AP Physics 1 2025- 2026: Summer assignment

Welcome to AP Physics 1!

I'm so excited to be your teacher for next year. This course and the AP exam will be challenging. AP classes are taught just like college courses– not just college-level courses, but actual college courses (which is why you're getting college credit for it!)

For this summer assignment, if you need help in any particular area, please review the links I have attached that can be found below. The summer assignment is a review of the math necessary for the AP physics 1 course. These topics should have been part of your experiences in the prerequisite math and science courses. We will use these skills constantly throughout our AP physics 1 course. You should answer all of the questions and bring them to the first class of the school year. Please keep in mind: **IF YOU DO NOT COMPLETE THE SUMMER WORK BY THE FIRST DAY OF SCHOOL, YOU WILL NOT BE PERMITTED TO ATTEND THE COURSE.**

Mathematics and Physics

- Mathematics
    - General mathematical skills
        - Converting units
        - Scientific Notation
    - Geometry
        - Calculating Area Review
        - Angles in Geometry Review
        - Trigonometry
        - Unit circles (converting degrees ⇆ radians, sins and cosines
    - Algebra
        - Deriving an equation for a variable
        - Manipulating expressions to write one variable in terms of the other
- Physics
    - Scalars and Vectors
    - Physics Chapter 1 Kinematics
    - Dimensional analysis
    - Graphing data
        - Slope and area - what do they imply?
    - Deriving expressions
    - Linearization

Part 1: Basic Mathematical Skills Practice (Deadline: 07/28/25)

Activity 1: Convert the following quantities from one set of units to another

Relevance: Understanding the variety of units and going from one unit to another is relevant to solving numerical problems from all units
Helpful link: Unit conversion within the metric system | Pre-Algebra | Khan Academy
Steps:

a. Write the conversion as a fraction (that equals one)
b. Multiply it out (leaving all units in the answer)
c. Cancel any units that are both top and bottom

1. 12.3 cm = _____ m
2. 4.3 km = _____ m
3. 0.045 l = _____ m^3
4. 38 ml = _____ cm^3
5. 5.3 KJ = _____ J
6. 5000 N =_____kN
7. 70 Pa (pascal - unit of pressure) =_____ atm (another unit of pressure)

PREFIXES		
Factor	Prefix	Symbol
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

Figure1: From the equation sheet provided by College Board

Activity 2: Practicing Scientific Notation

Relevance: Scientific notation is used in scenarios involving very large or very small numbers. It is extremely important that you know how to work with scientific notation to be successful working with gravitational force and fluids (pressure, cross sectional area etc.)
Helpful links:

- *Introduction to scientific notation | Pre-Algebra | Khan Academy*
- *Multiplying and dividing in scientific notation (example) | Pre-Algebra | Khan Acade…*
- *Scientific Notation - Addition and Subtraction*

Note: the current accepted practice on the AP exam is to round final answers to no more than 3 significant figures. Do not round in the middle of a problem. AP Physics is not overly focused on sig figs; they are more relevant to chemistry.

Express the following numbers in scientific notation:

1. 96,000 s =
2. 0.000764 m =
3. 300,000,000 m/s =

Convert from scientific notation to normal notation:

1. 8×10^{6} =
2. 2×10^{-3} m =
3. 2.5×10^{4} kg/m^{3} =

Solve the following problems involving scientific notation:

1. $(2.5 \times 10^{8}) + (1.2 \times 10^{8})$ =
2. $(1.8 \times 10^{2}) - (7.3 \times 10^{-3})$ =
3. $(1.5 \times 10^{6}) \times (3.2 \times 10^{3})$ =
4. $(6.0 \times 10^{-2}) \times (6.1 \times 10^{-8})$ =
5. $\frac{2.4 \times 10^{8}}{2 \times 10^{4}}$ =
6. $\frac{3.6 \times 10^{-6}}{2 \times 10^{4}}$ =

<u>Activity 3:</u> Reviewing geometry and trigonometry

Relevance: We will use the basic geometry and trigonometry skills in almost every unit of this course including: finding the area and volume of objects while calculating buoyant force, fluid pressure etc.; finding the components of vectors such as velocity and force in kinematics and dynamics respectively; finding the area bounded by a graph to calculate quantities such as displacement, velocity etc.

Helpful links:

- *Basic trigonometry | Basic trigonometry | Trigonometry | Khan Academy*
- *Math Antics - Volume*
- *The Easiest Way to Memorize the Trigonometric Unit Circle*

GEOMETRY AND TRIGONOMETRY

Rectangle
$A = bh$

Triangle
$A = \frac{1}{2}bh$

Circle
$A = \pi r^2$
$C = 2\pi r$

Rectangular solid
$V = \ell wh$

Cylinder
$V = \pi r^2 \ell$
$S = 2\pi r\ell + 2\pi r^2$

Sphere
$V = \frac{4}{3}\pi r^3$
$S = 4\pi r^2$

A = area
C = circumference
V = volume
S = surface area
b = base
h = height
ℓ = length
w = width
r = radius

Right triangle
$c^2 = a^2 + b^2$
$\sin\theta = \frac{a}{c}$
$\cos\theta = \frac{b}{c}$
$\tan\theta = \frac{a}{b}$

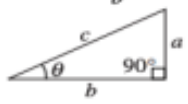
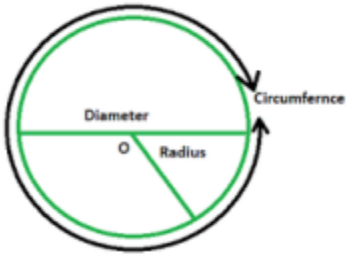


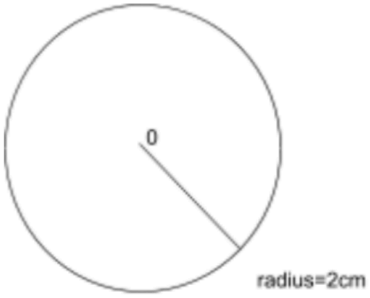
Figure 3: From the equation sheet provided by College Board



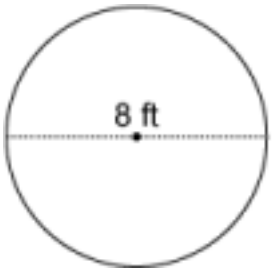
Solve the following geometry review problems

1. Calculate the area and circumference of the following circles (use π ≈ 3.14)

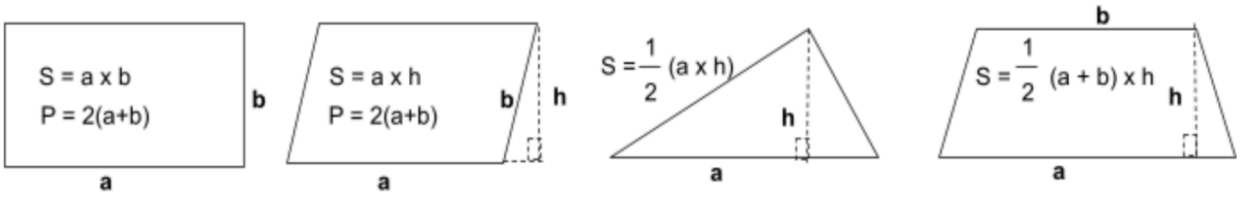
a.

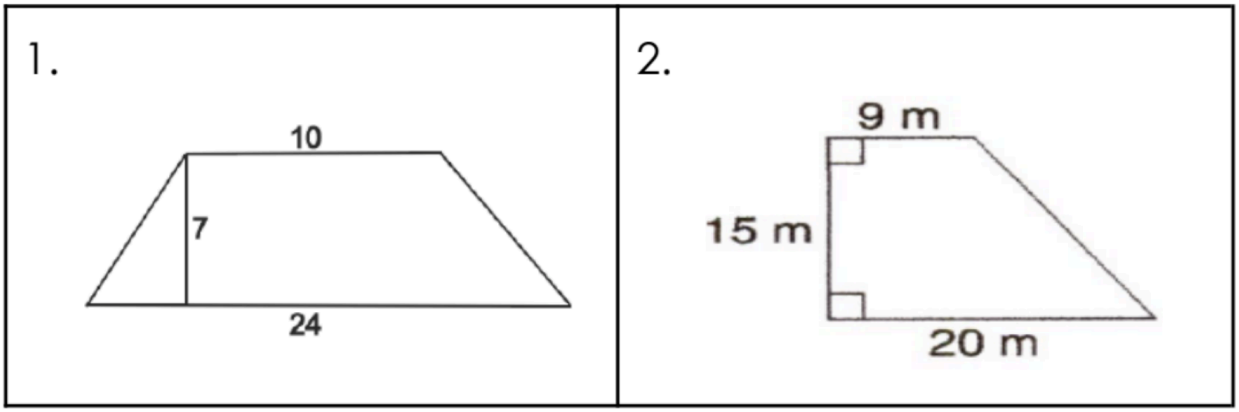


b.

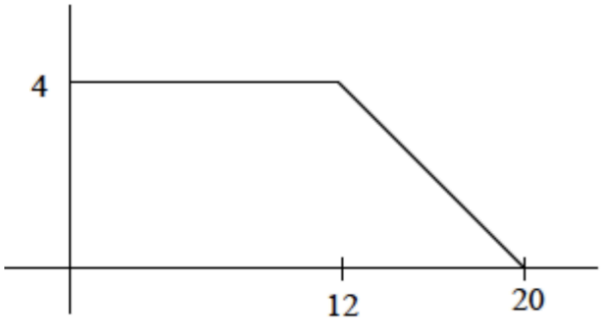


2. The circumference of a circle is 125.6cm. Find its radius.
3. Calculate the area of the following basic geometric figures

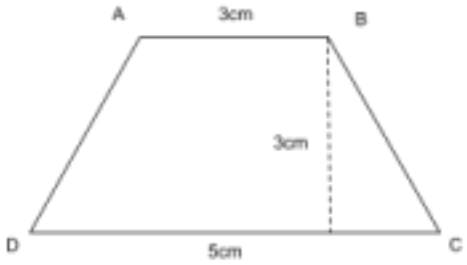




4. Find the area bounded by the graph:

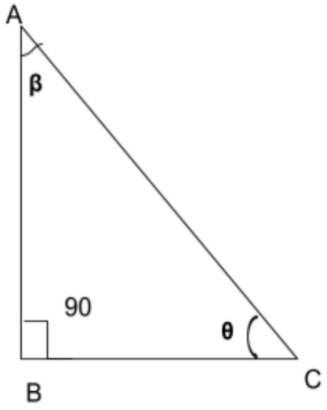


5. Find the area of a rectangular physics classroom whose length and width are 620 cm and 540 cm, respectively. Draw a rectangle using 1:100 scale in cm.
6. A floor whose length and width is 50 m and 40 m respectively needs to be covered by rectangular tiles. The dimension of each tile is 1 m x 2 m. Find the total number of tiles that would be required to fully cover the floor.
7. Calculate the area of the parallelogram with a base of 6 cm and height of 4 cm. Draw a figure to support your solution.
8. The base of the parallelogram is twice its height. If the area is 72cm2, find the base and height. Draw a figure to support your solution.
9. Find the area of the trapezoid ABCD shown below.



Solve the following trigonometry review

ABC is right triangle $\widehat{B}=90^0$.



For θ angle BC is adjacent and BA is opposite. AC is the hypotenuse of a right triangle.

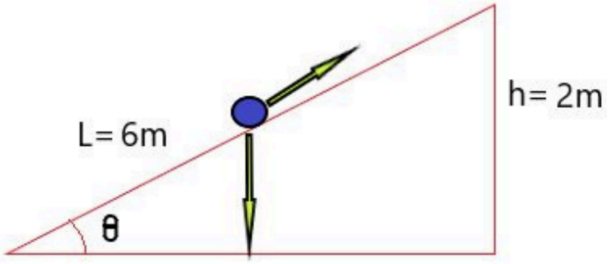
$sin\theta = \frac{opposite}{hypotenuse} = \frac{AB}{Ac}$ $\quad cos\theta = \frac{adjacent}{hypotenuse} = \frac{BC}{AC}$

$tan\theta = \frac{opposite}{adjacent} = \frac{AB}{BC}$

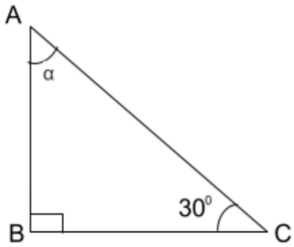
For β angle AB is adjacent and BC is opposite. AC is hypotenuse of a right triangle

$sin\beta = \frac{opposite}{hypotenuse} = \frac{BC}{AC}$, $cos\beta = \frac{adjacent}{hypotenuse} = \frac{AB}{AC}$, $tan\beta = \frac{opposite}{adjacent} = \frac{BC}{AB}$

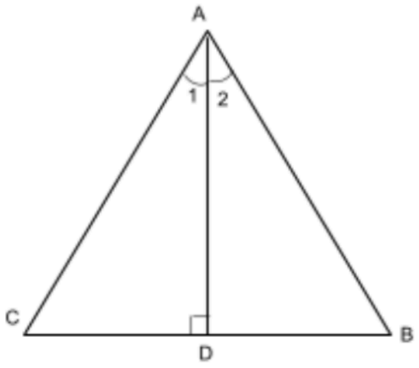
1. An object of mass m is placed on an inclined plane as indicated below. Calculate the angle of inclination of the plane.



2. The angle θ in the figure is 30°. Find the base and height of the incline plane. Also, find **α**.

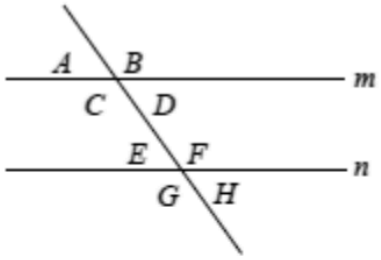


3. ABC is an equilateral triangle ,it means AB=BC=CA. AD is the perpendicular with the base CB of the equilateral triangle. Calculate:



a. The angle B, C, angle 1 and angle 2
b. What is the length of AD if DB is 3cm

4. In the figure below, lines m and n are parallel. Calculate the rest of the angles marked.

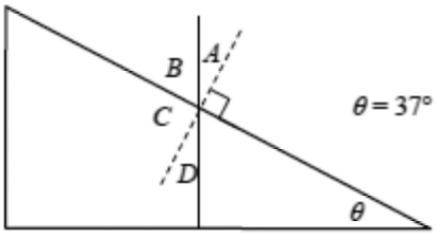


Lines m and n are parallel.

$A = 75°$ $B =$ $C =$ $D =$

$E =$ $F =$ $G =$ $H =$

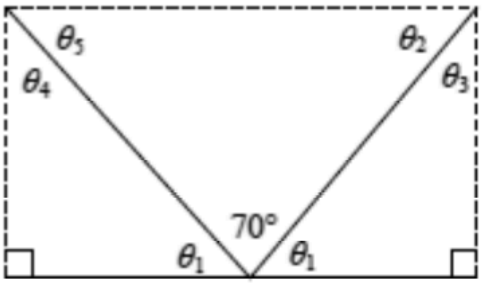
5. Calculate the angles indicated in the incline plane below. (Relevant to Unit 2, 5, 6)



$A =$ $B =$

$C =$ $D =$

6. Calculate the angles indicated below (Unit 2, 5, 7)



θ_1 =

θ_2 =

θ_3 =

θ_4 =

θ_5 =

Use your knowledge of the unit circle to solve the following problems

1. The given point "P" is located on a unit circle. Find the angle made with the X-axis in degrees and radians. Also calculate the sine, cosine, and tangent for these angles.

1) $P\left(-\frac{1}{2},\frac{\sqrt{3}}{2}\right)$

Quad:

$\sin\theta$:

$\cos\theta$:

$\tan\theta$:

2) $P(0,-1)$

Quad:

$\sin\theta$:

$\cos\theta$:

$\tan\theta$:

3) $P\left(\frac{-\sqrt{2}}{2},\frac{-\sqrt{2}}{2}\right)$

Quad:

$\sin\theta$:

$\cos\theta$:

$\tan\theta$:

2. Solve the following using your knowledge of unit circles:

1) $\sin(90^\circ) =$

2) $\cos\left(\frac{\pi}{4}\right) =$

3) $\sin\left(\frac{5\pi}{4}\right) =$

4) $\cos\ 135^\circ\ =$

5) $\tan\left(\frac{5\pi}{4}\right) =$

6) $\tan(180^\circ) =$

7) $\sin\left(\frac{-\pi}{4}\right) =$

8) $\cos\ -90^\circ\ =$

Activity 4: Algebra skills practice

1. Rearrange the variables in the equation given to solve for the one being asked:

1. $v = \frac{\Delta x}{\Delta t}$ solve for Δt_

2. $v_f = v_i + a\Delta t$ solve for a_

3. $y = \frac{gt^2}{2}$ solve for t_

4. $KE = \frac{mv^2}{2}$ solve for m_

5. GPE=mgh solve for h_

6. $T = 2\pi\sqrt{\frac{l}{g}}$ solve for l_

7. $\omega = \sqrt{\frac{k}{m}}$ solve for k_

8. $F = \gamma\frac{m_1 m_2}{r^2}$ solve for r_

2. In the following questions, please read the description and solve for the required variable. Even if you don't know the equation or the concept described here, don't worry. We are simply practicing writing one variable in terms of another.

    a. Find an equation for C in terms of the other variables. Also, find the units of C

    A group of students has a collection of parachutes of different radii. They are curious about how the terminal speed depends on the radius of the parachute and find the following equation on the Internet.

    $$F_{\text{air}} = Crv^2,$$

    where F_{air} is the force exerted by air, r is the parachute's radius, v is the parachute's speed, and C is a constant that has appropriate units.

    b. While conducting experiments using a fan cart (a small cart with a fan attached to it) running on an incline plan, students correctly find that the acceleration of the fan cart could be given by the equation. Derive an expression for the fan force in terms of a, m, g, and θ.

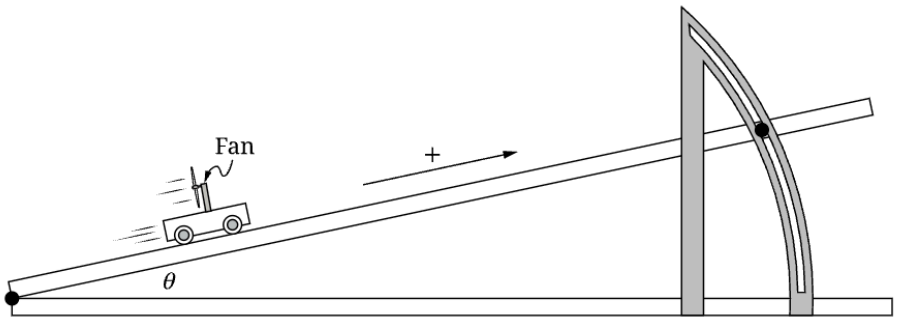


Figure 2

$a = \frac{F_{fan}}{m} - gsin\theta$

c. In an experiment where students are measuring a quantity called ROTATIONAL INERTIA, which kind of describes how difficult it is to start or stop rotating an object. For a complex system whose rotational speed is changing, the students find the following equation.. Write an equation for I_0 in terms of the other variables given.

$$\frac{\omega_i}{\omega_f} = \frac{MR^2}{I_0} + 1$$

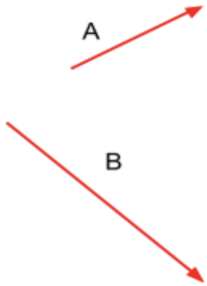
Part 2: Physics Fundamentals and Review (Deadline: 09/01/2025)

In this section of the summer packet, we will introduce one new topic that you need for pretty much all units - scalars and vectors. Then we will review some concepts from Units 1, 2 and 3

Activity 1: Introduction to Vectors

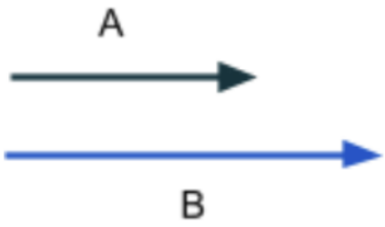
Step 1: Please complete Khan Academy modules assigned through Schoology and Clever
Step 2: Use the knowledge gained from the Khan Academy course to answer the questions

1. For the two vectors A and B shown below, find and draw:



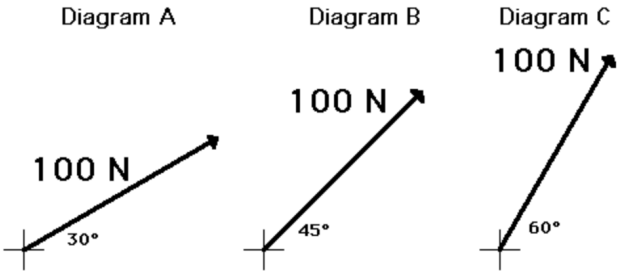
   a. -A
   b. -B
   c. A+B
   d. B-A (you can use the triangle rule)
   e. 3A
   f. -2B
   g. B+A (using the parallelogram rule)

2. A and B are two parallel vectors as shown below. Find and draw:



   a. -A
   b. -B
   c. A+B
   d. 2A + B

3. Resolve the three vectors below into their vertical and horizontal components



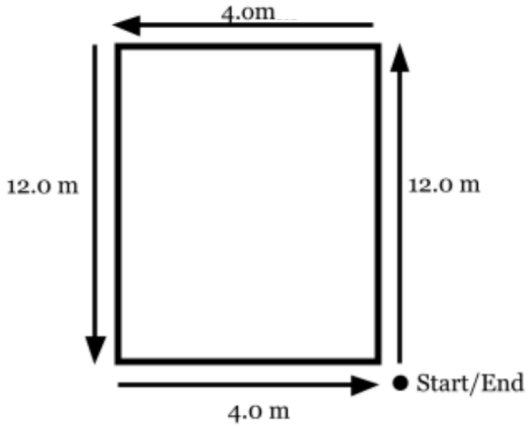
<u>Activity 2:</u> Kinematics quick review

In this section, we are going to review the basics of Kinematics, based on what you learned in your sophomore year.

Quantities with some units	**Equations**
d: distance (m)	d = st
t: time (s)	t = d/s
s: speed (m/s)	s = d/t
xi: Initial position	
xf: final position	
Δx: displacement (m, cm, miles)	$\Delta x = x_f - x_i$
ti: Initial time of observation	
tf: final time of observation	
Δt: time interval (s, minutes, hours)	$\Delta t = t_f - t_i$
v: velocity (m/s, cm/s, mph)	$v = \frac{x_f - x_i}{t}$ [or, we can rewrite it as] $v = \frac{\Delta x}{t}$ (if v is constant)
vi: Initial velocity	
vf: final velocity	

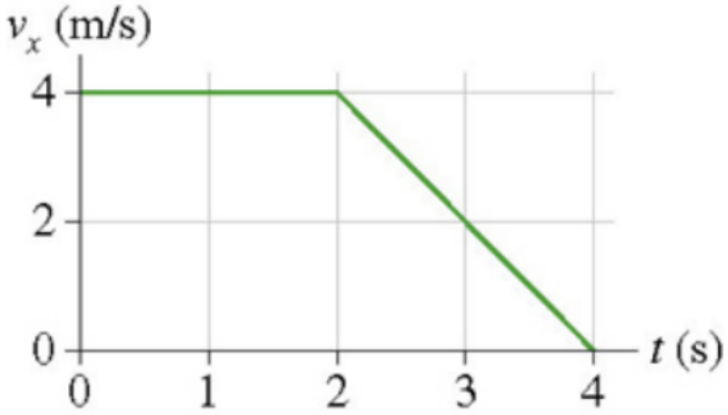
Δv: Change of velocity (m/s)	$\Delta v = v_f - v_i$
a: acceleration (m/s/s)	$a = \frac{v_f - v_i}{t}$
v_{avg}: Average velocity (mostly used in accelerated motion)	$v_{avg} = \frac{\Delta x}{t}$ $v_{avg} = \frac{v_f + v_i}{2}$
<u>Kinematics Equations</u> Vi = initial velocity Vf = final velocity Δx = displacement a = acceleration t = time	1st Kinematic equation: $v_f = v_i + at$ 2nd Kinematic equation $\Delta x = v_i t + \frac{1}{2} a t^2$ [or] $x_f = x_i + v_i t + \frac{1}{2} a t^2$ 3rd Kinematic equation: $v_f^2 = v_i^2 + 2a(\Delta x)$

1. If a car travels 300m in 30 seconds, how fast is it going?
2. If you run 60 meters toward the north in 15 seconds, what is the magnitude and direction of your velocity ?
3. Mira walks around the classroom as shown in the diagram .Using the diagram below answers the following questions



a. What is the distance Mira traveled?
b. What is her displacement?
c. If the walk took 5 minutes, what is Mira's average speed through the journey? Express your answer in m/s.
d. If the whole journey took 5 minutes, what is Mira's average velocity?

4. A car is traveling east and has an initial velocity of 35 m/s when it reduces its engine power, and after 5 seconds the car has a final velocity of 11.5 m/s.What is the car's average acceleration in its direction of motion?
5. A car has initial velocity 15m/s and an acceleration 1.0 What is the car's travel distance after 10 seconds?
6. A stone is dropped from a cliff.What is the stone's travel distance after 2 seconds. [Hint: Is the rock accelerating as it falls? What will this acceleration be? Round to the nearest whole number]
7. Below is given the graph of velocity versus time. Describe motion from intervals 0-2s and 2s-4s. Is this an example of accelerated motion?



a. Find the DISPLACEMENT of the object during the interval 0-2s. [Hint: from a VELOCITY-TIME graph, you can figure out the velocity of the object during a certain time. Then, use the appropriate kinematic equation]
b. Find the ACCELERATION of the object from 2s to 4s [Hint: use the equation for acceleration given in the table]

Activity 3: Introduction to dimensional analysis

Relevance: Understanding the dimensions of a quantity will help you when you are deriving an expression for an unknown quantity. It will also help you check your work to see if you're on the right track, especially in a unit such as fluids, which uses a lot of derived quantities.
Helpful links:

- *Dimensional Analysis | A-Level Physics*

1. A car is moving with speed v, given by the equation: $v = C+Dt^2$, where t represents time and C and D are constants. Determine the SI units of C and D.

2. Newton's Law of Universal Gravitation states that the force of gravity between two objects with mass can be found to be: $F_G = \frac{Gm_1m_2}{r^2}$, where m1 and m2 are the masses of the object and the r is the distance of separation between them. G is a universal constant. Find the units of G, using dimensional analysis.

Activity 4: Graphing physical functions and analysis

Relevance: Your ability to make and interpret graphs will be tested across every single unit across the curriculum. It is one of the most important skills to master, in order to be successful at the AP Physics 1 exam.

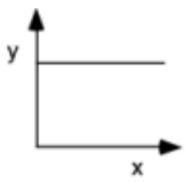
Helpful links:

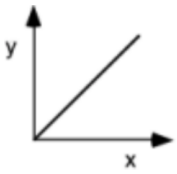
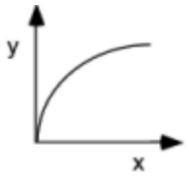
- *AP Physics 1: Introduction 7: Basic Graphing*
- *http://www.studyphysics.ca/newnotes/20/unit01_kinematicsdynamics/chp03_kinematics/lesson08.htm*
- *https://serc.carleton.edu/mathyouneed/graphing/bestfit.html*

Essential elements of any good graph:

a. Each axis should be labeled with the variable being plotted along with appropriate units
b. Each axis should include a reasonable number of labeled tick marks at even intervals
c. Graphs should be labeled with a meaningful title or caption.
d. The y intercept represents the value of the function when the argument of the function (x-value) is zero. In physics, this can represent some constant quantity that doesn't vary with respect to another variable. E.g. The pressure on an object at any depth under a fluid will be **atmospheric pressure** (y-intercept) plus the pressure of the fluid on the object.
e. The relationship between the independent variable and the dependent variable can be found by plotting the line or curve of best fit.

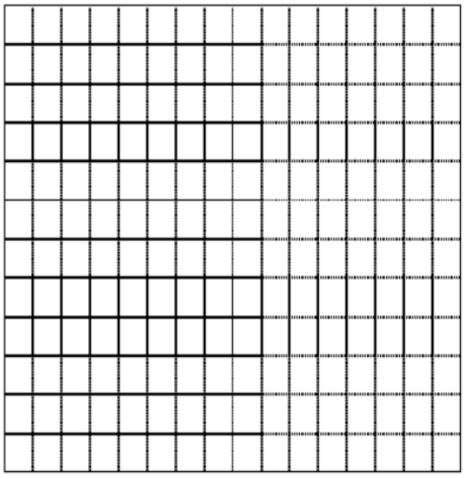
1. In the following data, various shapes of typical graphs are given. Please identify what kind of relationship exists between the independent and dependent variable. Write it in the form of a proportionality equation:

Graph Shape	Describing the relationship between x and y	General equation of the line/curve
	As x increases, y remains constant. There is no relationship between x and y	y = m (some constant)

	As x increases, y _____. The relationship between x and y is _____	y =
		
	(assume this graph is a PARABOLA)	
	(assume this graph is a PARABOLA)	

2. The centripetal force acting on an object moving in a circular path is given by the equation: $F=mV^2/R$. What would be the shape of the graph of:
    a. F and R
    b. F and m
    c. F and V
3. Suppose a mass is placed on a horizontal table that is nearly frictionless. Various horizontal forces are applied to the mass. The distance the mass traveled in 5 seconds for each force applied is measured. The results of the experiment are shown in Table 1.

Table 1	
Distance Traveled with Different Forces	
Force (N)	**Distance (cm)**
5.0	24
10.0	49
15.0	75
20.0	99
25.0	120
30.0	145



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a. Plot a graph of the data provided and also plot the curve of best fit.
b. Write a general equation connecting the force applied to the distance traveled by the mass
c. What is the constant of proportionality in this equation? Find its units
d. Predict the distance traveled by the object if a force of 22N is applied to the mass, using the line of best fit you have made.

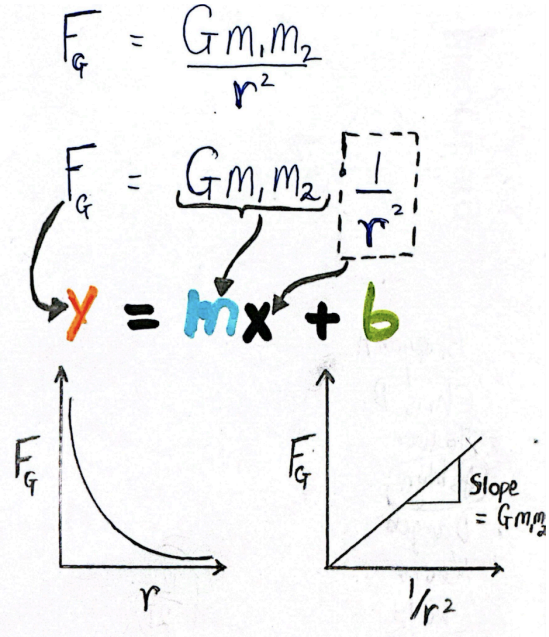
Activity 5: Linearization

Relevance: Linearization is one of the most important skills you will need to be successful in the LAB type of FRQ (designing your own lab) in the AP Physics 1 exam. It will also help you in several labs, solving graphical analysis MCQ etc.
Definition: Linearization is a process by which we can convert any relationship between variables into a linear relationship, making it easier to graph and analyze. All of you know how to find the slope and y-intercept of a line, which you can use to find required physical quantities.

For example: we know that Newton's Law of Gravitation states that: $F_G = \frac{Gm_1m_2}{r^2}$

If we plot F vs. r, we would get a parabolic curve downward, which would be difficult to analyze. But, if we plot F vs. $1/r^2$, we would get a LINEAR GRAPH with slope "Gm_1m_2".
Rules:

- Write the general equation of the line (y = mx + b) next to or under the given function.
- Match parts of the equation to the corresponding parts of the general equation for a linear equation
- Plot the data according to the new linear version of the graph you obtained
- Find the slope and y-intercept manually from your graph, and use it to find/calculate any other values or constants you need.



From the slope, I can experimentally find the value of “G” if m1 and m2 are given to me.

Helpful links:

- *Linearizing graphs to establish relationships between variables*
- *How to Linearize Data in Physics Lab*

Problem 1: Marty McFly has to go back in time to save… well everything! To do so he has to drive at 88 mi/h in Doc’s time traveling Delorean. However, the Delorean is a real lemon and won’t start. They decide to just push it off a cliff and let gravity accelerate it. The problem is they are not sure if the local cliff is high enough! They only get one chance at this so they need a good model of this phenomenon to make a prediction of how high the cliff has to be for the Delorean to reach 88 MPH. They decide to design a non-destructive experiment using a bowling ball to develop their model.

Doc and Marty design an experiment and collect data by dropping a bowling ball from different heights in meters (m) in the lab and measuring the speed of the ball in meters per second (m/s) as it hits the floor. They record their data and voila, here it is:

Trial	height (meters) +/- 0.05 m	Speed (m/s) +/- 0.1 m/s
1	.50	3.1
2	1.00	4.4
3	1.50	5.4
4	2.00	6.3
5	2.50	7.0
6	3.00	7.7

On separate graph paper make a good graph of this data. Then linearize the graph to determine a good mathematical model. Describe your model verbally and as a mathematical equation.

Verbal description:
Equation:

After performing the experiment and examining the data Doc and Marty decide to drop the Delorean, with Marty in it, off the local cliff that is 52 meters high. Good idea? Explain your answer based on the model you developed.

Problem 2: Students in Ms. Raj’s AP Physics class did an experiment to find the PERIOD of a spring-mass system. A period refers to the time taken by the spring-mass to complete one

oscillation (starting from the lowest point, swinging up to the highest point, and returning back to where it started). As shown in the figure, the students set up the spring mass system vertically:

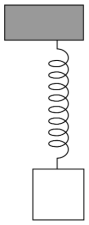


Figure 1

Next, they looked into their physics textbook and found an equation/formula for the period of oscillation of a spring-mass system:

$$T = 2\pi\sqrt{\frac{m}{k}}$$

The students conducted the experiment and found the following values for period of the spring for blocks of different masses:

M (kg)	T (s)
0.3	0.77
0.6	1.07
0.9	1.29
1.2	1.50

a. Suppose we plotted a graph between period (T - dependent variable) and mass (M - independent variable), what would the *shape* of the graph look like? Make a sketch.
b. The above graph will not help us find the SPRING CONSTANT, k, of the spring directly. How can we LINEARIZE the given equation so that we can make a linear graph instead of the shape you made above? Show your work.
c. Plot the linearized graph and find the slope. You may use Desmos. Show your work and add a screenshot of the graph you have made.
d. What quantity does the slope of the line give us? How can we rearrange the variables so that we can find the value of “k”?

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