Early E. C.: / 1
Total HW Points Unit 1: / 26
Total Lab Points Unit 1: / 20
Unit 1 Apps.: / 5
Late, Incomplete, No Work, No Units Fee? Y / N

Unit 1 – Introduction to AP Physics 1

Essential Fundamentals of Measurement

1. AP Physics uses the metric system (SI) for all measurements.

Add more here!

Link to Algebra

In Unit 1, the following equations will be used. Isolate the variables indicated to prepare for it.

AP Equations

In-Class Equations

$d = rt$ Dirt Equation

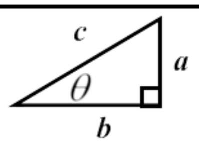
$r =$

$t =$

$\rho = \dfrac{m}{v}$ **Density Equation**

$m =$

$v =$



$\sin\theta = \dfrac{a}{c}$

$\cos\theta = \dfrac{b}{c}$

$\tan\theta = \dfrac{a}{b}$

$S = \dfrac{O}{H}$: $\sin\theta = \dfrac{Opposite}{Hypotenuse}$

$\theta =$

$O =$

$S =$

$C = \dfrac{A}{H}$: $\cos\theta = \dfrac{Adjacent}{Hypotenuse}$

$\theta =$

$A =$

$H =$

$T = \dfrac{O}{A}$: $\tan\theta = \dfrac{Opposite}{Adjacent}$

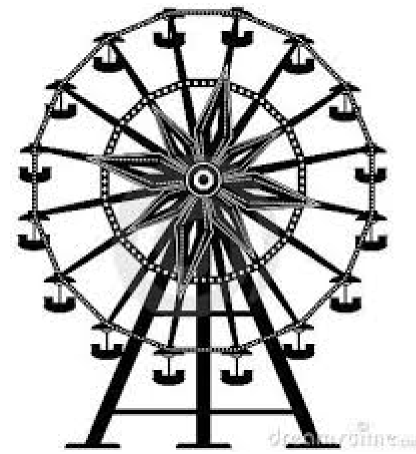
$\theta =$

$O =$

$A =$

Possible 1.1 Pts.:	6
Late, Incomplete, No work, No Units Fee:	-1 -2 -3
Final Score:	**/ 6**

1.1 Problems – Introduction to Physics



1. In the following picture of a Ferris wheel, identify and describe any three parts or processes that can be described using physics.

2. How do you expect physics to serve your future?

3. It is said that all sciences can boil down to physics, which ultimately can boil down to mathematics. Consider a biology situation: a cow grazing in a meadow. How can the action of eating grass be traced to physics?

4. Physics relies on a firm grasp of geometry and shape analysis. Compute the following dimensions:
   A. The volume of a sphere with a radius of 25 cm.

   B. The radius of a circle with an area of 155 m^2.

   C. The height of a cube with a total surface area of 556 cm^2.

Possible 1.2 Pts.:	7
Late, Incomplete, No work, No Units Fee:	- 1 - 2 - 3
Final Score:	/ 7

1.2 Problems – Measurement of Commom Quantities
Sections 1.1 – 1.3 of your book.

1. Convert the following:
    a. 51.6 mm to m

    b. 98.2 km/h to m/s

    c. 0.067 N to μN (The symbol N represents the SI unit of force: the newton)

2. A rectangular container filled with water measures 55 cm by 1.2 m by 870 mm. If the density of water is 1.00 g/cm^3, how many a. grams and b. kilograms are in the container?
    a. grams =

    b. kilograms =

    c. At minimum, would you need one finger, three students, or a forklift to move this container? Defend your answer completely.

3. Your mission is to measure the longest dimension of the Senior parking lot at Hutch without conventional tools, by the <u>most expedient</u> way possible. Your value should come out in meters (2 Points).
    a. Circle the following tools you need, and describe in complete sentences how you would use them.
    A sharpie, a 3” X 5” notecard, a length of string about four times longer than a small car, a pencil, a stopwatch, a laser, and a bag of Cheetos.

Possible 1.3 Pts.:	5
Late, Incomplete, No work, No Units Fee:	- 1 - 2 - 3
Final Score:	**/ 5**

<u>1.3 Problems – Link to Algebra, Unit Analysis</u>
Section 2.1 of your book.

1. How many significant figures in the following examples? Round each problem to two sig figs (½ point each).
   a. 12.209 W

   b. 0.00340 cm

   c. 1.89 E 32 N

   d. 1200 J

2. Perform the following operations. Make sure your answers have correct units and sig figs (½ point each):
   a. 15.6 m X 0.12 m

   b. 14.82g / 10 mL

   c. 1.4 E 4 m / 708 s

   d. 5.8 kg•m / 14.2 kg

3. In physics, much time is spent analyzing units. This is done to determine whether equations are correct, as well as to make final units more compact. In the following problem, condense the following expression to as simple a unit as you can. While there are no numbers in this problem, you still may have to do mathematical operations to get to your final answer. This problem is meant to be a little brain teaser, don't panic if it seems weird.

   One quantity measured in physics is that of work, with the units of joules (J). The joule is a derived unit, and can be determined using a couple relations and substitutions. Using the following equations and substitutions, express the joule in terms of base units:

   <u>Equations</u>: Work = Force X Distance Force = Mass X Acceleration
   <u>Unit Substitutions:</u> Mass = kg Distance = m Acceleration = m/s^2

Possible 1.4 Pts.:	8
Late, Incomplete, No work, No Units Fee: - 1 - 2 - 3	
Final Score:	/ 8

1.4 Problems – AP Exam Strategies

1. **Ratios.** The AP exam stresses a variety of comparisons between two or more physical scenarios. These are often based on equations from the AP Equations Sheet (at the back of the booklet).
   Two circles are drawn on a sketch pad: circle A has a radius twice that of circle B: find the circles' areas, then answer:

   A. What is the ratio of area A to area B?

   B. What percent of circle A's area is circle B?

2. **Justification.** In Free Response questions, students often have to select a comparison, then justify their answer. These questions rely on conceptual, as well as numeric understanding.
   Two students of different masses sit on a teeter totter. Student A is 40 kg more massive than Student B. A. Which student will be resting on the ground when they sit on the teeter totter?
   ___________ Student A ___________ Student B ___________ Insufficient Data
   B. Justify your answer.

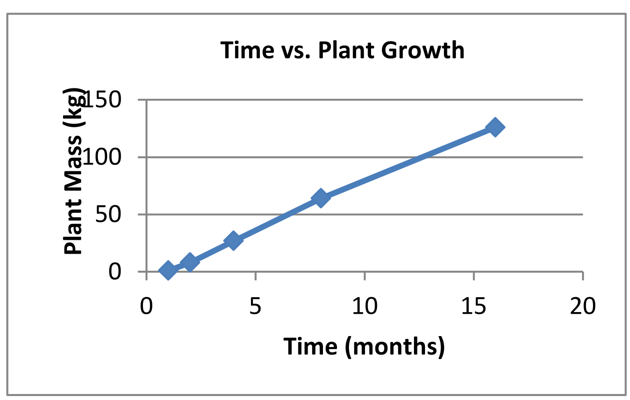
3. **Equation Manipulation.** Often, calculations will rely on equation manipulation, followed by evaluation (often without numbers. The volume of a sphere is $4/3\ \pi r^3$. If the radius of a sphere is 1.5 times the height of some standard (call it 1.5 h), what is the volume of a sphere in terms of h?

4. **Graphing.** Sketching (drawing a crude graph of a concept), plotting (taking data points and putting them on a chart, and analysis (making inferences based on provided graphs) are all skills that the AP Physics depends on.
   A. Sketch the shape of a population that doubles yearly. Assume no population die off.

   B. Plot the following time (x-axis) vs. temperature (y-axis) data, and find the rough slope of the line. Be sure in your graph to label the axes (numeric values AND the quantities you're graphing), and provide a title that briefly describes your graph.

Time (minutes)	Temperature (°C)
0.0	12.3
3.0	14.5
6.0	18.2
9.0	19.9
12.0	22.1
15.0	25.0

   C. What inferences can you make from the following graph? For example, is it linear or quadratic, how do quantities compare across the graph, etc



Lab Booklets

You have been provided with a dedicated Physics Lab Notebook. This notebook will serve at least two purposes: the first is to model good science practices, and the second is to serve as a grading tool.

In an actual laboratory environment, it is unlikely that your boss or professor will give you a fill in the blank worksheet that determines the day's assignment. Instead, you'll have had meetings with your boss and other colleagues, and know what your project/assignment/goal is. Then, you'll write in you notebook any pertinent experimental information, such as procedures, equipment, operating parameters, as well as data collected during your experiment. Later, graphs might be produced that get added into the lab notebook, and any follow up information for future experiments might be included.

In AP Physics, laboratory activities will always be described in your Booklet, and all work you do pertaining to that lab will have to be done in your Lab Notebook. At the end of a Unit, I will collect your Booklets, as well as your Lab Notebooks for grading purposes. Scores will appear in your Booklets, but all comments will be in your Lab Notebooks. Any corrections you make should be in your Lab Booklets, in a different color so I can see where you made changes.

Grading Details

There will be several items that ALWAYS should be in your Lab Notebooks,

1. Table of contents – First page. As you progress through your Lab Notebooks, write page numbers and fill in the table of contents. Also, you may choose to write only on the right side of a page spread throughout any lab (it is standard practice in some labs), but when you start a new lab you MUST begin on the right side page.
2. Lab title and date. Keeps order in your Lab Book and makes it easier for me to find the lab.
3. Synopsis of lab. List all procedures followed and equipment used. While your may paraphrase the instructions from your Booklets, you might have to make your own procedures for certain labs and describe them in detail.
4. Purpose of lab. Determine at least TWO specific reasons why this lab has value. What will you learn? How does it apply to the real world?

Other Details

Besides the previous components, any raw data, data tables, graphs, computations, and questions from the Booklet should be included in the Lab Notebook. Additionally, if you have any notes from the lab or questions to ask me about it, include those too, so that the information is always available.

Raw Data vs. Data Tables. Often, a scientific inquiry will gather more raw (unrefined) data than is used in a final report. Later, data used for calculations should be put into be neat, well labeled tables with components and units, and boxed in, so that anyone can look at the information and get what they need to verify findings. Tables can be hand written, and lines should be drawn with the aid of a straight-edge. The following example is a simple model to follow, but you will most likely need to make more complex ones for the majority of your labs:

	Trial 1	Trial 2	Trial 3
Time (s)	23.4	22.9	24.0
Distance (m)	15.6	14.8	15.7

Graphs. These should be made in Excel, or some other graphing program. I may score hand-drawn graphs at full point value if indicated in the Booklet, but plan on using a computer for all graphs. Our second lab will include an Excel tutorial to get you up to speed on a this graphing program.

Computations. Often you will be asked to derive a numeric conclusion from lab data. For example, finding the Earth's gravitational constant will entail using measurements and formulas to derive a number. Any equations you use to figure out values should be shown in your Lab Notebook, as well as the process you use to get to that final answer.

Questions. Every lab will have questions for you to think about and answer. Your responses should be in complete, well-written sentences. Scores will be based in part on your writing skills as well as the content.

Lab Notebook Example

AP Physics 1	Unit 0.0 Lab - Example
Reminder: Update Table of Contents	Correction Credit: Half

Lab Overview: Students have two missions, involving metric measurements, calculations, and graphing. Be sure to abide by significant figures in your reported values.

Materials List:

Caliper Measuring Device
Hot Plate
250 mL Beaker
Thermometer
Stopwatch

Example Lab (0.0) Guide		
General: Title/Date, Synopsis, Purposes		/ 1
Mission 1: Linear Distance	Partner's Height	/ 3
Mission 2: Heating Rate	Setting 1 Rate	/ 2
	Setting 2 Rate	/ 2
	Setting 1 Graph	/ 3
	Setting 2 Graph	/ 3
Question 1: Sources of error in Mission 1.		/ 2
Question 2: Sources of error in Mission 2. Sensible results?		/ 2
Work Not Shown Fee:		1 2 3
Late Lab Fee:		-4
Total:		**/ 18**

Mission 1: Linear Distance

Measure the height of your lab partner using the caliper measuring device.

Mission 2: Rate of Heating

Determine the rate of heating that a hot plate produces at two different settings. Use 200 mL of water as a sample size in your beaker. Make time vs. temperature graphs for both trials, with labels.

Questions: Rephrase and answer in complete sentences for full credit.

1. What are the greatest sources of error in Mission 1?
2. What are the sources of error in Mission 2? Did your results for Mission 2 make sense?

Sample Lab Notebook Report

0.0 Lab – Example of Notebook Lab 8/24/16

Synopsis – In this lab, my partners and I had two missions: 1. to measure the height of one of us with the calipers; 2. to determine the heating rate of a hot plate using a water filled beaker.

Purposes – 1. To practice working with standard lab equipment, such as the calipers and hot plate,
2. To learn how to function as a team,
3. To examine sources of error in a lab environment.

Mission 1.

To measure our lab partner's height, we stood him up against the wall and marked on a piece of tape how far off the floor the top of his head was. We then extended the calipers it as far as possible (exactly 15.000 cm) and locked it. We then realized that the calipers couldn't measure against the floor because of their design (but they would do fine about three cm off the floor), so we had our partner stand on a book. We then relocated the piece of tape, marked on the wall where the top of the book was, and used the calipers (set at 15.000 cm) to measure between the two points on the wall. Since we had to move the calipers several times, we made a small tick mark at the end point of each measurement. For the last iteration, the span was less than the full extension of the calipers, so we unlocked it and got the last value.

Number of 15.000 cm Iterations	Last Measurement (cm)	Total Height (cm)
11	10.286	175.286

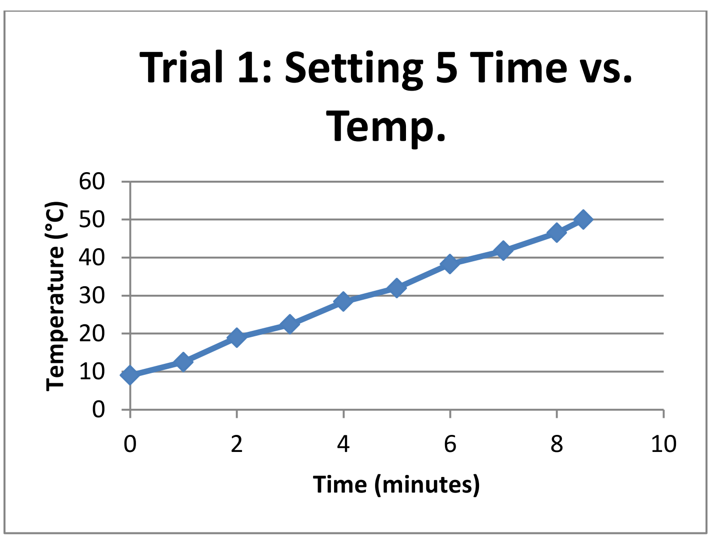
Total height calculation: 11 x 15.000 cm + 10.286 cm = 175.286

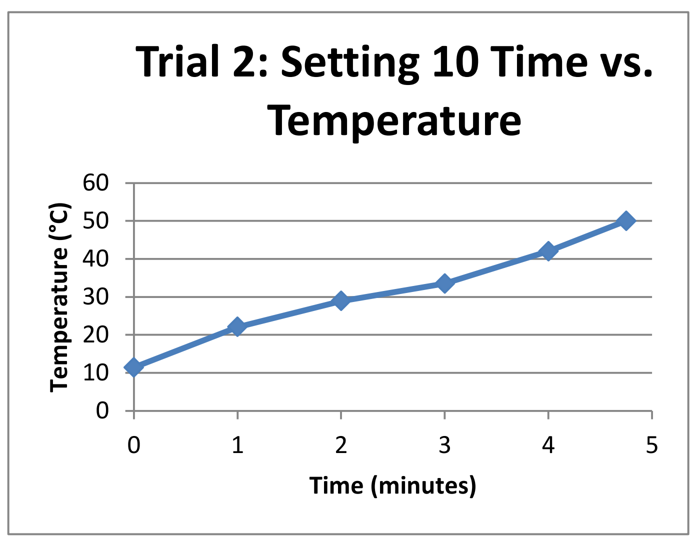
Mission 2.

To measure the rate of heating, we added 100. mL of water to our beaker, and put it on the hot plate. Since the mission didn't specify how hot the water should get (it just said "determine the rate of heating"), we decided to measure time vs. temperature data to 50.0 °C. We measured the temperature of the water initially, then turned the heater on to setting 5 (out of 10) and started the stopwatch. While constantly stirring the beaker's contents with the thermometer, we took temperature data every minute. When the beaker's contents reached 50.0 degrees, we turned the heater off, let it cool down for 10 minutes, and repeated the process at setting 10.

Time (minutes)	Trial 1: Setting 5 Temperatures (°C)	Trial 2: Setting 10 Temperatures (°C)
0.0	9.0	11.4
1.0	12.5	22.1
2.0	18.9	28.9
3.0	22.4	33.5
4.0	28.4	42.0
5.0	32.0	50.0 (at 4 minutes, 45 seconds)
6.0	38.3	
7.0	41.8	
8.0	46.5	
9.0	50.0 (at 8 minutes, 30 seconds)	

To determine the rate of heating, we divided the temperature change by the total time elapsed.
Trial 1: (50.0 °C – 9.0 °C) / 8.50 minutes = <u>4.82 °C/minute</u>
Trial 2: (50.0 °C – 11.4 °C) / 4.75 minutes = <u>8.13 °C/minute</u>





Questions

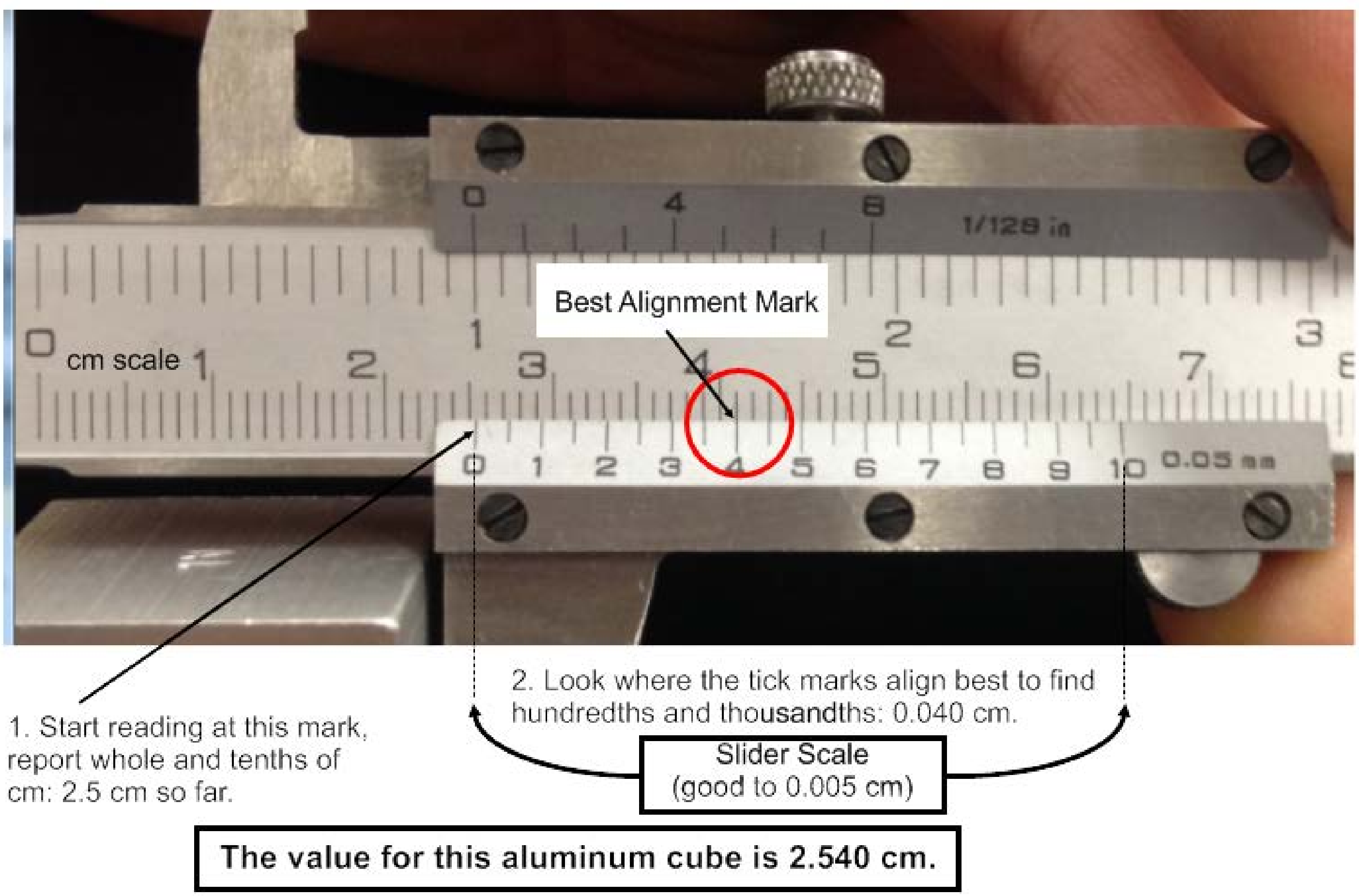
1. The greatest source of error in our measuring lab partner mission was moving the calipers. We marked the span of the calipers, but certainly the dot we used was greater than the accuracy of the caliper, so we're certain that we can't report the height to the 0.005 cm. Also, when we marked the wall, we might not have been exactly horizontal with respect to the top of our subject's head. Any variance from horizontal would make our value off.

2. In mission 2, the greatest source of error was not letting the heater cool down all the way. The water's temperature for trial 2 was higher to start with than for trial 1, and this could be due to residual heat affecting our run. Also, we had no way of knowing if the hot plate was adding energy to the heating element at a uniform rate. Another source of possible error was the beaker. Beakers are good at estimating volume to +/- 5 %, so our actual volume could have been as high as 105 mL, or as low as 95 mL.

We think that our results made sense, though, since the higher setting made the water heat up at a faster rate. At setting 10, the 100 mL of water took 3.75 minutes less time to heat than at setting 5.

Caliper Tutorial.

0. Place object between jaws.
1. Look where zero mark is to determine whole cm and tenths of cm.
2. Look along slider scale to see where marks align to determine hundredths and thousandths.



AP Physics 1	Unit 1.1 Lab - Measurement
Reminder: Update Table of Contents	Correction Credit: Half

Overview:

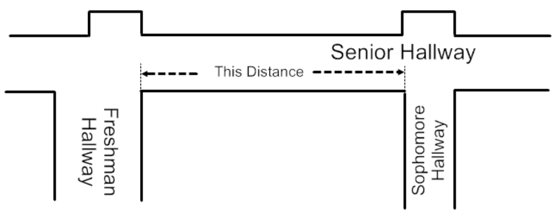
Students are given a series of missions to accomplish, involving metric measurements and calculations. Be sure to abide by significant figures in your reported values

There will also be a caliper reading workshop (P. 17).

Measurement Lab (1.1) Guide		
Table of Contents, Title/Date, Detailed Synopsis, Two Purposes		/ 2
Mission 1: Distance	Table Format Followed, Length Reported	/ 1
	Method Description	/ 2
Mission 2: Density of Al	Data Table Present, Format Followed	/ 1
	Sample 1 Density	/ 2
	Sample 2 Density	/ 2
Mission 3: Car Speed	Data Table Present, Format Followed	/ 1
	Average Speed	/ 1
Question 1: Mission 1 Error Sources		/ 2
Question 2: Density Comparison. Sources of Error.		/ 3
Question 3: Sources of Error, Comparison to other Groups.		/ 3
Work Not Shown Fee:		- 1 - 2 - 3
Late Lab Fee:		- 4
Total:		**/ 20**

Materials List:

- Metersticks
- Standardized Testing Rulers
- Triple Beam Balance
- Stopwatches
- Physics Cars
- Aluminum Samples
- Caliper Measuring Device



Mission 1: Linear Distance

Measure and report the length of the senior hallway that connects the freshman to sophomore hallways, from exactly near corner to near corner (see picture above). Use whichever measuring devices you choose, and put your data in a data table. Describe your exact method of data acquisition.

Mission 2: Density of Aluminum

Using measuring tools of your choosing, determine the density (in g/cm^3) of one sample of aluminum. Remember: density is mass divided by volume: you may have to research the volume equations for some of the solids if you've forgotten them. Include all measurements (with dimensions) in a data table, and show all your calculations (and dimensions) for full credit.

Mission 3: Model Car Speed

Using measuring tools of your choosing, determine the average speed of a physics car. Include values in a data table. Be sure that your data is taken over a long enough distance to be significant. Make at least **three** runs for a good average.

Questions: Rephrase and answer in complete sentences for full credit.

1. What are the greatest sources of error in mission 1?

2. Research and report aluminum's density, and compare your two values to that. How did your values compare? What sources of error could lead to disparities between your values and the accepted value?

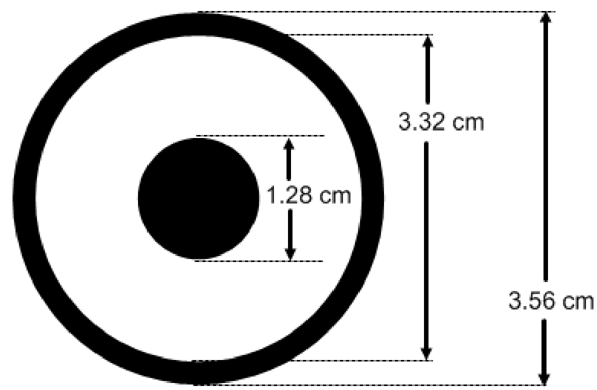
3. What were sources of error in mission 3? How did your average value compare to the values of other groups?

AP Physics 1	Unit 1 - Measurement				
Application Problems, AP Test Preparation Questions					
Presentation Points:	/ 5	Late Fee:	-2	Completion (Booklet Check)	/ 5

In groups of 3 or 4 (my choosing), solve the following problems, observing significant figure rules! I will assign each group one or two problems, and students will have five minutes to make a presentation to show the class. This is an opportunity for the class to get all problems right; I will stay out of the presentations as much as possible. Ask questions of the presenters if you have any.

Presentation grades depend on: 1. if you get the right answer, 2. how well (and audibly) you explain your process, and 3. mechanical details (units, significant figures, boxing your answer, etc.). Completion points will be assessed during your Unit 1 Booklet check, and are based on how complete this is.

1. Which black region has greater area, the center circle or outer ring? Prove your answer.



2. The lightest solid material is silica aerogel, which has a typical density of 0.10 g/cm^3. The molecular structure of silica aerogel is typically 95% empty space. What is the mass (in grams) of 1 m^3 of silica aerogel?

3. As the Raven Flies. To go to a hockey game from your house, you first drive 2100 m north, then 700 m west, then 1350 m south. What is the straight line distance from your house to the arena in km?

4. A person's heart beats an average of 80 times per minute. How many times would an average heart beat in the month of September?

5. The average amount of blood per heartbeat is 70.0 mL. If an average heartrate is 80 beats a minute, how many cubic meters of blood per year does an average heart pump?

6. Unit Analysis. The SI derived unit for power is the watt (W). Describe the watt in terms of base units using the following equations and unit relations:

Equations:

Power = Energy / Time
Energy = Force X Distance
Force = Mass X Acceleration
Acceleration = Distance/Time^2

Unit Relations:

Time = seconds (s)
Distance = meters (m)
Mass = kilograms (kg)

AP Physics 1	Unit 1 Review - Measurement						
Points:	**/ 14**	**Late or Incomplete Fee:**	**-2 -4 -6**	**Correction Credit:**		**Final Score:**	

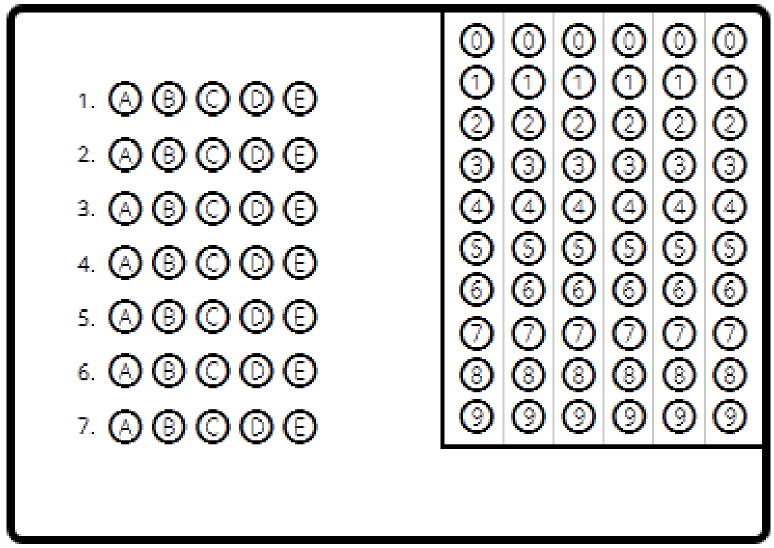
Solve these problems here, THEN enter your responses in the bubble sheet provided. Fill in your student number in the GradeCam ID columns of the bubble sheet.

On the due date, I will scan your responses in class, mark which problems you missed, and enter your score in Powerschool.

If you submit your responses on time, you will have one attempt to correct errors you made (for half credit back).

If you are late, you will only get one attempt, and will only receive half credit for the problems you got right.

Each question is worth two points. When I scan your Booklets I will take points off for correct problems that show no work (1 point per problem). I expect the complete process of problem solving to be shown, from a logical sequence of equations to a final boxed answer.



1. What is the density of an object with a mass of 13.5 grams and a volume of 5.02 mL?
   A. 0.5 g/mL B. 2.7 g/mL C. 0.37 g/mL D. 2.69 g/mL E. 0.371 g/mL

2. How many significant figures are in the following three numbers? 13,080 g 0.023 N 1.40 E 8 m

   A. 5, 2, 3 B. 4, 2, 3 C. 5, 2, 2 D. 4, 4, 3 E. 5, 4, 4

3. Make the following conversions, then choose the corresponding answer set:
   2.5 mg to kg 5.1 m to cm 13.8 km/h to m/s

   A. 2.5 E -6 kg; 510 cm; 3.83 m/s
   B. 2.5 E -3 kg; 51 cm; 230 m/s
   C. 1.9 E -6 kg; 5,100 cm; 2.43 m/s
   D. 2.5 E -6 kg; 510 cm; 230 m/s
   E. 2.5 E -3 kg; 5,100 cm; 3.83 m/s

4. Perform the following operations, round to the correct number of significant figures, and select the correct answer set: 14,020 X 0.024 2.3 E 2 / 408

A. 336.48; 0.56372549	B. 336.5; 0.56372	C. 340; 0.56
D. 300; 0.6	E. 340; 0.564	

5. If the capillaries of an average adult were unwound and spread out end to end, they would extend to a length over 40,000 miles! If you are 1.75 meters tall, how many times your height would the capillary length equal? Round to **two** significant figures.
   A. 2.3 E 4 times B. 2.3 E 7 times C. 3.7 E 7 times
   D. 21,000 times E. 340,000 times

6. A person weighs 170 pounds. What is his mass in kilograms?
   A. 0.013 kg B. 370 kg C. 150 kg D. 89 kg E. 77 kg

7. A 170 pound person has a density close to that of water (1.00 g / 1.00 mL). What is his approximate volume in cubic meters (m^3)? Hint: remember that 1.0 cm^3 = 1.0 mL.
   A. 1.3 m^3 B. 0.077 m^3 C. 770 m^3 D. 0.28 m^3 E. 0.39 m^3