THE UNIVERSITY OF NEW MEXICO

Engineering Student Success Center | CAPS

Start Your Semester Off Right

Join us for a *FREE*

Pre-Semester Prep Workshop Series

These interactive workshops will review all foundational material leading up to the specified course so you are better equipped to hit the ground running.

Synchronous in-person in the ESS suite (ABQ Main Campus) & virtual via Zoom

College Algebra Prep	Monday, January 13, 2025	10 AM - 12 PM
*Pre-Calc/Trig Prep	Monday, January 13, 2025	1 - 3 PM
*Calc 1 Prep	Tuesday, January 14, 2025	10 AM - 12 PM
*Calc 2 Prep	Wednesday, January 15, 2025	10 AM - 12 PM
Calc 3 Prep	Thursday, January 16, 2025	10 AM - 12 PM
Math working session	Thursday, January 16, 2025	1 - 3 PM
Chem 1 Prep	Friday, January 17, 2025	10 AM - 12 PM
*Physics 1 Prep	Friday, January 17, 2025	1 - 3 PM

**Attend these sessions & give feedback for access to a general knowledge exam.*

RSVP is preferred but not required

ess.unm.edu/events > January

or through our web-app - succESS

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Physics 1 Prep

(for PHYS 1310)

Presented by:

Bryan & Paul Tice

ENGINEERING STUDENT SUCCESS CENTER

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ENGINEERING STUDENT SUCCESS CENTER

A tool for engineering your

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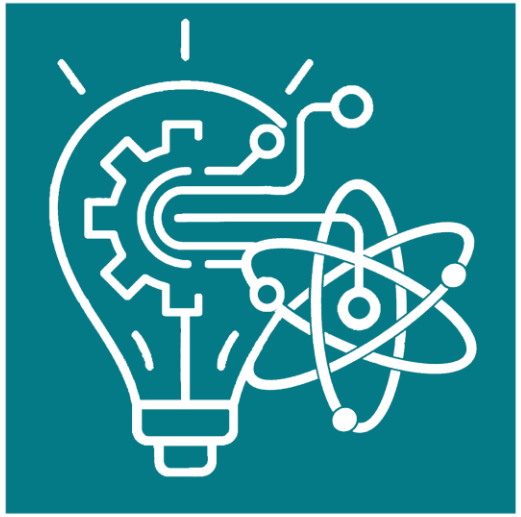
This web APP allows you to keep up to date on all we have to offer.



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Includes 1-click RSVP

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ENGINEERING STUDENT SUCCESS CENTER

You are WELCOME to ALL events

Spring 2025 Events

We are Student Success

Pre-Semester Prep Series
Algebra through Calc 3, Chem 1, Physics 1

Semester Long Programs
Mentoring, Internships, Research

Pizza & Presentation Prep Series
What is a Conference?
Designing Effective Presentations
Data Visualization
Delivering Presentations

1st & 2nd Year Student Events
Student Bash & Find Your Pack
STEM Mixer
How to make the most of your learning
Manage Your Time
Study Skills
Fundamentals of MATLAB
Basic Excel

Career and Professional Development Events
Building Connections & Networking
Resumes and Cover Letters
Interviewing Basics
Landing an internship
So, What's Next? Start-Ups, Patents, and Publications
...and industry site visits...

Additional Events
JEADI Summit
UROC - Attendance Participation
Engineering Expo

Lab Safety Series
Hazard Communication & Hazard Evaluation
Hierarchy of Controls & Basics of PPE
Chemical Waste Management

And more! For more details, visit:
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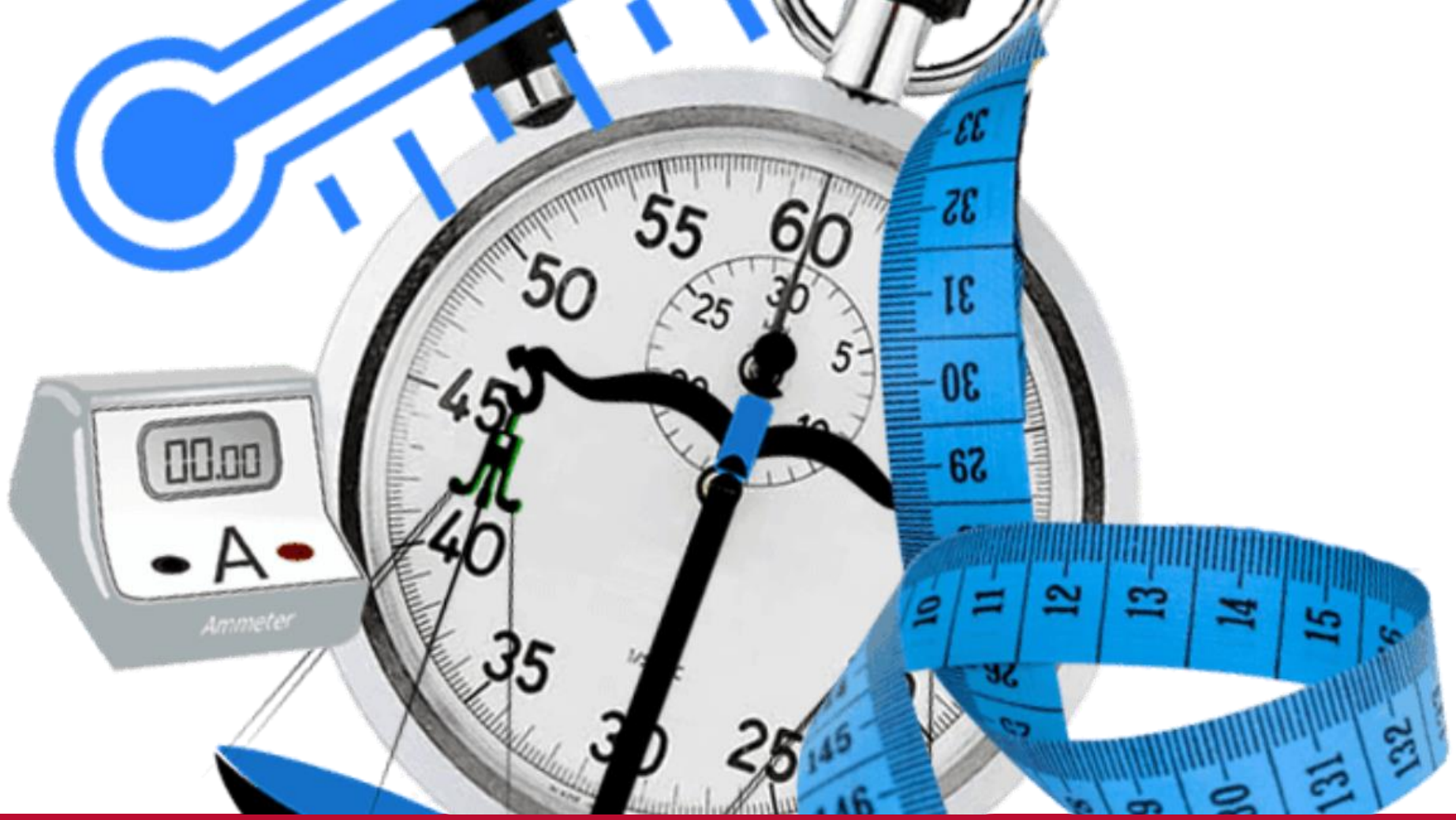
WIN a gift card. **GAIN** experience.
BUILD your skill set. **ENHANCE** your resume.

Outline

- Units
- Graphs
- Motion
- Geometry/Trigonometry in physics
- How to approach word problems



Units

A standard of measurement of physical quantities

What are Units?

Scalar

Volume

Time

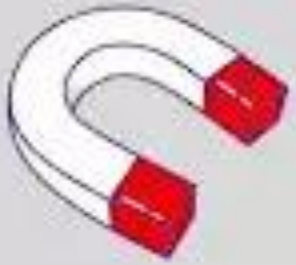
Tempereture

Speed

Vector

Weight

Thrust

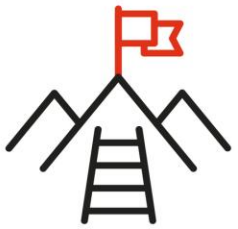


Magnetic field

Velocity

What are physical quantities?

STIMULATING WORK

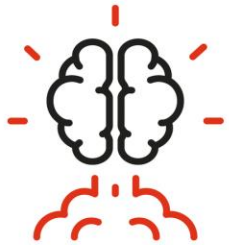


DETERMINATION

COURAGE

THOUGHTFULNESS

VISIONARY



CREATIVITY

EMPATHY

PROBLEM SOLVING

STRATEGIC PLANNING

COMMUNICATION

INSPIRATION

POSITIVITY

HONESTY

EXPERTISE

DISCIPLINE

What are NON-physical quantities?

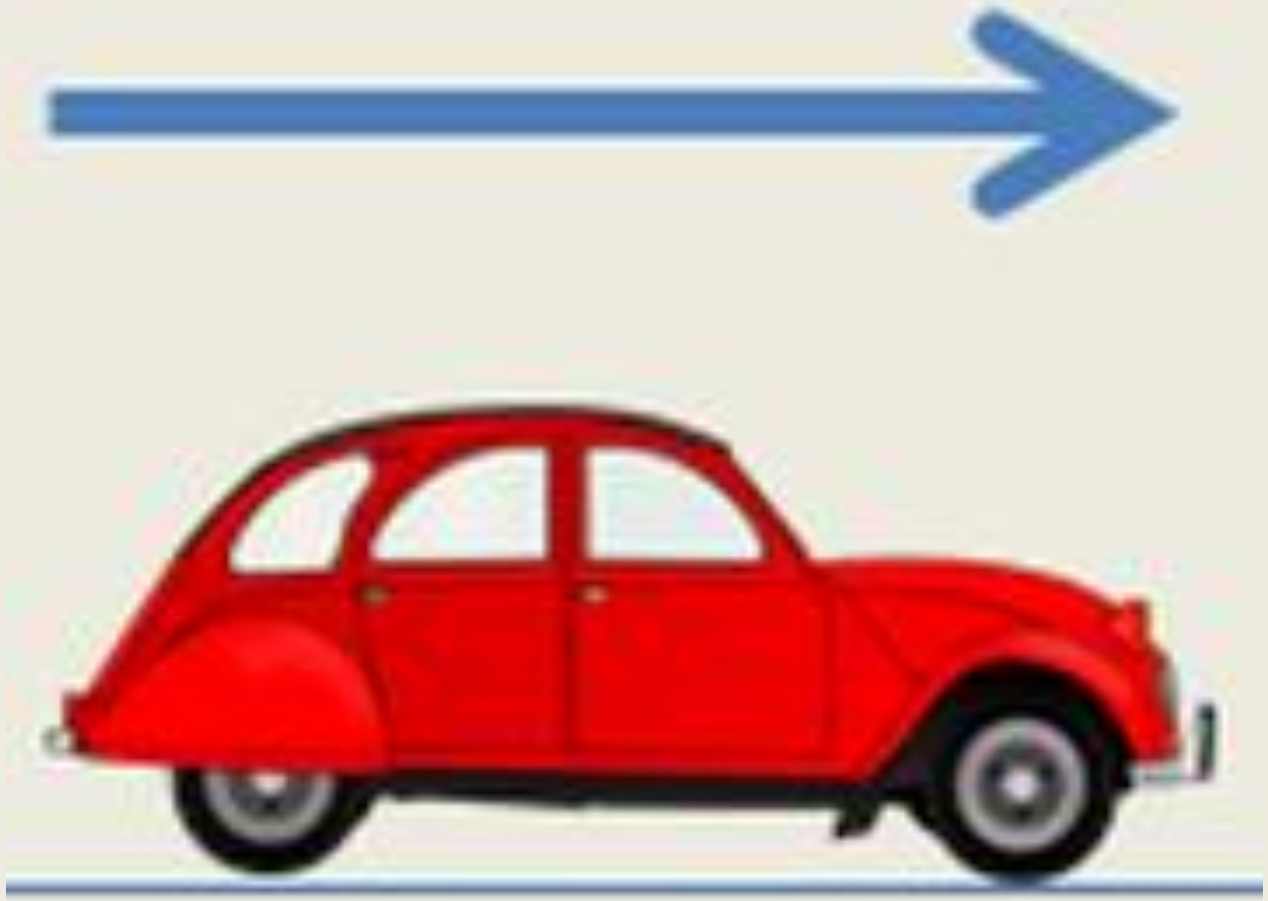
What are SI units?

Base Quantity	Name	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Electric Current	Ampere	A
Temperature	Kelvin	K
Amount of Substance	Mole	mol
Luminous Intensity	candela	cd

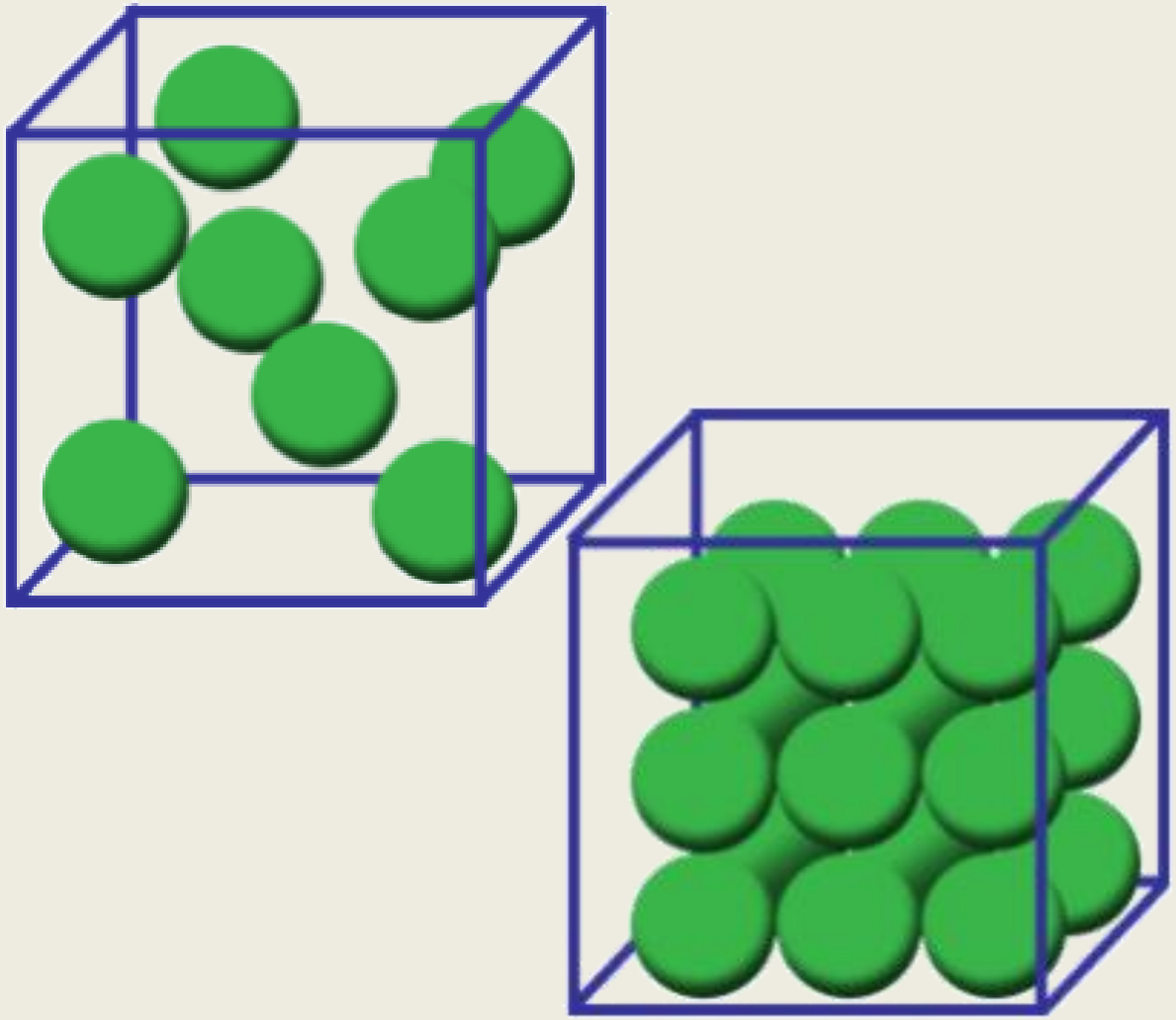
Helpful Website: National Institute of Standards and Technology
https://physics.nist.gov/cuu/Units/units.html

Fundamental Base SI Units

Velocity = +25 m/s



Density = kg/m^3



Derived Quantities

Scalar

Volume

Time

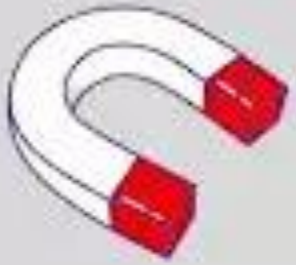
Tempereture

Speed

Vector

Weight

Thrust



Magnetic field

Velocity

Scalar and Vector quantities

Is density scalar or vector?

Is Time (seconds) fundamental or derived?

Is Area (m^2) "fundamental or derived?"

What does 2500 m equal to in km?

What does 2500 m equal to in km?

What is 10 $^{g}/_{cm^3}$

equal to in $^{kg}/_{m^3}$?

Problem 5: Unit conversions – Dimensional Analysis

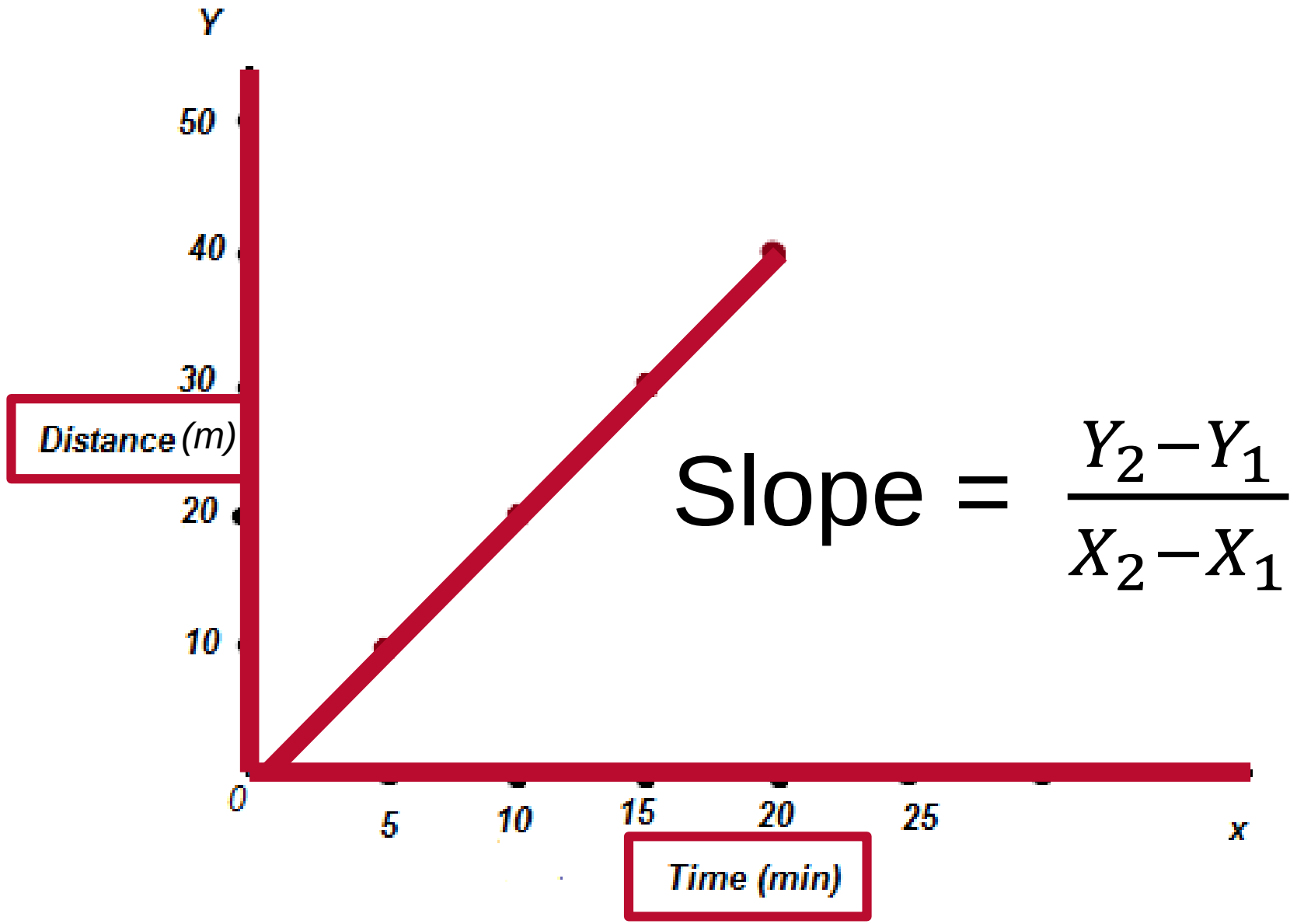
What is 10 $^{g}/_{cm^3}$ equal to in $^{kg}/_{m^3}$?

Problem 5: Unit conversions – Dimensional Analysis

Graphs

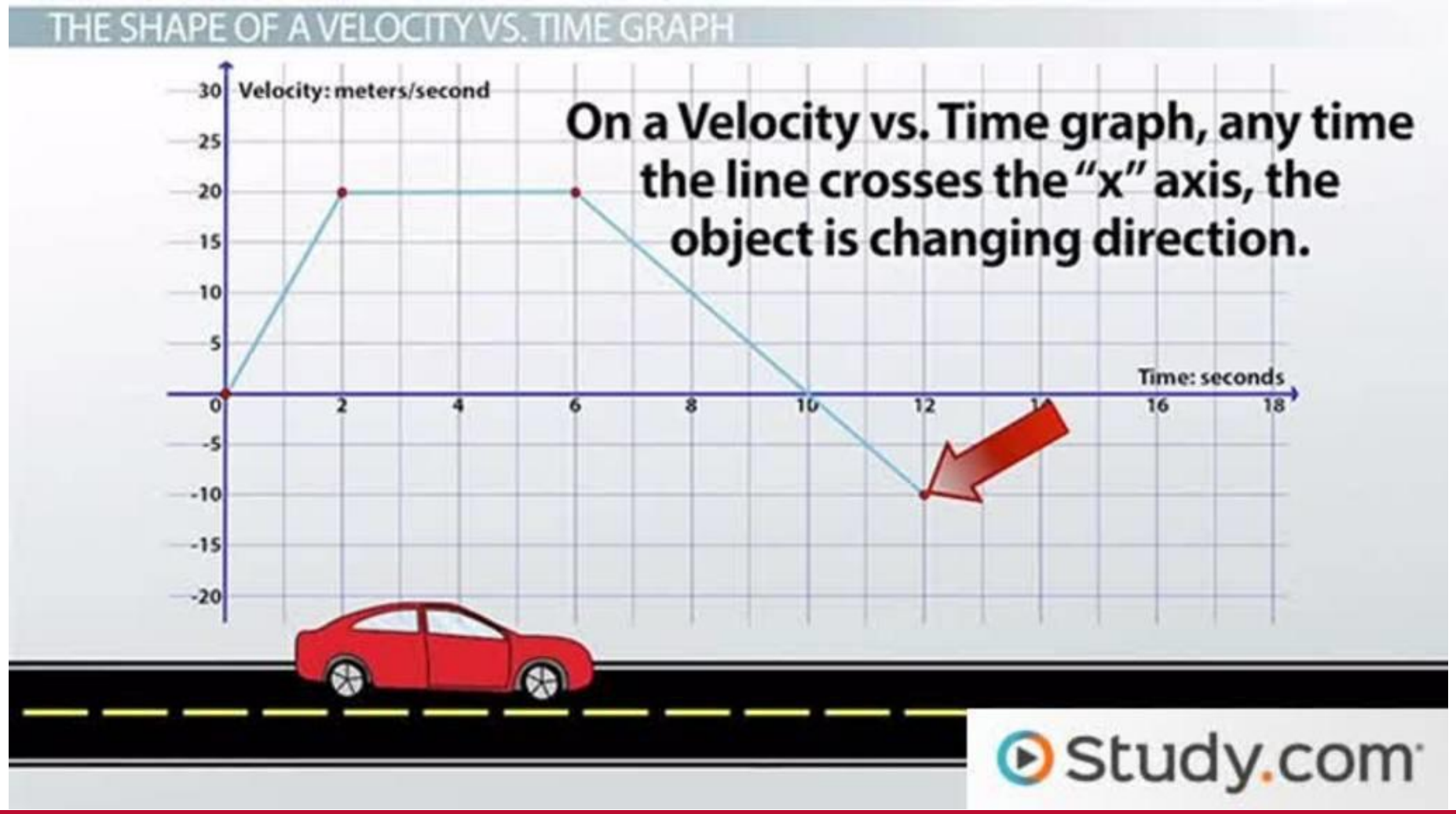
(Independent variable) causes a change in (Dependent Variable) and it isn't possible that (Dependent Variable) could cause a change in (Independent Variable)

The Basics



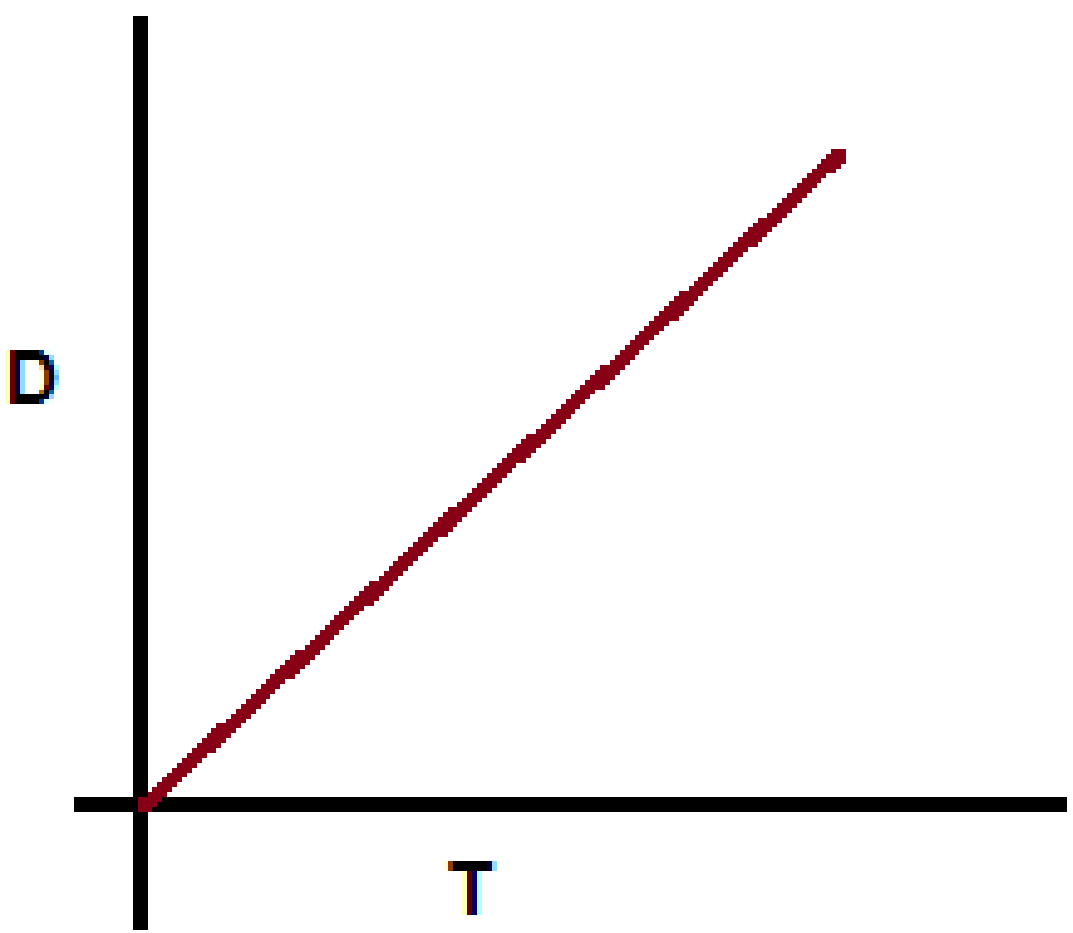
$$\text{Slope} = \frac{Y_2 - Y_1}{X_2 - X_1}$$

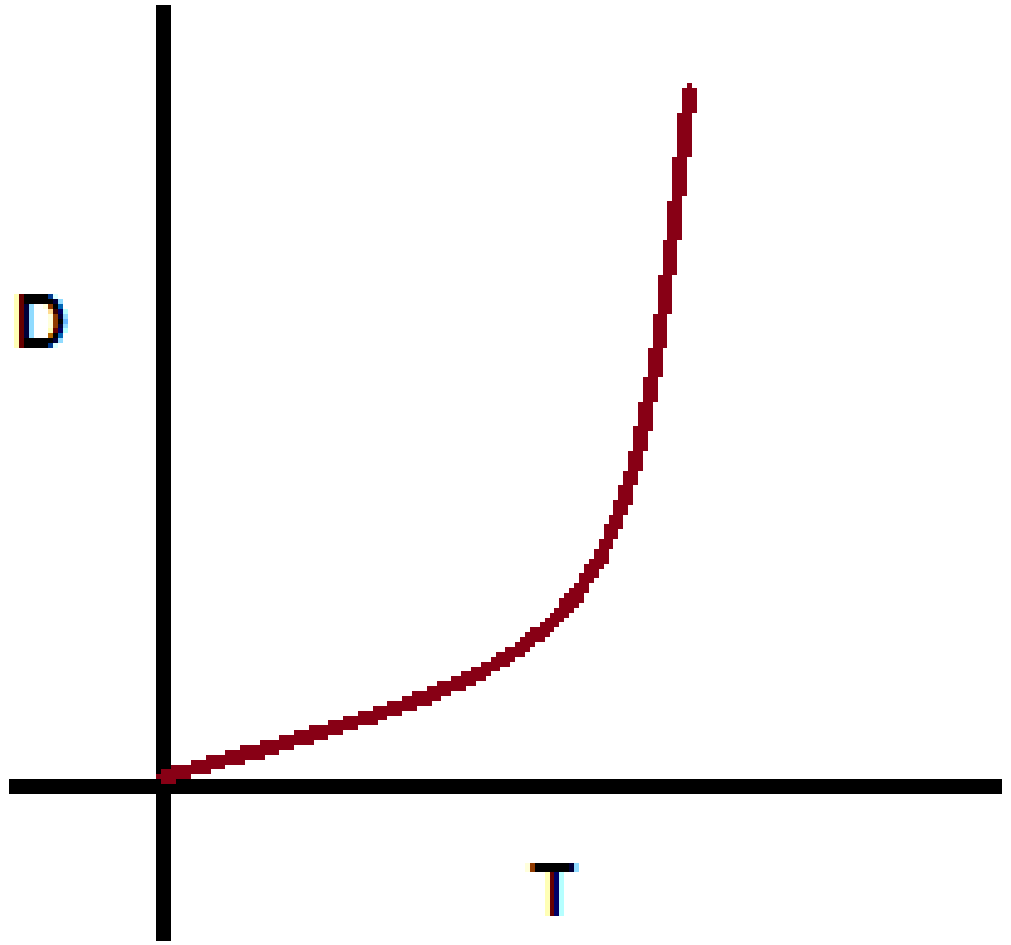
How to read a graph


THE SHAPE OF A VELOCITY VS. TIME GRAPH
Velocity: meters/second
30
25
20
15
10
5
0
-5
-10
-15
-20
Time: seconds
2
4
6
8
10
12
16
18
On a Velocity vs. Time graph, any time the line crosses the "x" axis, the object is changing direction.
Study.com

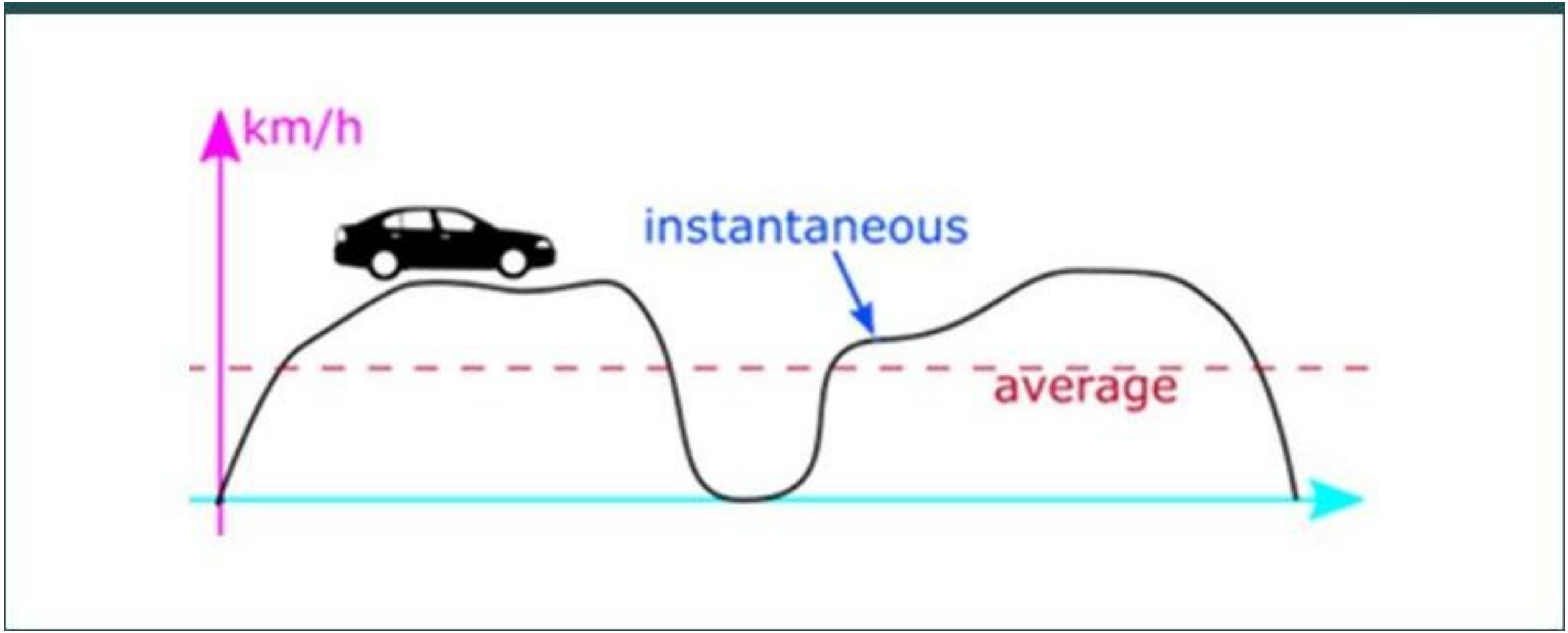
Motion

Distance-Time Graphs

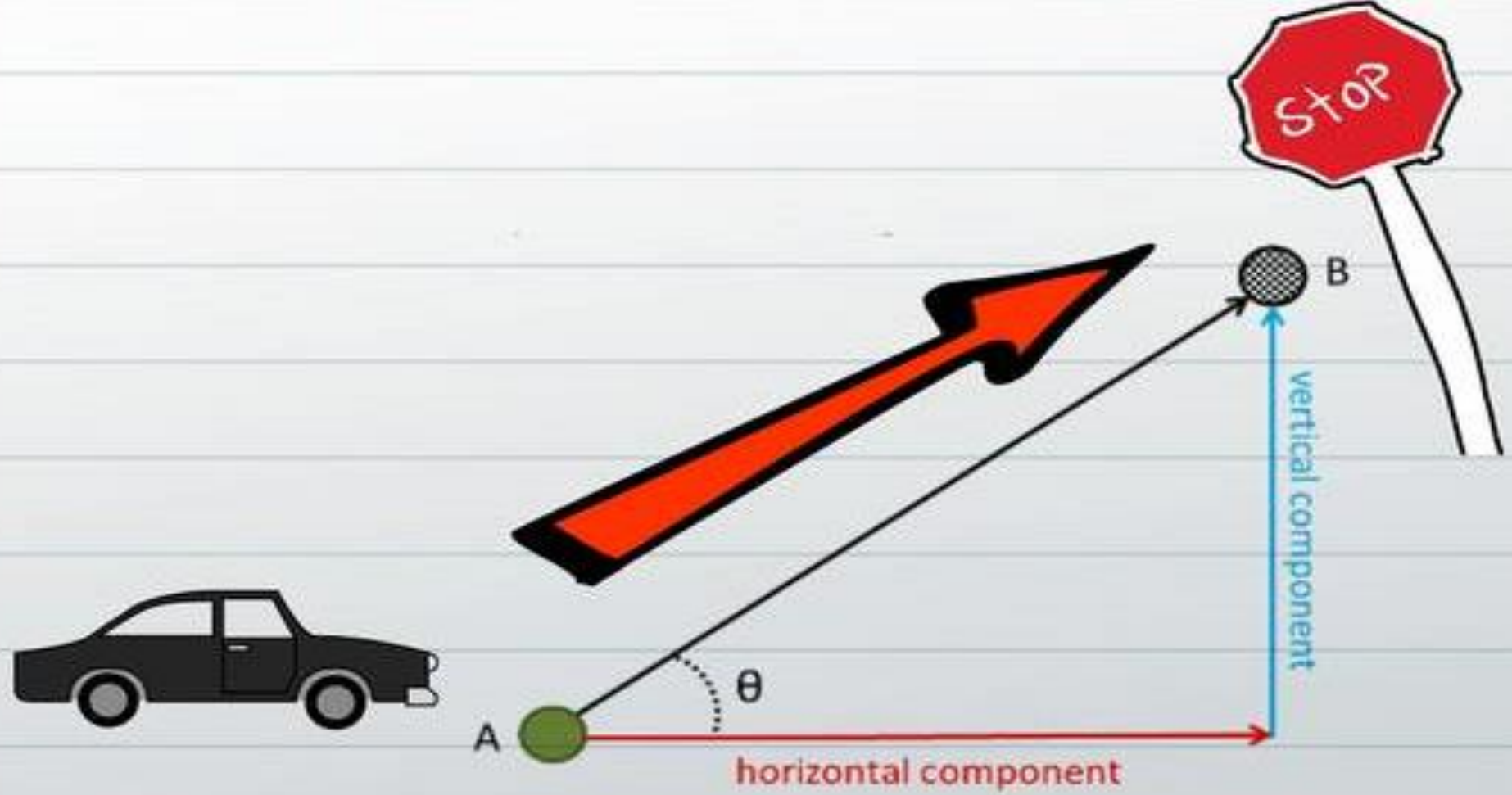




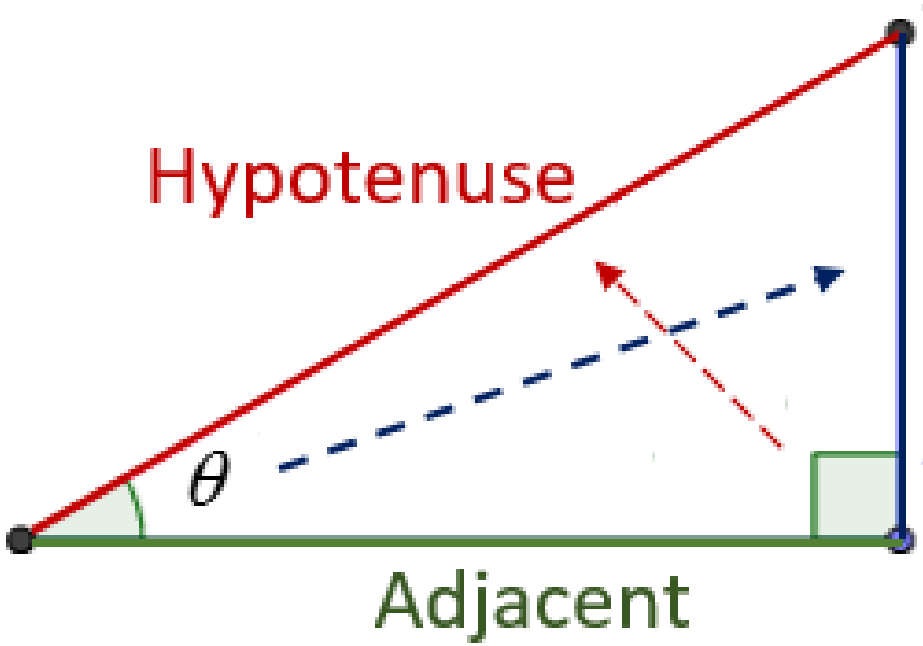
Variable Speed



Average and instantaneous speed



Geometry & Trig in Physics



SOH $\quad \text{Sin}\,\theta = \dfrac{\text{Opposite}}{\text{Hypotenuse}}$

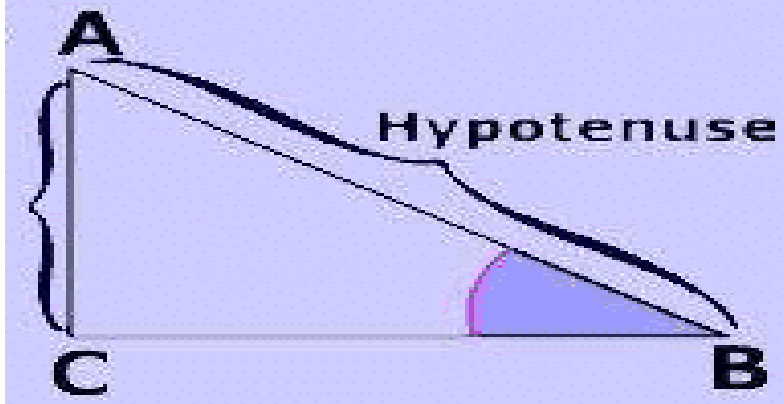
CAH $\quad \text{Cos}\,\theta = \dfrac{\text{Adjacent}}{\text{Hypotenuse}}$

TOA $\quad \text{Tan}\,\theta = \dfrac{\text{Opposite}}{\text{Adjacent}}$

Basic Trigonometric Functions

$$\text{Sin}(\theta) = \frac{\text{Opposite}}{\text{Hypotenuse}} \qquad \text{Cos}(\theta) = \frac{\text{Adjacent}}{\text{Hypotenuse}} \qquad \text{Tan}(\theta) = \frac{\text{Opposite}}{\text{Adjacent}}$$

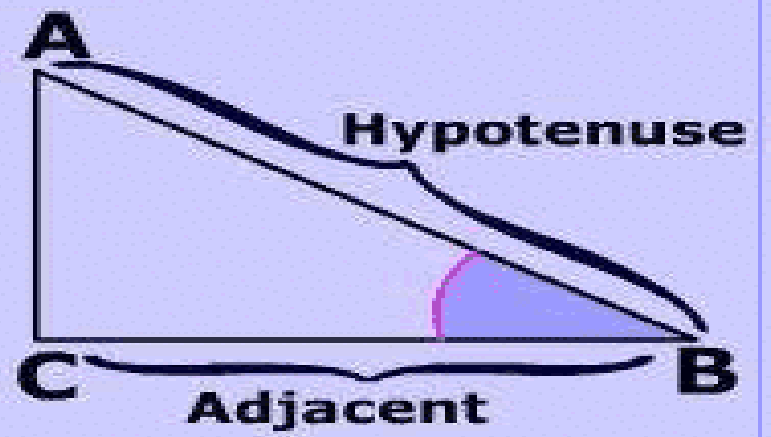
Sine



$$\frac{\text{opposite}}{\text{hypotenuse}}$$

SOH

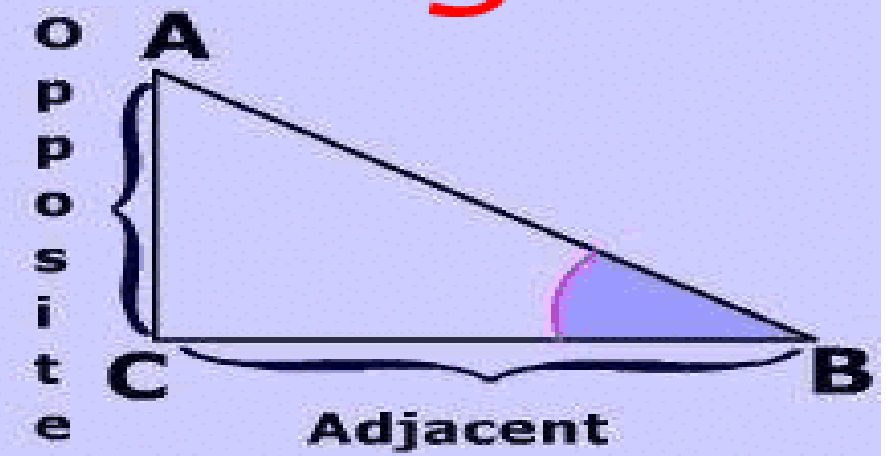
Cosine



$$\frac{\text{adjacent}}{\text{hypotenuse}}$$

CAH

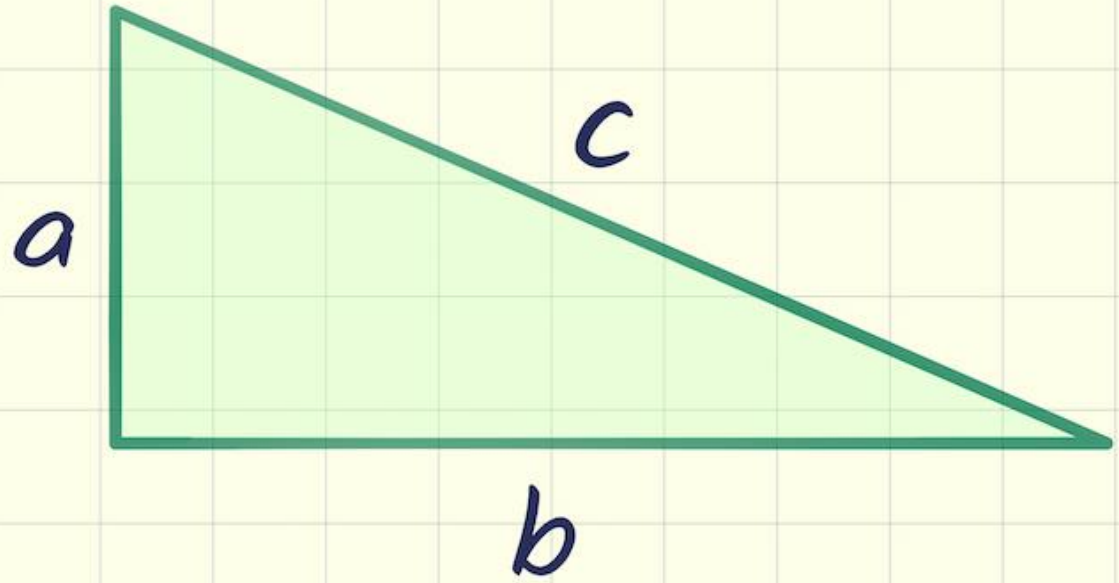
Tangent



$$\frac{\text{opposite}}{\text{adjacent}}$$

TOA

SOH CAH TOA Rule

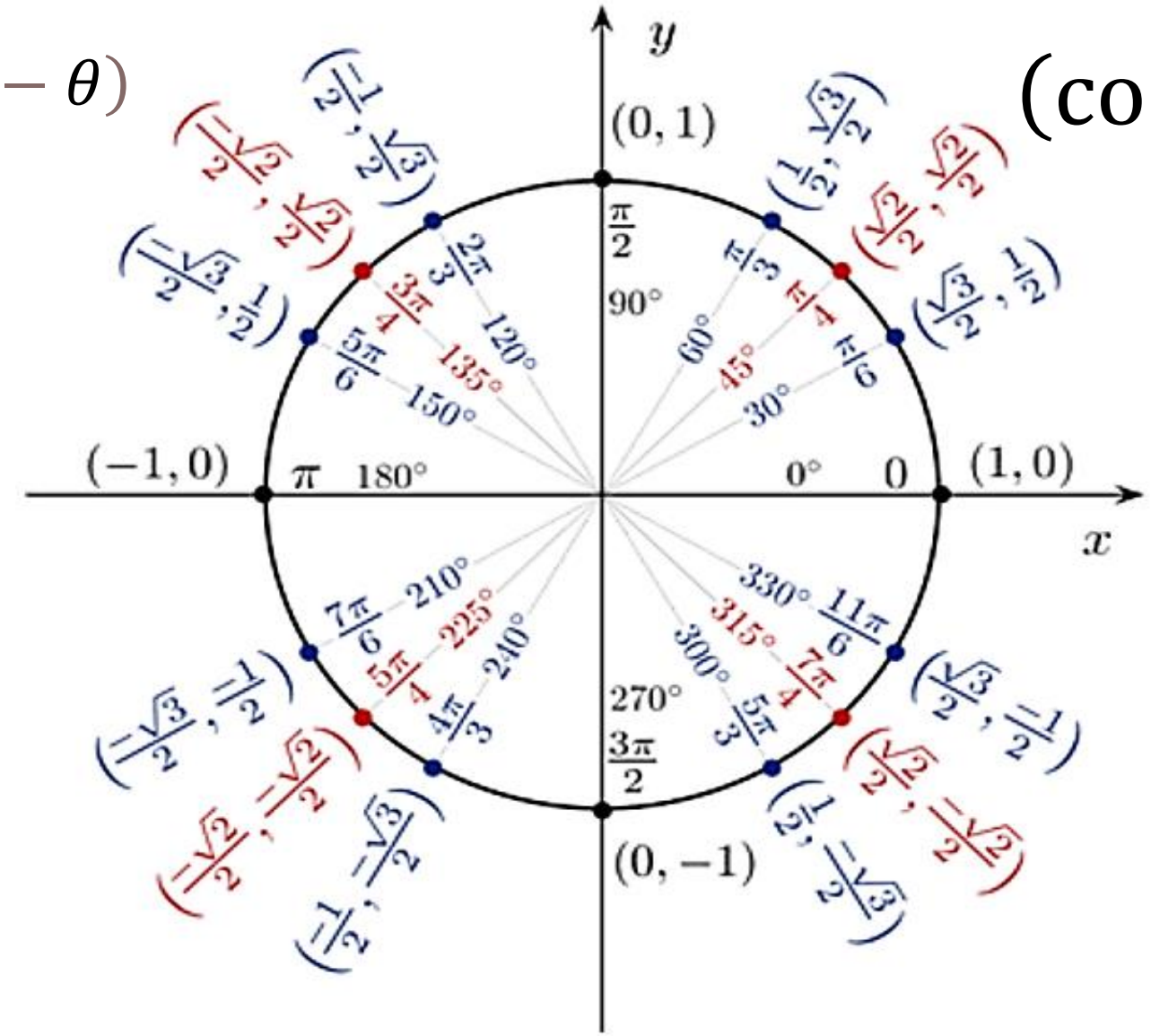


$$a^2 + b^2 = c^2$$

Pythagorean Theorem

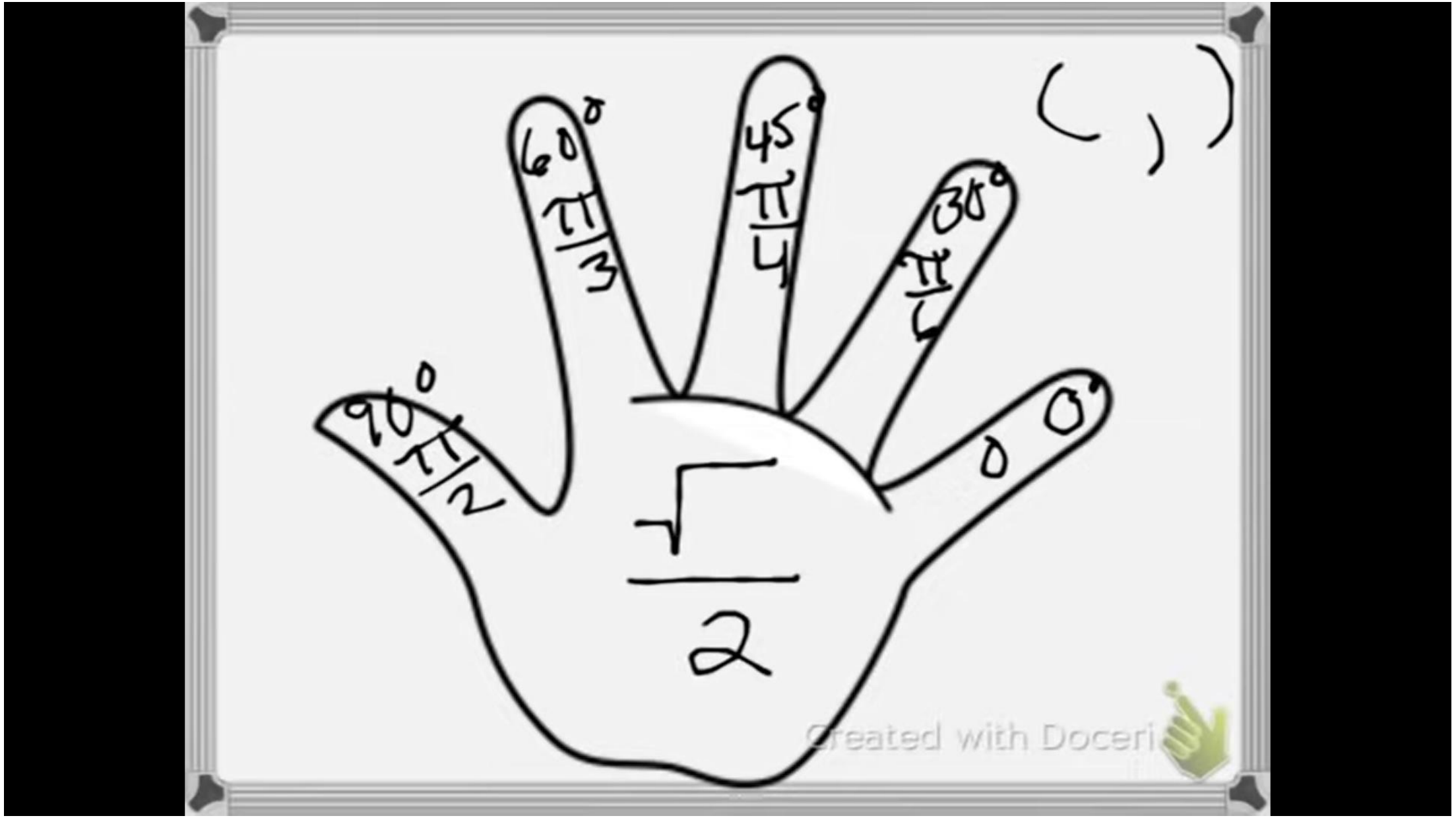
$\sin(\theta) = \cos(90° - \theta)$

$(\cos(\theta), \sin(\theta))$



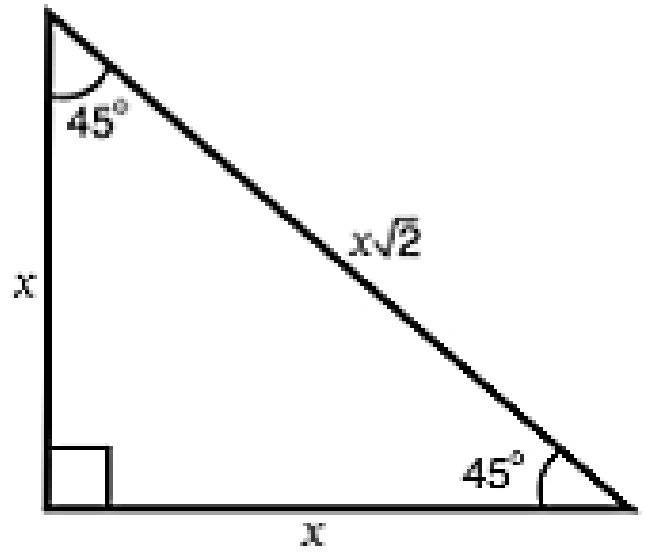
Memorizing the Unit Circle. Ms. Pruitt's Left-Hand Trick. https://youtu.be/LE6dmczMc68

The Unit Circle

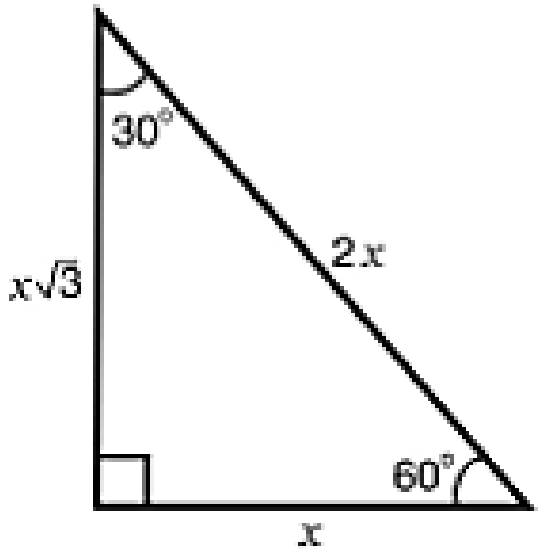


https://youtu.be/LE6dmczMc68

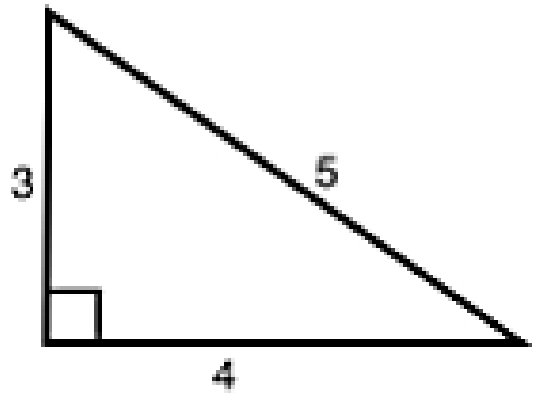
45-45-90 Triangle



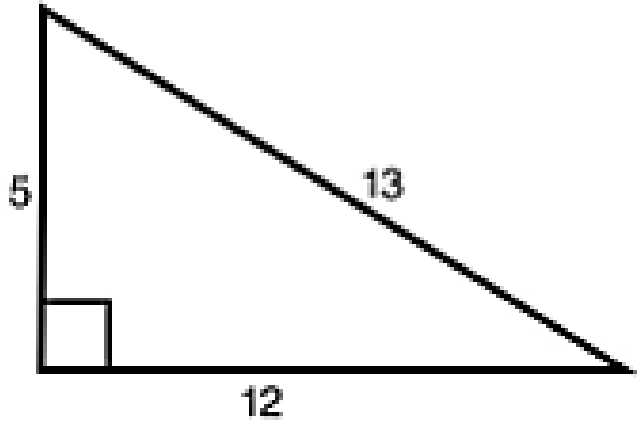
30-60-90 Triangle



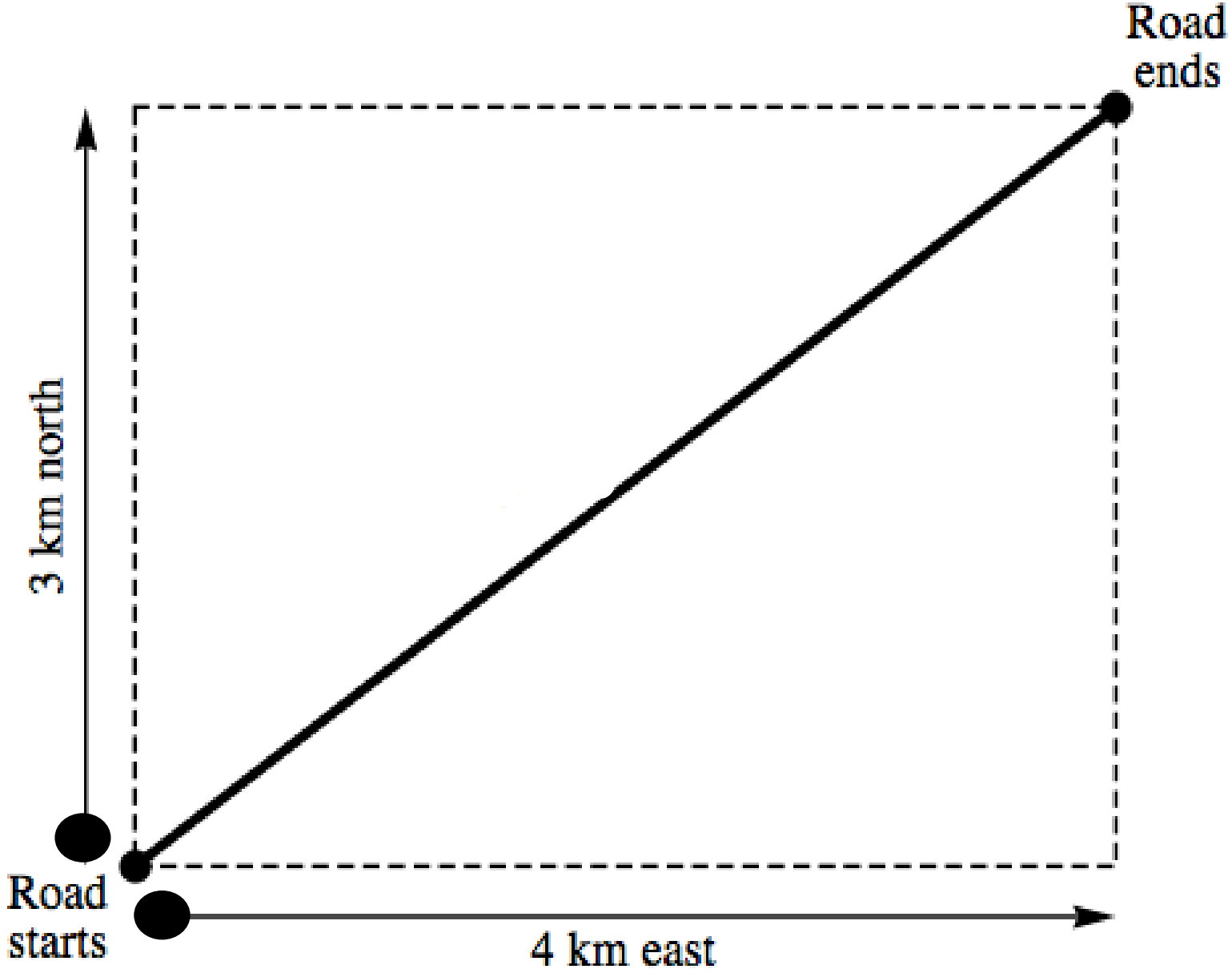
3-4-5 Triangle



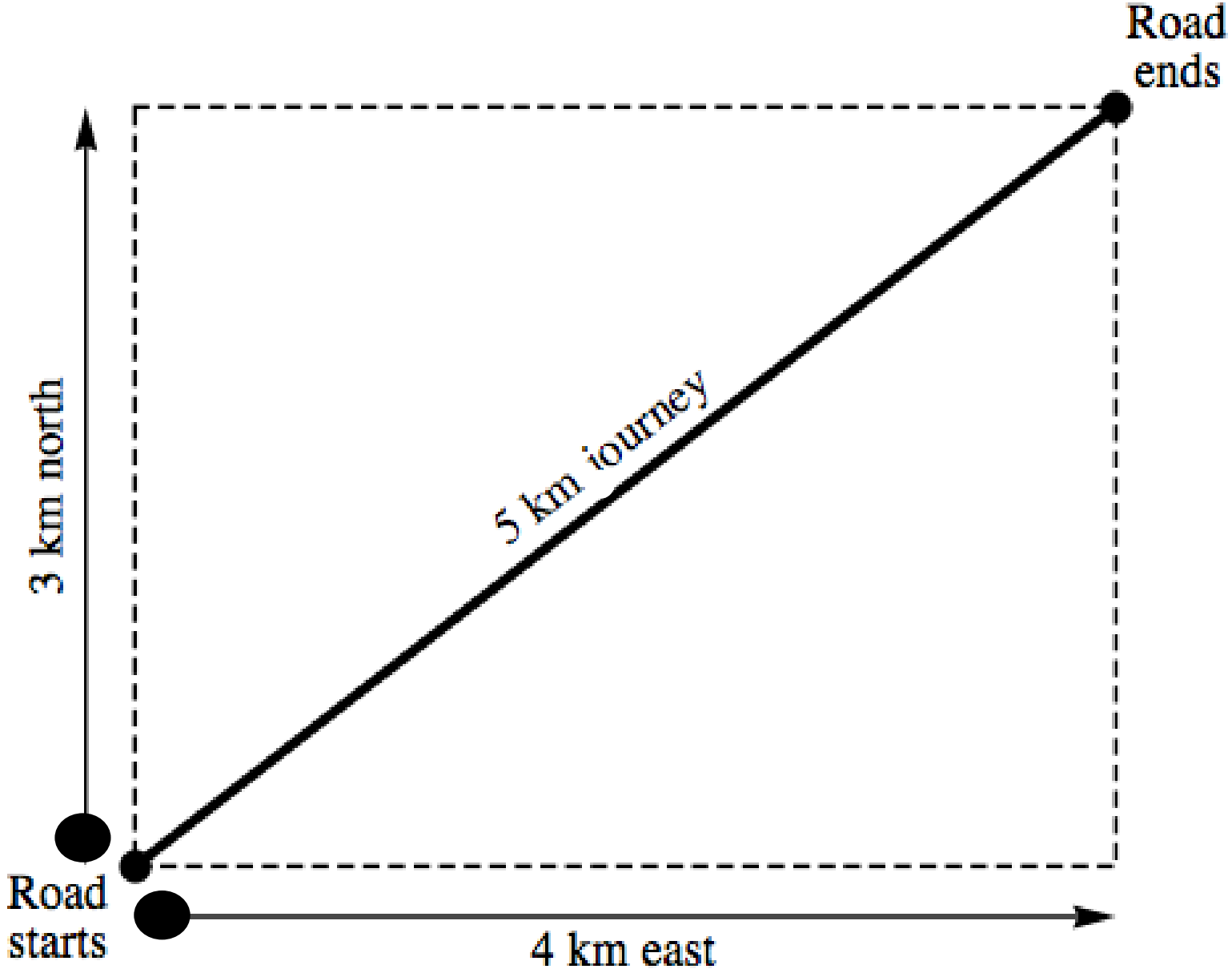
5-12-13 Triangle



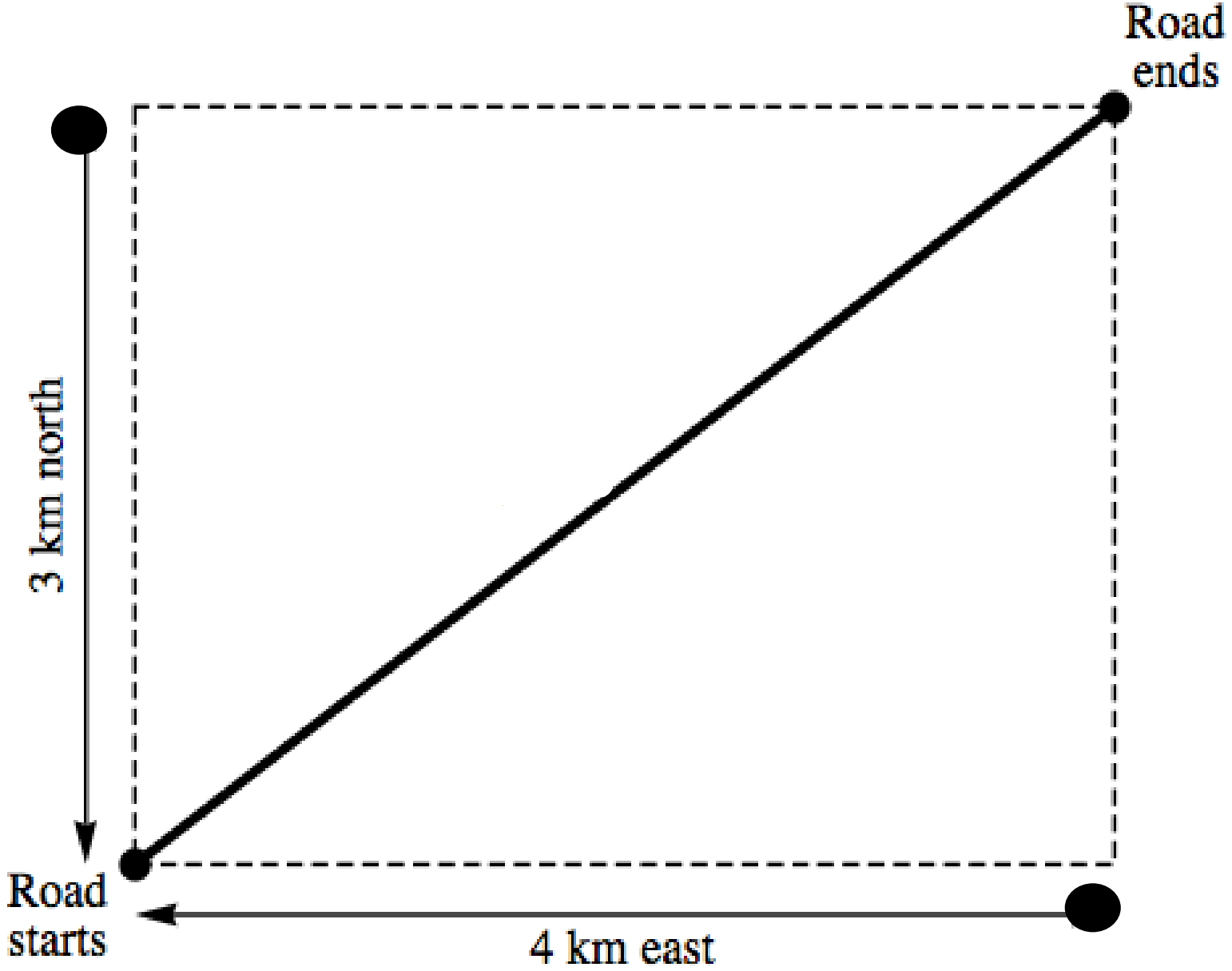
Special Triangles



Determine the Magnitude and direction



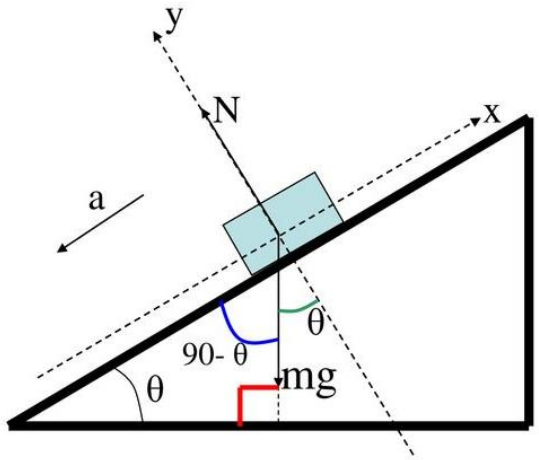
Determine the Magnitude and direction

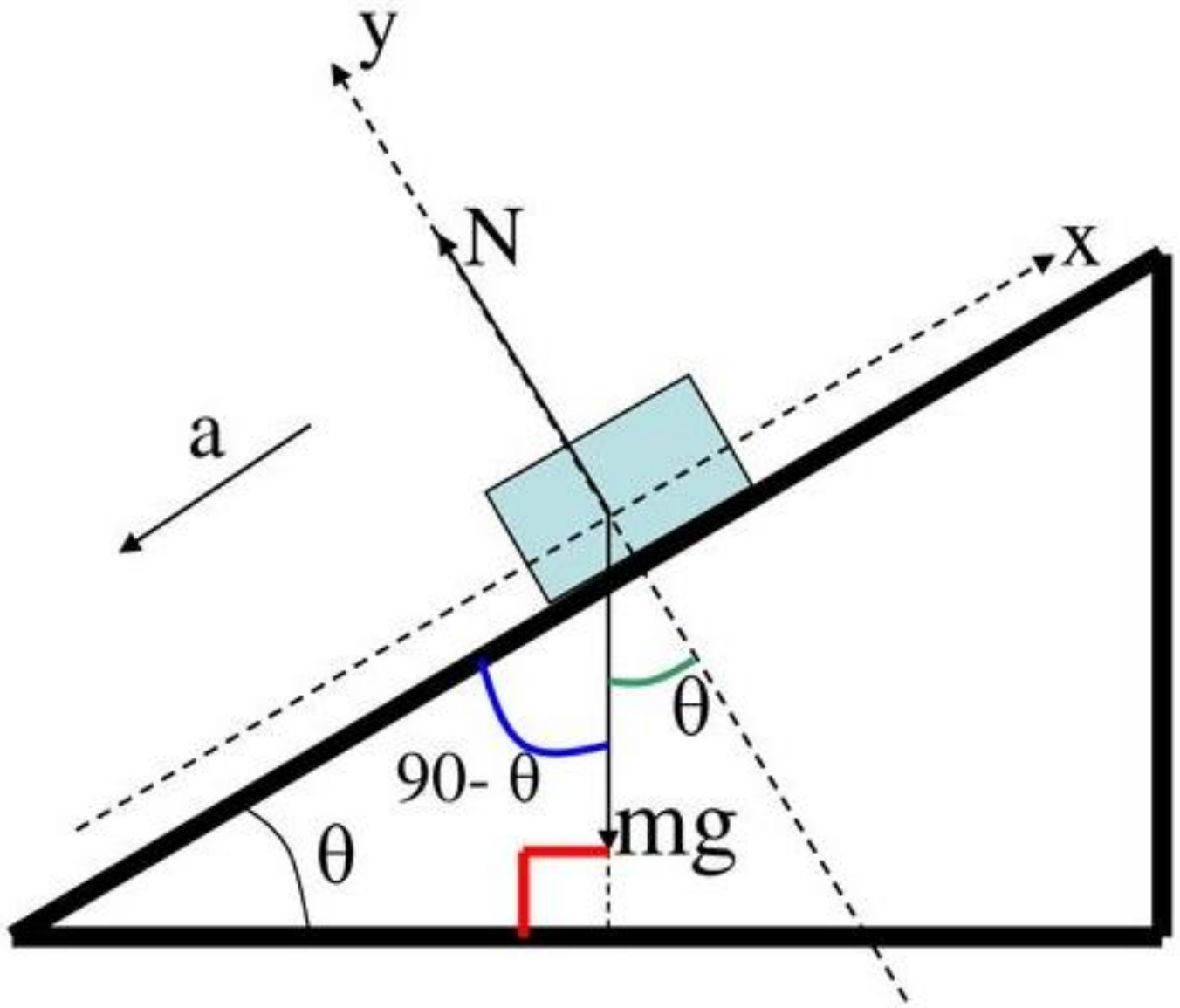


Determine the Magnitude and direction

A **Force** is a push or a pull that causes an object with mass to move faster (accelerate), or slower (decelerate), change direction, or deform.

Forces are vector quantities because they have a magnitude and direction.





Forces

Types of Forces:

- Applied Force
  - Pull (Tension)
  - Push (Compression)
- Normal Force (Perpendicular to the Surface)
- Drag Force (Resistance to motion in Air or Water)
- Friction (Always moves opposite to motion)
- Spring Force
- Weight (mass * acceleration)

Sir Isaac Newton

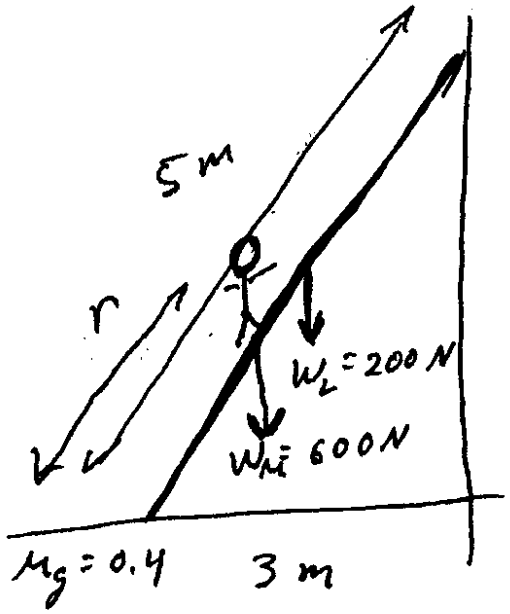
Force=Mass*Acceleration

$$[N] = [kg] * \left[\frac{m}{s^2}\right]$$

$$\sum \vec{F} = m\vec{a}$$

Sir Isaac Newton and Newton's Second Axiom

A uniform ladder 5 m long weighing 200 N is leaning against a smooth vertical wall with its base 3 m from the wall. The coefficient of static friction between the bottom of the ladder and the ground is 0.4. How far, measured along the ladder, can a 600 N man climb before the ladder starts to slip?



Word Problems

Quadratic Formula

$$ax^2 + bx + c = 0$$

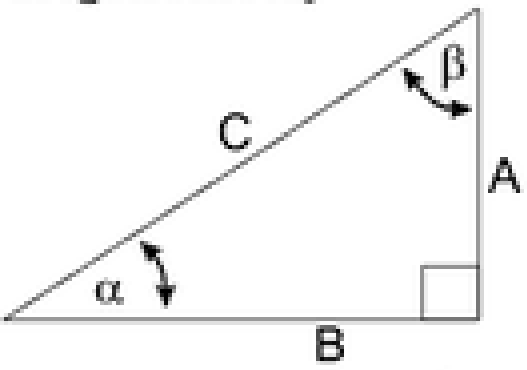
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Geometry

Circle: circumference$=2\pi R$, area$=\pi R^2$

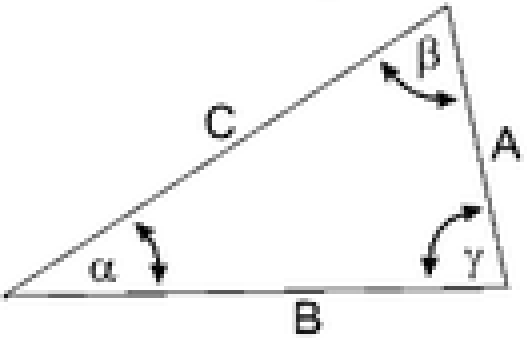
Sphere: area$=4\pi R^2$, volume$=4\pi R^3/3$

Trigonometry



$$\sin\alpha = \frac{A}{C}, \quad \cos\alpha = \frac{B}{C}$$

$$\tan\alpha = \frac{A}{B}$$



$$\frac{\sin\alpha}{A} = \frac{\sin\beta}{B} = \frac{\sin\gamma}{C}$$

$$A^2 + B^2 - 2AB\cos\gamma = C^2$$

Polar Coordinates

$$PE = -G\frac{Mm}{r}, \ \Delta PE = mgh(\text{small } h), \ F = G\frac{Mm}{r^2} = mg$$

$$a = \frac{v^2}{r}, \ \frac{GM}{4\pi^2} = \frac{R^3}{T^2}$$

Rotational Motion & Gravity

$$v = \omega r = \frac{2\pi r}{T}, \quad \omega = 2\pi f = \frac{2\pi}{T}, f = 1/T$$

$$\alpha = \frac{\omega_f - \omega_0}{t} = \frac{a}{r}$$

$$L = I\omega = mvr\sin\theta, \ (\theta = \text{angle between v and r})$$

$$KE = \frac{L^2}{2I} = \frac{1}{2}I\omega^2$$

$$\tau = rF\sin\theta, \ I\alpha = \tau, \ I_{\text{point}} = mR^2$$

$$I_{\text{cyl.shell}} = mR^2, \ I_{\text{sphere}} = \frac{2}{5}mR^2 \ I_{\text{solid cyl.}} = \frac{1}{2}mR^2.$$

Gases, liquids and solids

$$PV = NkT \text{ and } P = \frac{1}{3}\frac{N}{V}m\overline{v^2}, \ T =$$

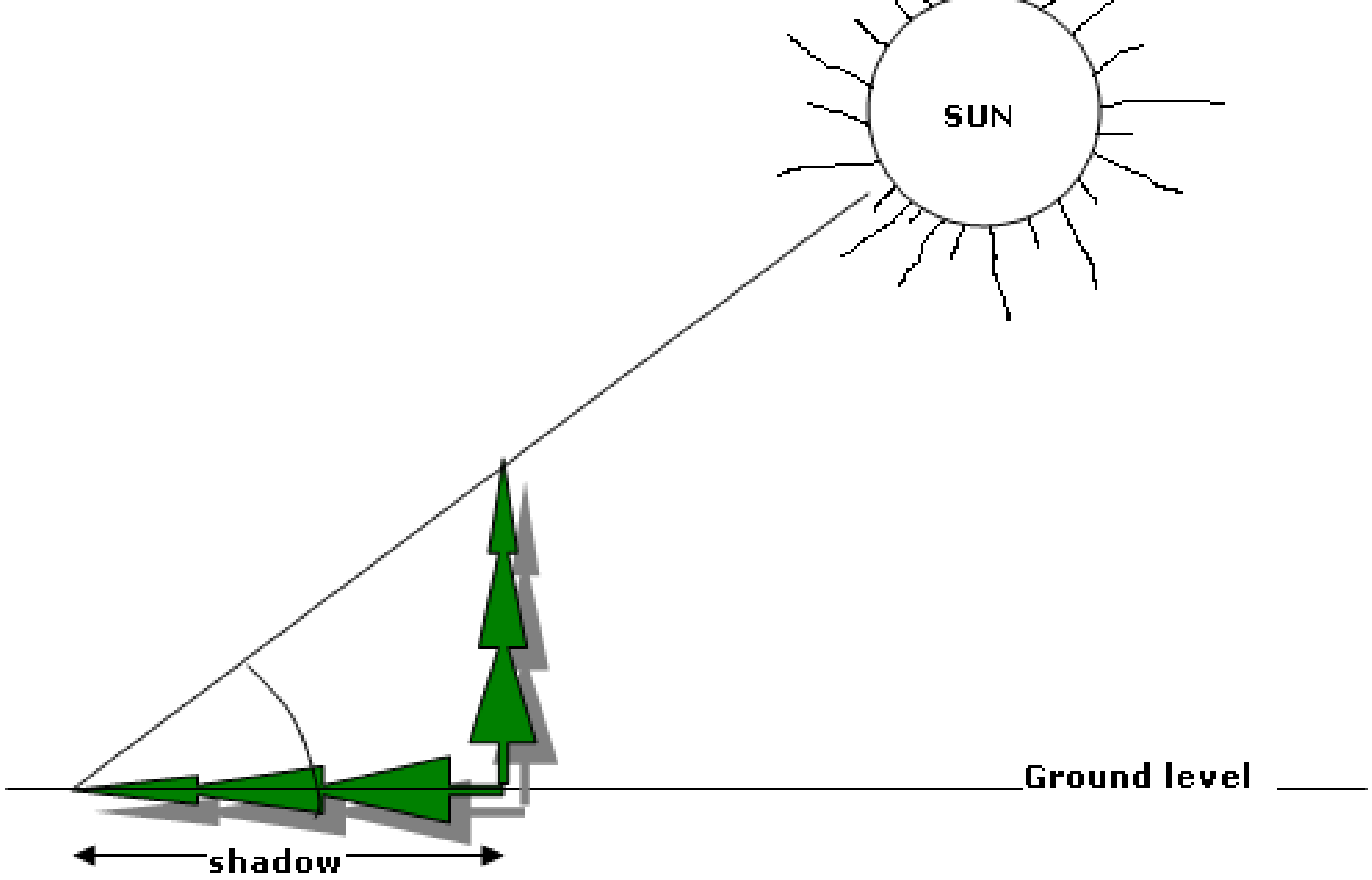
As you go along…Formula Sheet

A bus traveled on a level road for 6 hours at an average speed 20 miles per hour faster than it traveled on a winding road. The time spent on the winding road was 3 hours. Find the average speed on the level road if the entire trip was 462 miles.

$d = rt$

categories	rate	time
level road 6hr	$x+20$	6 hr
winding rd. 3hr	x	3 hr

Step 1: Identify variables/ physical quantities



Step 2: Draw a picture

A rectangular field is to be fenced off next to a straight wall, with fencing on three sides, with the wall making the fourth side. Exactly 150 feet of fencing is to be used. Express the area of the field as a function of its width.

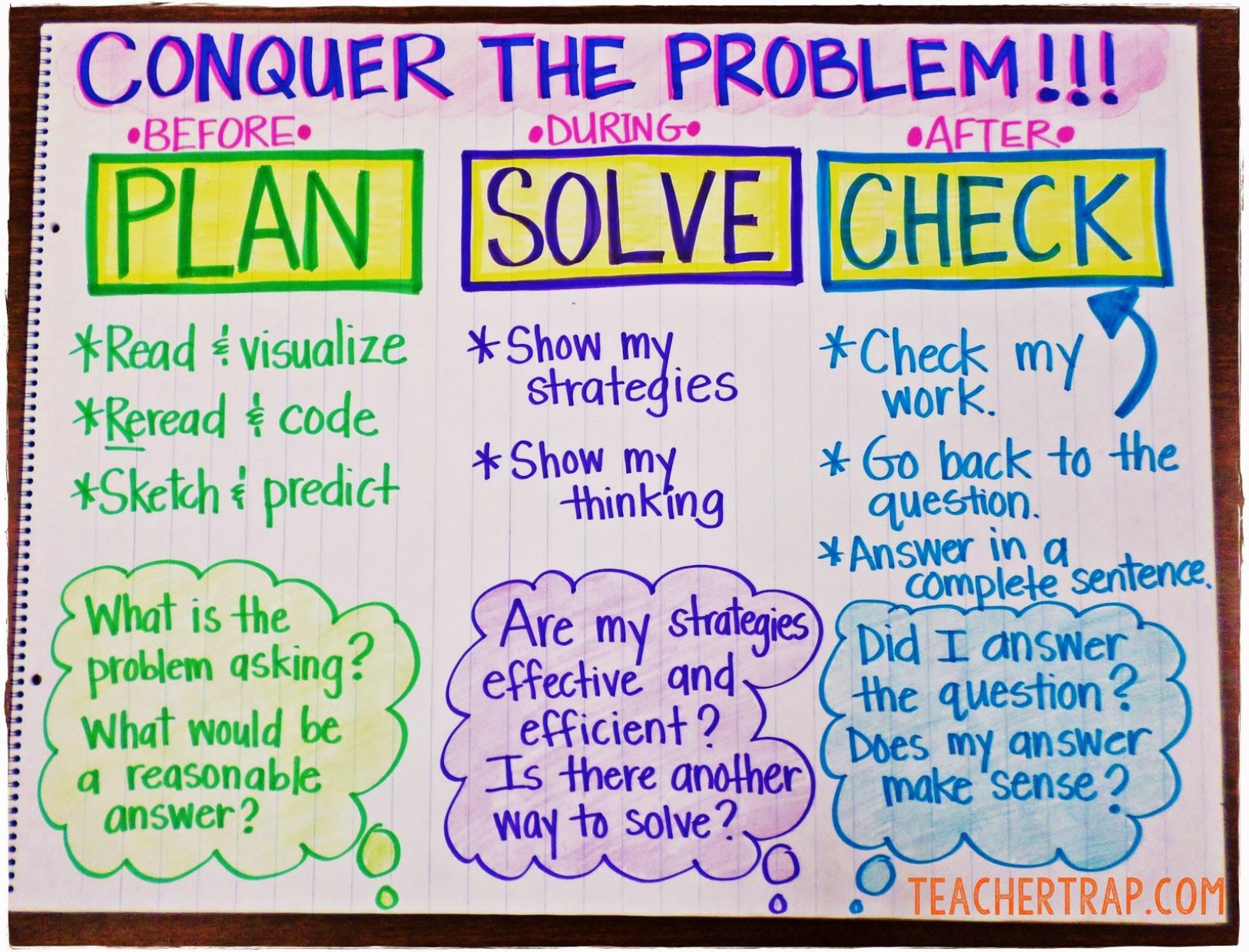
Given: $P = 150$ ft (3 sides)
x = width
y = length

Step 3: Identify given information

Three coffees and two muffins cost a total of 7 dollars. Two coffees and four muffins cost 8 dollars. What is the individual price for a single coffee and a single muffin?

Let x = cost of a single coffee
Let y = cost of a single muffin

Step 4: Identify the unknowns



Step 5: Begin strategizing for the answer based on the given information

What is the average velocity of the car if it travels 60 km in 1.5 hours?

What is the average velocity of the car if it travels 60 km in 1.5 hours?

Word Problem 1

Displacement: $= x_2 - x_1$ = 60 km

Time = 1.5 hours

Average Velocity = Displacement / Time

Word Problem 1

A plane lands at a speed of 68 m/s and slows down at a rate of $4\text{m}/s^2$. How much runway is needed to stop the plane?

Word Problem 2

A plane lands at a speed of 68 m/s and slows down at a rate of $4\text{m/}s^2$. How much runway is needed to stop the plane?

Word Problem 2

x_{initial}	0 m	x_{final}	
t_{initial}	0 s	t_{final}	
v_{initial}	$68\ \frac{m}{s}$	v_{final}	$0\ \frac{m}{s}$
a_{initial}	$4\ \frac{m}{s^2}$	a_{final}	$4\ \frac{m}{s^2}$

Word Problem 2: Write all the given quantities

Word Problem 2

A plane lands at a speed of 68 m/s and slows down at a rate of 4m/s^2. How much runway is needed to stop the plane?

$x_{initial}$	0 m	x_{final}	
$t_{initial}$	0 s	t_{final}	
$v_{initial}$	68 $\frac{m}{s}$	v_{final}	0 $\frac{m}{s}$
$a_{initial}$	4 $\frac{m}{s^2}$	a_{final}	4 $\frac{m}{s^2}$

x_1=0m

x_2

Word Problem 2: Write all the given quantites

A plane lands at a speed of 68 m/s and slows down at a rate of 4m/s^2. How much runway is needed to stop the plane?

$x_{initial}$	0 m	x_{final}	578 m
$t_{initial}$	0 s	t_{final}	17 s
$v_{initial}$	68 $\frac{m}{s}$	v_{final}	0 $\frac{m}{s}$
$a_{initial}$	4 $\frac{m}{s^2}$	a_{final}	4 $\frac{m}{s^2}$

x_1=0m

x_2

Word Problem 2: Write all the given quantities

A family pool holds 10,000 gallons of water. How many cubic meters is this?

264.2 gal = 1 cubic meter

Use dimensional analysis to solve these problems

If the average person in Albuquerque uses 127 gallons of water per day, and there are 560,274 people in Albuquerque, how many drops per second must be pumped from the various water sources (e.g., river, aquifer) every second to supply the city?

1 gal = 3.79 L
1 L = 1000 mL
20 drops = 1 mL

Use dimensional analysis to solve these problems

If a gas car consumes 25.00 gallons of fuel when driving a distance of 400.0 km, and the cost per gallon is $2.82 per gallon, how many liters will it consume when driving 250.0 miles and what is the total cost?

0.621 mi = 1.00 km
1 gal = 3.79 L

Use dimensional analysis to solve these problems

Imagine you designed a 5-stage, pipelined processor and synthesized it for a 45nm process technology node with a target clock rate of 1.0GHz. During power analysis, you found that at the target clock rate with a supply voltage of 1.0V, this processor draws 40mW of dynamic power and 4mW of static power. Consider the following power and energy trade-offs:

(a) Assuming a cryptographic operation takes 0.5 seconds to complete on your processor, what is the energy per operation at the target clock rate?

(b) For certain applications, your processor performs cryptographic operations 4x faster than necessary. If you were to slow the clock down to 250MHz without adjusting the voltage, what would be the energy per operation? What would be the overall power draw?

(c) Assuming you could safely drop the voltage to 0.7V when operating at a 250MHz clock, recalculate the power draw and energy per operation. Assume the leakage current remains the same.

(d) Instead of lowering the clock rate, you could gate the clock off when not performing a crypto- graphic operation. This would essentially bring dynamic power draw to 0 while leaving static power unchanged. Assuming your system performs one operation every 2 seconds and gates the clock off in between, what would be the energy per operation? Also assume the original 1.0GHz clock rate and 1.0V supply voltage. How does this compare to the Dynamic Voltage Frequency Scaling scheme discussed earlier?

(e) What would be the energy per operation if your system also gated the power in between operations? What would be the draw back to this technique?

(f) Static timing analysis shows that if you were to increase your supply voltage to 1.2V, you could run your processor at 1.25GHz. Recalculate the power draw with the increased voltage and frequency parameters. Recalculate the energy per cryptographic operation.

(g) The technology node that a particular processor is fabricated at can also affect the energy efficiency. Imagine that you resynthesized your processor at a 180nm process technology node with a 1.8V supply voltage. In order to maintain the same transistor count, you set your target clock rate for 300MHz. Assuming the leakage current remains the same and that the capacitance of the design approximately scales linearly with the feature size, calculate the dynamic and static power for your processor at the 180nm node. What is the energy per cryptographic operation at the 180nm node and how does this compare to that of the 45nm node?

Use dimensional analysis to solve these problems

1. A chemistry teacher working at a golf camp during the summer found a liquid, which caused him to slice ball after ball into the water without disturbing him at all. He thought that this was an important liquid to identify so he set out to determine its density. He found that a sample of the liquid had a mass equal to 455 golf balls and occupied a volume of 620 water cups that he obtained at the 7^{th} hole. Each golf ball massed 50 g and the water cups at the 7^{th} hole of the golf course held 45 mL each. What is the density of the unknown liquid?

2. How much force, in g cm / s2 , is exerted by a golf ball described in problem 1 striking a tree while accelerating at 20 cm / s2 ? Show how you can solve this problem without knowing that F = m a. Explain your solution.

Use dimensional analysis to solve these problems

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