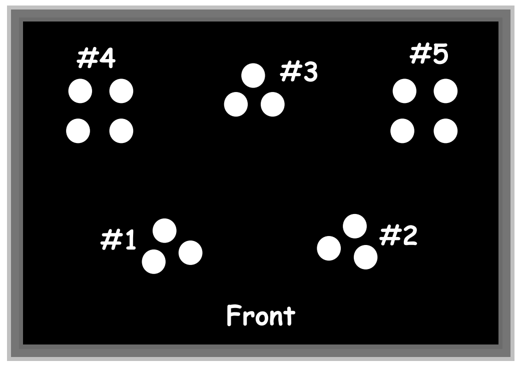
FIRST DISCUSSION SESSION
(1101, 1201, 1301)

Objectives:
- Introduce discussion sessions.
- Have the students work on solving a real problem (i.e., can't solve in one step).

Preparation:

❑ Name tags and markers. ❑ Grade book ❑ Assign students to groups ❑ Group Roles sheets for Discussion (make copies; Instructor's Handbook)	❑ Problem sheets with useful information and equations (1 per student) ❑ Answer Sheets (1 per group) ❑ Problem Solution (1 per student)

Write on Board:
- Course # and section #
- your name
- Your office hours
- Your e-mail
- groups -- names with roles
- a room map showing where each group sits in the room
- "Purpose – introduce what its like to solve a real problem in a cooperative group."
- "Draw a picture with variables defined, and write equations you used to solve the problem".



	DO
Opening Moves: (25 min) 4 min	0. Get there early and close door. Write information on board. Wear your name tag! Arrange chairs if necessary into groups so that members face each other • Open Door - **Greet students as they come in. SMILE** ☺ - Ask them to wear a name tag **COURSE STUFF**
3 min	a) <u>Teacher introduction</u>, office hr (if discussion session is before lab)
1 min	b) <u>Introduce attendance rules</u> *as decided by your instructional team*.
1 min	c) <u>Introduce purpose of discussion sessions</u> • The purpose of these discussion sessions is to help you learn how to solve physics problems and communicate your solutions in a logical, organized fashion. • So you will practice solving problems in cooperative groups. I will be here to coach you in the things you need to think about when you are solving physics problems.

	DO
	• I will **not** be solving problems for you. Professor /// will demonstrate how to solve problems in the lecture, and there are many examples of solved problems in your textbook."
3 min	d) Introduce structure of discussion session. All discussion sessions have three parts. 1. First, you will come into the room and sit in the groups indicated on the board. I will then tell you the purpose of the practice problem and what I want each group to but on the board for a class discussion near the end of the session. For example, for today the purpose is …. and …. (point to what is written on the board). 2. Then you will have a specified time to construct a solution together as a group. Only one person will write the group solution. Each team member will sign the group solution. You may not have time to finish the mathematics of the problem. That's OK. 3. I will randomly call on one person from each group to put their picture or diagram and equations on the board. Then we will have a class discussion about how to solve the problem. As you leave the class, I will hand out an example solution to the problem.
1 min	e) Introduce grading *as decided by your instructional team.*
5 min	f) Introduce Group Roles Solving problems in cooperative groups means you discuss and construct a solution together. YOU DO NOT SOLVE THE PROBLEM SEPARATELY AND THEN COMPARE YOUR ANSWERS! Groups work more effectively if each group member is responsible for a specific role necessary to accomplish any technical task. You will change this role responsibility every time we meet, so everyone gets the chance to practice a role several times. • **Pass out Group Roles sheets (if students do not have them already from lab). Tell your students to read the roles for discussion section, and give them time to do so.** The group roles are the Manager, the Recorder/Checker, and the Skeptic/Summarizer. The **Manager** makes sure that everyone in the group contributes to solving the problem, keeps the group focused, and watches the time.

<table>
<tr><th></th><th>DO</th></tr>
<tr><td></td><td>The Recorder/Checker records the group solution and makes sure that all members agree on what is written.

The Skeptic/Summarizer makes sure that alternative ideas are explored, that the group does not come to consensus too quickly, and periodically summarizes the discussion and decisions. In groups with four members, the Skeptic and Summarizer are different roles.

When you are assigned a role, it does not mean that only you can fill the role function. It simply means that you are responsible for seeing that your role is accomplished, either by you or by other group members.

Notice that everyone does physics. Cooperative groups does not mean that you stop thinking about physics or exploit your partners' efforts. It is also true that none of the roles is that of leader. Every member of the group is responsible for its leadership and group solution.</td></tr>
<tr><td>5 min</td><td>② Prepare Students for Group Work

a) Your group roles for today are written of the blackboard. (If this is first meeting, have all people in Group 1 raise their hand and have the students look at each other. Repeat for other groups.)

After I finish giving directions, you will get into your groups. The map on the board shows where you should sit.
• Be sure to move the chairs so you are all facing each other.
• Move all books and notebooks off your desks.
• When you are properly seated in your groups and know your roles, I will pass out the problem and the one answer sheet to the Recorder/Checker.

b) Pass out problem and answer sheets.

c) You will have 15 minutes to work on this problem. Remember, everyone in the group needs to understand the solution that your recorder writes. I will call randomly on one group member to write on the blackboard.</td></tr>
<tr><td>Middle Game
(20 min)</td><td>③ Coach groups

a) Circulate around groups, watching and listening. You will probably need to tell some groups to get up and move their chairs so they are all facing each other. Do not intervene with any group until all groups are sitting correctly.

b) <u>Intervene in groups that are trying to solve the problem individually</u>. Say</td></tr>
</table>

	DO
	something like: "I notice that you are solving the problem individually, not as a group. Who is the Recorder/Checker? You should be the only person writing the solution. Manager and Skeptic/Summarizer put your pencils away and work with the Recorder/Checker to solve the problem." If you notice **later** that the group persists in solving the problem individually, then take the pencils from the Manager and Skeptic (return them at the end of class), and have the group read the green Group Role sheet again. Be sympathetic, but do not leave until they have started solving the problem together. <u>Intervene in groups *with a loner solving problem by himself/herself*</u>. Say something like: "I notice that while two of you are working together, you (loner) appear to be solving the problem by yourself. What are each of your group roles? Why are you (loner), as the group Manager (or Skeptic /Summarizer) solving the problem by yourself?" Frequently the loner will only need a gently reminder to discuss and solve the problem with the group. Ask the Recorder/Checker to explain to the loner what they have done so far to solve the problem.
5 min	<u>Intervene in groups with *non-participant*</u>. Ask the student who is not participating to explain what the group is doing and why. If the student can do this, s/he may be a quiet student who pays attention, but does not speak as often as others. You do not need to intervene further. ④ Prepare students for class discussion a) Remind them when they have 5 minutes left. b) I would like the skeptic in each group to put their group's picture and equations on the board. The other people in the group should watch their partner for errors and watch the other groups for similarities and differences.
End Game (5 min)	⑤ Lead a very brief discussion about differences or similarities in the pictures and/or equations they used to solve the problem. • Collect their group solutions. Make sure that all of their names are on the solution and group functioning sheets. ⑦ Stand at door and pass out solutions as your students leave. Say good-bye and thank them. SMILE ☺

First Discussion Session

Fall 2007

Example of End-Game discussion for Lake Problem.

- How are the pictures of Lake Calhoun similar?
- How are the pictures different?

After the general questions, you can become more specific. For example

- Which pictures include all the information necessary to solve the problem?
- What are some advantages of drawing a picture with symbolic definitions of all the known and unknown quantities?

    A good picture helps you analyze the problem -- what are the important positions and times of interest.

    A good picture helps you determine relationships between the objects that are important for solving the problem -- like $d = d_y + d_r$.

    Once you have drawn the picture, then you should not have to read the problem again. This makes for better time efficiency in solving the problem.

Remember to count silently up to 30, then call on a group if necessary. Always encourage an individual to get help from other group members if he or she is "stuck."

:

Group Problem

It's a sunny Sunday afternoon and you are walking around Lake Calhoun. A runner approaches you wearing a T-shirt that you try to read as he runs past. You didn't finish reading the T-shirt, so you wonder, if the runner continues around the lake, when you will see him again.

You look at your watch and it is 3:07 p.m. You recall the lake is 3.4 miles in circumference. You estimate your average walking speed at 3 miles per hour and the runner's average speed to be about 7 miles per hour.

Possibly Useful Information: $$\text{average speed} = \frac{\text{distance traveled}}{\text{time interval}}$$

1 mile = 5280 ft, 1 hour = 60 minutes = 3600 seconds

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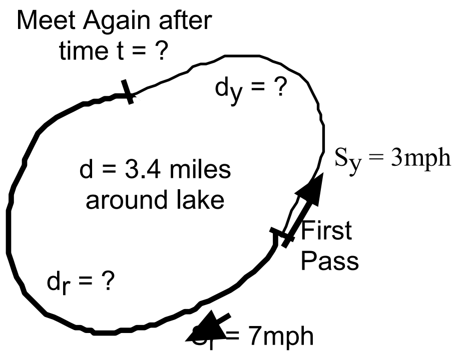
1 mile = 5280 ft, 1 hour = 60 minutes = 3600 seconds

First Lab Session

Fall 2007

Lake Problem Solution

Picture with Definition of Symbols for Known and Unknown Quantities



s_y = 3 mph (speed of "you")
s_r = 7 mph (speed of runner)
d = 3.4 miles (total distance around lake)
t_s = 3:07 PM (when you & runner first pass)
d_y = ? (distance "you" ran to meet runner)
d_r = ? (distance runner ran to meet "you")
t = ? (time runner and "you" ran from first

Find $t_f = t_s + t$: The clock time "you" and runner will pass again is the clock time you started plus the time it took to meet again.

Useful Equations: $s = \frac{d}{t}$; for "you" $\left(s_y = \frac{d_y}{t}\right)$ & runner $\left(s_r = \frac{d_r}{t}\right)$; and $d = d_y + d_r$

Algebraic Solution Using Defined Symbols

	Unk.	Kn.
Find t_f	t_f	
① $t_f = t_s + t$	t	t_s
Find t		
② $s_y = \frac{d_y}{t}$	d_y	s_y
Find d_y		
③ $d = d_y + d_r$	dr	
Find d_r		
④ $s_r = \frac{d_r}{t}$		

4 equations and 4 unknowns – so can solve.

Solve ④ for d_r and substitute into ③

$$s_r = \frac{d_r}{t}$$
$$s_r t = d_r$$
$$d = d_y + s_r t$$

Solve ③ for d_y and substitute into ②

$$d_y = d - s_r t$$
$$s_y = \frac{d - s_r t}{t}$$

Solve ② for t and substitute into ①

$$s_y t = d - s_r t$$
$$(s_y + s_r)t = d$$
$$t = \frac{d}{s_y + s_r}$$

$$\text{So } t_f = t_s + \frac{d}{s_y + s_r}$$
$$= 3:07\text{ PM} + \left(\frac{3.4\text{ m}}{3\text{ m/hr} + 7\text{m/hr}}\right)\left(\frac{60\text{ min}}{1\text{ hr}}\right)$$
$$= 3:07\text{ PM} + 20\text{ min}$$
$$t_f = 3:27\text{ PM}$$

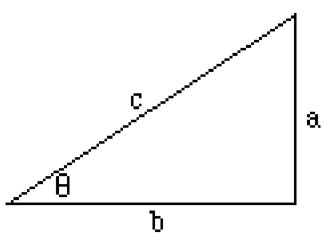
Unreasonable? No. In 20 min "you" walks 1.0 mile and the runner travels 2.4 miles
Complete? Yes -- answers question of when "you" and runner pass again.

Group Problem

You have been given a job working on a team searching for asteroids that might collide with the Earth. This search is important because current theories indicate that dinosaurs and other organisms became extinct when the Earth was struck by a large asteroid. If such a collision happens again it could cause the extinction of the current dominant species on Earth, us. The reason given for the extinction of dinosaurs is that 65 million years ago dust from an asteroid impact went into the upper atmosphere all around the globe, where it stayed for several years blocking the sunlight from reaching Earth's surface. To scan space for this danger, you need to know how large an asteroid you are looking for. A dangerous asteroid size is roughly the same as the one that wiped out the dinosaurs. You are told that about 20% of that asteroid's mass ended up as dust that was spread uniformly over Earth after eventually settling out of the upper atmosphere. Geological exploration indicates that a layer of 0.020 grams of dust, which is chemically different than the Earth's rock, covers each square centimeter of the Earth's surface on the average. Typical asteroids have a density of about 2.0 g/cm^3.

Possibly Useful Information:

Surface density $= \frac{\text{mass}}{\text{area}}$ Volume density $= \frac{\text{mass}}{\text{volume}}$



For a right triangle: $\sin\theta = \frac{a}{c}$, $\cos\theta = \frac{b}{c}$, $\tan\theta = \frac{a}{b}$,

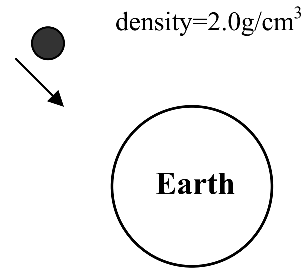
$a^2 + b^2 = c^2$, $\sin^2\theta + \cos^2\theta = 1$

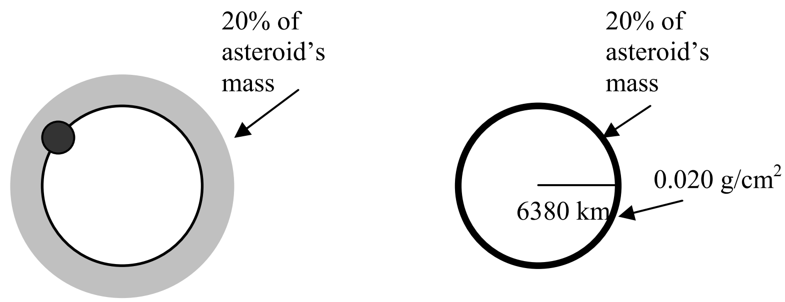
For a circle: $C = 2\pi R$, $A = \pi R^2$

For a sphere: $A = 4\pi R^2$, $V = \frac{4}{3}\pi R^3$

Earth's Radius= 6380 km, 1 km = 10^3 m = 10^5 cm

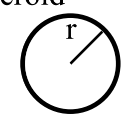
Picture with Definition of Symbols for Known and Unknown Quantities





What is the size of the asteroid?

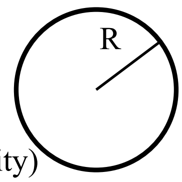
Assume both the Earth and asteroid are spheres. Use definitions of surface area and density to find the mass of dust. Use mass fraction of dust to find mass of asteroid. Use definition of density to find size of asteroid.



$M = ?$ (asteroid mass)

$r = ?$ (asteroid radius)

$D = 2.0\ \text{g}/\text{cm}^3$ (asteroid density)



$R = 6380$ km (Earth radius)

$S = 0.020\ \text{g}/\text{cm}^2$ (surface density of dust)

$f = 0.20$ (fraction of mass of asteroid that is dust)

$m = ?$ (mass of dust)

Find r

Useful Equations $V = \frac{4}{3}\pi r^2$, $A = 4\pi R^2$, $D = \frac{M}{V}$, $S = \frac{m}{A}$, and $m = f M$

Algebraic Solution Using Defined Symbols

	Unk.	Kn.
Find r: $V = \frac{4}{3}\pi r^3$ ① $r = \sqrt[3]{\frac{3V}{4\pi}}$	r	
	V	
Find V: $D = \frac{M}{V}$ ② $V = \frac{M}{D}$	M	D
Find M: $m = f M$ ③ $M = \frac{m}{f}$	m	f

	Unk.	Kn.
Find m: $S = \frac{M}{A}$ ④ $m = SA$	A	S
Find A: ⑤ $A = 4\pi R^2$		R

5 equations & 5 unknowns, so can solve problem

Substitute ⑤ into ④, and ④ into ③

$$M = \frac{m}{f} = \frac{S4\pi R^2}{f}$$

Substitute into ②

$$V = \frac{M}{D} = \frac{S4\pi R^2}{Df}$$

Substitute into ①

$$r = \sqrt[3]{\frac{3V}{4\pi}} = \sqrt[3]{\frac{3\left(\frac{S4\pi R^2}{Df}\right)}{4\pi}} = \sqrt[3]{\frac{3SR^2}{Df}}$$

Check Units

$$r = \sqrt[3]{\frac{\frac{g}{cm^2}(km)^2}{\left(\frac{g}{cm^3}\right)\left(\frac{10^5\ cm}{km}\right)}} = \sqrt[3]{km^3} = km = OK$$

Numerical Calculation

$$r = \sqrt[3]{\frac{3\left(\frac{0.02\ g}{cm^2}\right)(6380\ km)^2}{0.20\left(\frac{2.0\ g}{cm^3}\right)\left(\frac{10^5\ cm}{km}\right)}} = 3.9\ km$$

Answer. The asteroid has a radius of 3.9 km (~2 miles). But an 8-km wide (~4 miles wide) asteroid seems too small to wipe out all those life forms!

First Lab Session

Fall 2007

Objectives:

- Have students complete Force Concept Inventory (& Math Diagnostic or Energy survey, as decided by the course instructor.)
- Have students complete background information in the test booklet.
- Acquaint students with the laboratory structure and equipment.

Preparation:

- ☐ Photocopies: Lab Group Roles
- ☐ Name tags and markers.
- ☐ List of groups to put on blackboard
- ☐ Numbers 1-5 to put on tables
- ☐ Grade book
- ☐ Get extra pencils for answer sheets
- ☐ Read the student's lab manual
- ☐ Count answer sheets in room (1/person)
- ☐ Count test booklets (1/person)
- ☐ Count background surveys (1/person)
- ☐ Scratch paper for tests
- ☐ Laboratory manual
- ☐ Sample laboratory notebook/journal
- ☐ Read the instructor's guide to the lab manual

Write on Board:

- Course # and section #
- Your name & e-mail
- Groups (numbered)
- Instructions for filling out the answer sheet.
- The physics department web site http://www.physics.umn.edu/

OPENING MOVES

0. Get there early and lock door.

a) Put a number on each table.
b) Write information on board. (your name & e-mail, course number, section number, groups, instructions for the tests and questionnaire, physics department web site)
c) Wear your name tag!
d) Read instruction sheet for tests to yourself.

1. Open Door

Greet students as they come in. SMILE ☺

a) Tell students sit with their groups – as shown on the blackboard.

2. Introductions

a) Teacher introductions (your name, your interests, where you are from). "You will be working in groups in the laboratory and the groups will change several times during the semester. Changing groups will help you meet more people in the class.

b) Have your students introduce themselves by name, major, and where they are from to the other members of their group.

3. Tell students' agenda for the day. "We'll be doing several things today…"

a) You will be taking some tests for us that help us evaluate and improve this course.

b) Then I will tell you how this class uses the web and e-mail.

c) I will then introduce how the groups will function in this class.

d) Finally, I will introduce you to the lab manual and lab. I will discuss how the labs will be graded during the next laboratory meeting after you have read the syllabus that is posted on the class web site.

The majority of your laboratory grade will be based on a written report of one lab problem that will be done individually. I will assign which problem each person writes up at the end of all of the problems that make up a laboratory block (usually about 2-3 weeks). Since you will not know which problem you will write up until you have finished all of the problems in a given set, it is necessary to keep a good laboratory journal. Usually each member of a team will write up a different problem. You will usually have 2 days (or your instructional team's policy) to turn in a report after it is assigned. A good laboratory journal is necessary to write a good report."

TESTS

a) Read the first page of instructions to the students.

"You will have xx minutes to complete the basic physics test, xxxxxxx, and the questionnaire. Work as rapidly as you can. You may take a break if you finish early, but you must be back by _______."(set time)

b) Go over the instructions on the board for filling out the answer sheet. **Once the students have completed their name, ID, course number, section number, etc**, on the answer sheet, then pass out the test booklet.

c) Give them xx minutes and write the ending time on the board. While they are taking the test, go around and check that they are filling out the answer sheet correctly.

d) Collect the tests and questionnaires and the answer sheet and thank your students.

FIRST-LAB INFORMATION

1. Course Stuff (depends on when your labs are during the week)

a) <u>Use of web</u>
This class will make extensive use of computer communication. The class web site is reached from the physics department web site on the board. Just click on the link for class web pages (on left side of the screen) and then on this course number. That will take you to the class web page. That first page will have announcements and links to other important class information such as the syllabus, office hours, and further links to

such things as the reading preparation test. It is important to check this page at least once per day for important announcements."

b) <u>Pre-lab</u> <u>Quiz</u>

"You will take a quiz on the web every week over the reading necessary to understand what you are doing in the laboratory. Since this test is on the web, you can take it from anywhere. You can use whatever help you need to pass this test (75% is passing), but reading and understanding the assigned reading should be sufficient. You may take this test as many times as necessary to pass it, but if you don't pass it after two times, please get help from me or any other physics teaching assistant. Help is available from me by email or from other TAs in room 230.

If you do not pass this test by two hours before this laboratory (or whatever you instructional team's policy), you will not be admitted to lab and will get a zero for that week (or whatever your instructional team's policy). Your lab grade is part of your grade for the entire course but, since this course satisfies a University laboratory requirement, you will fail the entire course if you do not score at least a 60% in the laboratory."

c). <u>E-mail</u>

"Each of you has a University email account and you need to go on the web to activate it. There are instructions of how to do this on the web under the links in *Student One Stop*. We will communicate important information to you and send you your grades using this email account. If you have another email account you can forward your email to that account but we are not permitted to send your information to any account other than your University account."

2. Introduce Purpose of Labs

a) The labs in this course are **very different** from the labs you have done in the past. The purpose of the labs is the same as the purpose of the discussion sections -- to help you learn how to solve physics problems and communicate your solutions in a logical, organized fashion.

b) So you will practice solving problems in cooperative groups like in the discussion sections. The difference between the lab and the discussion section is that you will *check your lab problem solutions* by taking measurements in the lab.

c) I will be here to coach you in the things you need to think about when you are solving physics lab problems.

3. Introduce Structure of Labs

a) Please take out your lab manuals and turn to the table of contents. *(pause while they do this)* The instructions are divided into "labs" or topics. Each lab topic is then further divided into several problems. Each of these lab topics will take 1-3 weeks to complete. During that time, you will usually complete *1-2 problems* per week. At the end of each laboratory period, I will tell you what problems to solve for the next laboratory session.

b) There are also several appendices to help you with various parts of the laboratory. Please turn to the appendices and see what information is there *(pause while they do this)*.

c) Now turn to the beginning of Laboratory 1. You will see the motivation that is behind all of the problems in that laboratory, and the reading that is necessary to function effectively in the laboratory. This is the reading that is tested in the prelab test on the web.

d) Now turn to the beginning of Laboratory 1, Problem 1. Notice that a lab problem is similar to the problems you will solve in the discussion sessions. The difference is that instead of passing out a solution, you will test your predicted solution using laboratory equipment.
   - The **Warm-up Questions** are suggestions and questions that guide you through a logical, organized solution to the problem, called the **Prediction**
   - The **Exploration** section guides you through testing your equipment so you can decide the best way to take measurements. This section is **very important** and by doing it you will save a lot of time and frustration with your measurements. Usually your group decides n a measurement plan at the end of this section.
   - The next sections guide you through the **Measurement** and **Analysis** of your data.
   - Next, you are guided to draw a **Conclusion** that compares your prediction to the analysis of your measurements. All of the lab problems have this structure."

e) Preparing for a laboratory session means that you do three things:
   1. First, complete all the prerequisite textbook reading,
   2. Then take and pass a test on that reading. The tests are on the web.
   3. Finally, complete all the Warm-up questions to arrive at a predicted solution for each assigned lab problem.

4. Introduce Grading the Labs

a) Have students turn to the first grading sheet and look at the grading checklist. Tell students the number of points they will get for each section (from team meeting).

GRADING CHECKLIST	Points
LABORATORY JOURNAL:	
WARM-UP QUESTIONS AND PREDICTIONS (individually completed before each lab session)	
LAB PROCEDURE (measurement plan recorded in journal, tables and graphs made in journal as data is collected, observations written in journal)	
PROBLEM REPORT:*	
ORGANIZATION (clear and readable; correct grammar and spelling; section headings provided; physics stated correctly)	
DATA AND DATA TABLES (clear and readable; units and assigned uncertainties clearly stated)	

RESULTS (results clearly indicated; correct, logical, and well-organized calculations with uncertainties indicated; scales, labels and uncertainties on graphs; physics stated correctly)	
CONCLUSIONS (comparison to prediction & theory discussed with physics stated correctly ; possible sources of uncertainties identified; attention called to experimental problems)	
TOTAL (incorrect or missing statement of physics will result in a maximum of 60% of the total points achieved; incorrect grammar or spelling will result in a maximum of 70% of the total points achieved)	
BONUS POINTS FOR TEAMWORK (as specified by course policy)	

* An "R" in the points column means to <u>rewrite that section only</u> and return it to your lab instructor within two days of the return of the report to you.

b) <u>Warm-up Questions and Prediction</u>. Tell students when and where students should turn in their journals with their Warm-up Questions and Predictions before lab. Tell students that

- **The Prediction is *not* graded.**
- **The Warm-up Questions are graded for <u>REASONABLE EFFORT</u>, and *not* for the correct answers**.

So what does reasonable effort mean? You will receive the maximum number of points if you:

- answer all the questions correctly;
- answer all the questions, *even if some of answers are incorrect*;
- answer some of the Warm-up questions, and clearly indicate **where you got stuck and why.**

c) <u>Lab Procedure.</u> While you are working through the Exploration, Measurements, Analysis, I will be grading you for how well you are keeping track of your procedure and data in your journal. In particular, you will be graded for

- a measurement plan recorded in your journal **before** you begin making measurements;
- you make tables and graphs made in journal **as data is collected** (not after all the data is collected); and
- observations are written in the journal.

d) <u>Written Problem Report</u>. Remind students that this course is a **writing intensive course**. So they will practice *technical writing* in this course. Tell students for which lab (decided by team) they will write a draft (turned in), edit the returned draft, and then turn in a rewritten report.

At the end of the 2 – 3 weeks of a lab topic, I will assign each member of your group a different lab problem to write up and turn in (tell students you team's decision about how many days after lab the report is due). Since you will not know which problem you will write up until you have finished all of the problems in a given set, it is necessary to keep a good laboratory journal.

Your lab report will be graded using four criteria – Organization, Data and Data Tables, Results, and Conclusions (have students look at checklist). Read through each criterion. Notice that ***physics stated correctly*** is part of three of the four criteria.

Have students turn to the Appendix that contains the *Sample Problem Report*. Tell students to be sure to read through this sample before they write their own report.

END GAME OR BEGINNING IF SECOND LAB

What happens next depends on the course and section. In some courses, this could be the end of the lab. In other courses, you may start the first lab problem. Before students start working in the lab, be sure to introduce the group roles for lab, as outlined below.

Working in Cooperative Groups

We will be working in groups all semester in both lab and discussion sections. You will work in the same group in both the lab and the discussion sections. I will assign new groups after each quiz (or team's policy).

I want to introduce how the groups will function before we get started today. Working in cooperative groups is more than sharing a table. We expect you to discuss what you should do, what this has to do with the physics the class is investigating, and how you will go about something before you act.

Pass out Group Roles sheets (if students do not already have them).

In the lab, the **Recorder/Checker** is the person with the primary responsibility for making sure that ***everyone*** records the data in their lab journal so they can write their own lab report. In a computer lab, the Recorder has the keyboard.

The **Manager** has a special responsibility in the lab. The Manager should read the instructions for each section out loud to the group ***before*** the group starts to work on that section. The manager also keeps track of the time, and make sure everyone participates.

The Skeptic/Summarizer makes sure that alternative ideas are explored, that the group does not come to consensus too quickly, and periodically summarizes the discussion and decisions. In groups with four members, the Skeptic and Summarizer are different roles."

You will only benefit from this laboratory to the extent that you contribute to your team's effort. By working closely together, you will help each other learn the material in this class. I will be here to guide you when I notice that you may be going astray. To be helpful I must know what YOU are thinking so I will be listening to what you say to each other and watching what you decide to do."