AP Physics Summer Packet

Welcome to AP Physics! This is going to be a fun and challenging class. As this class is designed to build on the knowledge and skills that you have developed in your previous classes, it is important that you maintain them throughout the summer. "The brain is just like other muscles, if you don't use it, it atrophies!" In that vein, this summer packet is a guide to help you flex your brain. I broke things down into four simple parts:

I. Basic Science Skills
II. Essential Mathematics
III. Scientific Investigations
IV. Physics Concepts

For each part, there are two activities. I am expecting you to complete one activity from each part. Each activity is weighted equally, so choose what you find the most interesting. You will have four turn-in dates (turn in one activity on each date via e-mail, twithee@gmail.com). The first activity is due on **June 26**, the second on **July 10**, the third on **July 24** and the fourth on the **first full day of school (August 17)**. NO LATE WORK WILL BE ACCEPTED (so turn them in early if you won't be home/near a computer with internet). If you have any questions or concerns, please e-mail me at twithee@gmail.com.

In order to help you and for me to keep things organized, you MUST e-mail me by June 12. (Please have your subject line indicate your first and last name and class you are in: example: Subject: Albert Einstein in Pre-AP Physics)

Basic Science Skills

Activity One – The Metric System

The Systeme International de Units was developed so that scientists across the globe would have and accurate way of recording and sharing information. In physics, the SI system is useful in making sure that you are recording/reporting/calculating what you intended to record/report/calculate. For example, a simple calculation of speed from traveling 32 m in 16 s reveals a speed of 2 m/s. Knowing that m/s is an acceptable unit of speed, we move on. Similarly, reporting the mass of an electron as 0.511 MeV/c^2 instead of $9.11*10^{-31}$ kg is also acceptable. Your task is to develop a USEFUL table of metric units two of their alternative

representations/conversions. Do NOT find a table of conversions and send it to me. You must develop your own. In addition, you might find it useful to make and Excel spreadsheet that can do the conversions for you.

Activity Two – Light Years From Here

Physics is notorious for using outrageous units that make it difficult to understand the concepts that are addressed. Your task is to write a short story (three to four pages) that utilizes the most outrageous units you can. As a simple example, how tall are you in Angstrom Units? What is your mass in slugs? (you should use as many units as possible).

Essential Mathematics

Activity Three – The Language of Science

Mathematics is an important tool of science, it is the language that scientist communicate their ideas in. If a picture is worth a thousand words, then an equation is worth a trillion words. In science, we break down the variables into three simple categories: Dependent, Independent and Constant. A dependent variable is what you are concerned about being effected by your experiment. An independent variable is what you are manipulating in your experiment. The constants are all those things that matter but you are not altering during your experiment. Take the following formulas and perform the following:

a) Identify what the variable stand for (F is for force).
b) Solve each formula for each non-constant variable
    a. $F = ma$
    b. $m = F/a$
    c. $a = F/m$
c) For each phrasing of the formula identify the dependent variable and how the dependent variable is affected by the independent variable.
    a. When force is dependent, it is directly related to both the mass and the acceleration.
    b. When mass is dependent, it is directly related to force and inversely related to acceleration.
    c. When acceleration is dependent, it is directly related to force and inversely related to mass.

Your formulas are:

$d = d_o + v_o t + \frac{1}{2}at^2$

$F_G = Gm_1m_2/r^2$

$F_G = kq_1q_2/r^2$
$T_p = 2\pi\sqrt{(l/g)}$
$C = \kappa\varepsilon_o A/d$

Activity Four – All that Math

Solve the following as indicated.

a. If $f(x) = 2x^2 + 3x - 4$, find $f(0)$, $f(2)$, $f(\sqrt{2})$, $f(1 + \sqrt{2})$, $f(-x)$, $f(x+1)$, $2f(x)$ and $f(2x)$.
b. A stone is dropped into a lake, creating a circular ripple that travels outward at a speed of 60 cm/s. Express the area of this circle as a function of time t (in seconds).
c. A spherical balloon is being inflated. If the radius of the balloon is increasing at a rate of 1 cm/s, express the volume of the balloon as a function of time t (in seconds).
d. The radius of the Earth is about 3960 mi. What length of ribbon would you need to wrap the Earth around the equator? How much more ribbon would you need on foot above the equator?
e. In a right triangle, the hypotenuse has length of 5 cm and another side has length 3 cm. What is the length of the altitude that is perpendicular to the base?

Scientific Investigations

Activity Five – Experimental Design

Your goal here is to design and perform a simple experiment. You must have a testable hypothesis, control variables, one dependent variable and one independent variable. Once you have designed your simple experiment, perform your experiment, collecting data on your dependent variable (I suggest at least ten trials for each state of your independent variable). Then analyze your data by plotting a graph (USE EXCEL!!!, with averages, standard deviations and error bars). If possible state any conclusions that you can draw from your analysis. Then discuss all possible sources of error and any potential further investigations you would suggest.

Activity Six – Science Olympiad

Your goal here is to begin preparing for Science Olympiad, TEAMS competition or WYSE competition. Choose one topic from one of these three and prepare the necessary materials. (All three competitions and

their guides can be found online at the various websites. You will have to use last year's materials, 2007 - 2008)

Science Olympiad - http://www.soinc.org/events/index.htm
WYSE - http://www.engr.uiuc.edu/wyse/AC/students.html
TEAMS - http://www.jets.org/TEAMS/archives/index.cfm

Activity Seven – The Media

Scientific topics are all over the media. Throughout the summer, find one scientific topic that makes the headlines and follow up on its sources. Make a short report (three to four pages, should be mostly facts/tables/graphs that you copied) that explains what the topic is and the important features. Then, discuss the impact of this topic in the world today and possible changes society will have to make to adjust around the new topic.

Physics Concepts

Activity Eight – Mechanics

1) One 3 kg lump of clay traveling at 17 m/s overtakes a second 5kg lump traveling at 12.1 m/s. After collision they are stuck together. To the nearest tenth of a m/s what is their common velocity?

2) A white ball, mass of 1 kg has a speed of 1.68 m/s and a yellow ball, mass of 2kg, is at rest prior to an elastic glancing collision. After the collision the white ball has a speed of 1.24 m/s. To the nearest tenth of a degree, measured counterclockwise from east, what angle does it scatter at if the yellow ball is scattered at 280°?

Activity Nine – Beyond Mechanics

1) A vibrating stretched string has length 60 cm, mass 25 grams and is under a tension of 43 Newtons. What is the frequency to the nearest Hz of its 3rd harmonic?

2) 1.09 kg of ice at temperature T' = 0°C is melted into water at the same temperature by placing it in contact with a reservoir at temperature T = 10.8°C. What is the change in the entropy of the universe to two decimal places?

3) Assuming all the Laws of Newtonian Mechanics apply (ie do NOT try to employ any relativity or quantum mechanics), what is the speed of an electron orbiting a proton in a hydrogen atom (Hint: Assume the electron is experiencing uniform circular motion).