Journey of Flight
Chapter 1 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Ch. 1, as you have read, is an overview of flight from the time it was just an idea, to the point of the first flight of the Wright Brothers. It's hard to remember sometimes that flight is relatively young – only just having celebrated it's 100th birthday!

Two of the things that make air and space travel unique are the advantages of speed and perspective.

Legends

The concept of flight began as legends in many countries. The Chinese are credited with inventing the kite, gunpowder, and using gunpowder for rockets. Wan Hoo is the legendary figure associated with flight for the Chinese.

Greek and Roman legends provided pictures of winged children, and Pegasus – the winged horse. Probably the most famous legend is that of Icarus and Daedalus. A father and son that were imprisoned, Daedalus (the father) was an architect and mechanic. He constructed a set of wax and feather wings that were attached to their arms allowing them to fly out of prison. Icarus ignored his father's warnings and flew too close to the sun, his wings melted, and he fell to his death in the sea.

The Persian King, Kai Kawus; and the Macedonian King, Alexander the Great, both have stories involving flight.

Early Scientific Research

- Leonardo da Vinci – Italian artist, architect, man of science. Made first experiments in the field of aviation.
- Francesco de Lana
- Laurenco de Gusmao – 1709 – invented hot air balloon
- Henry Cavendish – flammable air
- Montgolfier Brothers – demonstrated hot air balloon in 1783. Who were the first two men to fly in a lighter-than-air craft?

Balloons

- First flight in US didn't occur until 1793. First military use occurred during the Civil War.

Dirigibles

- 1852 – Henry Giffard credited with building the first successful dirigible. Others say LaFrance in 1884.

- 1872 – Paul Haenlein (German engineer) – 1st dirigible powered by internal combustion engine.
- 1898 – 1907 – Alberto Santos-Dumont built and flew 14 gasoline-powered, non-rigid airships.
- 1900 – First successful rigid dirigible, the LZ-1 built and flown by Ferdinand von Zeppelin.

Developing the Airplane
- Struggle was with developing and sustaining lift, controlling the aircraft.
- George Cayley
- John Montgomery
- Otto Lilienthal – Father of Modern Aviation
- Octave Chanute
- W.S. Henson & John Stringfellow – Ariel
- Samuel Pierpont Langley – government supported Aerodrome project – failure.

Wright Brothers
- Wing-warping technique
- December 17, 1903 – Orville flew first flight: 12 seconds/120 feet
- Same day, Wilbur later flew 59 seconds/852 feet.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 1 - Introduction to Air Power

1. Who is credited with inventing gunpowder?
a. Americans
b. Chinese
c. Japanese
d. Russians

2. Who was a great artist, architect, man of science and conducted the first scientific experiments in the field of aviation?
a. J.A.C. Charles
b. Francesco de Lama
c. Leonardo da Vinci
d. Joseph Montgolfier

3. The first use of balloons by the United States military occurred during
a. the Civil War
b. the American Revolutionary War
c. the War of 1812
d. World War I

4. Who built and flew the world's first successful rigid dirigible?
a. Jean Pierre Blanchard

b. Henry Cavendish
c. Alberto Santos-Dumont
d. Ferdinand von Zeppelin

5. Who has been called the "Father of Modern Aviation"?
a. Octave Chanute
b. Samuel Pierpont Langley
c. Otto Lilienthal
d. Wilbur Wright

6. Which one of the following statements about the Wright Brothers is NOT true?
a. They wanted to first develop an aircraft that would fly and could be controlled in flight, and then add a power plant.
b. They felt they had to get into the air themselves to further test their wing-warping technique.
c. On their first attempt to fly, Wilbur was at the controls. The Flyer became airborne but stalled and fell back into the sand. It was slightly damaged.
d. On December 17, 1903, the Flyer flew for two minutes and 1200 feet.

7. T / F The first men to fly in a lighter-than-air craft rode a Montgolfier balloon into the air over Paris on November 21, 1783.

8. T / F In 1903, the *Aerodrome*, built by Samuel Pierpont Langley, was launched by catapult from a barge in the Potomac River. It did not fly and fell into the river.

9. T / F The first balloon flight in the United States took place in 1793 with President George Washington and Benjamin Franklin on board. The balloon ride lasted over one hour, and both Washington and Franklin landed safely.

10. T / F A dirigible is defined as a heavier-than-air craft that cannot be steered.

Journey of Flight
Chapter 2 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 2 takes us through air power from 1904 – 1919. We will see more interest develop, but little realization of the capacity of air power. It is interesting to note that America is reluctant to utilize air power, many things were happening in Europe first.

United States
- 1904 – 1905 the Wright Brothers continued their work.
- 1905 – offered 3 times to build aircraft for American government, turned down.

- President Theodore Roosevelt requested an aircraft be tested, Orville began work while Wilbur went to France to form a French aircraft building company.
- 1907 – Glenn Curtiss and Alexander Graham Bell found the Aerial Experiment Association - two "firsts": 1st American airplane with ailerons, 1st seaplane to be flown in the US.
- 1908 – Lt. Thomas Selfridge became first man to lose his life in powered aircraft.
- 1908 – Curtiss won the Scientific American Trophy in the *June Bug*
- 1909 – Curtiss won the Gordon Bennett Trophy in the *Golden Flyer*
- 1909 – Army bought first airplane.
- 1910 – Wrights and Curtiss open flying schools
- 1910 – former Pres. Theodore Roosevelt becomes 1st president to fly.
- 1911 – Vin Fizz Flyer flew coast to coast in 49 days.
- 1911 – Harriet Quimby - America's first licensed female pilot.

Europe

- 1904 – Robert Esnault-Pelterie built glider with ailerons (replaced wing-warping technique).
- 1906 – Alberto Santos-Dumont flew first powered plane in Europe.
- 1907 – Louis Bleroit – built & flew first powered monoplane.
- 1909 – Bleroit flies across the English Channel
- 1909 – First international air meet in Rheims, France.
- 1911 – Short Brothers (England) – built first multi(two)-engine craft (Triple Twin)
- 1913 – Igor Sikorsky built first 4-engine craft.

Helicopters

- Rotary wing aircraft
- 1907 – Louis Breguet built and flew 1st helicopter.
- 1909 – Emile and Henry Berliner – first Americans to build and fly helicopter.

Commercial Flying

- 1914 – First regularly scheduled airline service – St. Petersburg – Tampa Airboat Line.

War

- By 1912, all major modern countries had formed military flying services, US was present in name only.
- US entered the war in 1917, but didn't have any combat-worthy aircraft.

WWI

- At the start of 1914, the average plane speed was 70-80 mph, could fly no higher than 10,000 ft. By the end of the war, avg. speed was 140-150 mph, with altitudes up to 24,000 ft.
- Airplane first used for observation, then as bomber (pilot or observer carried the bombs in their laps).

Fighter Development

- Roland Garros
- Anthony Fokker
- Hugo Junkers

Fighter Aces

- French developed method for recognizing pilots – if the pilot shot down 5 enemy aircraft, they were called an "Ace" – America and Britain used same criteria. Germany required 10 enemy aircraft.

US in WWI

- Entered in 1917
- Lafayette Escadrille
- Eddie Rickenbacker
- Billy Mitchell

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 2 - The Adolescence of Air Power: 1904 - 1919

1. In the early 1900's the Wright Brothers signed a contract with the US Army to build an airplane. While Orville was working on the contract, what was Wilbur doing?

a. Wilbur was working with him on the contract.
b. Wilbur was teaching President Roosevelt how to fly.
c. Wilbur was back home in Dayton, Ohio working on a more advanced airplane.
d. Wilbur was in France demonstrating the airplane for European governments.

2. The first powered dirigible in the United States used a _____engine.

a. Bell
b. Curtiss
c. Lahm
d. Wright

3. Who won the 1908 Scientific American Trophy and the 1909 Gordon Bennett Trophy?

a. Glenn Curtiss
b. Calbraith Rodgers
c. Harriet Quimby
d. Wilbur Wright

4. In 1911, _____ _____ became America's first licensed female pilot.

a. Bessie Coleman
b. Amelia Earhart
c. Phoebe Omlie
d. Harriet Quimby

5. Who built the first powered monoplane and also built 11 planes before getting one that could cross the English Channel?
a. Louis Bleriot
b. Alberto Santos-Dumont
c. Calbraith Rodgers
d. Glenn Curtiss

6. Who designed and flew the first 4-engine aircraft?
a. Glenn Curtiss
b. Paul Cornu
c. Alberto Santos-Dumont
d. Igor Sikorsky

7. When World War I ended, the speed of aircraft has increased to ___ to ___mph, and could operate up to about _____ feet.
a. 50, 60 and 10,000
b. 70, 80 and 10,000
c. 100, 120 and 20,000
d. 140, 150 and 24,000

8. Who were the Lafayette Escadrille group?
a. They were a group of French men who flew in WWI.
b. They were a group of Americans who flew for France in WWI.
c. They were an elite group of the French Foreign Legion.
d. They were a group of French men and women who led the resistance movement in WWI.

9. T / F Orville Wright was the first man to lose his life in a powered airplane.

10. T / F President Theodore Roosevelt was the first US President to fly.

Answers for Chapters 1 & 2:

Ch. 1 - 1. b. 2. c. 3. a. 4. d. 5. c. 6. d. 7. T 8. T 9. F 10. F

Ch. 2 - 1. d. 2. b. 3. a. 4. d. 5. a. 6. d. 7. d. 8. b. 9. F 10. T

Journey of Flight

Chapter 3 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 3 covers the 20 years (1919-1939) known as the Golden Age of Flight, extending from the end of WWI to the beginning of WWII.

Air Power after WWI

By the end of WWI, aviation industry had been built up in the major modern countries. In the US, within 3 days of the war ending, the government cancelled $100 million in contracts. This resulted in layoffs, closure of military airfields, and major unemployment of aviation related personnel. If not for military aviators and barnstormers, aviation in the US almost died.

Barnstormers
- Ex-military pilots
- Some were women pilots.
- Bessie Coleman - 1st female African American pilot

Army Air Power
- General Billy Mitchell - believed air power would decide winner of next war, use of bombs for military and industrial targets, advocate for air force as separate service, planned first round-the-world flight - completed in 1924 in a Douglas aircraft
- 1921 Ostfriesland sunk by Gen. Mitchell's pilots.

National Air Races
- Ralph Pulitzer - Pulitzer Trophy
- Charles Thompson - Thompson Trophy Race
- Bendix Trophy Race

Women's Air Derby
- 1929 - National Air Races open to women
- Ninety-Nines.

Air Mail
- 1918 - Post Office Dept. began airmail service
- First airmail route?
- Air Mail Act of 1925

- Air Commerce Act of 1926
- 1934 - new Air Mail Act
- 1938 - Civil Aeronautics Act.

Aviation Pioneers
- Charles Lindbergh - 1st to cross the Atlantic solo. (1927)
- Amelia Earhart -

Aviation Grows
- Travel Air Manufacturing Co.
- 1915 - National Advisory Committee for Aeronautics.
- 1929 - James Doolittle - first successful "blind" takeoff and landing.

Commercial Aviation
- McNary-Watres Act
- Boeing
- TWA
- American

Seaplanes
- 1927 - Pan American Airways - Clipper.
- Clipper made the 1st airline crossing of both Atlantic and Pacific Oceans.
- Boeing 314/Yankee Clippers

Dirigibles
- Treaty of Versailles
- Zeppelin - Hindenburg

Military Air Power
- Boeing 299 - long range bomber

Possibility of War
- January 1939 - President calls for buildup of existing military forces.
- Civilian flight schools
- General Hap Arnold
- Civilian Pilot Training Program - Tuskegee Airmen

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 3 - The Golden Age: 1919 - 1939

1. Within a few months of the end of WWI, which one of the following did not happen?
a. US government cancelled $100 million in airplane contracts.
b. Aircraft production dropped 85 % and 175,000 factory workers were laid off.
c. Military aviation was cut back by 95%.
d. The "barnstormers" contributed to the decline in aviation after the war.

2. Which one of the following statements is not true about General Billy Mitchell?
a. Gen. Mitchell was a vocal advocate for a separate air service, but equal to the Army and Navy.
b. After WWI, Gen. Mitchell believed that naval power would decide the winner of any future world wars.
c. Gen. Mitchell believed that the airplane could be used to bomb military and industrial targets inside an enemy's homeland.
d. Gen. Mitchell believed that air power could fly over the battlefield, attack the enemy's supplies, thus shorten the war and save lives.

3. In 1924, the US Army performed the first round-the-world flight using four aircraft. What were the names of the aircraft?
a. Boston, Chicago, Seattle, and New Orleans
b. Arkansas, Ohio, Nevada and Utah
c. Dickey, Gehrig, Ruth and Wagner
d. Doolittle, Lindbergh, Mitchell and Rickenbacker

4. In 1931, the Bendix Trophy Race was added to the National Air Races. Which of the following statements best describes the Bendix Trophy Race?
a. It was a transcontinental race flown from the west coast to Cleveland, Ohio.
b. It was a four-lap race around a 29-mile course.
c. It was an intercontinental race flown from Paris to New York City.
d. It was an international race flown from London to Paris.

5. The first air mail route in the United States was between
a. New York City and Chicago
b. New York City and Washington, DC.
c. Chicago and Cleveland.
d. Chicago and San Francisco

6. Who was the first person to fly across the Atlantic Ocean solo?
a. Amelia Earhart
b. Bessie Coleman
c. Charles Lindbergh
d. Billy Mitchell

7. In 1915, President Woodrow Wilson formed an organization whose purpose was to supervise and direct the scientific study of the problems of flight, with a view of their practical solutions. What was the name of this organization?
a. National Aeronautical Association (NAA)
b. National Advisory Committee for Aeronautics (NACA)
c. National Civil Aeronautics Authority (NCAA)
d. Civil Aeronautics Administration (CAA)

8. T / F Phoebe Fairgrave Omlie was the first licensed black female pilot.

9. T / F The Women's Air Derby led to the formation of an association of women fliers called the "Ninety-Nines".

10. T / F The Tuskegee Airmen were a group of African-American pilots who flew in WWII.

Journey of Flight
Chapter 4 Review Notes

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Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 4 describes air power at war. WWII is also known as the Air War. During the five years of air involvement, the airplane experienced faster growth and development than at any other time.

WWII

- Although the Treaty of Versailles prevented Germany from building military aircraft after WWI, they did build civilian aircraft – which were the basis for the Luftwaffe for WWII.
- Italy's Air Force was in place, and Japan had two forces – the Army Air Force and the Navy.

Allied Preparedness

- Unfortunately, at the end of WWI, England, France and the US cut back on their very powerful air forces. The axis powers continued to expand their forces.
- England changed it's offensive strategy (bombers) to a defensive one (smaller fighter aircraft) when they noticed Germany building it's air power. England made protecting the homeland and holding off Germany it's priority.
- France concentrated on ground defense.
- US had almost completely disarmed!

A New Type of War

- Blitzkrieg – combined army/air force operations. Known as the lightening war due to the rate at which events occurred.
- Messerschmitt 109 – backbone fighter for Germany

War

- Hitler invaded Poland in Sept., 1940 and with Blitzkrieg strategy, Germany defeated Poland in 20 days.
- Britain and France declared war on the axis powers when Poland was invaded.
- Germany continued to invade and defeat – Norway, Denmark, Netherlands, Belgium, and France.

Battle of Britain

- Defensive battle for the Royal Air Force. The Luftwaffe was not designed to be a long-range bombing force. The RAF was equipped with long-range strategic bombers.
- During Battle of Britain, battles were also occurring in the Mediterranean and Northern Africa. During this time, Germany occupied all of south and southeastern Europe.

Russian Front
- Russia was the only country among the major air powers to allow women to fly in combat.
- Germany viewed Russia as an easy conquest – not so. Russia was able to halt the German advance.
- Germany was fighting on too many battle fronts (Britain, Eastern Europe, Mediterranean and North Africa). They backed off Britain to concentrate on Russia.

New Countries Enter the War
- At the end of 1941, the US entered the war (Dec. 7, 1941 with the Japanese bombing of Pearl Harbor) with the allied powers. The Japanese joined the axis powers.
- The allied powers agreed that defeating Germany was the first priority, then Japan
- Japan was looking to expand her territory, had already moved into Manchuria and China in 1939. That move resulted in embargoes from Britain and the US. Japan decided to fight rather than give up on expansion.

Pearl Harbor
- Dec. 7, 1941 – primary purpose was to cripple the American fleet.
- As a result, US began build-up of air resources. Allowed women to ferry aircraft – no combat.
- Once US entered war, the strategy was switched from defensive to offensive – recapture territory taken by Germany, force Germany and Japan into unconditional surrender.
- US air power was to be used for supporting ground troops and long range bombing.

North Africa
- Allied powers learned importance of centralized control (air superiority, interdiction, and close ground support)
- 1943 – Axis powers defeated in North Africa

Air Power Strategy
- Douhet
- Trenchard
- Mitchell
- Chennault

- US – unescorted high altitude daylight precision bombing; Britain – night bombing

Combined Bomber Offensive

- Initial priorities: 1. submarine factories, docks and ports; 2. aircraft factories and munitions plants; 3. communications and transportation systems.
- Late summer of 1943 – US bombers being destroyed by Luftwaffe – US stopped unescorted, high altitude, daylight bombing.
- New strategy: P-51 Mustangs began escorting the bombers, chased enemy fighters.

Normandy Invasion

- June 6, 1944
- Pre-invasion bombing gave Allies air superiority for the invasion.
- April 15, 1945 – bombing of Germany ended – no more targets
- May 7, 1945 – Germany surrenders.

Pacific Campaign

- Japan was stronger than Britain of the US – militarily.
- Two critical battles stopped the Japanese advance by summer of 1942: Battle of Coral Sea and Battle of Midway.
- Both were Naval battles, but fought entirely by aircraft. Surface ships never saw each other or fired a shot.
- Very damaging to Japan war effort.
- War in Pacific was very spread out – over miles and islands.
- US built airfields on conquered islands – eventually assisted in strategic bombing.

Flexibility of Air Power

- Gen. MacArthur – had two goals: retain control of Phillipines, capture islands necessary to launch bombing campaign.
- Pacific Campaign remained second priority to European.
- Poor condition of air forces.
- Maj. Gen. Kenney – air commander.
- Maj. Gen Kenney used different strategy – contributed to Allies' victories in the Pacific.

Bombing of Japan

- April 1942 – 1st episode – very successful
- 2nd attack June 1944 – start of actual air campaign against the Japanese homeland.
- US unsuccessful return to previous bombing strategy – then switched to low level night bombing with more success.
- March 1945 – US bombed Tokyo.
- Japanese fighters not very successful at night.

Atom Bomb

- July 27, 1945 – President Truman authorizes use of "ultimate weapon".
- August 6, 1945 – B-29 Enola Gay drops atom bomb on Hiroshima.
- August 9, 1945 – Nagasaki bombed.
- Aug 10, 1945 – Japan radioes willingness to surrender.
- Sept. 2, 1945 – Official Japanese surrender.

Lessons Learned

- Flexibility and importance of air power.
- Futility of war in modern society.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 4 - Air Power Goes to War

1. At the end of WWI, the Allied Nations (England, France, and the US) had the most powerful air forces in the world. What did each country do with these air forces after the war?

a. Each country retained approximately the same amount of planes.
b. Each country increased their air forces substantively.
c. Each country decreased their air forces and weakened them.
d. England and France cut back on theirs, but the US increased theirs dramatically.

2. Which of the following best describes Blitzkrieg?

a. It was the name the British gave for the German bombing of London.
b. It was the combined arms operations strategy that Germany used in WWII.
c. It was the lightning response Poland gave to the German invasion.
d. It was the US' strategy against Germany in WWII.

3. Which of the following statements is true concerning the Battle of Britain?

a. The German Luftwaffe was designed to be a long-range bombing force.
b. The Luftwaffe's short- and medium-range aircraft could takeoff from France, fly to England, fight the British RAF and strike their targets without refueling.
c. During the Battle of Britain, the RAF's Bomber Command stood idly by waiting for a mission.
d. The RAF had the right aircraft for this battle, but the Luftwaffe did not.

4. By 1941, who was the only major power of WWII to use women pilots in combat?

a. England
b. Germany
c. Russia
d. United States

5. What was the primary purpose for the Japanese attack on Pearl Harbor?
a. to cripple the American fleet at Pearl Harbor
b. to convince the Americans not to enter WWII
c. to control all of the islands in the Pacific Theater
d. to adhere to Hitler's request of Japan

6. Once the US entered WWII, all of the following were part of the overall allied strategy except which of these?
a. The strategy switched from defense to offense.
b. The strategy called for the recapture of territory occupied by Germany.
c. The strategy was to force Germany and then Japan to unconditionally surrender.
d. The strategy switched from a European focus to a Pacific focus.

7. Which one of the following people did not believe in unescorted high altitude, daylight, precision bombing?
a. Claire Chennault
b. Giulio Douhet
c. Billy Mitchell
d. Hugh Trenchard

8. What is significant about the Battles of the Coral Sea and Midway?
a. The Japanese won both of these battles with superior air power.
b. Both battles were fought entirely by aircraft without the surface ships seeing each other.
c. Both battles were decided by the superior American submarine fleet.
d. The battleship regained its predominance as the primary US naval weapon.

9. In which battle did the Japanese lose over 100 of their best pilots and served as a key to defeating Japan?
a. Battle of the Coral Sea
b. Battle of Iwo Jima
c. Battle of Midway
d. Battle of Tarawa

10. On August 6, 1945, what happened that devastated the Japanese and hastened the end of WWII?
a. The Soviet Union declared war on Japan.
b. The US troops captured Iwo Jima and the Marianas Islands.
c. US aircraft bombed Tokyo with incendiary bombs.
d. A US B-29 dropped an atom bomb on Hiroshima.

Ch. 3 - 1. d., 2. b., 3. a., 4. a., 5. b., 6. c., 7. b., 8. F, 9. T, 10. T

Ch. 4 - 1. c., 2. b., 3. d., 4. c. 5. a., 6. d., 7. a., 8. b., 9. c., 10. d.

Journey of Flight
Chapter 5 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 5 is long! It covers everything from the Cold War to Desert Storm. This is a time period that will be familiar to many senior members, though. This chapter in particular has some great photos of military and civilian aircraft. Take time and check these out!

Cold War
- Between the US and Soviet Union
- Antagonistic relationship with different ideas – but didn't want to go to war.
- Was responsible for shaping aviation developments.

Military
- Once again, military force was cut back. In 2 years US went from >2 million to 300,000. US figured with the A-bomb, no one would bother us.
- Finally, in 1947, the Air Force became a separate branch – primary mission was deterrence.
- Airplanes improved, bombers improved (check out the B-36), the B-29 was the first to have pressurized crew compartments.
- Jet Propulsion
- Frank Whittle
- Heinkel HE-178 – Aug 22, 1939
- Bell XP-59 Airacomet – 1 Oct 42
- F-80 – Shooting Star
- "Vengeance Weapons" – Germany – V1-Buzz Bomb; V-2 from Wernher Von Braun
- Helicopters – Sikorsky R-4

Cold War Heats Up
- The Berlin Airlift
- The Korean War
- N. Korea – ally of the Soviet Union/communist, S. Korea ally of the US/republic after WWII.
- June 1950 – N. Korea invades S. Korea – UN resolves to provide assistance to S. Korea
- Gen MacArthur – Commander of US forces AND the UN forces. His first priority was to stop advance of the N. Korean Army (stronger than the S. Korean army)

- Air battles were all-jet. US pilots better trained. 9 enemy MiG's were lost for every 1 US fighter.
- 38th parallel
- July 1953 – cease-fire treaty signed. Objectives of the UN accomplished, but no clear victor.
- What did we learn? A-bomb wasn't enough to prevent war; US again wasn't prepared, and we forgot the importance of centralized control and one person having control of air campaign.

Aviation Continues to Develop
- Good PR as a result of aviation in WWII.
- Commercially, great benefits to aviation as a result of war-time improvements: instruments, navaids, safety, radar, pilots (lots of them and with good skills), and larger and better airports.
- DC-3 – commercial aircraft from converted C-47's. Surplus of aircraft after the war.
- Better airplanes were continually being developed.
- Commercial aircraft get jet engines – first were British built.
- Turboprop and pure jet – both used jet turbine engine.
- Vickers Viscount
- DeHavilland Comet I
- Went from 3 million people traveling commercially in 1945 to over 30 million in 1958.

General Aviation
- Did well, again due to the war. Surplus of pilots, plus ability to earn license through the GI Bill.
- C-120 – forerunner to the C-150/152, C-140 – forerunner to the C-172
- Big Three of GA – Cessna (#1 manufacturer by the end of the 50's), Beech and Piper.

Aviation Research and Development
- Initially done by NACA – but then private companies began R & D.
- Airborne R & D evolved.

Sound Barrier
- Bell X-1
- October 1947 – Chuck Yeager – Bell X-1
- November 1953 – Scott Crossfield – D-558-II Skyrocket
- Variable angle wings from the German Messerschmitt P-1101.
- 1953 – F-100 Super Sabre.

Bomber Developments
- Straight wing prototypes – XB-45, XB-46, Xs-47
- XB-47 with swept-back wings – poor range
- B-52 – bigger and better range

Smart Bombs
- Snark

Vietnam Conflict
- Phase I – July 1950 – 1954 – US had role as advisor
- Phase II – July 1954 – August 1964 – US went from advising to fighting for S. Vietnam.
- Phase III – August 1964 – June 1969 –
- August 1964 – Tonkin Gulf Resolution
- 1965 – 1968 – Operation Rolling Thunder – raise the morale on S. Vietnamese Army – get N. Vietnam to begin peace negotiations or bombings would continue.
- Tet Offensive – January 1968
- Phase IV – June 1969 – April 1975
- Nixon became president in Jan 1969.
- Vietnamization.
- March 30, 1972 – Operation Linebacker – B-52 strikes, cut off supplies from China and the Soviets, destroy their ability to make war. Bomb until peace negotiations.
- October 1972 – Linebacker II (only strategic bombing campaign in this war/conflict) – 12 days later both sides at negotiating table.

Cold War, continued….
- Both sides had atomic bombs, continued to build bigger and better defenses
- Ended 1989 with the fall of the Berlin Wall and collapse of the Soviet Union.

War in the Desert
- Aug 2, 1990 – Kuwait invaded by Iraq (dispute over oil loans)
- Iraq had 4th largest army in the world
- Operation Desert Shield – most massive airlift in the history of air power.
- UN Resolution 660
- President Bush ordered immediate military deployment to defend Saudi Arabia – Aug 1990.
- UN Resolution 678
- Civil Reserve Air Fleet activated (first time)
- Air campaign was based on previous lessons learned (finally)
- Operation Desert Storm – major damage within first 10 minutes of air attacks beginning.
- 100-Hour War

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 5 - Aviation: From the Cold War to Desert Storm

1. Who were the two major powers in the Cold War?
a. The US and England

b. The US and the Soviet Union
c. The Soviet Union and China
d. The Soviet Union and Poland

2. In 1947, the United States Air Force came into being with the passage of the
a. National Aeronautical Act
b. Army-Air Force Separation Act.
c. National Security Act
d. National Space Act

3. Who designed the world's first turbojet engine for use in an airplane?
a. Glenn Curtiss
b. Billy Mitchell
c. Carl Spaatz
d. Frank Whittle

4. After WWII, Germany was divided into East and West Germany. Who controlled East Germany?
a. England
b. France
c. United States
d. Soviet Union

5. What was the US' first priority in the Korean War?
a. bomb North Korea
b. stop the advance of the North Korean troops
c. send American troops to the 38th parallel
d. attack China and Russia for helping the North Koreans

6. What was the world's first "pure" jetliner?
a. DeHavilland *Comet 1*
b. Lockheed *Constellation*
c. Douglas *DC-4*
d. Vickers *Viscount*

7. Who was the first man to penetrate the sound barrier and fly faster than the speed of sound?
a. Scott Crossfield
b. Mel Apt
c. Kit Murray
d. Chuck Yeager

8. What was the only true strategic bombing campaign of the Vietnam, which resulted in the North Vietnamese coming back to the negotiating table?
a. Rolling Thunder I
b. Rolling Thunder II
c. Linebacker I
d. Linebacker II

9. T / F By 1990, Iraq had the fourth largest army in the world.

10. T / F In 1991, when discussing the Desert Storm Victory, President Bush said that the number one lesson from the Gulf was the value of air power.

Journey of Flight
Chapter 6 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 6 is an overview of the past 40 – 50 years of research and development in aerospace.

Aeronautical Research

X-15

- Joint effort between Air Force, Navy, and NACA.
- Intent was to build an aircraft that would fly at 4,500mph, reach 250,000 feet – as a result, the temperature of the aircraft would reach 1,200 degrees F.
- 50 feet long, 22-foot wingspan. Weight – 33,000lb (18,000 lb. was fuel)
- Rocket powered
- Launched from a B-52
- September, 1959 was first flight, reached speed of 1,400 mph.
- Scott Crossfield piloted first 8 flights.
- Continued through 1967 with over 200 flights.
- Reached top speed of 4,534 mph (Mach 6.72), top altitude of 314,750 ft.

XB-70

- US requested supersonic replacement for B-52 in 1954
- First flight in 1964
- Flew at 2,000mph, altitude of 70,000 ft.
- Congress cancelled the program – decided US didn't need supersonic bomber.

Other Research

- Fuel efficiency and environmental concerns were priority in 1970's.
- Weight and in-flight stress problems were addressed with advances in construction materials.
- Super-strong, lightweight, nonmetallic, epoxy graphite materials were developed.

Air Foil Design Research

- Forward-swept wings – X-29A in the early 1980's – see pg. 162
- Oblique wings – change form during flight for optimum lift and best aerodynamic flight characteristics. AD-1 Scissors.

- Joined wings
- Mission-adaptive wings – used now. Maintains optimum efficiency by moving forward for slow speed flight, and folding rearward for supersonic flight. Example: B-1B.
- Winglets – design helps decrease wing-tip vortices and improve efficiency
- Canards – horizontal surfaces placed forward of the main wings – help with trim and control, increase maneuverability, allow for main wings to be smaller in size. Example – X-29A

Military R&D Benefits
- U2 and SR-71 developed to fly at high altitudes
- B-2 and F-117A are true stealth aircraft – invisible to enemy radar.

Civil Aviation R & D Benefits
- 1954 – Boeing 707 revolutionized commercial aviation. Became the Air Force's C-135.
- 1962 – British Aircraft Corporation and the Sud-Aviation (later known as Aerospatiale) agreed to build the Concorde. Began flying in 1976 – London and Paris to Washington DC.
- 1963 – Boeing 727 – most successful jet ever built.

General Aviation
- Grew at a faster rate than military or commercial aircraft from 1958 – 1982.
- 1950's – first twin-engine. Beechcraft Twin Bonanza was 1st in 1951

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 6 - Advances in Aeronautics

1. The two X-series aircraft, which were flown during the 1950's and 1960's, were the
a. X-15 and XB-70
b. X-10 and X-100
c. XB-1 and XF-5
d. X-52 and X-2

2. The X-29A was built to demonstrate the capabilities of
a. adaptive-wing aircraft
b. forward-swept wing aircraft
c. oblique-winged aircraft
d. skewed-wing aircraft

3. Which of the following is a stealth aircraft designed to be invisible to enemy radar?
a. B-1
b. B-2
c. B-52
d. X-15

4. Which of the following is a high-altitude reconnaissance aircraft?
a. A-10
b. F-4
c. SR-71
d. XB-70

5. Which jet revolutionized the commercial aviation industry and went on to become the standard long-range jet of the 1960's?
a. Boeing 707
b. Boeing 727
c. Boeing 737
d. Boeing 747

6. The Bristol Aeroplane Company and Sud-Aviation together built what aircraft?
a. Airbus
b. Caravelle
c. Concorde
d. U-2

7. T / F The first twin-engine aircraft was the Beechcraft *Twin Bonanza*.

8. T / F From 1958 to 1982, general aviation in the US grew at a faster rate than military or commercial aviation.

9. T / F The F-117A is a stealth aircraft.

10. T / F Canards are vertical surfaces behind the main wings of an aircraft.

Ch. 5 - 1. b; 2. c; 3. d; 4. d; 5. b; 6. a; 7. d; 8. d; 9. T; 10. T

Ch. 6 - 1. a; 2. b; 3. b; 4. c; 5. a; 6. c; 7. T; 8. T; 9. T; 10. F

Journey of Flight
Chapter 7 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 7 is a discussion of basic aerodynamics. For some of you this will be a review, so bear with us!

Realm of Flight
- Our atmosphere is a mixture of gases: approx. 79% nitrogen, 21% oxygen, and 1% other gases.
- Atmosphere extends out about 100 miles.

Pressure
- Less at the top of the atmosphere, most at Earth's surface. Greater altitude = less pressure, less altitude=greater pressure.
- Standard pressure – sea level = 29.92 inches or 14.7psi.

Temperature
- Measure of energy. Hotter air=more energy inside=faster molecular movement.
- Temp decreases at a rate of 3 _ degrees F. for every 1000 ft. increased altitude.

Density
- Density of air=how many molecules are squeezed into a given volume. Air with higher density is squeezed in more tightly than lower density.
- Air at higher altitudes has less pressure and is less dense.
- Density is also related to temperature – hotter air=molecules move farther apart=decreased density. This is why some airplanes have trouble taking off in a high elevation on a hot day.

Viscosity
- Fluid's resistance to flow. Ex.: honey is thicker (more viscous) than water.
- Greater air density=greater resistance(viscosity)
- Viscous drag is when an object is placed in the path of moving air.

Laminar Flow
- As air flows over an object, it will either be smooth or turbulent.
- Smooth air flow (obviously more desirable) is called laminar flow.
- Important consideration in aircraft design!

Speed of Sound in Air
- Sound waves travel like ripples in water, travels in all directions.

- Ernst Mach (Austrian physicist) determined the correct mathematical value for speed of sound.
- Varies with altitude because temp. decrease with increase in altitude. Ex.: 761mph at 59 degrees, 692mph at 30 degrees.
- Chuck Yeager exceeded the speed of sound in an X-1 on Oct. 14, 1947.

Airfoil – Designs that Capture the Energy of the Wind

Airfoil Design
- See illus. on page 177.
- Parts of an airfoil: leading edge (meets relative wind first), upper and lower camber (either positive – curving away from the centerline, or negative – curving toward the centerline), trailing edge (rear of the wing), chord (imaginary line the connects the leading with the trailing edge), relative wind (opposite the flight path), angle of attack {see page 181}(the angle between the chord line and the oncoming relative wind)[not the same as the angle of incidence~the angle between the chord line and the centerline of the aircraft.]

Daniel Bernoulli
- Born 1738, Dutch physicist.
- Discovered relationship between the pressure and speed of a fluid in motion.
- Bernoulli's Principle=as the velocity of a fluid increases, the pressure decreases.

Forces of Flight
- 4 forces = lift, gravity(weight), thrust, drag
- Thrust balances drag – more thrust than drag = place accelerates; lift balances weight – more lift than weight = plane climbs.
- Vectors – graphical mathematical illustration showing both direction and magnitude.
- Changing the shape of the camber can increase lift (induced lift) to overcome weight.
- Using light-weight materials can overcome weight issue, as well as paying attention to cargo load.
- Drag opposes motion through the atmosphere – goal is to design a plane that has a lot of thrust with little drag.

Real World Lift and Weight
- Turbulence decreases efficiency of airfoil
- Stalls – when streamlines (air next to the wing's surface) separate, it flows more slowly and loses its lift capability. See pg. 184
- Weight distribution within the airplane has a profound effect! Maximum weight limitation=maximum gross weight. Useful load=maximum gross weight less empty weight.

Real World Thrust and Drag
- Thrust vectoring – plane's thrust to be pointed in a particular direction.

- Induced drag is a component of lift that adds to the drag. Ex. Wing tip vortices – see page 185.

Supersonic Aerodynamics

- Supersonic flow – when airplane travels at supersonic speed, the air ahead receives no warning of the plane's approach because the plane is out-speeding it's own pressure wave.
- Wave drag is result of lost energy.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 7 - Basic Aeronautics and Aerodynamics

1. When an object is placed in the path of moving air the mutual attraction of the molecules slows the rate of flow. This is called:
a. density drag
b. laminar flow
c. camber flow
d. viscous drag

2. Which one of the following is not part of an airfoil?
a. leading edge
b. camber
c. chord
d. vector

3. The angle between the chord line and the oncoming relative wind best defines
a. angle of attack
b. angle of incidence
c. angle of descent
d. camber angle

4. Bernoulli's Principle states that
a. as the velocity of a fluid increases, the pressure increases.
b. as the velocity of a fluid increases, the pressure decreases.
c. as the density of a fluid increases, the pressure increases.
d. as the density of a fluid decreases, the pressure decreases.

5. The four forces of flight are lift, _____, thrust and weight.
a. drag
b. gravity
c. pressure
d. volume

6. Running your hand over a piece of sandpaper would be an example of _____drag.
a. form
b. friction
c. induced

d. wave

7. T / F Subtracting the empty weight from an airplane's maximum allowable weight defines useful load.

8. T / F Lift can be increased by changing the camber of the airfoil shape of the wing. This type of lift is called Induced Lift.

9. T / F The angle between the chord and the centerline of the aircraft is called the Angle of Attack.
10. T / F The trailing edge of an airfoil meets relative wind first.

Journey of Flight
Chapter 8 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 8 covers aircraft in motion, including the axes of flight, flight controls, instruments and engines. For those members having difficulty understanding the axes of flight, I would strongly recommend using the 3-axis demonstrator found in Aerospace Dimensions. Sometimes it helps to use paper labels on the straws, and you can add things like the four forces of flight, CG, etc. If this doesn't make sense, contact me directly and I'll talk you through it.

The Axes of an Aircraft

Axis	Motion Around that Axis	Reference point on the aircraft
Longitudinal	Roll	Tip of the nose to tip of the tail
Lateral	Pitch	Wingtip to Wingtip
Vertical	Yaw	Passes vertically through meeting Point of other two axes.

Longitudinal and Lateral axes are horizontal, Vertical axis is just that, vertical!
(See pg. 191)

Aircraft Structures and Components
- Engines – two common types: reciprocating and turbine

Reciprocating
- Powers conventional vehicles for transportation
- Parts of the motor move back and forth in straight-line motion
- AKA Internal Combustion engine

- Uses fossil fuel and converts into energy

Turbine
- Turbine means whirl and refers to any type of wheel device that has vanes attached to it.
- Four basic types: Turbojet, turbofan, turboprop, and propfan.
- Takes a small amount of air at the intake and accelerates it to extremely high velocities through the exhaust nozzle.

Turbojet (see illus. pg 197)
- Uses a series of fan-like compressor blades to bring air into the engine and compress it with a series of rotor and stator blades.
- Rotor blades perform somewhat like propellers – they gather air and push it backward into the engine.
- Hot gases strike the blades of the turbine and cause it to spin rapidly.
- The spinning turbine is what causes the compressor sections to turn.

Turbofan (see illus. pg. 198)
- One or more rows of compressor blades extend beyond the normal compressor blades.
- More air is pulled in than in a turbojet.
- Quieter and more fuel efficient than turbojet.

Turboprop (see illus. pg 199)
- Combines the best features of turbojet and propeller aircraft.
- Uses a gas turbine to turn a propeller – can turn the propeller with twice the power of a reciprocating engine.

Propfan Systems
- Thruster resembles a ship's screw more than it does an airplane propeller.
- Combines the air-moving efficiency of the turbofan engine with the thrusting efficiency of the propeller.

Ramjet and Scramjet Engines
- Simplest of all jet engines – no moving parts.
- Force of inertia rams air into a streamlined chamber of a fast-flying ramjet.

Flight Controls
- Wright Brothers gave aviation ***sustained, controlled and powered flight*** of heavier than air vehicle.
- Flaps – attached to trailing edge of wings. Increases camber of the wing airfoil to which it is attached.
- Slats – protrusions from the leading edge of a wing. Add induced lift.
- Spoilers – destroy lift by interrupting laminar flow. Located on the top of the wing.

- Drag devices – produce drag only. May be on the trailing edges of the wing or may protrude from the craft's fuselage upon activation by the pilot.

Fuselage
- Means to shape like a spindle or streamline.
- Three classifications: 1. Truss – tubing framework. 2. Semimonocoque – uses internal braces – high performance aircraft. 3. Monocoque – single shell type.

Landing Gear
- Three types of landing gear arrangements in use today: conventional, tricycle, and tandem.
- Conventional – two wheels forward and one small wheel in the rear. (Tail-dragger)
- Tricycle – nose wheel and two wheels, one on each side, underneath the pilot. (ex. C-172)
- Tandem – two sets of wheels located one behind the other on the fuselage. (AV-8 Harrier – now wouldn't we all like to try that one out!)
- Landing brakes – must be used with caution because they move much faster than a car's brakes!
- Landing gear: fixed or retractable. Most small planes have fixed gear because they don't cost as much.

Systems
- Fuel systems – includes everything that involves delivery of fuel to the engine.
- Fuel tanks – can be located anywhere on the aircraft. There are two fuel-feed systems: gravity feed (uses gravity to cause the fuel to flow from the tanks downward to the engine.) and force-feed (uses a fuel pump to drive the fuel from the tanks to the engine.)
- Fuel Lines – lead from each tank to distribute the fuel throughout the aircraft.

Hydraulic and Electrical Systems
- Hydraulic systems – means water tube. May operate: brakes, landing gear, move the flight controls, and extend and lower the flaps.
- Electrical Systems – a generator mechanically attached to an aircraft's engine provides the electricity required to charge the battery, start the engine, operate the radios, and operate navigation and landing lights.

Aircraft Instruments
- First aviators relied on their senses – no instruments!
- Early instruments were adequate for low and slow aircraft.

Instrument Classification
- By Principle of Operation: mechanical, pressure or electrical.
- Mechanical – work by means of direct mechanical linkage. Ex. Gyroscopic stability – a spinning flat weight tends to line up on one of its axes.
- Pressure – work on the idea that a fluid, like air, exerts pressure.

- Electrical – operate on the principles of electricity, including magnetism.
- Classification by Use: Performance and Control
- Performance – tells how the aircraft has responded to our commands.
- Control – tells the current state of some aircraft devices, so that we are aware of their condition.

Typical Instruments

- Engine instruments: tachometer (measures how fast the crankshaft is turning), oil pressure and temperature gauges (constant readings on oil pressure and temp. while engine is operating.
- Flight instruments (allow for safe flight and show pilot how well the airplane is performing.): **airspeed indicator** (speed through the air), **altimeters** (aneroid barometers that read in feet of altitude and are calibrated to atmospheric pressure in inches of mercury.), **turn and slip** (turn indicator is the needle, indicates direction and rate of turn. Ball in the glass tube is called the inclinometer, indicates the quality of the turn), **VVI, or vertical velocity indicator, or vertical speed indicator, or rate-of-climb indicator** (what rate the airplane is climbing or descending), **attitude indicator** (gyroscopic instrument that provides artificial horizon).
- Navigation instruments (help the pilot find the way!): most important is a magnetic compass (contrary to popular GPS belief!) it doesn't require any outside power source – operates independently of the aircraft. Most planes also have a heading indicator also, a type of compass, but requires aircraft system for power.

New Concepts

- VTOL – vertical take-off and landing
- STOL – short take-off and landing
- Tilt-Rotor aircraft – these aircraft turn their rotors up to takeoff and land like helicopters, and down to fly like fixed-wing vehicles.
- Hypersonic transports – are designed tot ravel at Mach 5 and greater.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 8 - Aircraft in Motion

1. The _____ axis runs from the tip of the nose to the tip of the tail of a single-engine airplane.

a. elevation
b. lateral
c. longitudinal
d. vertical

2. Where is the central area of a reciprocating engine where fuel is converted into energy?

a. crankshaft
b. cylinder
c. pistons

d. spark plugs

3. Which of the following is not one of the four basic types of turbine engines?
a. turbojet
b. turbofan
c. turboprop
d. turborod

4. Which of the following are protrusions from the leading edge of a wing?
a. flaps
b. rudders
c. slats
d. spoilers

5. Which of the following is not a type of fuselage?
a. truss
b. monocoque
c. semimonocoque
d. trimonocoque

6. Which of the following is not a common landing gear?
a. conventional
b. tandem
c. tricycle
d. unicycle

7. Aircraft instruments classified by their use fall into two major groups:
a. performance and control
b. horizontal and vertical
c. flight and navigation
d. takeoff and landing

8. T / F The vertical velocity indicator tells the pilot at what rate the airplane is climbing or descending.
9. T / F The attitude indicator is a gyroscopic instrument that provides an artificial horizon to the pilot.
10. T / F The modular air vehicle is a hypersonic or supersonic vehicle that has an attached shock wave along its leading fuselage edge.

Ch. 7 - 1. d. 2. d. 3. a. 4. b. 5. a. 6. b. 7. T 8. T 9. F 10. F

Ch. 8 - 1. c. 2. b. 3. d. 4. c. 5. d. 6. d. 7. A 8. T 9. T 10. F

Journey of Flight
Chapter 9 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 9 covers navigation. We'll talk about maps, aeronautical charts, navigation principles, techniques and systems. The AEX program has a good activity called Cool Cartographics. It is a good hands-on tool for this chapter.

Maps and Map Projections

- Global Coordinate System – a system of horizontal and vertical lines drawn on an image of planet Earth. There are 18 primary great circles going north-south called lines of longitude. Parallel lines having 10 degrees spacing between them from the equator to the poles are called lines of latitude. **The starting point for lines of longitude, or zero degrees, passes from the North Pole to the South Pole through Greenwich, England and is known as the PRIME MERIDIAN.**
- Mercator and Conic Projections: Mercator is a cylindrical projection of a map. Conic projection places a cone over the earth and projects the meridians and parallels.

Sectional Aeronautical Charts

- The most commonly used aeronautical chart.
- Contains relief charts – elevations are depicted by color tints, contour lines and shading. Ex.: Highest point is shown by a black dot with elevation printed next to it.
- Contains hydrographic (water) features – lakes and streams are depicted in blue.
- Contains cultural features – cities or towns are featured in bright yellow, while small communities are shown in small black circles. Check out a sectional – are you in a bright yellow area, or in a small black circle?
- Defines airports – broad categories are: civilian, military, or joint-use. Page 236 discusses the differences in depiction in depth.
- Airspace and airways – Controlled airspace is subject to control by FAA air traffic controllers. Largest area of controlled airspace is called the continental control area. Most control areas are around most airports.
- Airways are three-dimensional highways in the sky.
- Special-use Airspace – Good to know where these are – sectional gives details so pilots can avoid these prohibited and restricted areas.

Basic Navigation Principles

- True North = Earth's north geographic pole.
- True-course Line – a line or series of lines that the navigator indicates the airplane will (is supposed to) follow.

- Magnetic Courses – Magnetic north and south are different from true north and south because the magnetic pole is different from the geographic pole.
- Compass deviation – occurs once the compass is mounted in a plane. It must be adjusted because of electrical power and metals in the aircraft.
- Altimeter is the only non-electronic means the pilot has of determining the airplane's distance over the surface. Altimeter readings can be inaccurate if the instrument is sealed in any way.
- True Airspeed – how fast you are moving through the air.
- Ground speed – how fast your airplane is moving across the surface of the Earth.
- Wind and the Wind Triangle – Wind can either increase or decrease the ground speed depending on whether the plane is flying with or against the wind. Wind triangle is a tool pilots use to figure out where the wind drift will cause the aircraft to fly over the ground.

Navigation Techniques

- Pilotage means navigating by reference to visible landmarks.
- Dead reckoning (not what it sounds like) involves the systematic consideration of all factors that will and could affect the flight.

Electronic Aids

- Aircraft radio – communication with FAA personnel
- Very-High-Frequency Omnidirectional Radio Range (VOR) receiver is the second half of the aircraft radio. It must be tuned to the broadcast frequency of the VOR radio station just like the aircraft radio.
- Automatic Direction Finder (ADF) (not necessarily your co-pilot or navigator) – another type of radio receiver that is used to determine direction, but it does not provide as much information as the VOR.
- Distance Measuring Equipment – (DME). Sends a signal and measures the time it takes to go from the aircraft to the VORTAC and return.
- Weather and Ground Radar. Radar works on the principle of reflected radio energy. Weather radars show areas of precipitation and storms.

Navigation Systems

- VOR – the total system includes the airplane receivers and the ground stations working together to help the pilot navigate.
- LORAN – (Long-Range Navigation) – complete navigation system that is used by large cargo ships and many small, privately owned sea craft. It is also used by aircraft as a means of navigation.
- GPS – (Global Positioning System) – consists of roughly 24 satellites in orbit around the Earth, several ground tracking stations and a receiver in the aircraft. The total number of satellites varies due to repairs and upgrades. GPS converts satellite signals into position coordinates.
- PPS – (Precise Positioning System) – military's encoded signal.
- SPS – (Standard Positioning System) – civilian public's signal.
- Inertial Navigation is a self-contained unit located within the aircraft that needs only to be programmed for a starting point and a destination.

- RNAV – (Area navigation system) – computer-controlled navigation system that allows pilots to fly directly from the airport of origin to the destination airport without passing over a single VOR station.

Landing Navigation Systems

- ILS – (Instrument landing system) – used only within a short distance from the airport and only when the purpose is to land the airplane. Basically, on final approach in bad weather or simulated bad weather.
- MLS – (Microwave landing system) – In Europe, this system is replacing the ILS. More efficient than the ILS.
- Differential GPS Landing Systems can be molded to the community's needs and still satisfy the aviator.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 9 - Flight Navigation

1. On a map, parallel lines are called lines of
a. meridian
b. prime
c. latitude
d. longitude

2. The prime meridian passes from the North Pole to the South Pole through
a. Miami, Florida
b. Greenwich, England
c. Athens, Greece
d. Hong Kong, China

3. What is the term used to describe elevations on maps?
a. conic
b. mercator
c. meridian
d. relief

4. On a map, the largest area of controlled airspace is called the _____control area.
a. continental
b. oceanic
c. mountainous
d. valley

5. Which of the following is a tool used by a pilot to determine where wind drift will cause the aircraft to fly over the ground?
a. altimeter
b. true-course line
c. pilotage

d. wind triangle

6. Which of the following is a technique of navigation that involves the systematic consideration of all factors that will and could affect a flight?
a. dead reckoning
b. pilotage
c. true-course line
d. compass deviation

7. T / F LORAN is an acronym for long-range navigation

8. T / F The Global Positioning System (GPS) consists of one major satellite in orbit around the Earth and several ground tracking stations.

9. T / F The Standard Positioning System (SPS) is the military's encoded signal and its accuracy is controlled by a program called Selective Assignment (SA).
10. T / F The Instrument Landing System (ILS) is used only within a short distance from the airport, but is used for both takeoff and landings.

Journey of Flight
Chapter 10 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 10 is a short chapter, a review of the airport itself. Although most people are familiar with some type of airport, this is a good refresher.

The Airport

- Runway – the most important part of the airport! They have a dashed white line down the center of the runway. At night, runways have steady white lights on the edges (and sometimes down the middle), red lights at the end, and green lights at the beginning. Runways are numbered by taking the first two numbers of the compass direction and rounded to the nearest ten. One runway has two numbers – always 180 degrees different. Ex. If you are sitting on the runway, and your compass heading is 273 degrees, you are on runway 27, the other end of the runway is labeled 09. Runway headings are oriented magnetically.
- Taxiway – the "road" the aircraft use to get to the runway. The most common is a parallel taxiway, but each airport will have it's own pattern.
- Ramps – parking lot for airplanes. Hangars – parking garage for airplanes.
- Control Tower – Primary function is to control the runway, it gives the aircraft permission for take off and landing. An airport with no control tower is referred to as uncontrolled.

- Passenger Terminal – Where the passengers check in with their tickets, luggage is picked up. May have other facilities for travelers. Now has a lot of security people!
- Weather Station
- Fire Station
- FBO – Fixed Base Operations – a "service station" for airplanes and pilots.
- Rotating Beacon – a light visible from the air that indicates the type of airport. A civilian airport has a light that flashes green then white. A military airport flashes green/white/white.

Airport Concerns and Challenges

- Wildlife – animals and especially birds, wander of the runway and cause accidents.
- Noise – airplanes are noisy! Airplanes try to take off and land more quickly.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight) Chapter 10 - The Airport

1. At night, runways have steady _____ lights on the edges and sometimes down the middle.
   a) Blue
   b) Green
   c) Red
   d) White

2. The most common taxiway is called the _____ taxiway.
   a) Parallel
   b) Ramp
   c) Perpendicular
   d) Vertical

3. T / F An airport without a control tower is called an uncontrolled airport.

4. T / F A fixed base operation is basically a service station for airplanes.

5. T / F Taxiways are the parking spots for aircraft.

6. T / F The number of a runway is the first 2 digits of a compass direction rounded to the nearest 10 degrees.

7. T / F At the beginning of a runway, the lights are red.

8. T / F A hangar is really just a garage for airplanes.

9. T / F At civilian airports, a rotating beacon, which is used to help pilots locate an airport in bad weather, uses flashing red and white lights.

10. T / F Because of technology, birds are no longer a concern for airplanes.

Ch. 9 - 1. c. 2. b. 3. d. 4. a. 5. d. 6. a. 7. T. 8. F. 9. F. 10. F

Ch. 10 - 1. d. 2. a. 3. T 4. T 5. F 6. T 7. F 8. T 9. F 10. F

Journey of Flight
Chapter 11 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 11 is a discussion of air carriers of all sizes.

Major Air Carriers

- FAA (Federal Aviation Administration) – regulates safety. The FAA is responsible for controlling the flight of all air traffic over the United States.
- Airline Deregulation Act of 1978 gave the airlines free entry into the air routes of the US. The Civil Aeronautics Board (CAB) thought this would increase competition and reduce prices. Although it did to some extent, many of the major airlines cut back on their unprofitable routes and only flew the more profitable ones.
- Airliners can be categorized as: Modern Airliners, Cargo Carriers, or Regional-commuter Aircraft.

Modern Airliners

- These are the most familiar to the general population. Usually carrier >100 passengers, and fly from large city to large city.
- Boeing 747 – largest commercial airliner ever built.
- McDonnell-Douglas DC-10: a little smaller than the 747 – can carry between 255 – 380 passengers depending on the seating configurations.
- McDonnell-Douglas MD-11: world's only modern large, wide-cabin trijet.
- Lockheed L-1011 – very similar to the DC-10. Both were originally designed to be profitable on high-density short-to-medium-length routes.
- Airbus A-300B – An international corporation builds these with industries in England, France, Germany, the Netherlands and Spain. Engine is American-made.
- Boeing 767 – uses the latest in technology in design.
- Boeing 777 – fills the gap between the Boeing 767 and 747.
- Boeing 727 – the most successful airliner ever built in terms of numbers. The unique features are the three engines mounted in the rear of the plane and the T-tail.
- Boeing 737 – twin-engine, short-range jet transport.
- Boeing 757 – is a short to medium range aircraft, twin-engine.
- McDonnell-Douglas DC-9 – twin engine with a range of 1000 – 1500 miles.

Air Cargo Carriers

- Fly a variety of cargoes
- Major market is medium or long routes where speed of delivery is important.

- McDonnell-Douglas DC-10-30CF – convertible passenger/freighter
- Boeing 747F – giant of the airfreight world. See pg. 279.

Regional/Commuter Carriers

- Serve very small cities, or those with little air traffic. Average trip is several hundred miles with about 20 passengers.
- Swearingen SA-266 Metro II – carry up to 20 passengers.
- Shorts SD-3-30 (England) – twin-turboprop engines and carries up to 30.
- Beechcraft 99 – twin-turboprop that can carry up to 15.
- Dehavilland DHC-7 (Dash 7) (Canada) – a four-engine turboprop that carries up to 50 passengers.
- British Aerospace Company manufactures three aircraft that are used by regional carriers. The are: BAE Jetstream 31 (smallest, carrying 18 – 19 passengers), ATF, and the BAE 146 (largest, carries 82-93 passengers).
- Embraer (Brazil): builds two twin-engine turboprop aircraft – the EMB 110 Bandeirante (carries 21) and the EMB 120 Brasilia (carries 30).
- Fokker (Netherlands) – Well known for WWI aircraft. Leader also in bulding short-range commercial aircraft. Ex. F-27, F-50, F-28, and the F-100.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 11 - Air Carriers

1. Who is responsible for regulating the safety of the airlines and controlling the flights while flying over the United States?
a. Civil Aeronautics Board (CAB)
b. Federal Aviation Administration (FAA)
c. Airline Safety Organization (ASO)
d. National Aeronautical Association (NAA)

2. Boeing 747s and McDonnell-Douglas DC-10 fall into what category of major air carriers?
a. cargo carrier
b. modern airliner
c. regional-commuter aircraft
d. none of the above

3. The Airbus is built by an international corporation. Which of the following countries makes the engines for the Airbus?
a. England
b. France
c. Germany
d. United States

4. Which one of the following aircraft is used as an air cargo carrier?

a. Boeing 777
b. Lockheed L-1011
c. McDonnell-Douglas DC-9
d. McDonnell-Douglas DC-10-30-CF

5. T / F The Airline Deregulation Act of 1978 allowed airlines free entry in the air routes of the nation.

6. T / F The Regional-Commuter aircraft mainly carry freight.

7. T / F The Boeing 727 is the most successful airliner ever built in terms of numbers.

8. T / F The Boeing 747F is the giant of the air freight world.

9. T / F The Airbus best fits into the Regional/Commuter carrier category.

10. T / F The Boeing 777 was designed to fill the size gap between the 767 and 747.

Journey of Flight
Chapter 12 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

This chapter covers General Aviation. **General Aviation is defined as all civil aviation other than the flying done by scheduled air carriers and government agencies.** It is the largest segment of the aerospace industry. Very few people realize the size and importance of this branch of aerospace.

Instructional Aviation
- Deals with aircraft used to teach someone to fly.
- Pilot certification – training includes both ground school and flight instruction. Prior to flying solo, a student must acquire an FAA student pilot certificate by passing an FAA Class III Medical Examination. At some point in the training, the student has to pass a written exam. After passing the exam, the student earns the private pilot certificate.

Personal Aviation
- Accounts for 24% of general aviation flying.
- Defined as flying for other than business or commercial use.
- Beech Aircraft Company – built six aircraft that were used for personal aviation. All were all-metal, low-wing monoplanes. Only the Bonanza is still in production today.
- Cessna Aircraft Company – built 8 different models that were all-metal, high-wing aircraft. Cessna is the world's largest manufacturer of general aviation airplanes.

- Mooney Aircraft – the Mooney 201 is an all-metal, low-wing aircraft with a retractable tricycle landing gear.
- Piper Aircraft Co. – one the big three of general aviation. It still offers the PA-18 Super Cub, which is the longest continuously produced airplane in American aviation history.

Sport Aviation

- Flying for fun!
- Seven Categories:

1. Homebuilts
2. Ballooning
3. Soaring and Gliding – Soaring=flying without engine power and without a loss of altitude. Gliding=controlled descent of a non-powered aircraft.
4. Antique Aviation – finding and restoring vintage aircraft OR building replicas from original plans.
5. Racing – usually at low altitude and high speed.
6. Aerobatics – stunt flying
7. Ultralights – began as powered hang gliders.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 12 - General Aviation

1. What is defined as all civil aviation other than flying done by scheduled air carriers and government agencies?

a. business aviation
b. commercial aviation
c. general aviation
d. personal aviation

2. Use of an aircraft for other than business or commercial use defines _____aviation.

a. instructional
b. personal
c. sport
d. trainer

3. Who is the world's largest manufacturer of general aviation airplanes?

a. Beech
b. Cessna
c. Mooney
d. Piper

4. What city is sometimes referred to as the Air Capital of the World?

a. Dayton, Ohio
b. Lubbock, Texas
c. Salt Lake City, Utah
d. Wichita, Kansas

5. Which of the following is not considered as sport aviation?
a. aerobatics
b. crop dusting
c. racing
d. soaring and gliding

6. T / F Ultralight aircraft do not require FAA certification and pilots do not need a license.

7. T / F The Immelmann, the hammerhead stall and Cuban 8s are maneuvers seen during a typical aerobatic performance.

8. T / F The National Championship Air Races are held in Kitty Hawk, North Carolina.

9. T / F In order to qualify as an antique, an aircraft must by a least 50 years old.

10. T / F Gliding is the controlled descent of a non-powered aircraft.

Ch. 11 - 1. b. 2. b. 3. d. 4. d. 5. T 6. F 7. T 8. T 9. F 10. T

Ch. 12 - 1. c 2. b 3. b 4. d 5. b 6. T 7. T 8. F 9. F 10. T

Journey of Flight
Chapter 13 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

This chapter deals with business and commercial aviation.

Business Aviation

- Use of a private- or company-owned general aviation aircraft for business purposes.
- Usually divided into two categories: business and executive. Business = if an individual personally pilots an aircraft used by a business in which the pilot is engaged. Executive = if a professional pilot flies the company aircraft to transport employees.
- Three main concerns:

1. Fuel Efficiency –
2. Noise
3. Cost Effectiveness

- Executive Aircraft – very competitive market. Consists of: Multi-engine Piston Aircraft, Turboprops, Turbojets.
- Business Aircraft – 78% are single- and piston-engine aircraft, 21% are twin- and piston-engine aircraft. Includes business twins and helicopters.

Commercial Aviation

- A segment of general aviation. Deals with using general aviation aircraft for hire as a commercial (money-making) business.
- Transportation – Air taxis and charter services provide transportation on a nonscheduled or demand basis.
- Non-transportation – includes agricultural application (fixed and rotary wing), aerial advertising, aerial photography, fire fighting, fish and wildlife, patrol aircraft, and industrial uses.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 13 - Business and Commercial Aviation

1. Business aviation is usually classified into two groups according to who is flying the aircraft:
a. official and unofficial aircraft
b. civilian and military aircraft
c. business and non-business aircraft
d. business and executive aircraft

2. There are three areas of concern in aviation today; fuel efficiency, cost effectiveness and
a. air stability
b. storage capability
c. comfort
d. noise

3. What is the largest turboprop executive aircraft?
a. *Beech King Air* BE 300
b. *Piper Cheyenne* II
c. *Swearingen Merlin* IVA
d. *Turbo Seminole*

4. In the turbojet area, who leads all other manufacturers in numbers of aircraft?
a. Gates *Learjet*
b. Grumman *Gulfstream*
c. Cessna *Citation*
d. Israel *Westwind*

5. What is the only single-engine business aircraft built in the United States that is pressurized?
a. Piper *Cub*
b. Piper *Malibu*
c. Gates *Learjet*
d. Cessna *Citation*

6. Which of the following is not in the non-transportation area of commercial aviation?
a. air taxis
b. agricultural application
c. aerial photography
d. wildlife conservation

7. T / F Commercial aviation is a segment of general aviation

8. T / F The Federal Government places limitations on the amount of engine noise an aircraft can produce.

9. T / F All of the Fortune 500 companies in the US have at least one company aircraft.

10. T / F Most of the helicopters used for business aviation are Bell 206 *Jet Rangers* and McDonnell-Douglas 500Ds.

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 14 is a review of military aircraft – and has some great pictures! Ever wonder (for those of us who were militarily challenged) what all those letters before, during and after the numbers for aircraft (ex. OV-10, or KC-135) mean? Check out the chart on pg. 324!

Combatant Aircraft

- Bombers – large, long-range aircraft. Mission is to reach into the enemy's homeland and destroy the ability to wage war. Targets include: factories, military bases, population centers and troops. The US has three bombers: B-52, B-1 and B-2.
- B-52 – built in the 1940's. Has gone through 8 model changes. Current one is the B-52H. Has 8 turbofan engines, goes about 660mph, range of up to 10,000 miles.
- B-1 – B-1B was approved by President Reagan in 1981. Speeds of Mach 2.1 at 50,000 ft.
- B-2 – new Advanced Technology Bomber and is often called the "stealth" bomber. The B-2 uses the latest technology to make it invisible to enemy radar and infrared detectors.
- Fighters – destroy other aircraft! US has seven different fighters:
- A-10 Warthog – primary mission is to support ground troops. It is slow, but is highly maneuverable and can operate at extremely low altitudes.
- F-15 Eagle – is an all-weather, extremely maneuverable, tactical fighter designed to gain and maintain air superiority in aerial combat. Speed of more than Mach 2.
- F-16 Fighting Falcon – lightweight fighter, speed of Mach 2.
- F-117 – F-117A Nighthawk – first operational aircraft designed to exploit low-observable stealth technology. Unique design provides exceptional combat capabilities.
- F-14 Tomcat – supersonic, twin-engine, variable sweep wing, two-place. Designed to attack and destroy enemy aircraft at night and in all weather conditions. (Top Gun!)
- F/A-18 – all-weather fighter and attack aircraft.
- F-22 – built to replace the F-15, and is called the Advanced Tactical Fighter. Only aircraft in the world that can travel at Mach 1 without using afterburners.

Reconnaissance and Observation Aircraft

- Used by the military to watch an enemy or potential enemy.
- TR-1/U2 – built in the 1950's as a spy plane. It can fly at extremely high altitudes (90,000 ft.).
- SR-71 Blackbird – world's highest and fastest aircraft. Operates at altitudes of 80,000 – 100,000 ft. at a speed in excess of Mach 3.
- E-3A AWACS (Airborne Warning and Control System) is based on the Boeing 707, and serves as an airborne command and control center.

- E-4B – serves as the National Airborne Operations Center for the National Command Authorities.
- E-8 J-STARS – The Joint Surveillance Target Attack Radar System (J-STARS) is an airborne platform equipped with a long-range, air-ground surveillance system designed to locate, classify and track ground targets in all weather conditions.
- Noncombatant Navy Aircraft – for antisubmarine patrol, the Navy used the P-3C Orien and the S-3A.

Transports and Tankers

- C-5 Galaxy – the USAF's largest aircraft. Built primarily to provide massive strategic (intercontinental) airlift for combat supplies. The C-5 is massive, nearly 248 feet long, wingspan of more than 222 feet.
- C-141B Starlifter – backbone of out strategic airlift.
- C-130 Hercules – much smaller than the other two, but considered one of the most successful aircraft of all time. Over 30 models have been produced, and is used by the US and 52 foreign countries.
- KC-135 – Military version of the Boeing 707. It has been produced in several models. KC-135 Tanker, and WC-135 Weather aircraft are probably best known.
- KC-10A Extender – an advanced tanker/cargo aircraft; selected to eventually replace some of the older KC-135 tankers.
- C-9 – The McDonnell-Douglas DC-9 has been modified into two models for the military – the Air Force C-9A Nightingale (medical airlift transport), and the Navy C-9B Skytrain (personnel transport).
- C-17 Globemaster – (picture on page 325!) – Newest and most flexible cargo aircraft. Capable of rapid delivery of troops and all types of cargo.

Trainers

- All pilots must go through flight training (yes, even CFI's and CFII's)
- T-3 Firefly – initial training for some.
- T-37B – comes after the T-3, subsonic jet that seats the pilot and instructor beside each other.
- T-38 Talon – After the T-37. The T-38 is supersonic, and can fly at Mach 1.2. the student and instructor sit behind one another. Used specifically for fighter pilot's training.

Utility Aircraft

- C-12A – military version of the Beechcraft Super King Air 200, is quickly converted for cargo missions. Crew of two and eight passengers.
- C-20 – USAF has 11 and uses them for airlifting very important people. Crew of 5, 14 – 18 passengers.
- C-21A - military version of the Learjet 35A, used for operational support airlift from 16 USAF bases. Crew of two, carries 8 passengers or 3,100 lbs. cargo.
- C-22B – military version of the Boeing 727. The Air National Guard on Operational-support airlift missions is operating four of these.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 14 - Military Aircraft

1. Which of the following is not in the US' current bomber inventory?
a. B-1
b. B-2
c. B-25
d. B-52

2. Which of the following is often called the "stealth" bomber?
a. B-1
b. B-2
c. B-25
d. B-52

3. Which category of military aircraft has the mission of destroying other aircraft?
a. bombers
b. fighters
c. reconnaissance
d. tankers

4. Which aircraft is not classified as a reconnaissance aircraft?
a. TR-1
b. SR-71
c. E-3A
d. C-9

5. What is the US Air Force's largest aircraft?
a. C-5
b. C-141
c. B-52
d. SR-71

6. The military version of the Boeing 707 is the
a. C-5
b. C-130
c. C-135
d. C-141

7. T / F The C-9A is used by the Air Force to transport medical patients.

8. T / F The T-1 *Jayhawk* is used in training for pilots who will be flying fighter aircraft.

9. T / F The C-141B *Starlifter* has been the backbone of our strategic airlift.

10. T / F The SR-71 *Blackbird* is the world's highest flying and fastest aircraft.

Ch. 13 - 1. d 2. d 3. c 4. a 5. b 6. a 7. T 8. T 9. F 10. T

Ch. 14 - 1. c 2. b 3. b 4. d 5. a 6. c 7. T 8. F 9. T 10. T

Journey of Flight
Chapter 15 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Helicopters and less-than-traditional aircraft will be covered in this chapter.

Helicopters

- In use since the end of WWII.
- Latest push in civilian helicopters is into the executive/business aviation fields.
- Shortcomings of helicopters: high maintenance costs, high noise levels, vibrations, and slow cruise speeds. Advances in technology have overcome most of the problems to some degree.

Military Helicopters

- Only two that are limited strictly to military use: Bell AH-1 (Huey Cobra) and AH-64 (Apache).
- Bell AH-1 – designed specifically as an attack helicopter. Gunner sits in front of and below the pilot. The AH-1 is very fast for a helicopter (200mph)
- AH-64 – also designed and produced to be an attack helicopter. Larger and slower than the AH-1.

Heavy-lift Helicopters

- Initially designed for military use, now used by civilians also.
- Boeing Vertol CH-47 Chinook – twin-rotor, heavy-lift helicopter powered by two turbine engines. Comes in three models, with the major differences being the power plants and rotor systems. The civilian version is called Model 234, and carries 44 passengers and is useful for carrying people and supplies to remote sites.
- Boeing Vertol CH-46 – large twin-rotor helicopter used by the US Navy and the Marine Corps as a transport helicopter for getting supplies from aboard ship to the troops on shore.
- Sikorsky HH-3 – comes in two models: HH-3E Jolly Green Giant used by the USAF and the HH-3F Pelican used by the US Coast Guard. Both are used for search and rescue. The Jolly Green Giant won fame in the Vietnam War where is rescued downed pilots and performed emergency evacuation. In 1967, 2 HH-3E made the 1st non-stop transatlantic flight by helicopter – 4,270 miles from NY to Paris.
- Sikorsky CH-53 – very large, heavy-lift helicopter built for use by the US Navy, Marine Corps, and Air Force. Navy and Marines used it for troop transport and cargo hauling. Air Force used it for search and rescue.

- Sikorsky CH-54 Skycrane – one of the largest helicopters in the world and holds several world's records for its lifting ability. Can lift bulldozers, road graders and armored personnel carriers.
- Bell UH-1 – Hueys and Iroquois are the most common helicopters used by the military. Also used a lot in the civilian market. It is the right size for most transportation and hauling jobs.
- Sikorsky UH-60A – Newest US Army helicopter. It was selected to replace the older Hueys. The UH-60A Black Hawk is used for transporting troops and supplies on the battlefield. Much faster than the Huey.

Light-lift Helicopters

- Used in the military for observation and transportation of personnel. Used in the civilian community for executive transport, crop dusting, construction and hauling personnel.
- Bell 206 Jet Ranger – This is the most popular light-lift helicopter in the US. It comes in four models. Used for supplying offshore oil platforms.
- Bell 222 – Fast, quiet, long-range helicopter aimed at the executive aircraft market and other commercial uses.
- McDonnell-Douglas 500D – used as light observation helicopters. There are four models, with the E model used widely by law enforcement agencies.
- Sikorsky S-76 – developed specifically for the civilian market. It uses the latest technology to be one of the smoothest and quietest helicopters ever built. It has many plush interiors from which to choose and is aimed at the executive market.

Foreign-built Helicopters

- Aerospatiale – This is the national industry of France, and it is currently producing 10 different models of helicopters.
- Agusta – Italian company that markets one helicopter, the 109A MkII. Light-haul helicopter in competition with the Bell 222.
- MBB – The MBB Helicopter, Inc. markets the MBB NO 105 CBS, which is imported from West Germany. It is very popular for use in the supply of offshore oilrigs.

Compound and Hybrid helicopters

- Offered as improvements to the helicopter.
- Compound Helicopter – conventional helicopter with extra forward thrust provided by either a jet or propeller unit.
- Hybrid Helicopter – a variety of advanced helicopter concepts lumped together. They are trying to solve the problem of using rotors for vertical takeoff and landing without impeding forward flight.

Short-takeoff-and-landing airplanes

- USAF definition: ability of an aircraft to clear a 50-ft. obstacle within 1,500 ft. of commencing takeoff and to stop within 1,500 ft. after passing over a 50-ft. obstacle when landing.

- Value of STOL – differences of opinion about the importance of STOL when VTOL is being pursued. Most people don't think that STOL will become obsolete because of VTOL.
- STOL characteristics and problems: wings tend to be long in span, engines are relatively powerful for the weight of the airplane and provide extra thrust for takeoffs and landings, some have additional airfoil areas for additional lift.

Vertical-takeoff-and-landing Aircraft

- Difference between STOL and VTOL is considerable.
- VTOL Principles – Newton's 3rd Law of Motion applies. As the exhaust gas or air is directed downward toward the ground, the aircraft movement is upward.
- Turboprop VTOL – the propellers tilt straight upward for VTOL and forward for level flight.
- Jet VTOL – The jet engine can have a swiveling exhaust nozzle to provide vertical or horizontal thrust.
- Fan-in-wing VTOL Principle is experimental
- Combination Engines – The US Army and Air Force have experimented with six jet engines, four vertically mounted and two horizontally mounted.
- The AV-8 Harrier – Only VTOL aircraft put into common use in any country.
- Harrier has VTOL and STOL capability.

Unmanned Air Vehicles (UAV)

- Small aircraft with no pilot that perform missions considered too dangerous or politically unwise for manned flight. Missions are classified as either non-lethal or lethal.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 15 - Helicopters, STOL, VTOL, and UAVs

1. There are only two US helicopters that are limited strictly to military use - the Bell AH-1 *HueyCobra* and the

a. AH-64 *Apache*
b. CH-47 *Chinook*
c. HH-3F *Pelican*
d. UH-60A *Black Hawk*

2. In 1967, what helicopters made the world's first non-stop transatlantic flight by helicopter?

a. Two AH-1s
b. Two AH-64s
c. Two HH-3Es
d. Two HH-53Bs

3. What is the most popular light-lift helicopter built in the US?

a. Bell 206 Jet Ranger
b. Bell 222

c. McDonnell-Douglas 500D
d. Sikorsky S-76

4. The ability of an aircraft to clear a 50-foot obstacle within 1,500 feet of commencing takeoff and to stop within 1,500 feet after passing over a 50-foot obstacle when landing best defines
a. ATOL
b. HTOL
c. STOL
d. VTOL

5. What is the only VTOL aircraft that has been put into common use in any country?
a. 109A *MK II*
b. AV-8A *Harrier*
c. OV-10 *Bronco*
d. V-22 *Osprey*

6. T / F Aerospatiale is the national aerospace industry of Italy.

7. T / F The variety of advanced helicopter concepts can be lumped together as a category called hybrid helicopters.

8. T / F VTOL capability is achieved through the application of Newton's First Law of Motion.

9. T / F The missions of UAVs are classified as either non-lethal or lethal.

10. T / F A compound helicopter is a conventional helicopter with extra forward thrust provided by either a jet or propeller unit.

Journey of Flight
Chapter 16 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 16 discusses governmental and non-governmental aerospace organizations. We will look briefly at their roles in the aviation community.

Governmental Organizations

Federal Aviation Administration

- Federal Aviation Administration (FAA) – Responsible for regulating air commerce, helps improve aviation safety, promotes civil aviation, and develops and operates a common system of air traffic control.

- The Air Commerce Act of 1926 gave the US Government the responsibility for the operation and maintenance of the airway system over the US, including all aids to navigation.
- Civil Aeronautics Act of 1938 placed all air transportation regulations under three separate agencies: the Civil Aeronautics Authority, the Office of the Administrator of Aviation and the Air Safety Board.
- In 1940, the three agencies were reduced to two: the Civil Aeronautics Board (CAB) and the Civil Aeronautics Administration (CAA). The CAB was involved in policy-making and accident investigation. The CAA was responsible for executing safety regulations and operating the airway system. In 1946, the Federal Airport Act provided for the CAA to use federal funds to design and develop a system of airports throughout the US.
- In 1958, the Federal Aviation Act changed the CAA to the Federal Aviation Agency (FAA).
- In 1966, it became the Federal Aviation Administration.

National Transportation Safety Board (NTSB)

- A 5-member board appointed by the president of the US
- Appointed to a 5-year term.
- Responsible for determining the cause, or probable cause, of any transportation accident.

National Aeronautics and Space Administration (NASA)

- Mission: 1.) To explore, use and enable the development of space for human enterprise. 2.) To advance scientific knowledge and understanding of the Earth, the solar system and the universe and use the environment of space for research. 3.) To research, develop, verify and transfer advanced aeronautics, space and related technologies.
- NASA promotes economic growth by conducting research in partnership with industry.
- Preserves the environment through studies of Earth as a planet.
- Supports education by encouraging learning through many educational endeavors.
- NASA research has created a large spin-off technology. Many developments stem from NASA research; such as pocket calculators or microwave ovens.

International Civil Aviation Organization (ICAO)

- Primary objective is to standardize aviation functions. Some examples of functions that are standardized: rules of the air, aeronautical meteorology, aeronautical charts and symbols and airport designations. This allows countries to standardize aviation.

Civil Reserve Air Fleet

- Composed of commercial airliners which have been designated by the Department of Defense for use in time of national emergency or disaster.
- Primary objective is to transport supplies and/or personnel.
- Includes airplanes as well as aircrews and maintenance crews.

- Subject of call on 24-hour notice.

Civil Air Patrol

- Federally chartered, private, nonprofit corporation that is also the official civilian auxiliary of the USAF.
- Three missions: Emergency Services, Aerospace Education, and Cadet Programs.

Nongovernmental Organizations

Aircraft Owners and Pilots Association (AOPA)

- Founded in 1939.
- Formed to support the rights and views of aircraft owners and pilots.
- In 1950, the Air Safety Foundation was founded as a sub-organization of AOPA. It is the nation's largest organization dedicated to providing aviation education and safety programs for general aviation. (The ASF is a great resource for us, as CAP members to use for educational material.) *Not in the book – just my opinion from experience!

Experimental Aircraft Association (EAA)

- Formed to help builders safely construct and fly their homebuilt aircraft.
- Responsible for one of the largest air shows in the world – "Osh Kosh".

Industry Organizations

- Aerospace industries involved in some form of manufacturing related to aircraft, missiles, spacecraft and their parts and accessories.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 16 - Aerospace Organization

1. Who is responsible for regulating air commerce?
a. AOPA (Aircraft Owners and Pilots Association)
b. EAA (Experimental Aircraft Association)
c. FAA (Federal Aviation Administration)
d. CAB (Civil Aeronautics Board)

2. What law gave the Federal Government the responsibility for the operation and maintenance of the airway system over the US?
a. Air Commerce Act of 1926
b. Civil Aeronautics Act of 1938
c. Federal Airport Act of 1946
d. Federal Airport Act of 1958

3. When an aircraft is in flight, who assigns the aircraft a certain altitude and a specific route to follow to its destination?
a. Air Traffic Control Tower

b. Air Route Traffic Control Center
c. Federal Aviation Administration
d. Flight Service Station

4. Where is FAA's Aeronautical Center, which trains FAA, military and foreign personnel to operate air traffic controllers, located?
a. Kansas City, Kansas
b. Little Rock, Arkansas
c. Oklahoma City, Oklahoma
d. Omaha, Nebraska

5. What group is responsible for determining the cause, or probable cause, of any transportation accident?
a. Civil Aeronautics Administration (CAA)
b. Bureau of Aviation Safety (BAS)
c. Federal Aviation Administration (FAA)
d. National Transportation Safety Board (NTSB)

6. T / F NASA's budget is under one percent of the federal budget.

7. T / F The Civil Reserve Air Fleet (CRAF) is composed of commercial airliners, which have been designated by the DoD for use in time of national emergency.

8. T / F The 3 main missions of CAP are: emergency services, aerospace education, and cadet programs.
9. T / F The Experimental Aircraft Association was formed to help aircraft builders safely construct and fly their own aircraft.
10. T / F The Aircraft Owners and Pilots Association is an international organization dedicated to standardizing aviation functions.

Ch. 15 - 1. a 2. c 3. a 4. c 5. b 6. F 7. T 8. F 9. T 10. T

Ch. 16 - 1. c 2. a 3. b 4. c 5. d 6. T 7. T 8. T 9. T 10. F

Journey of Flight
Chapter 17 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Aerospace careers and training are the subject of this chapter. We will look at some of the aptitudes necessary for these careers, and some of the ways you can achieve these careers.

Aptitudes and Aerospace Careers

- Aptitudes are special talents and natural abilities that a person possesses. Aerospace careers require strong aptitudes in mechanical, verbal, numerical, social and artistic skills.
- Aerospace Careers – see list on page 364 to match aptitudes with careers.

Community Colleges

- Also called junior colleges.
- Very popular in recent years. Students can live at home and attend classes.
- Less costly that 4-year colleges.
- Usually have courses that help fulfill the needs of local employers.
- Offer basic courses that are transferable to 4-year schools.

Technical/Vocational Schools

- Provide the majority of formal technical educational courses.
- Students learn special trades and skills.
- Courses of study are about as long as those in community college; sometimes shorter.
- Graduates go directly to work for private industry or government.

Institutes

- Special schools that offer only those courses and degrees that are designed for specific career fields.
- They place more emphasis on subjects that are essential to doing the job.
- Students can earn a bachelor's degree.

Four-year Colleges/Universities

- A much broader program than the others.
- Recommended for students who don't know how they will use their education.
- Could take longer than an institute due to more emphasis on humanities.

Air Force Schools

- Education and training is important to the Air Force.

- Broad range of courses open to officers and airmen to develop their skills and knowledge.
- These courses will help them with their careers and help them when they get out of the military.

Air Force Reserve Officer Training Corps (AFROTC)

- Primary source of commissioned officers for the Air Force.
- Located on many colleges and universities across the country.
- Offers two-year and four-year programs to both men and women.
- Students take AFROTC classes like any other class on campus. There are some additional training requirements in the summers.
- Upon graduation from college, students receive their commission and enter the Air Force.

The US Air Force Academy

- Located in Colorado Spring, Colorado.
- See list of admission requirements on pg. 374
- Students receive a 4-year college education, plus military and physical training.
- US senators and representatives make most of the yearly appointments.
- Upon graduation, the students receive a commission in the US Air Force.

Community College of the Air Force (CCAF)

- Helps airmen and noncommissioned officers by translating what they have learned in the Air Force in technical training and on-the-job training into college-level semester hours.
- Air Force enlisted members can earn credit toward an associate degree.
- CCAF offers associate degrees in more than 70 programs.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 17 - Aerospace Careers and Training

1. Special talents and natural abilities are called
a. attribute
b. aptitude
c. attitude
d. feeling

2. In which of the following schools do people learn special trades and skills?
a. community college
b. junior college
c. technical/vocational school
d. 4-year college

3. Which of the following is the primary source of commissioned officers for the Air Force?
a. Air Force Academy
b. Community College of the Air Force
c. Officer Training School
d. Air Force Reserve Officer Training Corps

4. Which of the following is NOT a requirement for a prospective appointee to the Air Force Academy? A candidate must be
a. at least 18 years old
b. unmarried and have no dependent children
c. in good physical condition
d. of good moral character

5. T / F A college or university offers a much broader education than does a junior college.

6. T / F During the first two years of study at community colleges, they offer many of the same courses as 4-year colleges.

7. T / F There is a definite relationship between aptitudes and a person's success in certain occupations.

8. T / F The Community College of the Air Force is designed to help Air Force officers receive their masters degrees.

9. T / F AFROTC programs offer scholarships to qualified cadets.

10. T / F One reason community colleges are popular is because they are generally less expensive than 4-year schools.

Journey of Flight
Chapter 18 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

With Chapter 18, we are entering a section in the book on the air environment. We'll cover the atmosphere and weather as it relates to aviation. The next 3 chapters will be helpful for those working with cadets on Module 3 of Aerospace Dimensions.

The Atmosphere
- An envelope or ocean of air surrounding the earth.
- No distinct boundary line between the atmosphere and space.
- Makeup of the atmosphere: elements, regions and pressures.

Atmospheric Elements
- 78% nitrogen

- 21% oxygen
- 1% argon, neon, helium, methane, hydrogen, xenon, water vapor, carbon dioxide, ozone, carbon monoxide, sulfur dioxide and nitrogen dioxide.

Atmospheric Regions by Temperature Distribution

- Troposphere – where people live and where most weather occurs. Extends to about 10 miles or 55,000 ft. at the equator and to 28,000 ft. at the poles. Temperature decreases with an increase in height. The tropopause is at the top of the troposphere and is the dividing line between the troposphere and the stratosphere.
- Stratosphere – temperature increases with an increase in altitude. Begins at about 10 miles and extends to about 30 miles. At the base of the stratosphere, temp is about –60 degrees Celsius and at the top of the stratosphere it reaches –40 degrees Celsius. At about 30 miles, the warming trend stops and there is another dividing line called the stratopause.
- Mesosphere – starts at the top of the stratopause and at first shows a marked increase in temperature to 10 degrees Celsius, then it decreases until at about 50 miles altitude the temperature drops to as low as –90 degrees Celsius. The area at the top of the Mesosphere is called the mesopause.
- Thermosphere – starts at about 50 miles and goes to about 300 miles. Here, temperature increases with height. Usually 750 to 1,250 degrees Celsius depending on solar activity.

Atmospheric Regions by Physiochemical Processes

- Ozonosphere – extends from about 10 to 30 miles. Sun's radiation reacts with oxygen molecules causing them to pick up a third atom creating ozone. This ozone shields us from ultraviolet and infrared radiation.
- Ionosphere – begins at about 25 miles and extends to about 250 miles. Because of interactions between atmospheric particles and the sun's radiation there is a loss or gain of electrons, forming ions.
- Neutrosphere – this is a region below the ionosphere that extends down to the surface of the Earth. Very little ionization takes place here.
- Chemosphere – begins at about the stratopause and overlaps into the ozonosphere and ionosphere. Number of important photochemical reactions take place here.

Atmospheric Regions by Molecular Composition

- Homosphere – Earth's surface to about 60 miles. Gaseous composition and mixing are relatively constant.
- Heterosphere – begins at about 55 – 60 miles altitude. Molecules are farther apart and gravity influences them. So, the heavier nitrogen and oxygen molecules are found in the lower part of this region and the lighter ones in the upper part.

Atmospheric Regions by Dynamic and Kinetic Processes

- Exosphere – top of the atmosphere, above the heterosphere. Particles of the atmosphere move in free orbits subject only to the Earth's gravity. Bottom of the

exosphere is somewhere between 310 – 621 miles above the Earth's surface. Upper boundary extends into space without end.

Atmospheric Pressure

- Pressure is the weight of molecules pressing down on molecules below them.
- Pressure is greatest at the surface of the Earth and the gravitational influence is also the greatest.
- Pressure decreases with an increase in altitude.

**Now that your head is spinning, take a look at the illustration on page 383. It kind of puts things in perspective. I found it helpful to kind of diagram everything together – helpful for the visual learners.

Roles of Water and Particulate Matter in the Atmosphere

- Water – found mostly in the troposphere. Some reaches into the stratosphere (with heavy thunderstorms). Can be in liquid (rain, lakes), solid (ice, hail or snow), or a gas (water vapor). Water vapor is always present, no matter how dry the air is. **Saturated** means that the parcel of air is holding all the water vapor it can. **Dew Point** is the temperature at which saturation occurs. **Condensation** is when a gas is converted to a liquid. Clouds are a product of condensation. Curious? Try one of the hands-on activities in Module 3 of Aerospace Dimensions.
- Evaporation – The process by which liquid water molecules change to a gas or water vapor. Main factor in evaporation is temperature. Most of the water vapor in the atmosphere comes from the oceans.
- Humidity and Relative Humidity – Humidity is the amount of water vapor or moisture in the air. Relative Humidity is the amount of water vapor in the air compared to its total capacity at that temperature.
- Condensation and Precipitation – Clouds, fog, dew and frost are forms of condensation. Rain, sleet, snow and hail are forms of precipitation. If visible water falls, it is precipitation.
- Dew-Point Temperature – Dew point is defined as the temperature at which saturation occurs. If you add a little bit of water to a parcel of air that is saturated, condensation will occur. Or if the temperature drops condensation will occur. This has important application in flight planning. The difference between the outside air temperature and the dew point temp. is called "the spread". The closer the two numbers are together, the more likely you are to see fog or precipitation on the ground, or clouds aloft. When the numbers are within 4 degrees or less, there is a very good possibility of fog or precipitation. When the actual temperature and the dew point temperature are the same, the relative humidity is 100%.
- Particulate Matter – small particles of dust, salt or soot stick to the water vapor in the atmosphere and are called condensation nuclei. The represent the beginning of condensation and become small particles of the clouds.

Atmosphere in Motion

- The atmosphere is in constant motion.
- Heat and Temperature – Heat is the total energy of all moving molecules within a substance. Temperature is a measure that expresses the average energy of molecular motion.
- Methods of Heat Transfer:
    1. Conduction – heating by direct contact
    2. Convection – heat transfer by vertical motion
    3. Advection – heat by lateral transfer
    4. Radiation – heat transferred by the Sun.
- Insolation – The rate at which the Earth's surface is heated by solar radiation. Depends on the angle the Sun's rays make with the horizon (angle of incidence), the distance of the Earth from the Sun and the amount of radiation absorbed by the atmosphere. Insolation is greatest in the equatorial zone.
- The Heat Balance – some of the insolation is radiated back into space or the atmosphere. It is estimated that only about 50% of the insolation reaches the Earth. The other 50% is reflected by the atmosphere and absorbed by the atmosphere.
- Wind – Warm air rises. When this happens, cooler air flows in sideways to take its place. This lateral movement is referred to as wind. This happens on a larger scale, too. Generally, the warm air rises from the equator and the cold air sinks from the poles. This, plus the rotation of the Earth complicates the simple concept of the wind.
- Coriolis Effect – The Earth rotates in a counterclockwise direction. This rotation causes objects in the Northern Hemisphere to be deflected to the right (east). It is just the opposite in the Southern Hemisphere.
- The Pressure Gradient – simply means a pressure change with distance. A pressure gradient exists whenever air pressure varies from one place to another. Isobars (those wavy lines you see on the weather map) are lines drawn through points of equal sea-level atmospheric (barometric) pressure. Generally, when you see those lines very close together on a map, you can expect greater wind. Lines that are farther apart are associated with less windy conditions.
- Other Factors Affecting the Wind – Include gravity, friction and centrifugal force. Gravity tends to pull the air downward. Friction tends to slow the air down (up to about 6000 ft. or more). Centrifugal force slows down the air with a low-pressure system and speeds up the air with a high-pressure system.
- Local and Surface Air Movements – Land and sea breezes are good examples of this. These breezes are caused by temperature differences, which cause pressure differences, which cause air to move. During the afternoon, the air over the water is cooler and heavier, so the breeze flows back out to the water.
- Jet Stream – a narrow current of air that moves across the Northern and Southern Hemispheres in wavelike patterns. It is usually 100 – 400 miles wide, 1 – 3 miles thick and is generally encountered at 30,000 – 35,000 feet. The wind speeds range from 150 – 300 mph, but speeds of 450 mph have been recorded. It's general motion is from west to east.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 18 - The Atmosphere

1. Most of our weather occurs in the
a. mesosphere
b. stratosphere
c. thermosphere
d. troposphere

2. What is the standard lapse rate?
a. 1 degree Celsius or 3 degrees Fahrenheit
b. 2 degrees Celsius or 3.5 degrees Fahrenheit
c. 3 degrees Celsius or 2 degrees Fahrenheit
d. 5 degrees Celsius or 5 degrees Fahrenheit

3. When a parcel of air cannot hold any more water vapor, it is said to be
a. evaporated
b. condensed
c. humidified
d. saturated

4. The method of heat transfer by vertical motion is called
a. conduction
b. convection
c. advection
d. radiation

5. The rate at which the Earth's surface is heated by solar radiation is called
a. advection
b. conduction
c. insolation
d. radiation

6. On a weather map, lines of equal pressure are called
a. gradients
b. isobars
c. isotherms
d. troughs

7. T / F A high is a center of high pressure surrounded by even higher pressure.

8. T / F The lateral movement of air is referred to as wind.

9. T / F Heating by direct contact is called convection.

10. T / F Jet streams have recorded winds as high as 450 mph.

Ch. 17 - 1. b 2. c 3. d 4. a 5. T 6. T 7. T 8. F 9. T 10. T

Ch. 18 - 1. d 2. b 3. d 4. b 5. c 6. b 7. F 8. T 9. F 10. T

Journey of Flight
Chapter 19 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 19 deals with weather elements and how they affect flight. Although this chapter won't make you a better forecaster than the weatherman, it will give you a good understanding of why things happen.

Weather
- "the condition of the atmosphere at any particular time and place"
- Usually described by its elements – temperature, air pressure, humidity, clouds, precipitation, visibility and wind.

Air Masses and Fronts
- An air mass is a huge body of air that generally has the same temperature and moisture content within the entire air mass. Usually covers an area 1,000 or more miles across.
- Air Mass Origination and Type
  - A – Artic – cold
  - P – Polar – cold
  - T – Tropical – hot
  - E – Equatorial – hot
  - m – maritime, humid
  - c – continental, dry
- Characteristics of Air Masses depend on 4 things: the surface over which it forms, the season, surface over which it travels, and the length of time away from its source.
- Fronts – the boundaries between air masses of different characteristics
- Cold Front – cold air comes in and pushes the warmer air aloft and out.
- Warm Front – warm air comes in and moves over the cooler air. The cooler air will slowly move out.
- Stationary Front – When there isn't much of a difference between the air masses, neither one will replace the other for a while. They become stationary.
- Occluded Front – Occurs when a warm air mass lies between two cold air masses.

Clouds – please note the excellent visual aids in this chapter – pg. 410 - 414
- Three basic types: cumulus (piled up), stratus (layered), and cirrus (high, thin appearance).
- Three general ranges: low (near the surface to about 6,500 ft.), middle (from 6,500 to about 20,000 ft.), and high (from 20,000 ft. and up).

- Stratus clouds have smooth appearance. Any precipitation will be light drizzle or light snow. Usually not associated with turbulence, but is associated with reduced visibility. Stratus are usually low range.
- Altostratus is relatively thin, and is found in the middle range.
- Cirrostratus is very thin and appears in the high range. It is composed of ice crystals.
- Cumulus are low range, and appear puffy like cotton balls. It is usually associated with bumpy flight conditions under the cloud base. Cumulus that are building "up" or vertically are indicative of at least a strong rain shower, and potentially more severe weather.
- Stratocumulus – low range clouds, more gray and elongated than cumulus clouds. Associated with light rain or snow showers, as well as turbulence.
- Cumulonimbus or CB is the thunderstorm cloud. This is a cumulus cloud with very strong vertical development. These are interesting to watch build. Associated with extreme turbulence, precipitation, and sometimes hail.

Fog

- A cloud that touches the ground.
- Radiation fog forms at night when the land radiates much of the heat absorbed from the Sun.
- High-inversion fog is formed by the condensation of water vapor or near the top of cool air that is covered by a warmer air layer.
- Advection fog is formed when wind blows moist air over a cold surface and the surface cools the air to its dew-point temperature.
- Evaporation fog occurs when cold air moves over warm water; the water's normal evaporation process saturates the cooler air with water vapor, and the dew point is reached.
- Upslope fog – results when wind carries moist air up a mountain slope or sloping land until the air is cooled.
- Obvious application for flight and ground teams – an awareness of developing conditions that will impede visibility!

Wind Shear

- Atmospheric condition in which changes in speed and direction of the wind occur. Can be dangerous for airplanes during takeoffs and landings.
- A Microburst is a downdraft shear associated with a thunderstorm.
- Shears and microbursts can be devastating for aircraft (large and small), vigilance to changing weather conditions is a necessity.

Clear Air Turbulence (CAT)

- Associated with convective currents, wind shears and obstructions (mountains). Can be classified as light, moderate, severe and extreme. Light may require airplane passengers tow ear seat belts. Moderate means passengers must wear seat belts and unsecured objects move about. Severe means the aircraft may be out of control at times and occupants are thrown against seat belts. Extreme

means the entire aircraft is tossed about and practically impossible to control. Structural damage may occur.

Unique Weather Patterns

- El Nino is the warming of the East Pacific Ocean temperature. It occurs when warm water moves in and displaces colder water for a longer than normal period of time.
- La Nina is the opposite. La Nina occurs when the ocean temperature off the coast is colder than normal for a longer than normal period.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 19 - Weather Elements

1. Which air mass classification refers to cold dry air?
a. continental polar
b. continental tropical
c. maritime tropical
d. maritime polar

2. What are the three basic cloud types?
a. cumulus, stratus and cumulonimbus
b. stratus, cirrus and stratocumulus
c. stratus, altostratus and cirrostratus
d. cumulus, stratus and cirrus

3. Which of the following clouds is composed entirely of ice crystals?
a. cumulus
b. cirrostratus
c. nimbus
d. stratus

4. Which cloud is associated with thunder and lightning?
a. cirrus
b. cumulonimbus
c. nimbostratus
d. stratocumulus

5. Which type of fog is formed when the wind blows moist air over a cold surface and the surface cools the air to its dew-point temperature?
a. advection
b. evaporation
c. radiation
d. upslope

6. T / F A microburst is a downdraft shear associated with thunderstorms.

7. T / F When air masses lose their punch and are not replacing one another, an occluded front develops.

8. T / F Moderate turbulence is defined as times when the aircraft may seem out of control, and occupants are thrown against seat belts.

9. T / F El Nino occurs when warm waters move in and displace the colder waters for a longer than normal period of time.

10. T / F The boundaries between air masses of different characteristics are called fronts.

Journey of Flight
Chapter 20 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 20 deals with aviation weather. The two previous chapters have given you a background and general picture of weather and the environment. Now we will narrow our focus.

Flight (Weather) Conditions

- Visual Flight Rules (VFR) – the general flight conditions a pilot can expect at the surface. VFR criteria – or to "fly under VFR" conditions, means that you have a cloud ceiling greater than 3,000 feet, and visibility greater than 5 miles.
- Instrument Flight Rules (IFR) – the weather conditions at an airport that cause a pilot to use his instruments to assist in takeoffs and landings. IFR criteria is defined as cloud ceiling is greater than 500 feet and less than 1,000 feet, and visibility is greater than 1 mile, but less than 3 miles. Flight under these conditions require the use of instruments to assist in takeoff and landing.

Weather Hazards

- Clouds, Rain, Snow, Fog and Obstructions – Depending on the intensity of these weather conditions, reduced visibility can be a hazard to flight. The moisture caused by these conditions, in combination with freezing temperatures can also pose icing hazards for aircraft.
- Haze and Smoke – Also visibility deterrents. Haze and smoke become a more of a problem in a calm wind situation, as they remain in place. Pollution can cause them to become thicker.
- Blowing Dust, Sand or Snow – In combination with strong winds; dust, sand or snow becomes a visibility hazard. Dust is generally a localized problem, whereas dust can reach altitudes of 15,000 ft. in windy conditions.
- White Out – This requires a snow-covered surface, and will produce a loss of reference to the horizon and visual references needed for depth perception.

Turbulence

- Unstable air, may be associated with cumulus clouds.
- Wake turbulence – caused by aircraft and can create swirling air currents.

Icing

- Carburetor Ice – when water vapor condenses within the carburetor of an aircraft reciprocating engine. Know where your "carb heat" is!
- Glaze and Rime Ice – types of ice that form on the leading edges of the aircraft, and can result in loss of lift. These types of ice can be difficult to see, although by being aware of weather conditions (precipitation/moisture in the air, and temperatures) allow the pilot to plan flight accordingly. Most specifically, not to fly into known or heavily anticipated icing conditions. Glaze ice is formed when super cooled rain droplets turn to ice when they strike the plane. Rime ice has the frost appearance seen on the walls of frozen-food lockers.
- Frost – disturbs airflow and reduces lift efficiency.

Severe Weather

- Thunderstorms are any storm accompanied by thunder and lightning. There are three stages of a thunderstorm:

  Cumulus or Building Stage – First stage involving updrafts of air currents. Water droplets are growing to raindrop size, and clouds are building into cumulonimbus clouds. You may observe rapid vertical development of cumulus clouds.

  Mature Stage – This stage is marked by the beginning of rain. As the rain falls, it brings the air with it, developing downdrafts.

  Dissipating Stage – The downdrafts produce heating and drying, causing the raindrops to weaken and dissipate. This stage usually lasts the longest.
- Hail – Frozen ice that can cause structural damage to aircraft, buildings, and other structures.
- Tornadoes – Most often occur in North America and Australia.
  - Consist of violently swirling winds, and occur with severe thunderstorms.
  - Have been reported in every state in the continental US
  - When a tornado touches the ground, it destroys most things in its path. The path is erratic.
  - Consist of very low pressure
  - **Refer to the Fujita-Pearson Tornado Intensity Scale on page 432.**
- Hurricanes – Strong tropical cyclones.
  - Contain strong winds, but not as strong as tornadoes. Can cause tornadoes.
  - Flooding causes most of the damage with hurricanes.
  - Have a calm center – the "eye"
  - **Refer to the Saffir-Simpson Hurricane Damage Potential Scale on page 434.**

Arctic and Tropic Weather

- Arctic Weather brings the coldest air masses.
- Tropic Weather – brings hot air masses, and normally contain a lot of moisture.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 20 - Aviation Weather

1. Visual Flight Rules (VFR) apply when
a. the ceiling is 1,000 feet or higher and the visibility is 1 mile or greater
b. the ceiling is 2,000 feet or higher and the visibility is 2 miles or greater
c. the ceiling is 3,000 feet or higher and the visibility is 5 miles or greater
d. the ceiling is 5,000 feet or higher and the visibility is 7 miles or greater

2. What are the three stages of a thunderstorm?
a. beginning, middle and end
b. building, mature and dissipating
c. calm, developing and violent
d. rain, lightning and thunder

3. Where do tornadoes most often occur?
a. North America and Central America
b. South America and Africa
c. Asia and Africa
d. Australia and North America

4. Hurricane winds of 160 mph would cause the hurricane to be classified as a category
a. 1
b. 3
c. 5
d. 7

5. What distinguishes the "eye" of a hurricane?
a. It is the most violent part of a storm.
b. It is the leading edge of a storm
c. It is the calm center of a storm
d. It is the trailing edge of a storm

6. T / F Flood damage is often a major problem associated with hurricanes.

7. T / F Hailstones, the size of baseballs, are estimated to occur 1 out of every 100 thunderstorms.

8. T / F A tornado has been observed in every state in the continental US.

9. T / F Rime ice has that frosty appearance seen of the walls of frozen-food lockers.

10. T / F Blowing sand is seldom lifted more than 50 feet above the surface.

Ch. 19 - 1. a 2. d 3. b 4. b 5. a 6. T 7. F 8. F 9. T 10. T

Ch. 20 - 1. c 2. b 3. d 4. c 5. c 6. T 7. F 8. T 9. T 10. T

Journey of Flight
Chapter 21 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 21 is a discussion of rocket fundamentals. If you are interested by this, you may want to consider working with the model rocketry program for cadets. Module 4 in Aerospace Dimensions is also a discussion of rocketry.

History of Rockets

- The Chinese first used rockets in 1220. A few years later, they were also the first to use them as weapons.
- Many rocketry experiments were carried out between 1400's – 1700's.
- Col. William Congreve added flight-stabilizing guide sticks to rockets, and built the first launching pad at the end of the 18th century. He increased the range of a rocket from about 300 yards to several thousand yards.
- William Hale developed a technique called spin stabilization.
- In 1903, Konstantin Tsiolkovsky, a Russian scientist, proposed the idea of using rockets for space exploration.
- Early in the 20th century, Dr. Robert Goddard conducted many rocket experiments. He was the first to use liquid propellants, which became the forerunner for today's rockets. **He is known as the father of modern rocketry.**

Newton's Laws

- Gravity is the force of attraction that exists between all matter within the universe.
- Newton believed that bodies in space were attracted to each other.
- Newton's Law of Universal Gravitation defines the relationship of force, weight and mass. This law states that two bodies attract each other with a force directly proportional to their mass and inversely proportional to the square of the distance between them. This means that as either or both of the masses increase, the force increases, but that as the distance increases, the force decreases.
- Newton's Laws of Motion:
  First Law of Motion states that a body in a state of rest and a body in motion tend to remain at rest or in motion unless acted upon by an outside force.
  Second Law of Motion states that the rate of change in the momentum of a body is proportional to the force acting upon the body and is in the direction of the force.
  Third Law of Motion states that to every action, there is an equal and opposite reaction.

Application of Newton's Laws to Rocketry

- 1st Law – when launching a rocket vertically, the propulsion system must produce enough force (thrust) to overcome the inertia of the launch vehicle.
- 2nd Law – f=ma, or force equals mass time acceleration. The more mass, the more force required to accelerate it.
- 3rd Law – The thrust produced is a reactive force acting in a direction opposite to the direction of the exhaust.
- Momentum = mass times velocity.

Rocket Systems

- There are 4 major systems
- Airframe system – serves to contain the other systems and to provide the shape.
- Propulsion system – includes everything directly associated with propelling the rocket.
- Guidance system – is the brain of the rocket. Employs a computer that is programmed for the desired flight trajectory.
- Control system – steers the rocket to its destination and also keeps the rocket stable.

Specific Impulse and Density Impulse

- Impulse means thrust and is the measure of how much thrust will be obtained from a propellant.
- Specific impulse is the number of pounds of thrust delivered by consuming one pound of propellant in one second.
- Density impulse is a measurement of a propellant's thrust according to the volume involved.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 21 - Rocket Fundamentals

1. What country first used rockets as a weapon of war?
a. China
b. England
c. Japan
d. Russia

2. Who added flight-stabilizing guide sticks to rockets and built the first viable launching pad?
a. Christopher Geissler
b. Konrad Kyeser
c. William Congreve
d. William Hale

3. Who was the first scientist to use liquid propellants and is known as the father of modern rocketry?
a. William Congreve
b. William Hale

c. Robert Goddard
d. Hermann Oberth

4. Who gave us the Law of Universal Gravitation that defines the relationship of force, weight and mass?
a. Galileo
b. Goddard
c. Hale
d. Newton

5. To every action, there is an equal and opposite reaction, is Newton's
a. First Law of Motion
b. Second Law of Motion
c. Third Law of Motion
d. Fourth Law of Motion

6. Which rocket system contains the other systems and provides the streamlined shape?
a. airframe system
b. propulsion system
c. guidance system
d. control system

7. T / F Specific impulse is the number of pounds of thrust delivered by consuming one pound of propellant in one second.

8. T / F The guidance system is the brain of a large sophisticated rocket.

9. T / F In Newton's Second Law of Motion, the M in his equation stands for motion.

10. T / F Konstantin Tsiolkovsky made the first computations for rocket flights into space.

Journey of Flight
Chapter 22 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 22 is concerned with oxidation, combustion, and chemical propellants.

Oxidation and Combustion

- Oxidation is the combining of oxygen with another substance.
- Combustion is very rapid oxidation.
- Oxidizers and Reducers – oxygen in its pure form, as two molecules is an oxidizer; rocket fuels are called reducers. Reducers contain hydrogen, carbon and nitrogen.

- Propellant Combinations – it takes both an oxidizer and a reducer to propel a rocket, so they can be called propellants. If the oxidizer and reducer are stored in different containers, the term bipropellant is used. If the same storage tank is used, the tern monopropellant is used.

Combustion for Propulsion

- The qualities of a good propellant are: 1.) The propellant must contain oxidizer and fuel. 2.) It must ignite correctly every time. 3.) It must produce energy in the form of force. 4.) The force produced must be controllable.
- Need for packaged oxidizers – must be placed in a concentrated package or it will burn.
- Ignition Characteristics – the propellant must start every time and must start easily.
- Energy for Force – the momentum of moving molecules.
- Controllable Force – the speed of the combustion should be fast but not too fast.
- Pressure and Mass Flow – the rocket engine provides a container that will increase the temperature which will increase the pressure.

Solid Propellants and the Solid-Propellant Engine

- Solid Propellants – the fuel and oxidizer and mixed together from the start.
- Chemical and Physical Properties – today's solid propellants are composites in which the fuel and oxidizer are two different compounds. Polyurethane fuel base is the most common solid-fuel mixture.
- Grain Design and Thrust Control – the grain of a skyrocket most likely is a solidly packed propellant, with a space for ignition between the charge and the nozzle. The thrust control is also thought of as the burn rate. Using different propellant mixtures for the grain that have different burn rates can control it.
- Igniters – solid propellants are ignited by a composition that both heats the grain to ignition temperature and increase the pressure. Two igniter compositions frequently used are common gunpowder and a metal oxidizer mixture such as magnesium and potassium perchlorate.

Liquid Propellants and the Liquid-propellant Engine

- Liquid Propellants – two classifications – bipropellant and monopropellant. When the oxidizers and fuels are separated they are bipropellants. When they are together, they are monopropellants. Bipropellants are more stable and capable of better performance. A monopropellant only requires half the storage, pumping and controlling equipment, but it is sensitive to temperature and shock, therefore more unstable.
- The Liquid-propellant Engine – contains propellant tanks, a combustion chamber and a means of forcing propellants through the valves to the chamber.
- Combustion Chamber – is the heart of the liquid-propellant engine. Several combustion phases take place here: 10 atomizing, 2) mixing, 3) preheating to ignition temperature and 4) the reaction of the propellant
- Valves – the range in type and size depending on their specific functions.

- Injector – its function is similar to a carburetor; it atomizes and mixes fuel and oxidizer.

Hybrid Propellants

- This term applies to rockets that use both liquid and solid propellants in combination within the same engine.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 22 - Chemical Propulsion

1. What is nothing more than very rapid oxidation?
a. cryogenics
b. hypergolics
c. combustion
d. thrust

2. The substance to be oxidized is known as the
a. combuster
b. oxidizer
c. propellant
d. reducer

3. If the oxidizer is stored in one container and the reducer in another, the term _____is used.
a. bipropellant
b. monopropellant
c. propellant
d. cryogenic propellant

4. Which of the following is not a characteristic of a good propellant?
a. It must contain an oxidizer and fuel
b. It must produce energy in the form of force.
c. It must ignite correctly at least every other time.
d. The force it produces must be controllable.

5. Increase the temperature of a medium and its molecular activity and pressure will
a. increase
b. decrease at first, then increase
c. decrease dramatically
d. not change

6. The grain design that produces the most thrust shortly after ignition, and then diminishes thereafter is called
a. progressive design
b. neutral design
c. regressive design

d. none of the above

7. There are two general classifications of liquid propellants:
a. hot and cold
b. gas and solid
c. oxidizer and reducer
d. bipropellant and monopropellant

8. T / F The combustion chamber is the heart of the liquid-propellant engine.

9. T / F The polyurethane fuel base of the most common solid-fuel mixture is a type of synthetic rubber.

10. T / F Hybrid propellant systems use only liquid propellants within the same engine.

Ch. 21 - 1. a 2. c 3. c 4. d 5. c 6. a 7. T 8. T 9. F 10. T

Ch. 22 - 1. c 2. d 3. a 4. c 5. a 6. c 7. d 8. T 9. T 10. F

Journey of Flight
Chapter 23 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

Chapter 23 covers everything you could want to know about orbits and trajectories!

Orbit and Trajectory

- Orbit means a path described by one body in its revolution about another body.
- Trajectory is a path of a body through space.
- Basic orbital trajectories – an orbit affects a balance between the gravitational and inertial forces. The farther away two objects are from each other, the less effect their mutual gravitation will have. The only way to keep an object from falling to Earth is to produce a force that is equal and opposite to the gravity and which balances the gravitational attraction. This is exactly what a satellite does, and the equal and opposite force is the inertial force or centrifugal effect.
- Circular orbit – an orbit that maintains a virtually constant altitude above the Earth's surface.
- Elliptical orbit – any closed orbit that is not circular. All elliptical orbits around Earth have an apogee and a perigee. Apogee is the point on the orbit where the object is the farthest away from the body being orbited. The perigee is the point where the object is the closest. Apogee = A = AWAY.
- Equatorial orbit – the satellite travels from west to east over the Earth's equator.
- Escape trajectory – In launching a spacecraft, it is necessary to accelerate the spacecraft to its escape velocity (about 25,000 mph).

Velocity Requirements

- This means the velocity required in order to travel a certain path.
- Burnout velocity – the velocity that is required to place a spacecraft on its intended trajectory in order to attain burnout (when rocket engines cease to produce thrust).
- Total Velocity Requirement – adding all velocity requirements for all stages of the mission.

Ballistic Trajectories

- Ballistics is the study of the arc of a non-orbiting body.
- Ballistic flight is concerned with propelling an object from one place on Earth's surface to another place or target on Earth's surface.
- All ballistic trajectories behave as if they were going into an elliptical orbit around Earth's center of gravity.

Sounding-rocket Flights

- The trajectory of a sounding rocket is straight up.
- Rockets sent into the Earth's atmosphere and beyond, one a one-way trip, are called sounding rockets.

Types of Orbits
- For satellites, there are two basic orbits – elliptical and circular.
- The lowest orbit is an approximate circular one at 100 NM of altitude, with an injection velocity of 17,454 mph required.
- For any higher orbits, higher velocities are needed to reach higher altitudes.

Circular Orbits and Transfers
- To change from an elliptical orbit to a circular orbit requires added thrust. Circular velocity minus apogee velocity gives the amount of kick needed to circularize an orbit at a given altitude.
- The Hohmann Transfer – is a practical method of space maneuver. The vehicle is placed into a low-elliptical parking orbit. When the vehicle swings around to perigee, sufficient thrust is applies to push the vehicle to apogee at the desired altitude. When the vehicle reaches the high point of this transfer, thrust is applies again and the vehicle moves out on a circle that is tangent to the transfer ellipse.
- Other Coplanar Transfers – a faster transfer can be accomplished by choosing a trajectory that intersects or crosses the two orbits.
- Non-coplanar Transfers – a vehicle is launched to its minimum angle and when the satellite passes the Equator, thrust is applied to get on an orbit coplanar with the Equator.

Special Orbits
- Geostationary Orbit – satellite is kept in an orbit stationed above one point on the Earth's surface.
- Polar Orbit – involves a path that crosses or nearly crosses the North and South Poles during each orbit.
- Sunsynchronous Orbit – it's a form of a polar orbit that keeps a satellite exposed to constant sunlight.

Launch Vehicles
- If the payload of a rocket is a satellite or a spacecraft rather that a warhead (missile), the vehicle is called a launch vehicle or a booster.
- There are two categories of launch vehicles – expendable and reusable. Rockets that are only used once are considered expendable. The Space Shuttle is the only reusable vehicle we have.
- NASA launches ALL non-military spacecraft for the US.
- Refer to the launch vehicle chart on page 492.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 23 - Orbits and Trajectories

1. An orbit that maintains a virtually constant altitude above the Earth's surface is a/an

a. apogee orbit
b. circular orbit
c. elliptical orbit
d. escape orbit

2. The point where the orbiting body is closest to the body being orbited is called
a. apogee
b. burnout
c. ellipticity
d. perigee

3. At the moment a rocket engine ceases to produce thrust, it is at
a. apogee
b. burnout
c. ellipticity
d. perigee

4. All ballistic trajectories behave as if they were going into an _____ orbit around Earth's center of gravity.
a. apogeal
b. elliptical
c. equatorial
d. escape

5. T / F Sounding is associated with measuring or sampling the depths of a body of water.

6. T / F Velocity requirement means the velocity required in order to travel a certain path.

7. T / F The adding together of all the velocity requirements for all stages of the mission is called maximum velocity requirements.

8. T / F The Hohmann transfer pertains to boosting a satellite into a chosen orbit.

9. T / F A form of polar orbit that keeps a satellite exposed to constant sunlight is called a sunsynchronous orbit.

10. T / F There are two basic categories of launch vehicles - expendable and reusable.

Journey of Flight
Chapter 24 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

SPACE – THE FINAL FRONTIER – but, alas, not the final chapter! (Also, we're not talking about the region between the ears!) This is a general discussion about space. In chapter 25, we will talk about our solar system.

Space

- Begins where the Earth's atmosphere leaves off. NASA says that at 50 miles, a person earns astronaut wings. However, the altitude needs to be about 80 miles for an orbiting object to stay in orbit. Regardless of where is starts, it extends indefinitely.
- Cislunar Space – The space between the Earth and the moon. This space varies with the seasons, but the average distance in 237,087 miles. Part of the magnetosphere is found here. Meteoroids, asteroids and comets are also found here. Cislunar space is not void, but it isn't crowded either.
- Interplanetary Space – is measured from the center of the Sun to the orbit of its outermost planet.
- Interstellar Space – the distance between the extent of one solar system, and the beginning of another solar system.

Sun

- It is the center of our solar system. It is a medium-size star. The Sun's diameter is 864,000 miles. The Sun's magnetic field is at least 100 times stronger than Earth's. The Sun emits a tremendous amount of energy. It is generally accepted that the Sun is a giant thermonuclear reactor. The Sun is plasma, not a solid body.
- Solar Atmosphere – consists of photosphere, chromosphere and corona.
- Photosphere – the portion of the Sun that gives off light. It is a very thin cell made of mostly hydrogen and helium. Sunspots are found here. Sunspots appear darker because they are cooler than the surrounding plasma.
- Chromosphere – a sphere of color that extends to about 15,000 miles. It is characterized by spicules. Spicules are hair-like projections that shoot up from the surface of the Sun.
- Corona – is n enormous area of faint white light that extends for 3 – 4 million miles. Steady emissions from the Sun are called solar wind. These are extensions of the Sun's corona into interplanetary space.

Space Environment Around the Earth

- Ionosphere – a zone of electrically conductive layers in the upper atmosphere. In this region, the gas particles are ionized or charged.
- Characteristics of the Ionosphere – The ion is an atom that carries a positive or negative electrical charge as a result of losing or gaining one or more electrons.
- Causes of Ionization – powerful ultraviolet radiation from the Sun and the ultra-high-frequency cosmic rays from the stars.
- Ionospheric Behavior – sunspots, solar flares, and other disturbances on the surface of the Sun produce fluctuations in the output of the Sun's rays. These in turn, produce ionospheric disturbances.
- Magnetosphere and Solar Wind – Magnetosphere is the region of the Earth's atmosphere where ionized gas plays a big part in the dynamics of the atmosphere

and where the geomagnetic field plays an important role. The solar wind strikes the magnetosphere with considerable force and forms a bow shock wave where the magnetic lines of force of the magnetic field are struck by the solar plasma.

- Cosmic Rays – energetic charged particles from all over the galaxy that continuously rain down upon the Earth.
- Van Allen Radiation Belts – are filled with charged particles. They are the product of interaction between the Sun and The Earth. They are crescent-shaped in cross section, and composed of two shells. The horns of the crescents dip toward Earth's magnetic poles. The belts are caused by the Sun constantly emitting charges particles. These particles are mainly protons and electrons traveling at a million miles per hour as a plasma. Sustained exposure to the radiation would kill humans.

Effects of Solar Disturbances

- Magnetic Storms are characterized by a sudden onset of radiation bursts in which the magnetic field undergoes marked changes in less than an hour. This is followed by a gradual return to normalcy, which may take several days.
- Polar Magnetic Storms – solar disturbances observable only in the polar areas. These storms produce sporadic radiant emissions from the upper atmosphere over middle and high latitudes. These emissions are called aurora borealis in the northern latitudes and aurora australis in the southern latitudes.

Environmental Effects on Space Operations

- Communications – problems caused by environmental factors. 1) Not all radio frequencies are useable. 2) Scintillation – electron density variations in the ionosphere cause rapid changes in radio signals. 3) Solar flares causes solar radio burst, which jams the radio for a few minutes.
- Spacecraft – space environment can be hostile to spacecraft. 1) Atmosphere – can cause drag on the spacecraft and slow it down. It can also cause oxidation from the free oxygen atoms. 2) Vacuum – materials used in the spacecraft can contain tiny bubbles of gas, which can escape when the pressure is removed. 3) Electrostatic Charging – many parts of the spacecraft carry charges; therefore smalls parts of the craft can be shocked. Absolute charging is when the whole craft gets charged, differential charging is when different parts of the craft have different charges. 4) Collisions – biggest worry about collisions is with space debris. NORAD currently tracks over 8,000 orbiting pieces of debris that are baseball size or larger. It is estimated that there are billions of much smaller pieces.
- Manned Operations – man wasn't designed to live in space. So, a lot of weightlessness and psychological training must take place before humans go into space. NASA uses the "Vomit Comet", a free-fall trainer.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 24 - Space Environment

1. The space between the Earth and the Moon is called

a. cislunar space
b. interplanetary space
c. interstellar space
d. solar space

2. The portion of the sun that gives off light is a very thin shell called the
a. corona
b. filament
c. chromosphere
d. photosphere

3. The sun's diameter is almost _____ miles.
a. 1,000
b. 10,000
c. 100,000
d. 1,000,000

4. Aurora borealis is associated with what zone of electrically conductive layers in the upper atmosphere?
a. chromosphere
b. ionosphere
c. magnetosphere
d. plasmasphere

5. They are thought to be crescent-shaped in cross section and composed of two shells. The horns of these crescents dip toward Earth's magnetic poles. What does this describe?
a. cosmic rays
b. aurora australis
c. solar winds
d. Van Allen radiation belts

6. T / F Meteoroids, asteroids and comets can all be found in cislunar space.

7. T / F One parsec is 3.26 light years.

8. T / F Sunspots are enormous areas of the sun where the photosphere is dark.

9. T / F Solar winds are not affected by the Sun's 11-year cycle.

10. T / F An ion is an atom that carries only a negative electrical charge.

Ch. 23 - 1. b 2. d 3. b 4. b 5. T 6. T 7. F 8. T 9. T 10. T

Ch. 24 - 1. a 2. d 3. d 4. b 5. d 6. T 7. T 8. T 9. F 10. F

Journey of Flight
Chapter 25 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

For this chapter, we'll deal with our own little part of space – our solar system. This correlates to Module 5 in Aerospace Dimensions.

Mercury

- Closest planet to the Sun, revolves around the Sun in 88 days.
- Takes 59 Earth days to rotate on its axis.
- Has a rocky, crusty surface with many craters. It has no atmosphere except for small amounts of helium and hydrogen.
- Daytime temperatures reach 750 degrees F., nighttime temperatures a cool –330 degrees.

Venus

- 2nd planet from the Sun, nearest planet to the Earth in both distance and size.
- Venus takes 225 Earth days to orbit the Sun and 240 Earth days to complete one rotation on its axis.
- It is the only planet known to rotate on its axis in a clockwise (east to west) direction.
- Venus is covered with a thick blanket of clouds made of water vapor and sulfuric acid. The clouds rotate every four days, much different than the planet.
- Venus is 96% carbon dioxide and 4% nitrogen.
- Because the clouds hold the heat in, the temperature on Venus doesn't change that much. Venus is the hottest planet with a temperature of almost 900 degrees F.
- Venus is the easiest planet to see at night, and the brightest, too.

Earth

- 3rd planet from the Sun.
- 78% nitrogen and 21% oxygen
- revolves around the Sun in 365 days and rotates on its axis every 24 hours.
- Covered with over 70% water; over 50% of that is the Pacific Ocean.
- Only planet that sustains life.
- Earth's Moon – average distance from Earth is about 235,000 miles.
- Moon's orbit around the Earth is about 27 days.
- Moon's temperature reaches about 270 degrees during the day, and drops to about –250 degrees at night.
- A fine dust covers the surface of the Moon, along with many rocks and craters.
- Anorthosite – most common moon rock.

- Basalt and Anorthosite – 2 best known moon rocks.

Mars

- 4th planet from the Sun
- known as the Red Planet and appears as a small reddish light when viewed by the naked eye. The color comes from the reddish rusty-looking dust on Mars.
- The surface is covered with deserts, high mountains, deep craters and huge volcanoes.
- One day on Mars is 24 hours, 37 minutes. A Martian year lasts 687 Earth days.
- Mariner and Viking probes have been flying by or landing on Mars for over 30 years. In 1997, the Mars Pathfinder with its rover Sojourner landed on Mars and analyzed its atmosphere and the composition of Mars.
- Daytime temperature is about – 18 degrees, and the nights are –130 degrees.

Jupiter

- 5th planet from the Sun
- The largest planet in the solar system.
- Rotates very quickly, about every 10 hours. Causes high winds and giant storms.
- Jupiter is a gas giant – hydrogen is most prominent, followed by helium, methane and ammonia.
- Outer core is composed of liquid hydrogen and helium, and these mix with the gaseous atmosphere to form colorful clouds. There is also a giant red spot in the lower half of Jupiter. This spot is a giant storm that is 30,000 miles long and 10,000 miles wide.
- Jupiter has 16 known moon. Jupiter revolves in about 11 Earth years.
- Temperature ranges from 60,000 degrees at its center, to –220 degrees at the upper cloud layers.
- The Pioneer and Voyager probes have studied Jupiter for years.

Saturn

- 6th planet from the Sun, 2nd largest planet.
- Known for its rings. They are icy chunks of rock ranging from tiny particles to large boulders. The main rings are made of hundreds of narrow ringlets. The ring system is about 1 mile thick and extends about 250,000 miles from the planet.
- Has an icy rock core surrounded by metallic hydrogen with an outer layer of hydrogen and helium.
- Rotates in 10 hours, but it takes over 29 years to revolve around the Sun.
- Has very strong winds. They have reached 1,100 miles per hour.
- Daytime temperatures get to 130 degrees F., while at night they reach –330 degrees F.
- Has 18 known moons, one of them, Titan, has an atmosphere of its own.
- Pioneer and Voyager missions have explored Saturn since the late 1970's.

Uranus

- 7th planet from the Sun, 3rd largest planet.
- Rocky core surrounded by water, ammonia and methane, in both ice and liquid form.
- Outer layer consists of hydrogen and helium. Methane is also present in the upper atmosphere. This gives Uranus a bluish greenish color.
- Rotates every 18 hours and spins sideways.
- Takes 84 years to orbit the Sun. Uranus has 42 years of daylight, and then it has 42 years of darkness.
- Temperature is about –340 degrees F.

Neptune

- 8th planet from the Sun, 4th largest planet.
- About 3 billion miles from the Sun, and it takes 165 Earth years to complete an orbit.
- Day lasts about 19 hours.
- Rocky core surrounded by water ammonia and methane.
- Atmosphere consists of hydrogen, helium and methane. The methane gives Neptune a bluish color.
- The windiest planet in our solar system. Winds blow about 1,500 miles per hour on Neptune.

Pluto

- Yellowish in color.
- Rotates on its axis in about 6.5 Earth days.
- Orbits the Sun in 249 years, however, for 20 of those years, its orbit is inside of Neptune's.
- 50% - 75% rock mixed with ice.
- Temperature varies widely because its orbit takes it as close to the Sun as 2,939 million miles and as far away as 4,583 million miles.

Other Bodies

- Asteroids – rocky and metallic objects orbiting the Sun. They are too small to be considered planets. They range in size from a diameter of 623 miles, to the size of pebbles. The main belt of asteroids lies between the orbits of Mars and Jupiter.
- Comets – small, irregularly shaped bodies whose tiny nucleus is composed of water, ice, rock and frozen gases. Comets travel in highly elliptical orbits that take them very close to the Sun and swing them into deep space. As comets move closer to the Sun, they develop an enormous tail that can extend for millions of miles from the head, away from the Sun.
- Meteoroids – bits and clumps of matter orbit the Sun. The very small, dust-particle size bits of matter are called micrometeorites. Anything larger is called a meteoroid. When a meteoroid enters the Earth's atmosphere it is called a meteor. Meteors are also called shooting stars.

The Milky Way and Beyond

- The Milky Way is the name of our galaxy. It is an enormous collection of stars arranged in a spiral shape.
- Nova and Supernova – Novas are stars that are not stable. They flare, subside, and flare again. A supernova occurs when a star gives up great mass in one giant explosion of light and energy.
- Quasars and the Formation of the Universe – A quasar is a very luminous body that is about the same size as our solar system. It emits 10,000 times the energy of our galaxy.
- Pulsar – also known as a pulsating star because it flashes electromagnetic emissions in a set pattern.
- Nebulae – can be dark or bright. A dark nebula is a vast cloud of matter, which has not yet formed into a star. The bright nebula may be studded with stars and sends for brilliant arrays of color. Some bright nebulae are remnants of supernova.
- Black Holes – probably was a large star that exhausted its nuclear fuel and collapsed inward upon itself. It cannot emit radiation.
- Other Galaxies – scientists have found many other galaxies.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 25 - Our Solar System

1. What is the closest planet to the Sun?
a. Earth
b. Mercury
c. Pluto
d. Uranus

2. What is the only planet known to rotate about its axis in a clockwise direction?
a. Earth
b. Jupiter
c. Mars
d. Venus

3. Which of the following planets has a reddish color even when viewed with the naked eye?
a. Earth
b. Jupiter
c. Mars
d. Saturn

4. On a recent Pathfinder mission, the small exploration rover called Sojourner investigated the atmosphere and composition of what planet?
a. Jupiter
b. Mars
c. Saturn

d. Venus

5. Which planet is by far the largest in our solar system?
a. Jupiter
b. Neptune
c. Saturn
d. Uranus

6. Which planet has recorded the strongest winds and is known as the most windy planet?
a. Pluto
b. Neptune
c. Uranus
d. Venus

7. When a meteoroid enters Earth's atmosphere it is called a/an
a. asteroid
b. comet
c. meteor
d. meteorite

8. T / F A quasar is also known as a pulsating star because it flashes electromagnetic emissions in a set pattern.
9. T / F A black hole probably began as a large star that exhausted its nuclear fuel and collapsed inward upon itself.
10. T / F Uranus is the smallest planet in our solar system and also is the farthest away from the sun.

Journey of Flight
Chapter 26 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

We are looking at how space programs for the US and Russia began and progressed. Also, this chapter looks at unmanned satellites.

The Space Race Begins

- Dr. Werner von Braun, a German scientist, headed a team of German scientists who lead the US' rocket research. The research was slowed by the lack of money.
- In 1949, the Soviet Union exploded it first atom bomb, and in 1950 the Korean War began. These two events changed national priorities, and the money for the Air Force Intercontinental ballistic program became available.
- In 1955, President Eisenhower announced the US would place several small satellites into orbit. This project was called Vanguard.

- In 1956, Premier Khrushchev, of the Soviet Union, announced that Russia had developed an ICBM. Then in August 1957, Russia successfully test-launched its ICBM. On October 4, 1957, using the same rocket, Russia launched Sputnik 1, the world's first artificial satellite. On November 3, they launched Sputnik 2, which carried a dog named Laika.
- On December 6, 1957, the US launched the Vanguard. It exploded. The Army had the Redstone missile, and it put the test rocket Jupiter C with this missile and successfully launched Explorer 1. This was the US' first satellite. The date was January 31, 1958.
- The Space Age – the Soviet Union had launched the first satellite and much heavier satellite into space. The Sputnik 2 weighed 2,926 pounds, while our Explorer 1 weighed 31 pounds. Our smaller satellite actually helped the US develop miniature electronics that eventually put the US far ahead of the Russians. The space race was occurring during the cold War between the US and Russia. So in the beginning, one of the biggest reasons for the space race was international prestige.
- NASA Established – On July 29, 1958, President Eisenhower signed the National Aeronautics and Space Act into law, creating the National Aeronautics and Space Administration (NASA). NASA was established to lead America's civilian space program.
- Space Law – Space is an international concern. So the most powerful source of international law is treaties. There are three principles for space law: 1) freedom of use, meaning all nations have access to space; 2) non-appropriation, the idea that no one owns any part of space; 3) common interests, which says that space belongs to all mankind and all should share in its benefits. [Opinio juris – consensus opinion of experts in field]

Treaties

- Outer Space Treaty – occurred in 1967. The United Nations General Assembly approved it and 90 nations signed it. It established the basic principles of space law. (freedom of use, "province of all mankind"). It said that nations, not organizations were responsible for the launched objects. It stated that space would be used for peaceful purposes, but allowed military personnel to conduct research.
- ABM Treaty – provided for only peaceful use of space.

National Space Law

- National Aeronautics and Space Act (NASA Act) – it is the legal basis for military and civil space activities in the US. It defines civil and military responsibilities.
- Commercial Space Launch Act (CSLA) – purpose was to promote private sector activity and investment in space. It sought to create a single agency to regulate commercial space. The Office of Commercial Space Transportation was created within DOT to manage the effort.
- Land Remote Sensing Commercialization Act (LANDSAT Act) – was designed to commercialize the government LANDSAT Program.

International Space Issues

- International Telecommunications Union (ITU) is a United Nations organization that regulates international communications. ITU was created to regulate radio frequencies and set standards. It operated on "first come, first served."
- Eight nations issued the Bogata Declaration in 1976, claiming sovereignty over geostationary orbits above their territories. No major space powers recognized their claim.
- The International Space Station Agreement was signed in 1988. The US managed the program. It was the combined effort of several nations.

Satellites – Unmanned Spacecraft

- A satellite is a natural or artificial object that orbits around the Earth. An example of a natural object in space is the Moon. It is Earth's only natural satellite. Artificial means man-made.
- Thousands of satellites now occupy various orbits. Many old satellites lasted longer than originally planned. So, they had to be silenced because of lack of money, but they are still out there.
- Satellites can be divided by their purpose. There are four broad categories: communication, navigation, observation and scientific.

Communications Satellites (SATCOM)

- Began in 1958 with the Score satellite. It operated for only 13 days.
- Echo 1 was a large reflective balloon placed in orbit in 1960. it extended the range of line-of-sight signals.
- Courier 1B also orbited in 1960; the first of the repeater type communications satellites.
- In 1962, Telstar 1 was an active satellite that amplified and retransmitted as many as 60 two-way telephone conversations at one time.
- A few months later, Relay 1 added Italy and Brazil to the countries that were receiving broadcasts from space.
- INTELSAT – is a series of satellites and an organization standing for International Telecommunications Satellite Organization. The organization has over 140 member nations. It links the world's telecommunications networks together via a global satellite system of geostationary satellites.
- Galaxy Series – a series of satellites that relays video, voice, data and facsimile information worldwide. Galaxy 1 was dedicated to distributing cable television programming.
- Tracking and Data Relay Satellite System (TDRSS) – designed to provide simultaneous full-time coverage for the Space Shuttle and up to 25 other NASA low-Earth-orbiting spacecraft.
- Deep Space Network (DSN) – supports all deep space probes.

Navigation Satellites

- TRANSIT – was designed to update the inertial navigation system on Polaris submarines. It became operational in 1964.

- TIMATION – was a two-dimensional navigation system. It determines longitude and latitude.
- NAVSTAR Global Positioning System (GPS) – a space-based radio positioning system. It provides navigation and timing information. Position, velocity and time can be precisely determined. GPS is rapidly replacing all other navigational means.

Observation Satellites

- Weather satellites – measure temperatures at the surface and in the atmosphere. They also measure cloud cover, moisture levels and even lightning strikes. Tiros 1 was the first weather satellite. The National Oceanic and Atmospheric Administration (NOAA) has a series of weather satellites.
- Multi-spectrum-imaging Satellites – observe radiant energy. Landsats locate natural resources and monitor other conditions on the Earth's surface.
- Reconnaissance Satellites – monitors the activities of people on the surface of the Earth. Generally, they serve military purposes. They provide early warning by detecting enemy missile launches, detecting nuclear explosions, electronic reconnaissance and photo-surveillance.

Scientific Satellites

- Used for gaining information; either orbital astronomy or environmental analysis.
- The Explorers – a series of satellites that studied the Van Allen radiation belts, micrometeoroids, and solar flares. The Explorers gave us the first photographs of Earth from space.
- Orbiting Solar Observatory (OSO) – studied the Sun and solar flares.
- Orbiting Astronomical Observatory (OAO) – broadened scientists' understanding of the universe. It studied ultraviolet, infrared, gamma and x-ray wavelengths.
- High-Energy Astronomy Observatory (HEAO) – investigated the sources and intensities of high-energy radiation at the very far end of the electromagnetic spectrum.
- Rossi X-ray Timing Explorer (RXTE) – studying x-ray emissions.
- The Hubble Space Telescope – operates at an altitude of 310 miles above the Earth. At this altitude, it is free of atmospheric interference. Astronomers' clarity is seven times better than for ground observations.
- Solar Mesosphere Explorer (SME) – environmental analysis satellite. It studies the reactions between sunlight and the Earth's atmosphere.
- Earth Radiation Budget Satellite (ERBS) – studies Earth radiation and the interaction of the Earth with radiation energy received from the Sun.
- Earth Observing System (EOS) – studies the Earth and how air, water, land and life interact.

Probes

- Spacecraft that fly by, orbit or land on a celestial body, other than Earth.
- The Rangers – investigated and took pictures of the Moon. Provided the first close-up pictures of the Moon.

- The Surveyors – probes landed on the Moon between 1964 – 1968. Five of these actually landed on the Moon and sent hundreds of pictures back to Earth.
- Lunar Orbiters – five of these took high-quality photographs of the Moon's entire surface. From these photos, maps of the moon were made.
- The Mariners – used to investigate the inner planets. Gave us pictures of Venus and Mercury.
- The Pioneers – probed both the outer and inner planets. Gave us the first close-up pictures of Jupiter in 1973. Also, gave us the first pictures and data on Saturn in 1979.
- The Vikings – explored the environment of Mars. They analyzed the Martian atmosphere and photographed Mars surface. Plus, searched for life.
- Voyagers 1 and 2 – gave us greatly improved pictures of Jupiter and Saturn.
- Giotto – explored Halley's Comet.
- Mars Global Surveyor – designed to orbit Mars for 2 years and collect data on Martian atmosphere, gravity, and magnetic fields.
- Mars Pathfinder – primary objective was to prove the feasibility of low-cost landings on Mars.
- Galileo – 6-year journey to orbit Jupiter
- Cassini – In 1997, it began its journey to reach Saturn. It will reach Saturn sometime after 2004.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)

Chapter 26 - Unmanned Space Exploration

1. What country launched the world's first artificial satellite, the Sputnik?
a. China
b. Germany
c. Russia
d. United States

2. Which of the following is not one of the three principles of space law?
a. freedom of use
b. non-appropriation
c. common interest
d. national customs

3. Which space treaty called space the province of all mankind, and also stated that exploration of space should benefit all countries?
a. 1965 Moon Treaty
b. 1967 Outer Space Treaty
c. 1969 Outer Limits Treaty
d. 1972 ABM Treaty

4. Which of the following is not one of the four broad categories of satellites?
a. communication
b. intelligence

c. navigation
d. scientific

5. What was the name of the US' first weather satellite?
a. Score 1
b. Telestar 1
c. Tiros 1
d. Transit 1

6. What family of probes gave us our first look at Jupiter?
a. The Mariners
b. The Rangers
c. The Pioneers
d. The Vikings

7. T / F GPS is rapidly replacing all other navigational means.

8. T / F Treaties are the most powerful source of international law.

9. T / F Explorer 1 discovered the Van Allen radiation belts.

10. T / F The Galaxy series is used to locate natural resources and monitor other conditions on the Earth's surface.

Ch. 25 - 1. b 2. d 3. c 4. b 5. a 6. b 7. c 8. F 9. T 10. F

Ch. 26 - 1. c 2. d 3. b 4. b 5. c 6. c 7. T 8. T 9. T 10. F

Journey of Flight
Chapter 27 Review Notes

This is not intended to be a substitute for studying the book. Please use this as a baseline for taking notes to help you study.

The final chapter of the book deals with the manned spaced program. Congratulations – you've done it!

US Manned Space Program

- Project Mercury – America's first manned space flight program. Its mission was to find out if a human could survive space travel and what, if any effects would space travel have on the human body. It lasted 2 years and six manned flights. The first flight was sub-orbital and lasted for only 15 minutes. May 5, 1961, astronaut Alan Shepard became the first American in space. Astronaut John Glenn became the first American to orbit the Earth. He remained in orbit for 4 hours and 35 minutes, while orbiting the Earth three times.
- The 7 original astronauts – Scott Carpenter, Gordon Cooper, John Glenn, Virgil Grissom, Walter Schirra, Alan Shepard, Donald Slayton
- Project Gemini – had several objectives; improve techniques needed for a lunar mission, put two persons in space, rendezvous and dock with another spacecraft, and achieve the first walk in space. Enough information was gathered that scientists were convinced that humans could last in space for several weeks or even months safely.
- Project Apollo – its mission was to put a man on the Moon. Several of the early Apollo flights traveled to the Moon, orbited it and returned to Earth. Apollo 11 landed on the Moon on July 20, 1969. Neil Armstrong was the first man to walk on the Moon. A few minutes later, Buzz Aldrin joined Armstrong on the Moon. Five more Apollo flights landed on the Moon.
- Project Skylab – used left over equipment from the Apollo flights to put a laboratory in space. Scientists continued their studies of long-duration space flights. The final Skylab mission lasted 84 days in space and showed that people could live and work in space with no ill effects.
- Project Apollo-Soyuz – the link-up in space of an American and a Soviet manned spacecraft.

US Second Era

- Space Shuttle – launched in 1981, also called the Space Transportation System (STS). It provides a system for transportation into space and a return back to Earth. The shuttle can be used again and again. It consists of three main parts: the orbiter, the solid rocket boosters and the external tank. There have been over 100 shuttle launches, and our knowledge has increased tremendously because of

them. The Enterprise was the 1st shuttle, but has never gone into space (Sorry Trekkies!)

- The Crew – the shuttle has many diversified missions. So, the pool of astronauts contains many individuals with special skills. Knowledge and skills from several scientific fields are needed. The astronauts are assigned as mission pilots, mission specialists and payload specialists.
- Sally Ride was the 1st American woman in space.
- The Craft – the orbiter has a wingspan of 78 feet; its length is 122 feet. The orbiter's payloads can weigh a total of 65,000 pounds on a single flight. The orbiter carries the crew and payload to and from space. There are three major sections; the forward fuselage, the mid-fuselage and the aft-fuselage. Astronauts and payload specialists occupy the forward fuselage. The mid-fuselage houses the payload bay; therefore, it contains the purpose of each mission. The aft-fuselage contains units for orbital propulsion and aerodynamic flight control.
- Payloads – the shuttle can carry a variety of payloads into space. Most shuttle missions are geared toward those that need onboard specialists.

Soviet Manned Space Program

- Developed along the same lines as the American space programs, however, the Soviets had several "firsts" in the space race.
- Vostok – On April 12, 1961, the Soviets put the first man in space, Major Yuri Gagarin, who was aboard Vostok 1. In June 1963, Vostok 6 carried the first woman in space, Valentina Tereshkova.
- Voskhod – the first Voskhod was launched in 1964 and was a 3-man capsule. On March 18, 1965, aboard the Voskhod 2, Alexei Leonov became the first person to walk in space.
- Soyuz – means union and was designed for docking in space. Forty Soyuz spacecraft were launched between 1967 and 1981, including the 1975 Apollo-Soyuz rendezvous.

Space Stations

- Soviet Space Stations
- Salyut – The Soviets launched the Salyut 1 in April 1971, and three days later, Soyuz 10 docked with the world's first space laboratory. By 1976, the Soviets had put up six Salyut space stations. By the early 1980's, several modifications had been made and a Soviet crew set an endurance record for 234 days in space.
- Mir – was the next space station model. Mir was launched in 1986 and stayed in space until the spring of 2001. It conducted many experiments over the years and docked many spacecraft. In fact, the US sent several Space Shuttles to Mir.
- American Space Station – Skylab – On May 14, 1973, Skylab 1 was placed in orbit. Skylab was NASA's only orbited space station. Three different crews lived there at different times. The longest stay was 84 days. Skylab came back to Earth after six years in space.
- European Space Station – Spacelab was designed to be flown in the Space Shuttle's cargo bay. Spacelab's environment allowed specialists to work in short-

sleeve shirts and not space suits. Missions included astronomy, microgravity, life sciences and biomedicine.

- Long-duration Exposure Facility (LDEF) – was designed to provide long-term data on the space environment and its effects on space systems and operations. The facility remained in space for 69 months before it was retrieved by Space Shuttle Columbia in 1990.
- Living and Working in Space Stations – creation of the International Space Station will provide a permanent laboratory where gravity, temperature and pressure can be manipulated to achieve a variety of scientific and engineering pursuits that are impossible in ground-based laboratories. Astronauts have learned how to function effectively in weightlessness. Food will still be dehydrated because it saves weight and storage. Sleeping will be either restrained in bunks or sleeping bags tethered to a wall.

Future Manned Spacecraft

- International Space Station is scheduled for completion in the 2005 – 2006 timeframe. The space station will be permanently manned. Beyond the space station, space colonies are a serious consideration. Committees are still working on where the best locations would be.

Sample Test Questions (from Teacher's Guide for Aerospace: The Journey of Flight)
Chapter 27 - Manned Spacecraft

1. What was the name of America's first manned space flight program?
a. Apollo
b. Gemini
c. Mercury
d. Redstone

2. Which of the following was America's first astronaut in space?
a. John Glenn
b. Scott Carpenter
c. Alan Shepard
d. Chuck Yeager

3. Which Apollo flight was the first to land on the Moon?
a. Apollo 5
b. Apollo 11
c. Apollo 13
d. Apollo 15

4. John Glenn accomplished which of the following?
a. He was the first human in space.
b. He was the first American to walk in space.
c. He was the first American to orbit the Earth.
d. He was the first American to walk on the Moon.

5. Which of the following is not a name of one of the space shuttles?
a. Atlantis
b. Challenger
c. Endeavour
d. Voyager

6. In space terms, what does EVA stand for?
a. Environmental Vehicular Association
b. Extra Vehicular Activity
c. Electrical Voltage Allowance
d. Extraterrestrial Visitor Act

7. T / F Skylab was NASA's only orbited space station.

8. T / F Sally Ride was the first woman in space.

9. T / F Yuri Gargarin was the first human in space.

10. T / F Project Gemini's mission was to land on the Moon.

Ch. 27 - 1. c 2. c 3. b 4. c 5. d 6. b 7. T 8. F 9. T 10. F