AP 1 Summer Enrichment and Preparation for Fall:

The exercises below are a review of the prerequisite math skills that you need to succeed in AP Physics 1. Make sure to read all directions throughout the packet. Calculators CAN be used. This work will not be turned in. It is to give you a sample of the math skills. In the AP 1 class you will be doing what I like to call acrobatics of algebra, so your algebra skills need to be really solid. I'll give you some exercises and strategies during the first week of class that can help. Any questions you have regarding the problems here should be asked either via email over summer or the first week of school. If you haven't had a previous physics class, I encourage you to get familiar with the topics via youtube videos or other sources. The topics we will cover are: Kinematics, Dynamics, Work, Energy and Power, Momentum and Impulse, Circular Motion and Gravitation, Oscillations in Simple Harmonic Motion, Rotational Motion and Fluids. We will cover the topics thoroughly, but it will be helpful to have some familiarity. Have a great summer and I look forward to meeting you in the fall!

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Unit Conversions Review

1. Given the SI prefix table below. Follow the example of the centi- prefix. You will need to use these for unit conversions.

Symbol	Name	Numerical Equivalent
n		
μ		
m		
c	centi	10^{-2}
k		
M		
G		

2. 16.7 kilograms is how many grams?

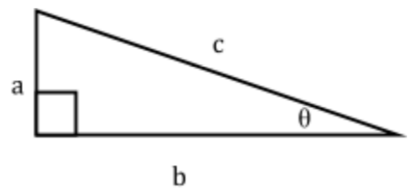
3. 560 nm is how many meters?

4. 15 years is how many seconds?

5. $8.99x10^9$ seconds is how many years?

6. $2.998x10^8$ m/s is how many kilometers per hour?

Trigonometry Review
Directions: Use the figure below to answer problems 7-16. Simplify as much as you can.



7. Find *c* if given *a* and *b*.

8. Find *a* if given *c* and θ.

9. Find *c* if given *b* and θ.

10. Find θ if given *a* and *b*.

11. If $c = 10.0$ and $\theta = 60^\circ$, what is *b*?

12. Find *a* if given *b* and *c*.

13. Find *b* if given *a* and θ.

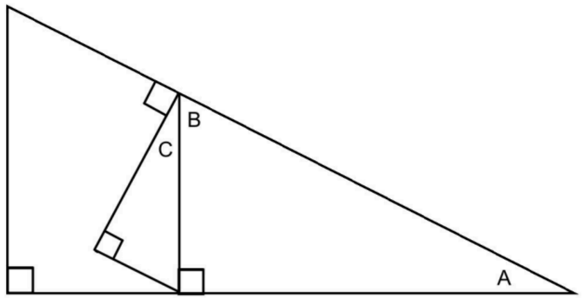
14. Find θ if given *b* and *c*.

15. If $a = 2.0$ and $c = 7.0$, what is *b*?

16. If $a = 12.0$ and $\theta = 30^\circ$, what is *b*?

Using the properties of triangles, prove that ∠A ≅ ∠C in the drawing below.

Answer:



17. Complete the table below.

Angle	0°	90°
sin θ		
cos θ		

18. 360 degrees = ________ radians.

19. 4.5 revolutions = _______ radians.

The above example is really important - this triangle relationship will come up over and over again, and you will need to be confident that the theta of both triangles are equal.
For the algebra review, it is not necessary to know a value for a variable. Just be able to use your algebra skills to solve for whatever variables you are asked to solve. You will need to be able to solve problems using only variables or dimensions often on the ap exam.

Algebra Review

Directions: Solve the following equations for the given variable and conditions. Simplify if needed.

Example: $2x + xy = z$. Solve for *x*.

$$x(2+y) = z$$

$$\boxed{x = \frac{z}{2+y}}$$

20. $v_1 + v_2 = 0$. Solve for v_1.

21. $a = \dfrac{v - v_0}{t}$. Solve for *t*.

22. $v_x^{\ 2} = v_{x0}^{\ 2} + 2a(x - x_0)$

a. Solve for v_{x0}.

b. Solve for x.

23. $x = x_o + v_{xo}t + \frac{1}{2}a_x t^2$

a. Solve for v_{xo}.

b. Solve for t, if $v_{xo} = 0$

c. Solve for t, if $x_o = x$.

24. $F = m\frac{v_f - v_i}{t_f - t_i}$

a. Solve for v_f, if $t_i = 0$.

b. Solve for t_f, if $v_f = 0$ and $t_i = 0$.

25. $a_c = \frac{v^2}{r}$. Solve for v.

26. $mg\sin\theta = \mu mg\cos\theta$ Solve for θ.

27. $\frac{1}{2}mv_f^{\ 2} + mgh_f = \frac{1}{2}mv_0^{\ 2} + mgh_0$

a. Solve for h_f, if $h_0 = 0$ and $v_f = 0$.

b. Solve for v_f, if $h_f = 0$.

28. $Ft = mv_f - mv_0$. Solve for v_f.

29. $m_1 v_{0,1} + m_2 v_{0,2} = (m_1 + m_2) v_f$. Solve for $v_{0,2}$.

30. $m_1 v_{0,1} + m_2 v_{0,2} = m_1 v_{f,1} + m_2 v_{f,2}$. Solve for $v_{f,2}$ if $v_{0,1} = 0$.

31. $(F_1 \sin\theta) r_1 + (-F_2 \sin\phi) r_2 = 0.$ Solve for r_2.

32. $-kx + m(-g) = 0.$ Solve for *m*.

33. $\left|\vec{F}_g\right| = G \frac{m_1 m_2}{r^2}$. Solve for *r*.

34. $L - L\cos\theta = \frac{v^2}{2}$ Solve for *L*.

35. $\frac{mv^2}{R} = G\frac{Mm}{R^2}$. Solve for v.

36. $T = 2\pi\sqrt{\frac{L}{g}}$. Solve for g.

37. $\frac{1}{2}mv_f^{\ 2} + \frac{1}{2}kx^2 = \frac{1}{2}mv_0^{\ 2} + mgh_0$. Solve for x if $v_f = 0$.

38. $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$. Solve for R_P.

Miscellaneous

39. Consider $z = \frac{x}{y}$, $c = ab$, $l = m - n$, or $r = \frac{s^2}{t^2}$.

   a. As x increases and y stays constant, z ___________________.

   b. As y increases and x stays constant, z ___________________.

   c. As x increases and z stays constant, y ___________________.

   d. As a increases and c stays constant, b ___________________.

e. As *c* increases and *b* stays constant, *a* ____________________.

f. As *b* increases and *a* stays constant, *c* ____________________.

g. As *n* increases and *m* stays constant, *l* ____________________.

h. As *l* increases and *n* stays constant, *m* ____________________.

i. If *s* is tripled and *t* stays constant, *r* is multiplied by ____________________.

j. If *t* is doubled and *s* stays constant, *r* is multiplied by ____________________.

Systems of equations

Use the equations in each problem to solve for the specified variable in the given terms. Simplify.

40. $F_f = \mu F_N$ and $F_N = mg\cos\theta$. Solve for μ in terms of F_f, m, g, and θ.

41. $F_1 + F_2 = F_T$ and $F_1 \cdot d_1 = F_2 \cdot d_2$. Solve for F_1 in terms of F_T, d_1, and d_2.

42. $\Sigma F = ma_c$ and $a_c = \frac{v^2}{r}$. Solve for r in terms of ΣF, m, and v.

43. $T = 2\pi\sqrt{\frac{L}{g}}$ and $T = \frac{1}{f}$. Solve for L in terms of π, g, and f.

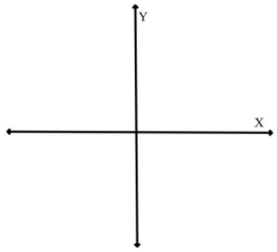
Graphing Equations

44. If $r = -x*t+c$ was graphed on an r vs. t graph, what would the following be?

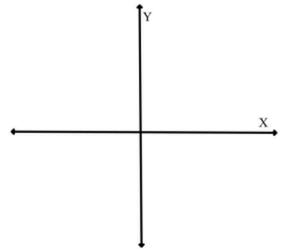
Slope: ___________ y-intercept: _____________

45. On the y vs. x graphs below, sketch the relationships given.

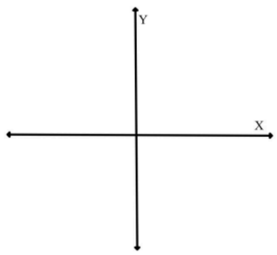
a. $y = mx + b$, if $m > 0$ and $b = 0$.



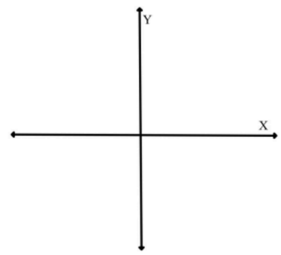
b. $y = mx + b$, if $m < 0$ and $b > 0$.



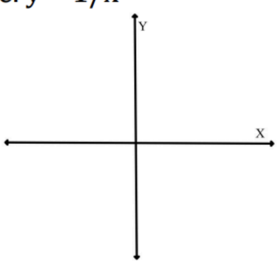
c. $y = x^2$



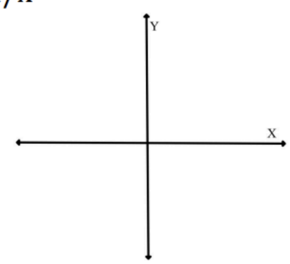
d) $y = \sqrt{x}$



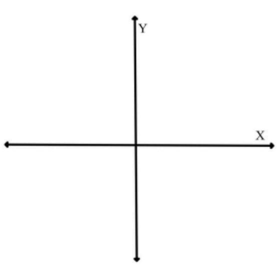
e. $y = 1/x$



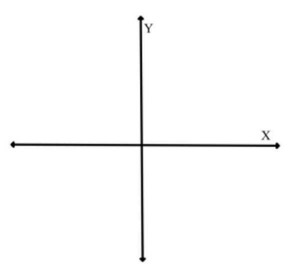
f. $y = 1/x^2$



g. $y = \sqrt{\frac{1}{x}}$



h. $y = \sin(x)$



Marbles in Cylinder Lab

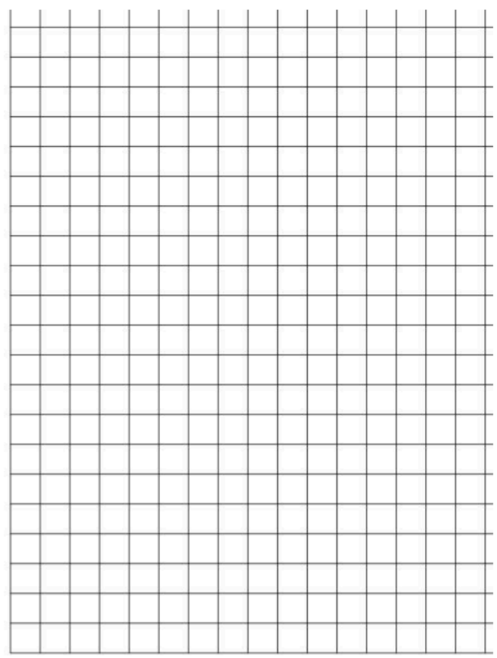
a. You received a graduated cylinder with three identical marbles and an unknown amount of water already in it. You placed extra identical marbles in the cylinder and obtained the data below. Use the data to graph a best-fit line showing the relationship between the water level and the number of marbles. The y-intercept should be visible on the graph. Label your axes and include units.
b. From the graph, determine a mathematical formula for the water level for any number of marbles. Lastly, give an explanation of your formula in words. Make sure to give an explanation of the slope and y-intercept of your formula.

Number of Marbles in Water	Water level (mL)
3	58
4	61
5	63
6	65
7	68

46. Graph the data point to the right.

47. Formula: ______________________________

48. Explanation of the formula in words: (Include the meaning of the **slope** and **y-intercept**.)



Finally, you'll need to understand rates of change (all of this will be taught, of course, but seeing it beforehand will make it easier to understand in class):
Understand rates. Displacement/time, velocity/time, and acceleration/time are the basic rates of change you will work with the most.

Displacement / time gives velocity. Both displacement and velocity are vectors, and velocity is the derivative of displacement. Displacement is the integral of velocity.

Velocity / time gives acceleration. Both quantities are vectors, and acceleration is the derivative of velocity. Velocity is the integral of acceleration.

While we won't use calculus in the course, we will use the graphical analysis of derivatives and integrals, which are the slope and the area under the curve, respectively.

Acceleration is the hardest rate for students to grasp. Acceleration is the rate of change of an object's speed or direction.

An acceleration is a change in velocity. Since velocity is a vector, this change can be in speed or direction. An object in circular motion that is moving at a constant speed still has an acceleration, since it is constantly changing direction. Also, we do not call slowing down a deceleration. We call it an acceleration (change in velocity).

Physical meaning:
Imagine you drop an object off of a cliff. The instant you drop it, it has a vertical velocity of 0 m/s. It then accelerates at a rate that is due to the force of gravity: 10 m/s/s or 10 m/s^2. I like the first term better, because it describes what is actually happening:

The object is speeding up by 10 m/s every second until the instant before it hits the ground. So think to yourself, what is the object's speed after 2 seconds? After 5 seconds? No calculations needed, it's easy to do in your head. This scenario can really help to grasp the concept of acceleration.
The following video will be helpful. Kinematics is our first unit, after unit 0 which is where you will learn about vectors and important diagrammatic strategies.

Flipping Physics AP Physics 1 Kinematic Review