PH 1110 **Term C00**

STUDY GUIDE 1: Introduction, Vectors, Kinematics

PH 1110 Study Guides are intended to help you achieve the objectives of this course as completely and as efficiently as possible. Each Study Guide begins with a listing of OBJECTIVES to which we will key our instruction, assignments, and exam for that section of the course. A SUGGESTED STUDY PROCEDURE follows, including hints and elaborations (always intended to be helpful!) about some of the more important or challenging concepts, as well as a listing of those end-of-chapter exercises and problems that best exemplify the application of our course objectives. Finally, there is a listing of the HOMEWORK ASSIGNMENTS, due each lecture period during that section of the course. The objectives specify the concepts and tasks we want you master during this course; the suggested study procedure and assigned homework provide a playing field on which you can develop your mastery of those concepts and tasks, prior to examination.

As you prepare to immerse yourself in PH 1110, please keep in mind that physics is more than problem solving. On the other hand, no one learns physics without solving lots of problems. Physics teachers smile at the oft-repeated complaint, "I understand the material, but I can't do any of the problems." **THIS IS SIMPLY NOT TRUE**! If you can't do MOST of the problems, you do not yet understand the physics. The entire support structure of this course is geared toward helping you learn how to solve the requisite problems appropriate to learning this physics, but YOU must schedule the necessary practice. Students reaching the end of this course agree! On the end-of-course evaluation form, most students write that their best piece of advice for someone just beginning the course is: **"DO ALL OF THE SUGGESTED EXERCISES AND PROBLEMS!"**

And while we're on the subject of things to do, here's a DON'T: **Don't** just blindly memorize. Rote memory has little to do with learning physics. Almost always, time spent memorizing something could be better spent working on some illustrative problems. Through careful and thoughtful problem solving, those items you need implanted in your memory banks will automatically end up there.

Now back to a DO: **Do** take time to learn from your problem solutions. (In general, the least important detail of a solution is the specific numerical answer!) Did you draw a SKETCH that properly captures all essential detail of the situation at hand? What FUNDAMENTAL PRINCIPLE(S) did you apply? Is there an unbroken logical CHAIN OF REASONING, including proper application of the fundamental principle(s), connecting the given information all the way through to your answer? Does your answer have correct UNITS as well as the proper number of SIGNIFICANT FIGURES? Does your answer seem to be of a PROPER SIZE? This, in a nutshell, is what physics is all about! Welcome aboard!

<u>Objectives for Study Guide 1</u>

1. Express numerical answers to the correct number of significant figures using scientific notation. Convert units from one system to another.

2. Distinguish between scalar and vector quantities; use and express them correctly.

3. Determine graphically the magnitude and direction of the resultant of two or more vectors.

4. Determine the components of a vector in a specified coordinate system; add and subtract vectors analytically by using their components.

5. Define unit vector; solve for the unit vector parallel to any given vector. Use the **ijk** unit vectors to express a vector in standard **ijk** form.

6. Define displacement, velocity and acceleration. Distinguish between displacement and distance, velocity and speed, average and instantaneous velocities, and average and instantaneous acceleration.

7. Given the graph or functional form of one of the quantities $x(t)$, $v_x(t)$, or $a_x(t)$, determine the graphs of the other two. Describe in your own words the motion from an analysis of one or more of the graphs.

8. Solve problems of uniformly accelerated motion in one dimension.

Suggested Study Procedure for Chapter 1.

Study Secs. 1-1 through 1-10.
Study particularly Examples 1-5 through 1-9.
Answer Discussion Questions 13, 15, 17, 18 - first part only (p. 25)
Do Exercises in Chapter 1 - 2, 3, 9, 15, 17, 20, 27, 31, 32, 35, 39, 41 (pp. 25-27)
Do Problems 55, 57, 59 (p. 28)

A. As you read Secs. 1-1, 2, 3; note the discussion about the use of models. The use of models is intrinsic to physics.

B. Pay close attention to Secs. 1-4 through 1-6. As part of the standard language of science and technology, correct use of units and numerical notation is important. To try to estimate the value of a desired quantity can be fun. Sec. 1-7 gives you an idea of making these estimates ("ball-park" calculations).

C. Here's the meat and potatoes of Chapt. 1: Sec. 1-8 shows you how to add and subtract vectors graphically; Sec. 1-9 shows you how to obtain precise, quantitative results in what is called an analytic approach. The whole point is that to deal successfully with vectors you must be able to transform vectors between the

magnitude/direction form: $\vec{\mathbf{A}} = |\vec{\mathbf{A}}|\angle\Theta$

and the component form: $\vec{\mathbf{A}} = A_x\hat{\mathbf{i}} + A_y\hat{\mathbf{j}}$,

two equivalent ways to represent the same thing. For some purposes (visualizing, graphing) we tend to use the magnitude/direction form; for other purposes (adding, subtracting) we use the component form. The Problem-Solving Strategy on p. 16 provides the key to this transformation; Examples 1-5 through 1-8 provide some good practice.

D. More meat and potatoes await in Sec. 1-10: the unit vector is an enormously useful part of this vector stuff. One detail the authors should have included is that **i**, **j**, and **k** are not the only unit vectors in the world. You can make a unit vector, $\hat{\mathbf{u}}_A$, which is parallel to some vector $\vec{\mathbf{A}}$ simply by dividing $\vec{\mathbf{A}}$ by its magnitude:

$$\hat{\mathbf{u}}_A \equiv \frac{\vec{\mathbf{A}}}{|\vec{\mathbf{A}}|} \quad .$$

Example: Given that $\vec{\mathbf{A}} = (6.00\hat{\mathbf{i}} - 4.00\hat{\mathbf{j}})$ m, solve for the unit vector parallel to $\vec{\mathbf{A}}$

$$\text{Answer: } \hat{\mathbf{u}}_A = \frac{(6\hat{\mathbf{i}} - 4\hat{\mathbf{j}})m}{\sqrt{6^2 + (-4)^2}\,m} = 0.832\hat{\mathbf{i}} - 0.555\hat{\mathbf{j}} = \angle -33.7^o$$

Suggested Study Procedures for Chapter 2.

Study Secs. 2-1 through 2-6; Skim Sec. 2-7.
Study particularly Examples 2-1 through 2-8.
Answer Discussion Questions 7, 10, 11, 12, 16 (pp. 52-53).
Do Exercises in Chapter 2 **-** 1, 13, 15, 22, 23, 28, 35, 41 (pp. 53-56)
Do Problems in Chapter 2 **-** 50, 55, 56, 58, 66, 73 (pp. 57-60)

A. Study the Key Concepts on p. 31. Although we want you to be familiar with average velocity and average acceleration, it is actually the instantaneous velocity and acceleration we are most often interested in. So when we refer to velocity and acceleration (see the third key concept), we mean the instantaneous versions of each.

B. Graphs of x, v_x , and a_x vs. t help us understand the relationships among these quantities. In Sec. 2-3, Figs. 2-5 and 2-6 are intended to help you see that v_x at any given moment is the slope of the x vs. t graph at that very moment. (Once you think you understand this, try your hand at drawing the v_x vs. t graph corresponding to Fig. 2-6.) In Sec. 2-4, Figs. 2-9 and 2-10 are intended to help you see that a_x at any given moment is the slope of the v_x vs. t graph at that very moment. (Try your hand at drawing the a_x vs. t graph corresponding to Fig. 2-10). Finally, the acid test is to draw the v_x vs. t graph corresponding to x vs. t in Fig. 2-11, and then the a_x vs. t graph corresponding to that.

C. Just as you can move from x vs. t to v_x vs. t to a_x vs. t by taking slopes, you can go in the other direction (a_x to v_x to x) by taking areas under the graphs. The authors show this in Sec. 2-7, but they make it seem difficult. We'll show how easy it actually is in lecture.

D. All motion problems can be analyzed and solved graphically as above. In the important case of constant acceleration, however, the graphs lead to a standard set of equations which automatically link the various system parameters. Sec. 2-5 shows how to solve such problems algebraically. The two approaches are really equivalent, so we urge you to practice both approaches for the added insights you will gain.

E. When analyzing freely falling bodies (Sec. 2-6), we like the convention of choosing vertically upward to be the positive y-axis direction. Because the Earth causes a downward acceleration, the y-component of the acceleration is thus negative:

$$a_y = -g = -9.80 \text{ m/s}^2 .$$

Please note that a_y is the negative quantity here, not g. The acceleration due to gravity (g) is **ALWAYS** stated as a positive number (i.e., as the magnitude of an acceleration) **--** just look in any listing of physical constants, such as under the back cover of your text, and see for yourself.

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PH1110 <u>Homework - Term C00</u>

General Information:

A. There will be a homework assignment due at each lecture (except on exam days).

B. **Homework must be submitted on standard 8 1/2 by 11 (inches) paper (lined or unlined).** In keeping with professional standards, the paper must not have ragged edges (e. g., just torn out of a spiral notebook), and multiple pages must be **stapled** together. Each homework submission must have:

1. Your Name at the **TOP RIGHT** of each page
2. Conference Section Number at the **TOP RIGHT** of the first page
3. Homework Number at the **TOP RIGHT** of the first page.
4. <u>Boxes drawn around all numerical and symbolic answers. (This is the least **you** can do to help out the grader!)</u>

FAILURE TO DESIGNATE THE CORRECT CONFERENCE NUMBER AT THE TOP RIGHT OF THE FIRST PAGE WILL RESULT IN A PENALTY. Each homework problem will be graded on the basis of 10 points maximum.

<u>HOMEWORK WILL ONLY BE ACCEPTED PRIOR TO THE START OF EACH LECTURE</u>

HOMEWORK ASSIGNMENTS FOR STUDY GUIDE 1

<u>Homework Assignment #1 - due in lecture Monday, January 17</u>.

HW 1-1: Ex. 1-34 (p. 26); PLUS **solve** for the unit vector parallel to $\vec{\mathbf{A}} + \vec{\mathbf{B}}$, and the one parallel to $\vec{\mathbf{B}} - \vec{\mathbf{A}} = -(\vec{\mathbf{A}} - \vec{\mathbf{B}})$. Use **ij** notation.

HW 1-2: Ex. 1-40 (p. 27); PLUS **solve** for the unit vector parallel to $\vec{\mathbf{C}}$. Use **ij** notation.

HW 1-3: Prob. 1-56 (p. 28); **express** this final displacement vector in distance/direction form. ALSO, **determine** the distance (measured in steps) traveled by the explorer on this four-part round trip.

<u>Homework Assignment #2 - due in lecture Wednesday, Jan. 19.</u>

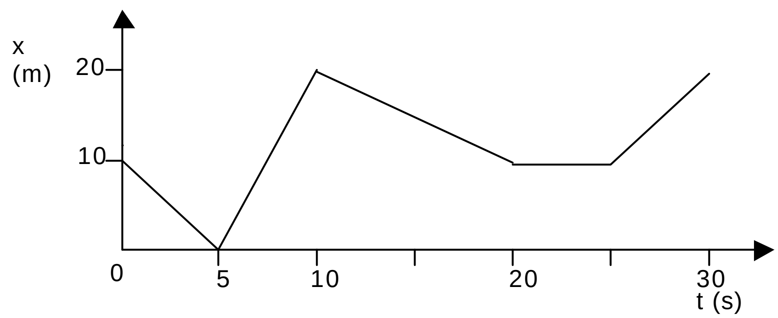
HW 2-1: Airplane 1, starting from airport A, flies 300 km east, then 350 km at 25.0° west of north, and then 250 km west, to arrive finally at airport B. The next day airplane 2 leaves airport A and flies directly along a straight-line path to airport B.

a) **Determine** the direction in which airplane 2 must head and the distance it must travel to get to airport B.
b) At the same moment that airplane 2 departs airport A, airplane 1 departs airport B to retrace yesterday's path back to airport A. Assuming that the two planes travel at the same speed, **determine** the displacement (vector) from airport B to airplane 1 at the moment airplane 2 reaches airport B.

c) **Determine** also the (straight-line) distance between airplane 1 and airport A at the moment airplane 2 reaches airport B, as described in (b).

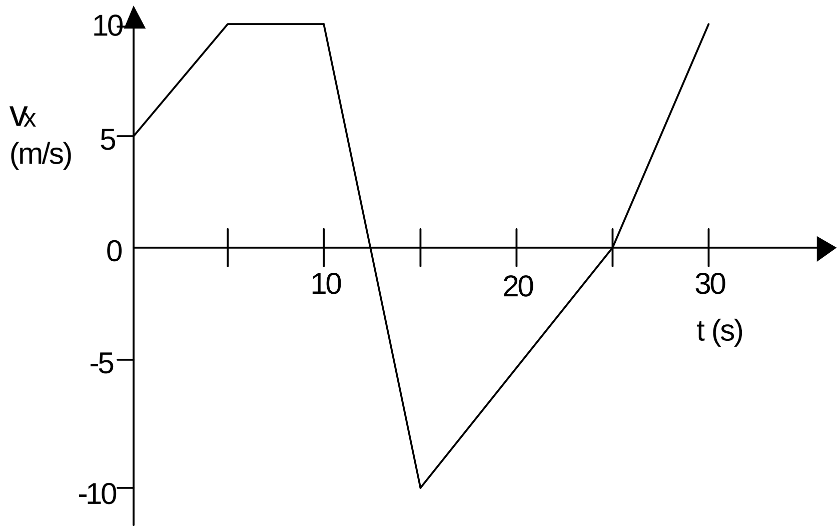
HW 2-2: A car moves according to the graph shown.

a) **Plot** a graph of $v_x(t)$ for this time interval. Scale the axes properly.
b) During what part(s) of this interval is the *x*-component of displacement negative? During what part(s) is the *x*-component of velocity negative?
c) What distance does the car travel during this interval? What is the displacement of the car at 30s relative to its starting point?
d) Explain what is most unrealistic about this motion.



HW 2-3: A car moves according to the graph shown.

a) **Plot** a graph of $a_x(t)$ for this time interval. Scale the axes properly.
b) During what part(s) of the interval is the *x*-component of velocity negative? During what part(s) is the *x*-component of acceleration negative?
c) What is the maximum value of the speed during this interval? At what time(s) does it occur?
d) Given that the car starts at $x(0)=0$, where is the car at t=10s ? t=20s ? t=30s ? **Sketch** an approximate graph of $x(t)$ for this 30s interval on properly scaled axes.



Homework Assignment #3 - due in lecture Friday, Jan 21.

HW 3-1: A truck on a straight road starts from rest, accelerating at 2.00 m/s^2 until it reaches a speed of 20.0 m/s. Then the truck travels for 20.0 s at constant speed until the brakes are applied, stopping the truck with constant acceleration in an additional 5.00 s. **Draw** graphs of x, v_x , and a_x vs. t for this time interval, and **determine** the following quantities: (a) the length of time the truck is in motion, (b) the acceleration when the brakes are applied, and (c) the distance traveled during each of the three segments of this motion. **Scale** the axes of the three graphs accordingly.

HW 3-2: A jet plane lands with a speed of 100 m/s and can be accelerated at a maximum rate of -5.00 m/s^2 as it comes to rest. (a) From the instant the plane touches the runway, **determine** the minimum time it needs before it can come to rest. (b) **Determine** whether this plane can safely land on a runway that is 0.800 km long.

HW 3-3: A ball thrown vertically upward is caught by the thrower 4.40 s later. **Determine** (a) the initial speed of the ball, (b) the maximum height reached by the ball, and (c) the time and height when the ball has exactly 1/2 its initial speed, both coming up and coming down. **Draw** graphs of y, v_y , and a_y vs. t for this situation. **Scale** the axes precisely.