SPACE EXPLORATION
MERIT BADGE

HANDOUT

Narragansett Council
Merit Badge College
Rhode Island College
Providence, RI

Councilor Contact Information:

Don Kern

Home Phone: 401.253.0027

Cell Phone: 401. 297.5156

email: don-kern@cox.net

Chris Kern

Cell Phone: 401.835.0863

email: chris-kern@cox.net

SPACE EXPLORATION MERIT BADGE HANDOUT

Contents

Why Explore Space?

Some reasons for space exploration (Rqmt #1)
(from Randy Culp's website (http://www.rocketmime.com/space/reasons.html))

The Top Ten Reasons for Going into Space (the lighter version)

Reason Number 10 - Colonization - in another twenty years it is estimated the population of the earth will reach over 8 billion. We could use a place to live.

Reason Number 9 - Place a spy satellite over the Miss Hawaiian Tropics contest.

Reason Number 8 - International Diplomacy - we went to the moon to beat the Russians, now we're building the International Space Station as a way to work with the Russians. Go figure. In any event, prestige and international relations are among the most powerful reasons we've had for going into space.

Reason Number 7 - Natural Resources - some day we may be able to mine the Moon for green cheese and the asteroids for minerals and ores.

Reason Number 6 - Researching the universe - orbiting observatories like Hubble Space Telescope, Advanced X-Ray Astrophysics Facility (AXAF), and Cosmic Background Explorer (COBE) to study the stars, galaxies, and the structure of the universe.

Reason Number 5 - Technology Spin-Offs from NASA-developed technology like small solid-state lasers which led to Compact Discs, cordless power tools, solar power cells, laptop computers AND TANG.

Reason Number 4 - Researching the sun, moon, and planets - deep-space planetary probes and manned exploration to study the atmosphere, composition, and physics of other bodies in the solar system.

Reason Number 3 - Get Marvin the Martian's autograph

Reason Number 2 - Many applications that can be accomplished only from orbit, for example - telephone & TV communications around the world, weather observation and prediction (notably hurricanes), land surveys, and navigation (notably the Global Positioning System, GPS).

Reason Number 1 - BECAUSE IT'S THERE.

The Top Ten Reasons for Going Into Space (the more serious version)

Reason Number 10 - Colonization: it's a long shot, but there are serious people who still claim that we can travel to mars and turn it into livable space for humankind. The process is called "terraforming".

Reason Number 9 - Intelligence Surveillance: Ok maybe we wouldn't bother placing a spy satellite over the Hawaiian Tropics contest (then again maybe we would) but the very first truly functional (i.e. non-experimental) satellite was a U.S. spy satellite. This was the Corona series, first operational in August of 1960. The U.S. maintained a strong lead in this super-secret technology throughout the cold war and it was the only distinct intelligence advantage this nation ever really had. Since the U.S. won the cold war, you simply can't dismiss the importance of this capability.

Reason Number 8 - International Diplomacy: this one speaks for itself. It's the only reason we went to the moon.

Reason Number 7 - Natural Resources: there are people who believe that we would want to mine the asteroids & the moon for minerals. The most credible argument for this is assuming we would want to build a huge space structure and wouldn't want to have to loft the raw material into earth orbit or higher on rocket power.

Reason Number 6 - Researching the universe: this one also speaks for itself. The discoveries and observations made from the Hubble telescope alone are staggering, and could never have been made from earth because of the obscuring effect of the atmosphere. There are new discoveries being made every day, such as finding planets around other stars and discovering the true structure of the outer solar system (the Kuiper belt).

Reason Number 5 - Technology Spin-Offs: this also speaks for itself, although the list of new technologies just goes on and on and on. These new technologies mean new industries, new jobs, and saved lives. For example, kidney dialysis, which has kept (and still keeps) countless people alive, came from the Apollo program. A new artificial heart came from technology used in Space Shuttle. New insulin pumps can eliminate the need for injections for diabetics, and the space program is constantly producing new materials for prosthetic devices.

Reason Number 4 - Researching the sun, moon, and planets: - planetary probes like Voyager, Pioneer, Viking, and Pathfinder landers on Mars, Magellan probe to Venus, these and others have all changed our entire view of the solar system and all the planets. Nothing else has ever given us the close-up view of the planets or their moons. For example, no telescope could ever have shown us the volcanoes on Jupiter's inner moon Io or the ice on Jupiter's second moon Europa. Nothing could ever have given us the clue that there could be life on those moons, aside from the space probes we've sent.

With these probes and the new, powerful orbiting telescopes we've put in place, we are updating our once-simple view of the solar system - learning about the many asteroids and comets and their complex orbits. We are only now becoming aware that an asteroid or comet may have been the end of the dinosaurs, and could be the end of us. By studying our solar system, knowing what's there and what threatens us, and devising the capability of averting disaster, space exploration could mean the very survival of the human race.

We may care very much someday about this reason for space exploration.

Reason Number 3 - Marvin's autograph: well maybe not his, but the more we learn about our solar system and the universe the more likely it is that we'll someday contact intelligent life.

Reason Number 2 - Satellites in orbit: The biggie in my opinion - you would not be reading this page if it weren't for communications satellites that make the world wide web possible. Thousands and thousands of lives would be lost each year to hurricanes if it weren't for weather forecasting satellites. Even the conflicts in the Middle East could have come out differently if it weren't for satellite positioning capabilities. The civilized world owes much of what it is today to satellite technology.

Reason Number 1
Because it's there: This one may seem whimsical but it is not. The society that stops exploring and begins to stagnate begins to die. It is only through the constant effort to learn and to achieve that we remain vigorous, bright, and strong. The fact that we don't know yet what is out there, and the fact that space represents our final limitation, is reason enough for us to strive to master it. Note that the same could be said for the ocean floor.

Our Steps into Space

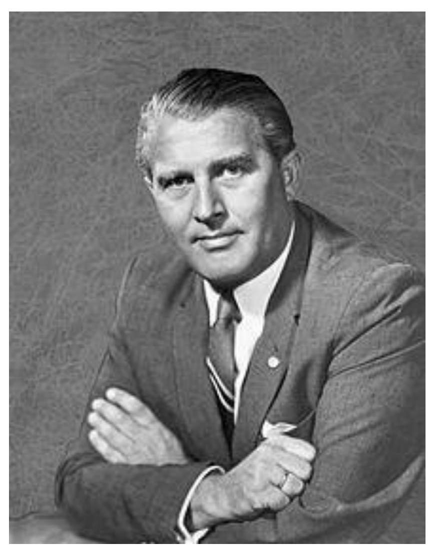
Some space pioneers (Rqmt #2)

Robert Goddard American; October 5, 1882 – August 10, 1945
https://en.wikipedia.org/wiki/Robert_H._Goddard

An American engineer, professor, physicist, and inventor who is credited with creating and building the world's first liquid-fueled rocket. Goddard successfully launched his model on March 16, 1926, ushering in an era of space flight and innovation. He and his team launched 34 rockets between 1926 and 1941, achieving altitudes as high as 2.6 km (1.6 mi) and speeds as fast as 885 km/h (550 mph).

Goddard's work as both theorist and engineer anticipated many of the developments that were to make spaceflight possible. He has been called the man who ushered in the Space Age. Two of Goddard's 214 patented inventions—a multi-stage rocket (1914), and a liquid-fuel rocket (1914)—were important milestones toward spaceflight. Two years after mathematically proving rockets can be used to reach high altitudes, Physicist Robert Goddard is the first to receive U.S. patents for liquid-fueled and multi-staged rockets. A year later, he proves a rocket can work in a vacuum - without air to push against - a key concept in space travel.

Wernher von Braun German/American March 23, 1912 – June 16, 1977
https://en.wikipedia.org/wiki/Wernher_von_Braun



Wernher von Braun was a German, later American, aerospace engineer and space architect credited with inventing the V-2 rocket for Nazi Germany and the Saturn V for the United States. He was the leading figure in the development of rocket technology in Germany and the father of rocket technology and space science in the United States.

Following World War II, he was secretly moved to the United States, along with about 1,600 other scientists, engineers, and technicians. He was the leader in developing the rockets that launched the United States' first space satellite Explorer 1, and the played a crucial role in sending American astronauts to the Moon with Apollo program manned lunar landings. On June 16, 1977, Wernher von Braun died of cancer in Alexandria, Virginia, at the age of 65. He was buried at the Ivy Hill Cemetery in Alexandria, Virginia.

Yuri Alekseyevich Gagarin (Russian; 9 March 1934 – 27 March 1968) (http://en.wikipedia.org/wiki/Yuri_Gagarin)

Yuri Gagarin was a Soviet pilot and cosmonaut. He was the first human to journey into outer space, when his Vostok spacecraft completed an orbit of the Earth on 12 April 1961.

Gagarin became an international celebrity, and was awarded many medals and titles, including Hero of the Soviet Union, the nation's highest honor. Vostok 1 marked his only spaceflight, but he served as backup crew to the Soyuz 1 mission (which ended in a fatal crash). Gagarin later became deputy training director of the Cosmonaut Training Centre outside Moscow, which was later named after him. Gagarin died in 1968 when the MiG 15 training jet he was piloting crashed.

Alan Bartlett Shepard, Jr. First Class Scout (November 18, 1923 – July 21, 1998) (http://en.wikipedia.org/wiki/Alan_Shepard)

Alan Shepard was an American naval aviator, test pilot, flag officer, NASA astronaut, and businessman, who in 1961 became the second person, and the first American, to travel into space. This Mercury flight was designed to enter space, but not to achieve orbit. Ten years later, at age 47 the oldest astronaut in the program, Shepard commanded the Apollo 14 mission, piloting the lander to the most accurate landing of the Apollo missions. He became the fifth person to walk on the Moon and the only astronaut of the Mercury Seven to walk on the Moon. During the mission he hit two golf balls on the lunar surface.

These were his only two space flights, as his flight status was interrupted for five years (1964–69) during the Mercury and Gemini programs by Ménière's disease, an inner-ear disease that was surgically corrected before his Moon flight. Shepard served as Chief of the Astronaut Office from November 1963 – July 1969 (approximately the period of his grounding), and from June 1971 – August 1, 1974 (from his last flight, to his retirement). He was promoted from Captain to Rear Admiral on August 25, 1971. He retired from the U.S. Navy and NASA in 1974.

John Herschel Glenn, Jr. (July 18, 1921 – December 8, 2016)
(http://en.wikipedia.org/wiki/John_Glenn)

John Glen is a former United States Marine Corps pilot, astronaut, and United States senator. He was the first American to orbit the Earth and the third American in space. Glenn was a combat aviator in the Marine Corps and one of the Mercury Seven, who were the elite U.S. military test pilots selected by the National Aeronautics and Space Administration (NASA) to operate the experimental Mercury spacecraft and become the first American astronauts. He flew the *Friendship 7*mission on February 20, 1962. In 1965, Glenn retired from the military and resigned from NASA so he could be eligible to stand for election to public office. As a member of the Democratic Party he was elected to represent Ohio in the U.S. Senate from 1974 to 1999.

Glenn received a Congressional Space Medal of Honor in 1978, and the Presidential Medal of Freedom in 2012. He was inducted into the Astronaut Hall of Fame in 1990. On October 29, 1998, he became the oldest person to fly in space, and the only one to fly in both the Mercury and Space Shuttle programs, when at age 77, he flew on *Discovery* (STS-95). Glenn died on December 8, 2016, at the Ohio State University Wexner Medical Center. He was interred at Arlington National Cemetery

Leroy Gordon Cooper, Jr. Life Scout (March 6, 1927 - October 4, 2004),
(http://en.wikipedia.org/wiki/Leroy_Gordon_Cooper

Mercury Gordon Cooper launched into space on May 15, 1963 aboard the Mercury-Atlas 9 (*Faith 7*) spacecraft, the last Mercury mission. He orbited the Earth 22 times and logged more time in space than all five previous Mercury astronauts combined—34 hours, 19 minutes and 49 seconds, traveling 546,167 miles (878,971 km) at 17,547 mph (28,239 km/h), pulling a maximum of 7.6 *g* (74.48 m/s²). Cooper achieved an altitude of 165.9 statute miles (267 km) at apogee. He was the first American astronaut to sleep not only in orbit but on the launch pad during a countdown.

Like all Mercury flights, Faith 7 was designed for fully automatic control, a controversial engineering decision which in many ways reduced the role of an astronaut to that of a passenger and prompted Chuck Yeager to describe Mercury astronauts as *spam in a can*.

Toward the end of the *Faith 7* flight there were mission-threatening technical problems. During the 19th orbit, the capsule had a power failure. Carbon dioxide levels began rising and the cabin temperature jumped to over a hundred degrees Fahrenheit. Cooper fell back on his understanding of star patterns, took manual control of the tiny capsule and successfully estimated the correct pitch for re-entry into the atmosphere. Some precision was needed in the calculation since if the capsule came in too deep, g-forces would be too large, and if its trajectory was too shallow, it would bounce off the atmosphere and be sent back into space. Cooper drew lines on the capsule window to help him check his orientation before firing the re-entry rockets. "So I used my wrist watch for time," he later recalled, "my eyeballs out the window for attitude. Then I fired my retrorockets at the right time and landed right by the carrier." Cooper's cool-headed performance and piloting skills led to a basic rethinking of design philosophy for later space missions.

Gemini Two years later (August 21, 1965), Cooper flew as command pilot of Gemini 5 on an eight-day, 120-orbit mission with Pete Conrad. The two astronauts established a new space endurance record by traveling a distance of 3,312,993 miles (5,331,745 km) in 190 hours and 56 minutes, showing astronauts could survive in space for the length of time necessary to go from the Earth to the Moon and back. Cooper was the first astronaut to make a second orbital flight and later served as backup command pilot for.

John Watts Young Second Class Scout (born September 24, 1930 - January 5, 2018) (http://en.wikipedia.org/wiki/John_Watts_Young)

John Young is a retired American astronaut, Naval officer, test pilot and aeronautical engineer, who became the ninth person to walk on the Moon as commander of the Apollo 16 mission in 1972.

Young enjoyed the longest career of any astronaut, becoming the first person to make six space flights, over the course of 42 years of active NASA service, and is the only person to have piloted four different classes of spacecraft: Gemini, the Apollo Command/Service Module, the Apollo Lunar Module, and the Space Shuttle. In 1965 Young flew on the first manned Gemini mission, and in 1969 was the first person to orbit the moon alone during Apollo 10. He is one of only three persons who twice journeyed to the Moon, and drove the Lunar Roving Vehicle on the Moon's surface. He also commanded two Space Shuttle flights, including its first launch in 1981, and served as Chief of the Astronaut Office from 1974–1987. Young retired from NASA in 2004. Young died on January 5, 2018, at his home in Houston of complications from pneumonia

Neil Alden Armstrong Eagle Scout (August 5, 1930 – August 25, 2012)
(http://en.wikipedia.org/wiki/Neil_Armstrong)

Neil Armstrong was an American astronaut and the first person to walk on the Moon. He was also an aerospace engineer, naval aviator, test pilot, and university professor. Before becoming an astronaut, Armstrong was an officer in the U.S. Navy and served in the Korean War. After the war, he earned his bachelor's degree at Purdue University and served as a test pilot at the National Advisory Committee for Aeronautics High-Speed Flight Station, now known as the Dryden Flight Research Center, where he logged over 900 flights. He later completed graduate studies at the University of Southern California.

A participant in the U.S. Air Force's Man in Space Soonest and X-20 Dyna-Soar human spaceflight programs, Armstrong joined the NASA Astronaut Corps in 1962. He made his first space flight, as command pilot of Gemini 8, in 1966, becoming NASA's first civilian astronaut to fly in space. On this mission, he performed the first docking of two spacecraft, with pilot David Scott.

Armstrong's second and last spaceflight was as mission commander of the Apollo 11 moon landing, in July 1969. On this mission, Armstrong and Buzz Aldrin descended to the lunar surface and spent two and a half hours exploring, while Michael Collins remained in lunar orbit in the Command Module. Along with Collins and Aldrin, Armstrong was awarded the Presidential Medal of Freedom by President Richard Nixon; in 1978, President Jimmy Carter presented Armstrong the Congressional Space Medal of Honor in 1978; he and his former crewmates received the Congressional Gold Medal in 2009.

Armstrong died in Cincinnati, Ohio, on August 25, 2012, at the age of 82, after complications from coronary artery bypass surgery

Dr. Sally Kristen Ride (May 26, 1951 – July 23, 2012)
(http://en.wikipedia.org/wiki/Sally_Ride)

Sally Ride was one of 8,000 people to answer an advertisement in a newspaper seeking applicants for the space program. As a result, Ride joined NASA in 1978. During her career, Sally served as the ground-based Capsule Communicator (CapCom) for the second and third Space Shuttle flights (STS-2 and STS-3) and helped develop the Space Shuttle's robot arm.

On June 18, 1983, she became the first American woman in space as a crew member on Space Shuttle Challenger for STS-7. (She was preceded by two Soviet women, Valentina Tereshkova in 1963 and Svetlana Savitskaya in 1982.) On STS-7, during which the five-person crew deployed two communications satellites and conducted pharmaceutical experiments, Ride was the first woman to use the robot arm in space and the first to use the arm to retrieve a satellite.

Her second space flight was in 1984, also on board the Challenger. She has cumulatively spent more than 343 hours in space. Ride had completed eight months of training for her third flight when the Space Shuttle Challenger accident occurred. She was named to the Presidential Commission investigating the accident, and headed its subcommittee on Operations. and founded NASA's Office of Exploration.

Yang Liwei (Chinese: 杨利伟; born June 21, 1965)
(http://en.wikipedia.org/wiki/Yang_Liwei)

Yang Liwei was the first man sent into space by the Chinese space program and his mission, Shenzhou 5, made China the third country to independently send people into space. Yang was selected as an astronaut candidate in 1998. He was chosen from the final pool of 13 candidates to fly on China's first manned space mission. A former fighter pilot, he held the rank of Lieutenant Colonel at the time of his mission.

He was launched into space aboard his *Shenzhou 5* spacecraft atop a Long March 2F rocket from Jiuquan Satellite Launch Center on October 15, 2003. Prior to his launch almost nothing was made public about the Chinese astronaut candidates; his selection for the *Shenzhou 5* launch was only leaked to the media one day before the launch

Yang punctuated his journey with regular updates on his condition—variations of "I feel good", the last coming as the capsule floated to the ground after re-entry. State media said

Yang's capsule was supplied with a gun, a knife and tent in case he landed in the wrong place.

Yang's craft landed in the grasslands of the Chinese region of Inner Mongolia on October 16, 2003, having completed 14 orbits and travelled more than 600,000 km. Yang left the capsule about 15 minutes after landing, and was congratulated by Premier Wen Jiabao. But the astronaut's bleeding lips seen in the official images broadcasted sparked rumors of a hard landing confirmed by accounts of personnel present at the landing site.

Yang Liwei is now (2020) Deputy Director of the China Astronaut Research and Training Center and also Deputy Director General of China's manned space program

Carl Edward Sagan (November 9, 1934 – December 20, 1996)
https://en.wikipedia.org/wiki/Carl_Sagan

Carl Sagan was an American astronomer, cosmologist, astrophysicist, astrobiologist, author, science popularizer, and science communicator in astronomy and other natural sciences. He is best known for his work as a science popularizer and communicator. Sagan was associated with the U.S. space program from its inception. From the 1950s onward, he worked as an advisor to NASA, where one of his duties included briefing the Apollo astronauts before their flights to the Moon. Sagan contributed to many of the robotic spacecraft missions that explored the Solar System, arranging experiments on many of the expeditions. Sagan assembled the first physical message that was sent into space: a gold-anodized plaque, attached to the space probe Pioneer 10, launched in 1972. Pioneer 11, also carrying another copy of the plaque, was launched the following year. He continued to refine his designs; the most elaborate message he helped to develop and assemble was the Voyager Golden Record that was sent out with the Voyager space probes in 1977.

Sagan published more than 600 scientific papers and articles and was author, co-author or editor of more than 20 books. He wrote many popular science books and narrated and co-wrote the award-winning 1980 television series Cosmos: A Personal Voyage. The most widely watched series in the history of American public television. The book Cosmos was published to accompany the series. He also wrote the science fiction novel Contact, the basis for a 1997 film of the same name.

Sagan always advocated scientific skeptical inquiry and the scientific method, pioneered exobiology and promoted the Search for Extra-Terrestrial Intelligence (SETI). He spent most of his career as a professor of astronomy at Cornell University, where he directed the Laboratory for Planetary Studies. Sagan and his works received numerous awards and honors, including the NASA Distinguished Public Service Medal, the National Academy of Sciences Public Welfare Medal, the Pulitzer Prize for General Non-Fiction for his book The Dragons of Eden, and, regarding Cosmos: A Personal Voyage, two Emmy Awards, the Peabody Award and the Hugo Award. He married three times and had five children. Sagan died of pneumonia at the age of 62, on December 20, 1996

Peggy Annette Whitson (February 9, 1960)
https://en.wikipedia.org/wiki/Peggy_Whitson

An American biochemistry researcher, NASA astronaut, and former NASA Chief Astronaut. Her first space mission was in 2002. Her second mission launched October 10, 2007, as the first woman commander of the ISS with Expedition 16. She was currently in space on her third long-duration space flight and was the commander of the International Space Station for Expedition 51, before handing over command to Fyodor Yurchikhin on June 1, 2017.

Whitson now holds the records for the oldest woman spacewalker, and the record for total spacewalks by a woman, which was broken by herself again after a ninth and tenth EVA in May 2017. She is also the oldest female astronaut ever in space, at age 57.

Peggy Whitson became the first woman astronaut to command the International Space Station twice. Whitson returned to earth on September 3, 2017 with the duration of her stay in space during expeditions 50/51/52 was 289 days, 5 hours and 1 minute. She has accrued a total of 665 days in space over the course of her career. This total was more time in space than any other woman worldwide and any other American. On June 15, 2018, Whitson announced her retirement from the agency.

Astronauts with Scouting Experience

(http://www.usscouts.org/eagle/eagleastronauts.asp)
Of the 312 pilots and scientists selected as astronauts since 1959, at least 207 have been identified as having been Scouts or active in Scouting. The list includes 39 Eagle Scouts, 25 Life Scouts, 14 Star Scouts, 26 First Class Scouts, 17 Second Class Scouts, 13 Tenderfoot Scouts, 3 Explorers, 25 Cub Scouts, 10 Webelos Scouts, 1 King's Scout, 2 Wolf Scouts, and 32 with unknown ranks, including 27 who were Girl Scouts.

Of the 24 men to travel to the moon on the Apollo 9 through Apollo 17 missions , 21 were Scouts, including 10 of the 12 men who physically walked on the moon's surface, and all three members of the crew of Apollo 13. Three travelled to the Moon twice.

All three of the astronauts who died in the Apollo 1 fire, four of the seven who died in the Challenger launch explosion, and five of the seven who died in the Columbia re-entry explosion were Scouts.

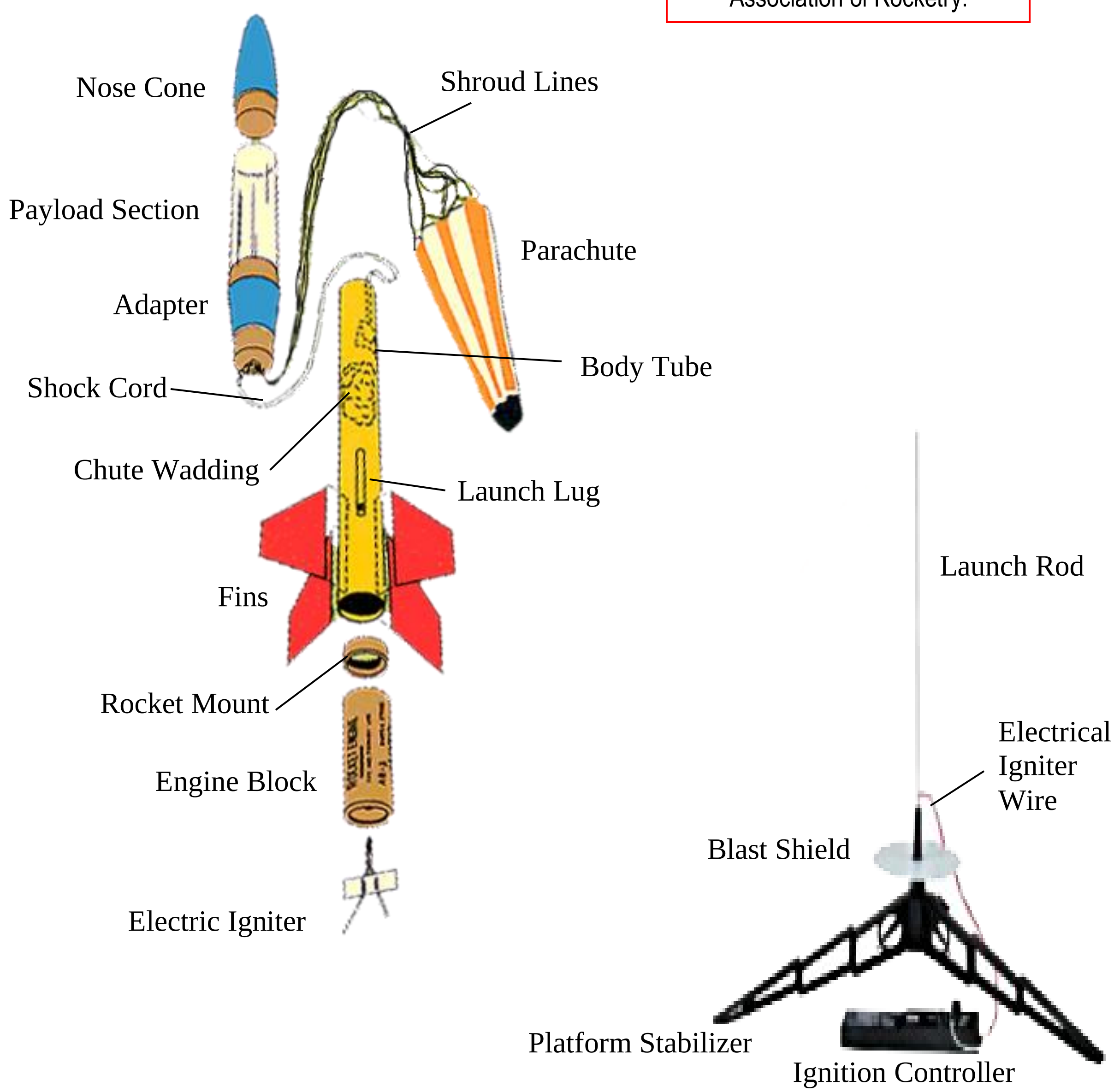
Eagle Scouts:

ADAMSON, James C. ARMSTRONG, Neil A. (First man to walk on the Moon), BAGIAN, James P, BLUFORD, Guion S. Jr. BOWERSOX, Kenneth D. BRADY, Charles E, CARR, Gerald P. CARTER, Manley Lanier "Sonny" Jr. CHAFFEE, Roger B. (Died in the Apollo 1 fire on Jan 27, 1967),CHAMITOFF, Gregory Errol, COVEY, Richard O. CREIGHTON, John O. DUKE, Charles M., Jr. (Walked on the Moon during the Apollo 16 mission), EISELE, Donn F. FORRESTER, Patrick G. FOSSUM, Michael E. FULLERTON, Charles G. GREGORY, William G. GRIGGS, S. David, HOFFMAN, Jeffrey A. JOHNSON, Gregory H. JONES, Thomas D. LEE, Mark C. LIND, Don L. LINDSEY, Steven W, LOVELL, James A. Jr. (Flew to the moon on the Apollo 8 and Apollo 13 missions), McCOOL, William C. (Died during the re-entry of Columbia on Feb 1, 2003), McCULLEY, Michael J. O'LEARY, Brian T. ONIZUKA, Ellison S. (Died when Challenger exploded on Jan 28, 1986), OSWALD, Stephen S. PARAZYNSKI, Scott E, PETTIT, Donald R. REIGHTLER, Kenneth S. Jr. SEARFOSS, Richard A. SEE, Elliot M. Jr., TANNER, Joseph R. TRULY, Richard H. WALKER, David M. LLEWELLYN, John A (King's Scout - equivalent to Eagle Scout)

Model Rocketry

(Rqmt # 3)

Rocket must be built to meet the safety code of the National Association of Rocketry.



Typical Model Rocket Set-Up

The Way Things Work

The law of action-reaction

(Rqmt #4A)
(from Randy Culp's website http://www.rocketmime.com/space/newton.html)

Newton's First Law:

- An object at rest will remain at rest
- An object in motion will stay in motion - in a straight line, at the same speed
- As long as no force is applied (more accurately, no unbalanced force).

Newton's Second Law:

- An object's acceleration is proportional to the force applied to it.
- The force to accelerate an object is proportional to the object's mass.
- In equation form, if we call the force "F", the object's mass "m" and the acceleration "a", then Newton's Second Law is simply

  $F = m * a$

  which is the most famous form of this fundamental principle of physics.

Newton's Third Law:

"For every action, there is an equal and opposite reaction."

Demonstration of Newton's Third Law:

1. Blow up a balloon.
2. Let it go.

How rocket engines work (Rqmt #4B)

Propellant:

A rocket carries both the fuel and the oxygen to burn it. This is how a rocket, unlike any other engine, can operate in the vacuum of space. It is also why rocketry is the technology of space travel.

Oxidizer:

This is the oxygen or an oxygen equivalent that is used to burn the fuel. In reality, most rocket motors use some other substance to serve the function of oxygen in burning. One example - the black powder motors in model rockets use saltpeter (potassium nitrate) as the oxidizer to burn charcoal. Both of these are found in the black powder propellant, so you could fly your model rocket in space, if you really wanted to. The fuel will burn in a vacuum.

Thrust:

Is the force, or "push" the rocket develops, measured in newtons or pounds (or tons for very big rockets).

Nozzle:

Increases the thrust of the rocket by increasing the speed of the exhaust.

Impulse:

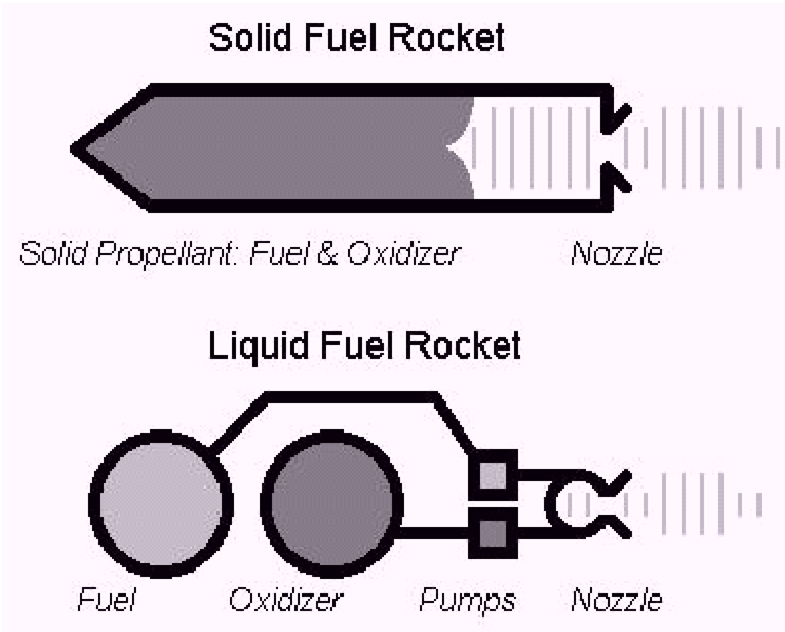
The thrust multiplied by the burn time. This figure tells the "total push" the motor gives the rocket. For motors using the same propellant (e.g. black powder), a motor with twice the impulse will usually have twice the propellant, so it can burn twice as long for twice the total push.

Solid Fuel Rocket:

Uses a solid mixture of fuel and oxidizer for a propellant. Since it has no moving parts, it is very reliable. However, once a solid rocket is ignited it cannot be shut down until all the propellant has been burned.

Liquid Fuel Rocket:

Uses separate liquid fuel and oxidizer, which are combined only at the moment of combustion. Pumps are required to get the fuel & oxidizer to the motor quickly enough to develop desired thrust. This makes liquid fuel rockets more complicated, however liquid fuel is up to twice as powerful as solid. Also, liquid fuel rockets can be turned off and then turned on again. On the space shuttle, they can be throttled for more or less thrust. So liquid fuel rockets are not only more powerful, they are more controllable.



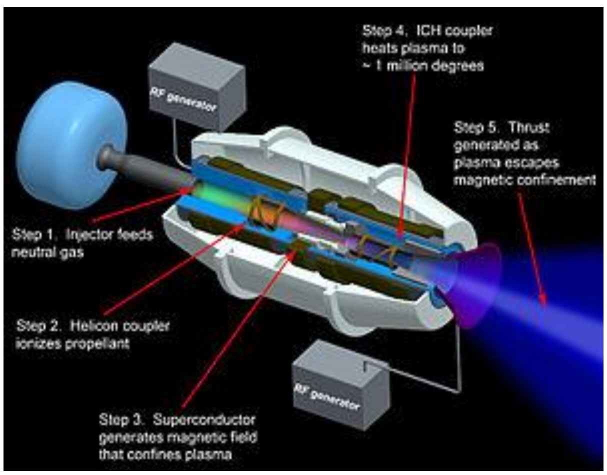
Extra Credit: There is a new type of rocket engine. What is it?

Answer: *Electric Plasma*.
Excerpted from Wikipedia
https://en.wikipedia.org/wiki/Variable_Specific_Impulse_Magnetoplasma_Rocket

The **Variable Specific Impulse Magnetoplasma Rocket** (**VASIMR**) is an electromagnetic thruster for spacecraft propulsion. It uses radio waves to ionize and heat a propellant, and magnetic fields to accelerate the resulting plasma to generate thrust.

The method of heating plasma used in VASIMR was originally developed as a result of research into nuclear fusion. VASIMRs units for development and test have been assembled by the Ad Astra Rocket Company, headquartered in the city of Houston, Texas, United States.

The Variable Specific Impulse Magnetoplasma Rocket, uses radio waves to ionize and heat propellant, which generates plasma that is accelerated using magnetic fields to generate thrust. Since every part of a VASIMR engine is magnetically shielded and does not come into direct contact with plasma, the potential durability of this engine design is greater than other ion/plasma engine designs.



VASIMR can be most basically thought of as a convergent-divergent nozzle for ions and electrons. The propellant (a neutral gas such as argon or xenon) is first injected into a hollow cylinder surfaced with electromagnets. Upon entry into the engine, the gas is first heated to a “cold plasma” by a RF antenna which bombards the gas with electromagnetic waves, stripping electrons off the atoms and leaving plasma to continue down the engine compartment. A second coupler, known as the Ion Cyclotron Heating (ICH) section, emits electromagnetic waves in resonance with the orbits of ions and electrons as they travel through the engine. This section further heats the plasma to temperatures upwards of 1,000,000 Kelvin - about 173 times the temperature of the Sun’s surface. The final, diverging, section of the engine contains a steadily expanding magnetic field which ejects plasma from the engine parallel and opposite to the direction of motion at speeds of up to 50,000 m/s, propelling the rocket forward through space.

Potential future applications

VASIMR is not suitable to launch payloads from the surface of Earth due to its low thrust-to-weight ratio and its requirement of a vacuum to operate. Instead, it would function as an upper stage for cargo, reducing the fuel requirements for in-space transportation. The engine is expected to perform the following functions at a fraction of the cost of chemical technologies:

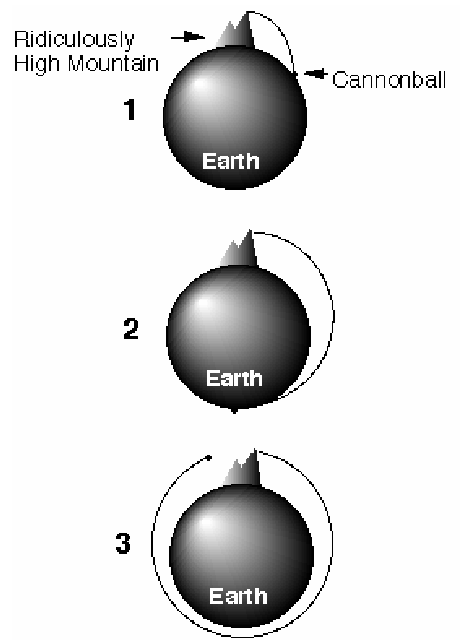
- drag compensation for space stations
- lunar cargo delivery
- satellite repositioning
- satellite refueling, maintenance and repair
- in space resource recovery
- ultra fast deep space robotic missions

Other applications for VASIMR such as the rapid transportation of people to Mars would require a very high power, low mass energy source, such as a nuclear reactor (see nuclear electric rocket). NASA Administrator Charles Bolden said that VASIMR technology could be the breakthrough technology that would reduce the travel time on a Mars mission from 2.5 years to 5 months.

How satellites stay in orbit (Rqmt #4C):

from: Randy Culp's website http://www.rocketmime.com/space/orbit.html

What an Orbit Really Is



The drawing at the right simplify the physics of orbiting Earth. We see Earth with a huge, tall mountain rising from it. The mountain, as Isaac Newton first envisioned, has a cannon at the top. When the cannon is fired, the cannonball follows its ballistic arc, falling as a result of Earth's gravity, and it hits Earth some distance away from the mountain. If we put more gunpowder in the cannon, the next time it's fired, the cannonball goes halfway around the planet before it hits the ground. With still more gunpowder, the cannonball goes so far that it never touches down at all. It falls completely around Earth. It has achieved orbit.

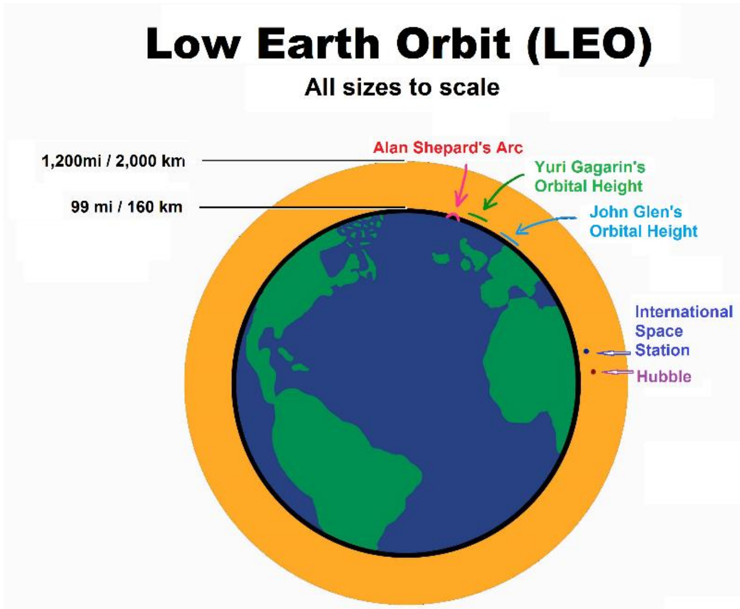
If you were riding along with the cannonball, you would feel as if you were falling. The condition is called free fall. You'd find yourself falling at the same rate as the cannonball, which would appear to be floating there (falling) beside you. You'd never hit the ground. Notice that the cannonball has not escaped Earth's gravity, which is very much present -- it is causing the mass to fall. It just happens to be balanced out by the speed provided by the cannon.

Getting Into Orbit

The cannonball provides us with a pretty good analogy. It makes it clear that to get a spacecraft into orbit you need to

- Raise It Up (the mountain) to a high enough altitude so that Earth's atmosphere isn't going to slow it down too much. In practical terms you don't generally want to be less than about 100 miles above the surface of the Earth. At that altitude, the atmosphere is so thin that it doesn't present much frictional drag to slow you down.
- Accelerate It until it is going so fast that as it falls, it just falls completely around the planet.

Low Earth Orbit (LEO) 160 km to 2,000 km



Low earth Orbit is between 160 kilometers (99 mi) (orbital period of about 88 minutes), and 2,000 kilometers (1,200 mi) (about 127 minutes). With the exception of the 24 human beings who flew lunar flights in the Apollo program during the four year period spanning 1968 through 1972, all human spaceflights have taken place in LEO or below. The International Space Station conducts operations in LEO about 400 km (250 mi) above the Earth's surface. All manned space stations to date, as well as the majority of satellites, have been in LEO, making one complete revolution around the Earth in about 90 minutes.

A low Earth orbit is simplest and cheapest for satellite placement. Since it requires less energy to place a satellite into a LEO and the LEO satellite needs less powerful amplifiers for successful transmission, LEO is used for many communication applications. It provides high bandwidth and low communication time lag (latency), but satellites in LEO will not be visible from any given point on the Earth at all times. Because these LEO orbits are not geostationary, a constellation of satellites is required to provide continuous coverage. Some communications satellites including the Iridium phone system use LEO.

Over the coming years, Elon Musk’s private spaceflight company, SpaceX, will launch thousands of small Starlink satellites as part of an effort to provide global, space-based internet. But with each launch, astronomers have grown increasingly worried that this satellite constellation will interfere with their telescopes’ abilities to study the night sky.

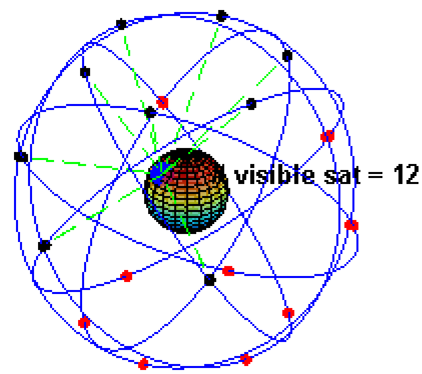
Earth observation satellites and spy satellites use LEO as they are able to see the surface of the Earth more clearly as they are not so far away. They are also able to traverse the surface of the Earth.

Polar orbits are often used for earth-mapping, earth observation, reconnaissance satellites, as well as for some weathers satellites. The Iridium satellite constellation also uses a polar orbit to provide telecommunications.

Medium Earth Orbit (MEO) 2,000 km to 35,785 km

A small percentage of other satellites are in Medium Earth Orbit (MEO), which is everything in between LEO and GEO. Ranging in altitude from 2,000 km (1,240 miles) to just below geosynchronous orbit at 35,786 kilometers (22,236 mi). These orbits are "most commonly at 20,200 kilometers (12,600 mi), or 20,650 kilometers (12,830 mi), with an orbital period of 12 hours.

The GPS system is a MEO system put in place by the US Department of Defense , which went live in 1995, and now uses 32 satellites. Until 2012, the number was only 24—six orbits, each with four satellites. As you can see in the GIF below that even with 24, a given point on the Earth can be seen by at least six of the satellites at any given time. The GPS satellites have an orbital period of about 12 hours, making two full rotations of the Earth each day. You can see satellite locations using Google Earth.



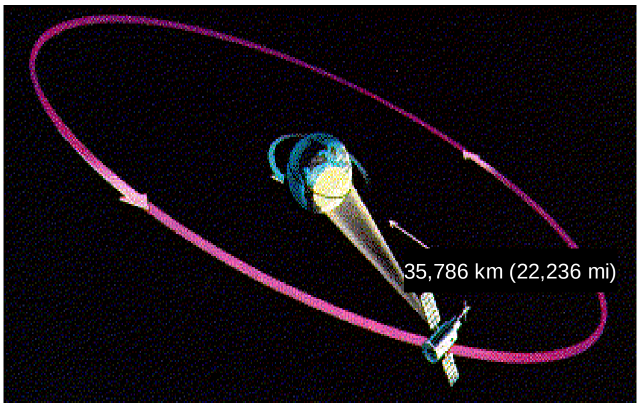
GPS illustration key:
Blue dot is a person on the ground
Satellites in view can at a given time
Sat. lines of sight to the person
Satellites with no view

High Earth Orbit (HEO) Above 35,786 km

Geosynchronous If you want a satellite to rotate around the earth once every day, so you can 'see' it constantly, it has to be in an orbital position 35,786 km (26,199 mi) above the earth's surface. At this position, the satellite is 'geosynchronous'. It has the same rotation speed as the earth, but viewed from the earth it can go up and down. Since the orbit has some inclination and/or eccentricity, the satellite would appear to describe a more or less distorted figure-eight in the sky, and would rest above the same spots of the Earth's surface once per sidereal day. There are more orbital planes and positions available to satellites using this technique. The result is - it's always "close" to above the city but leads or lags and "floats" up and down - (relative to a city's viewpoint) even though it is orbiting the Earth.

Geostationary If a geosynchronous satellite hangs above the earth and seems to be hanging 'still', it is in a geostationary orbit. This means the angle of the orbit flight is 0 degrees in comparison to the equator. A geostationary satellite therefore is a geosynchronous satellite that has a trajectory angle of 0 degrees.

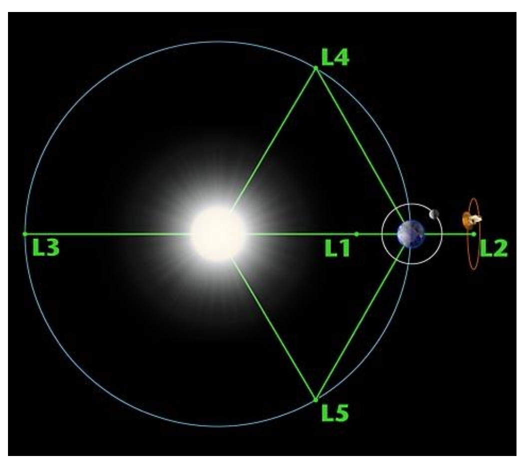
Geostationary satellites are easy to use. You only have to aim a dish once, then you can fix it. Until the satellite operator moves the satellite, you can always receive it's signal. Almost every television station nowadays has a channel at some geostationary satellite



If we place a satellite at an altitude of 22,236 miles / 35,786 km, then to stay in orbit, the satellite should travel at 6,873 mph. At that speed, you can show that it takes 23 hrs 56 min 4.0909 seconds to orbit Earth, which just happens to be the same as the sidereal rotation period of the Earth.

The satellite stays above the same point on the Earth, or looking at it from the Earth's surface, the satellite stays in the same place in the sky. This is called a "geostationary" orbit, since the satellite seems to be stationary - it looks like it doesn't move!. However a lot of satellites are in the Geostationary orbit. (Refer to Appendix E)

The Lagrange Points



The Italian-French mathematician Joseph-Louis Lagrange discovered five special points in the vicinity of two orbiting masses where a third, smaller mass can orbit at a fixed distance from the larger masses. More precisely, the Lagrange Points mark positions where the gravitational pull of the two large masses precisely equals the centripetal force required to rotate with them.

Of the five Lagrange points, three are unstable and two are stable. The unstable Lagrange points - labeled L1, L2 and L3 - lie along the line connecting the two large masses. The stable Lagrange points - labeled L4 and L5 - form the apex of two equilateral triangles that have the large masses at their vertices.

The L1 point of the Earth-Sun system affords an uninterrupted view of the sun and is currently home to the Solar and Heliospheric Observatory Satellite SOHO. The L2 point of the Earth-Sun system is home to the WMAP spacecraft and (perhaps by the year 2018) the James Webb Space Telescope. The L1 and L2 points are unstable on a time scale of approximately 23 days, which requires satellites parked at these positions to undergo regular course and attitude corrections. However, the China National Space Administration (CNSA) launched the Queqiao relay satellite on 20 May 2018 to a halo orbit around the Earth–Moon L2 point, which is a location that has a clear view of both the Chinese Lunar Exploration Program landing site on the back side of the Moon and the Earth.

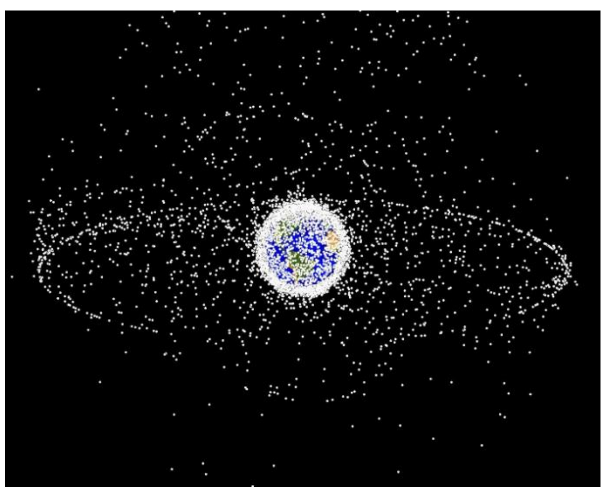
NASA is unlikely to find any use for the L3 point since it remains hidden behind the Sun at all times. The idea of a hidden "Planet-X" at the L3 point has been a popular topic in science fiction writing. The instability of Planet X's orbit (on a time scale of 150 years) didn't stop Hollywood from turning out classics like The Man from Planet X.

The L4 and L5 points are home to stable orbits so long as the mass ratio between the two large masses exceeds 24.96. This condition is satisfied for both the Earth-Sun and Earth-Moon systems, and for many other pairs of bodies in the solar system. Objects found orbiting at the L4 and L5 points are often called Trojans after the three large asteroids Agamemnon, Achilles and Hector that orbit in the L4 and L5 points of the Jupiter-Sun system.

Space Junk

Space debris, junk, waste, trash, or litter is the collection of defunct man-made objects in space – old satellites, spent rocket stages, and fragments from disintegration, erosion, and collisions – including those caused by debris itself. As of December 2016 there were 5 satellite collisions with space waste. As of July 2016, the United States Strategic Command tracked a total of 17,729 artificial objects, including 1,419 operational satellites. They cause damage akin to sandblasting, especially to solar panels and optics like telescopes or star trackers that cannot be covered with a ballistic shield

… and if you are really interested in the mathematics of obits, check out the following links:
http://www.braeunig.us/space/orbmech.htm#motions



A computer-generated image representing space debris. The two main debris fields are the ring of objects in geosynchronous Earth orbit (GEO) and the cloud of objects in low Earth orbit (LEO).

Appendix D - Model Rocket SAFETY CODE

National Association of Rocketry

Effective August 2012

1. **Materials.** I will use only lightweight, non-metal parts for the nose, body, and fins of my rocket.
2. **Motors.** I will use only certified, commercially-made model rocket motors, and will not tamper with these motors or use them for any purposes except those recommended by the manufacturer.
3. **Ignition System.** I will launch my rockets with an electrical launch system and electrical motor igniters. My launch system will have a safety interlock in series with the launch switch, and will use a launch switch that returns to the "off" position when released.
4. **Misfires.** If my rocket does not launch when I press the button of my electrical launch system, I will remove the launcher's safety interlock or disconnect its battery, and will wait 60 seconds after the last launch attempt before allowing anyone to approach the rocket.
5. **Launch Safety.** I will use a countdown before launch, and will ensure that everyone is paying attention and is a safe distance of at least 15 feet away when I launch rockets with D motors or smaller, and 30 feet when I launch larger rockets. If I am uncertain about the safety or stability of an untested rocket, I will check the stability before flight and will fly it only after warning spectators and clearing them away to a safe distance. When conducting a simultaneous launch of more than ten rockets I will observe a safe distance of 1.5 times the maximum expected altitude of any launched rocket.
6. **Launcher.** I will launch my rocket from a launch rod, tower, or rail that is pointed to within 30 degrees of the vertical to ensure that the rocket flies nearly straight up, and I will use a blast deflector to prevent the motor's exhaust from hitting the ground. To prevent accidental eye injury, I will place launchers so that the end of the launch rod is above eye level or will cap the end of the rod when it is not in use.
7. **Size.** My model rocket will not weigh more than 1,500 grams (53 ounces) at liftoff and will not contain more than 125 grams (4.4 ounces) of propellant or 320 N-sec (71.9 pound-seconds) of total impulse.
8. **Flight Safety.** I will not launch my rocket at targets, into clouds, or near airplanes, and will not put any flammable or explosive payload in my rocket.
9. **Launch Site.** I will launch my rocket outdoors, in an open area at least as large as shown in the accompanying table, and in safe weather conditions with wind speeds no greater than 20 miles per hour. I will ensure that there is no dry grass close to the launch pad, and that the launch site does not present risk of grass fires.
10. **Recovery System.** I will use a recovery system such as a streamer or parachute in my rocket so that it returns safely and undamaged and can be flown again, and I will use only flame-resistant or fireproof recovery system wadding in my rocket.

Recovery Safety. I will not attempt to recover my rocket from power lines, tall trees, or other dangerous places.

LAUNCH SITE DIMENSIONS

Installed Total Impulse (N-sec)	Equivalent Motor Type	Minimum Site Dimensions (ft.)
0.00--1.25	1/4A, 1/2A	50
1.26--2.50	A	100
2.51--5.00	B	200
5.01--10.00	C	400
10.01--20.00	D	500
20.01--40.00	E	1,000
40.01--80.00	F	1,000
80.01--160.00	G	1,000
160.01--320.00	Two Gs	1,500

Scout Name: ____ Unit #: ______________

Appendix J - Merit Badge Requirements
Space Exploration

Requirements were REVISED effective January 1, 2014.

1. Tell the purpose of space exploration and include the following:
   a) Historical reasons,
   b) Immediate goals in terms of specific knowledge,
   c) Benefits related to Earth resources, technology, and new products.
   d) International relations and cooperation

2. Design a collector's card, with a picture on the front and information on the back, about your favorite space pioneer. Share your card and discuss four other space pioneers with your counselor.

3. Build, launch, and recover a model rocket.* Make a second launch to accomplish a specific objective. (Rocket must be built to meet the safety code of the National Association of Rocketry. See the "Model Rocketry" chapter) Identify and explain the following rocket parts:
   a) Body tube
   b) Engine mount
   c) Fins
   d) Igniter
   e) Launch lug
   f) Nose cone
   g) Payload
   h) Recovery system
   i) Rocket engine

4. Discuss and demonstrate each of the following:
   a) The law of action-reaction.
   b) How rocket engines work
   c) How satellites stay in orbit
   d) How satellite pictures of Earth and pictures of other planets are made and transmitted.

5. Do TWO of the following:
   a) Discuss with your counselor a robotic space exploration mission and a historic crewed mission. Tell about each mission's major discoveries, its importance, and what was learned from it about the planets, moons, or regions of space explored.
   b) ~~Using magazine photographs, news clippings, and electronic articles (such as from the Internet), make a scrapbook about a current planetary mission~~.
   c) Design a robotic mission to another planet or moon that will return samples of its surface to Earth. Name the planet or moon your spacecraft will visit. Show how your design will cope with the conditions of the planet's or moon's environment.

6. Describe the purpose and operation of ONE of the following:
   ~~a) Space shuttle or any other crewed orbital vehicle, whether government owned (U.S. or foreign) or commercial~~
   b) International Space Station

7. Design an inhabited base located within our solar system, such as Titan, asteroids, or other locations that humans might want to explore in person. Make drawings or a model of your base. In your design, consider and plan for the following:
   a) Source of energy
   b) How it will be constructed
   c) Life-support System
   d) Purpose and function

8. Discuss with your counselor two possible careers in space exploration that interest you. Find out the qualifications, education, and preparation required and discuss the major responsibilities of those positions.

Scout Name: ________________________________ Unit #: ______________

Appendix K - Merit Badge Workbook
Space Exploration

January 2018

This workbook can help you, but you still need to read the merit badge pamphlet.

The work space provided for each requirement should be used by the Scout to make notes for discussing the item with his counselor, not for providing the full and complete answers. Each Scout must do each requirement.

---

1. Tell the purpose of space exploration and include the following:
   a. Historical reasons ____

   b. Immediate goals in terms of specific knowledge ______________________

   c. Benefits related to Earth resources, technology, and new products. ______________

   d. International relations and cooperation. ______________________________

2 . Design a collector's card, with a picture on the front and information on the back, about your favorite space pioneer.

Front	Back

Share your card and discuss four other space pioneers with your counselor.

Your Card ____

____

____

1. ____

____

2. ____

____

3. ____

____

4. ____

____

3. Build, launch, and recover a model rocket.

   Make a second launch to accomplish a specific objective*. (Rocket must be built to meet the safety code of the National Association of Rocketry. See the "Model Rocketry" chapter of the *Space Exploration* merit badge pamphlet.)
   ** If local laws prohibit launching model rockets, do the following activity: Make a model of a NASA rocket. Explain the functions of the parts. Give the history of the rocket.*

   Identify and explain the following rocket parts.

   a. Body tube ____

   b. Engine mount ____

   c. Fins ____

   d. Igniter ____

   e. Launch lug ____

   f. Nose cone ____

   g. Payload ____

   h. Recovery system ____

   i. Rocket engine ____

4. Discuss and demonstrate each of the following:

a. The law of action-reaction

b. How rocket engines work

c. How satellites stay in orbit

d. How satellite pictures of Earth and pictures of other planets are made and transmitted

5. Do TWO of the following:
   a. Discuss with your counselor a robotic space exploration mission and a historic crewed mission. Tell about each mission's major discoveries, its importance, and what we learned from it about the planets, moons, or regions of space explored. ____
   b. ~~Using magazine photographs, news clippings, and electronic articles (such as from the Internet), make a scrapbook about a current planetary mission~~.
   c. Design a robotic mission to another planet or moon that will return samples of its surface to Earth. __________

   Name the planet or moon your spacecraft will visit. ______________________________

   Show how your design will cope with the conditions of the planet's or moon's environment.______________

6. Describe the purpose, operation, and components of ONE of the following:
   a. ~~Space shuttle or any other crewed orbital vehicle, whether government owned (U.S. or foreign) or commercial~~
   b. International Space Station

   Purpose ____

   ____

   ____

   Operation ____

   ____

   ____

   Components ____

   ____

   ____

7. Design an inhabited base located within our solar system, such as Titan, asteroids, or other locations that humans might want to explore in person..

   Make drawings or a model of your base.

   In your design, consider and plan for the following:
   a. Source of energy ____
   b. How it will be constructed ____

   ____

   ____

   ____

   ____

   ____

c. Life-support system ______________________________

d. Purpose and function ______________________________

8. Discuss with your counselor two possible careers in space exploration that interest you. Find out the qualifications, education, and preparation required and discuss the major responsibilities of those positions. ______________

Career 1 ______________________________

Qualifications ______________________________

Education ______________________________

Preparation ______________________________

Major responsibilities ______________________________

Career 2 ______________________________

Qualifications ______________________________

Education ______________________________

Preparation ______________________________

Major responsibilities ______________________________

Requirement resources can be found here:

http://www.meritbadge.org/wiki/index.php/Space Exploration#Requirement_resources

Appendix L - Sample Blue Card

Information for Applicant

- A merit badge application can be approved only by a registered merit badge counselor.
- You must have a buddy with you (Scout buddy system) at each meeting with the merit badge counselor.
- Turn in your approved application to your unit leader. You will be awarded the merit badge emblem and certificate at a suitable occasion.

Information for Counselor

- Merit badge applications must be signed in advance by the applicant's unit leader.
- The Scout must have his buddy (Scout buddy system) in attendance at all instructional sessions.
- You may not change any requirement, but you may share your knowledge or experience that will make the counseling more interesting and valuable.

Space Exploration

Requirement No. and letter	Date of approval	Counselor initial
1a		
1b		
1c		
2		
3		
3a-i		
4a		
4b		
4c		
4d		
5a		
5c		
6		
7a		
7b		
7c		
7d		
8		

APPLICATION FOR MERIT BADGE

Name ______________________

Address ______________________

City ______________________

is a registered

☒ Boy Scout ☐ Varsity Scout ☐ Venturer

of Troop No. ______
(Troop, team, crew, ship)

District ______________________

Council ______________________

and is qualified to begin working for the merit badge noted on the reverse side.

Date ______ Signature of unit leader ______

BOY SCOUTS OF AMERICA®

The applicant has personally appeared before me and demonstrated to my satisfaction that he has met all requirements for the (please print)

Space Exploration
Merit badge

Donald Kern
Name of counselor

32 Defiance Ave
Address of counselor

Bristol, R.I. 02809
City Zip Code

401.253.0027
Telephone number of counselor

Signature of counselor ______ Date 1/06/2018

Checked and recorded:

Date ______ Initials ______

Date certificate and badge presented: ______

Applicant will turn in this portion to his unit leader for record posting.

APPLICANT'S RECORD

Name ______________________

has given me his completed application for the

Space Exploration
Merit badge

Completed on 1/6/2018 by
Date

Signature of counselor ______

Signature of unit leader ______

NOTE TO BOY SCOUT, VARSITY SCOUT, OR VENTURER: Retain this copy for your permanent records.

COUNSELOR'S RECORD

Applicant ______________________

☒ Troop
☐ Team Unit number ______
☐ Crew

Space Exploration
Merit badge

Date completed ______

Remarks:

It is suggested that the counselor keep this record for at least 1 year in case any question is raised later in regard to this award.