## Unit 0 - Measurement \& Vector Review

| Early E. C.: 11 |  |
| :---: | :---: |
| Total HW Points |  |
| Unit 0: | / 20 |
| Late, Incomplete, Units Fee? | ork, No |

### 0.1 Problems - Significant Figures, Conversions, Measurement Review

How many significant figures in the following?

1. 431801 kg
2. 1.43506 E 4 mL
3. 1.03449 m
4. 0.0028503 g
5. 0.0230 mL
6. 14000 m

Solve the following, and round to the correct number of sig figs.
7. $7.31 \mathrm{E} 4 \mathrm{~g}+3.23 \mathrm{E} 3 \mathrm{~g}$
8. $38,736 \mathrm{~km} / 4784 \mathrm{~km}$

Make the following conversions:
9. 59.2 grams to kilograms
10. 0.0034 milliseconds to seconds
11. $1489 \mu \mathrm{~L}$ to L
12. 481 mg to kg
13. 0.00298 kL to mL
14. $15.8 \mathrm{~km} / \mathrm{h}$ to $\mathrm{m} / \mathrm{s}$
15. 440 rpm to rad/s

| Possible 0.2 Pts.: | 6 |
| :--- | ---: |
| Late, Incomplete, No work, |  |
| No Units Fee: | -1 |
| Final Score: | -3 |

### 0.2 Problems - Vector Review

1. What makes a vector quantity different from a scalar quantity?
2. List five vector quantities.
3. List three scalar quantities.
4. A plane flies with a velocity of $750 \mathrm{~km} / \mathrm{h}, 30^{\circ}$ north of east. What are the magnitudes of the plane's north and east velocities?
5. Two bulldozers are pulling on a sequoia stump from different directions, in an effort to clean up a national forest. One bulldozer is pulling due west with a force of $14,000 \mathrm{~N}$, and the other is pulling due North with a magnitude of $38,000 \mathrm{~N}$. What resulting force does the stump experience, and in which direction?
6. An out-of-control spaceship heading $36^{\circ}$ with respect to the $x-y$ coordinate plane is about to crash into an asteroid. To avert disaster, it requires $140,000 \mathrm{~N}$ of force oriented exactly opposite its heading. What forces would have to be supplied by its two retro engines, which are pointing at $0^{\circ}$ and $90^{\circ}$ to save it?


### 0.3 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 $\qquad$ Student B $\qquad$ 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 $4 / 3 \pi \mathrm{r}^{3}$. 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 $\left({ }^{\circ} \mathrm{C}\right)$ |
| :---: | :---: |
| 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 $(\mathrm{s})$ | 23.4 | 22.9 | 24.0 |
| Distance $(\mathrm{m})$ | 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 2 | Unit 0.0 Lab - Example |  |
| :---: | :---: | :---: |
| Reminder: Update Table of Contents |  | Correction Credit: <br> 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

## 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

| Example Lab (0.0) Guide |  |  |
| :---: | :---: | :---: |
| General: Title/Date, Synopsis, Purposes |  | $/ 1$ |
| Mission 1: <br> Linear Distance | Partner's Height | $/ 3$ |
| Mission 2: <br> Heating Rate | Setting 1 Rate | $/ 2$ |
|  | Setting 2 Rate | $/ 2$ |
|  | Setting 1 Graph | $/ 3$ |
| Question 1: Sources of error in <br> Mission 1. | $/ 2$ |  |
| Question 2: Sources of error in <br> Mission 2. Sensible results? | $/ 2$ |  |
| Work Not Shown Fee: |  | 123 |
| Late Lab Fee: |  | -4 |
| Total: |  | $/ \mathbf{1 8}$ |
|  |  |  | your beaker. Make time vs. temperature graphs for both trials, with labels.

## Questions:

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

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: $11 \times 15.000 \mathrm{~cm}+10.286 \mathrm{~cm}=175.286$

## Mission 2.

To measure the rate of heating, we added $100 . \mathrm{mL}$ 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 $50.0^{\circ} \mathrm{C}$. 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 <br> Temperatures ( ${ }^{\circ} \mathrm{C}$ ) | Trial 2: Setting 10 <br> Temperatures ( ${ }^{\circ} \mathrm{C}$ ) |
| :---: | :---: | :---: |
| 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: $\left(50.0^{\circ} \mathrm{C}-9.0^{\circ} \mathrm{C}\right) / 8.50$ minutes $=4.82^{\circ} \mathrm{C} /$ minute
Trial 2: $\left(50.0^{\circ} \mathrm{C}-11.4^{\circ} \mathrm{C}\right) / 4.75$ minutes $=8.13^{\circ} \mathrm{C} /$ minute



## 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.

