AP Physics 1 – Summer Assignment Packet

Welcome to AP Physics 1! Your summer assignment is designed to help you succeed in physics by reviewing necessary skills.

This assignment is due when you return to school. It will be collected on the first day of class. Every problem must be completed and work must be shown in order to receive credit.

You are encouraged to use any resources available (textbooks, Internet). If you have any questions, please email me at wheats@pcsb.org.

I look forward to seeing you in the fall.

Ms. Wheat

Manipulating Variables and Constants

Often in science and mathematics you are given an equation and asked to solve it for a particular variable symbol or letter called the *unknown*. The symbols which are not the particular variable we are interested in solving for are called *literals*, they are our givens, or known variables. Equations are solved by isolating the unknown variable on one side of the equation, and all of the remaining given/known variables on the other side of the equation. Sometimes the unknown variable is part of another term. A *term* is a combination of symbols such as the products ma or πr^2. In this case the unknown (such as r in πr^2) must factored out of the term before we can isolate it.

The following rules, examples, and exercises will help you review and practice solving equations.

PROCEDURE

In general, we solve a literal equation for a particular variable by following the basic procedure below.

1. Recall the conventional order of operations, that is, the order in which we perform the operations of multiplication, division, addition, subtraction, etc.:
    a. Parenthesis (If some parentheses are enclosed within others, work from the inside out.)
    b. Exponents
    c. Multiplication and Division
    d. Addition and Subtraction
2. If the unknown is a part of a grouped expression (such as a sum inside parentheses), use the distributive property to expand the expression.
3. By adding, subtracting, multiplying, or dividing appropriately,
    a. move all terms containing the unknown variable to one side of the equation, and
    b. move all other variables and constants to the other side of the equation. Combine like terms when possible.
4. Factor the unknown variable out of its term by appropriately multiplying or dividing both sides of the equation by the other literals in the term.
5. If the unknown variable is raised to an exponent (such as 2, 3, or ½), perform the appropriate operation to raise the unknown variable to the first power, that is, so that it has an exponent of one.

EXAMPLES

1. $F = m\mathbf{a}$. Solve for $\mathbf{a}$. $F = ma$
Divide both sides by m:

$$\frac{F}{m} = \mathbf{a}$$

Since the unknown variable (in this case a) is usually placed on the left side of the equation, we can switch the two sides:

$$\mathbf{a} = \frac{F}{m}$$

2. $P_1V_1 = P_2\mathbf{V}_2$. Solve for $\mathbf{V}_2$.

$$P_1V_1 = P_2\mathbf{V}_2$$

Divide both sides by P_2:

$$\frac{P_1V_1}{P_2} = \mathbf{V}_2$$

$$\mathbf{V}_2 = \frac{P_1V_1}{P_2}$$

3. $v = \frac{d}{\mathbf{t}}$. Solve for $\mathbf{t}$.
Multiply each side by $\mathbf{t}$:

$$\mathbf{t}v = d$$

Divide both sides by v:

$$\mathbf{t} = \frac{d}{v}$$

4. $PV = n\mathbf{R}T$. Solve for $\mathbf{R}$.

$$PV = n\mathbf{R}T$$

Divide both sides by n:

$$\frac{PV}{n} = \mathbf{R}T$$

Divide both sides by $\mathbf{T}$:

$$\frac{PV}{nT} = \mathbf{R}$$

$$\mathbf{R} = \frac{PV}{nT}$$

5. $R = \frac{\rho\mathbf{L}}{A}$. Solve for $\mathbf{L}$.

$$R = \frac{\rho\mathbf{L}}{A}$$

Multiply both sides by A:

$$RA = \rho\mathbf{L}$$

Divide both sides by ρ:

$$\frac{RA}{\rho} = \mathbf{L}$$

$$\mathbf{L} = \frac{RA}{\rho}$$

6. $A = h(a+\mathbf{b})$. Solve for $\mathbf{b}$.
Distribute the h:

$$A = ha + h\mathbf{b}$$

Subtract ha from both sides:

$$A - ha = h\mathbf{b}$$

Divide both sides by h:

$$\frac{A-ha}{h} = \mathbf{b}$$

$$\mathbf{b} = \frac{A-ha}{h}$$

7. $P = P_0 + \rho\mathbf{g}h$. Solve for $\mathbf{g}$.
Subtract P_0 from both sides:

$$P - P_0 = \rho\mathbf{g}h$$

Divide both sides by ρh:

$$\frac{P-P_0}{\rho h} = \mathbf{g}$$

$$\mathbf{g} = \frac{P-P_0}{\rho h}$$

8. $U = \frac{1}{2}\mathbf{Q}V$. Solve for $\mathbf{Q}$.
Multiply both sides by 2:

$$2U = \mathbf{Q}V$$

Divide both sides by V:

$$\frac{2U}{V} = \mathbf{Q}$$

$$\mathbf{Q} = \frac{2U}{V}$$

9. $U = \frac{1}{2}k\mathbf{x}^2$. Solve for $\mathbf{x}$.
Multiply both sides by 2:

$$2U = k\mathbf{x}^2$$

Divide both sides by k:

$$\frac{2U}{k} = \mathbf{x}^2$$

Take the square root of both sides:

$$\sqrt{\frac{2U}{k}} = \mathbf{x}$$

$$\mathbf{x} = \sqrt{\frac{2U}{k}}$$

10. $T = 2\pi\sqrt{\frac{\mathbf{L}}{g}}$. Solve for $\mathbf{L}$.
Divide both sides by 2π:

$$\frac{T}{2\pi} = \sqrt{\frac{\mathbf{L}}{g}}$$

Square both sides:

$$\frac{T^2}{4\pi^2} = \frac{\mathbf{L}}{g}$$

Multiply both sides by g:

$$\frac{gT^2}{4\pi^2} = \mathbf{L}$$

$$\mathbf{L} = \frac{gT^2}{4\pi^2}$$

11. $F = \frac{Gm_1m_2}{\mathbf{r}^2}$. Solve for $\mathbf{r}$.
Multiply both sides by $\mathbf{r}^2$:

$$F\mathbf{r}^2 = Gm_1m_2$$

Divide both sides by F:

$$\mathbf{r}^2 = \frac{Gm_1m_2}{F}$$

Take the square root of both sides:

$$\mathbf{r} = \sqrt{\frac{Gm_1m_2}{F}}$$

12. $\frac{h_i}{h_o} = -\frac{s_i}{\mathbf{s}_o}$. Solve for $\mathbf{s}_o$.
Cross-multiply:

$$h_i\mathbf{s}_o = -h_o s_i$$

Divide both sides by h_i:

$$\mathbf{s}_o = -\frac{h_o s_i}{h_i}$$

13. $\frac{1}{R_{EQ}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{\mathbf{R}_3}$. Solve for $\mathbf{R}_3$.
Subtract $\frac{1}{R_1} + \frac{1}{R_2}$ from both sides:

$$\frac{1}{R_{EQ}} - \frac{1}{R_1} - \frac{1}{R_2} = \frac{1}{\mathbf{R}_3}$$

Take the reciprocal of both sides:

$$\frac{1}{\frac{1}{R_{EQ}} - \frac{1}{R_1} - \frac{1}{R_2}} = \mathbf{R}_3$$

$$\mathbf{R}_3 = \frac{1}{\frac{1}{R_{EQ}} - \frac{1}{R_1} - \frac{1}{R_2}}$$

14. $F = qvB\sin\boldsymbol{\theta}$. Solve for $\boldsymbol{\theta}$.
Divide both sides by qvB:

$$\frac{F}{qvB} = \sin\theta$$

Take the inverse sine of both sides:

$$\boldsymbol{\theta} = \sin^{-1}\left[\frac{F}{qvB}\right]$$

Manipulating Variables and Constants EXERCISES

Directions: For each of the following equations, solve for the variable in **bold** print. Be sure to show each step you take to solve the equation for the **bold** variable.

1. $v = \mathbf{a}t$

2. $P = \dfrac{F}{\mathbf{A}}$

3. $\lambda = \dfrac{\mathbf{h}}{p}$

4. $F(\Delta \mathbf{t}) = m\Delta v$

5. $U = \dfrac{G\mathbf{m}_1 m_2}{r}$

6. $C = \dfrac{5}{9}(\mathbf{F} - 32)$

7. $v^2 = v^2 + 2\mathbf{a}\Delta x$

8. $K = \dfrac{1}{2}m\mathbf{v}^2$

9. $v_{rms} = \sqrt{\dfrac{3RT}{\mathbf{M}}}$

10. $F = \dfrac{1}{4\pi\varepsilon_0}\dfrac{Kq_1q_2}{\mathbf{r}^2}$

11. $x = x_0 + v_0 t + \dfrac{1}{2}\mathbf{a}t^2$

12. $n_1 \sin \theta_1 = n_2 \sin \boldsymbol{\theta_2}$

Part II: Factor-Label Method for Converting Units (Dimensional Analysis)

A very useful method of converting one unit to an equivalent unit is called the factor-label method of unit conversion. You may be given the speed of an object as 25 **km/h** and wish to express it in **m/s**. To make this conversion, you must change **km** to **m** and **h** to **s** by multiplying by a series of factors so that the units you do not want will cancel out and the units you want will remain. Conversion factors: 1000 **m** = 1 **km** and 3600 **seconds** = 1 **hour**

$\left(\frac{25\ \text{km}}{\text{h}}\right)\left(\frac{1000\ \text{m}}{1\ \text{km}}\right)\left(\frac{1\ \text{h}}{3600\ \text{s}}\right)$ = 6.94 m/s

What is the conversion factor to convert km/h to m/s?

What is the conversion factor to convert m/s to km/h?

Do the following conversions using the factor-label method. <u>Show all of your work!</u>

1. How many seconds are in a year?
2. Convert 28 km to cm.
3. Convert 450 g to kg.
4. Convert 85 cm/min to m/s
5. Convert 6 grams to kg.
6. Convert 823 nm to m.

Part III: Scientific Notation:

200,000 = 2 x 10^5 0.00000123 = 1.23 x 10^{-6}

Express the following numbers in scientific notation:

1. 86,400 s =
2. 300,000,000 m/s =
3. 0.000564 m =
4. 0.0000000000667 =

Convert from scientific notation to normal notation:

1. 9 x 10^9 =
2. 1.93 x 10^4 kg/m^3 =
3. 1 x 10^{-3} m =
4. 4.5 x 10^{-7} m =

Part IV: Trigonometry and Basic Geometry

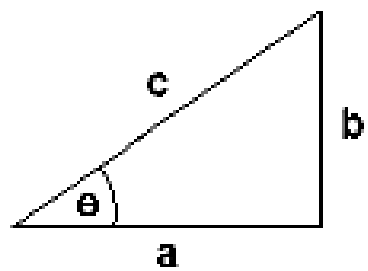
Solve for all sides and all angles for the following triangles. Show all your work.

Information:

$\sin\theta = \frac{opposite}{hypotenus}$ *(SOH)*

$\cos\theta = \frac{adjecent}{hypotenus}$ *(CAH)*

$\tan\theta = \frac{opposite}{hypotenus}$ *(TOA)*



Example: $\theta = 20°$ and c = 10 m, solve for **a** and **b**

$\sin 20° = \frac{b}{10}$, $b = 3.42$ m $\cos 20° = \frac{a}{10}$, $a = 9.40$ m

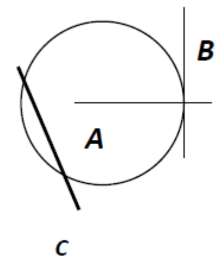
Your calculator must be in **degree mode! Show all of your work!**

1. θ = 55° and c = 32 m, solve for **a** and **b**

2. θ = 45° and a = 15 m/s, solve for **b** and **c**

3. $\theta = 65°$ and b = 17.8 m, solve for **a** and **c**

4. Line **B** touches the circle at a single point. Line **A** extends through the center of the circle.



   a. What is the line **B** in reference to the circle?

   b. How large is the angle between lines **A** and **B**?

   c. What is line **C**?

Do the following problem and show your work:

A bus driver clocked the following times for portions of his route:

Station A to Station B	1.63 hours
Station B to Station C	4.7 hours
Station C to Station D	0.755 hours
Station D to Station E	2.00 hours

a. How long did it take him to drive from Station A to Station E?

b. What part of the whole traveling time does the time between Stations B and D represent?

c. The time to go from Station A to Station C is how much more than the time to go from Station C to Station E?

PART V. GRAPHING TECHNIQUES

Graph the following sets of data using proper graphing techniques.

The first column refers to the *y*-axis and the second column to the *x*-axis

1. Plot a graph for the following data recorded for an object falling from rest:

Velocity (ft/s)	**Time** (s)
32	1
63	2
97	3
129	4
159	5
192	6
225	7

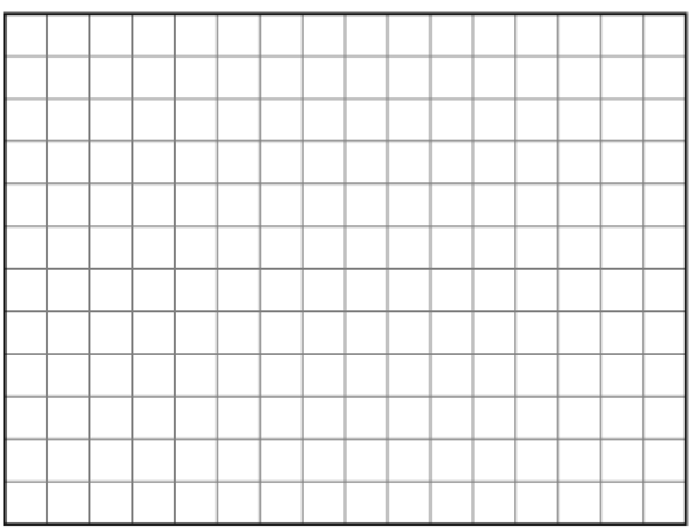
a. What kind of curve did you obtain?

b. What is the relationship between the variables?

c. What do you expect the velocity to be after 4.5 s?

d. How much time is required for the object to attain a speed of 100 ft/s?

2. Plot a graph showing the relationship between frequency and wavelength of electromagnetic waves:



Frequency (kHz)	**Wavelength** (m)
150	2000
200	1500
300	1000
500	600
600	500
900	333

a. What kind of curve did you obtain?

b. What is the relationship between the variables?

c. What is the wavelength of an electromagnetic wave of frequency 350 Hz?

d. What is the frequency of an electromagnetic wave of wavelength 375 m?