ROCKETS

(REVIEW, AEROSPACE DIMENSIONS, MODULE 4)

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TERMS TO KNOW

- **NEIL ARMSTRONG**: First man to walk on the Moon
-
- **ROGER BACON**: Increased the range of rockets
-
- **WERNHER VON BRAUN**: Director of the V-2 rocket project
-
- **WILLIAM CONGREVE**: Designed rockets for military
- use
-
- **JEAN FRISSART**: Improved the accuracy of rockets by launching them through tubes

TERMS (CONTINUED)

- **JOHN GLENN**: First American to orbit the Earth
-
- **ROBERT GODDARD**: Experimented with solid and liquid propellant rockets and is called the Father of Modern Rocketry
-
- **WILLIAM HALE**: Developed spin stabilization
-
- **HERO**: Developed first rocket engine
- (**over 2300 yrs ago**)
-
- **SIR ISAAC NEWTON**: Laid scientific foundation for modern rocketry with his laws of motion
-

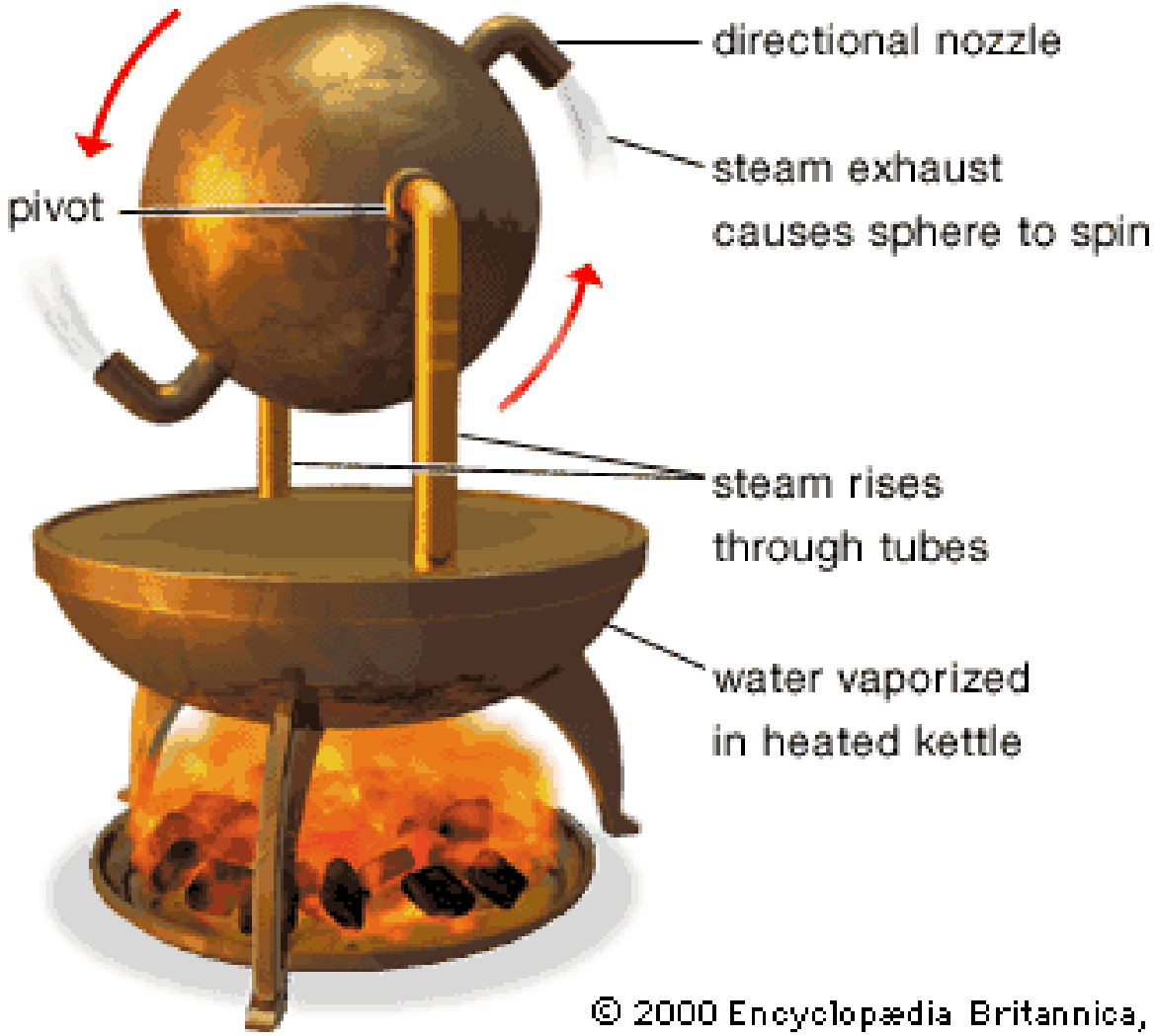
TERMS (CONT'D)

- **HERMAN OBERTH**: Space pioneer; wrote a book about rocket travel into outer space
-
- **ALAN SHEPARD**: First American in space
-
- **SKYLAB**: First US space station
-
- **SPACE SHUTTLE**: A space transportation system for traveling to space and back to Earth
-
- **SPUTNIK**: First artificial satellite
-
- **KONSTANTIN TSOILKOVSKY**: Proposed the use of rockets for space exploration

EARLY RESEARCH/HISTORY

- The **history of rockets** began around 400 BC, Greek named Archytas built flying wooden pigeon.
-
- 300 years later; another Greek, developed **first rocket engine (propelled by steam)**
-
- Hero placed a **sphere on over a pot of water**, The water was **heated**, **turned into steam**. The steam **traveled through pipes into the sphere**. Two **L-shaped tubes** on opposite sides of sphere **allowed the gas to escape.**
-
- This **created a thrust** that caused the sphere to rotate. This device is **known as a Hero Engine**.

“HERO” ENGINE (FIRST ROCKET)




Fireworks and rockets share a common heritage.

CHINESE ROCKETS

- First centuryAD, Chinese develope a form of **gunpowder**
-
- Used it as **fireworks** (Religious and festive celebrations)
-
- Chinese began experimenting with **gunpowder-filled tubes.**

- Attached bamboo tubes to arrows, launched them with bows.
-
- **1232,** Chinese and Mongols at war
-
- These early rockets used as **arrows of flying fire**.
-
- This was a **simple form of a solid-propellant rocket**.


Chinese soldier launches fire-arrow

CONGREVE ROCKET

- End of 18th century, **Col. William Congreve**, (British artillery expert) designed rockets for military use.
-
- **Increased range from 200 to 3,000 yards**, were successful in battle, not for accuracy, but because
- of the **sheer numbers that could be fired**.
-
- During a siege, **thousands could be fired**.
-
- Became known as **“Congreve Rockets”,** and were the rockets that lit sky at battle of **Fort McHenry (1812),** as **Francis Scott Key** wrote his poem later known as **"The Star Spangled Banner”.**

Congreve Rocket

IMPROVING ROCKET ACCURACY

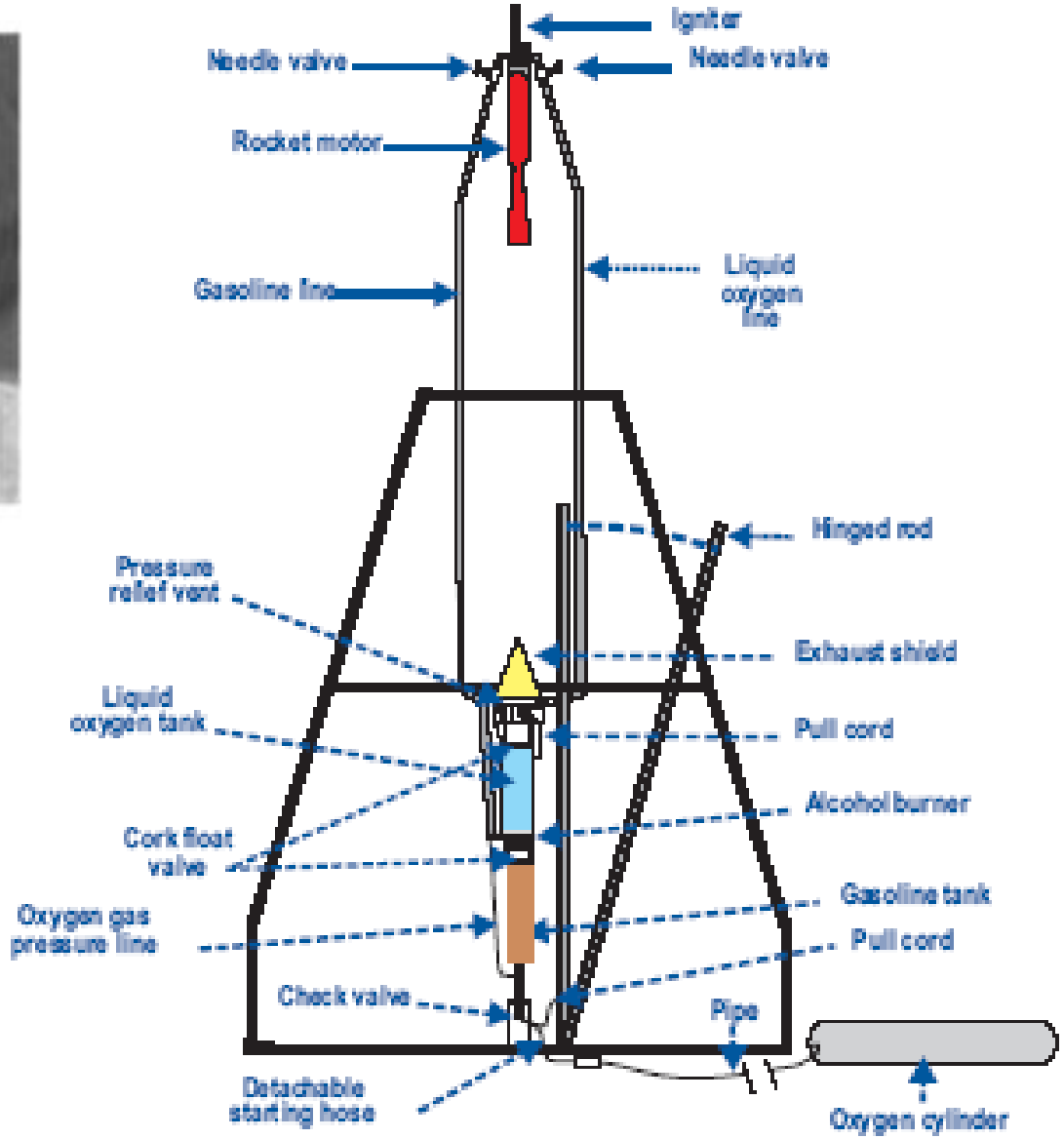
Englishman, **William Hale**, developed technique called **"spin stabilization".**

The escaping **exhaust gases strike small vanes at bottom of rocket**, causing it to **spin as a bullet does** in flight.

Many rockets **still use this principle today**.

GODDARD'S ROCKET

Dr. Robert H. Goddard



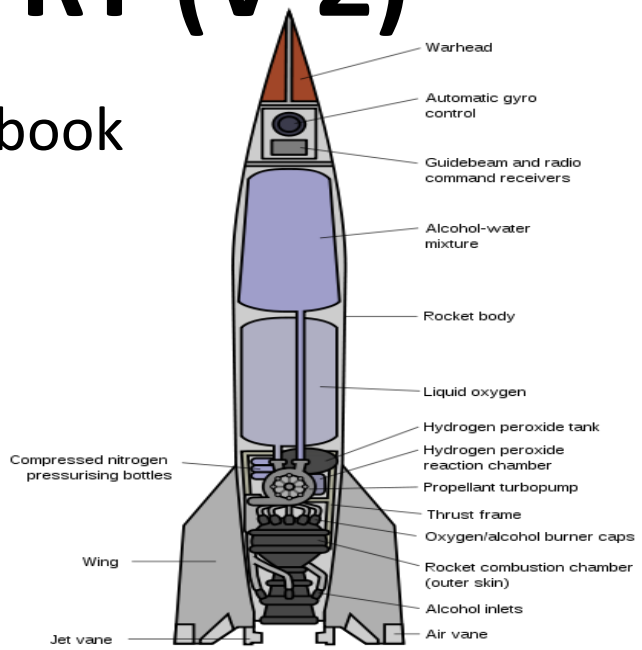
Dr. Goddard's First Liquid Propellant Rocket

GODDARD/LIQUID FUEL ROCKET

- Became convinced that **liquid fuel** would better propel a rocket.
-
- **1926, Goddard achieved first successful flight with liquid-propellant rocket.**
-
- It was fueled by **liquid oxygen and gasoline**.
-
- This was **forerunner of today's rockets**.
-
- Liquid-propellant rockets **grew bigger and flew higher** over time.

GERMANY'S ROCKETRY (V-2)

- **1923 Herman Oberth** (Germany), published book
- about rocket travel into outer space.
-
- His writings led to formation of small rocket
- Societies around the world.
-
- **Germany:** one such society, **Society for Space Travel**,
- led to development of **V-2 rocket**.
-
- The V-2 rocket (with explosive warhead) was a
- **formidable weapon (could devastate whole city blocks).**
-
- **Germany used this weapon against London during World War II**



Wernher von Braun

BEGINNINGS OF U.S. PROGRAM

- V-2 was built under the directorship of **Wernher von Braun**
- **War came to an end before German rocket program completed.**
- Germany falls, **US/Allies capture V-2 rockets/components.**
- German rocket scientists captured, **came to the U S** though some went to **Soviet Union**.
- Von Braun/120 scientists sign contracts with **US Army**.
- Von Braun's team used **captured V-2s** to teach American scientists/engineers rocketry.

THE "SPACE RACE"

- United States/Soviet Union recognize **potential of rockets as military weapon.**
- Began experimental programs. U. S. began program of **high altitude atmospheric sounding rockets .**
- US developed **medium - and long range I.C.B.M. missiles**.
- These became **starting points for US Space Program.**

EARLY RUSSIAN PROGRAM

- **Sergei Korolev** led Russian scientists in rocket development (also with captured German technicians).
-
- He organized and led **first successful Soviet intercontinental ballistic missile launch** in August 1957
-
- He was ready to launch the **world's first satellite (Sputnik, 1957).**
-
- He is considered to be the **father of the Soviet program**

ROCKET SYSTEMS

- **Redstone**, **Atlas** and **Titan** Missiles would eventually **launch satellites and astronauts into space.**
-
- Collectively, they were called **rocket launch vehicles**, (workhorses for the space program).
-
- Launch vehicle is **rocket system** that **lifts a spacecraft** giving spacecraft the force to reach **orbit**.
-
- These launch vehicles **propelled people and cargo into space.**
-
- The diagram following shows rocket launch vehicles used by US space program from **“Scout” to Saturn V”.**

FIRST SATELLITES

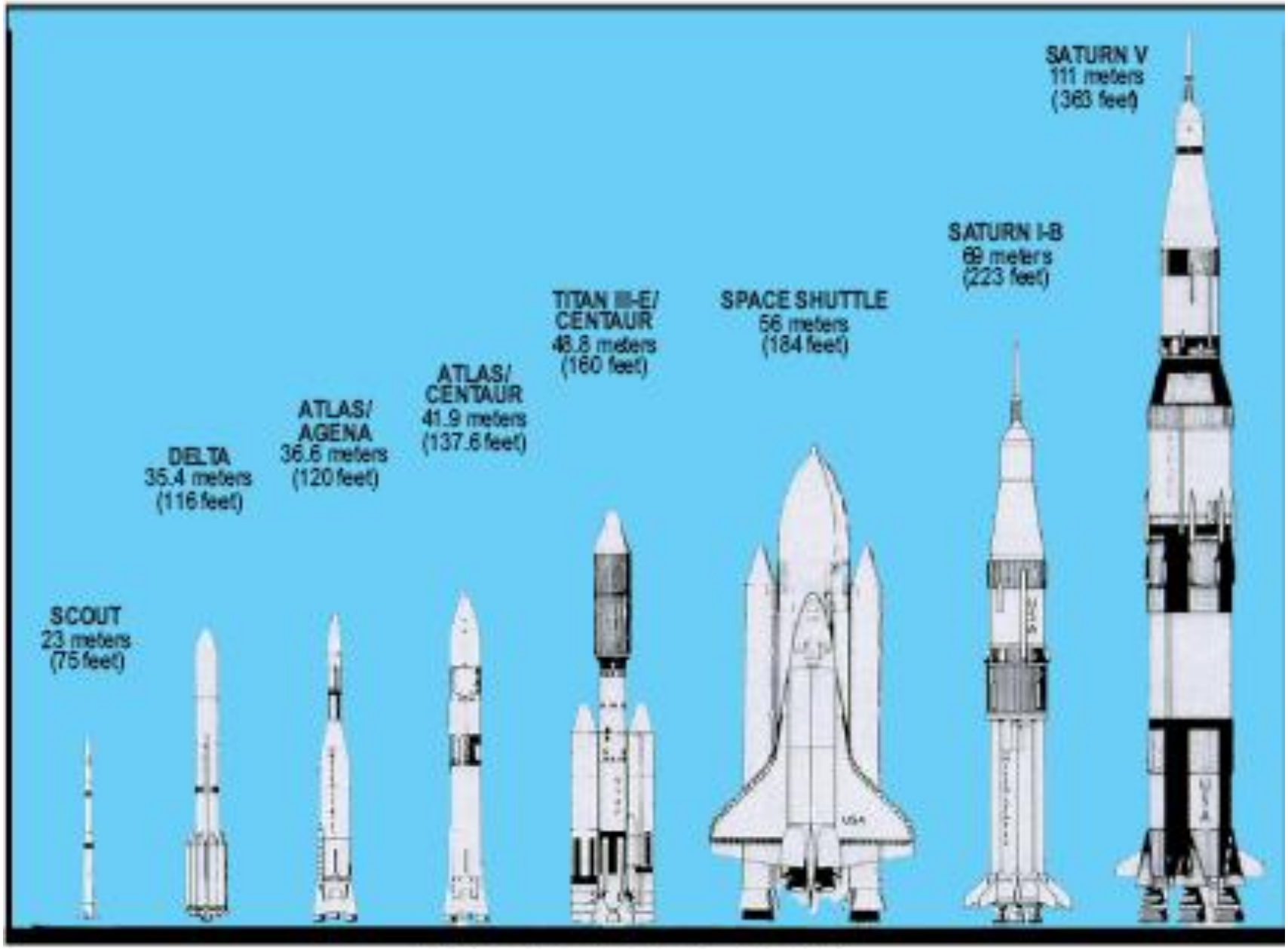
Sputnik I

Explorer I.

SPACERACE AND CIVILIAN AND MILITARY ROLES IN US PROGRAM

- **October 4, 1957**, Soviet Union launched first artificial (man-made) satellite, **"Sputnik"!** The **race for space** between the superpowers, **US and the USSR, had begun**.
-
- **On January 31, 1958, the US launched Exploror I.**
-
- **October 1958**, US formally organized space program, creating the **National Aeronautics and Space Administration (NASA).**
-
- NASA became a **civilian agency** with goal of **peaceful exploration of space** to benefit all humans.
-
- The **Department of Defense (DoD)** became responsible for **research/development in area of military aerospace activities.**

SPACE RACE



The United States Rocket Launch Vehicles

INTO SPACE

- FAR LEFT: ALLEN SHEPARD, FIRST U. S. IN SPACE
- LEFT: JOHN GLENN, FIRST U.S.
- TO ORBIT EARTH

MAN ON THE MOON

- October, 1968, **Saturn IB** was first **three-person mission, Apollo 7.**
-
- Then, **three-stage Saturn V** was developed, one goal, **send humans to the Moon**.
-
- July 20, 1969, **Apollo 11 landed on the Moon**, powered by **Saturn V launch vehicle**.
-
- **Neil Armstrong became first man to walk on the Moon**.

SKYLAB PROJECT

- The United States' **next project**:
- US' first space station, **Skylab**.
-
- Saturn IB launch vehicle for
- Skylab.
-
- Launched **May, 1973**, had
- **Three separate missions**
- **between 1973and 1974**.
-
- **Last mission the longest lasting 84 days.**

SPACE TRANSPORTATION

- Next, US concentrated on a **reusable launch**
- **system**, the Space Shuttle.
-
- The shuttle uses **solid rocket boosters** and
- **three main engines (liquid)** on orbiter to
- launch.
-
- Reusable boosters fall off at two minutes into
- flight.
-
- Parachutes deploy to decelerate solid rocket
- boosters for splashdown in the Atlantic, Ships
- recover them.
-
- The Shuttle is really a **space transportation system** used to transport to space and back to Earth.

A SHORT REVIEW

- 1. Whose **laws of motion** laid the scientific foundation for modern rocketry?
- a. Colonel Congreve b. Roger Bacon
- c. Francis Scott Key **d. Sir Isaac Newton**
-
- 2. Whois known as the **father of modern rocketry?**
- a. Roger Bacon **b. Dr. Robert Goddard**
- c. Sir Isaac Newton d. Wernher von Braun
-
- 3. Who was the first American to **orbit the Earth**?
- a. Neil Armstrong **b. John Glenn**
- c. Alan Shepard d. Chuck Yeager
-
- 4. Who was the first **American to walk on the Moon**?
- **a. Neil Armstrong** b. John Glenn
- c. Alan Shepard d. Chuck Yeager
-
- 5. What was the name of **America's first space station**?
- a. Apollo I b. Mercury I
- **c. Skylab**

ROCKETS

(AEROSPACE DIMENSIONS, MODULE 4)

CHAPTER 2, ROCKET PRINCIPLES

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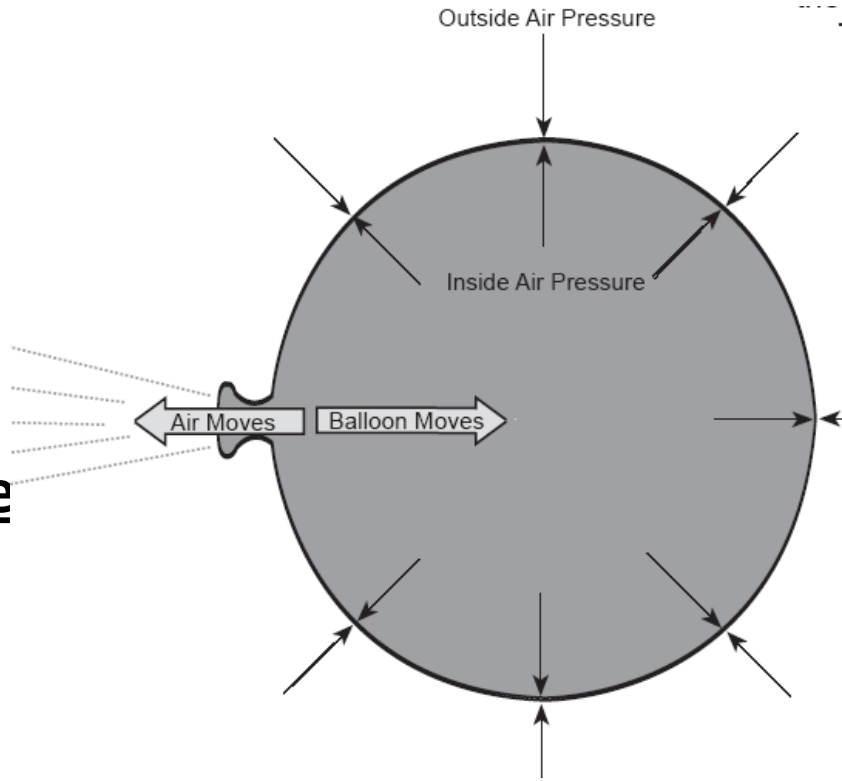
IMPORTANT TERMS

- **Acceleration:** The rate of change in velocity with respect to time
-
- **Inertia:** The tendency of an object at rest to stay at rest and an object in motion to stay in motion
-
- **Newton's First Law Of Motion:** A body at rest remains at rest and a body in motion tends to stay in motion at a constant velocity unless acted on by an outside force
-
- **Newton's Second Law Of Motion**: 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
-
- **Newton's Third Law Of Motion:** To every action, there is an equal and opposite reaction
-
- **Thrust:** To force or push , the amount of push used to get the rocket traveling upwards

PRINCIPLES (THE ROCKET)

- **Rocket a chamber enclosing gas under pressure.**
-
- **Small opening** at one end of chamber **allows gas to escape**, providing **thrust** that **propels rocket in opposite direction.**



- Example is a **balloon.**
-
- Balloons and rockets: **strong**
- **similarity**.
-
- Only significant **difference is way the**
- **pressurized gas is produced.**
-
- With space rockets, **solid or liquid**
- **burning propellants produce the gas.**

NEWTONS FIRST LAW

- **NEWTONS FIRST LAW: A body at rest remains at rest and a body in motion tends to stay in motion at a constant velocity unless acted on by an outside force.**
-
- **Rest** and **motion** are the **opposite of each other**.
-
- If **ball is sitting** on the ground, it is **at rest**. If it is **rolling**, it is **in motion**!!!!!
-
- If you **hold a ball in your hand** and keep it still, the **ball is at rest**.
-
- All the time the ball is being held there, it is **acted upon by forces**.
-
- Force of **gravity is trying to pull ball down**, at the same time **your hand is pushing the ball to hold it up.**
-
- **Forces** acting on the ball **are balanced**.

NEWTON'S SECOND LAW

- **NEWTONS SECOND LAW OF MOTION:** 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.
-
- This law is essentially a mathematical equation. There are **three parts**: mass (m), acceleration (a), and force (f). f=ma (**force equals mass times acceleration**)
-
- Amount of **force required** to accelerate body **depends on mass of the body.**
-
- The **more mass**, the **more force required** to accelerate it.

ACCELERATION (NEWTON'S SECOND)

- **ACCELERATION** is defined as the **rate of**
- **change in velocity with respect to time.**
-
- **Explanation:** When cannon is fired, **explosion**
- **propels cannon ball out open end of barrel**, it
- flies to target.
-
- At the same time, **cannon is pushed backward**.
-
- Force acting on cannon and ball is the same. **Since f =ma,** if **mass increases, then acceleration decreases**; if **mass decreases, then acceleration increases.**
-
- **Apply principle to a rocket**. Replace mass of cannon ball with mass of gases ejected out of rocket engine.
-
- Replace the mass of cannon with mass of rocket moving to other direction. Force is pressure created by controlled explosion taking place inside rocket's engines.
-
- **That pressure accelerates gas one way and rocket the other.**

NEWTON'S THIRD LAW OF MOTION

- **NEWTON'S THIRD LAW OF MOTION**: To every action, there is an equal and opposite reaction.
-
- A **rocket lifts** off the launch pad **only when it expels gas** out of engine.
-
- Rocket **pushes on gas, gas in turn pushes** on rocket.
-
- **Example**: Skateboarder illustrates point.
-
- Imagine skateboarder at rest. **Rider jumps off skateboard**.
-
- The **jumping is the act**ion. The **skateboard responds** to action by **traveling in the opposite direction**.

A REVIEW OF PRINCIPLES

- 1. The amount of push needed to get a rocket traveling upward is called
- a. acceleration. **b. thrust.**
- c. velocity. d. speed.
- 2. A body at rest remaining at rest is part of Newton's _____ Law of Motion.
- **a. First** b. Second
- c. Third d. Fourth
- 3. For every action there is an equal and opposite reaction is Newton's _____ Law of Motion.
- a. First b. Second
- **c. Third** d. Fourth
- 4. The rate of change in the momentum of a body is proportional to the force acting upon the body and in the direction of the body is Newton's _____ Law of Motion.
- a. First **b. Second**
- c. Third d. Fourth

ROCKETS

(REVIEW, AEROSPACE DIMENSIONS, MODULE 4)

CHAPTER 3, ROCKET SYSTEMS/CONTROLS

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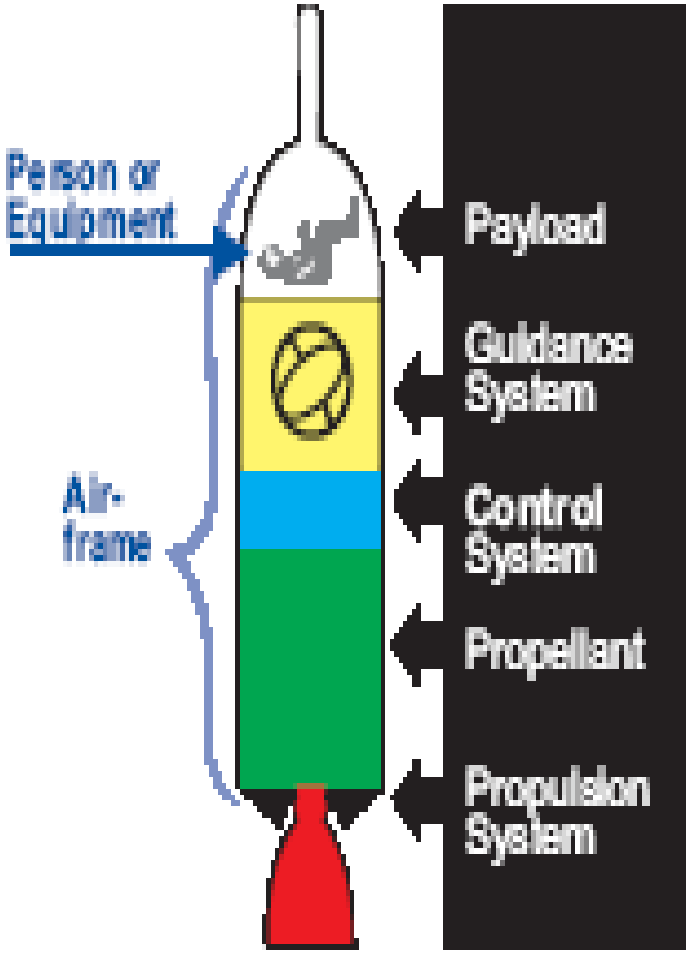
IMPORTANT TERMS

- **AIRFRAME:** The **shape** of the rocket
-
- **CONTROL SYSTEM**: **Steers** the rocket and keeps it stable
-
- **GUIDENCE SYSTEM**: Gets rocket to destination; **"BRAIN" of rocket**
-
- **PAYLOAD**: What the rocket is **carrying**
-
- **PROPULSION:** Everything associated with **propelling** the rocket
-
- **THRUST:** Force or **push the amount needed to get a rocket traveling upwards**

ROCKET SYSTEMS

- Modern rockets have four major systems:
- **Airframe, Guidence, Control** and
- **Propulsion.**

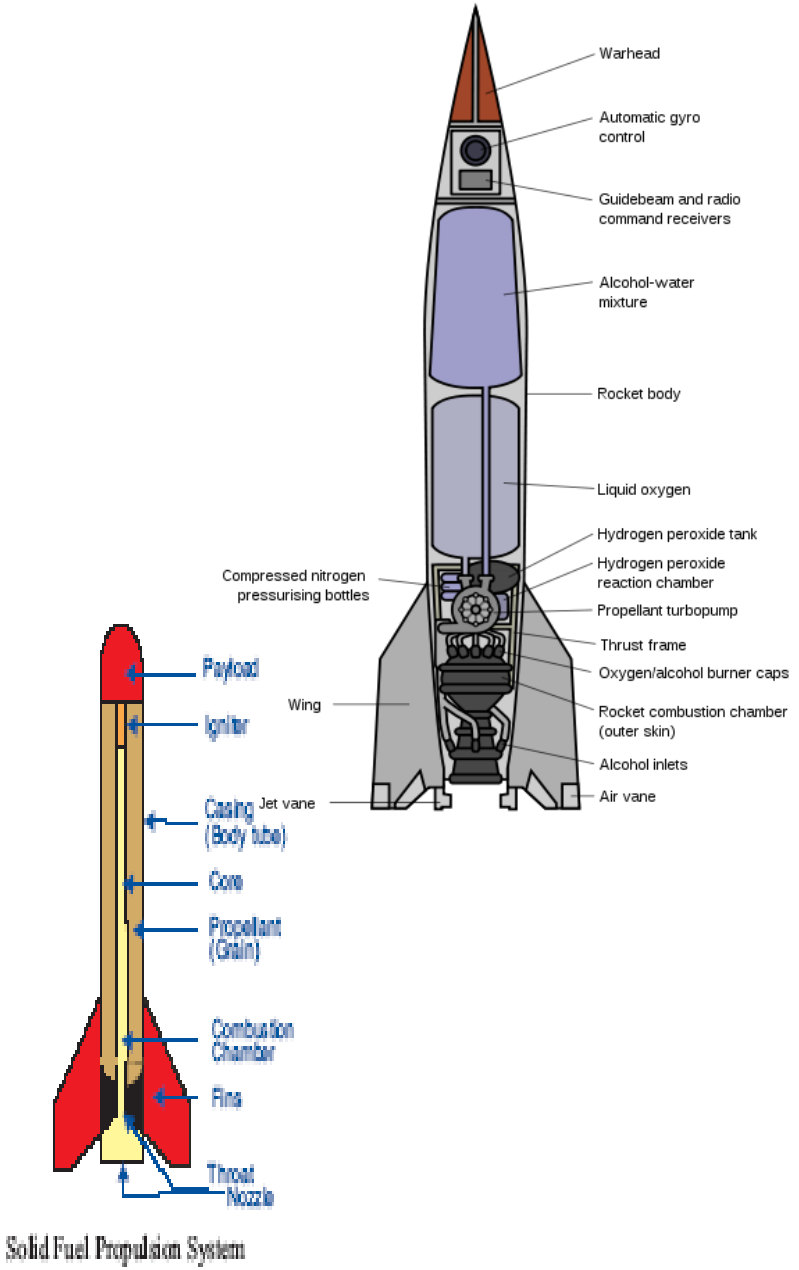
- Systems **work together** to deliver
- payload.
-
- Payload defined as whatever rocket is
- carrying. (**military payload might be**
- **explosives civil might be satellites**
- **and/or astronauts**)
-
- Airframe: Provides **shape of rocket** and
- all systems contained within.



Major Systems of Rockets

SOLID/LIQUID FUELED PROPELLANT

- **Solid Fueled**: propellant carried in combustion chamber
- and is **much simpler** than the liquid propellant.
-
- This type is used for **most modern military missiles** due
- to its **ability to be stored for long periods** without danger.
-
- The solid propellant rocket is on the following slide.
-
- Fuel is usually mixture of hydrogen compounds and
- carbon, with an oxidizer of oxygen compounds.
- Liquid **more complicated (and dangerous!!).**
-
- **Liquid** propellants carried in **compartments separate**
- **from combustion chamber,** one for the fuel, one for oxidizer.
-
- Liquid usually kerosene or liquid hydrogen; oxidizer usually
- liquid oxygen.
-
- Liquid **commonly used today for space vehicles** (somewhat
- more thrust can be developed).
-
- Liquid **heavier** than solid propellant, but **easier to control.**
-
- All rockets today operate with either solid or liquid
- propellants.



A SHORT REVIEW

- 1. Which of the four major rocket systems provides the shape of the rocket?
- **a. Airframe** b. Guidance
- c. Payload d. Propulsion
- 2. Whatever the rocket is carrying is called the _____.
- a. airframe b. control
- **c. payload** d. propulsion
- 3. Which of the following systems is the brain of the rocket?
- a. Airframe **b. Guidance**
- c. Payload d. Propulsion
- 4. What system steers the rocket and keeps it stable?
- **a. Control** b. Guidance
- c. Propulsion d. Payload

THIS COMPLETES REVIEW, MODULE 4, AEROSPACE DIMENSIONS

ROCKETS

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