Rocketry for Kids

Science Level 4

History of Rocketry
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Greek “Rockets”
The very first rocket was not in fact a rocket - it was a pigeon! An ancient Greek by the name of Archytus created a wooden bird that was powered by steam, and flew along a wire. It was created around 400 B.C. In 100 B.C another Greek, Hero of Alexandria, created a steam powered rocket called an aeolipile. This machine used water boiled in a kettle, to create steam, which travelled up two pipes supporting a sphere with two ‘L-shaped’ tubes pointing out of it. The pressure of the steam forced it into the sphere and then it escaped out of the two L-shaped tubes, causing it to rotate. Both these rockets use Newton’s action-reaction principle: Every action has an opposite and equal reaction. This was first stated by Isaac Newton as a scientific principle in the 17th century: nearly two thousand years later!

Chinese Rockets
The first true rocket was developed by the ancient Chinese around 1 A.D, who had discovered rudimentary gun powder and used it as ‘fireworks’ to celebrate festivals. They filled bamboo tubes with gunpowder and fixed these tubes to arrows to fire at their enemies with bows. Around 1232, they discovered that the power (action-reaction) produced by the escaping exhaust of the ignited powder caused the ‘rockets’ to launch themselves. And the first rocket was launched!

European Developments
During the 13th century rocket experimentation began in Europe, possibly introduced by the Chinese during their war with the Mongols. In England a monk called Roger Bacon worked on methods of refining the gunpowder powering the rockets, which extended the range of the rockets. In France, a man named Jean Froissart discovered that rockets travel straighter when fired out of a tube, like a bazooka of today. In Italy an inventor named Joanes de Fontana designed a surface-running rocket-powered torpedo for setting enemy ships on fire.

In the 16th Century a German fireworks maker, Johann Schmidlap, invented the "step rocket," a rocket that was capable of multiple explosions, or stages, that could lift his rockets to greater altitudes than other rockets before. A large rocket (1st stage) lifted the rocket off the ground and a second rocket ignited after the first burnt out, sending the rocket higher into the air. This idea is now used today to power all rockets travelling into space.

Isaac Newton’s Laws of Motion
During the 17th century rocketry changed from being used primarily as entertainment and warfare and started to become a science. Sir Isaac Newton outlined three basic principles of physical motion into laws:
1) Unless an external force acts upon it, an object will either remain at rest or remain at a constant velocity.
2) The velocity of an object will change when subjected to external forces.
3) Every reaction has an equal and opposite reaction.
These laws had a huge impact on the way we understood how rockets worked, both in the atmosphere (during lift off) and in space. Newton’s Laws also had a tremendous influence on the design of rockets including size and weight of the rockets.

In the early 1700s rocket experimenters in Germany and Russia began working with larger rockets of a mass greater than 45 kilograms. Some of these rockets were so powerful that their escaping exhaust flames bored deep holes in the ground even before lift-off!

In the 1800s an Englishman named William Hale, developed a technique called spin stabilization, which pushes the escaping exhaust gases past small fins, or vanes at the bottom of the rocket. This makes the rocket spin very fast and makes it much more stable in flight. Variations of the principle are still used today.

In 1898, a Russian schoolteacher, Konstantin Tsiolkovsky (1857-1935), proposed the idea of space exploration by rocket. He suggested the use of liquid propellants for rockets in order to achieve greater range. Tsiolkovsky stated that the speed and range of a rocket were limited only by the exhaust velocity of escaping gases. For his ideas, careful research, and great vision, Tsiolkovsky has been called the father of modern astronautics.

American Innovations
Early in the 20th century, an American, Robert H. Goddard (1882-1945), conducted practical experiments in rocketry. He had become interested in a way of achieving higher altitudes than were possible for lighter-than-air balloons. Goddard’s earliest experiments were with solid-propellant rockets. In 1915, he began to try various types of solid fuels and to measure the exhaust velocities of the burning gases.

While working on solid-propellant rockets, Goddard became convinced that a rocket could be propelled better by liquid fuel. No one had ever built a successful liquid-propellant rocket before because it was a much more difficult task than building solid-propellant rockets. Goddard achieved the first successful flight with a liquid-propellant rocket on March 16, 1926. Fuelled by liquid oxygen and gasoline, the rocket flew for only two and a half seconds, climbed 12.5 meters, and landed 56 meters away in a cabbage patch! Goddard’s gasoline rocket became the forerunner of a whole new era in rocket flight.

Goddard’s rockets became bigger and flew higher; he developed a gyroscope system for flight control and a payload compartment for scientific instruments. Parachute recovery systems were employed to return rockets and instruments safely. Goddard, for his achievements, has been called the father of modern rocketry.
German Ideas
Hermann Oberth, a Transylvanian physicist, published a book in 1923 about rocket travel into outer space. His book inspired numerous small rocket societies to develop around the world.

In Germany, the formation of one such society, the Verein fur Raumschiffahrt (Society for Space Travel), led to the development (with Oberth and other German scientists and engineers) of the V-2 rocket, which was used against London during World War II.

The V-2 rocket was a very advanced rocket, a ballistic missile, and was used during World War II against the Allies. The V-2 rocket (in Germany called the A-4) achieved its great thrust by burning a mixture of liquid oxygen and alcohol at a rate of about one ton every seven seconds.

Post War Development
After the Second World War both the USA and the USSR used the German advances in rocketry as the basis for their own rocket and space programs.

In October 4, 1957, a rocket launched the world’s first Earth orbiting artificial satellite into space. Sputnik I was launched by the Soviet Union, who less than a month later launched the first living organism into orbit around the Earth – a dog named Laika.

Very soon after Sputnik was launched, America launched their own satellite – Explorer I.

By the 1960s many people and machines were being launched into space and the demand for more and larger payloads increased, and a wide array of versatile rockets were being built to suit.

Satellites have been launched from many countries including Australia but manned missions have only been launched by the USSR/Russia, the USA and China. Below are images of a wide range of American rockets.

Rockets historically used for launching satellites and space probes:


Scout-X4 Rocket – can launch small satellites into Earth orbit. It can carry a maximum weight (payload) of 140kg up to 185 Km high orbit. Carried the Explorer 27 scientific satellite into orbit in 1965.
Delta Rocket – can carry over 5,000kg to 185 Km high orbit, or 1,180Kg into a geosynchronous orbit with an attached booster stage. Carried the Galaxy-C communication satellite into space on September 21, 1984.

Titan III Centaur Rocket – a mixture of a U.S Airforce missile (the Titan), a Centaur upper stage from NASA and two extra side mounted boosters - carried Voyager 1 into space on September 5, 1975.

Pegasus air-launched space booster – carries small satellites into Earth orbit, after being released from a large aircraft. Launch took place April 5, 1990.

Rockets historically used for sending American astronauts into space:

Redstone rocket with Mercury space capsule (Mercury Redstone) – launched Allan Shepard into space, for the first American manned mission on May 5, 1961.

An Atlas rocket with Mercury space capsule (Mercury Atlas) launched four orbital missions including the first American to fly in Earth orbit, John Glenn.
Titan Rocket with Gemini spacecraft mounted on top (Gemini-Titan). The Gemini spacecraft reached an orbit ranging from 161 to 225 Km, with pilots Virgil I. Grissom and John W. Young on March 23, 1965.

The Saturn 1B rocket with Apollo spacecraft was 70 meters tall and lifted the Apollo Spacecraft to Earth orbit. It transported Apollo 7 crew on October 11, 1968; crews for Skylab (1973-1974) and the Apollo/Soyuz missions (1975).

The Saturn V Rockets were 111 meters tall and carried the Apollo 11 crew to the moon in July, 1969. A modified Saturn V rocket was used to send the 90,600 Kg Skylab Space Station into orbit on May 14, 1973. The space station replaced the third stage booster in the rocket.

The Space Shuttle is a winged orbiter that climbs into space as a rocket, orbits Earth as a satellite, and lands on a runway as an airplane. Two recoverable solid rocket boosters provide additional thrust and an expendable external tank carries the propellants for the orbiter's main engines. All recent American manned launches used the Space Shuttle, this image is of the launch of STS-53 on December 2, 1992.
Possible Rockets of the future:

The Delta Clipper experimental (DC-X) vehicle – lifts off and lands vertically, it could lead to a low cost payload launching system.

The X-34 - is a reusable booster concept that could lead to larger vehicles in the future - would launch from a carrier aircraft to deliver a payload to orbit.

The X-33 – is one of the reusable space shuttle designs that NASA is considering to replace the Space Shuttles – a single stage-to-orbit vehicle, which lifts off into space and returns to Earth intact.