Third Law of Motion), and therefore equal changes in momenta. Using a crash barrier is more cost efficient.

7. Show mathematically why a small increase in your vehicle's speed results in a tremendous increase in your vehicle's kinetic energy. (For example: doubling your speed from 30 mph to 60 mph results in a quadrupling of your kinetic energy.)

   The velocity is squared in the equation; therefore if the speed is first doubled then squared, its kinetic energy must quadruple to keep the equation balanced.

   $KE = 1/2\ mv^2 \qquad 4KE = 1/2\ m2v^2$

8. The Law of Conservation of Energy states: energy cannot be created or destroyed; it can be transformed from one form to another but the total amount of energy never changes. Car crashes can involve huge amounts of energy. How does the crashworthiness of the car affect the transfer and transformations of the energy and, ultimately, protect the occupants?

   In a crash of a well designed car, the kinetic energy does the work that crushes the car's crumple zones. Some of the energy also becomes heat and sound generated by the crash. The safety cage must be strong enough to resist the forces that arise during the crash so that it holds its shape and allows the restraint system to do its job.