INSTRUCTOR GUIDE

PARTS ONE and TWO

WEEKEND NAVIGATOR
U.S. Coast Guard Auxiliary Navigation Course

This guide contains Instructor Notes that correspond with the presentation slides and answer keys for the Student Study Guides.

INSTRUCTOR (IT) NOTES
For
WEEKEND NAVIGATOR PART I
U.S. Coast Guard Auxiliary Navigation Course

CHAPTER 1: ABOUT THIS BOOK

Slides (Preface) i – iii: The course, ***WEEKEND NAVIGATOR, PART I*** is designed to give the student the rudiments of navigation by using charts, navigation plotting tools, and limited use of GPS. The intent is TO provide the student with a solid foundation with emphasis on technique and not electronics. GPS will be mentioned and discussed as it relates to plotting waypoints, etc., but more detail on the use of GPS and other electronic devices will be covered in more detail in ***WEEKEND NAVIGATOR: PART II.***

On pages 2 and 3 of Weekend Navigator, the author briefly discusses how to use the book. The following points should be explained to the students in order to understand the scope of the book and the subject matter:

- Navigation has changed since the "old days" when navigators plotted a course and relied on dead-reckoning and seeing a ATON was a bonus
- Today we have (**Global Positioning System**) (**GPS**) which have become common and affordable. Today with a couple of hundred dollars and two AA batteries, you can find your position anywhere on the face of the earth.
- While electronics can be very helpful, easy to use, and accurate, they can break or quit. Knowing how to navigate "the old fashion way" using dividers, parallel rulers, and a compass could make the difference between survival and a catastrophe.

Helpful Suggestion: *Without taking too much time, share a "sea story" from your experience about how you may have lost the use of electronics and how you had to rely on your experience, trained eye, and knowledge of the local area to reach your destination safely.*

Explain to the students that the book is divided up into Parts I-VII. Part I and II will covered in ***WEEKEND NAVIGATOR, PART I.*** The remaining parts of the book (III-VII) will be covered in ***WEEKEND NAVIGATOR, PART II.***

- Part I (Chapters 1-4) provides an overview. In Chapters 2 and 3 students will learn about traditional navigation and modern methods. In Chapter 4, both traditional and digital navigational tools will be covered.

- Part II (Chapter 5) discusses with pre-voyage planning including plotting courses on paper and digital charts, and entering waypoints into a GPS.

The Student Study Guides consists of both review questions and exercises. The review questions can be used in class, and the exercises are designed for doing at home. Review all of this with the class. There is a take home cruise exercise to complete Part I.

CHAPTER 2: WHAT IS NAVIGATION?

Slide 2: In Chapter 2: **What is Navigation?** We need to stress that operating on the water, is not the same "as driving a car". Our goal is to go from Point A to Point B and to avoid hazards. Point out that we use land maps to find our way, how much more so should we use a chart on the water.

Slides 3, 4: In this chapter we will discuss the basics of navigation including:

- Piloting versus navigation
- The three steps of navigation
- What to include in pre-voyage planning
- Planning on the fly
- What to watch for when underway
- Double – checking
- Piloting without electronics
- Using ATONs, plotting courses, distances, and bearings

Slide 5: Briefly list the **three steps of navigation** stressing that a skilled and prudent navigator does not rely only on electronic devices to get where he/she is going.

Like any event or activity, **pre-planning** is essential.
Helpful Suggestion for Audience Involvement: Ask how many are extensive planners/micro managers and how many are more "free spirits" when it comes to planning an event/activity.

Pre-voyage planning includes preparing for the following:

- Voyaging from one location to another
- Tacking into the wind and waves
- Meandering freely in a region while fishing or recreating

Slide 6: Point out the differences (pros/cons) between commercial **pre-plotted charts** and **government charts** and how they can be used effectively.

Slide 7: Suggestion for Audience Involvement: For those that like to "plan on the fly", discuss what are some of the risks associated with this approach and how can the use of charts reduce some of those risks.

Slides 8-11: Once you have made your plans, you want to follow them. The main objective is to stay on course to avoid hazards and to make sure you reach your destination safely. **Monitoring your position** is essential to make sure you stay on course. Getting off course is easy to do. GPS and **double-checking** can help get you back on course.

Use a brief sea story and/or ask the audience for a situation where they have wandered off course. If it is safe (no spousal fights), throw in some humor with the ***"he will never ask directions" or "I am not lost, I am just not sure where I am right at the moment".***

Slide 12: Remind your students that mistakes can happen. I think we can all relate to this in the electronic age. Point out that the skipper is responsible for his crew and must know where he is at all times**. Safety is paramount!**

Slide 13: Simple techniques for **double – checking** include:

- "**seaman's eye**" (similar to "***groundtruthing***" with hikers)
- GPS
- Radar and other electronics

As pointed out earlier, the point here is we should never rely solely on one means of double-checking our position**. Redundancy** is a necessity when navigating on the water.

Slide 14, 15: The emphasis of this section is **piloting without electronics**. Introduce the students to the subject of **piloting** and what techniques (i.e. landmarks, land features, ATONs), are used in piloting and how this method compares to GPS.

Slide 15: Discuss the concept of "**local knowledge**" and why it is important in piloting and navigation. Help them relate to the fact that we use local knowledge everyday to complete our daily activities and responsibilities.

Slide 16, 17: The fundamental task in piloting is to determine and follow safe paths on the water. Discuss and explain the following terms:

- **Intended course**
- **Track or line of motion**
- **Course direction**
- **Course distance**

Slide 17: Briefly demonstrate how to use the **plotting tools** to measure the course direction on a chart and the use of **dividers** on determining distance. Explain to the students that they will get a chance to use these tools in Chapter 4.

Slide 18: Dead reckoning (DR) is a way to approximate a boat's current position from a known past position and the intervening times, speeds, and directions of travel. Explain to the student that it is important to understand the basic principles of DR in case the electronics fail.

Using the example mentioned in the book, demonstrate on a chart or on the board, using a set of dividers, how you would establish a **DR plot** or **DR track**. Again, they will have more opportunity to learn this skill later in the course.

Helpful Suggestion: ***Above all, make sure you know how to do the exercise and are comfortable with it. If you are confused and not knowledgeable, then everyone will be nervous and stressed.*** If you have other students in the class that are knowledgeable on this procedure, put them to work and get them involved helping other students. This will help alleviate boredom, assist you if it is a large class, and provide a different perspective on the topic. Who knows, you might even get a future Auxiliary instructor out of it.

Slide 19, 20: Taking a **bearing** is the process of measuring the direction to a charted landmark you can see from your boat. Bearings are a powerful means for determining your location independent of GPS or DR.

Helpful Suggestion: You might use a **hand held compass** to demonstrate this concept. If you have several compasses, have the students work in groups and have them pick out an object in the room and determine the bearing from where they are sitting.

Slide 21, 22: One form of **fix** is the intersection of two bearings and is a more precise indication of your true location than just DR alone (Figure 2-11). Make sure they understand and can locate the **compass rose** and the different scales.

Slide 23, 24: Ranges are straight lines emanating from a pair of visible charted landmarks (i.e. smokestack, church steeple, etc.). When they come into perfect alignment from your position, you know that your current location lies somewhere on the range line.

Navigational ranges will be printed on the chart and usually are at the end of a narrow channel.

Slide 25-27: A **relative bearing** is any bearing taken with respect to your boat. In order to use them they must be converted before plotting them. To **convert a relative bearing**, determine how many degrees the relative bearing lies clockwise from the bow of your boat and then add that number to your boat's magnetic heading to get the equivalent magnetic bearing.

Helpful Suggestion: This may be a hard concept for some students to grasp, so you may need to do a number of examples. This can be a good opportunity to have the students work in small groups (3-4 people) and practice. Give them several different scenarios and then see how close they come. Get the students involved and have them figure it out until they hit a roadblock.

Slide 28: This concludes Chapter 2: **Review with the students the following major points** and make sure everyone understands the concepts. We will be building on these concepts in Chapters 3-5.

- **Steps of Navigation**
- **Piloting with Electronics (i.e. using ATONs, plotting courses and distances, DR)**
- **Review the basic steps of the sample cruise**
- **Visual bearings, ranges, and relative bearings and their use in navigation**

CHAPTER 3: FUNDAMENTALS OF WAYPOINT NAVIGATION

Slide 3, 4: In Chapter 3 our **Learning Objectives** will focus on the following areas:

- Advantages of waypoint navigation
- Using pre-plotted course segments
- GPS and waypoint navigation
- Other uses of waypoint navigation
- Using our skills in a sample cruise exercise

Slide 5: Waypoint navigation is the process of navigating along a series of straight-line segments, called legs. The beginning and endpoints of each leg are called waypoints.

Slide 6: One of the principle advantages of **waypoint navigation** is that each **leg** has been pre-qualified to be free of charted obstacles.

Preplotted courses usually end at ATONs which can be considered waypoints. **Helpful Suggestion:** Use the Titanic ("The Corner") waypoint story given in the text to reinforce this concept.

Slide 7: An **active leg** is the segment you are currently sailing. A **route** is a series of segments that get you from Point A to Point B.

Slide 8: Using GPS, you enter waypoints with the latitude and longitude coordinates of the **endpoints** for each leg. Your GPS will compute the course direction and course distance from your *current* location to the next waypoint each time you select to GOTO that waypoint. Be sure you have a safe path from where you are to the waypoint before selecting the GO TO option.

When not using GPS, you will need to measure the course direction and distances on the chart and use that information to steer your boat.

In the real world it is easy to make mistakes and enter the wrong waypoints into you GPS unit. Always make sure to double check **"the traditional way".**

Slide 9: The Sample Cruise. In this segment, we will use waypoint navigation with our GPS.

Step 1 is to conduct some pre-voyage planning. You will need to enter your **waypoints** in advance before using GPS. Remember, GPS waypoint navigation is based on navigating from point to point as compared to traditional navigation which is based on course directions and distances.

On this cruise you will have four (4) waypoints including a:

- Starting point
- Two turning points

- Destination point

You will need to measure the **coordinates (latitude and longitude)** of each waypoint and enter them into your GPS and assign each a unique name (refer to Figure 3-1). **Step 2** is to **draw line segments** between each of the waypoints on your chart. These are called **legs.** Scan the area along each leg to make sure the path is clear of shoals and hazards

In **Step 3** it is time to start your cruise. You will be starting at waypoint **EH1**. Upon reaching EH-1, you use the GO TO function on your GPS, which will list all of your waypoints. Select **CITURN** and press ENTER.

The GPS will compute the **course direction** (205M) and the distance (7.7 nautical miles). GPS will draw this course on your ***Map Screen***. Steer your boat to 205M and set your speed.

In this leg, fog has rolled in and the utility of GPS becomes readily apparent. By examining your GPS you realize that you are actually heading (**course over bottom**) 215M instead of 205M. **Helpful Suggestion:** At this point, ask the students why this occurred and what factors may have contributed to being off course. Ask: is it serious enough to worry about?

Ask the students what will they need to do to get back on course? Bring the boat back on the GPS course line. Realize that the GPS course line and your compass may differ. In this case, the difference between the **GPS course line** and your boat's compass is 10^{o} (195M) (Figure 3-1, page 19).

Your course through the water is actually 195M, but your **course over ground (COG)** or **actual track** is 205M.

Upon arriving at **CITURN,** use the GPS GO TO function again to activate WCTURN and then repeat the process as before. At **WCTURN** you repeat the process to activate WCDEST and turn in that direction.

The GPS unit has not been affected by the weather and you can proceed to your destination. **Helpful Suggestion:** Think about one of your own sea stories or ask any of the students if they have had a similar experience to give the Sample Cruise validity and reinforcement.

At this point, we will temporary leave GPS and will discuss it in detail in PART II.

Slide 10: Other uses for waypoints include:
- Marking hazards and areas to avoid
- Double-checking or verifying your current position

Many GPS models are capable of storing **avoidance waypoints** or **proximity waypoints**. The coordinates are entered just like other waypoints. In addition, a **buffer zone** or **avoidance radius** can also be entered to ensure you avoid the hazard.

Slide 11: Navigation aids, buildings, towers, and other visible landmarks can be entered into your GPS system to help you in knowing where you are. These features will appear on your GPS screen, but you should always double check what you see on the screen with what you can actually see from your boat.

CHAPTER 4: THE TOOLS OF NAVIGATION

Slide 3-5: In this chapter we will look at the **"tools of the trade".** GPS is great, but it alone cannot always provide safe navigation.

Chapter 4 goes into more detail about:

- Nautical charts
- Information contained on nautical charts and how to use it
- Navigational aids (ATONs) and what they mean
- Various plotting tools and their use
- Overview of electronic navigation instruments and their use

Please remind students that WEEKEND NAVIGATOR PART 1 is basic navigation with the emphasis on use of charts and plotting tools. WEEKEND NAVIGATOR PART 2 will go into much more detail about GPS, radar, depth finders, and autopilot.

Slide 6: A **chart** is a flat surface scaled representation of the Earth that accurately portrays shapes, distances, and directions and includes water depths.

Slide 7: Chart information comes primarily from:

- **National Oceanographic and Atmospheric Administration (NOAA)**

Charts are prepared by the:

- **National Ocean Service (NOS)**

Due to only periodic updating, your GPS is probably more accurate than your chart. ***Prudent navigators treat charts as essential, but not absolute.*** They are however, your primary source of information about a given area.

Slide 8: Charts are prepared in basically two ways. The challenge is portraying a nearly spherical Earth on a flat chart.

Slide 9-11: A **Mercator chart projection** has the following characteristics (Figure 4-3):

- Maintains directional relationships better over long distances
- Tends to be the projection of choice for coastal and offshore navigation
- **Parallels of latitude** are horizontal and straight
- All **meridians** of longitude are vertical and straight
- Parallels intersect the meridians at right angles

- The navigator can measure and plot directions and distances directly on the chart and use them for navigation
- Distorts the shapes of relative landmasses and ocean basins and is exaggerated near the poles
- Landmasses near the poles (i.e. Greenland) will appear larger than they actually are
- The globe and the chart match up much more closely at the equator because of far less distortion

Slide 12-16: A **polyconic projection** has the following characteristics:
- Maintains proportions better and tends to be used more for inland and lake nautical charts
- Not suitable for plotting courses over great distances
- Used primary for the Great Lakes and major river systems (i.e. Mississippi River)
- Can be used for plotting a course over a short distance (regionally) much like you would with a Mercator projection chart

Slide 17: Where local charts may not be available (i.e. small lakes), you can use **US Geological Survey (USGS) topographic maps** as well as local maps and guides (Figure 4-4). Be advised, that these maps may not show underwater features (i.e. old dams, shoals, bars, rock, shipwrecks) which may pose hazards to boating.

When **underwater features** are added (i.e. **depth contours**), the "map" becomes a chart **Helpful Suggestion:** compare Figures 4-4 through 4-7 to show how the addition of features makes a chart useful.

In order to give perspective or a frame of reference, charts have **grid lines** drawn on them, which are comprised of latitude and longitude lines. Using a pair of latitude and longitude coordinates, you can determine location in numerical form.

Slide 18: Depth measurements are plotted on the chart and are called **soundings**. Because water levels fluctuate, soundings must be referenced to a **vertical datum** or **standard** that is referenced on the chart.

On older charts, depths are referenced to **mean low water (MLW)** which is the average local height of all low tides as recorded over a 19 year natural cycle. In most regions there is a low tide twice per day and one of those tides is usually lower than the other one.

Current charts use the more conservative vertical datum of **mean lower low water (MLLW)** which is the long term average of the lower of the two (2) daily low tides.

On US charts, depths are expressed in feet (ft.). In the rest of the world, depths are expressed in meters (m). In some cases it may be expressed in **fathoms** (1 fathom = 6 feet). To check which depth sounding unit is being used, check the **title block**

Slide 19: Depth contour lines may also be used on charts much like you would see on a topographic map. Depth contours may be plotted at 6, 12, 18, 30, and 36 feet (multiples of a 1 fathom) (Figure 4-7).
Depth contours can be distinquished from sounding because they will be oriented with the contour, interrupt the contour line and printed in italics while soundings are in regular type (Figure 4-7).

Slide 20: Shallow water is usually shaded **blue**; **deep water** is **white**. **Very shallow water** that uncovers at low tide is **green** and **land** is colored **tan**.

The **type of bottom** is depicted by a combination of symbols and abbreviations.

Slide 21: Charts can come in a variety of **scales** which is indicated as a **ratio**. For example, a 1:40,000 scale chart is read as 1 inch on the chart equals 40,000 inches (approximately ½ nautical mile) in the real world (Figure 4-9).

Different scales are used in different situation such as:

- 1:20,000 is typical for local waters
- 1:10,000 for a specific harbor
- 1:80,000 for a wider boating region

Slide 22: A 1:10,000 is considered a **large scale chart** for running in narrow, rock strewn areas while a 1:120,000 is considered a **small scale chart** ("big picture") and is used for cruise planning.

Large scale charts show more detail, but cover a small area while small scale charts depict a larger area with less detail. Remember, large scale = large detail. **Helpful Suggestion:** This will be a hard concept to get across. We tend to associate large numbers with more detail, but in this case it is just the opposite. Remind the student that scale is a ratio. The larger the denominator, the smaller the scale (ratio/fraction) and less detail.

Slide23: Charts are periodically updated. The latest information can be found in **Notice to Mariners (NTM)** or via the USCG in its weekly **Local Notice to Mariners (LNM)**.

Slide 24: To plot our exact position on the Earth, we use a system of coordinates called **latitude and longitude.**

Slide 25: A nautical address consists of its latitude (LAT) and longitude (LON). The LAT scale is printed on the left and right margins of the chart. The LON scale is printed at the top and bottom margins. Point these out on Figure 4-7.

Slide 26: Lines of longitude or meridians are vertical slices that pass through both poles. Meridians are numbered from 0^{o} at the **prime meridian** (passes through Greenwich,

England) increasing by degrees both east and west until they meet ½ way around the globe at 180^{o}.

A **great circle** is an imaginary line scribed on the Earth's surface by a plane passing through the exact center of the earth (Figure 4-10). All Meridians are great circles.

Slide 28: A **rhumb line** is a course on a single bearing. Great circles define the shortest distance between two points and would require the helmsman to steer a constantly changing compass course. For local navigation, a rhumb line course won't differ much from a great circle course in terms of distance.

Slides 29: LAT and LON scales often are divided into degrees, minutes, and tenth of minutes. A minute of angle is equivalent to $1/60^{th}$ of a degree. Charts for the Great Lakes and rivers are usually divided into degrees, minutes, and seconds. A second of an angle is $1/60^{th}$ of a minute.

Slide 30: A minute of LAT is always equal to one (1) nautical mile. Therefore, you can use the LAT scale for measuring distance on a chart.

A minute of LON is equal to one (1) nautical mile only at the equator and diminishes as you move toward the poles. ***IMPORTANT POINT: The LON scale cannot be used to measure distance!***

Slide 31: In this section will discuss **Chart Symbology** (Figures 4-11 and 4-12). A wide variety of symbols and lettering is used to depict any of a number of structures and features. Like a road map, the student must become familiar with some of the more common symbols and understand what they depict/represent. **Helpful Suggestion:** Give the students 10-15 minutes, if possible, and let them look over the chart, getting familiar with the title box, chart symbols, and other features. You might even have a contest to see who can come up with the most symbols and/or the most unusual chart symbol.

Slide 32: One group of symbols includes **Navigational Aids (ATONs).** Navigational aids are either **lateral, regulatory or informational** in North America

Lateral Marks indicate the sides and center of the navigation channel. In the US and Canada, we use the **"red right returning"** rule of lateral marking.

This means you will see a red lateral aid on your right when:

- Returning from the sea
- Entering a harbor or marina
- Heading upriver

At all times, you must know your point of reference relative to the chart. Are you going up or down river or circling a continent? For example, follow the North American continent clockwise starting at Maine in the northeast US and going south.

Slide 33: Government (Federal) **ATONs** are depicted on a chart using abbreviations or symbols that describe their appearance and/or **characteristics**. Remind students that buoys are not fixed, but will move with currents, tides, etc.

Slide 34, 35: Unlighted, fixed navigation aids are called **day beacons** and are usually a green square or red triangle.

Slide 36: Lighted beacons are indicated by symbols that resemble **exclamation marks (!).** The solid black dot indicates that beacon's fixed location. A **magenta tear-drop flare** distinguishes the lighted beacon from other buoys or ATONs (Figure 4-14 and Figure 4-15B and C).

Slide 37, 38: The **characteristics of the beacon** are printed right next to the symbol and indicate the following information:

- **Light pattern** ("FL" for flashing and repetition interval in seconds "4s")
- **Light color** ("R" for red, "W" for white, "G" for green, "Y" for yellow)
- **Height (height of the light above the local waters) only used if out of the norm.**
- **Visible range (the distance under optimal atmospheric conditions that the light would be visible)**
- ***For example: "FL R 4s" denotes a red light flashing at 4 second intervals***

Slide 39: A **lighted center channel buoy** will flash a Morse code "A" (short-long) pattern with a white light

A **junction buoy** will flash a two short plus one short (2+1) pattern in the color of the top band (either green or red)

Slide 40, 41: Buoys have different shapes, colors, and numbers. The color of the buoy will be represented on the chart with "R" = red; "G" = green; and "RW" = red/white

Slide 42: Buoy shapes include "**N" for nun; "C" for can**. A mid channel buoy will have a white light and red/white alternating vertical striping

Slide 43: Other buoys include those that make **sounds (**i.e. **sound making buoys)** such as bell, gong, or siren buoys along with their corresponding colors of red, green, or white

Slide 44: Common plotting tools include dividers, parallel rulers, a protractor, a tool kit. **Helpful suggestion:** You might have examples of different types of plotting tools to show your students.

Slide 45: Dividers are a drawing compass but without one point being a pencil. They can be used for the following:

- **Measuring distances**
- **Measuring LAT and LON coordinates**

Slide 46: For **determining latitude coordinates**, place one point on the spot of interest and the other point on a line of latitude. Transfer the divider to the latitude scale and determine the latitude measurement, which is read in degrees, minutes, and 1/10ths of a minute north (N)

For **determining longitude coordinates**, place one point on the spot of interest and the other point on the nearest meridian line. Transfer the divider to the longitude scale and determine the longitude measurement, which is read in degrees, minutes, and 1/10ths of a minute west (W)

Slide 47: For **determining distance**, place one point on each end of the distance to be measured and then transfer the dividers to the distance scale or to the latitude scale on the sides of the chart.

Slide 48: ***It is important to remember that most charts have distance scales in nautical miles, statute miles, and kilometers. On the water, use nautical miles due to the natural relationship with latitude.***

Slide 49: If the distance to be measured is longer than the span of your dividers, set your dividers to a known distance and then "walk" your dividers along the distance line.

Helpful Suggestion: You might want your students to practice this technique as it does require a certain level of finesse.

Slide 50: Parallel rulers are a pair of rulers held together by two or more swinging hinges and can serve as a straight edge for plotting. They are used to transfer a plotted bearing line across the chart to the compass rose. ***Again, you might want your students to practice this technique as it does require a certain level of finesse.***

Slide 51: Rolling parallel ruler consist of a single straight edge with build in rollers so it can actually be "rolled" across the chart to the compass rose. ***Have your students practice this procedure to make sure they are comfortable with the technique and proficient.***

Slide 52: The **protractor plotting tool** is easier to use than parallel rulers particularly where space is limited.

Slide 53: Additional items for your **navigation tool kit** that may be helpful include:

- Drawing compass
- Calculator
- Notebook
- Pencils and erasers
- Water-proof sleeves for charts

Slide 54: Other navigational tools include the following:

- Ship's compass

- Hand bearing compass
- GPS
- Other electronics

Slide 55: A **ship's compass** is a must! Quality and size are important considerations. It is best to have the deviation adjustment done by a professional unless you are skilled in such adjustments.
Slide 56: A **hand bearing compass** should have a built in sight and is used to take visual bearings. Make sure to use the compass from a single location on the helm for consistent readings.

Slide 57: GPS will be discussed in Part II of this course. GPS is an electronic navigation system using satellites. The area above your boat must be clear of obstructions in order to receive the satellite signals. Remember, until you plot a GPS position it is just an abstraction!

Slides 58-60: Other **electronic navigational devices** include:
- **Radar** – useful for fixing positions and is the only electronic device for tracking other vessels
- **Depth sounder** – gives the water depth under your boat
- **Fluxgate compass** – reads magnetic, thereby eliminating deviation adjustments
- **Autopilot** – controls the boat's rudder and must be connected to a fluxgate compass or GPS device
- **VHF radio** – particularly valuable in emergencies and assists the USCG in determining your position

Slide 61, 62: Briefly review the main points of this chapter and check to see if there are any questions before moving on to Chapter 5 including:
- **Nautical charts**
  - Depths
  - Updates
  - Horizontal datum
  - Symbology
  - Scales
  - Chart grid
  - Coordinates
- **Plotting tools**
  - Dividers
  - Protractor
  - Parallel rules
  - Tool kit
- **Other navigation tools**
  - Ship's compass
  - GPS
  - Hand bearing compass
  - Other electronics

CHAPTER 5: PLANNING WITH GPS AND PAPER CHARTS
Slide 3: The **Chapter 5 lesson objectives** include:
- Criteria for a safe course
- Steps in pre-voyage planning

- Plotting on a chart
- Entering waypoints into your GPS

Slide 4: ***Stress the importance of using up to date charts!*** Things do change and it is important to have the latest information available for the waters on which you boat.

Slide 5: The criteria for a safe course include:
- Determining safe depths which include characteristics of your boat and the seabed
- Soundings will give you a measure of the bottom depth at a particular location
- Contour lines can be drawn for constant depths just like contour lines on a topographic map

Slide 6: Because of the phenomenon of tides, all soundings are referenced to a **standard datum** or **mean lower low water (MLLW)**. Each sounding represents the shallowest water for that particular location. This is extremely important when navigating in tidal areas and where there are major differences between high and low tides

Slide 7: **Draft** is the measure of how far a boat's **keel** or **drive unit** extends below the waterline.

Slide 8: Considerations for determining adequate safety and to avoid **running aground** include:
- Type of seabed
- Likely sea conditions
- Characteristics of your boat

Examples of different types of **seabeds** and potential dangers associated with each should be mentioned.

Slide 9: In addition to water depth, **isolated hazards** can be a problem and may be natural and/or man made. Hazards include outlying rocks, wrecks, and old pilings. Any or all of these can pose serious danger to you and your boat if they are struck. **Helpful Suggestion:** A very brief "sea story" might be appropriate here to drive the point home.

Slide 10: **Shoals** are the tops of underwater hills that may lie along a line. Some run parallel to main channels

Slide 11: On the surface, you need to pay attention to **horizontal clearance** or adequate room to steer around obstacles. Make sure your intended path is ten (10) times wider than your GPS error to either side (i.e. error of 50 feet for most units).

Slide 12: **Overhead clearance** is the vertical clearance between the water level and an overhead object including bridges and cables. Make sure to include antennas, radar, and outrigger poles, in your vertical clearance calculations!

Slide 13: Overhead clearances will be printed on charts as referenced to **mean high water (MHW)** or **mean higher high water (MHHW)**.

Slides 14-16: Listed below are the seven (7) steps involved in **pre-voyage planning**:

- Step 1: Locate home port and port visits
- Step 2: Locate hazards
- Step 3: Plot straight paths to points of interest
- Step 4: Invent short names for connecting waypoints
- Step 5: Note landmarks
- Step 6: Measure coordinates (LAT/LONG) of each waypoint
- Step 7: Complete waypoint table and enter into GPS

Slide 17: To create your route, you will need to select **waypoints** in a definite sequence to create your desired course/route

Slide 18: When plotting on a chart, be sure to thoroughly annotate your paper chart with information stored in your GPS including the following:

- Course lines
- DR plots
- Range lines
- Bearing lines

Slide 19: To plot your course, draw **straight line segments** on your chart to avoid obstacles and measure the coordinates (LAT/LON) of the end points of each leg

Program your **endpoints** into your GPS as named waypoints. Your program route can be retrieved by calling up your waypoint in a desired sequence

Slide 20, 21: There is a standard protocol or system for labeling your course lines on a chart. Course lines should be labeled as follows:

- C = course followed by a three (3) digit direction
- M = magnetic
- ***Example:*** A course of 3º should be labeled on the chart as "C 003 M"
- The label is placed near the waypoint and above the course line

Slide 22, 23: For **labeling distances**, the distance of a leg starts with the letter "D" and then the distance. For example, "D 2.6". The distance label is placed under the course line and near the center of the leg.

Slide 24: ***Remember: Waypoint coordinates are just numbers until they are plotted on a chart!***

Slide 25: A **reciprocal** is the course your steer from the opposite direction. To determine a reciprocal, either add 180^{o} to a course less than (<) 180^{o} or subtract 180^{o}

from a course greater (>)180^{o}. The reciprocal course heading is labeled at the other end of each line.

Slides 26-27: Have the students practice this concept using the examples shown in these slides. Encourage them to get so familiar that it is automatic.

Slides 28-29: Explain to the students what **the compass rose** is and have them find it on their chart. The outer ring aligns with the chart grid of LAT/LON and with true north (T). The inner ring aligns with magnetic north (M).

Slides 30-31: Variation is the east (E) or west (W) magnitude of difference in degrees and minutes between true (T) and magnetic (M) north. The variation as of a certain date is noted in the center of the compass rose, as is the annual change in variation. Have the students locate the variation change and read it out loud.

Slide 32*:* ***In general, it is easier to plot courses and bearings in degrees magnetic (M) instead of degrees true (T).*** Stress to the students it is important, however that they can do both.

Slide 33: Variation must be included in determining your compass course. Westerly (W) variation is added (+) to your true course and easterly (E) is subtracted (-) from your true course.

Slide 34: Here are some examples illustrating how to **add or subtract variation** to arrive at your magnetic course. Have the students practice a number of example problems until they are comfortable with the concept.

Slide 35: Another adjustment that must be included in our course calculations is **deviation.** Deviation is the compass error or the difference between your compass and magnetic north. Stress that compass deviation is unique to each boat, and why, while variation is consistent within a given area!

Slide 36: Here is a helpful guide to keeping it straight concerning variation (V) and deviation (D). A common approach is **T V Makes Dull Children (TVMDC)**.

Slide 37: When **converting from true (T) to magnetic (M),** you add westerly (W) variation (V) and subtract easterly (E) variation (V). When converting from magnetic (M) to true (T), you add (+) easterly (E) variation (V) and subtract (-) westerly (W) variation (V).

Slide 38: When **converting from magnetic (M) to compass (C)** you add (+) westerly (W) deviation (D) and subtract (-) easterly (E) deviation (D). When converting from compass (C) to magnetic (M), you add (+) easterly (E) deviation (V) and subtract (-) westerly (W) deviation (D).

Slide 39: ***True (T) and magnetic (M) are commonly used for plotting. Compass (C) courses used for steering the boat, but are not plotted on the chart.***

Slide 40: A **bearing** is a **line of position (LOP)** and represents a line on which your boat is located, extending from you to an object. The object is used as your reference point, not your boat.

Slide 41, 42: To plot a bearing line (or LOP), proceeds as follows:

- Align your parallel rules on a compass rose with that bearing
- Maintain the direction of your parallel rules as you move them to align with the object you sighted
- Draw the bearing line toward the object
- Determine the direction of the bearing
- Estimate the location of your boat relative to the object
- Label the bearing line using the 24-hour clock above the bearing line and the direction of the bearing (3 digits) below the line

Have students practice plotting bearing lines and proper labeling

Slide 43: A **range** is plotted as a straight dashed line between charted objects with the line extending to the navigation area. The **bearing of the range line** is placed on top of the line. Water towers, church spires, and day beacons may be used as ranges.

Slide 44: **In summary**, we have talked about what is required for a safe course, the necessary steps in pre-voyage planning, plotting this information on a chart, and entering the waypoints into your GPS unit.

At this point we are ready to revisit our **Sample Cruise from Chapter 2 on** pages 9-15 using Figures 1-10 A-E. The intent of this **Sample Cruise** is as follows:

- Provide the students with a hands on experience to reinforce concepts discussed earlier
- Give the students a break from the seated portion of the class
- Illustrate to the students the utility and importance of basic navigation
- Have fun and not feel threatened by all of the technical terms and jargon

Helpful Suggestion: Keep in mind, that when calculating distance, etc., some students' math skills may be deficient and may require assistance. Make sure everyone gets help and that they are successful. Setting the proper learning environment here will determine the rest of the course and how well they will learn. Let them fail, but gently point out where they made their mistake(s). Keep it light hearted and fun.

This concludes Part I of the Weekend Navigator. We hope you found it helpful. If you want to learn more about navigation, we encourage you to take Part II. Be safe and good boating!

Chapter 2
Answers to Review Questions

1. Avoid hazards from point A to point B
2. Pre-voyage planning, navigating underway, double checking
3. Pre plotted charts, plot your own courses, plot areas to avoid, choose a safe path, plot current positions and locate hazards
4. Don't rely on any one device for navigation
5. Put GPS up against your surroundings
6. Navigation with the aid of landmarks, land features, and charted navigation aids
7. Using local mariners for help when plotting a course
8. a) While you are planning
   b) Actual course over ground
   c) A way to approximate a boats current position
   d) The equal distance from one plot to another
   e) The process of measuring the direction to a charted landmark you can see from the boat
   f) Any pair of visible charted landmarks
   g) Any bearing taken with respect to your boat
9. Bearings are important because they help you guide yourself using landmarks and landmarks plotted on the charts
10. Each bearing taken represents a line of position
11. 277

Chapter 2
Answers to Exercise Questions

1. A

2. a) Pre-voyage planning or deciding which path to take
   b) Navigating underway of following by independent means
   c) Double checking or confirming by independent means that you are where you think you are

3. a) Pre-plotted charts and course segments
   b) Plot your own courses
   c) Plot areas that you want to avoid
   d) Choose a safe path
   e) Plot current positions and locate hazards

4. a) Follow your plan
   b) Regularly monitor your course and progress along your course
   c) Know where you are at all times

5. a) Use your seaman's eye to confirm your position

b) Use radar and other devices to confirm GPS readings
c) Don't rely on any one device for navigation

6. A & D

7. B

8. B

9. D

10. a) GPS
    b) dead reckoning

11. C

12. E
    B
    A
    D
    C
    G

13. C

Chapter 3
Answers to Review Questions

1. Way point navigation is the process of navigating along a series of straight-line segments called legs. The beginning and endpoints of each segment are defined by their coordinates, commonly their latitude and longitude. And these are called way points.
2. The advantage of pre plotted lines is that they are free of obstacles.
3. The corner is a way to turn in the ocean at even given point to avoid ice flows or glaciers.
4. An active leg is a segment that you are currently sailing. A route is a sequence of legs that go from a starting point to a destination.
5. A) Simple
   B) Powerful
6. Landmarks can be helpful in navigation because they can mark the opening to a channel and also mark the route that you take. Some common examples of landmarks are lighthouses, bridges, and rock formations.

Chapter 3
Answers to Exercise Questions

1. D

2. B
   A
   C

3. Double check your GPS waypoints with your chart

4. Mistakes can be made when entering or accessing GPS coordinates

5. a) Mark hazards
   b) Double check and verify

6. Landmarks are important because they can help check for human error and electronic malfunction.

Chapter 4
Answers to Review Questions

1. A nautical chart provides the mariner with information that is useful about features that are under the water and also on the surface.
2. The Mercator provides a better relationship over long distances and is the projection of choice for coastal and offshore navigation.
3. The Mercator chart has all latitude lines as parallel horizontal lines and all longitude lines as parallel vertical and straight. This is better because it creates 90 degree angles for better navigation.
4. The Mercator system distorts shapes and relative sizes of land masses and ocean basins near the poles.
5. A polyconic chart is used for the great lakes and some major rivers.
6. Maintains proportions better.
7. Using the chart over great distance would be very difficult.
8. Soundings are depth measurements on the chart and are measured in feet
9. Chart scale is a ratio. A chart with a scale of 40,000:1 means 1 inch on the chart equals 40,000 inches.
10. a) 1:20,000 scale- local waters, b) 1:10,000 scale- specific harbor, c) 1:80,000 scale- boating region.
11. Notices to Mariners and Local Notices to Mariners.
12. Latitude is expressed in degrees north or south of the Equator and its scale is printed on the left and right margins of the chart. Longitude is expressed in

degrees east or west of the Prime Meridian and its scale is found on the top and bottom of the chart.

13. A) the unique “address” of a latitude and longitude

B) An imaginary great circle on the earth's surface passing through the North and South geographic poles. All points on the same meridian have the same longitude. Note that a meridian ends at each pole and the great circle on the other side of the earth is a separate meridian.

C) The zero meridian (0°), used as a reference line from which longitude east and west is measured.

D) An imaginary line scribed on the Earth’s surface by a plane passing through the exact center of the Earth.

E) A course on a single bearing

F) Degree: A unit of latitude or longitude, equal to $^{1}/_{360}$ of a great circle; minute: unit of angular measurement equal to one sixtieth of a degree; second: an angle that is $1/60^{th}$ of a minute

14. * ,+ ,Rk ,Rks

15. Lateral marks – define sides and center of channels; safe water marks – indicate safe water or channel center; informational aids – may mark danger or note local rules; lighted beacons – fixed aids

16. Dividers- measure a distance between a latitude and longitude coordinates; Parallel Rules- tool used for plotting parallel lines; Protractor plotting tool- measuring the degrees and angles of your course

17. Ship’s Compass, Hand held bearing compass, GPS, Square protractor tool

18. GPS

Chapter 4
Answers to Exercise Questions

1. A
2. B
3. A
4. A and B
5. a) Depths
   b) Scales updates
   c) Coordinates
   d) Symbols
   e) Chart grid
   f) Horizontal datum
6. C
   B
   F
   A
   D
   E
7. C

8. B
9. B
10. C
11. D
12. Outlet store or commercial companies
13. a) Latitude scale- found on the left and right margins of the chart
    b) Longitude scale- found on the top and bottom margins
14. D
    G
    C
    I
    B
    A
    F
    H
    E
15. Lateral aids are used to indicate the sides and center of the channel.
16. Keep red buoys on your right when entering a harbor, navigating up river, or traversing the North American coast in a clockwise direction.

Note that “traveling back to a harbor” may mean open ocean travel which falls under the clock wise pattern for North America

17. Right
18. a) Danger
    b) No wake zones
    c) Restricted operations
    d) Exclusion area

19. a) light pattern
    b) light color
    c) light range
    d) light height
20. B
    D
    A
    C
21. Dividers are used to measure distances and latitude and longitude coordinates on a chart.
22. a) transfer a plotted bearing line across a chart to the compass rose for measurement
    b) Transfer a measures bearing from the printed compass rose across the chart for plotting
23. a) Drawing compass
    b) Calculator
    c) Notebook
    d) Fine tip pencils

24. a) Hand bearing compass- handheld magnetic compass with built in sight
b) GPS- finds your exact location
c) Fluxgate compass - senses the earth's magnetic field
d) Radar - fixes your position by bearings and ranges

Chapter 5
Answers to Review Questions

1. Planning, navigating underway, double checking
2. Determine safe depths, shoals, horizontal clearance, clearance overhead, and isolated hazards
3. Draft- how far its keel or drive unit extend below the waterline
Shoal- shallow areas that are the tops of underwater hills
Horizontal clearance- the safe distance that needs to be kept between you and obstacles around you
Mean High Water - the clearance between the water and the boat.
Mean higher high water - The clearance of the high water level and the bridge.
4. Locate home port, locate hazards, plot a sequence of straight lines, invent short names, note any landmarks, use your plotting tools, waypoint tables are complete
5. Use the route function within the GPS the select the waypoints in a desired sequence and this builds the route.
6. Course and range
7. DR and bearing
8. 3 degrees magnetic
9. Distance
10. Labeled on the other end of each line the opposite of the direction you are heading
11. 227, 90
12. Compass rose indicates the direction of travel and which direction is the magnetic north.
13. The amount in which it will change in one year
14. The difference in degrees and minutes
15. 72
16. 54
17. 217
18. 363
19. 102
20. Line drawn toward an object in the direction of the bearing
21. Straight dashes lines between charted objects with the line extending into the intended area

Chapter 5
Answers to Exercise Questions

1. A
2. a) Type of seabed
   b) Likely sea conditions
   c) Characteristics and vulnerabilities of your boat
3. C
   D
   A
   B
4. a) Locate home port and ports to visit
   b) Locate hazards
   c) Plot straight line paths to points of interest
   d) Invent short names for connecting waypoints
   e) Note any landmarks
   f) Measure coordinates of each waypoint
   g) Complete waypoint table and enter into GPS
5. D
6. C
7. C
8. D
9. B
10. C
    A
    E
    B
    D
11. 50°
12. 82°
13. 217°
14. 363°
15. 165°
16. 118°
17. 111°
18. 102°
19. +4°
20. 190°

INSTRUCTOR (IT) NOTES
For
WEEKEND NAVIGATOR PART II
U.S. Coast Guard Auxiliary Navigation Course

In *Weekend Navigator Part II* (Chapters 6-28), we will begin to learn how we use electronic devices to assist in navigation. Part II is considerably more technical and will require instructors who have a thorough understanding of the topic and who can explain the material in a way that everyone can understand. Be sure to have installed the sample charting software and be familiar with its use!

PART II: PREVOYAGE PLANNING
CHAPTER 6: PLANNING WITH DIGITAL CHARTS

Slide 1: I would recommend that instructors keep the technical jargon to a minimum and use terms and phrases that are easily understood. ***Remember, not everyone is a technology wizard!*** If jargon is used, make sure the students understand what you are talking about to avoid confusion. This will help facilitate the learning process and give the students the needed confidence to complete the course and feel successful.)

Slides 2-3: Chapter 6 starts out with planning using digital charts. In this chapter the focus will be on explaining the different types of digital charts, available software and how it is used in navigation, chartplotters, and their use, and PDAs.

Slide 4: Explain the difference between a vector chart and raster chart, but emphasize that while they make look different they come from same information

Slides 5-6: Briefly discuss types of software and their availability. Cover the various chart-planning software features to make sure everyone is familiar with the terminology and features that are available

Slide 7-10: Using the CD that comes with the book, demonstrate how to "navigate" the screen pointing some of the main features and how they are used

Slides 11-12: Discuss the concept of Quick Planning and how it can be useful in navigation. Make sure the students understand route plan, marks, editing, moving waypoints, and how to add or delete waypoints

Slides 13-15: Briefly discuss a chartplotter and its use. Details will follow in later chapters

Slides 16-18: Briefly discuss the utility and limitations of using PDA's for navigation. Details will follow in later chapters

Slides 19-32: This optional section discusses the principles of fuel management. Discuss the following:

- Fuel Reserves, the 1/3 Rule and larger reserves for longer trips
- How to develop a fuel consumption table
- How to calculate fuel consumption using Speed-Time-Distance
- The effects of current
- The "Howgozit" Chart

Slide 21: A Speed Curve Table calculates speed through the water at various engine speeds. Include a column for fuel consumption at each speed. The Speed of Advance is Speed Through Water plus or minus the current. Enter your fuel capacity during trip planning. When underway may enter remaining fuel for calculations of achievable distances.
Use 10% reserve when there are few variables and unknowns; 20% as they increase.

Slides 22-23: Using the Speed-Time-Distance example on this slide, demonstrate how to add fuel consumption at 2500 RMP to the table.

Slides 24-26: ***Demonstrate how to recalculate the range (distance you can travel with the amount of fuel) and endurance (hours you can travel with the amount of fuel) using a 20% reserve.***

*Slides 27-28****: Discuss the effects of a foul current and demonstrate how to recalculate the range and endurance with a 2 knot foul current.***

Slides 29-32: Discuss the "Howgozit" chart and how to construct and use one. This chart simplifies that calculation. It is the Remaining Fuel/Distance chart with fuel consumption slopes added in the upper right corner. The chart does not compensate for current. You must remember to adjust.

- Draw a line from your last reading to the fuel reserve amount you wish to have.
- Transfer that line up to the fuel consumption section until you match one of those slopes. (Parallel ruler?)
- Do not exceed this speed (fuel consumption) for the balance of the trip.

CHAPTER 7: PLANNING TO AVOID DANGER

Slides 3-6: Emphasize the importance of defining your area to avoid hazards. Review the different types of hazards (i.e. isolated hazards and hazardous regions). Get the students involved and ask some to share a "sea story" or two about hazards. Limit the time and then move on.
Slides 7-10: Define and explain how to identify bands of clear area, use of ranges (clearing lines), how to set up danger bearings and danger circles using information

obtained from a circle of position (COP). Remember, you may need to review what a bearing is and how they are taken. Students may have forgotten since Part I.

PART III: NAVIGATING UNDERWAY

CHAPTER 8: UNDERWAY WITH GPS AND PAPER CHARTS

Slides 3-4: In this chapter, we begin to integrate technology with paper charts. Review the steps in waypoint navigation using a handheld GPS unit if possible. If you have multiple units, have the class break up into small groups so everyone gets a chance to observe and possibly "do" the exercise. This is where patience and good teaching skills will be critical in bringing everyone along. You may have to repeat the steps several times so that everyone understands otherwise they will be lost and frustrated. ***We do not want that!***

Slides 5-12: In this section the emphasis is on "*Staying on Course*" and what to do if you wander off course. Subtopics include:

- Recovering from off course
- How to tell if I am where I am with a GPS?
- Plotting LAT and LON
- Plotting bearing and distance
- Using another waypoint for bearing and distance

In several cases, the book provides "***TIPS***". These are good short exercises to use to reinforce and drive home the main points. In some cases, you may need to review basic navigation (i.e. using LAT and LON, using a ruler or parallel rulers, compass rose, etc.) particularly if it has been a while since the students have had Part I. Have your students practice with their GPS units and a chart. Minimally, demonstrate the concepts yourself. Be sure to discuss the GPS data terms in red on page 101 in the book. Make sure everyone understands them and knows how they apply.

There is a short discussion about the effects of wind and currents. Wind will apply to virtually all situations, but currents and tides may not be an issue depending on where your students boat. It is still important to mention the subject to raise their awareness. Be sure to explain what is meant by a "hooked course", downwind, downcurrent, upwind, upcurrent, crabbing (not the seafood), steering angle, and cross-track error. We will go into more detail about the effect of tides and currents in a later chapter.

Slides 13-17: The remainder of this Chapter 8 provides an outline of how to navigate a route with GPS including selecting a route, following a route, entering a route at a midway point, navigating a region, marking objects, and keeping track of your position. Using Figures 8-28 through 8-32 in the book and by demonstrating with a GPS unit, walk your students through this section and help them develop their proficiency in using a GPS unit with a chart.

CHAPTER 9: UNDERWAY WITH DIGITAL CHARTS

Slide 3: Chapter 9 emphasizes the use of digital charts and chartplotters and GPS while underway. Discuss how digital charts function including their liabilities and benefits along with the best application of computers (enclosed helms) versus chartplotters (exposed helms).

Slides 4-9: In this section, the book discusses how to use a chartplotter while underway. On page 116, the book outlines the basic setup for using a chartplotter. Review the process, and if you have access to a chartplotter, let the students get some practice using it. Hands on training can be a very effective method of teaching. Emphasize that the ***accuracy of the chart is limited to the accuracy of the source chart and the danger of over zooming! Warn them about too much detail. Simpler is better!***

Slides 10-12: Explain that the elements can be harsh on computers along with the display on bright, sunny days. Cover the difference between navigation software and planning software including the variety of alarms (i.e. anchor, avoidance, off course, etc.) that are available. Figures 9-13 through 9-15 in the book should be reviewed and explained.

Slides 13-14: The remainder of Chapter 9 concludes with a brief treatise of PDAs, pocket PCs and the future of onboard computers. Point out their utility and pros and cons, and what new software is on the horizon. If you have examples to pass around, all the better.

<u>PART IV: DOUBLE-CHECKING YOUR NAVIGATION</u>

CHAPTER 10: DOUBLE – CHECKING USING INSTRUMENTS

Slides 3-5: In this short chapter, it is important to emphasize the need to double check your location and to make sure all of your instrumentation is working properly. The book provides several techniques for doing this including:

- Taking a bearing using your boat as a reference
- Taking a bearing using your ship's compass
- Comparing visual bearings with your GPS
- Periodically plotting your quick bearings on a chart
- Taking a more accurate bearing to establish a fix

You may need to review how to take a fix, the need for taking more than one bearing, and converting between true and magnetic.

CHAPTER 11: THE EYE OF THE MARINER

Slides 3-9: In this short, but important, chapter, the author discusses situational awareness and "course keeping". There are several practical and easy methods for determining your position including the use of you hands. Review what is a heading, range, direct, relative and collision bearings. You might consider placing pictures of

landmarks and/or "X's" on the wall of the classroom and have the students practice using their hands to determine their position. This will provide a fun break, but at the same time give them excellent hands on (no pun intended) training.

A review of the Rules of the Road on page 139-142 is in order here. This is extremely important particularly as it relates to collisions and collision bearings. Provide your students with several scenarios and have them work in small teams (3-4 people) to figure out what they would do in a given situation. Have a spokesperson from each group report their conclusions to the class and discuss. This is a great way for students to learn and develop their critical thinking skills.

PART V: RESPONDING TO CHANGING CONDITIONS

CHAPTER 12: WHAT TO DO IF THE GPS QUITS

Slides 3-4: Electronics are great when they work, but we all need to be prepared for situations when our electronics fail us. Stress the need to know where you are and to plot your position "the traditional way" using landmarks and ATONs. Prepare and conduct a drill with your students. All of sudden, announce that their GPS unit has "gone south". Have them explain what steps they would take to find their position, what other instruments could be used to figure out where they are, and how to obtain a fix.

Slides 5-7: Once they have determined their position, have them proceed on their desired course. At 10 minute intervals, have them determine their new position, estimate their ETA, and any hazards in the area. Continue this process until they have reached their destination. This will provide a more realistic scenario that will help them develop their skills and confidence in knowing they can still find their way even when GPS is not available.

CHAPTER 13: PLANNING AS YOU GO WITH GPS

Slides 3-5: In this very short chapter, you will need to briefly cover some basic concepts of using GPS as you move along your course. Briefly discuss how you find your location along an active leg using a:

- Bearing to a landmark
- Grid line
- Waypoint

Demonstrate how you enter intermediate waypoints into your GPS unit. Point out the potential for errors when entering coordinates and why bearings and distance might be a better approach.

CHAPTER 14: TIDES, WINDS, AND CURRENTS

Slides 3-20: This will probably be one of the most difficult topics you will teach in this course. Take it slow, explain terms and concepts thoroughly, and be patient. This can be a very abstract subject for some people and many will not see the relevance of tides and currents particularly if they are inland boaters.

Start with a basic discussion of what causes tides, tidal heights versus tidal currents, spring and neap tides, tidal patterns and ranges, and vertical datums. Have your students refer to the terms and definitions on page 156. Keep it simple and with minimal details.

You might point out sources for tide heights and tidal current information mentioned on pages 157 and 161.

Slides 21-32: Now we get into the meat of the topic. On pages 158-160 are tide tables and a chart. Step by step explain the various types of information (data) that are provided on a tide table and how to read the table. Again, in their small groups, have them "drill" each other until they feel confident and proficient at reading a tide table.
Now we are ready to move into adjusting for tides and tidal currents. Beginning on page 162, work through the example on page 162 (right column). Make sure the students fully understand before moving on otherwise they will be confused, frustrated, and fail to learn. Explain and demonstrate the Rule of Twelfth and its application. Use the example on pages 164-165.

On pages 166-169, we begin a discussion of predicting tidal currents and using the 50-90 rule. Again, be sure to explain the relevance and importance of this information and it application when boating. This will help reduce learning barriers, fear, and poor attitudes about the topic.

Make use of Figures 14-13A through 14-13C to explain the concept and use a boat model or illustration to help explain this topic. Discuss the 50-90 rule and use the example described on pages 167 and 168. Work several problems to make sure the students have it down.

Slides 33-41: The chapter concludes with wind, waves and other predictable effects. Everyone deals with wind, so this chapter should have a broader appeal to your audience. Point out a few "**TIPS**" they can use while on the water to observe the effects of wind. Discuss yaw, swell, wavelength, period of a wave, fetch, chop, variable currents, and seiches (Figure 14-17).

Explain the difference between ocean waves and waves on small and large lakes (i.e. Great Lakes) and why it is usually rougher on these water bodies. You might even consider showing a few short clips of the movie "***The Perfect Storm***" to help students visualize the difference especially if they have never been on the ocean. A few short, but poignant "sea stories" might be appropriate here as well, but be brief and do not ramble.

Take a few moments to discuss the effect of current on speed of advance and fuel consumption.

PART VI: OTHER ELECTRONICS
Chapter 15: NAVIGATING WITH RADAR

3-4: This will be another topic that will be rather abstract for most people. A brief description of radar and how it works might be in order here. Again, keep is simple, just a basic understanding is all that is needed.

Slides 5-13: On pages 174-178, the book discusses the basic aspects of a radar display including:

- Visual relationships
- Orientation
- Range rings and bearing marks
- EBL and VRM
- Trails
- Directional relationships and relative motion

Be sure to explain that images on a radar screen do not precisely correspond with the size and shape of the scanned objects. Have them practice looking at objects portrayed in Figure 15-4.

The "*you are here*" concept is good for illustrating radar orientation and is something that everyone can relate to. Have them study Figures 15-5 and 15-6 to illustrate this principle. Also point out what we mean by heading –up versus north-up.

On page 176, they discuss electronic bearing lines (EBLs) and variable range markers (VRMs). Avoid using abbreviations or acronyms, as these can be confusing and hard to understand. Make use of Figures 15-7 and 15-8 to illustrate these concepts.

Slides 14-15: Relative motion will be one of the hardest topics to teach and illustrate. Take your time and explain it thoroughly. Figure 15-9 on page 177 illustrates the concept. Work through the process step by step and reinforce it with a small group activity using several scenarios that they have to figure out on their own. They all may not understand, but the key here is to expose them to the concept. There will be other opportunities for study in advanced courses.

Slides 16-19: One of the most important uses of radar is for avoiding collisions. If they get nothing else out of this chapter, they have learned something. Stress this and it utility! Be sure to explain the following:

- Using EBL to help evaluate collision risk
- Rate of closure
- Predicting a miss
- Closest point of approach
- Time of closest approach

All of the above are important components in mitigating collision (Figures 15-11 and 15-12).

The effect of a boat turn or change of speed on the radar display will need to be discussed in the context of relative motion. Emphasize why this is important in avoiding collisions.

Slides 20-26: Finally, the topic of using radar in navigation is discussed on pages 180-184. Break it down for the students showing them how radar can help with detecting shorelines and land-based objects which can used to help determine your position and avoid running aground (Figures 15-15A-B).

Explain how you might use radar alone by plotting ranges and bearings to shorelines, buoys, and plotting by range alone. Review the exercise on calculating a magnetic bearing using a relative bearing and magnetic heading (bottom left column of page 183). A set of practice problems or exercises might be appropriate here.

Radar can also be used for avoidance such as tracking a shoreline to avoid running aground and using a radar danger circle to avoid hazards. Review the steps for determining the minimum approach radius and how to set your VRM.

Slides 27-28: A final use of radar is to monitor weather, particularly storm fronts and squall lines. Stress that radar is not a substitute for NOAA weather radio channel on their VHF radio. Radar is a secondary device, not a primary one.

CHAPTER 16: USING DEPTH IN NAVIGATION

Slides 3-4: You might want to briefly explain the basic components of a depth sounder and how it compares to sonar and fish finders. Emphasize why it is important to know the depth of water under the boat and the underwater topography in order to prevent grounding and/or doing serious damage to your boat or worse.

You might want to play a short clip of a navy movie to demonstrate how sonar works, just to break up the session.

Slides 5-7: Here we discuss the use of depth sounders in navigation. Explain how depth sounders can be integrated with GPS and charts, and radar. They are not a substitute for good navigation, but can be a reliable back up and a way to cross or double-check your electronics. Depth sounders are particularly useful when operating near shore or when entering and navigating small areas like harbors or mouths of rivers.

CHAPTER 17: USING A RADIO IN NAVIGATION

Slides 3-4: In this chapter we will cover the use of a radio in emergencies and for making routine calls. If they have had an ABC or BS&S course some of this may be review, but it never hurts to go over the basics. Make it clear how Channel 16 is to be used and why false emergency calls are a serious offense. Briefly discuss the Global Marine Distress and Safety System (GMDSS) and how that applies to the typical recreational boater. Have MMSI Registration sheets available and discuss how to register the radio.

Help them understand the difference between a Mayday, Pan-Pan, and Securite call and when they should be used. **Helpful suggestion**: have family radios available so they can practice proper radio use and etiquette.

Slides 5-6: Briefly discuss the importance of weather radio and its use. It might be helpful to students if you provide some insight on the pros and cons of a fixed versus a handheld VHF radio.

CHAPTER 18: USING AN ELECTRONIC COMPASS
Chapter 18 discusses the use of an electronic compass in navigation. As before and without going into too much detail, briefly describe the different types of compasses, their use, liabilities, and benefits. With any type of equipment, we want to make sure the student selects that right compass for their boat and to avoid overkill.

Make sure that they consider having a professional install and set the compass to insure its accuracy. This might be a good time to review the concept of deviation and how it affects navigation.

Make sure they remember that **the compass is still a heading reference that reflects the pointing angle of the bow not the movement of the boat over ground as reported by the GPS!**

CHAPTER 19: USING AN AUTOPILOT IN NAVIGATION
Most students will be familiar with the concept of an autopilot. In this chapter we simply want to discuss how it can be used on a boat for navigation and integrated with a GPS unit.

Review the basic components of an autopilot and by adjusting the range of settings how it can be helpful in narrow channels and "tight areas".

Briefly describe how the autopilot can be integrated with a GPS unit to help control the boat's actual track along a preset course toward your waypoint and the use of alarms.

PART VII: SPECIAL TECHNIQUES
CHAPTER 20: NAVIGATING WHILE TACKING INTO THE WIND
Optional Chapter
This chapter deals more with sailing, so it might be a good idea to get an experienced sailor to teach this section. Major points to emphasize here would be:

- Finding the best angle and trim
- Knowing when to tack
- When to make the final tack

CHAPTER 21: NAVIGATING HARBORS AND CHANNELS WITH ELECTRONICS

Slides 3-10: In this chapter we want to cover how GPS and radar can be helpful in navigating harbors and channels in both good visibility and limited visibility.

One of the main points of this chapter is that the boater should practice with their electronics in good visibility so they can visually see what is on the water and how it compares with their GPS, radar, and/or a depth sounder. If the channel or harbor is transited frequently, this is the time to plot their course and enter their waypoints and ATONs into their GPS for future use.

You should also point out GPS accuracy (45 feet, 90% of the time) and that the USCG feels an accuracy of 15 feet or less is needed for navigating channels. They should not totally rely on GPS when navigating a narrow channel or harbor. There is no substitute for visual observations, local knowledge, and the use of a chart.

Slides 11-12: The chapter concludes with how to integrate your GPS, radar, and depth sounder when navigating under limited visibility. Create a scenario and have your small groups practice using electronics to navigate in a fog bank, heavy rain, or darkness.

Emphasize that practicing with good visibility and knowing how your instruments work will pay off during stressful times with limited visibility. Again, a "sea story" might help drive home the point.

CHAPTER 22: NAVIGATING UNDER ADVERSE CONDITIONS

Slide 3: The chapter is divided into three parts including the use of a lookout and sound signals, navigating with electronics, and wind and sea.

Slides 4: In the section on a lookout and sound signals, stress the importance of always having a lookout besides the helmsman and more on larger boats. Boat speed should be appropriate for the sea condition and they must have a sound-producing device to sound every 2 minutes. Review the sound making rules when underway and when anchored.

Slides 5-7: The second section explains how a boater can integrate GPS, radar and the radio when operating under adverse conditions. Much of this has been discussed previously and should be familiar to the students. The key here is to illustrate how it can be used under these conditions.

Slide 8: The third section gives a short discussion on how to deal with rough seas and how to prepare the crew. Key points here include taking the waves at a 45-degree angle, if possible, avoid broaching, and slow down. ***As the old saying goes, haste makes waste.***

CHAPTER 23: A LAST WORD ON AVOIDING DANGER

Slides 3-4: Main points to emphasize here are the benefits and utility of using electronic alarms (i.e. avoidance, anchor watch, crosstrack error) when multi-tasking. You might

want to briefly discuss the user-defined polygon as the most practical way of defining a large hazard area.

Slides 5-6: Reviewing previous chapters, repeat the concept of using visual observations and radar to identify and to plot danger bearings and the how waypoints can be used to mark hazards.

CHAPTER 24: ADVANCED TOPICS IN RADAR

Much of what is presented in the chapter has already been covered in *Chapter 15: Navigating with radar*. Instructors may choose to cover such topics as:

- Radar range
- Installation and alignment
- Radar controls (i.e. gain, rain clutter, sea clutter, tuning EBL, VRM, range rings, trail, guard zone, zoom, and racons)

If possible, the use of a portable radar set could be very helpful in demonstrating the various components and adjustments associated with using a radar unit.

CHAPTER 25: OTHER INSTRUMENTATION

The chapter discusses basic weather instruments that can be helpful when navigating including:

- Wind sensors
- Weather instruments (i.e. barometer, anemometer, sling psychrometer)

Other major points to stress include:

- Wind direction and speed are key forecasters of weather
- Warm fronts generally precede cold fronts
- After a cold front passes, the winds shift to the northwest
- Southeast winds usually precede a warm front
- Water temperature can be important in identifying current patterns

CHAPTER 26: CONNECTING IT ALL TOGETHER

This chapter summarizes how you can integrate your GPS system with your radar, autopilot, and computer. Mention the NMEA 2000 system as an example. For high-speed connections for use with multiple navigation and helm stations, there is Raymarine's interconnection system and the Furuno or NavNet system. Unless the instructor is an expert with these systems, it might be a good idea to have an industry representative serve as a guest speaker to further explain all of the details of these systems. Just watch out for the heavy sales pitch!

CHAPTER 27: ELECTRONIC NAVIGATION TOOLS AND RULES – A SUMMARY

Chapter 27 is basically an equipment checklist and rules to follow. You might want to review them one more time to make sure there are not further questions.

CHAPTER 28: MEASURING COMPASS DEVIATION USING GPS
This repeats some of the material covered in Part I about deviation. A quick review might be helpful here on what is deviation and how to build a deviation table.

Explain how your GPS unit can be used to check your compass and build a deviation table. In order to do this, preparation before leaving the dock includes picking a suitable location, good conditions, preparing your GPS unit with coordinates and make sure you have a hand held bearing compass on your boat. Once you are cruising, explain how to monitor your GPS track and compass heading. **Remember, your GPS track should correspond with the plotted magnetic course direction.**

CONCLUSION
This concludes Weekend Navigator Part II. This course covers a lot of material. Stress to the students that practicing these skills as often as possible is the key to proficiency. Invite them to take any other courses the flotilla offers, and point out that membership in the Coast Guard Auxiliary offers many opportunities to continue their learning and training.

Chapter 6
Answers to Review Questions

1. Nautical charts look like traditional charts, great detail, small memory not cost effective
2. are available by region as raster images; are available on compact discs that are small and cost effective
3. Waypoint Mark - scroll across the screen and mark waypoints
   Route Development - builds a route by moving the cursor from point to point
   Edit Waypoints - clicking on any waypoint and moving it to another location
   Edit Routes - move waypoints on the computer and create new ones
   Measure distance and bearings- A to B feature measuring from point A to B
   Route Plan - view the elements of a planned route
   Chart Management - view various charts at a given location
4. Bearings, distance units, Lat/ Lon Format,
5. Cursor, chart list, charts at this location, scale, zoom, A to B, create route, create mark, annotate chart, chart display, locate
6. Flexibility
7. Route plan - legs of selected route
   Marks - list of your marks by name
   Editing - plotting routes using digital charts
   Moving waypoints - moving any marks on the screen
   Adding or Deleting waypoints - Placing cursor over route line
8. Superimposes GPS information directly on a displayed digital chart
9. More tedious - used to plan when on the move
10. Routes - new routes - selected named waypoints- map screen- then make your way points

11. A-E, discussion items. F: more engine speed means more fuel consumption

Chapter 6
Answers to Exercise Questions

1. A
2. Raster and vector
3. C
   D
   E
   A
   B
4. B
5. D
6. A)Route plan
   B) Edit routes
   C) Route development
7. D
8. B
9. A
10. Quick planning is quicker and easier than the liner approach because it modifies a route, which is actually easier than creating one.
11. A
12. D
13. a) at 10 knots, 84.4; at 25 knots, 127.2
    b) the slower speed as there is only 100 gallons aboard
    c) 15.6 gallons
    d) at 10 knots, 21.2 hours; at 25 knots, 8.48 hours
    f) at 10 kts, 26.5 hours and 106 gallons; at 25 knots 9.2 hours and 138 gallons.
14. Will vary by individual

Chapter 7
Answers to Review Questions

1. Define area
2. Isolated, hazardous, shoals
3. 1/10 of a nautical mile or 600 feet
4. Rock out cropping
5. Larger, shallow regions in the water, two types
6. Distance right or left of current position from active course line
7. Two chorded objects to define an edge
8. Use only one visible charted landmark - determine which is safe side

9. The distance you are from danger. COP is knowing your distance from a charted object. Allows you to stay outside the danger area.

Chapter 7
Answers to Exercise Questions

1. Define the area
2. A) Isolated hazards
   B) Hazardous regions
   C) Shoals
3. A, C, D
4. D
5. B
6. B
7. Determining if the bearing needs to be more or less in the danger bearings
8. Distance from a charted object
9. Will vary by individual
10. Will vary by individual

Chapter 8
Answers to Review Questions

1. A) Select the active waypoint
   B) Double check
   C) Steer in direction on the GPS
   D) Monitor progress
   E) Be alert
   F) Select to activate waypoint
2. Pre-planned areas
3. You must select the next waypoint upon reaching the current one; that may distract you from other duties
4. Shows satellite signal strength
5. Presents coordinates
6. 2-D Plan view
7. 3-D Plan view
8. Circular representation of a compass card
9. Steer to avoid visible obstacles, cross winds, cross current, inattention at the helm, yawing in waves
10. Satellite Screen - tells you what the receiver is doing when you first turn your GPS on

    Position Screen - presents your coordinates in lat and long

Map Screen - a 2-d plan view of the area
Highway screen - 3-D representation of the highway to then active waypoint
Compass screen - shows a circular representation of a compass card

11. Latitude and Longitude coordinates, bearing and distance to a waypoint
12. Hazards and making sure that you can find your way back on course
13. Wind or current
14. A curved path instead of the intended straight line to your waypoint
15. Down current is when your actual angle is pointing downwind. Up current is when your actual angle is pointing upwind
16. Over steering is when you are steering at a much higher angle then normally used; Steering angle is the slight angle that is used to keep the ship in the middle of the highway; Crabbing is the amount you have to go left or right to get back on course.
17. Cross Track Error is the distance you are off course; it is labeled XTE
18. The beginning point is the active from and the leg destination is the active to.
19. Routes should be preplanned and should be done in segments
20. The meaning of measure twice cut once is it is better to double check yourself instead of having trouble in the end.
21. Map Screen; you must be careful not to outrun yourself on the map
22. Hazards and points of interest
23. It is important to plot your GPS points on the chart because if your GPS fails you have a back up and it will invert your routes so dead reckoning is not needed
24. An hourly check is plenty if you are sailing in open waters.
25. Since you are navigating your course leg the difference is a current impact of 006 degrees. Since your speed through the water is less than your RPM table indicates, it is an unfavorable current of unknown direction and speed, but affecting you by 006 degrees and a negative 3 knots. The impact is an increase in fuel required of 3/18 or 17%. If the entire 50 miles is subject to the same current you will need 17% more for the entire distance.

Chapter 8
Answers to Exercise Questions

1. A) Select the active waypoint
   B) Double check
   C) Steer in direction on the GPS
   D) Monitor progress
   E) Be alert
2. E
   D
   B
   C
   A

3 A) Steer to avoid visible objects
   B) Cross winds
   C) Cross current

4. a) use lat and long coordinates
   b) Bearing distance to waypoint
5. C
6. Going upwind or up current stay along intended line
7. Small increments to stay in center of highway
8. Distance you are off course either port or starboard
9. a) Local buoys
   b) Lobster pots
   c) Uncharted hazards
10. B
11. Will vary by individual

Chapter 9
Answers to Review Questions

1. A chart plotter is a custom display and processing unit that presents live position information; a computer uses navigation software and is not live.
2. A chart plotter is a processing unit that displays live information and the uses are a chart screen, highway screen, Celestial and tide data
3. Chart plotters utilize Vector Charts
4. You can lose the progress on your destination and you could outrun the screen
5. Start the chart plotter at the dock, look at the setup menu, make sure you have up to date data in your system; Check under routes; Check intended path on the chart; make sure you have backup strategies, recheck the GPS, select your first waypoint
6. Planning and navigating
7. Map screen and the highway screen
8. Getting into position for a leg
9. While running a leg
10. The elements of a marine environment and display brightness
11. Convenient to handle and require limited battery power to operate; The display is the issue and also making sure that the elements don't get to the laptop
12. The software is more versatile and also has more waypoints and routes
13. Circles of a given radius like the ones on a radar screen
14. The ability to accept and plot GPS positions on the screen
15. Nautical chart
16. Vessel, waypoint, cursor, chart rose, steering, chart info, GPS info, controls
17. Does the same thing as a chart plotter or computer in a handheld model and can be hooked up to a GPS to make you points on the handheld
18. Not waterproof
19. Maptech i3 represents the next generation of charting technology. Its compact size and ability to stand up to the marine elements will change small boat navigation.

Chapter 9
Answers to Exercise Questions

1. A
2. D
3. A) Planning
   B) Navigating
4. A
5. a) local Channels
   b) Harbors
6. a) Marine Environment
   b) Display Brightness
7. Can accept and plot GPS positions on screen
8. Small Size
9. Will vary by individual
10. Will vary by individual; discussion item

Chapter 10
Answers to Review Questions

1. Bearings using the boat as a reference, bearings using the ships compass, quick comparisons with the GPS, comparing the GPS with a chart
2. Use hand bearing compass to sight a landmark and compare to the GPS bearing
3. Sight a bearing over the bow and compare to ship's compass

Chapter 10
Answers to Exercise Questions

1. A) Quick observations
   B) Quick comparison GPS
   C) Comparing with chart
2. A
3. C
4. a) 001M
   b) 230C
   c) 288C

Chapter 11
Answers to Review Questions

1. The techniques and skills that have been developed over time using awareness of what's around you
2. Headings are planned course lines
3. A path that is offset to one side or the other from an intended landmark; calculate or estimate the angle and steer the difference
4. Range is a plotted line through two visually prominent charted objects. It can be used to quickly check your GPS by reading off the range and comparing the results to the reading on your GPS
5. Bearings are lines plotted from your boat to charted objects
6. Direct bearings are taken with a compass and then plotted using the magnetic line toward the object; a relative bearing is taken by the naked eye using the bow of the boat as 000º
7. The path that you and another vessel might have in crossing paths; this is important because you do not want to be on a collision bearing because this could cause danger to you and to the other boat
8. Discussion
9. Overtaking a boat means to pass a boat in the highway
10. The boat that has the other on it's starboard side is the give way vessel
11. Can be used as quick angle measurements
12. a) 135M
    b) 215M
    c) 042M

Chapter 11
Answers to Exercise Questions

1. E
   C
   A
   F
   D
   B
2. D
3. A
4. B & C
5. a) Constant bearing, decreasing range; collision course
   b) Maintain course and speed but be prepared to alter course to avoid a collision
   c) Yes; always give way for a sailboat under sail
   d) No
   e) Alter course and speed to pass astern

Chapter 12
Answers to Review Questions

1. Stop and Regroup
2. Use a Backup GPS - find your bearings and use charted objects - Radar
3. Plan
4. Dead Reckoning
5. Will divide your estimated distance by the speed to get ETA on next waypoints
6. Taking bearings and chart visible objects as reference points

Chapter 12
Answers to Exercise Questions

1. C
2. Find present location
3. A) Use a back up
   B) Use landmarks
4. a) Radar
   b) Backward dead reckoning
   c) Depth - depth profiling
5. Course Speed, Elapsed Time, Estimate Travel Time
6. a) 002C
   b) Discussion
   c) 6 minutes

Chapter 13
Answers to Review Questions

1. Bearing to a landmark, using a grid line, and using a waypoint
2. By using intersecting grid lines you steer until those lines appear on the screen
3. Selecting a charted object that is seen on radar, you can get bearings from that object
4. Enter waypoints into GPS and follow the highway screen. Once a new starting point is determined, measure a bearing and distance on the chart from the spot to another waypoint

Chapter 13
Answers to Exercise Questions

1. A) Bearing to landmark
   B) Using a grid line

C) Using a waypoint
2. A) Plan legs around the obstacle
   B) Consider a different starting point
3. Via coordinates
4. Will vary by individual

Chapter 14
Answers to Review Questions

1. a) 11.2’
   b) Local Notice to Mariners
   c) Discuss how and why tide tables are subjective
2. a) one high and low tide daily; two high and two low tides daily, of similar low and high; two high and two low tides daily, of significantly different heights
   b) larger than normal tidal ranges; smaller than normal tidal ranges
   c) The moon’s gravitational pull
   d) difference between a high tide and following or preceding low tide
   e) low tide that registers as a negative value (tide is below tidal datum)
   f) Average of the two lower low waters each day; used as vertical datum for soundings
   g) incoming current
   h) interval of zero flow between flood and ebb
   i) the direction of the current
   j) stations for which daily tide and current predictions are available
   k) stations for which tide and current predictions are referenced to a nearby reference station by a time difference and a ratio
   l) the distance between wave crests
   m) how long it takes two consecutive crests to pass a stationary point
3. Discussion items
4. Discussion; 45 degrees
5. Yaw is the bow of the boat being pushed away by oncoming waves; by crossing waves at an angle
6. Discussion
7. Discussion

Chapter 14
Answers to Exercise Questions

1. A
2. F
   K
   M
   D

C
L
J
B
A
H
E
I

3. A
4. D
   A) Electronic
   B) Print and online
   C) Tide Current arrows and nautical charts
6. A
7. B
8. C
9. B
10. A & D
11. C
12. E
    D
    F
    G
  B
    H
    A
    C
13. Ride gently over the swells
14. 3+24= 27. 27x7 = 189 feet. Be aware of the 7’ tide range and how it will affect scope
15. At 0600, 5.0’. At 1400, 2.0’
16. 50% 0737, 90% 0844, 100% 0951; 90% 1052, 50% 1153, Slack 1254

Chapter 15
Answers to Review Questions

1. See only as far as the horizon
2. Height
3. granularity is the pixilation of a picture
4. as black squares or swishes
5. “You are Here”
6. heading up - means the top of the display is where you are heading
   North-up – means that the top of the screen is north
7. Quick visual reference to the range of an echo

8. EBL- a radial line set on any relative direction on the display
   VRM - circle of constant range
9. 24 sweeps per minute - shows where an object was and where it is now
10. Collision avoidance
11. Targets heading in your direction are threats
12. The radar will adjust accordingly
13. It will be updated on the next sweep
14. Can show shorelines and other obstacles
15. You can place waypoints and coordinates on your radar
16. When using waypoints on your radar they look like lollipop's
17. Yes, by using electronic bearing line (EBL) through the image the set VRM to get distance and direction
18. Tracking a shoreline - Radar danger circle
19. Radar can be set on its largest range to detect sever weather and squalls. Rain is usually associated with cold fronts, so keeping a track of rain is key
20. ELB; range rings for rate of closure
21. Discuss these three ways to determine the other boat's true motion
22. Discuss the Navigation Rules and using all available means to avoid collision

Chapter 15
Answers to Exercise Questions

1. D
2. A
3. C
4. A
5. G
   D
   F
   A
   B
   E
   C
6. B
7. Collision Avoidance
8. A & B & E
9. A) Reflectivity to the signals
   B) Aspect angle to the radar
10. A) Plotting by range bearing, shoreline
    B) Plotting by range bearing and buoys
11. Severe squalls
12. This appears to be a collision course. Proceed with caution
13. You could be anywhere along the circle of position; no other blips indicate no buoys in the area; no fix is plotted. Adding a bearing would be a good idea.

Chapter 16
Answers to Review Questions

1. Underwater equivalent of radar
2. Control unit because it gives you the depth
3. Hull mounting, transom mounting, and inside the hull
4. Depth with radar - can help refine your position and estimate it on the radar
   Intentional miss - aim a good distance away from objects
   Dead reckoning with depth - Using your knowledge combined with the depth sounder
5. If not sure of your position, steer off to the right or left until you can follow a contour line

Chapter 16
Answers to Exercise Questions

1. C
   A
   A
   D
   B
   A
2. C
3. A) Inside the hull
   B) on a Transom
4. A) Depth
   B) Depth – Radar
5. Intentional miss to the right or left, follow the contour line to the mouth of the harbor

Chapter 17
Answers to Review Questions

1. VHF-FM
2. Safety
3. 16
4. 9
5. Global Marine Distress Safety System
6. Digital Selective Calling- Sends a digital signal instead of Verbal
7. VHF Radio
8. a) Listen - identify boat – Listen

b) Generally switch to the channel you wish to use and listen for availability. Press the DCS calling button. A display of vessels who's MMSI numbers you have entered appear. Scan and select. Press DCS calling button again; the radio switches to CH 70 and sends a signal for the selected boat only. The party must be scanning CH 70. The radios connect with each other and emit a tone to notify you to begin transmission

9. Repeat MAYDAY three times, your boat name three times, MAYDAY once, your boat name once
10. MAY DAY- Immediate risk to human life
    PAN-PAN - Potential emergency
    SECURITE - Announce a navigational risk
11. Very, because it keeps you safe
12. Handhelds are weak; handhelds are portable; handhelds have short range; fixed are powerful, have a large range, large

Chapter 17
Answers to Exercise Questions

1. D
   F
   C
   E
   A
   B
   H
   G
2. VHF-FM
3. 78A
4. a) Listen
   b) Identify the boat and message
   c) Listen
5. a) 68
   b) 69
   c) 71
   d) 72
6. Hourly - Provide weather reports
7. a) Handheld maximum 5 watts; fixed 25 watts
   b) Hand held only goes for a few miles due to line of sight and short antenna
8. Register your DCS radio with BoatUS or another authorized organization
9. Generally switch to the channel you wish to use and listen for availability. Press the DCS calling button. A display of vessels whose MMSI numbers you have entered appear. Scan and select. Press DCS calling button again; the radio switches to CH 70 and sends a signal for the selected boat only. The party must be scanning CH 70. The radios connect with each other and emit a tone to notify you to begin transmission

Chapter 18
Answers to Review Questions

1. More accurate
2. Fluxgate compass
3. Uses coils of wire to sense the magnetic field
4. Improved accuracy, has to be horizontal to be accurate
5. Compass that doesn't use the earths fields – commercial use
6. No, uses three different GPS antennas and uses them all to find a heading
7. Calibrate it and select a dampening level
8. Check the compartment with the remote sensor to see if a foreign object was placed there

Chapter 18
Answers to Exercise Questions

1. A
   C
   C
   C
   A
   B
   B
   C
   A
2. Calibrate it

Chapter 19
Answers to Review Questions

1. Steers the boat on a course set by the helmsman
2. Good for long voyages- Don't have to be at the helm all the time
3. Yes
4. External heading reference
5. Dodge control allows for a heading change then automatically returns to course
6. Control unit - heading sensor - rudder sensor - drive system - rate gyro
7. Using autopilot with GPS helps you because you don't have to change heading. When using autopilot GPS will automatically do it when changing a to another waypoint

Chapter 19
Answers to Exercise Questions

1. Steers the boat on a course set by the helmsman
2. external heading reference
3. a heading deviation that will go back on course
4. a) GPS
   b) Wind Value
5. D
   B
   E
   A
   C

Chapter 20 intentionally omitted

Chapter 21
Answers to Review Questions

1. Running aground, Rocks, Docks, Pylons, Boats
2. No, because it may not be accurate enough
3. Go slow and mark each buoy on either side of the boat
4. 45 feet
5. 15 feet of better
6. Wide Area Augmentation System; high
7. plots where you have been as you go and stores them
8. to make sure you are safe; you can never be too careful
9. Channel is the path of a river or other closed water area that has been dredged
10. This means that you should be aware of the bottom of the area in which you are boating by using depth sounders and other objects
11. Night, fog, heavy precipitation
12. Because then you can get a feel for how they work, and during times of limited visibility you can be confident in your instruments
13. GPS – Radar – Depth sounder
14. Use your GPS to define your position, use the chart to determine what ought to be there, and compare to the data on the screen

Chapter 21
Answers to Exercise Questions

1. D
   E
   H

C
A
B
F
G

2. a) can lose your direction easy
   b) helps avoid the close hazards
3. a) GPS
   b) Radar
   c) Depth Sounder

Chapter 22
Answers to Review Questions

1. Operating blind and collision
2. Post a lookout
3. To a rate at which you can stop in half the visibility
4. 2 minutes and a horn
5. One prolonged blast every 2 minutes
6. Two prolonged blasts every two minutes
7. Radar
8. 1/4 of a mile
9. 1/10 of a mile
10. Look out for boats; navigation
11. 16
12. wind and sea conditions
13. 45
14. Broaching
15. Get life jackets on - close hatches - and post a lookout

Chapter 22
Answers to Exercise Questions

1. Harbors and channels
2. Boat is underway
3. C
4. A
5. C
6. a) Radar
   b) Radio
   c) GPS
7. close range 1/4 a mile and 1/10 of a mile
8. an unknown spot on the radar
9. 45 degrees
10. turning over

11. a) life jackets
    b) close hatches
    c) post lookout
12. Sound your one prolonged, two short signals again; Hail unknown vessel on channels 13 or 16, giving your location and intentions
13. C

Chapter 23
Answers to Review Questions

1. Avoid danger
2. Intimate knowledge of the surrounding water, electronic alarms, and visual bearings
3. Electronic alarms are helpful because they help when looking for many possible dangers. They should be used when in areas with a lot of danger
   Avoidance or proximity waypoints - when you go within a certain radius an alarm sounds
   Anchor watch - If you leave the area of the radius an alarm sounds
   Cross track error - creating an area that is safe, and if you go outside this area an alarm sounds
4. Polygon
5. a danger bearing is a bearing from a landmark to the hazardous area -
   NMT – Not More Than the prescribed bearing
   NLT – Not Less Than the prescribed bearing
6. They can mark the perimeter of the waypoints and also the area around a waypoint
7. It is a frame of reference to monitor hazardous areas

Chapter 23
Answers to Exercise Questions

1. Avoid Danger
2. a) intimate knowledge of the surrounding water
   b) electronic alarms
   c) visual bearings
3. D
   A
   E
   B
   C
4. a) Placing cardinal waypoints around the danger
   b) also making an artificial line of buoys to mark the danger
5. a) turn to port
   b) Turn to starboard

6. Discussion item
7. Discussion or classroom exercise

Chapter 24
Answers to Review Questions

1. Narrow
2. Narrow
3. D
   A
   C
   A
   D
   A,C
   B

4. Scanner and display/processor
5. Gain, rain clutter, sea clutter, tuning EBL, VRM, cursor, offset, range rings, ship's heading, trail, hold, guard zone, zoom, and racons. Discuss the feature and use of each.

Chapter 24
Answers to Exercise Questions

1. As high as possible, usable radar range is a function of antenna height; away from other antennas

2. Select a near and far range, and two bearings. This creates a curved box, generally set ahead of your bow. When a target enters the guard zone an alarm will sound. Generally used in a sector that represents a high potential for collision

3. 3.4 nautical miles

4. a) 7.7 NM
   b) 13.3 NM
   c) 11.1 NM

Chapter 25
Answers to Review Questions

1. A secondary display that can be placed on the cockpit

2. Barometer - atmospheric pressure
   Psychrometer - dew point local temp
3. In open waters

Chapter 25
Answers to Exercise Questions

1. D
2. Measures wind speed
3. C
4. B
5. a) wind directions
   b)sea
6. barometer- measuring the atmospheric pressure
   psychrometer - local temperatures and dew point

Chapter 26
Answers to Review Questions

1. NMEA
2. NMEA allows you to use the latest software and connect with others
3. To run the sophisticated chart plotters and other high tech devices that the skippers have
4. Chart plotters, radar scans, sounder depth profiles
5. Raymarine and Furuno
6. Connect all the systems together

Chapter 26
Answers to Exercise Questions

1. NMEA stands for National Marine Electronics Association; it is designed to interface with others as a protocol.
2. The current standard for the system
3. A
4. a) Furuno - NavNet
   b) Raymarine - High speed bus 2

Chapter 27
Answers to Review Questions

1. Magnetic compass- hand bearing compass – GPS - VHF Radio - Depth sounder - Spare GPS-Chart plotter – Radar – Autopilot - Electronic Compass - Wind Instruments. Discuss the importance of each
2. Always carry paper charts for your boating waters - Annotate those charts with waypoint names that you use in your GPS-Chartplotter and label legs onto your charts for ready reference on the water - Use waypoint names that have regional meanings - Check your electronics before you leave the harbor - Check the weather forecasts before you leave - Store your waypoints in your spare GPS - Carry extra batteries and/or alternate 12 volt power source - Carry tide tables, cruising guides and local facility information - Carry instruction manuals and supporting materials - Bring aboard a support kit

Chapter 28
Answers to Review Questions

1. Best you can afford, the biggest you can fit in your boat
2. Deviation is caused by natural occurrences such as wind and waves
3. Compensation is when a professional compass adjuster fine tunes your compass
4. 2-3 degrees
5. Build a deviation table and also steer courses by landmarks
6. Use a GPS, Execution
7. The margin of error and that GPS and compass measure different things
8. Hand bearing compass
9. Location – Conditions – Preparation - and storing coordinates
10. It can help you get back on track when you are in a cross current or cross wind
11. You can measure your deviation by checking your cross track error

Chapter 28
Answers to Exercise Questions

1. B
2. Gyrocompass
3. a) build a deviation table
   b) steer courses based on visual landmarks

4. a) Location
   b) Conditions
   c) Preparation
   d) Your hand bearing compass
5. a) landmarks stored in your GPS
   b) GPS bearings
6. should follow the track
7. Deviation is 2 degrees W and you are crabbing due to current