
Naval Science 2

**Maritime History, Leadership, and
Nautical Sciences for the NJROTC Student**

Instructor's Answer Guide

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Maritime History

Answer Guide

Chapter 1

Sea Power and Early Western Civilization

1. ***What is meant by a nation's sea power?***

Sea power is the ability to use the sea to meet a nation's needs. It means being able to defend a nation's own sea-lanes and the ability to deny an enemy the use of the sea in time of war.

2. ***A. How did navies start?***

Navies were started because early trading vessels were clumsy craft, easy prey for robbers in smaller, swifter craft. So merchants began to crew vessels with hired seagoing soldiers.

B. What was their purpose?

Their purpose was to protect their ships and to patrol the seaways.

3. ***What was the major type of warship used in ancient times?***

Ancient navies used special ships called galleys, which could be propelled by oars as well as sails.

4. ***Why did ancient Crete develop into the first sea power in the Mediterranean?***

Ancient Crete was a large, rocky island south of Greece. It was too rugged for farming, and it sits right on the major sea routes of the eastern Mediterranean.

5. ***How did the Phoenicians contribute to Western culture?***

The Phoenicians started colonies and trading stations, which grew into new centers of civilization. The Phoenician alphabet became the written language of traders, and they were the first to use money as a means to facilitate trade. Later, the Phoenician alphabet became the basis for our own alphabet.

6. ***Which great Middle Eastern empire was the main enemy of ancient Greece?***

By 492 B.C. Greek expansion had run into the mighty forces of Persia.

7. ***What was King Xerxes' invasion plan against Greece?***

Xerxes built a navy of 1,300 galleys. This fleet followed his 180,000-man army westward around the coast of the Aegean Sea until they came to the island of Salamis near Athens.

8. ***What was the Greek plan of battle at the Battle of Salamis?***

In the narrow strait at Salamis, the Persians lost the advantage of numbers, since only the lead ships had contact with the Greek fleet, which was better armed.

9. **A. *Who followed the Greeks as the leader in Western culture?***

The Romans became the leaders of Western culture after the Greeks. They absorbed the Greek culture, helping to continue the advance of Western civilization.

B. *Which country was their principal enemy during their rise to power?*

Carthage was the principal rival of Rome during its rise to power.

C. *What were the wars between these countries called?*

The wars between Rome and Carthage were called the Punic Wars.

10. ***What two sea battles won the Mediterranean for Rome after Caesar's death?***

In the first century B.C. a rebellion led by Mark Antony and Queen Cleopatra was crushed in 31 B.C. at a great sea battle near Actium. In an earlier battle at Naulochus, Agrippa had defeated Pompey, Caesar's other rival to power, and secured the western Mediterranean.

11. ***What is the period of western European history from the fall of Rome until about the eleventh century often called?***

The period of western European history from the fall of Rome until about the eleventh century has been called the Dark Ages because of numerous invasions of barbaric tribes, incursions of North African Moors, religious bigotry, and a general lack of education among the masses of people.

12. **A. *Which of the Italian states became a great commercial and naval power during the Crusades?***

Venice became a great commercial and sea power during the time of the Crusades.

B. *How did it do this?*

Venice profited from both sides of the Crusades, hiring out ships to Crusaders and then giving the Arabs commercial favors.

C. *What organization of ports dominated the trade of northern Europe at the same time?*

The north German port cities formed the Hanseatic League, or Hanse, which dominated the northern and western European economy.

13. ***What happened in 1571 to end the threat of control of the Mediterranean by the Moors?***

In 1571 the advance of the Turks into western Europe was halted by the Christian fleet (mostly Venetian and Spanish) in the Battle of Lepanto.

14. ***What happened by the time of the Battle of Lepanto that caused the Mediterranean to decline as the center of world maritime interest?***

The Turkish hold on the Middle East had caused seafaring nations to seek new routes to Asia. The Age of Discovery had dawned.

15. ***Which country led the way to the Age of Discovery with early explorations around Africa?***

The Portuguese were the first to seek a new sea route to the East Indies and the rest of Asia. Prince Henry the Navigator hired explorers to try to find a route to the East by sailing around Africa.

16. ***What changes occurred in Spain as a result of the discovery of the Americas?***

Columbus's discovery of America put Spain into a position of European leadership. Through sea power Spain established a huge empire. Millions in gold, silver, and jewels poured into the royal treasury.

17. ***Which country rose to oppose Spain as the leading sea power in the sixteenth century?***

England rose to oppose Spain as the leading sea power in the sixteenth century.

18. ***For what purpose did the Spanish Armada sail in 1588?***

The purpose of the Spanish Armada was to stop the English raids on Spain's ships and ports and to bring England back into the Catholic Church.

19. ***A. Which country challenged English colonialism in North America first?***

The Dutch fought three naval wars with the English between 1655 and 1674.

- B. What was the outcome of those wars in America?***

The English were the winners, and one of their gains was the Dutch colony of New Amsterdam, which the English soon renamed New York.

20. ***What was the main result of the French and Indian War in America?***

England's ultimate victory gained it many new possessions, the main one in North America being Canada.

Chapter 2

The American Revolution, 1775–1783

1. ***As a result of the Seven Years' War, whose worldwide colonial possessions did Britain obtain?***

During this war, Britain captured French and Spanish colonial possessions around the world. Chief among these were Canada and Florida in North America and India in Asia.

2. ***A. Why did the British Parliament begin to lay burdensome taxes on the American colonies?***

While England and France were busy fighting each other in the Seven Years' War, the American colonies grew and prospered. When the war was over, British officials looked to the colonies as a way to raise money to help pay off the debts built up during the long war. They felt the colonies had benefited unfairly without a proper share of the taxes and restrictions that had been borne by Englishmen at home.

B. What happened in 1773 as a result of the Townshend Act?

The Townshend Act set duties on paper, lead, and tea, and led to the Boston Massacre of 1770 and the Boston Tea Party in 1773.

3. ***What did the British response to the Boston Tea Party lead to in April 1775?***

The British Parliament responded to the Boston Tea Party with the Coercive Acts, which closed the port of Boston, abolished the right of the people of Massachusetts to select their own council, and restricted other civil liberties.

4. ***What naval materials did the colonies supply to the British Navy?***

The British had been getting much of their shipbuilding materials, such as tar, pitch, turpentine, and timber for masts and hulls, from the colonies.

5. ***When was the Marine Corps established?***

On 10 November 1775 the Continental Congress established a Marine Corps of two battalions. The Marine Corps still celebrates this date as its birthday.

6. ***What were the problems of recruiting a crew in the early Continental Navy?***

As the war continued, recruiting men became difficult, due to a combination of stricter discipline, low pay, and the rewards that could be obtained by privateering.

7. ***How did the American invasion of Canada in 1775 turn out?***

In the fall of 1775 American Patriots under General Benedict Arnold attacked Quebec in Canada, but they could not capture the city. In the spring British reinforcements arrived by ship, forcing the Patriots to retreat toward the colonies.

8. ***A. Who was the American commander at the first Battle of Lake Champlain in 1776?***

General Benedict Arnold.

B. What was the important outcome of the battle?

The Patriots were able to stop the southerly British advance, and thus gain time to regroup and train their forces until the following spring.

9. ***A. What was the overall British plan to defeat the Americans in 1777?***

The British plan was to use the same three-pronged plan of attack that had failed the year before because of the delays caused by the naval operations on Lake Champlain. Burgoyne would move south from Montreal to the Hudson Valley. An army of Tories and Indians would advance eastward from Lake Ontario. The main army under Howe would march north from New York City. The three forces would meet in Albany, New York, after destroying all Patriot forces in their paths, thus splitting the colonies in half.

B. What happened?

Burgoyne moved south and recaptured Fort Ticonderoga in early July. The Tories and Indians were beaten by Patriot militia near Fort Stanwix. Howe decided to take Philadelphia en route to meeting Burgoyne at Albany.

C. Why was the Battle of Saratoga vital to the American cause?

Saratoga was the turning point of the war. It convinced the French that the Americans had a chance of winning the war, and brought them into the war on the American side.

D. What were the names of the opposing generals in this battle?

General Horatio Gates led the American forces, while General Burgoyne led the British.

10. ***Who was the great American diplomat who brought about the French alliance early in 1778?***

Benjamin Franklin brought about the alliance with the French in February 1778.

11. ***Who was the greatest American naval hero of the Revolutionary War?***

John Paul Jones.

12. ***A. Where did John Paul Jones have his famous battle with HMS Serapis?***

The battle with HMS *Serapis* was fought off the northeast coast of England.

B. What was the name of the ship commanded by Jones?

The *Bonhomme Richard*.

C. What was Jones's strategy in the fight?

Jones saw that his only hope was to lay the *Richard* alongside and take the *Serapis* by boarding.

13. **What was Jones's famous reply when the British captain asked if he was ready to strike his colors?**

Jones's reply was, "I have not yet begun to fight!"

14. **A. What crucial naval battle made victory at the Battle of Yorktown possible?**

Off the Virginia Capes on 5 September Admiral de Grasse of France had driven the British fleet back to New York.

B. Who were the American and French commanders at Yorktown?

The overall American commander at Yorktown was General George Washington. The commander of the French Army was General Rochambeau.

15. **A. After Yorktown, where did the British concentrate their war effort?**

After Yorktown the war then shifted to the West Indies, the Mediterranean, and India.

B. When did the war officially end?

The U.S. Congress declared the war over on 11 April 1783, but it was not until 3 September that the American and British representatives signed the Peace of Paris.

Chapter 3

The Growth of American Sea Power, 1783–1860

1. **What occurred in the United States in 1789 that enabled Congress to authorize construction of a navy?**

In 1789 the Articles of Confederation were replaced by the U.S. Constitution, which authorized Congress to “provide and maintain a navy.”

2. **What were the names of the first three U.S. frigates?**

The first three U.S. frigates were the *United States*, the *Constitution*, and the *Constellation*, all launched in 1797.

3. **When was the Navy Department established by Congress?**

Congress established the Navy Department on 30 April 1798.

4. **Who was the U.S. naval officer who fought the two most famous battles of the Quasi-War with France?**

In his ship the *Constellation*, Commodore Thomas Truxtun fought the two most famous battles of the Quasi-War.

5. **A. What was the outcome of the war?**

In October 1800 a peace treaty was signed between France and the United States. One of the provisions in the treaty was a very unpopular clause canceling U.S. claims against the French for attacking U.S. merchant ships.

- B. Why was John Adams defeated in the next election?**

Partly because of all the uproar the treaty caused, Thomas Jefferson was able to defeat John Adams in the presidential election of 1800.

6. **How did the term “Preble’s Boys” come into being?**

Preble was worried because his officers were all younger than thirty. He said, “They have given me nothing but a pack of boys!”

7. **A. What was the Philadelphia incident?**

The USS *Philadelphia* had run aground while blockading Tripoli and had been captured. Her crew of more than 300 were then held for ransom. On 16 February 1804 Lieutenant Stephen Decatur and a raiding party slipped into the harbor of Tripoli in a captured ketch renamed *Intrepid*. They set the *Philadelphia* afire so it could not be used by Tripoli.

B. Who was the hero of the exploit?

When news of the exploit reached the United States, Decatur was hailed as a hero and given a captain's commission.

8. A. How did William Eaton finally get the war against Tripoli to end in 1805?

William Eaton, a U.S. naval agent to the Barbary states, devised a scheme to topple the pasha from his Tripolitan throne and to restore his dethroned brother Hamet. He assembled a ragtag army that included a few U.S. marines, which captured the Tripolitan city of Derna. In return for stopping U.S. support for his brother and \$60,000 in ransom, the pasha agreed to a treaty that released the captive *Philadelphia* crewmen and stopped all tribute payments by the United States.

B. What phrase in the Marine Hymn refers to this operation?

The phrase "to the shores of Tripoli" in the Marine Hymn refers to this operation.

9. Why was American public opinion divided on the Tripolitan treaty?

Some Americans believed the ransom was reasonable and should be paid to free the captives; they also welcomed the end of tribute paying. Others thought that more attacks on Tripoli would have forced it and the other Barbary states to accept treaties that were more favorable.

10. What was President Jefferson's "gunboat diplomacy," and how did it affect U.S. national interests?

Between 1803 and 1805, the only vessels built for the U.S. Navy were small gunboats. President Jefferson did not favor building large seagoing ships because he believed the Navy should protect the U.S. coastline, not carry out attacks on the high seas. Other nations immediately saw this "gunboat diplomacy" as a weakness. The dey of Algiers began capturing U.S. ships again, and the British began impressing U.S. seamen.

11. What are the lessons of the war with Tripoli concerning naval power?

The lessons of the war with Tripoli are that giving in to demands for tribute and ransom usually only leads to more demands. Second, a weak navy invites aggressive actions by enemies.

12. What caused American sentiment to turn against the British in the years leading up to the War of 1812?

American sentiment turned against the British because of increasing incidents of impressment of seamen off American ships.

13. What was the Chesapeake affair?

In 1807 the U.S. frigate *Chesapeake* was set upon by the HMS *Leopard* off Cape Henry, Virginia. The *Chesapeake* was fired upon and forced to surrender, after which the British took four of her seamen. One was soon hanged as a British deserter.

14. ***What was the U.S. naval strategy for the War of 1812?***

The U.S. naval strategy for the War of 1812 was to try to protect the nation's sea trade while harassing the British Navy and sea commerce with small squadrons and individual commerce raiders.

15. **A. *What naval battle fought in August 1812 helped sagging U.S. spirits?***

The USS *Constitution* defeated HMS *Guerrrière* in a battle off the coast of Nova Scotia.

B. *Who was the U.S. naval officer involved?*

The *Constitution* was commanded by Captain Isaac Hull.

C. *What famous nickname was the USS Constitution given because of this battle?*

The *Constitution* earned the nickname "Old Ironsides" in this battle because the British shots bounced harmlessly off the heavy oaken hull of the ship.

16. ***What famous battle cry was uttered by Captain James Lawrence in the battle between the USS Chesapeake and HMS Shannon?***

Lawrence's famous words were "Don't give up the ship!"

17. ***What was the result of the British blockade of U.S. ports during the War of 1812?***

After 1813, once American warships returned to port from their victories at sea, none could get to sea again for the duration of the war. By 1814 U.S. exports had fallen in value to only about one-tenth of what they were in 1811.

18. ***What was the result of the Battle of Lake Erie?***

As a result of the battle, Lake Erie was thereafter firmly under American control. Subsequently, U.S. forces defeated the retreating British and Indians at the Battle of the Thames, during which Tecumseh was killed, ending support for the British. Detroit was thus recaptured, securing the Northwest Territory for the United States.

19. ***What famous song was written during the British attack of Baltimore in 1814? Who wrote it?***

Francis Scott Key wrote "The Star-Spangled Banner" during the British bombardment of Fort McHenry.

20. ***What was the significance of the Battle of Lake Champlain in 1814?***

The victory had a profound effect on peace negotiations, which had been ongoing in Ghent for some time. It convinced the British that the cost of any new offensive would outweigh any probable gains, and that peace should be made at once, without demands for territory.

21. ***When and where was the peace treaty ending the war signed?***

The Treaty of Ghent ending the War of 1812 was signed in Belgium on Christmas Eve 1814.

22. ***A. Why was the Battle of New Orleans fought after the peace treaty was signed?***

The Battle of New Orleans was fought after the war was over because news of the signing of the peace treaty did not arrive in time to stop the British operations.

B. Who was the U.S. general who won the battle?

Andrew Jackson was the U.S. general.

23. ***What benefit did the U.S. gain from the War of 1812 around the world?***

The U.S. Navy had won new respect throughout the world. U.S. diplomats were again treated with respect. The victories of the Navy united the nation and started a great naval tradition. The United States stood as an equal among the powers of the world, respected as never before.

24. ***What task was of prime importance to the U.S. Navy following the War of 1812?***

The chief task of the U.S. Navy between 1815 and 1860 was promoting and protecting U.S. overseas commerce.

25. ***What caused the U.S. whaling industry to decline in the years before 1860?***

By 1860 a series of important developments ended the era of American whaling. Oil was discovered in Pennsylvania in 1859. Later, lighting by natural gas dealt the final blow to whalers. The flexible whalebone used for hoopskirts, corset stays, buggy whips, and umbrella ribs was replaced by other materials.

26. ***What was the infamous triangular trade carried on in the Atlantic from pre-colonial times to 1860? Describe the route and the cargoes carried.***

The triangular trade involved the shipping of rum to Africa, slaves to the West Indies, and molasses to New England distilleries. The equatorial run across the Atlantic Ocean from Africa was called the Middle Passage.

27. ***What action caused the United States to declare war on Mexico in 1846?***

In 1845 Texas was admitted to the Union and U.S. troops under General Zachary Taylor moved to garrison the Rio Grande boundary. In April 1846 a Mexican force crossed the river and attacked elements of Taylor's command. Taylor responded by invading Mexico and capturing the border town of Matamoros. A few days later President Polk called on Congress to declare war on Mexico.

28. ***What was the "Manifest Destiny" in the United States in the mid-1800s?***

The Manifest Destiny of the United States was to extend its borders from coast to coast across the American continent.

29. ***What happened to cause the era of the clipper ships to end?***

Their rapid decline was caused partly by the completion of a railroad across the Isthmus of Panama in 1855. Over the much shorter distance, larger and slower ships could haul bulk cargoes and more passengers much more cheaply. Also steamships were beginning to overtake sail as the preferred means of sea transport.

30. ***What was the outcome of Perry's mission to Japan in 1853–54?***

The resulting Treaty of Kanagawa in 1854 opened Japan to trade with the United States, established an American consulate at Shimoda, and secured protection of shipwrecked American seamen. A trade agreement was signed two years later, opening Japan to commerce with foreign nations.

Chapter 4

The Civil War, 1861–1865

1. ***What were the two different economies that had developed in the North and South?***

The South had developed an agricultural economy dependent on slave labor for profit. The North on the other hand had developed an industrial economy based on water power and coal for energy.

2. ***What political development caused the Southern states to secede from the Union?***

When Abraham Lincoln, the Republican candidate from the North, was elected president, Southern states began seceding from the Union, based on the idea that the election results did not represent the will of the Southern people.

3. ***What was the significance of the Fort Sumter surrender?***

The attack on Fort Sumter at Charleston, South Carolina, started the open military hostilities of the Civil War.

4. ***In spite of the odds, why were many in the South persuaded that they would be able to establish the Confederacy as an independent nation?***

A prolonged war was not expected by either side. Many in the South thought the North would quickly tire of casualties and war expenses, and that Northern politics would be so unstable that the Union would never be able to fight as one unit. The border states of Maryland, Delaware, Kentucky, and Missouri were at least partially sympathetic to the Confederate cause, supporting both sides with troops.

5. ***What maritime miscalculations did Jefferson Davis make in the early days of the war?***

Davis thought that the North's naval blockade would so anger the British and French merchants and textile business that foreign privateers would be attached to the Southern cause. He also believed that the blockade would eventually force the British and French to at least recognize and assist the South, if not openly join it as allies.

6. ***How did the U.S. Navy set about accomplishing its blockade?***

Gideon Welles, Lincoln's secretary of the navy, began a shipbuilding program and bought and adapted many vessels of the merchant marine to naval service. Every kind of vessel was commissioned, equipped with one or two guns, and staked out along the Southern coast. Crews were recruited from every walk of life and put to sea without much training.

7. ***What was the Navy's amphibious strategy to support the Union blockade?***

To support the blockade a plan was developed to establish a series of bases at strong points along the Confederate coast. These would be captured by amphibious assault, garrisoned strongly, and then used to support the blockade.

8. **A. *What was the Trent affair?***

The British ship *Trent*, carrying Confederate ambassadors James Mason and John Slidell to England and France, was stopped on the high seas by the Union sloop *San Jacinto*. Mason and Slidell were removed by force.

B. *How was it settled?*

The matter was settled by diplomacy by having the prisoners released to British custody.

9. ***What were the military and diplomatic gains achieved by the Union victory at New Orleans?***

This capture of the South's largest city enabled the North to advance on Vicksburg both from the north and south, thus dividing the South. Diplomatically, the victory convinced the British and French that there was not much chance the Confederacy could survive. Thereafter, they no longer seriously considered recognizing the South.

10. ***What was the great significance of the battle between the USS Monitor and CSS Virginia?***

The battle between the USS *Monitor* and the CSS *Virginia* was the first battle between ironclad vessels. With it, a whole new set of naval tactics had to be developed by the world's navies.

11. ***What was the great significance of the Union victory at Vicksburg?***

The Union victory at Vicksburg cleared the Mississippi River of all Confederate forces from Illinois to the Gulf of Mexico, thus splitting the Confederacy.

12. ***What great battle was the turning point of the war in the East?***

The turning point of the Civil War in the East was the Battle of Gettysburg.

13. ***Why was the Confederate effort with privateers unsuccessful?***

The efforts of Southern privateers were hampered somewhat by the Declaration of Paris of 1856, which made privateering illegal. By mid-1862 most had been sunk or captured by Union naval forces.

14. **A. *What was the principal effect of the Confederate cruisers?***

The main effect of the raiders was to drive some Union shipping companies out of business, hasten the transfer of American ships to foreign registry, and continue the decline of the merchant marine begun by the privateers. They also weakened the blockade by keeping over 100 Union ships busy tracking them down.

B. Which cruiser was the most successful?

The CSS *Alabama* was the most famous and successful of the Confederate cruisers.

15. What was the result of commerce raiding by the cruiser CSS Shenandoah?

The CSS *Shenandoah* wreaked such havoc among Union whaling ships in the Aleutian Islands that she all but destroyed the American whaling industry.

16. A. What command decision did Admiral Farragut have to make at Mobile after the ironclad Tecumseh was sunk?

Admiral Farragut had to take a calculated risk to proceed into the Confederate minefield at Mobile Bay or be defeated.

B. What was Farragut's famous order?

His famous order was "Damn the torpedoes! Four Bells! Captain Drayton [of the *Hartford*], go ahead! Jouett [captain of the gunboat lashed alongside], full speed!"

17. How did Grant use Sherman's striking force to set up his master plan to end the war?

Sherman's "march to the sea" cut a devastating path 60 miles wide to the coast from Atlanta, confining Lee to the Petersburg-Richmond area.

18. What was the importance of Fort Fisher at Wilmington, North Carolina?

Fort Fisher was the key to Confederate defenses of Wilmington, North Carolina, the Confederate's last open port.

19. What were some of the major developments and inventions that came about during the Civil War?

Among many others, the following were some of the most important developments and inventions: oil from Pennsylvania, made into kerosene, took the place of whale oil for lamps; food canning was developed by Gilbert Van Camp in Indianapolis; mines became an effective weapon of war (they sank thirty-five Union ships, more than any other single cause); ironclad ships were proved effective; the idea of the submarine was born again; balloons were used as observation platforms, beginning the idea of aerial reconnaissance; cameras were used for the first time to record battles; railways and the telegraph proved indispensable to armies; medical care of the wounded received great attention; and the Navy's first hospital ship was used.

20. What were the geopolitical and strategic lessons of the Civil War in regard to sea power versus land power?

The Confederacy's attempts to sustain itself by interior lines of communications, as advocated by continental strategists, failed in the face of superior naval power around its periphery. Movement by sea forces proved to be faster than movement by land forces over the poor roads and railroads of the South.

Chapter 5

The Rise to World Power Status, 1865–1914

1. ***What happened to the U.S. Navy after the Civil War?***

The usual postwar demand for economy quickly reduced the U.S. Navy in size after the Civil War. Within five years the fleet had dwindled from nearly 700 ships to fewer than 200. Only 50 of these were in commission, and most were already obsolete compared to those in European navies.

2. ***What developments were taking place in foreign navies in the post-Civil War years?***

The post-Civil War years in foreign navies were a time of technological progress, much of it stimulated by studies of naval actions during the war. Developments included self-propelled torpedoes, improved armor plate, large rifled guns, and powerful engines. In 1873 the British launched the prototype of the modern battleship.

3. ***A. When and where was the U.S. Naval Institute started?***

The Naval Institute was established in 1873 on the grounds of the U.S. Naval Academy at Annapolis, Maryland.

B. What is its purpose?

Its purpose is to advance professional and scientific knowledge about the U.S. Navy, other world navies, and the maritime industry.

C. What journal does it publish?

It publishes the Naval Institute *Proceedings*, the foremost naval and maritime publication of its type in the world.

4. ***What were Alfred Thayer Mahan's principal arguments for sea power in 1890?***

In 1890 Mahan published *The Influence of Sea Power upon History, 1660–1783*, in which he argued that it was command of the sea that had enabled Britain to create its empire, reap the profits of maritime commerce, and defeat the land powers that tried to challenge it. He believed that a seafaring nation could, if led by an enlightened and dynamic government, use the sea to become a world power.

5. ***Why did pressure begin building for the United States to rebuild its Navy and merchant marine in the 1880s?***

In the early 1880s pressure began to mount for the United States to rebuild its Navy and merchant marine, partly in response to naval building programs overseas by such nations as England, Germany, and Japan, and partly to try to ensure a foreign market for U.S. manufactured goods.

6. ***What ships comprised the U.S. Fleet at the start of the Spanish-American War in 1898?***

At the start of the Spanish-American War, the United States had four first-class battleships, two second-class battleships, two armored cruisers, ten protected cruisers, and a number of gun-boats, old monitors, and torpedo boats.

7. ***What happened in Havana Harbor that finally set off the war between the United States and Spain?***

The destruction of the battleship USS *Maine* at Havana, Cuba, by an explosion finally set off the war. Most Americans blamed the Spanish for the explosion, though later studies have indicated that the probable cause was spontaneous combustion in a forward coal bunker.

8. ***How was the U.S. Atlantic Fleet divided in response to Spanish admiral Cervera's sailing toward the Caribbean?***

A so-called Flying Squadron with a battleship and three cruisers under Commodore Winfield Schley was detached from the Atlantic Fleet and based at Norfolk for protection of the Atlantic seaboard. The main part of the fleet, consisting of three battleships and three cruisers under Rear Admiral Sampson, was ordered to Key West, ready for offensive actions against Cuba and Puerto Rico.

9. ***What was Commodore Dewey ordered to do with the Asiatic Fleet at Hong Kong at the start of hostilities?***

At the start of hostilities Commodore Dewey at Hong Kong was ordered to proceed to the Philippine Islands and commence operations against the Spanish fleet at Manila.

10. ***A. Where did Commodore Dewey meet the Spanish fleet in battle?***

Commodore Dewey met the Spanish fleet in battle in Manila Bay off Cavite.

B. What was Dewey's famous order to start the battle?

Dewey's famous order to start the battle was "You may fire when you are ready, Gridley."

11. ***A. Where was the major battle fought in the Caribbean Sea area?***

The major naval battle between the United States and Spain in the Caribbean was the Battle of Santiago de Cuba.

B. Who were the opposing commanders?

The opposing commanders were Spanish admiral Cervera and U.S. Navy commodore Schley. Admiral Sampson was off at a meeting with Army general Shafter and did not make it back in time for the battle.

C. What was the outcome of the battle?

The Spanish forces were able to clear the harbor, but then got annihilated by the superior U.S. fleet.

12. ***What territories did the United States acquire from Spain as a result of the war?***

Puerto Rico, the Philippines, and Guam.

13. ***Who was primarily responsible for the United States's rise to world power status in the early years of the twentieth century?***

While Mahan had provided the basic philosophy for the American rise to major power status in the years following the turn of the century, the most dynamic and influential leader who made it all happen was Theodore Roosevelt.

14. ***What naval development occurred in England in 1907 that would revolutionize warship design?***

In 1907 the British battleship *Dreadnought*, a warship that would set the standards for all capital ships thereafter, was built.

15. ***What events caused friction between the United States and Japan in the first decade of the twentieth century?***

In 1905 the Treaty of Portsmouth ending the Russo-Japanese War of 1904–5, negotiated through President Roosevelt, had no provision for payment of war reparations to Japan, which angered the Japanese and soured relations between them and the United States. Then in 1906 the Japanese were further agitated by a new San Francisco School Board policy of segregating the children of Japanese immigrant laborers.

16. ***What was the name of the war plans drawn up beginning in 1911 to prepare for possible Japanese threats against the Philippines?***

The war plans were collectively called War Plan Orange.

17. ***What was the "Great White Fleet," and what was its purpose?***

The Great White Fleet was composed of the sixteen most powerful U.S. battleships. In 1907 President Roosevelt sent it on a 46,000-mile around-the-world public relations cruise that lasted fourteen months. Visiting twenty foreign ports, the fleet symbolized peace as well as strength. Though overshadowed somewhat by the launching of the British battleship *Dreadnought*, it nevertheless demonstrated the might of America to the world.

18. ***A. What was the Roosevelt Corollary announced in 1904?***

The Roosevelt Corollary proclaimed in 1904 was an extension of the Monroe Doctrine of 1823. Roosevelt stated that the United States might feel obligated to intervene in any situation involving wrongdoing by or collapse of government in any Latin American nation, to prevent foreign intervention.

- B. Which nation was it initially directed toward?***

It was initially directed toward Germany as a result of its threat to collect debts in the Dominican Republic by force.

19. ***What heavily influenced Congress to authorize building mainly battleships for the U.S. fleet during the pre-World War I years?***

In a background of some hostility with Germany, Congress set out on a building program to surpass that of Germany, so that the United States and not Germany would have a navy second only to that of Great Britain. Navy planners assumed incorrectly that any war with Germany would be solely a naval war, fought between capital ships at sea. Thus the building of battleships, rather than cruisers and small destroyers, was stressed.

20. ***How had American interest in a Panama Canal developed?***

Over the years, talk of a Panama canal had increased, spurred by the California Gold Rush, an American railroad across the isthmus in 1855, an unsuccessful attempt by the French to build a canal in the 1880s, and finally, the trip of the battleship *Oregon* around Cape Horn from Seattle to the Caribbean during the Spanish-American War. Mahan's sea power concept foresaw the need to connect the Atlantic and Pacific so American naval and merchant ships could move quickly between the nation's coasts. With the new territories in the Pacific, the United States had to have either a canal or two separate navies.

Chapter 6

World War I, 1914–1918

1. ***What was the main focus of the United States during the Taft administration from 1908 to 1913?***

In the Taft administration the main focus of the United States was turned inward toward domestic reforms. The era was marked by a movement called progressivism, which focused on individual rights, engaging in antitrust legislation, banking reform, conservation of natural resources, and nonintervention in the affairs of Europe.

2. ***A. Which nations formed the Triple Entente in World War I?***

The Triple Entente consisted of France, Britain, Russia, and Serbia. Italy would join the Triple Entente in 1915, as would most of the nations of North Africa by war's end.

B. Which nations formed the Central Powers?

The Central Powers initially consisted of Germany and Austria-Hungary. At the end of 1914 the Ottoman Empire (modern Turkey) entered the war on the side of the Central Powers.

3. ***A. Which two navies were the principal enemies in World War I?***

At sea the principal enemies were the British home fleets (the Grand Fleet at Scapa Flow and the Channel Fleet) and the German High Seas Fleet.

B. What sea became the major area for hostilities in the Atlantic region?

In the Atlantic region the North Sea became the principal battleground between the English and German navies.

4. ***A. What geographic advantage did the Central Powers have?***

The Central Powers occupied the interior land position. Their railroads could shift forces quickly to either the western front in France or the eastern front in Russia. They controlled the central agricultural areas of Europe.

B. What major geographical disadvantage did Germany's navy have?

Germany had a geographical disadvantage because its ships would have to go through the North Sea to get into the Atlantic, and this would be difficult in the face of the British Home Fleet at Scapa Flow.

C. What great disadvantage did Britain have?

Britain was absolutely dependent on imported foodstuffs for survival.

5. ***What strategy did the enemy navies set out to follow to win the war?***

The Royal Navy sought to maintain sea control of the North Sea and English Channel, and blockade Germany. The German Navy sought to fight British control of the sea and hurt the British merchant fleet with far-ranging cruisers and raiders.

6. ***What major amphibious operation was carried out by the Allies in 1915–16?***

The invasion of the Turkish peninsula of Gallipoli.

7. ***A. Who was the commander of German surface forces in the Pacific when war broke out?***

The commander of German surfaces in the Pacific when war broke out was Vice Admiral Graf von Spee.

B. When and where did the German threat in the Pacific region end?

Von Spee's surface force was cut to pieces by superior British forces at the Falkland Islands in December 1914.

8. ***What major battle took place in the North Sea in 1916? What were the results?***

The Battle of Jutland took place in the North Sea in May 1916. The British fleet suffered more damage, but managed to drive the Germans back into their home port. In America, the battle shocked the Wilson administration. It demonstrated that the British fleet was not invincible, and that the United States might yet find itself facing Germany on the high seas without British protection.

9. ***What did Germany do in 1917 to try to bring the war to a favorable conclusion?***

In February 1917 the German kaiser ordered his U-boat fleet to begin unrestricted submarine warfare in designated "barred zones" around Britain, France, Italy, and in the eastern Mediterranean.

10. ***What two events nearly caused the United States to go to war with Germany in 1915 and 1916?***

In May 1915 the German submarine *U-20* sank the British passenger liner *Lusitania* off the coast of Ireland; among the dead were 128 Americans. In March 1916 the unarmed French steamer *Sussex* was sunk in the English Channel by a U-boat that mistook her for a warship.

11. ***What event in early 1917 caused all remaining Congressional support for Germany to cease?***

In March 1917 British intelligence intercepted and passed along to the United States a diplomatic message sent by Germany's foreign secretary, Arthur Zimmermann, to Mexico. In it he tried to convince Mexico to join Germany in the event of war with the United States. In return, Germany would help Mexico recover land it had ceded to the United States after the Mexican War.

12. ***What tactic caused Allied shipping losses from U-boat attacks to decline after May 1917?***

The institution of the convoy system.

13. ***What new weapons began to be used by destroyers against submarines in World War I?***

Location of submerged U-boats was greatly helped by the development of the hydrophone, a device that could pick up the bearing of underwater noise. Once located, the U-boats were attacked with newly developed depth charges that would detonate at a preset depth.

14. ***What weapon was used in large numbers to prevent egress of German U-boats into the North Atlantic?***

The Allies laid gigantic minefields to prevent U-boats from gaining access to the Atlantic.

15. ***What was the U.S. Navy's principal role in World War I?***

The U.S. Navy's principal role in World War I was to patrol and convoy huge numbers of troops and enormous amounts of supplies to the Allied ground forces on the western front. On land, the U.S. Army and Marines were vital in stopping the major German offensives against the Allies in 1918. Large-caliber naval guns mounted on railway cars helped destroy German railroads, bridges, and ammunition dumps. The American shipbuilding industry built several thousand merchant ships to carry supplies to Europe.

16. ***What turned the tide of the war on land for the Allies in 1918?***

Germany could not keep up its last offensives because the British naval blockade gradually caused widespread famine and shortages of war material.

17. ***When and where did Germany surrender to the Allies?***

Germany surrendered to the Allies in a railway car near Paris on the eleventh hour of the eleventh day of the eleventh month of 1918.

Chapter 7

The Interwar Years, 1918–1941

1. ***What provision of the Treaty of Versailles ending World War I caused much resentment by the German people toward the Allies for years to come?***

The provision that Germany would have to pay \$33 billion in war reparations to the Allies, an amount far beyond their ability to pay, caused resentment on the part of the Germans for years to come.

2. ***A. What was the League of Nations?***

The League of Nations was formed at President Wilson's insistence. It was an organization in which the nations of the world would join together to ensure peace and security for all.

- B. What defense provision did it have?***

It had a provision that an attack on one would be defended by all.

3. ***What provision of the Treaty of Versailles dealt with the German Navy?***

Another provision of the treaty that was a severe blow to German morale was that most of the newer German warships were to be turned over to the Allies, with Germany allowed to retain only half a dozen pre-readnought battleships and cruisers, twelve destroyers, and no submarines.

4. ***A. What were the five major naval powers invited to the naval disarmament talks in Washington in 1921?***

The major naval powers invited to the Washington disarmament talks were Britain, France, Italy, Japan, and the United States.

- B. What did the 5:5:3 ratio in the proposed disarmament treaty refer to?***

The ratio 5:5:3 meant that the United States and Britain could have five tons of battleships for every three that Japan had.

5. ***Why did the United States not embark on any large warship building programs throughout the 1920s?***

Most Americans were concerned with the weak economy of the time and wanted to stay isolated from events in Europe, and could not be persuaded to spend money on warships.

6. ***How did the worldwide economic problems of the 1920s allow the dictatorships to arise in Europe?***

In the 1920s Europe's faltering economy collapsed because of widespread inflation, first in Germany and then spreading to other nations. Revolution swept across Russia and riots and strikes erupted throughout Europe. In this climate of despair, anyone with a radical plan to end the depression could move crowds of disillusioned people to follow.

7. ***What did Hitler do regarding the German military forces after assuming power in 1933?***

In 1935 Hitler withdrew Germany from the League of Nations and refused to continue abiding by all treaty limitations imposed on German armaments and military service. The Germans began rebuilding their armed forces, including capital ships and submarines for a new German Navy.

8. ***In the Pacific, what three problems did the Navy and Marine Corps have to solve?***

In the Pacific the Navy faced three problems: (1) how to free the fleet from dependence on established bases, (2) how to isolate and attack enemy bases protected by land-based air units, (3) how to invade and occupy heavily defended enemy bases.

9. ***What did Billy Mitchell's test sinking of a battleship by aerial bombing cause Navy leaders to do?***

This test convinced Navy leaders to begin building aircraft carriers. They converted a collier into the Navy's first carrier, the *Langley*, and got the treaty powers to consent to the building of the carriers *Lexington* and *Saratoga*.

10. ***Who are the Seabees, and what is their mission?***

The Seabees were trained to create operating bases in territory captured from an enemy. "Seabees" is a nickname for Naval Construction Battalions (NCBs).

11. ***What was the British policy of "appeasement" toward Germany and Italy?***

Appeasement meant the making of concessions to Germany and Italy by Britain and France in return for promises of peace. In one of these deals Britain persuaded the League of Nations to recognize the Italian conquest of Ethiopia, and in another, Britain and France agreed to the German takeover of Czechoslovakia.

12. ***What action by Hitler's Germany in 1939 began World War II in Europe?***

Hitler's invasion of Poland on 1 September 1939 caused Britain and France to declare war on Germany.

13. ***What was the decision reached at the ABC-1 staff meeting in 1941 about the priority of fighting the war in the Atlantic versus the Pacific regions?***

The key decision was that the United States would make its principal military effort in Europe, even if Japan made war on America.

14. ***What were the final U.S. economic acts that made war with Japan inevitable?***

An embargo was placed on oil, along with a freeze on all Japanese assets in the United States. This prevented the Japanese from paying cash for Dutch oil. War was now inevitable.

Chapter 8

World War II: The Atlantic War, 1941–1945

1. ***What was the Maginot Line in Europe?***

The Maginot Line was a massive line of fortifications constructed by the French on the border between France and Germany.

2. ***What French city was the site of an amazing evacuation of trapped English troops in May 1940?***

The coastal French city of Dunkirk on the English Channel.

3. ***What actions took place during the Battle of Britain in 1940–41?***

In what has since become known as the Battle of Britain, between June 1940 and June 1941 the German Luftwaffe bombers carried out as many as 1,000 sorties a day against targets throughout England, and later concentrated against London.

4. ***Who was the senior U.S. naval leader who took over the leadership of the U.S. Navy following Pearl Harbor?***

Admiral Ernest J. King became commander in chief of the U.S. Fleet following the Pearl Harbor attack. He would become CNO in March 1942. Under his guidance the United States would contribute to the defeat of Germany in the Atlantic, and achieve victory over Japan in the Pacific.

5. ***What was the Battle of the Atlantic?***

The Battle of the Atlantic refers to the sea war fought in the Atlantic during World War II, between German U-boats and surface raiders and Allied forces attempting to counter them. Altogether during the war German U-boats sank 14.5 million tons of Allied shipping. The Allies accounted for 781 of the 1,175 U-boats entered into the war, and sank or blockaded most of the German surface raiders.

6. ***What was the German U-boat wolf-pack tactic?***

Using these tactics groups of as many as twenty or thirty U-boats would coordinate their attacks against Allied merchantmen targets.

7. ***Why was the German conquest of Norway and France important to U-boat warfare?***

Once Norway and France were conquered, U-boats operating out of bases in these countries could cut their transit time to the hunting grounds in the western Atlantic in half.

8. ***What famous antisubmarine group exploit was carried out under the leadership of Captain Dan Gallery in June 1944?***

In June 1944 an antisubmarine group commanded by Captain Gallery attacked and blasted the submarine *U-505* to the surface. Then before the U-boat could be sunk with demolition charges by her crew, a specially trained American salvage party boarded and captured it and the entire crew. The submarine was then towed to Bermuda.

9. ***What factors finally led to the defeat of U-boat warfare in the Battle of the Atlantic?***

Many factors led to the defeat of U-boats in the Atlantic. Among these were the eventual building of sufficient numbers of escort ships to convoy merchantmen across the Atlantic, the development of an improved radar that allowed U-boats to be detected and tracked, the breaking of the German Kriegsmarine code by British code breakers, increasingly effective land-based air patrols, escort carriers and hunter-killer group operations, and continued improvement in radio direction finding.

10. ***What was Operation Torch?***

Operation Torch was the Allied invasion of North Africa.

11. ***What battle turned the tide for the Allies on the eastern front in 1942–43?***

The Battle of Stalingrad in which the Soviets surrounded and defeated an entire German army turned the tide on the eastern front.

12. ***What was the most significant result of the Sicilian campaign of 1943 for the Allies?***

The Sicilian campaign was a major triumph for the Allies because it largely eliminated Italy from the war.

13. ***Where did the Allies stage an invasion in January 1944 to try to accomplish an “end run” around the Gustav Line in Italy?***

The Germans had consolidated their forces at the Gustav Line, about halfway between Naples and Rome. To bypass these defenses, the Allies executed an “end run” by an amphibious assault on Anzio Beach, about 37 miles south of Rome.

14. ***A. Where did the massive Allied invasion of northern France take place in June 1944?***

The Allies invaded at Normandy in Operation Overlord.

- B. By what name has 6 June 1944 been called ever since?***

The landing at Normandy took place on 6 June, which date has been referred to as “D Day” ever since.

15. ***What was the last major German offensive against the Allies?***

The last German offensive was the Battle of the Bulge, in December 1944 in the Ardennes area of Belgium.

16. ***When and where did Germany surrender to Allied forces?***

On 7 May 1945 Germany signed unconditional surrender documents at General Eisenhower's headquarters in a little red schoolhouse in Reims, France.

Chapter 9

World War II: The Pacific War, 1941–1945

1. ***After the United States restricted the sale of oil to Japan in 1941, where was their only remaining possible source of supply?***

When the United States restricted the sale of oil to Japan in July 1941, their only other possible source of oil was the Dutch East Indies.

2. ***What did the Japanese do to cause the United States to declare war on Japan?***

The Japanese conducted a surprise attack on Pearl Harbor on 7 December 1941.

3. ***A. What targets were successfully attacked by the Japanese at Pearl Harbor?***

All eight of the battleships at Pearl Harbor were sunk or severely damaged in the attack. Over 230 planes had been destroyed on the ground.

B. What key land assets were missed?

Not attacked were the carriers (at sea at the time), the important repair yards and machine shops, and the fuel-oil tank farm.

4. ***What three miscalculations did the Japanese make about Pearl Harbor?***

First, the Japanese had counted heavily on the efforts of their submarines in the attack, but their effects were minimal. Second, rather than demoralize their enemy as had their sneak attacks on the Chinese in 1894 and the Russians in 1904, the attack on Pearl Harbor roused and infuriated the American public as nothing else could have. Third, the attack forced the senior American naval leadership to build their offense in the Pacific around the aircraft carrier rather than the battleship as the Japanese persisted in doing.

5. ***What were Nimitz's orders at the start of the Pacific War?***

King directed Nimitz to cover and hold the Hawaii-Midway line and maintain communications with the U.S. West Coast and with Australia.

6. ***What was the name of the war plan for the Pacific War that had been developed and refined at the Naval War College?***

The contingency plan for the war in the Pacific was called War Plan Orange.

7. ***What was the ABDA defense alliance?***

ABDA stood for American, British, Dutch, and Australian—the Allied command formed to defend the East Indies.

8. ***What American general was ordered to leave the Philippines in March 1942?***

On 11 March 1942 General Douglas MacArthur was ordered out of the Philippines by President Roosevelt.

9. ***Where was there a gap in the Japanese defense perimeter?***

The only gap was on the central perimeter near Midway Island.

10. ***What were the Japanese hopes for the conduct of the war in 1942?***

The Japanese hoped that their string of well-defended bases and their fine navy would be sufficient to keep the growing American strength at bay. They hoped to defeat newly arriving American forces piecemeal in a prolonged war of attrition, which would cause the American people to become disheartened and receptive to a compromise peace that would let Japan keep her newly acquired territory.

11. ***What was the Doolittle raid on Japan in April 1942?***

In April 1942 a group of Army B-25s launched from the carrier *Hornet* conducted air raids on Tokyo, Nagoya, and Kobe in the Japanese home islands. They then continued on into China where most of the air crews escaped.

12. ***A. What battle was the first great combat of the Pacific War between carrier forces?***

The Battle of the Coral Sea.

B. What was the result of the battle?

The battle turned back the Japanese advance for the first time in the war. They lost the services of three of their carriers before the fight for Midway.

13. ***How did Nimitz know about Japanese intentions at the Battle of Midway?***

U.S. intelligence enabled Nimitz to deduce all the major movements in the Japanese plan through radio intercepts and code breaking.

14. ***Why is the Battle of Midway regarded as the turning point of the Pacific War?***

The Japanese lost four carriers and a cruiser and all their best pilots, which was one of the chief causes of Japan's ultimate defeat.

15. ***On what island in the Solomons did the Japanese and Allied forces converge to determine the outcome in the southwestern Pacific?***

The two forces converged at Guadalcanal in the Solomon Islands.

16. ***Where were “Ironbottom Sound” and “the Slot” located?***

Ironbottom Sound referred to the seaway area off the northern coast of Guadalcanal; it was so named because of the numerous ships from both sides that were sunk in battles in the area. “The Slot” was the sea passage running from Rabaul through the Solomons to Guadalcanal; it was so named because of the narrow confines through which so many ships from both sides fought, and through which the Japanese tried to reinforce their Guadalcanal garrison.

17. ***What name was given to the Japanese operations that attempted to reinforce Guadalcanal?***

They were called the “Tokyo Express.”

18. ***What was the fundamental difference between the submarine wars in the Atlantic and the Pacific?***

The submarine war in the Pacific was in many ways a mirror image of the Battle of the Atlantic. Whereas in the Atlantic it was the goal of German U-boats to interdict Allied shipping in order to strangle Britain, in the Pacific the roles were reversed, and it was the American submarines that attempted to gain a stranglehold against Japanese shipping.

19. ***What happened to the Japanese commander Admiral Yamamoto in April 1944?***

In an effort to boost morale, on 18 April Yamamoto and his staff set out on an inspection trip to Japanese bases in the Solomons. Because coded messages that outlined his itinerary had been broken by U.S. naval intelligence, American long-range fighters from Henderson Field were able to intercept his plane over Ballale Island near Bougainville and shoot it down, killing Yamamoto.

20. ***What central Pacific island was the target of one of the greatest military efforts in history in June 1944?***

The battle for Saipan involved U.S. forces in arguably the greatest military effort in history.

21. ***What was the principal effect of the Japanese defeat in the Battle of the Philippine Sea?***

Japanese naval air capability had been destroyed.

22. ***What was the new Japanese defense strategy put into effect on Peleliu in late 1944?***

The new strategy called for a “defense in depth.” The defenders were to have prepared positions well behind the beaches; resistant fortifications were to be constructed, and there were to be no useless banzai charges.

23. ***When and where did General MacArthur make good on his promise to return to the Philippines?***

MacArthur returned to the Philippines on 20 October on the first day of the landings on Leyte.

24. ***What did the Japanese see as the consequences if they lost the battles for Leyte Gulf in October 1944?***

Admiral Toyoda knew that if the Japanese lost the Philippines they would lose everything. The lifeline between Japan and the Indies would be cut and the Mobile Fleet would be divided. It could then be defeated piecemeal and Japan would be blockaded.

25. ***A. What were the kamikazes?***

Kamikazes were suicide airplanes that crash-dived into U.S. ships.

- B. Where did they first appear?***

The kamikazes first appeared at Leyte Gulf.

26. ***Why was it necessary for Allied forces to secure Iwo Jima?***

The island was between the Marianas and Japan. It gave warning to the home-island defenders that the B-29 raids were coming and enabled them to scramble fighters. Also, damaged bombers couldn't make it all the way back to the Marianas, so Iwo Jima could be made into both a U.S. fighter base and an emergency landing field for the damaged bombers. U.S. fighters based at Iwo Jima could provide fighter protection for the B-29s over Japan.

27. ***Why did the Japanese mount a fanatical defense of the island of Okinawa?***

The Japanese troops on Okinawa knew that they were the last obstacle to an Allied invasion of the Japanese home islands. Many had pledged to fight to the death to prevent the island from falling and their homeland being invaded.

28. ***To whom did the Japanese make their initial "peace feelers" to end the Pacific War?***

The Japanese made peace feelers to the Soviet Union, but the Soviets remained silent.

29. ***What three events in early August 1945 made it imperative for the Japanese to accept the Potsdam Declaration for their surrender?***

The three events were (1) the first atomic bomb was dropped on Hiroshima, (2) the Soviet Union declared war on Japan, and (3) the second atomic bomb was dropped on Nagasaki.

30. ***When and where did the Japanese sign the surrender document?***

The surrender document was signed on 2 September 1945 aboard the battleship *Missouri* in Tokyo Bay.

Chapter 10

The Cold War Era, 1945–1991

1. ***What happened to the U.S. armed forces after World War II ended?***

Even before the surrender of Japan, the American public had begun to bring pressure on Congress to “bring the boys home.” After the war the rush to demobilize was so swift that the American armed forces were soon rendered almost impotent.

2. ***What were the only two possible American response options to Soviet takeovers of Eastern European nations following World War II?***

America had only two options: make a diplomatic protest or use the atomic bomb.

3. ***What term was originated in 1946 by Winston Churchill to describe the conflict of interests between the West and the Soviet Union?***

He originated the use of the term “iron curtain” for the barrier between the West and Soviet communism.

4. ***What was the objective of postwar “unification” of the U.S. armed services?***

Many in government and in the Army and its Air Corps component proposed a centralized military establishment that would make the peacetime defense budgets stretch further.

5. ***What was the final result of congressional deliberations on armed forces unification?***

After long debate, Congress finally passed the National Security Act (NSA) in July 1947. The new law created the Department of Defense, headed by a secretary of defense, with subordinate Departments of the Army, Navy, and Air Force, and the Joint Chiefs of Staff. Under the terms of the NSA, the secretary of defense became a member of the president’s cabinet, while the secretaries of the services were not of cabinet rank. It established the Air Force as a separate service and gave it responsibility for strategic bombing and for combat operations in support of land armies. The Navy retained its carrier aviation and its land-based reconnaissance wing, as well as the Marine Corps. The Army kept its traditional roles. Secretary Forrestal became the nation’s first secretary of defense.

6. ***What events caused the beginning of the U.S. Sixth Fleet deployments to the Mediterranean?***

Ships of the U.S. Sixth Fleet deployed to the Mediterranean in the late 1940s as a result of Soviet moves toward Greece and Turkey.

7. ***What was President Truman's plan for reconstruction of war-torn Europe?***

The plan, formally announced in 1947 as the European Recovery Program, quickly became known as the Marshall Plan.

8. ***A. What two Soviet actions in the late 1940s caused the Western democracies to create a formal alliance to counter the spread of Soviet communism?***

The two incidents were the coup d'état in Czechoslovakia, after which the Soviets seized control of the country, and the Berlin Blockade of 1948.

B. What was this alliance called?

The alliance was called the North Atlantic Treaty Organization, or NATO.

C. What Soviet-sponsored military alliance was formed in response?

In 1955 the Soviets sponsored the Eastern European Mutual Assistance Treaty, more commonly referred to as the Warsaw Pact.

9. ***What happened in China in 1949?***

The government of Nationalist China, headed by Chiang Kai-shek, was driven from the mainland to Taiwan by Mao's Communists in December 1949 after five years of civil war.

10. ***A. Where did the Potsdam Conference draw the boundary line between North and South Korea?***

In Korea after World War II, the Potsdam Conference had decreed that this former Japanese possession would be temporarily divided, with the Soviets occupying the part north of the thirty-eighth parallel and the United States occupying the southern part of the country.

B. Which major nations aligned themselves with North and South Korea?

North Korea was backed by the Soviet Union and the Chinese Communists. South Korea was supported by the United States and eventually fourteen other countries—Great Britain, Canada, Australia, New Zealand, France, Brazil, Greece, Turkey, Norway, Sweden, the Netherlands, Thailand, Colombia, and the Philippines.

11. ***What were the objectives of the North Korean invasion of South Korea?***

The North Korean invasion of South Korea in June 1950, backed by the Soviet Union and the Chinese Communists, had two main purposes: to unify Korea into a Communist state, and to establish a geographic dagger pointed at the center of Japan, where General MacArthur's occupation rule prevented Communist subversion from gaining a foothold.

12. ***Who was the supreme commander of UN forces in Korea?***

General Douglas MacArthur.

13. ***What made the landing at Inchon so risky?***

The only approach to the port was through the Flying Fish Channel, a tortuous 30-mile run through mud flats that became visible each day at low tide. The range of tide at Inchon is one of the greatest in the world—twenty-nine feet on the average, and sometimes as much as thirty-six feet.

14. ***What happened on 25 November 1950 that changed the whole complexion of the Korean War?***

On 25 November 1950 200,000 Chinese, called Volunteers of the People's Liberation Army, launched a major offensive, sweeping the allies before them and cutting off a large group of U.S. Marines at the Chosin Reservoir north of Hungnam.

15. ***Why was General MacArthur relieved by President Truman?***

General MacArthur had chafed at the limitations placed upon him after the Chinese intervened. He particularly wanted to be allowed to follow Chinese aircraft in "hot pursuit" over the Yalu River into Manchuria and to bomb Chinese staging bases on the north bank of the river. When he was unable to persuade President Truman to accept his recommendations, in March 1951 General MacArthur sent a letter attacking the president's policies to Joseph Martin, the minority leader of the House of Representatives. When Martin made the letter public, President Truman relieved MacArthur for insubordination, replacing him with General Ridgway.

16. ***Where were the Korean truce talks held?***

The Korean truce talks were held at Panmunjom, a small village along the thirty-eighth parallel. Both the North Koreans and the United Nations still keep representatives at Panmunjom. They meet periodically to conduct negotiations on many military incidents that have occurred over the year since the armistice ending the war.

17. ***What was the historical significance of the Pueblo crisis in 1968?***

This incident marked the first time in over 150 years that a U.S. warship had been seized on the high seas by a foreign power.

18. ***What new kinds of submarines became part of the U.S. Fleet in the 1950s?***

The new kinds of submarines that joined the U.S. Fleet in the 1950s were the nuclear powered attack submarine and the ballistic missile submarine.

19. ***A. What was the American response to the discovery of Soviet intermediate-range missiles in Cuba in 1962?***

After an agonizing appraisal of the alternatives, President Kennedy called upon the Navy to establish a naval quarantine around Cuba. No ships carrying offensive missiles bound for Cuba would be allowed to proceed. By 24 October over 180 Navy ships were involved in the operation, establishing a quarantine line 500 miles to the east of Cuba.

B. *What was the result?*

On the afternoon of 24 October many of the Soviet ships that had been en route to Cuba turned back. Nuclear holocaust was averted.

20. *What did the USSR do as a result of the Cuban confrontation?*

Khrushchev and the Soviet Union were checked, but as a result, the buildup of Soviet sea power that had begun after the setback in Lebanon was given top priority. It moved forward with great momentum under the leadership of the admiral of the fleet of the Soviet Union Sergei G. Gorshkov. By the 1970s, that momentum would give the Soviets a navy second only to that of the United States.

21. *Where was the dividing line between North and South Vietnam after 1954?*

Just as the armistice agreement had created a 5-mile demilitarized zone (DMZ) between the opposing armies in Korea, so had a DMZ been established on the seventeenth parallel between North and South Vietnam following the breakup of Indochina in 1954.

22. *What triggered civil war in South Vietnam in 1956?*

The Diem regime that had established itself in South Vietnam in the mid-1950s was corrupt and dictatorial, repressive to both Communist and religious minorities. When it came for elections in 1956 to determine national unification and type of government, Diem refused to allow them. Civil war immediately followed.

23. *What controversial event brought the United States into the war on a major scale?*

Open involvement of the United States in the war began in August 1964, when the destroyers *Maddox* and *C. Turner Joy* were allegedly attacked by North Vietnamese torpedo boats. Later evidence has indicated the attacks may never have occurred.

24. *What official and common names were given to the Communist South Vietnamese insurgents?*

Their official name was the National Liberation Front, but their common name was the Vietcong.

25. *What was the "Brown Water Navy" and where did it operate?*

The "Brown Water Navy," formally named the Mobile Riverine Force, consisted of armored monitors, armored troop carriers, and a variety of patrol and minesweeping craft. Its patrols roamed through the myriad canals and rivers of the Mekong Delta south and west of Saigon.

26. *What restrictions were placed on the conduct of the war by U.S. civilian leadership?*

Many bombing restrictions in North Vietnam and prohibitions against mining North Vietnamese waters were imposed, mainly out of concern over provoking a reaction from the Soviet Union or China.

27. ***What result did the Tet Offensive of 1968 have in the United States?***

The offensive stimulated a peace movement in the United States, supported by all manner of leftists, liberals, and many college students. The president found his administration under increasing pressure to get out of the Vietnam War.

28. ***What was the final outcome of the Vietnam War?***

America's preoccupation with domestic political affairs in 1973–74 encouraged the Vietcong and North Vietnamese to violate all provisions of the cease-fire agreement. They began bringing in massive reinforcements through the northern provinces of South Vietnam. In March 1975, two years after American withdrawal, South Vietnam's ability to withstand Communist pressure collapsed. By the end of April, the whole country had capitulated to North Vietnam and the NLF.

29. ***What did the resolution of the Mayaguez incident show the world in 1975?***

At a time when its resolve was in doubt following the debacle in Vietnam, the incident showed the world that the United States would pay whatever price was necessary to protect its citizens and preserve its national honor.

30. ***What effects did the Falklands War of 1982 have on the U.S. Navy?***

Even though they were not as capable as the large-deck carriers of the United States, the major role of the two British carriers involved effectively quieted many skeptics in Congress who had begun to question the need for maintaining a force level of fifteen U.S. carriers in the 1980s. Also, the war showed the hazards associated with using aluminum vice steel plate in the construction of warships. Finally, the Falklands War demonstrated once again the value of naval power projection capability at a time when the new Reagan administration was pushing for funds to revitalize the U.S. armed forces.

31. ***What happened on the island of Grenada in 1983?***

In late October 1983, in response to a takeover of the Caribbean island nation of Grenada by Cuban-backed Communist forces, a joint U.S. task force conducted a major amphibious operation and took control of the island in three days. In the process about 600 American citizens and 80 foreign nationals were evacuated to safety. Subsequently, follow-up U.S. forces helped the Grenadians reestablish their representative government and rebuild damaged buildings and other facilities.

32. ***Why did the United States take military action in Panama in 1989?***

Relations between the United States and Panama had steadily deteriorated throughout the 1980s. By 1988 the country had become a major staging area for drug smuggling to the United States, and its dictator, General Manuel Noriega, was indicted on drug-trafficking charges by a U.S. federal grand jury. In December 1989, following a series of incidents that culminated in the killing of a U.S. Marine lieutenant by Panamanian Defense Force (PDF) troops, the Noriega government declared that a state of war existed between the United States and Panama. On

20 December 1989 President Bush dispatched a combined invasion force of some 12,000 U.S. Army, Navy, Air Force, and Marine Corps troops to depose Noriega and return the country to the control of the officials who had been lawfully elected in May.

33. ***Why did the United States conduct an attack against Colonel Qaddafi's Libya in 1986?***

In the early part of the 1980s a number of international terrorist actions were shown to have been directly sponsored by Libyan leader Colonel Muammar Qaddafi, who had established several terrorist training bases within Libya. In the mid-1980s Qaddafi began to make threats concerning freedom of navigation in the Gulf of Sidra. There were several incidents involving U.S. naval air and surface forces, during which Libyan fighters were shot down and Libyan patrol boats were sunk. Finally, on 15 April 1986, in reprisal for the continuing threats and several Libyan-sponsored terrorist acts against U.S. citizens in Europe, a combined attack by U.S. Air Force and Navy jets was carried out against Libyan terrorist support bases.

34. ***What was the role of the U.S. Navy during the Persian Gulf warfare in the 1980s?***

Because of our political role of peacemaker in the area, and perhaps also because we are less dependent on Middle Eastern oil than most other Western nations, the United States played an increasing role in keeping the Persian Gulf open for transit by oil tankers of all nations during the latter stages of the Iran-Iraq War. Throughout 1987 and 1988 U.S. frigates and cruisers served as convoy escorts, accompanying and protecting tankers of all nations transiting the gulf.

35. ***What profound change took place in the early 1990s that brought an end to the cold war?***

In the late 1980s and early 1990s there was a rising tide of democracy that, once set in motion, rapidly engulfed the Soviet Union. The populations of the satellite states took advantage of the erosion of Soviet control to press forward successful self-determination movements. These eventually resulted in complete independence of all the former satellite states by 1990. On Christmas Day 1991 the last Soviet premier resigned, and the pre-revolutionary Russian flag was raised over the Kremlin, thus ending the cold war.

Chapter 11

The 1990s and Beyond

1. ***What were the main provisions of the START II disarmament treaty signed by the United States and the Russian Commonwealth in 1993?***

START II was widely heralded as the broadest disarmament pact in history. Its terms called for both sides to reduce long-range nuclear arsenals to between 3,000 to 3,500 warheads within a decade, and the complete elimination of land-based multiple-warhead missiles.

2. ***A. What action caused the United States to engage in massive military operations in the Persian Gulf area in 1990–91?***

In August 1990, suddenly and without warning, Iraqi forces under the command of Iraq's leader Saddam Hussein staged a brutal invasion of neighboring Kuwait. That country was captured in short order, along with thousands of Western civilian oil-field workers and their families, who were subsequently detained and used as hostages against Western reprisal. In response the United States joined with many other nations to form a UN coalition to conduct operations against Iraq. A deadline of 15 January 1991 was imposed by which Hussein had to remove all his forces from Kuwait. When he did not, the coalition began military operations against Hussein.

- B. What were these operations called?***

These operations were called Operations Desert Shield and Desert Storm.

- C. What was the outcome?***

By the end of February 1991 Kuwait City was secured, and Hussein's army was defeated and forced to leave Kuwait.

3. ***What was the purpose of the no-fly zone imposed by the UN over southern Iraq in 1992?***

Following the cessation of hostilities in Operation Desert Storm, Iraqi president Hussein began to suppress Shiite Moslems in southern Iraq. In response to this, in August 1992 the UN imposed a no-fly zone over the southern part of Iraq, designed to protect the Shiites from further deprivations by Hussein.

4. ***What provocative actions did Hussein carry out in Iraq throughout much of the 1990s?***

Hussein continued to order occasional threatening troop movements, and provocative behavior within the no-fly zones, throughout the rest of the 1990s and beyond.

5. **A. *What major terrorist actions against the United States occurred in Africa in 1998?***

In early August 1998 U.S. embassies in Kenya and Tanzania were virtually destroyed by terrorist car bombs.

B. *Who masterminded these?*

These attacks were determined by U.S. intelligence services to have been masterminded by a wealthy exiled Saudi Arabian terrorist named Osama bin Laden, who had proclaimed a holy war against the United States for its part in the action against Iraq in the early 1990s.

C. *What was the U.S. response?*

In retaliation for these bombings, on 20 August 1998 President Clinton ordered cruise missile attacks to be carried out against terrorist training camps run by bin Laden in Afghanistan, and against a factory in Sudan believed to be involved in manufacturing chemical weapons for him.

6. ***Where in Europe did fighting break out in 1991?***

In 1991 a civil war began in the Baltic country of Yugoslavia. In June, after Croatia and Slovenia declared their independence from the former Yugoslavia, fighting broke out between ethnic Serbs in Croatia, who claimed part of that republic for Serbia, and the Croat militia. Soon the conflict broadened into Bosnia-Herzegovina, between Serbs who claimed part of that republic as well and Muslims and Croats who claimed the rest.

7. ***What other trouble spots in Africa involved the U.S. Navy and Marines in the 1990s?***

In January 1991 a civil war erupted in the former Soviet-aligned African state of Somalia after the cessation of aid from the former Soviet Union, when several clan-led rebel armies forced longtime president Mohammed Siad Barre to flee the country. In his absence several of these groups began battling among themselves for territory, soon resulting in widespread anarchy and famine. In December 1992 28,000 U.S. troops, including 1,800 marines, took part in the UN-sponsored Operation Restore Hope, which was intended to bring in food supplies and restore some order to the country.

In mid-1996 Navy-Marine Corps amphibious ready groups were called upon on two occasions to assist in evacuation of U.S. nationals and other noncombatants from the African nations of Liberia and the central African Republic of Bangui, both of whom were experiencing outbreaks of ethnic violence, famine, and disease.

8. ***What event in 1998 caused much concern over nuclear nonproliferation issues?***

In the spring of 1998 much apprehension arose over the issue of nuclear weapons proliferation when India and Pakistan each exploded nuclear test devices in response to the other doing so. Escalating conflict between the two nations that might have led to a regional nuclear war was halted only by the efforts of the Clinton administration.

9. ***What major incidents occurred in 1991 and 1996 that caused much internal tension in the U.S. armed forces?***

In 1991 there were allegations of sexual harassment by male naval aviators of female junior officers and civilians at an annual naval aviation convention held at the Las Vegas Hilton. In late 1996 there were incidents of fraternization with and harassment of female trainees by male drill instructors that surfaced at an Army training base at Aberdeen, Maryland.

10. ***What incident of domestic terrorism took place in Oklahoma in 1995?***

In April 1995 the threat of domestic terrorism once again came to the forefront when a powerful bomb exploded in front of the Federal Building at Oklahoma City, Oklahoma, killing and maiming scores of innocent people.

11. ***A. What terrorist attack against America took place in September 2001?***

On 11 September 2001 the two World Trade Center towers in New York City were hit and set afire by hijacked airliners. A short time later a third hijacked plane hit the Pentagon in Washington, D.C. A fourth plane, presumably headed toward targets in Washington, D.C., crashed into the countryside in western Pennsylvania.

B. What military action took place as a direct result of the attack?

Shortly after the attack, plans were made to retaliate against bin Laden's al-Qaida organization. Military assets were deployed in the region of Afghanistan in preparation for an attack. On 8 October Operation Enduring Freedom began with air strikes against strategic targets throughout the country. By late November the Northern Alliance, supported by U.S. forces, had gained control of most of the country from the Taliban.

12. ***What were the major concerns that led the United States to undertake Operation Iraqi Freedom in 2003?***

By 2002 continuing defiance of the terms of the 1991 cease-fire agreement by Iraq's Saddam Hussein became a major issue for the United States. There were also alarming intelligence estimates, later disputed, that Iraq was stockpiling weapons of mass destruction—chemical, biological, and of special concern, nuclear weapons. In early 2003 the United States decided to move toward war if Hussein and his sons did not agree to leave Iraq.

Leadership

Answer Guide

Chapter 1

NJROTC Leadership

1. ***How can you help incoming Naval Science 1 cadets?***

Your first rule must be to set the best example possible. You will find that your own correct wearing of the uniform, taking directions, snappy saluting, and sharp marching will be a better guide than will many things you say.

2. ***What are the three things upon which leadership depends?***

Leadership depends upon three things: the leader, the followers, and the job to be done.

3. ***What are the three basic things to remember as you develop your leadership abilities?***

There are three basic things to remember as you develop your leadership abilities. These are: Know your business. Know yourself. Know your personnel.

4. ***Explain the statement: "Respect of subordinates and confidence is not something that can be commanded; it must be earned."***

Subordinates expect their leaders to have an interest in and concern for their affairs. If juniors feel that their leader knows their needs and will do everything he or she can for them, they will trust that leader.

5. ***What is the difference between physical and moral courage?***

Physical courage implies a willingness to attempt a mission in spite of its danger. Training, education, drill, and professional preparation are the best ways to lay a foundation for physical courage. *Moral courage* means being able to stand up for one's beliefs, to call things as honestly seen, to admit a mistake. It takes moral courage to do right in the face of pressures to do wrong.

6. ***Why is humor (at the right time and place) an asset to a leader?***

Often a humorous remark at the right time and place can ease tension and restore morale. Laughter can be like a curing medicine. A leader who can see humor in a situation, when such exists, does much to relax his or her subordinates, restore their confidence, and cause them to think positively.

7. ***Explain the statement: "A truly great person can afford to be modest; lesser individuals cannot afford to be otherwise."***

A truly great person can be modest because his or her accomplishments speak louder than any words. While a person should be proud of strengths and abilities, one must not develop too high an opinion of oneself. Modesty, quiet dignity, even humility indicate great character and experience. Self-magnification is improper, often unpleasant, and normally unsuccessful.

8. ***Why are common sense and good judgment essential qualities of a leader?***

Common sense and good judgment enable a person to make good decisions. Common sense means being able to see and react to things as they really are. Good judgment comes with training and discipline and means the ability to analyze facts and draw correct conclusions. The more knowledge a person has, the better qualified he or she is to make good judgments.

9. ***Why is maintaining good appearance, dress, and conduct important?***

A leader must always set a good example, because subordinates will imitate the leader's bad actions as well as the good.

10. ***Summarize some of the most important things a leader must be and do.***

- Leaders must know the capabilities of each member of their group, and how to coordinate them to do their assigned jobs well.
- Leaders must be self-confident. They must have an optimistic winning attitude and be able to keep on track to accomplish the goal and know when it is better to stress the job or the individual.
- Leaders must be willing to take increased responsibility.

Chapter 2

Approaches to Leadership

1. ***What does authority mean in the Navy?***

Webster's New World Dictionary defines *authority* as "the power or right to give commands, enforce obedience, take action or make final decisions." In the Navy the person in authority is the person in charge.

2. ***What is the commanding officer of a naval vessel responsible for?***

The commanding officer has total responsibility for all things within his or her command. He or she is totally responsible for the performance of the ship and crew.

3. ***What is the difference between civilian authority and naval authority?***

Authority is not quite as total in civilian life. Civilian leaders may be held accountable in many cases only if they break the law.

4. ***Why do parents have authority over their children?***

Your parents have authority over you because they are responsible for your actions. They are legally responsible for what you do until you are legally an adult.

5. ***Who gives authority to law enforcement and school officials to carry out their responsibilities?***

They get their authority from the people, through laws.

6. ***Where do naval science instructors get authority to teach and manage the NJROTC unit?***

This authority arises from the agreement each cadet makes when he or she becomes a member of the cadet corps. The authority also comes from the school district and the Navy.

7. ***What is the first step toward developing self-discipline?***

Self-discipline begins with self-control.

8. ***Why does military drill help in learning self-discipline?***

Drill teaches self-discipline because it requires the unit to act as one person. Every cadet must know what to do, because everyone must act together. Anyone not doing so will stick out like a sore thumb.

9. ***What are the two extreme styles of leadership, and what are the features of each?***

The two extreme styles of leadership are the autocratic and the democratic. The autocratic style of leadership is centered on the leader. It is direct and often impersonal. It demands a fast response. The democratic style involves participation of the followers as well as the leader. The followers are encouraged to help set up procedures, make decisions, and discuss problems.

10. ***Upon what is effective leadership based?***

Effective leadership is based on *results*. The leader has to find the most effective way to get the best results.

11. ***What are the five styles of leadership in the range from autocratic toward democratic?***

The five styles of leadership in the range from autocratic toward democratic are

- *telling*, in which the leader keeps all authority and gives the group little freedom
- *selling*, in which the leader makes the decision and then persuades the group that this decision is best
- *testing*, in which the leader proposes, the group reacts, and then the leader decides what to do
- *consulting*, in which the leader selects a solution from among those presented by the group
- *joining*, in which the group decides and the leader follows

12. ***What are the four skills necessary for effective communication?***

The four skills necessary for effective communication are effective reading, writing, listening, and speaking.

13. ***What are the four important steps for effective writing?***

The four steps for effective writing are (1) clarify your purpose for writing, (2) limit the subject to material that suits your purpose, (3) list ideas that you want to get across, and (4) organize ideas into groups.

14. ***What are the four rules for being a good listener?***

The four rules for being a good listener are (1) get ready to listen, (2) take responsibility for understanding, (3) listen to understand rather than to disagree, and (4) listen for the main ideas.

15. ***What are the five basic steps to follow in preparing a speech?***

The five basic steps to follow in preparing a speech are (1) determine the purpose for the speech, (2) narrow the scope of your topic, (3) choose a subject of interest to you and your audience, (4) make an outline to organize your speech, and (5) practice your speech.

Chapter 3

Leadership Skills

1. ***After the basic human needs are satisfied, what higher needs will influence human behavior?***

After the basic human survival needs (food, air, and water) are satisfied, people require the higher needs, such as friends, job (or achievement), and respect.

2. ***What should the leader try to give subordinates?***

The leader must be sure that the basic needs of his or her subordinates are satisfied but then must also try to satisfy their higher needs. He or she can do this by giving them work that promises them the rewards (social and financial) of belonging, status, and getting ahead. Jobs must be assigned well so all work toward the goal; in this way, individual needs will be satisfied and the group will develop teamwork.

3. ***What is a good "rule of thumb" when making an inspection of a job?***

In a job inspection, give compliments first, then follow with constructive criticism of mistakes, if needed.

4. ***What must the leader do to motivate followers?***

To help motivate followers, a leader must give each one the chance to develop his or her abilities and talents. He or she must allow them to use their initiative and judgment within the constraints the leader sets up.

5. ***A. What is morale?***

Morale is the state of mind of an individual, which has been produced by his or her circumstances.

- B. What three things are essential to high morale in an individual?***

To have high morale, an individual must (1) have positive standards and goals that make daily life meaningful; (2) know what he or she must complete or solve in order to reach his or her goals, and thereby earn rewards; and (3) harmonize his or her basic convictions and aims with those of other members of the group so that his or her morale can be sustained during periods of stress.

6. ***What things are sure to destroy good morale?***

Nothing will destroy good morale so quickly and surely as inactivity and boredom. Yet relaxation and freedom are also essential because a proper mix of work and play is necessary to keep up good morale.

7. ***Why are frequent contacts with personnel important to building morale?***

Personal contact with subordinates is one of a leader's most effective ways of letting them know they are important. This will result in higher morale and will greatly contribute to the efficiency of the command.

8. ***What are three helpful rules to consider when starting a conversation?***

Three helpful rules to remember when starting a conversation are (1) no one wants to have others pry into their private affairs; (2) many people like to talk about themselves to someone they can trust, who will listen and understand; and (3) the key to getting acquainted is a sincere and unselfish interest in the people being approached.

9. ***Why is listening an essential skill for an effective leader?***

Listening is a skill the effective leader must have because few things make people feel so important or so good about themselves as really being listened to by someone they admire or respect.

Nautical Sciences

Answer Guide

Chapter 1

Maritime Geography of the Western Seas

1. ***What are the most important military sea-lanes in the Atlantic for the United States? Why?***

The most important military sea-lanes are those between the United States and our Western European NATO allies and those with the oil countries of the Middle East. The United States depends on oil from the Middle East and strategic minerals from Africa and South America.

2. ***A. What are the two Atlantic basins?***

The Atlantic Ocean is made up of the North Atlantic basin lying between North America and Europe/North Africa, and the South Atlantic basin lying between South America and southern Africa.

- B. Where is the deepest spot in the North Atlantic? The South Atlantic?***

The deepest spot in the North Atlantic is in the Puerto Rico Trench, 28,374 feet deep. In the South Atlantic it is the South Sandwich Trench, 27,113 feet deep.

3. ***What are the principal mineral and mining industries of the Atlantic and its gulfs and seas?***

The main mineral and mining operations in the Atlantic are for sands and gravels along the Atlantic seaboard of the United States, aragonite sands in the Bahamas, phosphates for fertilizers, and oil in the Gulf of Mexico and the North Sea.

4. ***Where are the major fishing areas of the Atlantic?***

The North Atlantic is one of the most heavily fished areas of the world. Cod, haddock, flounder, and ocean perch are caught in the Grand Banks off Newfoundland; lobsters are trapped off the New England coast; and tuna is caught along the African coast and in the Caribbean.

5. ***What are the major U.S. naval bases on the Atlantic coast?***

The major naval bases are Newport, Rhode Island; New London, Connecticut; Norfolk, Virginia; King's Bay, Georgia; and Mayport, Florida.

6. ***Which two European ports handle most of the support traffic for U.S. land forces in Germany?***

Almost all direct support for U.S. forces in Germany comes through Antwerp, Belgium, and Bremerhaven, Germany.

7. ***What are some important trade goods the United States imports from Africa?***

Important African trade goods include lead and cobalt from Morocco; iron ore from Liberia; oil from Nigeria; and gold, diamonds, platinum, and chromium plus other strategic materials from South Africa.

8. **A. *What does strategic geography mean?***

Strategic geography means those areas on Earth's surface that are very important from a military standpoint.

- B. *What are the choke points of navigation leading to and from the Atlantic basins?***

Strategic choke points are the Strait of Gibraltar between the North Atlantic and Mediterranean, the Danish Straits between the North Sea and Baltic Sea, the Greenland–Iceland–United Kingdom (G-I-UK) gap in the North Atlantic, and the Panama Canal in the Caribbean.

9. ***Why is the Greenland–Iceland–United Kingdom gap important to the allies?***

The G-I-UK gap is very important because it is through this area of the North Atlantic that Russian naval units from their northern fleet must transit to get to the North Atlantic sea-lanes.

10. ***What severe storms occur each fall season in the Gulf of Mexico and Caribbean Sea?***

Hurricanes, strong cyclonic storms with winds of more than 75 miles per hour, occur in the Gulf of Mexico and Caribbean in the late summer and fall seasons.

11. **A. *Which two minerals are the chief resources of the Gulf of Mexico and Caribbean areas?***

- B. *Where are these minerals being mined?***

The main mineral resource of the Gulf of Mexico and Caribbean is oil off the Gulf Coast of the United States and Mexico and from Lake Maracaibo in Venezuela. Natural gas is also growing in importance in these areas.

12. ***Where are the major naval air and surface bases in the Caribbean and Gulf of Mexico?***

The major naval bases in this area are the naval air base at Pensacola, Florida, and the naval base at Guantánamo, Cuba. Small training and development centers are located at Panama City and Key West, Florida, and Gulfport, Mississippi.

13. **A. *What is the vital navigational choke point of the Caribbean area?***

The vital navigational choke point of the Caribbean area is the Panama Canal.

B. *What is the principal importance of this waterway to the United States?*

The principal importance of this waterway is as a choke point on international trade.

14. ***Which Caribbean nation and government is a great worry to the United States?***

Cuba, with its government under Fidel Castro, has been a major problem for the United States in the Caribbean area since the early 1960s.

15. ***Why is the naval base at Guantánamo Bay important?***

The U.S. naval base at Guantánamo Bay is the main training base for the U.S. Atlantic Fleet. It has an excellent harbor and good facilities and good weather most of the year. There is also a large detention facility for prisoners taken by the United States during the war on terrorism.

16. ***Where is the deepest part of the Arctic Ocean?***

The deepest part of the Arctic Ocean is the Abyssal Plain running across the North Pole at a depth of 15,091 feet.

17. ***What valuable resource is being obtained from the continental shelf off Alaska and Canada in the Arctic Ocean?***

Oil is being taken from the continental shelf off Prudhoe Bay, Alaska, and the Beaufort Sea off Canada. The trans-Alaska pipeline takes the Prudhoe Bay oil to Valdez, Alaska, from where it is shipped to West Coast refineries by tanker.

18. ***Why would the Arctic probably become a major operational area in the event of a war between the United States and any Asiatic country?***

The Arctic would be a major operational area in the event of war because the great circle routes across the Arctic are the shortest distance between the United States and Asia.

19. ***How has the high dam on the Nile River at Aswan, Egypt, affected the ecology of the eastern Mediterranean?***

The dam has stopped the seasonal flood of fresh water and plant food into the sea, ending the fishing industry in the area.

20. **A. *What are some famous and important ports of the Mediterranean?***

Some famous and important Mediterranean ports include Barcelona and Valencia in Spain; Marseille in France; Genoa, Naples, and Venice in Italy; Piraeus, the port of Athens, Greece; Istanbul, Turkey; Beirut, Lebanon; Haifa and Tel Aviv, Israel; Alexandria in Egypt; and Algiers, Algeria.

B. *Where are some of the important naval bases in the Mediterranean?*

Some of the important naval bases include Barcelona, Spain; Toulon, France; La Spezia and Taranto, Italy; Izmir, Turkey; and Gaeta, Italy.

21. **A. *What are the names of the important Turkish straits?***

The Turkish straits separate European from Asiatic Turkey on either side of the Sea of Marmara—to the north, the Bosphorus, and to the south, the Dardanelles.

B. *Why are these straits so important to the NATO allies—and to the Ukrainians?*

Russian and Ukrainian fleet units must transit these straits when going to and from the Mediterranean and their Black Sea ports.

22. ***Why is the Suez Canal important to western Europe?***

Most of the trade between Europe and Asia passes through the Suez Canal.

Chapter 2

Maritime Geography of the Eastern Seas

1. **A. What is the narrow strategic sea located at the southern approaches to the Suez Canal?**

The Red Sea is located at the southern approaches to the Suez Canal.

- B. What is the key strait at the southern end of this sea?**

Bab el Mandeb is the key strait at the southern end of the Red Sea.

2. **Why is the Persian Gulf important to the United States and its allies?**

The Persian Gulf is extremely important to the United States and its allies because through it travels a major percentage of their oil.

3. **What is the key strait at the southern entrance to the Persian Gulf?**

The Strait of Hormuz at the southern entrance to the Persian Gulf is the key to the area.

4. **What occurred in the Middle East in late 1990 that caused U.S. and allied UN forces to go to war with Iraq?**

In August 1990 Iraqi forces under the command of Saddam Hussein invaded Kuwait, capturing the country in a few days and claiming it for Iraq. The response was Operation Desert Shield, which became Operation Desert Storm when the conflict began in January 1991. Ultimately some 527,000 U.S. military personnel and thousands of allied troops were involved. Kuwait was liberated on 27 February 1991 after the largest air and land campaign to be mounted since World War II.

5. **A. List the three main sea routes in the Indian Ocean.**

1. Persian Gulf through the Red Sea to Suez.
2. Along the east coast of Africa and around the Cape of Good Hope.
3. Past Singapore at the tip of the Malay Peninsula, through the Strait of Malacca, and across the Indian Ocean to Suez.

- B. Which one is the main route between Asia and Europe?**

The third route is the main one between Asia and Europe.

6. ***Which country in the Indian Ocean region received worldwide attention in 2001 because of the 11 September terrorist attack on the United States?***
Afghanistan.
7. ***Where has the United States built an important base in the Indian Ocean area?***
The United States has built a small, but important, base at Diego Garcia in the mid-Indian Ocean to support naval communication and Indian Ocean forces.
8. ***A. Which ocean is the largest in the world?***
The Pacific Ocean is the largest in the world.
B. Where is the deepest spot in this ocean, and what is the depth there?
The deepest spot in this ocean is the Marianas Trench, which is 36,161 feet deep. The trench is southeast of Japan and east of the Mañana Islands.
9. ***A. What formations are found on much of the western half of the Pacific sea floor?***
The western half of the Pacific sea floor has thousands of volcanic peaks, trenches, ridges, and submarine plateaus. The tops of the volcanic peaks are the Pacific islands.
B. What often forms around the rims of volcanic islands in the Pacific?
Coral barrier reefs often form around the rims of volcanic islands in the Pacific.
10. ***A. Where is the major naval base on the West Coast of the United States?***
The major naval base on the U.S. West Coast is San Diego, California.
B. Where are major naval shipyards located?
Major naval shipyards are located at Bremerton, Washington, and Mare Island, California.
11. ***Where are the major U.S. naval bases in the mid- and western Pacific?***
The major U.S. naval bases in the mid- and western Pacific are at Pearl Harbor, Hawaii; Guam; and Yokosuka, Japan.
12. ***Where does the Russian Pacific fleet have its headquarters?***
The Russian Pacific fleet headquarters is at Vladivostok. Other naval bases in the Pacific are at Nakhodka, Sovetskaya Gavan, and Petropavlovsk.
13. ***What are the two main tasks of the U.S. Navy in the event of war in the Pacific?***
The two main tasks of the U.S. Navy in event of war in the Pacific are (1) to protect the long supply lines to deployed forces and (2) to keep the sea-lanes open to allies, especially Japan, South Korea, the Philippines, Thailand, Australia, and New Zealand.

14. ***Which country is considered the key to U.S. foreign policy in the Pacific? Why?***

Japan has long been considered the key to U.S. foreign policy in the Pacific, because of its industry, industrious people, and strategic location.

15. ***What are present U.S. relations with China?***

U.S. relations with China were improving until the Tiananmen Square attack on student demonstrators in Beijing in mid-1989. In April 2001 a Navy reconnaissance aircraft was forced to land at Hainan Island. These incidents caused U.S. relations with China to be tense, but some improvement has occurred.

16. ***What is meant by the term "circumpolar ocean" when referring to the Antarctic seas?***

The term *circumpolar ocean* means that the ocean surrounds the South Pole, just as does the continent of Antarctica.

17. ***A. What valuable Antarctic resource has now been nearly wiped out?***

The whales have nearly been wiped out by modern whaling equipment and factory ships.

B. Which two countries still engage in this industry?

Iceland and Japan are the principal whaling nations.

18. ***Where does the United States have a research station in Antarctica?***

The United States has a research station at McMurdo Sound, Antarctica.

Chapter 1

Earth's Oceanographic History

1. ***What is oceanography?***

The Navy defines oceanography as the “application of the sciences to the phenomena of the oceans, including the study of their forms and their physical, chemical, and biological features.” Simply stated, oceanography is the scientific study of what happens on, in, and under the world’s energy-rich oceans.

2. ***Why does our government maintain an active program of oceanographic research?***

Our government conducts its oceanographic research programs for social, economic, political, and strategic purposes. *Socially*, the coastal regions of our nation and the world are major population and job centers. More than 40 percent of the U.S. population lives near the nation’s coastal regions. *Economically*, the oceans are rich in natural resources, food, and fuel. *Politically*, the oceans link the continents, providing the sea lines of communication between the industrialized and less developed nations of the world. *Strategically*, the oceans are vital to U.S. nuclear defense, especially the fleet ballistic missile submarine systems and their intercontinental ballistic missiles.

3. ***What is the scientific theory explaining the origin of the world ocean?***

As the water vapor cooled, condensed, and fell as rain, Earth gradually cooled; then, more and more water remained on Earth, eventually filling up the cracks and depressions in the crust and forming the world ocean. Lighter granitic rocks rose to higher elevations to become the continents, and the heavier basaltic rocks sank into the depressions to become the ocean bottoms.

4. ***How much of Earth’s surface is covered by water?***

About 71 percent of Earth’s surface is covered by the world ocean. The gradual buildup of polar ice caps has kept an almost uniform balance of the total amount of liquid water in the seas.

5. ***Describe the “construction,” or makeup, of Earth, listing and describing the major layers from the center outward.***

Earth is made up of several “shells,” much like a golf ball. The *core* consists of a solid inner core of nickel and iron with a diameter of about 860 miles, and a molten outer core of these metals about 1,300 miles deep. Above this is about 1,800 miles of dense rock called the *mantle*. The uppermost layer of the mantle, several hundred miles thick, is called the *asthenosphere*. It is

composed of molten rock called *magma*, or lava. The rigid outer *crust*, called the *lithosphere*, rides or floats on this molten part of the mantle. The crust is Earth's surface.

6. ***What are the names of the six major plates of the lithosphere?***

The six major plates of the lithosphere are the American, African, Eurasian, IndoAustralian, Antarctic, and Pacific plates. Most earthquakes and volcanic eruptions occur on the boundaries or margins of these plates.

7. ***A. Explain the theory of continental drift.***

B. When did the most recent sequence of geologic events leading to the present continental locations begin?

The theory of continental drift illustrates a constantly changing world. The plates floating on the asthenosphere have moved over the millions of years. The continents started to evolve into their present positions some 200 million years ago, breaking away from a single huge continent, Pangea. This great continent split along fault lines some 135 million years ago, first forming northern Laurasia and southern Gondwanaland. Gradually, the continents drifted apart to their present places.

8. ***Where is the most famous earthquake belt in the United States?***

The most famous earthquake belt in the United States is the San Andreas Fault, which runs through California. The entire West Coast is a notorious quake belt.

9. ***A. What is a tsunami?***

A tsunami is a huge, surging wall of water caused by an undersea event.

B. What events could cause a tsunami?

Earthquakes and volcanic eruptions can trigger a tsunami.

Chapter 2

Undersea Landscapes

1. ***How did Navy hydrophones open a whole new area of study for oceanographers?***

Hydrophones and echo sounders enabled oceanographers for the first time to chart the topography of the ocean floor. The time it took for echoes to return to a receiver from the bottom revealed the “lay of the land” beneath the sea; the results showed that the ocean floor had every bit as varied a topography as the land surface.

2. ***What are the two main levels in the relief of the earth?***

The two main levels in the relief of the earth are the continents, or continental terrace, including their submerged zones called the continental shelves, and the deep ocean floor/deep sea/deep ocean basin/abyss.

3. ***What are other names for the deep ocean floor?***

Other names for the deep ocean floor are the deep sea, the deep ocean basin, and the abyss.

4. ***A. How does an echo sounder determine the depth of water?***

Sound travels about 4,800 feet per second in water. If a sound pulse is sent to the bottom, part of it reflects as an echo from the bottom back to the receiver. By simply multiplying the time in seconds it takes to receive the echo by 4,800, and then dividing that answer by two (since the product is the distance down and back), the depth of the water can be determined.

- B. If it takes 5½ seconds for an echo to return to an echo sounder, how deep is the water in that spot?***

The water is 13,200 feet deep ($4,800' \times 5.5 \text{ sec} = 26,400 \div 2 = 13,200'$).

5. ***What are the three distinct divisions or areas of the ocean floor?***

The ocean floor is divided into three distinct areas: the continental shelf; the deep ocean basin, or abyss; and, between them, the continental slope.

6. ***Under international law, to what water depth does a maritime nation have the right to explore and exploit?***

International law grants a maritime nation the right to explore and exploit its adjacent continental shelf out to a depth of 200 meters, about 656 feet. This encompasses the continental shelf.

7. ***What is the continental slope?***

The main geographic characteristic of the continental slope is its sharp, or radical, descent from the shelf to the abyss, regardless of how far out from shore it occurs.

8. ***Why are the continental shelves the most valuable part of the ocean floor today?***

The continental shelves are the most valuable part of the ocean floor today because most ocean fishing is done there and because increasing amounts of oil and other minerals at depths from which they can be extracted have been discovered there.

9. ***What is a submarine fan, and how does it develop?***

A submarine fan is the silt eventually deposited in a plain of mud far out to sea from the mouths of great rivers and their submarine canyons.

10. ***What are the major segments of the Mid-Ocean Ridge?***

The major segments of the Mid-Ocean Ridge system are the Mid-Atlantic Ridge, Mid-Indian Ocean Ridge, and East Pacific Rise. The Mid-Ocean Ridge is a 40,000-mile-long mountain chain under the sea. A rift line runs down the ridge's centerline, and large portions of the major plate margins of Earth's surface coincide with this rift's centerline.

11. ***Describe the geologic sequence of events in the "wearing down" process of an oceanic island.***

All oceanic islands are volcanic in origin. Almost all of the small islands of the Pacific are the tops of volcanoes, most of these now extinct. *Island fragments* are large islands that have broken away from continental masses. Examples of island fragments are New Zealand, New Guinea, and Greenland.

One type of Pacific volcanic island is built up by explosive eruptions of lava on the landward side of a deep oceanic trench; examples are the Kurils, Bonins, and Marianas. The other type has been formed by deep, slow eruptions that have boiled or melted through the rigid Pacific plate itself, not on its marginal ridges. These eruptions occur as the plate moves over a volcanic plume, or hot spot, in the asthenosphere, and creates a series, or string, of oceanic islands of decreasing age. The Hawaiian Islands are the best example of a volcanic island chain formed by plate motion over a plume in the mantle. Kilauea and Mauna Loa on the big island of Hawaii are two of the world's most active volcanoes.

The older the island, the more eroded and worn down it is. At first the island has a steep peak. Gradually, fringing reefs are built up by corals, while the wind, waves, and rains erode the mountain. As the mountain subsides, the coral becomes a barrier reef of connecting coral islands called an atoll. Eventually most of the island wears away, leaving a lagoon surrounded by the coral reef, and, finally, all will disappear beneath the sea again.

12. ***What is the difference between a seamount and a guyot?***

A seamount is a peaked underwater summit that has not reached the surface. Seamounts that have reached the surface and been flattened out by erosion (usually wave action) down below water level again are called guyots.

13. **A. *What are the three general types of sediments found on the ocean floor?***

The three general types of sediment materials on the ocean floor are oozes, clays, and land-derived muds. *Oozes* are found in warm, shallow waters and are composed mainly of marine shells and skeletons of minute animals. *Clays*, usually dark brown or reddish, are found in the deep, cold parts of the ocean basin; they are made up of airborne, volcanic, and meteoric dusts. *Land-derived muds* are materials brought down by turbidity currents that flow into the oceans, or by icebergs that melt at sea. Sediments accumulate in the deep seabed at a rate of about one inch every 2,500 years.

B. *Why do sediment thicknesses vary widely from one part of the ocean floor to another?*

Sediments occur in varying thicknesses around the ocean floor because of underwater currents, landslides, and physical obstacles such as ridges, canyons, trenches, and seamounts. These actions and features result in scouring in some areas on the edge of abyssal plains, and in depositing great thicknesses of sediment in others.

14. **A. *How do metallic nodules form on the ocean floor?***

Mineral crystals often solidify or encrust around tiny objects on the sea bottom, forming nodules or lumps of metal. It is not yet scientifically clear how or why this occurs. Ions of manganese in solution in the seawater apparently attract each other—as well as other minerals in solution such as copper, nickel, cobalt, and iron—which creates nodules one to six inches thick on the seabed.

B. *What is the engineering problem that must be solved regarding the “mining” of these nodules?*

The difficulty of mining these nodules is great because most are found at depths in excess of 12,000 feet. The cost of such mining is still too great to compete with land mining, though extensive research is being conducted to discover methods that will make the mining economically feasible.

15. **A. *What is the purpose of a coring tube?***

The coring tube is used to capture a long cylinder of sediment up to 60 feet long from the ocean bottom for scientific study. It is a heavily weighted, hollow steel tube with an internal plunger, or piston.

B. *How does it work?*

Dropped over the desired site, the tube hits the bottom and the piston stops on contact with the sediment. The weight and momentum of the tube drive it deep into the ooze or clay. A partial vacuum is created as the plunger moves up the tube. When the corer is brought back aboard, the enclosed sediment sample is held in the tube by brass clamps that close automatically at the end of the tube.

Chapter 3

Seawater: Its Makeup and Movements

1. ***Who is the founder of modern U.S. Navy oceanography?***

The founder of modern oceanography was Matthew Fontaine Maury of the U.S. Navy.

2. ***What is unique about the cooling and freezing of water?***

Although most materials expand when heated and contract when cooled, water contracts until cooled to about 4 degrees C (39.2 degrees F), but then expands rapidly, increasing in volume about 9 percent. (Example: milk or water freezing in a bottle.) Without this unique expansion, the polar seas would probably have frozen to the bottom long ago, and much more of the globe would be under an icecap.

3. ***How does the ability of water to store heat make life possible on Earth?***

Water can store heat, while land absorbs and loses heat quickly. If Earth were all land, like the Moon, it would be scorching hot every day and freezing cold every night. Not many higher life forms could survive under these conditions. The oceans absorb heat in one area and transfer that heat to another, where some is released through evaporation—thus creating a temperate climate.

4. ***A. What are the four main elements in seawater?***

The four main elements in seawater are hydrogen, oxygen, sodium, and chlorine.

B. What is the percentage of salt in open ocean water?

The percentage of salt in seawater varies between 32 and 37 parts per thousand, with open ocean waters usually about 35 parts, or 3.5 percent ($35/1,000 = 0.035 = 3.5$ percent).

5. ***A. What are the saltiest bodies of water in the world ocean?***

The saltiest bodies of water in the world ocean are the Red Sea (highest at 4.1 percent) and the Mediterranean Sea (3.85 percent).

B. In landlocked lakes?

Landlocked lakes, like the Dead Sea of Israel (35 percent) and the Great Salt Lake of Utah (25 percent), have the highest salt content of any bodies of water on Earth.

6. ***How did the ocean water get salty?***

For millions of years, rain and melted snow have run over the land, dissolving minerals and carrying them down to the sea. The salts of the sea are the result of over two billion years of wearing away of the rocks of Earth's crust.

7. ***Describe the hydrologic cycle.***

The round trip of evaporation, condensation, and return travel of water to the sea is called the hydrologic cycle. Plants on land add to the amount of water vapor entering the air by the process called transpiration, or evaporation of moisture from plants and trees. As water evaporates from the surface of the sea, the water vapor moves toward shore and rises. As it rises, it cools, and the vapor condenses into rain or snow, which falls to Earth and begins its journey back to the sea, carrying minerals from the land as it goes.

8. ***What two minerals are extracted from seawater on a commercial basis?***

Only magnesium and bromine are presently taken from ocean water commercially. Magnesium is used in the manufacture of lightweight alloys for airplanes and satellites. Bromine is used in the manufacture of antiknock gasoline and other chemicals.

9. ***A. What is the freezing point of seawater?***

The freezing point of seawater is about 28 degrees F (–2.2 degrees C).

B. What is the constant temperature of water in the deep sea?

The constant temperature of water in the deep sea is about 39.2 degrees F (4 degrees C).

10. ***What determines the color of water (as seen by the human eye)?***

Clear, clean water actually has no color, but it appears to have shades of green or blue due to the reflection of the sky, scattering of light, or foreign materials in solution or suspension in the water. Some of the visible light that strikes the surface of the ocean is reflected back, but some penetrates the water. As it descends, it changes in quality and quantity. The water acts as a filter, gradually absorbing various wavelengths of light, starting at the red end of the spectrum, so that the light is bluer at greater depths.

11. ***What is the most common cause of ocean waves?***

Wind is the most common cause of ordinary sea waves.

12. ***Upon what three things does wind-generated wave height depend?***

The height of wind-generated waves depends on three main factors: wind speed, duration of the wind, and the length of the *fetch* (the distance the wind blows over the water without significant change of direction).

13. **What are the parts of a wave?**

The parts of a wave are the crest or top of a wave; and the lowest part between crests, the *trough*. Wave height is the vertical distance between the crest and the trough, while the length of the wave is the horizontal distance between two successive crests.

14. **What are the three kinds of breakers, and what determines each?**

Breakers occur when waves hit bottom in shallow water and “fall over” themselves. The kind of breaker is determined by the gradient or slope of the bottom. A *spilling breaker* develops on a mild, gradual, almost flat bottom slope. The breaker is slight and can be seen advancing as a line of foam toward the beach. A *plunging breaker* occurs on a steep bottom slope, such as occurs with a coral reef a mile or so offshore. The plunging breaker creates an advancing vertical wall of water called surf. A *surging breaker* occurs on a very steep bottom slope, such as abrupt rock formations. The waves crash into the bottom rocks, and the breaker explodes in a surge of foaming, turbulent water.

15. **A. Why are surf and swell so important to amphibious operations?**

Waves, swell, and surf conditions are vital information to planners of amphibious operations. Surf conditions determine when troops and vehicles from landing craft can be safely landed.

B. What is meant by “critical” height of surf?

Critical height of surf is generally considered to be four feet for normally safe amphibious landings on an average beach. Above that height, craft are apt to broach, or turn broadside to the beach, after grounding. Broaching can damage propellers and bring sand into engine intakes.

16. **A. What water actions reshape coastal landforms?**

Coastal landforms owe their shapes to the local action of waves, tides, and currents on coastal rocks and sediments.

B. What is such action called?

Such wearing down and changing of the coastal outline and makeup is called *erosion*.

17. **What is the main type of structure built to protect harbors from the sea called?**

The principal structure built to protect harbors from the sea is the *breakwater*.

18. **A. What is a longshore current?**

A longshore current is the movement of water from incoming waves as it moves parallel to the beach in a definite flow and speed away from where it hit the shore.

B. What type of structure is built to prevent erosion from these currents?

Groins are walls of stone or wooden pilings built at right angles to a shoreline to prevent erosion by longshore currents.

19. **A. What is a rip current, and how may it affect swimmers?**

Rip currents are strong, seaward-moving currents that occur along some shores to return excess water that has been pushed ashore by strong waves. They occur when a longshore current moving in one direction encounters another longshore current moving in the opposite direction. Rip currents are often incorrectly called undertow.

B. How should a swimmer move to get out of a rip current?

If caught in a rip, the swimmer must not fight the current. Because rip currents are rarely more than 100 feet wide, the best advice is to swim parallel to the shore or breakers until out of the rip, that is, across the current, using just enough strength to avoid being pulled out to deep water beyond the breakers. The swimmer must not panic or struggle, to avoid overexerting.

20. **A. What force, caused by Earth's rotation, affects the major currents of the world ocean?**

Earth's rotation, or spin, creates an invisible force called the *Coriolis force*.

B. In what direction does this force deflect major currents north and south of the equator?

The Coriolis effect deflects free-moving particles (including wind systems and currents) to the right (clockwise) in the Northern Hemisphere, and to the left (counterclockwise) in the Southern Hemisphere.

21. **What very important current affecting the United States originates on the southern border of the Sargasso Sea?**

The *Gulf Stream* originates on the southern border of the Sargasso Sea.

22. **A. Which current brings icebergs into the North Atlantic shipping lanes?**

The *Labrador Current* brings icebergs that have calved (broken away) from the glaciers of western Greenland into the North Atlantic shipping lanes.

B. How does the Gulf Stream affect icebergs?

The Gulf Stream, with its warmer waters, eventually melts the icebergs.

23. **A. What important current in the North Pacific has many similarities with the Gulf Stream in the North Atlantic?**

The *Kuroshio*, or *Japan Current*, originates from the North Equatorial Current and is very similar to the Gulf Stream system in the North Atlantic.

B. What severe storms originate in the same general area as does this current?

Typhoons, severe storms with the same characteristics as hurricanes, originate in the North Equatorial area and move toward the Asiatic coast in the same manner as do hurricanes in the North Atlantic.

24. **A. How do deeper water layers often move in relation to the major surface currents?**

As the frictional force of the winds on Earth's surface causes the motion of the major surface currents of the world, a counterforce caused by gravity and the Coriolis effect creates an opposite motion in major segments of the deeper water layers, particularly in higher latitudes.

B. What are these subsurface currents called?

These subsurface currents are called *countercurrents*.

25. **A. What is the main cause of the ocean tides?**

The main cause of ocean tides is the gravitational effect of the Moon on Earth's surface. The Moon's gravity pulls the oceans on the Moon's side of Earth toward it. A centrifugal force effect causes the water on the far side of Earth to bulge out as well. Since the Moon revolves about Earth every twenty-four hours, there is an ebb and flow of the tide twice daily.

B. How does the Sun affect the tides?

The Sun also has an effect on the tides, but this is only two-fifths as strong because the Sun is 390 times as far away. Variation in positions of the Sun and Moon relative to Earth produces the high and low ranges of tides.

26. **When are tides highest and lowest, and what are these tides called?**

At the times of the new and full moons, the tides are highest and lowest because the forces of the Moon and Sun are working together, resulting in *spring tides*. Halfway between the new and full moons, when the Moon is in its first and third quarters, the tidal forces of the Moon and Sun are opposed, greatly reducing the difference between high and low tides; these are called *neap tides*.

27. **A. How do naval personnel find out about the tidal situation in their port of call?**

Tide Tables are prepared and published for years in advance for most parts of the world by the National Oceanic and Atmospheric Administration (NOAA). Tides from these tide tables are usually published daily in the *Plan of the Day* aboard ship and at naval bases.

B. Which persons aboard ship are particularly concerned about the tides? Why?

Tides are important in port to the navigator, the OOD, responsible officers of the Deck Department, and boat officers and coxswains. The tidal information assists these people in providing for slack in mooring lines, determining anchorages, and planning boat schedules.

28. **Where do the world's highest tides occur?**

The world's highest tides occur in the Bay of Fundy, between Nova Scotia and the Canadian mainland; spring tides there may often exceed 50 feet.

29. **A. What is a tidal bore?**

A tidal bore, or tidal surge, is a twice-daily event, during which the tide sweeps up a river whose mouth opens directly on the sea.

B. *Where do the highest tidal bores occur?*

The highest tidal bores occur on the Amazon River in Brazil and on the Hangchow River in China, where bores 15–25 feet high speed up the rivers at 10–16 knots for hundreds of miles.

30. *What is the general theory of operation of a tidal power plant?*

The general theory of operation of a tidal power plant is to construct a dam that opens to allow the sea to enter during high tide, and then closes to block return of the water at low tide except through the turbines, which generate electricity.

Chapter 4

Life in the Seas

1. ***What is marine biology?***

Marine biology deals with the living, or organic, content of the sea—its plants and animals. Biological oceanography or marine ecology is concerned with the relationship between organisms and their environment. It is directly related to (1) human use of the sea's vast quantities of life for food and employment, and (2) the effect of marine life on naval operations.

2. ***In what areas does marine biology have a direct impact upon naval matters?***

Marine biology has a direct impact on naval matters that concern the condition of ships, installations, and equipment (fouling and marine damage), the ability of people to live and work on and under the sea, and the effectiveness of sonar equipment, among others.

3. ***What are the two basic families of plankton in the seas?***

The two basic families of plankton in the seas are phytoplankton (plants) and zooplankton (animals and larvae of larger sea life).

4. **A. *What is upwelling?***

Upwelling is the movement of subsurface layers of water toward the surface. It occurs near the steepest gradient of the continental slope. Upwelling occurs when prevailing winds along the shore cause the mass transportation of upper water layers away from the coast. The Coriolis force is also a factor. The resultant vertical circulation from great depths brings decayed materials high in nitrogen and phosphates to the surface.

B. *What is the effect of El Niño?*

The phenomenon that causes upwelling to stop occasionally along the Peruvian coast is called El Niño. It occurs when the cold Humboldt Current meanders out to sea rather than along the coast, allowing warmer currents to come in and stopping the upwelling of life-supporting nutrients. Fish and birds die by the millions, and the hydrogen sulfide from their decaying bodies turns the hulls of ships in the area black, an occurrence called the *Callao Painter*. It can also cause dramatic climatic changes in Central and North America and elsewhere. A related opposite effect called *La Niña* usually follows.

5. **What oceanographic phenomenon has given the Red Sea its name?**

The Red Sea is named from the periodic bloom of tiny red plankton called *dinoflagellata*, which are so numerous that the water takes on a reddish hue, giving it the name *Red Tide*. The Red Tide clogs the gills of millions of fish, causing them to suffocate and die.

6. **Why has the Black Sea been so named?**

Because the opening to the ocean through the Turkish straits is so shallow, little exchange of water occurs between the Black Sea and the Aegean Sea/Mediterranean Sea. Consequently, the Black Sea has no upwelling, is deficient in dissolved oxygen, and is, in fact, stagnant. The residue of marine life in its surface layers sinks to the bottom and remains there to decay. This decay uses up most available oxygen and creates hydrogen sulfide gas. Over thousands of years, all bottom life in the Black Sea has died, leaving a hydrogen sulfide layer that begins about 200 feet below the surface. This black zone has given its name to the sea.

7. **Describe the steps in the marine food cycle.**

The food cycle in the sea is triggered by sunlight, which starts the process of *photosynthesis*, the manufacture of food in a green plant. These chlorophyll-bearing (green-colored) plants called phytoplankton are food for the zooplankton. The zooplankton are the food for small flesh-eating fishes, which, in turn, are eaten by larger ones. Death and decomposition complete the cycle: the organic materials of both plants and animals decay as the result of bacterial action, releasing again the nutrient raw materials—carbon, phosphorus, and nitrogen—needed to start the process of photosynthesis over again.

8. **What are some of the unique characteristics of marine animals that live in the deep sea (abyss)?**

Marine animals that live in the abyss are generally small, ferocious carnivores with soft, scale-less bodies of many shapes. They are often snakelike with narrow fins and pliant bones, and most are black in color. Some have natural luminescence to attract prey or their mates, while others are totally blind.

9. **What are some special characteristics of sea animals living at the edge of the sea?**

Animals that live at the edge of the sea are subject to the extremes of drying, flooding, baking, and freezing if they are exposed when the tide ebbs. Waves and currents may wash them up on the beach, and many predators can get them when they are exposed. They often are small, flat, or streamlined with suction-type devices that hold them tightly to rocks. Barnacles, corals, sea anemones, sea cucumbers, sea urchins, starfish, and some species of crabs and clams live in this area.

10. **A. What are the smallest animals of the zooplankton group?**

B. The largest?

The smallest animals of the zooplankton group are the one-celled protozoans, the largest are the jellyfishes.

11. **How has the St. Lawrence Seaway affected the ecological environment of the Great Lakes?**

The St. Lawrence Seaway allowed a species of jawless fish called sea lampreys to enter the Great Lakes, where it has no enemies. The lampreys have caused great damage to lake trout and whitefish fisheries because they attach themselves to these fish and kill them.

12. **What are the four groups of marine animals with jaws?**

The four classes of marine animals with jaws are fish, reptiles, seabirds, and mammals.

13. **A. What are the four groups of living marine reptiles?**

The four groups of living marine reptiles are turtles, marine iguanas, sea snakes, and ocean crocodiles.

- B. Where are the most dangerous of these animals found?**

The sea snakes are very poisonous. Sea snakes inhabit sheltered coastal waters, especially near river mouths, and brackish water upstream. They live in the tropical Pacific and Indian Oceans. They are found as far north as Korea in the Japan Current, throughout the islands of Oceania, and along the Pacific coast of Central America.

14. **What part of the world is the penguin's native habitat?**

Antarctica is the natural habitat of most penguins, though some are native to the southern tip of South America (Chile and Argentina).

15. **A. What are the three groups of seals?**

The three groups of seals are the earless, or true seals; the eared seals, or sea lions; and the walrus.

- B. Which are protected by hunting laws?**

The fur seals of Alaska are now protected so they can be carefully harvested for their valuable pelts.

16. **A. What are the two main groups of whales?**

Whales, dolphins, and porpoises are the mammals most adapted to the marine environment. They spend their lives entirely in the water. The giant blue whale is the largest mammal ever to have lived on Earth. The two suborders of the whales are the *baleen*, or whalebone, whales and *toothed whales*.

- B. What is the main difference between the two groups?**

Baleen whales are equipped with a fine mesh sieve with up to 800 or more plates of baleen, or whalebone, that hang from the upper jaw. When feeding, the whale first opens its jaws, then

closes them, allowing the water to flow out through the baleen but keeping any collected marine life inside. The toothed whales have teeth that enable them to eat fish or squid. The nar-whal, however, has only a single long, tusklike tooth in its upper jaw.

17. **A. Why is the Sargasso Sea so named?**

The Sargasso Sea gets its name from the floating sargassum weed.

B. Why is this area almost a “desert” in the sea?

The area of the North Atlantic called the Sargasso Sea is nearly a desert in the sea because it has almost no upwelling of nutrients from the deep sea bottom to produce phytoplankton.

18. **What are three things that can help increase food production from the sea?**

Three things that can help increase food production from the sea are (1) a change in people’s eating habits, (2) careful conservation and harvesting practices, and (3) cultivation of selected kinds of marine plant and animal life for food through a growing industry called aquaculture.

19. **To date, what types of ocean fish or shellfish have proved to be most successful in aquafarming?**

To date, oysters and mussels have proved most successful in aquafarming. Fish farming with carp, milkfish, and shrimp have proved successful in Southeast Asia for centuries.

20. **A. How do the deep scattering layers affect naval operations?**

B. What causes these layers?

C. Because of biological noises in the sea, what special training did the Navy begin for sonarmen?

The *deep scattering layers* appear to be movements of vast numbers of zooplankton that rise from the depths during the night to feed on phytoplankton in the upper, lighted zone. These deep scattering layers create horizontal sound-reflecting bands at various depths over broad stretches of the world’s oceans. The bands cause some confusion with echo-sounding devices and sonar equipment. The Navy, therefore, recorded and identified the various biological and mechanical noises, and now trains sonarmen to distinguish among them.

21. **A. What does bioluminescence mean?**

B. What causes it?

C. How can this phenomenon affect naval operations?

Bioluminescence is that light created by insects (fireflies), certain fishes of the abyss, and microscopic marine dinoflagellata (a single-celled phytoplankton). Observed from the air or from the bridge of a large ship, the bioluminescent wake of a ship or periscope traveling through the sea can be detected for some distance, clearly revealing the vessel’s position and, roughly, her direction and speed.

22. **What is the most serious effect of marine fouling and deterioration for the Navy?**

Biological fouling and deterioration costs the Navy many millions of dollars annually. The most serious effect of marine fouling and deterioration is that it reduces the combat readiness of naval ships and shore facilities.

23. **What two categories of marine species can be dangerous to people?**

The two categories of marine species capable of harming people are poisonous or venomous, and carnivorous.

24. **What are the four groups of stinging animals that can injure humans?**

The four groups of stinging animals that can injure people are (1) corals, sea anemones, jellyfishes, and hydroids; (2) mollusks, including octopi and certain shellfish; (3) bloodworms and bristleworms; and (4) sea urchins.

25. **What are the four species of poisonous fish that are particularly dangerous to people?**

The four species of poisonous fish that are particularly dangerous are the stingrays, catfishes, weeverfishes, and scorpionfishes.

26. **A. What does SCUBA mean?**

SCUBA means self-contained underwater breathing apparatus. It is usually used with a specially tailored wetsuit, flippers, and mask, along with the compressed air tanks; the scuba swimmer can swim independently with this gear.

B. Before divers use scuba gear, what qualifications should they have?

Scuba divers must take a complete training course in the use of the equipment, be good swimmers, and be in good health; scuba diving is not for the novice.

27. **What is the purpose of the bathyscaphe?**

The bathyscaphe is a free-moving underwater research vessel. It is used for extended exploration of the deep sea; the scientists aboard can look through ports, take photos, collect samples with mechanical arms, and so on.

28. **What are the seven main groups of sea pollutants?**

The seven main groups of pollutants that now affect the marine environment are (1) petroleum; (2) heavy metals; (3) radioactive particles; (4) chemical and synthetic fuels, solvents, and pesticides; (5) litter; (6) domestic sewage; and (7) biological pollutants.

29. **A. What are the main causes of petroleum pollution in the sea?**

Petroleum pollution in the sea is caused mainly by intentionally pumping bilges and washing out fuel tanks, but it also results from ship collisions and groundings, and from oil drilling rig accidents.

B. *Where is the most damage caused by an oil spill?*

An oil spill causes most damage when an oil slick reaches shore, or collects in harbors, coves, or bays. The results are disastrous for the seabirds, mollusks, and other shallow-water life. Oil spills can also devastate the economy of a beach resort.

30. *What is the particular danger of heavy metal pollution?*

The sea's main heavy metal pollution is mercury and, to a lesser extent, barium. These metals are discharged in the effluent from chemical plants, cement works, and other manufacturing processes, doubling their natural accumulation in the sea. As a result, increased traces of mercury are picked up by shellfish and other fish, causing dangerous concentrations that can cause severe illness in humans when they eat the fish.

31. *How does pollution by synthetic compounds affect natural reproduction of seabirds and animals?*

Pollution by synthetic compounds, such as pesticides and herbicides, and by biphenols, such as solvents and refrigerants, causes reproductive failure in some marine birds. Pesticides and herbicides run off from farmlands and kill the eggs and small fry of fish, greatly reducing the natural reproduction of game fish in the inland streams, rivers, and ponds.

32. *How do radioactive pollutants affect marine life and humans?*

Radioactivity from nuclear waste builds up in fish and, in turn, affects humans when they eat the fish.

33. *How does domestic sewage upset the natural ecosystem in enclosed water areas?*

Domestic sewage contains high levels of nutrients that promote rapid plankton growth. This growth uses up the available oxygen and upsets the natural ecosystem.

34. *What are two forms of biological pollution that have found their way into U.S. waters in recent years?*

Two biological pollutants that have entered U.S. waters in recent years are the Zebra mollusk in the Great Lakes and various rivers, and a type of sprawling marine weed called hydrilla in the Chesapeake Bay.

UNIT 3 Meteorology

Chapter 1

Our Atmosphere

1. *What are the two main elements in our atmosphere and the approximate percentages of each?*

The two main atmospheric elements are nitrogen, 78 percent, and oxygen, 21 percent.

2. *What changes occur to the air as one ascends into the atmosphere?*

The higher one goes, the lighter the air becomes, and the more compressible it is.

3. *Where does most of Earth's weather occur?*

Most of Earth's weather occurs within the "air envelope," the first 3½ miles of atmosphere above Earth's surface.

4. *What are the five principal layers of Earth's atmosphere?*

In order from Earth's surface upward, the five principal layers are the troposphere, stratosphere, mesosphere, thermosphere, and exosphere.

5. **A.** *In what layer of the atmosphere are most clouds found?*

Most clouds and weather occur in the troposphere.

- B.** *What are the laws of gases that apply to the development of clouds?*

The applicable laws are (1) expansion is a cooling process, while (2) compression causes heat. These laws determine the formation of clouds.

6. *Why have the United States and several other countries studied Antarctic air masses in recent years?*

The movements of cold-air masses around Antarctica are a major factor in the world's weather. This has prompted the United States and several other countries to undertake intensive research there.

7. **A.** *What is the tropopause?*

The tropopause is the transitional zone between the troposphere and the stratosphere at altitudes of about 5 to 11 miles.

B. Why is it so important to commercial aviation?

The region from 20,000 to 40,000 feet has the jet stream, which enables planes to increase speed, shorten air time, and conserve fuel.

8. **What are some of the current studies concerning the jet stream, and why are these studies important?**

Jet streams move with the cool-air masses near Earth's surface, so commercial pilots can take good advantage of them in winter; in summer they move much farther north, out of most commercial lanes. Flight paths are plotted in accordance with jet-stream information.

9. **Why do modern commercial aircraft prefer to fly mostly in the stratosphere?**

Almost no weather exists in the stratosphere (above the tropopause to about 30 miles). There are no clouds, and there is almost constant temperature of -40 degrees F to -50 degrees F. There is much less air resistance here, so fuel mileage and speed are greater and there is no turbulence to disturb flight comfort.

10. **What visual phenomenon occurs in the ionosphere over the polar regions?**

The Northern and Southern Lights (Aurora Borealis and Aurora Australia) occur in the ionosphere over their respective polar regions.

11. **What is the importance of the ionosphere to communications?**

The ionosphere reflects radio waves. Determination of frequencies and transmission times on the basis of ionosphere conditions can greatly enhance communications.

12. **A. What is the average air pressure at sea level?**

The average air pressure at sea level is 14.696 psi.

B. What instrument measures air pressure?

The instrument that measures air pressure is the barometer.

13. **What are the two types of barometers used by the Navy?**

The Navy uses mercurial and aneroid barometers.

14. **What is weather?**

Weather is the condition of the atmosphere in terms of its heat, pressure, wind, and moisture content.

15. **What three things cause changes in the weather?**

Changes in weather are caused by the air's temperature, pressure, and water-vapor content; wind causes the weather to move.

16. **What is the "greenhouse effect"?**

Earth's cloud cover acts like the glass in a greenhouse. It lets short solar rays pass through to be absorbed by the Earth, but then reradiates them as long heat waves that cannot get through the atmosphere because they are absorbed by the water vapor.

17. **A. What are the two most widely used temperature scales?**

The Fahrenheit and Celsius (formerly called Centigrade) thermometer scales are the two most widely used today.

B. What are the freezing and boiling points of each?

Fahrenheit: 212 degrees F boiling, 32 degrees F freezing; Celsius: 100 degrees C boiling, 0 degrees C freezing.

18. **What is the water cycle?**

The water cycle is the cycle of evaporation, condensation, and precipitation, which is continually in process on the surface of the Earth. A part of evaporation is transpiration—the evaporation of water into the air from green leaves of plants.

19. **What is the dew point?**

Dew point is the temperature to which air must be cooled, at constant pressure and constant water vapor content, to reach saturation (100 percent relative humidity).

20. **What instrument measures relative humidity and dew point?**

Relative humidity and dew point are measured with a psychrometer.

Temperature Conversion Problems

1. A. 122 degrees F = 50 degrees C
B. 86 degrees F = 30 degrees C
C. -4 degrees F = -20 degrees C
D. 104 degrees F = 40 degrees C
2. A. 60 degrees C = 140 degrees F
B. 20 degrees C = 68 degrees F
C. -10 degrees C = 14 degrees F
D. 35 degrees C = 95 degrees F

Chapter 2

Clouds and Fog

1. ***Of what is a cloud made?***

A cloud is a mass of hygroscopic nuclei (dust particles) that have soaked up moisture from the water vapor in the air.

2. ***What causes earthbound moisture to evaporate?***

Heat generated by the Sun's energy causes earthbound moisture to evaporate into the sky in the form of water vapor.

3. ***What are the three basic guidelines used to determine which kinds of clouds are in the sky and how they may affect weather prediction?***

Three basic guidelines to determine how clouds may affect the weather are (1) what type of clouds, (2) how high they are, and (3) how fast they are changing.

4. ***What are the names of the three basic cloud types?***

The three basic cloud types are cirrus, cumulus, and stratus.

5. ***What are the two means of classifying clouds?***

Clouds are classified in accordance with their altitude and appearance.

6. ***What are the ranges of altitude for low, middle, and high clouds?***

The ranges for cloud altitudes are:

Low: surface to 7,000 feet

Middle: 7,000–20,000 feet

High: above 20,000 feet

Towering: exceptionally high cloud with base in low area

7. ***What type of weather is associated with these types of clouds?***

A. **Stratus:** drizzle; gray day

B. **Nimbostratus:** rain-laden clouds; in winter, steady snow

C. **Cumulonimbus:** thunderstorm, tornadoes

D. **Cumulus:** fair weather; in winter, clear and cold

E. **Cirrus:** clear and cold(er); if in parallel lines, a violent storm is likely within thirty-six hours

F. **Altostratus:** rain is probable within twenty-four hours

8. ***How were early navigators often able to find previously uncharted islands?***

Clouds usually form above islands as a result of moisture rising from transpiration; land below is often reflected on clouds above.

9. ***What is precipitation?***

Precipitation is any form of moisture falling from the air: rain, snow, sleet, and hail.

10. ***A. How do raindrops form?***

Raindrops form when moist air is cooled to the point where moisture condenses into heavy drops.

B. What is coalescence, and how does it happen?

Coalescence is a process that occurs when cloud droplets grow in size by combining with one another, either by bumping into other droplets in the cloud, or, more important, when ice crystals and water droplets form near each other in higher altitude clouds. When the droplets evaporate in the cooling process, the resulting vapor collides with the crystal and condenses into snow or ice pellets that fall toward Earth, melting into rain as they get into lower altitudes.

11. ***What two techniques are used in modern rainmaking?***

Aircraft dropping dry-ice crystals or silver-iodide crystals into potential rain clouds is a process called *seeding*, the most common rainmaking method. Silver iodide can also be sent up from the ground in the form of a gas by use of generators.

12. ***A. What is sleet?***

Sleet occurs when rain that has formed in relatively warm air falls through a layer of freezing air.

B. What causes it to occur?

The sleet forms around dust nuclei, falling as supercooled mush that often freezes upon contact with objects on the ground.

13. ***What is hail, and how are hailstones formed?***

Hail begins as frozen raindrops in high levels of cumulonimbus thunderheads; updrafts push the pellets upward one or more times, with pellets being coated with water from lower cloud layers each time; when the pellets get too heavy for further updraft effects, they fall as hail.

14. ***What is fog, and how is it formed?***

Fog really is a low-lying cloud near or touching the ground. It is formed when cool air moves in and mixes with warm air having a high relative humidity; the temperature of this air must fall below the dew point. Each water droplet has a particle of dust or smoke as its nucleus. If the fog is heavily mixed with smoke, it is often called smog.

15. **A. *Where are the two most famous natural sea-fog areas located?***

These areas are around the Aleutian Islands of Alaska adjacent to the Japanese Current and the Bering Sea, and off the Grand Banks of Newfoundland where the Gulf Stream strikes the Labrador and Greenland Currents coming south from the Arctic.

B. *Why do they have such frequent fog?*

The Japanese Current and Gulf Stream are the warm currents over which warm air circulates and changes into fog when impinging upon the cold currents and seas mentioned.

Chapter 3

Wind and Weather

1. **A. *What is a simple definition of wind?***

Air in motion is called wind. Winds blow because of the natural attempt to achieve a balance in atmospheric pressure, unequal distribution of which is caused by the unequal heating on Earth's surface.

B. *Upon what does the strength of wind depend?*

The strength of wind depends on the distance of the high-pressure area from the low, and the difference in pressure between the two areas.

2. ***What are the three primary wind belts in the Northern Hemisphere?***

The three primary wind belts are the northeast trades, the prevailing westerlies, and the polar easterlies.

3. **A. *What two motions of Earth affect the weather?***

The movement of Earth around the Sun (accounting for seasonal changes) and the rotation of Earth on its axis are the two motions that affect the weather.

B. *Which of these motions causes the major wind belts?*

It is Earth's rotation that produces the major wind belts.

4. ***How does the Coriolis effect cause winds to deflect in the Northern and Southern Hemispheres?***

The Coriolis effect causes winds to curve to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.

5. **A. *How does atmospheric pressure affect the primary wind belts?***

Air rises at the equator due to the heat and moves northward at high altitudes; it sinks near the surface, causing a high-pressure area, near 30 degrees north and south latitudes.

B. *What are the principal high-pressure belts on Earth's surface?*

Since wind flows outward from the center of the high, the air that flows inward from the Horse Latitudes (30°) is deflected to the right by the Coriolis effect to become the easterly trades; the wind moving outward from the highs to the poles becomes the prevailing westerlies. Similar effects occur at about 60 degrees with the polar highs.

6. **What determines the directional name of a wind?**

Winds are given directional names based on the point of the compass or area of origin from which they blow.

7. **Explain each of the world's prevailing wind and pressure belts.**

The prevailing wind and pressure belts are as follows:

- *Doldrums*: equatorial; high temperatures, often no winds; birthplace of severe tropical storms and cyclones.
- *Trade winds*: poleward from doldrums; prevailing NE and SE trades; received names from sailing vessels that used these winds to good advantage in the commercial trade.
- *Subtropical High-Pressure Belt/Horse Latitudes*: weak, undependable winds; fair weather because of diverging winds at surface; belts generally at 30 degrees north and south latitudes.
- *Prevailing westerlies*: poleward side of Horse Latitudes; provide most of air flow over the United States and Europe.
- *Polar Front Zone*: 60 degrees north and south latitude areas; bad-weather areas because of converging easterlies and westerlies.
- *Polar easterlies*: poorly developed surface winds created by outflow from the high pressure at the poles.

8. **A. What movement of Earth causes the seasons?**

Earth's revolution in its orbit, together with its inclination, causes the seasons.

B. What is meant by Earth's "inclination"?

Earth is inclined at an angle of $23\frac{1}{2}$ (23.5) degrees from the perpendicular to the plane of the orbit of revolution.

9. **What names are given to the 23.5 degrees north and 23.5 degrees south latitude lines?**

The northern line is called the tropic of Cancer, the southern parallel is called the tropic of Capricorn.

10. **What are the principal causes of secondary wind circulation?**

Secondary wind circulation is caused by the topography of the land (geography) and the current of the seas.

11. **What is the effect of the geography of the continents and seas on the primary wind belts in the Northern Hemisphere?**

The difference between the land and sea temperature causes the pressure belts of the primary wind circulation to be broken up into enclosed high- and low-pressure areas called centers of action.

12. **How does air "act" in a high-pressure area?**

Whenever a high-pressure area forms, fair weather and cooler or cold weather prevails. Air subsides in the center and diverges outward from the center. Clockwise anticyclonic spirals of air develop and begin flowing to surrounding lower-pressure areas.

13. **Over what countries in the Northern Hemisphere do "permanent" high-pressure areas exist?**

"Permanent" high-pressure areas form over Canada and the United States in North America and over Asiatic Siberia in the Soviet Union. A high-pressure area also exists over the island of Greenland all of the time because of the icecap there.

14. **A. Where do the principal low-pressure areas exist on Earth?**

The only permanent low-pressure area on Earth exists in the Doldrum Belt. Lows also form in winter in the Aleutians and near Iceland. Migratory lows move into the south-central United States and the U.S. East Coast near Cape Hatteras.

B. Where do seasonal lows usually develop in the United States?

Seasonal summer lows occur in the California and Arizona deserts. Lows occasionally form on the leeward side of mountain ranges, particularly in Colorado and the east slope of the Rockies.

15. **A. What are the most famous mountain winds, and where do they blow?**

The most famous mountain winds are the Chinooks of the Rockies, the Santa Anas of southern California, and the foehns of the Swiss and French Alps.

B. What type of weather do these winds bring?

These are very hot, dry winds that often bring dust storms.

16. **What valley wind is of particular concern to the Sixth Fleet?**

The famous Mistral of the French Maritime Alps brings strong winds into the Mediterranean south of the French Riviera.

17. **A. What are monsoon winds, and where are they most common?**

Monsoon winds are seasonal winds of South and Southeast Asia from India across through Burma, Thailand, Vietnam, and the Philippines.

B. Describe the generation of the southwest and northeast monsoons.

Simply described, the southwest (summer) monsoon begins when the central Asian area around the Gobi Desert begins to warm up in the late spring. Then the cooler, moisture-laden air of the Indian Ocean begins to move northward as the warm Asiatic air rises. The incoming air brings in torrents of rain that fall as the air begins to cool when coming overland and rising on the face of the southern slopes of the Himalayas. The opposite situation occurs in winter when the warmer air over the Indian Ocean rises and the cooler, dry air from Asia starts to blow down through the Himalayan passes onto the Deccan Plateau of India and the Southeast Asian countries.

18. **A. *What instrument is used to measure wind velocity?***

The anemometer is used to measure wind velocity.

- B. *What dialed instrument indicates wind speed and direction to the ship's bridge watch and navigator?***

The synchro-repeater on the bridge/chart house indicates wind velocity and wind direction.

19. **A. *What is the Beaufort Wind Scale?***

The Beaufort Wind Scale enables estimations of wind speed on the basis of visual comparison with sea state on the Correlative Sea Disturbance Scale. The Beaufort Scale was the work of Admiral Beaufort of the British Royal Navy. It is still used by all mariners in reporting the weather today.

- B. *How is the Correlative Sea Disturbance Scale used with the Beaufort Wind Scale?***

The Beaufort Scale is a wind scale in knots and descriptive terms on a scale of 1 to 12; the Correlative Sea Disturbance Scale describes sea state and mean height of waves as related to wind conditions on a scale of 1 to 9.

Chapter 4

Fronts and Storms

1. **A. How do weather fronts develop?**

Fronts develop when air masses of different temperatures collide. They rarely fuse unless very similar in temperature and moisture content.

B. What usually happens when a cold front meets a warm-air mass?

Usually, the colder of the two air masses prevails, forcing the warmer air upward.

2. **What kind of weather does a front usually bring?**

Frontal weather brings bad weather, unsettled conditions, and storms.

3. **What are the three types of frontal systems?**

There are cold, warm, and occluded fronts.

4. **A. What are the names of the world's primary frontal zones?**

The primary frontal zones are the Intertropical Convergence Zone, Arctic Frontal Zone, and Polar Frontal Zone.

B. Where is the Intertropical Convergence Zone (ITCZ), and why is it of particular importance?

The ITCZ is the band of unstable weather encircling Earth in the doldrums, where the northeast trades and southeast trades converge. This is the storm development area.

5. **What are squalls, and what are their characteristics?**

Squalls are brief, violent wind and rain storms that occur when unstable warm air rises over areas in the tropical seas.

6. **Why is the Polar Frontal Zone important to those who live in the temperate zones?**

Polar fronts influence the temperate zone weather; in summer, the polar fronts move toward the poles, but in the winter they move toward the equator, bringing cold waves that break through the warmer band of westerlies.

7. ***What are the first signs of an approaching cold front?***

The sky darkens at the horizon to the west and north; soon thereafter, the cloud ceiling lowers and rain begins. Squall lines may precede the cold front.

8. ***What are the signs of an approaching warm front?***

A warm front can be forecast by an advance of cirrus clouds in parallel, and then progressively lower cirro-, alto-, and nimbostratus, and finally stratus with fog, rain, drizzle, and perhaps a line of thunderstorms. As with the cold front, there is a marked change in temperature and wind shift.

9. ***What weather is associated with occluded fronts?***

The occluded front, either with cold- or warm-type occlusion, is a very unstable frontal cyclone. In the former, the faster-moving cold front overtakes a warm front and forces the warmer air upward; in the latter, a warm front pushes a colder air mass up, causing that colder air mass to ride over the overtaken air masses even though it may be warmer. This latter situation occurs mostly in the Pacific Northwest and causes much precipitation and icing in upper regions of air that are hazardous to air travel.

10. ***What are the three stages of a thunderstorm, and what happens in each stage?***

Three stages of a thunderstorm are (1) first stage, in which an updraft of warm moist air moves rapidly into the atmosphere, where it cools and condenses into clouds (cumulus stage); (2) next, the mature stage is characterized by updrafts and downdrafts in which hail forms within the cloud; (3) the final stage, called the dissipating or anvil stage, where downdrafts overtake updrafts as more air is brought down by raindrop friction and heavy rain falls on the ground.

11. ***What weather phenomena occur within a thunderstorm?***

Rain is in every thunderstorm, but there also may be hail, snow, and ice crystals at any time of the year.

12. ***Why should aircraft avoid flying through a thunderstorm?***

Aircraft should avoid thunderstorms because of the very turbulent winds they contain including updrafts and downdrafts, icing conditions, and lightning.

13. ***What is lightning, and what causes it to happen?***

Surging air currents in the thunderhead create static electricity, a phenomenon that apparently is caused by the breaking up of large water droplets into positively and negatively charged particles. An electrical discharge occurs when the higher layer of positive charges is attracted to the accumulation of negative charges at the base of the cloud; the lightning tends to equalize the charges between the two zones.

14. **A. *What is meant by the statement "Lightning follows the easiest route"?***

The electrical charge of lightning seeks to find the shortest route between the cloud and a direct contact with the Earth; the lightning will seek the route that is the quickest way to ground, and tall objects provide an easier route than air.

- B. *What causes thunder?***

Thunder is caused when the negatively charged lightning leaps up from the ground to complete the circuit started by the leader of charged air heading downward from the positive bank of power in the cloud. The lightning generates great heat, causing the explosive expansion of glowing hot air and producing the audible thunder.

15. **A. *Where do most tornadoes occur?***

They occur most commonly in the temperate zone, probably because of the greater atmospheric temperature contrasts there.

- B. *What name is given to a tornado over water?***

A waterspout is a tornado over water.

16. **A. *What are the three categories of tropical cyclone?***

The three categories are tropical depression, tropical storm, and hurricane or typhoon.

- B. *What is the established minimum wind velocity for a tropical cyclone?***

A cyclone is a circular area of low pressure around which winds in excess of 74 mph blow. So-called tropical cyclones are subdivided into three categories: (1) tropical depression—maximum wind less than 34 knots, (2) tropical storm—maximum wind 34–63 knots, and (3) hurricane or typhoon—maximum wind 64 knots and up.

17. ***How are the names given to tropical cyclones around the world chosen?***

Until 1978, hurricanes and other such tropical cyclones were named after women; now alternate storms have men's names.

18. ***How does a hurricane develop, and why is it so violent?***

A hurricane starts in the Intertropical Convergence Zone, but not over the equator because the twisting force of Earth's rotation is necessary to start the wind spinning. It requires the hot, moist air of the ITCZ low, which rotates and pushes air toward the center, forcing it to lift. The lifting causes condensation that heats the rotating air more, causing it to rise more swiftly. This cycle seems never ending, and that is why hurricanes are so violent—because of the tremendous energy release by the continuous condensation and an inexhaustible air supply turning more and more rapidly until it is a giant wheel.

19. ***What are the two most usual tracks or paths of a North Atlantic hurricane?***

The two principal North Atlantic hurricane tracks are (1) originate in the doldrums southeast of the West Indies, move westward and then northeastward from the Great Antilles, hit the east coast of Florida, and then go up the Atlantic coast of the United States as far north as New York and Massachusetts before moving on out to the North Atlantic; and (2) originate in same area, but then move south and west of Cuba, getting into the Gulf of Mexico, where it may move toward any coast—south United States, Mexico, or Central America.

20. ***What is the "eye" of the hurricane, and what is unusual about this part of the storm?***

The eye of the hurricane is usually about 14 miles in diameter. The winds there are moderate to calm, with only some drizzle; sometimes the skies in the eye are moderately clear.

21. ***What aspect of a hurricane usually causes the most damage and casualties?***

It is the storm surge from tides and wind-caused waves that cause more death and destruction than any other aspect of tropical cyclones.

22. ***When is "hurricane season"?***

"Hurricane season" extends from June to December, but hurricanes most frequently occur in September and October; this is the same time that most Pacific typhoons occur.

23. ***Explains the "dangerous" and "navigable" semicircles of a hurricane.***

In the Northern Hemisphere cyclonic winds circulate in a counterclockwise direction; in the Southern Hemisphere, they circulate clockwise. You can superimpose a circle over the mass of the tropical cyclone and then divide the storm into two semicircles bisecting the circle by a line in the direction of the storm's path. The right semicircle is the dangerous semicircle in which the wind will tend to carry a ship along with the storm. The left semicircle is called the navigable semicircle; it tends to drive the ship out of the path of the storm and help her get behind it.

24. ***What are the four categories of signals for unfavorable winds in the vicinity of harbors and beaches in the United States?***

The four categories of signals indicating unfavorable winds are (1) small craft warning, (2) gale warning, (3) storm warning, and (4) hurricane warning. They are indicated by one red pennant, two red pennants, a single square red flag with a black square in the center, and two red flags with black center squares, respectively.

25. ***What means are used to locate and track hurricanes?***

Reconnaissance aircraft are used to a limited extent, but most surveillance is done with weather satellites.

Chapter 5

Weather Forecasting

1. ***What is the purpose of weather forecasts?***

The purpose of weather forecasting is to enable many people and organizations to plan their activities—agriculture, travel, recreation, military operations, and such. Forecasts are used by farmers, airlines, travel bureaus and independent travelers, military planners, and agencies of government.

2. ***Which U.S. government agency is responsible for providing weather forecasts and accurate meteorological information?***

The National Weather Service of the Department of Commerce is our government's weather agency.

3. ***What is the purpose of the Naval Meteorological and Oceanography Command?***

It is organized to provide global weather forecast services to meet Navy requirements as well as Department of Defense oceanographic needs.

4. ***What is the principal difference between long-range and local forecasting?***

Long-range forecasting is concerned with an overall view of the climate, and with predictions for a year or more in the future. Local weather is predicted up to a month in advance. The accuracy is dependent on timely readings taken at many reporting stations, as well as weather ships, balloons, and satellites.

5. ***What is an area forecast?***

Area forecasts are prepared by major units afloat and ashore. An area forecast includes a synopsis of weather conditions, including all pressure systems, intensity, wind direction, and positions of highs and lows.

6. ***What weather information is transmitted back to Earth by weather satellites?***

Satellites transmit photos of the cloud formation near Earth's surface by day or night; sensors relate surface temperatures and fronts, storms, snow, sea ice, and cloud height.

Chapter 1

Astronomical Observations

1. ***What is an observatory, and what is it used for?***

An observatory is a building, usually fitted with a telescope housed under a revolving dome, used by astronomers for making celestial observations.

2. ***Where are observatories usually located, and why?***

Observatories are mostly located in remote places on mountaintops where the air is thinner and clearer and the environment is not affected by the lights, smoke, and smog of cities. This minimizes interference with observations.

3. ***Why are most astronomical photographs made in an observatory recorded on glass photographic plates?***

Glass plates are used for astronomical photography because they do not curl and can be stored and handled with ease.

4. ***What are some of the things an astronomer must be able to do, besides making celestial observations?***

The astronomer must also be an electronics technician, mathematician, photographer, computer operator, research analyst, office manager, and librarian, and even a technical machinist to design, make, and repair astronomical instruments.

5. ***Name and describe the two main types of telescopes.***

The two major types of telescopes are reflecting and refracting. The refracting telescope uses two lenses, while the reflecting type uses mirrors.

6. ***What does a radiotelescope do?***

Radiotelescopes gather radio waves from space. They trace out changes in the radio energy received so a radio map of the sky can be constructed. Modified radiotelescopes can direct beams at celestial objects and then receive rebounding waves, enabling acquisition of data about distances from Earth and composition of the bodies. They can also be used to send and receive signals from distant spacecraft.

7. **Why is a map of the radio sky different from a visual map?**

A radio sky map is different from a visual map because some celestial bodies are too far away or too cold to radiate visible energy.
8. **What are quasars?**

A quasar is a radio star found by radiotelescopes. They are no larger than a single star, but they emit hundreds of times more energy than most galaxies.
9. **What are pulsars?**

Pulsars are bodies that radiate energy at regular intervals. Once thought to be artificial beacons, they are now considered to be rapidly rotating compressed stars in the last stages of stellar life.
10. **What is the main advantage of making astronomical observations from a high balloon?**

Balloons are much cheaper than satellites and can easily carry people aloft to their 20-mile maximum height. They can carry up to two tons of telescopes and equipment, and the pictures can be brought down to Earth directly rather than by radio transmission.
11. **When and with what event did the space age begin?**

The space age began on 4 October 1957, when the world's first artificial satellite, *Sputnik 1*, was launched by the Soviet Union.
12. **What are the three main phases of the study of the solar system by spacecraft?**

The three main phases of the study of the solar system by spacecraft are: (1) the reconnaissance phase, consisting of photographic missions; (2) the exploration phase, involving the use of orbiters and probes to do detailed mapping and measurement; and (3) the intensive study phase, using landers and probes for closeup examination.
13. **What kinds of studies have the Explorer series of spacecraft done?**

To date, some fifty Explorer spacecraft have provided a wealth of information about Earth and the solar system, including the nature and effect of the solar wind; the nature, extent, and behavior of Earth's magnetosphere; the space between Earth and the Moon; and the nature and density of Earth's upper atmosphere.
14. **What was the main work of Skylab in 1973–74?**

Skylab contained a total of eight solar observation instruments. Altogether, some 150,000 solar observations were made between 1973 and 1974.
15. **A. What was the mission of the Pioneer 10 spacecraft?**

Pioneer 10 was launched in 1972 to fly by and photograph Jupiter.

B. *Where is it now?*

It crossed the orbit of Pluto in 1986 and is the first artificial object to escape the solar system. It is now some 6 billion miles from Earth.

16. A. *How many Apollo manned Moon exploration missions were there?***B. *During what period of time did they occur?***

Altogether there were six Apollo Moon missions using astronauts, carried out between 1969 and 1972.

17. *What important exploratory missions to Venus and Jupiter were conducted during the 1990s?*

In 1989 a *Magellan* spacecraft fitted with advanced radar imaging was launched to produce a radar and gravity map of the surface of Venus. It arrived in 1991 and concluded its mission in 1994. Also in 1989 a *Galileo* spacecraft was launched as a follow-on to the Voyager missions to Jupiter. It arrived in December 1995 and relayed back data from a probe that plunged into the Jovian atmosphere before beginning an extended orbital mission.

18. *What new space station is currently being constructed in Earth's orbit?*

A new space station called the *International Space Station* is currently being built and manned by international crews from the United States, Russia, and several other cooperating nations.

Chapter 2

The Moon

1. ***What is currently the most widely accepted theory of how and when the Moon was formed?***

The favored theory of the formation of the Moon is that shortly after Earth cooled, the planet was struck a glancing blow by a large object, which ejected material from Earth's mantle. This material eventually came together to form the Moon.

2. ***Why do we on Earth always view the same side of the Moon?***

The Moon circles Earth every 27½ days, a period that coincides with its rotation about its own axis. This accounts for the fact that the Moon always has the same side facing Earth; thus, one Moon rotation is accomplished in the same time as one revolution around Earth.

3. ***Why is there no gradual daily temperature change on the Moon?***

There is no atmosphere, so there is no gradual daily temperature change on the Moon. During the lunar day it gets as hot as 243 degrees F, and in the lunar night it goes down to –261 degrees F.

4. ***What causes erosion on the Moon's surface?***

Erosion is very slow on the Moon because there is no wind or rain; however, impact from meteorites and the constant stream of atomic particles from the Sun (solar wind) both cause erosion.

5. ***What is breccia?***

Breccia is fine broken rock from crashing meteorites lying in a deep layer on the surface of the Moon.

6. ***What are the maria, and how did they get that name?***

The maria are great smooth plains on the Moon that were originally thought to be "seas" by Galileo, hence the Latin word *mare* (plural, *maria*) for "sea." They are believed to be filled with lava or volcanic ash. When looking at the Moon, they are the darker-appearing areas.

7. ***A. What are mascons?***

Mascons are believed to be huge metallic bodies that lie under some maria; they probably are iron asteroids that crashed into the Moon two to three billion years ago.

- B. How were they discovered?***

Their presence has been determined by the magnetic and gravitational pull they exert on spacecraft in lunar orbit.

8. **What is "moonlight"?**

Moonlight is actually reflected sunlight, since the Moon gives off no light of its own.

9. **What probably caused most Moon craters?**

Most Moon craters were probably formed by the impact of huge meteorites, but some certainly were formed by volcanic actions.

10. **What significant discovery about the Moon was made in 1996?**

In late 1996 a discovery of possible water ice on the Moon was announced by U.S. scientists. Radar signals from a Defense Department satellite indicated the presence of ice in a large shady crater near the Moon's south pole. The ice, if indeed present, is thought to have been deposited there by a comet impact in the distant past.

11. **What are rays and rilles on the Moon?**

Rays are the "splash" of breccia radiating out from craters, either from volcanic explosion or from the impact of a meteorite. Rilles are giant cracks on the Moon's surface; they run uninterrupted by mountains, valleys, or craters.

12. **Explain the basic difference between a moonquake and an earthquake.**

Moonquakes differ greatly from earthquakes in that they cause the entire Moon to vibrate as the result of tremors set off by interior-caused quakes, meteorite collision, or avalanches of lunar rocks falling down the sides of craters. Earthquakes affect relatively small geographic areas.

13. **A. What are the phases of the Moon?**

Phases of the Moon are: new Moon, crescent, first quarter, gibbous, full Moon, gibbous, last quarter, crescent.

B. What does "gibbous" mean?

Gibbous moons occur between the first and last quarters, or on either side of the full Moon when more than half of the Moon is visible.

14. **What causes a lunar eclipse to occur?**

A lunar eclipse occurs when the illuminated Moon passes through the conical shadow of Earth.

15. **What are some practical reasons for exploring the Moon?**

Practical reasons to explore the Moon are that it could serve as a laboratory for further exploration of the solar system and stars; an ideal place to train space explorers and provide them a base; a laboratory unhindered by atmosphere; a communications relay station; a site for military applications in guidance, communications, and targeting, among others; and a source of mineral wealth at some distant date.

Chapter 3

The Sun

1. ***What is the source of most of Earth's energy?***

The Sun is the source of most energy. Exceptions are nuclear energy created by humans, lunar tidal energy, and heat produced by volcanoes and hot springs from sources within the earth.

2. ***How far is Earth from the Sun?***

Earth is roughly 93 million miles from the Sun

3. ***Why is it so dangerous to look at the Sun through any kind of lens?***

The Sun should never be directly observed through a lens of any kind because the focused rays would burn the retina of the eye and cause permanent damage.

4. ***What is the composition of the Sun? List and describe each succeeding major layer.***

The Sun is composed of luminous gases, principally hydrogen and helium, which comprise over 99 percent of all the matter in our solar system. The layers of the Sun, from inner core to surface, are the solar interior, the photosphere, chromosphere, and corona. The photosphere is the light-giving surface of the Sun. The chromosphere is the lowest layer of the Sun's atmosphere. Prominences come up from the core through the photosphere and flare into the chromosphere. The corona is the outermost layer of the Sun's atmosphere; though it undoubtedly extends at least to Earth, it can be seen only out to a distance of 7 million miles from the Sun.

5. ***What is the corona?***

The outermost layer of the Sun's atmosphere, extending millions of miles into space.

6. ***What is the importance of sunspots to Earth?***

Sunspots produce magnetic storms and major disturbances in radio broadcasts on Earth. The magnetic storms cause the auroras at the poles. Sunspots also affect compass readings and the weather.

7. **What is the magnetosphere? Explain the effect that the solar winds have on the magnetosphere.**

The magnetosphere is the region of space surrounding Earth that contains its magnetic field, which is confined by the solar winds within a boundary called the magnetopause. This magnetopause varies from about 40,000 miles above Earth's surface on the sunward side to several million miles long in a cometlike tail on the opposite side. As the solar winds vary, so does the shape of the magnetosphere.

8. **How does the Sun's energy get to Earth?**

The Sun's energy passes through space by the process of radiation.

9. **How is the Sun its own fuel?**

The Sun is composed mostly of hydrogen. Thermonuclear fusion at fifteen million degrees in the core of the Sun transforms this hydrogen into helium. The hydrogen that is destroyed in this process reappears as radiant energy. Thus, the Sun is burning itself up—but it will last at least six billion more years.

10. **Is solar energy the answer to the world's shortage of fuels for energy?**

When the means of harnessing solar energy is developed into a cost-effective process, it could supply the world's energy needs. Scientists are working on this now, but it has not yet been solved.

11. **What are the major problems in the use of nuclear energy for power?**

Nuclear energy, though quite efficient, is limited because of the lack of an abundant supply of uranium fuel, the dangers of radioactive contamination, and the difficulties of disposing of radioactive wastes.

12. **What spacecraft has been conducting observations of the Sun's north and south poles since its launching in 1990?**

The spacecraft *Ulysses* launched in 1990 by the space shuttle *Discovery* passed over the Sun's south pole in the fall of 1994 and its north pole the following year. It completed a second orbit of the Sun in December 2001. The *Hubble Space Telescope* has also been used for several investigations involving observations of the Sun since its launching in 1990.

Chapter 4

The Planets

- 1. Name the nine traditional planets in order from the Sun.**
Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto.
- 2. What gravitational force keeps the planets in their orbits?**
The gravitational pull of the Sun keeps the planets in their orbits.
- 3. What type of timetable is used to keep track of the movement and location of the planets?**
A chart that serves as a timetable for the movement and location of the planets is called a daily star almanac or an ephemeris.
- 4. What is an orbital period?**
The time it takes a planet to go around the Sun is called its orbital period.
- 5. Why do some planets appear at times to be going backward in their orbits?**
This is called retrograde motion. This occurs when Earth in its orbit overtakes a more slowly moving planet (because of its greater distance from the Sun). This makes it appear as though the other planet is moving backward.
- 6. Which two planets are closest to Earth?**
The two planets closest to Earth are Venus and Mars.
- 7. What information did Mariner 10 provide us about Mercury?**
Mercury is heavily cratered, with a dusty surface like the Moon, and has a large core of iron similar to Earth. It has a series of cliffs called "rupes" up to two miles high; these rupes cut across the surface for hundreds of miles.
- 8. What have recent space probes revealed about Venus?**
They have revealed that the planet is a very unlikely place for life of any kind. There is no water and no free oxygen on Venus, and the surface temperature is up to 900 degrees F. A heavy layer of carbon dioxide, a hundred times heavier than Earth's atmosphere, bears down on the surface, and this carbon dioxide traps the intense heat of the Sun. This dense CO₂ atmosphere makes visibility only a few hundred feet.

9. ***When do we usually see Venus best, and what do we call it at these times?***

Venus shines most brightly when it is between us and the Sun. It can be seen only shortly after sunset or before sunrise, so it is called either the morning or the evening star.

10. ***What planet is called the “red planet”?***

Mars is called the red planet.

11. ***A. What are the canali?***

The canali are visual illusions of straight lines on the Martian surface.

- B. What happened to the canali theory?***

Modern spacecraft photography has shown conclusively that there are no canals on Mars.

12. ***How far from the Sun is Mars?***

Mars is about 1½ times as far from the Sun as is Earth. Earth is 93 million miles away, and Mars 139.5 million miles away.

13. ***Compare Mars with Earth as to diameter, atmosphere, and other environmental factors.***

Mars has a diameter of 4,200 miles; Earth has a diameter of 7,926 miles. The Martian atmosphere contains insufficient oxygen and water vapor to sustain animal life as we know it on Earth. The atmospheric density is about that some 20 miles above Earth. Fierce windstorms are thought to rage for months at certain times of the year, at speeds of up to 300 mph, covering the planet with a fine, powdery, reddish dust. Gravity on Mars is only about one-third that on Earth.

14. ***What important discovery about Mars was allegedly made on Earth in 1996?***

In 1996 a great deal of renewed interest in the possibility of at least ancient life on Mars was generated by NASA scientists who reported that they had discovered fossilized evidence of bacteria in an Antarctic meteorite determined to have originated on Mars some three billion years ago.

15. ***Which planet is the largest of our solar system?***

Jupiter is the largest planet of the solar system.

16. ***Why is space travel to Jupiter by astronauts not possible in the foreseeable future?***

It would take twenty-one months to travel to Jupiter in the present state of space travel, and that is well beyond the capability of our life-support systems. Temperatures are about –200 degrees F above Jupiter’s cloud layer and probably thousands of degrees Fahrenheit closer in. Lethal radiation belts a thousand times more than a human being could stand have been detected around the planet.

17. **What is the probable composition of Jupiter?**

Jupiter is probably composed of liquefied hydrogen and helium and possibly has a metallic hydrogen core and other heavy elements unknown on Earth. It has an atmosphere of hydrogen, helium, and ammonium hydrosulfide.

18. **A. What is the Great Red Spot of Jupiter?**

It is a mysterious drifting haze, possibly a long-lived storm, about 17,000 miles in length and 8,500 miles in width. It stays generally in the same latitude of the southern hemisphere of the planet.

B. Why is the Red Spot of particular interest to scientists?

Some scientists think that it is a concentration of methane, ammonia, and hydrogen, the characteristic gases of Earth's primordial atmosphere.

19. **What were the significant discoveries made about Jupiter by the Galileo spacecraft and probe in the mid-1990s?**

The new discoveries about Jupiter and its moons by the *Galileo* orbiter and probe include a previously unknown radiation belt approximately 31,000 miles above its cloud tops; wind speeds in excess of 400 mph; far less lightning activity than anticipated; helium abundance in Jupiter very nearly the same as the Sun; extensive resurfacing of the moon Io's surface due to continuing volcanic activity since the Voyager flybys in 1979; and evidence of liquid water beneath the moon Europa's surface.

20. **Why were the explorations of Saturn by Pioneer 11 and the two Voyager spacecraft of such importance?**

The data gathered by these three spacecraft have revealed that Saturn is a kind of solar system in miniature, unlike any other planet in our solar system. It displays many of the physical processes believed to be connected with the formation and early evolution of our planetary system.

21. **How were the planets Neptune and Pluto discovered?**

Neptune and Pluto were discovered by variations in the regular orbit of Uranus. These variations from regular orbit are called perturbations. It was determined that the gravity effects of these planets pulled Uranus out of its regular elliptical orbit. Working with mathematics, the locations of the planets were calculated and then discovered with the aid of telescopes.

22. **What is unique about the magnetic fields of Uranus and Neptune?**

The magnetic fields of both planets are inclined at a considerable angle with respect to their spin axes, Uranus about 65 degrees and Neptune about 47 degrees.

23. **What discovery announced in 2005 resulted in a new perception of the solar system?**

In 2005 astronomers announced the discovery of a new planet X orbiting in the Kuiper comet belt about twice the distance of Pluto from the Sun.

Chapter 5

Asteroids, Comets, and Meteors

1. ***How is it thought that the asteroids originated?***

It is not known, but there are three possible explanations: leftover materials when the solar system was formed 4.6 billion years ago, leftovers from a collision of two small planets, and remnants of a small planet that exploded for some unknown reason.

2. ***Where are the asteroids located in the solar system?***

They are in an orbital region called the asteroid belt between the orbits of Mars and Jupiter.

3. ***Of what are comets composed?***

Comets are composed of frozen gases and dust, rather like a dirty snowball.

4. ***What causes a comet to be visible?***

When a comet approaches the Sun and Earth, its coma begins to glow and it begins to reflect sunlight from its head and dust tail.

5. ***In what respect are comets like planets?***

Comets are like planets in that they travel in the solar system in elliptical orbits, but these orbits are out of the plane of the ecliptic and go far beyond the planet Pluto.

6. ***Of what are the tails of comets composed?***

The luminous tail is composed of vapor and dust.

7. ***What happens when a comet breaks up, leaving debris that eventually enters Earth's atmosphere?***

When a comet breaks up, leaving debris along its former path, and Earth crosses a part of that path, the tiny particles collide with our atmosphere, producing a meteor shower.

8. ***A. What is the name of the most famous comet?***

The most famous comet is Halley's comet.

B. How often can it be seen from Earth?

It appears about every seventy-five years and was last seen in early 1986.

9. ***Which recent comet gave astronomers their most up-to-date comet information?***

When Halley's comet came through our solar system in 1986, it was photographed close up by two Soviet Vega spacecraft that sent back data on its composition and the extent of its tail, as well as pictures that indicated it was shaped like a potato. In 2005 a NASA spacecraft called *Deep Impact* impacted the comet Tempel and indicated that it was more compacted and contained less water than expected.

10. ***What causes a meteor to be a "fireball"?***

An extremely large and bright meteor is called a "fireball." It probably will end up as a large meteorite somewhere on Earth.

11. ***What happens to most meteors?***

Most meteors are seen only below a 100-mile altitude. Most of them burn up before reaching Earth, arriving as dust cinders.

12. ***What are the main kinds of meteorites?***

The two main kinds of meteorites are siderites, which are composed mainly of iron and nickel, and aerolites, composed of stone. A third kind are the very small tektites.

13. ***A. What are tektites?***

Tektites are small meteorites composed of a glassy compound having high silicon content.

B. Where did they probably originate?

They probably came from the interior of a destroyed planet where materials were subjected to extremely high temperatures.

Chapter 6

The Stars

1. ***What are the stars?***

The stars are distant suns in space.

2. ***After the Sun, what star is closest to Earth?***

Alpha Centauri, the nearest star beyond our own Sun, is about 26.46 trillion miles away.

3. ***A. What is the most common unit of astronomical distance?***

The most common unit of astronomical distance is the light-year.

B. In miles, what distance does it represent?

It is nearly 6 trillion miles.

4. ***Why is communication with distant galaxies impractical at the present time?***

It is basically impractical because it would take many millions of years for the message to be received by distant galaxies.

5. ***A. How are stars classified?***

Stars are classified according to their temperature and color as determined by their spectra. Brightness, or luminosity, is also used to classify stars.

B. What are the principal star colors?

The principal star colors are blue, white, yellow, orange, and red. Our Sun is a yellow star, average in brightness and temperature.

6. ***What is the difference between apparent and absolute magnitude of stars?***

Apparent magnitude of a star is its brightness as seen by an observer on Earth. Absolute magnitude is its brightness as seen from a standard distance of 10 parsecs.

7. ***A. What is the "main sequence" of stars?***

The main sequence composes 98 percent of all stars currently observed by astronomers. These are the medium-sized stars in the spectrum-luminosity scale, basically average in brightness and color.

B. *What is the spectrum-luminosity diagram?*

The spectrum-luminosity diagram shows the relationship between the color and magnitude of a star.

8. *What is unique about white dwarf stars?*

White dwarf stars are highly concentrated star masses that have come close to the end of their lives. Densities are much greater than any substance known on Earth, a cubic inch weighing about a ton.

9. *What are cepheid stars?*

Cepheid stars are pulsating variable stars, expanding and contracting in size and brightness with a definite rhythm.

10. *What is believed to be the sequence in the life cycle of a star?*

The life cycle of a star begins with an accumulation of cold, dark gases and dust, gradually becoming locked together by gravity and developing friction and pressure and, consequently, heat. As this radiation pressure builds up, the star begins to glow. As helium content builds up in the center, leftover hydrogen also accumulates, upsetting the internal balance of the star. The star then starts to grow in size and luminosity, growing to become a blue giant if there is a great amount of gas and cosmic dust; with lesser amounts, it will become a yellow star or orange dwarf. As the helium pile grows, that too begins to burn, gradually changing into heavier elements; eventually the ashes themselves are gone, and after a final burst in size and brilliance, the star collapses or explodes and disintegrates.

11. *What is the principal factor determining what kind of star will be "born"?*

The principal factor in determining what kind of star will be born is the amount of gases and cosmic dust that it gathers in its formative stages.

12. *Why do brighter stars have shorter lives?*

Brighter stars have shorter lives because they are burning themselves up faster, thus the greater luminosity.

13. *What is thought to be the normal evolution of stars?*

See also number 10 above. As helium builds up in the center of stars, they get hotter and more brilliant, and eventually become blue giants (if sufficient amounts of cosmic gases and dust have been accumulated). As blue giants age, they cool and move off the main sequence to become red giants, supergiants, and finally white dwarfs. At last they have a final burst of brilliance and disintegrate.

14. **What are novae?**

Novae are actually stars in the very last stages of life, but are seen for the first time in astronomical history. When it becomes sufficiently unstable, the nova will explode, becoming a huge expanding gas and dust cloud surrounding a small, dense core. After about two years it can be photographed as a gaseous cloud called a planetary nebula.

15. **A. What is a nebula?**

A nebula is a mass of gases and dust usually associated with the birth or explosion of a star in the far reaches of the sky.

B. What are the three kinds of nebulae?

The *bright nebula* glows because it is illuminated by a nearby star; a *dark nebula* can be seen only because it is silhouetted by stars behind it; the third kind is the *planetary nebula*, which is actually a nova with a large cloud of particles around it as the result of the stellar explosion that occurred at the end of the star's life.

16. **What are binaries?**

Binaries are stars that are in pairs due to gravitational attraction, one to the other.

17. **How are star clusters classified?**

Star clusters are larger groups of stars attracted by gravitation. They are classified by their appearance and their "population." Population refers to their location in the galaxy, either in regions where there is much dust and gas still to be gathered by the growing stars, or in an area where most of the gas and dust have been gathered and the stars there are nearing the end of their luminous lives. Types of star clusters are *moving*, containing a few stars that travel in parallel lines; *open*, loosely grouped stars in areas with a lot of glowing gases and dust; *globular*, containing thousands of stars; and *star clouds*, in which stars are so thick that they look like glowing clouds.

18. **A. What is a galaxy?**

A galaxy is a huge collection of stars, star clusters, dust, and gas, all held together by gravitation.

B. To which galaxy does our solar system belong?

We belong to the Milky Way galaxy.

19. **What is the shape of the Milky Way?**

The Milky Way is shaped like a giant disc or pinwheel; it is what is commonly called a spiral galaxy.

20. **What is the difference between the two population groupings in our galaxy?**

Population I stars are younger stars still forming, growing, and adding mass from surrounding gases and dust. Population II stars are older stars located in areas essentially free of dust and gas, since they have already absorbed most of it into their masses.

21. **A. *How are galaxies classified?***

Galaxies are classified into three groups according to their shapes.

B. *What are the three classifications?*

Ellipsoidal galaxies have clearly defined, symmetrical shapes ranging from spheres to ellipsoids; spiral galaxies have a distinct nucleus with one or more spiral arms; irregular galaxies have no particular shape.

Chapter 1

Motion, Force, and Aerodynamics

1. **A. According to ancient Greek philosophers, what keeps an object in motion?**

To the ancient Greeks' way of thinking, in order to keep moving an object had to have some unbalanced force acting on it.

- B. According to Isaac Newton, what keeps an object in motion?**

According to Newton a body in motion tends to stay in motion unless acted upon by an outside force.

2. **State Newton's three laws of motion.**

Newton's first law of motion states that a body at rest tends to remain at rest, and a body in motion tends to remain in motion in a straight line, unless an outside force acts on the body. This law is sometimes called the law of inertia.

Newton's second law of motion states that the acceleration of a body is directly proportional to the force acting on it, and inversely proportional to the mass of the body, and is in the same direction as the applied force. Mathematically this is often expressed by the formula $F = ma$.

Newton's third law of motion states that whenever one body exerts a force upon a second body, the second exerts an equal but opposite force back upon the first. Stated another way, for every action there is an equal but opposite reaction.

3. **A. How fast is light speed?**

The speed of light is 3×10^8 meters per second or 186,000 miles per second.

- B. What theory describes the motion of bodies with speeds near light speed?**

Einstein's *theory of relativity* describes the motion of bodies with speeds near light speed.

4. **What are the units of force**

- A. In the English system of units?**

The force unit in the English system is *pounds*.

- B. In the metric system?**

The force unit in the metric system is the *newton*. (One pound = 4.448 N)

5. **A. Is the weight or the mass of an object subject to change?**

Under most conditions the mass of an object does not change, while the weight varies according to the location.

B. How is the weight of an object determined?

The weight of an object is the force of gravity on it at a given location.

6. **What kind of force must be reckoned with for all earthbound objects in motion?**

Friction must be dealt with for all earthbound moving objects.

7. **What are the four aerodynamic forces on bodies in flight?**

The four aerodynamic forces on bodies in flight are thrust, drag, gravity (weight), and lift.

8. **According to Bernoulli's theorem, how is lift developed by a curved wing?**

According to Bernoulli's theorem, if one element in any fluid system is decreased, another must increase to counterbalance it. The air flowing over a curved wing must travel faster than the air under it. This produces a lower pressure on the top than on the bottom, thus producing lift.

9. **What is meant by g-forces?**

In aerodynamics acceleration is often measured in terms of multiples of the standard acceleration of gravity g .

10. **How are Mach numbers derived?**

The Mach number is the ratio of the speed of a body to the local speed of sound.

Chapter 2

Buoyancy

1. **Who is credited with discovering the law of buoyant force?**

The ancient Greek scientist Archimedes is credited with discovering the law of buoyant force.

2. **State the principles of Archimedes' law.**

An object immersed in a fluid is pushed up with a force that equals the weight of the fluid it displaces.

3. **What is the apparent weight of an object in water, and how is it computed?**

The apparent weight of an object in water is its weight in air less the buoyant force. It would be computed by finding the weight of the water it displaces, then subtracting that weight from the weight of the object in air.

4. **How can a boat constructed from a material more dense than water float?**

A hollow boat made from a material more dense than water will sink into the water to the point where the upward buoyant force of the water displaced equals its weight.

5. **What is density, and how is it computed?**

Density is a measure of how much of a material is present per unit of its volume. It is usually measured in kilograms per cubic meter or grams per cubic centimeter.

6. **Why does a hot-air balloon tend to rise in the air, while one filled with cold air does not?**

Heated air is less dense than cold air, so a hot-air balloon tends to rise because its upward buoyant force is greater than its weight.

7. **With what equipment is a submarine fitted to allow it to submerge?**

Submarines are fitted with *ballast tanks* that can be filled with water to compensate for excessive upward buoyant force acting on the hull.

8. **Upon what factors is a ship's stability dependent?**

The stability of a ship is dependent on the location of its center of gravity and its center of buoyancy at various angles of inclination or roll.

9. ***What might happen if excessive weight is added high in a ship?***

If excessive weight is added high in a ship, the center of gravity rises, and this might cause the righting torque to decrease to the point that the ship might capsize.

10. ***What will a ship sometimes do to lower its center of gravity in stormy seas?***

If a lightly loaded ship is operating in heavy weather, it will sometimes take on additional water in tanks near the keel or fill empty fuel tanks with water, in order to keep its center of gravity as low as possible.

Problems

1. A. 76,440 N

B. 9,800 N

C. 66,640 N (76,440 – 9,800)

2. A. 0.6 m³

B. 40%

C. 0.6 m (60 cm)

Chapter 3

Basic Electricity

1. **What are the positive and negative charged particles in an atom?**

The nucleus of an atom contains protons, which are positively charged particles, and neutrons, which are electrically neutral. Orbiting around the nucleus are one or more smaller particles of negative electric charge called electrons.

2. **What force keeps the electrons of an atom revolving in regular orbits?**

Electrons are held in their orbit by the attractive force between them and the protons in the nucleus.

3. **How is electricity conveyed?**

If an electric force is applied to a conductor such as copper wire, electrons in the outer orbits of the atoms are forced out of orbit and impelled along the wire. When an orbital electron is thus removed from an atom, it is called a *free electron*. Electrical energy is transferred through conductors via the free electrons that migrate from atom to atom inside the conductor. Electricity is transmitted through the conductor at the speed of light.

4. **A. What substances are the best conductors of electricity?**

B. Why?

Silver, copper, and aluminum wire, in that order, are the best conductors of electricity because these substances permit the free motion of a large number of electrons.

5. **What is an insulator?**

Insulators have very few free electrons and consequently are poor conductors. Examples of insulators are rubber, glass, and dry wood.

6. **What is the fundamental law concerning electrical charges?**

One of the fundamental laws of electricity is that like charges repel each other and unlike charges attract each other.

7. **What unit is used to measure electromotive force?**

The force which causes electricity to move in a conductor is called voltage or electromotive force. This electromotive force is the volt (E or V).

8. **What are the six common methods of producing voltage?**

Friction causes static electricity by rubbing two materials together.

Pressure, or piezoelectricity, produces voltage by squeezing quartz or artificial crystals so the compressed electrons move through the crystals at predictable frequencies; it is used to establish radio frequencies for communications gear.

Heat, or thermoelectricity, produces voltage by heating the junction of two unlike metals (thermocouple); it is used to measure and regulate electrically operated thermo-static controls.

Light, or photoelectricity; voltage is produced by light striking a photosensitive substance that dislodges electrons from surface atoms; photoelectric cells are used in instruments requiring extreme precision.

Chemical action, as in a battery cell; positive carbon and negative zinc strips are in an electrolyte solution that causes electrons to flow between the dissimilar electrodes; it is used as ignition sources in autos and other motorized vehicles.

Magnetism, used when a conductor moves through a magnetic field or vice versa in a manner that cuts the field's line of force; most common source of electric power, such as generators; the magnetic field is created by an electromagnet.

9. **What is a thermocouple?**

A thermocouple is the place where the moving electrons from two different metals which are subjected to heat meet. The difference in temperatures between the unlike metals determines the amount of voltage.

10. **Where is the photoelectric cell used?**

The photoelectric cell is used in precision instruments such as television cameras, automatic processing controls, door openers, and burglar alarms.

11. **What is the most common source of chemically created electricity?**

The most common source of chemically created electricity is batteries used to start the ignition systems in automobiles, boats, aircraft, ships, portable electronic equipment, and lighting equipment.

12. **What is the unit of measure for current?**

The unit of measure for current is the ampere (I). The amp measures the rate at which current flows.

13. **What is the unit of measure for resistance?**

The unit of measure for resistance is the ohm (Ω).

14. **What factors determine the amount of resistance in a conductor?**

Factors determining the amount of resistance in a conductor/wire are length, diameter, and composition.

15. **What is an electrical circuit?**

An electrical circuit is a conducting pathway for current flow consisting of the conductor and the path through the voltage source.

16. **How does electricity flow in a circuit?**

Electrons flow from the negative terminal of a battery through the conductor and any resistances (lamps) to the positive terminal; they go through the battery terminals from + to -. Electric currents, however, are traditionally said to proceed from the positive to the negative terminal in the external circuit.

17. **What is a schematic diagram?**

The schematic of an electrical circuit is a diagram which uses symbols for the circuit's components instead of pictures. This makes a circuit easier to draw and understand.

18. **A. Describe Ohm's law.**

Ohm's law states that the current in a circuit is directly proportional to the applied voltage and inversely proportional to the circuit resistance.

B. What does it enable us to find?

The law enables us to find the values of voltage, current, or resistance if any two of these three are known.

19. **What is the unit of measure for power?**

The unit used to measure power is the watt. Power is equal to the voltage across a circuit in volts multiplied by the current in amps through the circuit.

20. **What are the three formulas for electrical power?**

$$P = IE \quad P = E^2/R \quad P = I^2R$$

Simple Circuit Problems

1. A. 0.5 Amp
B. 240 Ω
2. $I = .575$ Amp
3. $E = 112.5V$

Power Problems

1. 200 W
2. 144 Ω

Chapter 4

Electronics

1. **A. What are the two types of waves?**

The two types of waves are mechanical and electromagnetic.

B. What are the two forms these waves can take?

The two kinds of waves classified by form are longitudinal (back-and-forth) waves and transverse (sine) waves.

2. **A. What is the standard unit of measurement of frequency?**

In recent years the unit hertz, abbreviated Hz, has come to be used in designating frequency.

B. What does this measurement represent?

One hertz is one cycle per second.

3. **What is the audible frequency range?**

The audible frequency range is 20 to 20,000 Hz. Electromagnetic waves in this frequency range must be transformed into mechanical sound waves through devices called speakers in order to be heard.

4. **What four variations from the straight wave path are caused by atmospheric or weather elements?**

- Atmospheric or weather elements may cause four variations from the straight path that the wave might otherwise take:
- *Refraction*: The density of the atmosphere tends to bend/refract waves downward, thereby increasing the distance the wave will travel before leaving the atmosphere.
- *Reflection*: Waves are reflected from the ionosphere 30–250 miles above Earth; the distance between transmitter and receiver which picks up the reflected signal is the skip distance.
- *Diffraction*: Spreading of radio waves behind obstructions. It results from the generation of secondary waves by the primary wave.
- *Trapping*: If temperature inversion in the atmosphere traps cold air in a belt or duct close to Earth's surface, radio signals may be reflected from the warmer air above or below the duct back to Earth a number of times.

5. **Define the following wave terms:**

A. Cycle

One complete sequence of values of the strength of a wave as it passes through a point in space.

B. Wavelength

The length of a cycle expressed in distance units, usually meters or centimeters.

C. Amplitude

The wave strength at particular points along a wave.

D. Period

The time required to complete one cycle of a wave.

6. **What range of frequencies in the electromagnetic spectrum comprise radio waves?**

Electromagnetic waves are classified as radio waves from about 5 kHz to 30 GHz.

7. **What is the fundamental principle of radar?**

The word *radar* comes from radio detection and ranging. Radar is based on the principle that electromagnetic waves can be beamed in a straight line, and that part of the transmitted wave will be reflected back from an object in its outgoing path.

8. **What are the three general categories of U.S. Navy radars?**

The three categories of U.S. Navy radars are: search, fire control, and special.

9. **What are the two categories of search radars, and what are they used for?**

The two kinds of search radars are air search and surface search radars; they are used for early warning and general navigation.

10. **What is the "scope" or PPI presentation for a search radar?**

In the case of a search radar, the echoes received by the radar receiver appear as marks of light on a cathode ray tube (CRT), a device similar to a TV screen. The scope is marked with a scale of yards or meters, miles or kilometers, and degrees. It provides a bird's eye view of the area covered by the radar, showing the transmitter in the center of the screen. Targets appear as intensified spots of light on the scope.

11. **What are the functions of EA and EP?**

EA stands for electronic attack measures. It involves hindering or rendering an enemy's electronic spectrum useless by jamming circuits with electronic countermeasures. EP or electronic protection refers to measures taken to ensure the proper use of our electronic spectrum, in spite of any enemy attempt to direct EA at our unit.

Chapter 5

Sound and Sonar

1. **A. What kind of wave is sound?**

Sound is a material wave.

- B. What form do sound waves have?**

Sound waves are longitudinal pressure waves.

2. **How does sound spread through a uniform medium?**

Sound waves expand through the medium in the form of expanding three-dimensional spheres.

3. **A. What is the minimum intensity in watts/m² that a sound must have in order to be heard?**

In order for a human to hear a sound, it must hit the eardrum with an intensity of at least 10^{-12} watts per square meter.

- B. What pressure in newtons/m² does this correspond to?**

This is equivalent to a pressure of only 2×10^{-5} newtons per square meter.

4. **What is the audible frequency range?**

The audible frequency range for the human ear is 20–20,000 Hz.

5. **In what units is relative intensity or noise level measured?**

Relative intensity is measured in units called *decibels*. Zero decibels is equal in intensity to the lowest that can be heard, while a sound of 120 decibels is the loudest sound that can be heard without pain.

6. **Why should people be careful to protect their eardrums against loud sounds?**

People should protect their ears against loud sounds because at the inner end of the ear canal is a very sensitive membrane called the eardrum, that can detect a sound pressure of only 2×10^{-5} newtons per square meter. Other sensitive parts of the middle and inner ear can also be damaged by exposure to loud sound.

7. **A. What is the apparent frequency shift of a passing whistle or horn called?**

Apparent frequency shifts that occur as a result of relative velocity between a sound source and a listener are called Doppler shifts.

B. What causes this shift?

As the sound source approaches, the sound waves are compressed, causing an increase in frequency. When the source moves away, the distance between sound waves is increased, causing a decrease in the frequency.

8. What three factors affect the speed of sound in water?

The speed of sound waves traveling through water is affected by three factors: (1) the water temperature, (2) the pressure, and (3) the salinity.

9. What does the Doppler effect enable a sonar technician to do when analyzing returning sonar echoes from a submarine?

Analysis of Doppler data provides accurate courses and speeds for the target submarine.

10. What are two modes of operation of shipboard sonar systems?

The two basic modes of sonar systems used in the detection of targets are referred to as active and passive. Active sonar transmits underwater sound pulses that strike targets and return in the form of echoes indicating range and bearing of the target. Active sonar is usually employed by the surface USW ship when seeking out submarines. It is also used to analyze shorelines, bottom characteristics, and ocean depths. Submarines usually use passive sonar. In this mode they just listen for sounds produced by the target vessel that will give away the bearing and range.

11. Why do submarines rarely use active sonar?

Submarines rarely use active sonar because it would give away their locations.

12. How do helicopters use sonar to detect submarines?

Helicopters can use "dipping sonar," a system that can be lowered on a cable about 400 feet into the water to search a 360-degree area. This may be either active or passive sonar.