Helpful Reminders:

$$(5\ m/s^2) = 5\ m/s^2$$

$$(-5\ m/s^2) = -5\ m/s^2$$

$$(-5m/s\ )^2 = 25\ m^2/s^2$$

Distribute the square!

$$5\ m/s^2 \neq 25\ m/s \neq 25\ m^2/s^2$$

The square here is ONLY attached to seconds!

Kinematic Equations

- **Remember kinematics is the science of describing the motion of objects using words, diagrams, numbers, graphs, and equations.**
- **The kinematic equations are a set of three equations which can be utilized to determine unknown information about an object's motion if other information is known.**
- **The equations can be utilized for any motion which can be described as being either a constant velocity motion (an acceleration of 0 m/s²) or a constant acceleration motion.**

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- **The kinematic equations can never be used over any time period during which the acceleration is changing.**
- **There are a variety of quantities associated with the motion of objects - displacement, velocity (final and initial), acceleration, and time.**
- **Each of the kinematic equations includes four of these variables; if the values of three of the four variables are known, then the value of the fourth variable can be calculated.**

First Kinematic Equation

$$v_f = v_i + at \qquad \cancel{\Delta x}$$

Where:

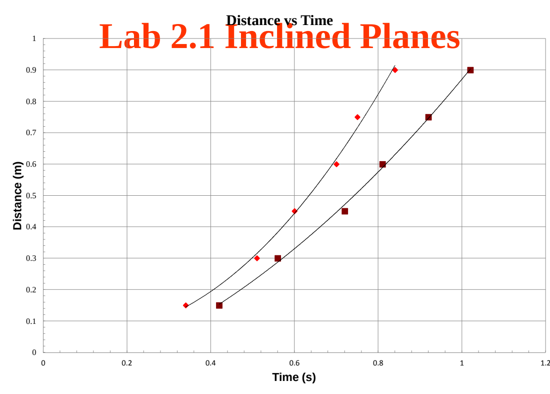
v_f = final velocity

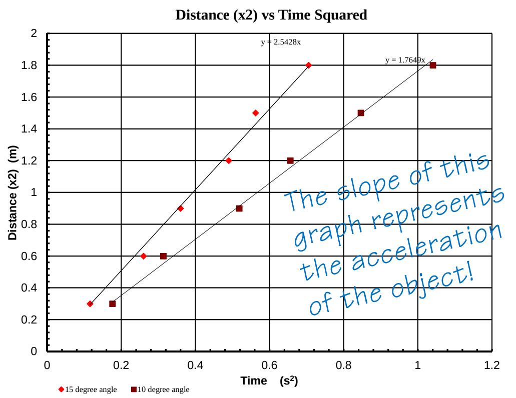
v_i = initial velocity

a = acceleration

t = time

Lab 2.1 Inclined Planes





Second Kinematic Equation

$$\Delta x = v_i t + \tfrac{1}{2} a t^2 \qquad \cancel{v_f}$$

Where:

Δx = displacement

a = acceleration

v_i = initial velocity

t = time

Third Kinematic Equation

$$v_f^{\,2} = v_i^{\,2} + 2a\Delta x \qquad \cancel{t}$$

Where:

v_f = final velocity

a = acceleration

v_i = initial velocity

Δx = displacement

Kinematic Equations and Problem Solving

1. **Construct an informative diagram of the physical situation. (*Draw a picture.*)**
2. **Identify and list the known information in variable form.**
3. **Identify and list the wanted unknown information in variable form, make a note of the unnecessary unknown info.**

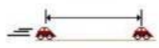
Kinematic Equations and Problem Solving

4. **Choose the naked formula based on what variable it *leaves out*.**
5. **Substitute known values with units into the equation and use appropriate algebraic steps to solve for the unknown information.**
6. **Check your answer to insure that it is reasonable and mathematically correct.**

Example A

- **Ima Hurryin is approaching a stoplight moving with a velocity of +30.0 m/s. The light turns yellow, and Ima applies the brakes and skids to a stop. If Ima's acceleration is -8.00 m/s², then determine the displacement of the car during the skidding process. (Note that the direction of the velocity and the acceleration vectors are denoted by a + and a - sign.)**

Diagram the problem



Determine known and unknown

V_i = 30 m/s $\quad a$ = -8.0 m/s^2

V_f = 0 m/s $\quad \Delta X$ = ???

Chose the correct kinematic equation:

$$V_f^{\,2} = V_i^{\,2} + 2a\Delta X$$

$$v_f^{\,2} = v_i^{\,2} + 2a\Delta x$$

Insert the correct values and solve.

$$(0m/s)^2 = (30m/s)^2 + 2(-8.0m/s^2)\Delta X$$

$$0m^2/s^2 = 900m^2/s^2 + (-16.0m/s^2)\Delta X$$

$$-900m^2/s^2 = (-16.0m/s^2)\Delta X$$

$$\frac{-900\ m^2/s^2}{-16\ m/s^2} = \Delta x$$

$$\boxed{\Delta x = 56.25\ m}$$

Example B

- **Ben Rushin is waiting at a stoplight. When it finally turns green, Ben accelerated from rest at a rate of a 6.00 m/s^2 for a time of 4.10 seconds. Determine the displacement of Ben's car during this time period.**

Diagram the problem

Determine known and unknown

V_i = 0 m/s $\quad a$ = 6.0 m/s^2

t = 4.10 s $\quad \Delta X$ = ???

Chose the correct kinematic equation:

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

$$\Delta x = \overset{0}{\cancel{v_i}}t + \frac{1}{2}at^2$$

Insert the correct values and solve.

$$\Delta x = \frac{1}{2}(6.00\ m/s^2)(4.10\ s)^2$$

$$\Delta x = (3.00\ m/s^2)(16.81\ s^2)$$

$$\boxed{\Delta x = 50.43\ m}$$

Will Bambi Survive????

Mr. Evans is traveling at 70 mi/hr; as he rounds a curve he sees Bambi standing in the road 75 meters away. He hits his brakes with an acceleration of –4.8 m/s^2. Can he stop or will Bambi be on the road kill menu at the cafeteria?

Will Bambi Survive????

Known:

V_i = 70 mi/hr

ΔX = 75 m

a = -4.8 m/s^2

Unknown:

V_f = ??

t = ??

$$V_f = V_i + at$$

$$\Delta X = V_i t + \tfrac{1}{2} a t^2$$

$$V_f^{\,2} = V_i^{\,2} + 2a\Delta X$$

$\xrightarrow[75\text{ m}]{-4.8\text{ m/s}^2}$

70 mi/hr = 31.1 m/s

V_f = ??

You might choose to use the 3rd Kinematic equation:

$$V_f^{\,2} = V_i^{\,2} + 2a\Delta X$$

$$V_f^{\,2} = (31.1 m/s)^2 + 2(-4.8 m/s^2)75 m$$

$$V_f = +/-15.72 m/s$$

Which means not only did Mr. Evans run over Bambi, but he backed up and ran over Bambi from the other direction!!

$\xrightarrow[\Delta X\ ? \leq 75m]{-4.8\text{ m/s}^2}$

70 mi/hr = 31.1 m/s

V_f = 0m/s

Or you could choose to use the 3rd Kinematic equation and set the final velocity to 0 m/s; solve for displacement to see if it is less than or greater than 75 meters:

$$V_f^{\,2} = V_i^{\,2} + 2a\Delta X$$

$$(0m/s)^2 = (31.1m/s)^2 + 2(-4.8m/s^2)\Delta X$$

$$100.75m = \Delta X$$

Which means Bambi did not survive!!

Practice

- A Ferrari traveling 35 m/s to the west comes to a stop in 3.4 seconds. What was the Ferrari's acceleration?

Known:

V_i = -35 m/s

V_f = 0 m/s

t = 3.4 s

Unknown:

a = ??

$$V_f = V_i + at$$

$$0\,m/s = -35\,m/s + a\,3.4\,s$$

$$35\,m/s = a\,3.4\,s$$

$$a = 10.29\,m/s^2$$