Augmented Reality
Solar System Magic Book

The Augmented Reality—Solar System Magic Book is created by Nedim Slijepcevic and Wanju Huang. This book contains basic descriptions and facts and features of the planets in the solar system created by the Solar System Exploration on NASA. (http://solarsystem.nasa.gov/planets/index.cfm) It also provides AR markers for each planet with which the readers can go to the Solar System AR blog to see 3D models of the planets. The idea of Augmented Reality Magic Book was originally developed by Dr. Mark Billinghurst (http://www.hitl.washington.edu/people/person.php?name=grof)

To know more about this project, please visit: http://www.jsnet.eku.edu/ARBlog/

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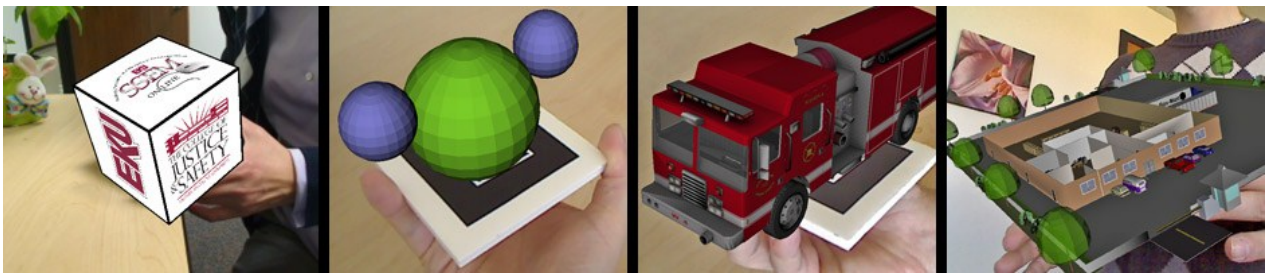

EARTH

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Basic Description

Earth is an ocean planet. Our home world's abundance of water -- and life -- makes it unique in our solar system. Other planets, plus a few moons, have ice, atmospheres, seasons and even weather, but only on Earth does the whole complicated mix come together in a way that encourages life -- and lots of it.

AR marker for Earth

Facts & Figures

Orbit Size Around Earth (semi-major axis)	Metric: 149,598,262 km English: 92,956,050 miles Scientific Notation: 1.4959826×10^{8} km (1.000 A.U.)
Perihelion (closest)	Metric: 147,098,291 km English: 91,402,640 miles Scientific Notation: 1.47098×10^{8} km (9.833×10^{-1} A.U.)
Aphelion (farthest)	Metric: 152,098,233 km English: 94,509,460 miles Scientific Notation: 1.52098×10^{8} km (1.017 A.U.)
Mean Radius	Metric: 6,371.00 km English: 3,958.8 miles Scientific Notation: 6.3710×10^{3} km
Mean Circumference	Metric: 40,030.2 km English: 24,873.6 miles Scientific Notation: 4.00302×10^{4} km
Volume	Metric: 1,083,206,916,846 km^3 English: 259,875,159,532 mi^3 Scientific Notation: 1.08321×10^{12} km^3
Mass	Metric: 5,972,190,000,000,000,000,000,000 kg Scientific Notation: 5.9722×10^{24} kg
Density	Metric: 5.513 g/cm^3
Surface Area	Metric: 510,064,472 km^2 English: 196,936,994 square miles Scientific Notation: 5.1006×10^{8} km^2
Surface Gravity	Metric: 9.80665 m/s^2 English: 32.041 ft/s^2
Escape Velocity	Metric: 40,284 km/h English: 25,031 mph Scientific Notation: 1.119×10^{4} m/s

MERCURY

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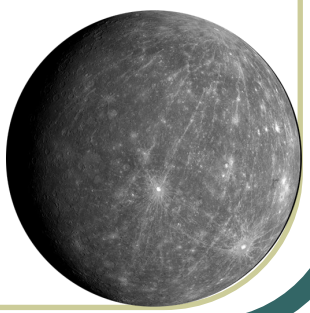
Basic Description

Sun-scorched Mercury is only slightly larger than Earth's Moon. Like the Moon, Mercury has very little atmosphere to stop impacts, and it is covered with craters. Mercury's dayside is super-heated by the sun, but at night temperatures drop hundreds of degrees below freezing. Ice may even exist in craters. Mercury's egg-shaped orbit takes it around the sun every 88 days.

AR marker for Mercury

Facts & Figures

Orbit Size Around Mercury (semi-major axis)	Metric: 57,909,227 km English: 35,983,125 miles Scientific Notation: 5.7909227 x 10^7 km (0.38709927 A.U.)
Perihelion (closest)	Metric: 46,001,009 km English: 28,583,702 miles Scientific Notation: 4.600 x 10^7 km (3.075 x 10-1 A.U.)
Aphelion (farthest)	Metric: 69,817,445 km English: 43,382,549 miles Scientific Notation: 6.982 x 10^7 km (0.4667 A.U.)
Mean Radius	Metric: 2,439.7 km English: 1,516.0 miles Scientific Notation: 2.4397 x 10^3 km
Mean Circumference	Metric: 15,329.1 km English: 9,525.1 miles Scientific Notation: 1.53291 x 10^4 km
Volume	Metric: 60,827,208,742 km^3 English: 14,593,223,446 mi^3 Scientific Notation: 6.08272 x 1010 km^3
Mass	Metric: 330,104,000,000,000,000,000,000 kg Scientific Notation: 3.3010 x 10^{23} kg
Density	Metric: 5.427 g/cm^3
Surface Area	Metric: 74,797,000 km^2 English: 28,879,000 square miles Scientific Notation: 7.4797 x 10^7 km^2
Surface Gravity	Metric: 3.7 m/s^2 English: 12.1 ft/s^2
Escape Velocity	Metric: 15,300 km/h English: 9,507 mph Scientific Notation: 4.25 x 10^3 m/s



SUN

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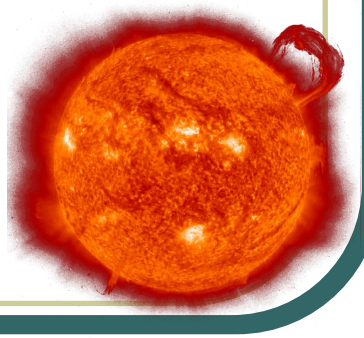
Basic Description

The sun is a star, a hot ball of glowing gases at the heart of our solar system. Its influence extends far beyond the orbits of distant Neptune and Pluto. Without the sun's intense energy and heat, there would be no life on Earth. And though it is special to us, there are billions of stars like our sun scattered across the Milky Way galaxy.

AR marker for Sun

Facts & Figures

Mean Radius	Metric: 695,508 km English: 432,168.6 miles Scientific Notation: 6.9551×10^5 km
Mean Circumference	Metric: 4,370,005.6 km English: 2,715,395.6 miles Scientific Notation: 4.37001×10^6 km
Volume	Metric: 1,409,272,569,059,860,000 km^3 English: 338,102,469,632,763,000 mi^3 Scientific Notation: 1.40927 x 1018 km^3
Mass	Metric: 1,989,100,000,000,000,000,000,000,000,000 kg English: 4,385,214,857,119,400,000,000,000,000,000 lbs Scientific Notation: 1.989×10^{30} kg
Density	Metric: 1.409 g/cm^3
Surface Area	Metric: 6,078,747,774,547 km^2 English: 2,347,017,636,988 square miles Scientific Notation: 6.07877×10^{12} km^2
Surface Gravity	Metric: 274.0 m/s^2 English: 899.0 ft/s^2 Scientific Notation: 2.740×10^2 m/s^2
Escape Velocity	Metric: 2,223,720 km/h English: 1,381,756 mph Scientific Notation: 6.177×10^5 m/s
Sidereal Rotation Period (Length of Day)	25.38 Earth days 609.12 hours
Equatorial Inclination to Orbit	7.25 with respect to the ecliptic
Minimum/Maximum Surface Temperature	Metric: 5,500 °C English: 10,000 °F



VENUS

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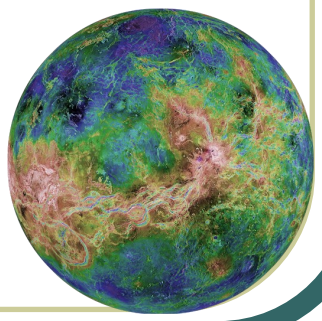
Basic Description

Venus is a dim world of intense heat and volcanic activity. Similar in structure and size to Earth, Venus' thick, toxic atmosphere traps heat in a run-away "greenhouse effect." The scorched world has temperatures hot enough to melt lead. Glimpses below the clouds reveal volcanoes and deformed mountains. Venus spins slowly in the opposite di-rection of most planets.

AR marker for Venus

Facts & Figures

Orbit Size Around Venus (semi-major axis)	Metric: 108,209,475 km English: 67,238,251 miles Scientific Notation: 1.0820948 x 10^{8} km (7.2333566 x 10^{-1} A.U.)
Perihelion (closest)	Metric: 107,476,170 km English: 66,782,596 miles Scientific Notation: 1.07476 x 10^{8} km (7.184 x 10^{-1} A.U.)
Aphelion (farthest)	Metric: 108,942,780 km English: 67,693,905 miles Scientific Notation: 1.08943 x 10^{8} km (0.7282 A.U.)
Mean Radius	Metric: 2,439.7 km English: 1,516.0 miles Scientific Notation: 2.4397 x 10^{3} km
Mean Circumference	Metric: 38,024.6 km English: 23,627.4 miles Scientific Notation: 3.80246 x 10^{4} km
Volume	Metric: 928,415,345,893 km^3 English: 222,738,686,740 mi^3 Scientific Notation: 9.28415 x 10^{11} km^3
Mass	Metric: 4,867,320,000,000,000,000,000,000 kg Scientific Notation: 4.8673 x 10^{24} kg
Density	Metric: 5.243 g/cm^3
Surface Area	Metric: 460,234,317 km^2 English: 177,697,463 square miles Scientific Notation: 4.6023 x 10^{8} km^2
Surface Gravity	Metric: 8.87 m/s^2 English: 29.1 ft/s^2
Escape Velocity	Metric: 37,296 km/h English: 23,175 mph Scientific Notation: 1.036 x 10^{4} m/s



MOON

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Basic Description

Our Moon makes Earth a more livable planet by moderating our home planet's wobble on its axis, leading to a relatively stable climate, and creating a rhythm that has guided humans for thousands of years. The Moon was likely formed after a Mars-sized body collided with Earth and the debris formed into the most prominent feature in our night sky.

AR marker for Moon

Facts & Figures

Orbit Size Around Earth (semi-major axis)	Metric: 384,400 km English: 238,855 miles Scientific Notation: 3.84400 x 10^5 km (0.00257 A.U.)
Perihelion (closest)	Metric: 363,104 km English: 225,623 miles Scientific Notation: 3.631 x 10^5 km (2.427 x 10^{-3} A.U.)
Aphelion (farthest)	Metric: 405,696 km English: 252,088 miles Scientific Notation: 4.051 x 10^5 km (2.712 x 10^{-3} A.U.)
Mean Radius	Metric: 1737.5 km English: 1079.6 miles Scientific Notation: 1.738 x 10^3 km
Mean Circumference	Metric: 10,917.0 km English: 6,783.5 miles Scientific Notation: 1.0917 x 10^4 km
Volume	Metric: 21,971,669,064 km3 Scientific Notation: 2.197 x 10^{10} km^3
Mass	Metric: 73,476,730,924,573,500,000,000 kg Scientific Notation: 7.3477 x 10^{22} kg
Density	Metric: 3.344 g/cm^3
Surface Area	Metric: 37,936,694.79 km^2 English: 14,647,439.75 square miles Scientific Notation: 3.793669 x 10^7 km^2
Surface Gravity	Metric: 1.624 m/s^2 English: 5.328 ft/s^2 Scientific Notation: 1.624 m/s^2
Escape Velocity	Metric: 8,552 km/h English: 5,314 mph Scientific Notation: 2,376 m/s

MARS

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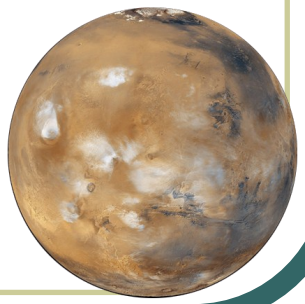
Basic Description

Mars is a cold desert world. It is half the diameter of Earth and has the same amount of dry land. Like Earth, Mars has seasons, polar ice caps, volcanoes, canyons and weather, but its atmosphere is too thin for liquid water to exist for long on the surface. There are signs of ancient floods on Mars, but evidence for water now exists mainly in icy soil and thin clouds.

AR marker for Mars

Facts & Figures

Orbit Size Around Mars (semi-major axis)	Metric: 227,943,824 km English: 141,637,725 miles Scientific Notation: 2.2794382 x 10^8 km (1.523662 A.U.)
Perihelion (closest)	Metric: 206,655,215 km English: 128,409,598 miles Scientific Notation: 2.06655 x 10^8 km (1.381 A.U.)
Aphelion (farthest)	Metric: 249,232,432 km English: 154,865,853 miles Scientific Notation: 2.49232 x 10^8 km (1.666 A.U.)
Mean Radius	Metric: 3,389.5 km English: 2,106.1 miles Scientific Notation: 3.3895 x 10^3 km
Mean Circumference	Metric: 21,344 km English: 13,263 miles Scientific Notation: 2.1344 x 10^4 km
Volume	Metric: 163,115,609,799 km^3 English: 39,133,515,914 mi^3 Scientific Notation: 1.63116 X 10^{11} km^3
Mass	Metric: 641,693,000,000,000,000,000,000 kg Scientific Notation: 6.4169 x 10^{23} kg
Density	Metric: 3.934 g/cm^3
Surface Area	Metric: 144,371,391 km^2 English: 55,742,106 square miles Scientific Notation: 1.4437 x 10^8 km^2
Surface Gravity	Metric: 3.71 m/s^2 English: 12.2 ft/s^2
Escape Velocity	Metric: 18,108 km/h English: 11,252 mph Scientific Notation: 5.030 x 10^3 m/s



JUPITER

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Basic Description

Jupiter, the most massive planet in our solar system -- with dozens of moons and an enormous magnetic field -- forms a kind of miniature solar system. Jupiter does resemble a star in composition, but it did not grow big enough to ignite. The planet's swirling cloud stripes are punctuated by massive storms such as the Great Red Spot, which has raged for hundreds of years.

AR marker for Jupiter

Facts & Figures

Orbit Size Around Jupiter (semi-major axis)	Metric: 778,340,821 km English: 483,638,564 miles Scientific Notation: 7.7834082 x 10^8 km (5.2028870 A.U.)
Perihelion (closest)	Metric: 740,679,835 km English: 460,237,112 miles Scientific Notation: 7.40680 x 10^8 km (4.951 A.U.)
Aphelion (farthest)	Metric: 816,001,807 km English: 507,040,015 miles Scientific Notation: 8.16002 x 10^8 km (5.455 A.U.)
Mean Radius	Metric: 69,911 km English: 43,440.7 miles Scientific Notation: 6.9911 x 10^4 km
Mean Circumference	Metric: 439,263.8 km English: 272,945.9 miles Scientific Notation: 4.39264 x 10^5 km
Volume	Metric: 1,431,281,810,739,360 km^3 English: 343,382,767,518,322 mi^3 Scientific Notation: 1.43128 x 10^{15} km^3
Mass	Metric: 1,898,130,000,000,000,000,000,000,000 kg Scientific Notation: 1.8981 x 10^{27} kg
Density	Metric: 1.326 g/cm^3
Surface Area	Metric: 61,418,738,571 km^2 English: 23,713,907,537 square miles Scientific Notation: 6.1419 x 10^{10} km^2
Surface Gravity	Metric: 24.79 m/s^2 English: 81.3 ft/s^2
Escape Velocity	Metric: 216,720 km/h English: 134,664 mph Scientific Notation: 6.020 x 10^4 m/s

SATURN

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Solar System Magic Book

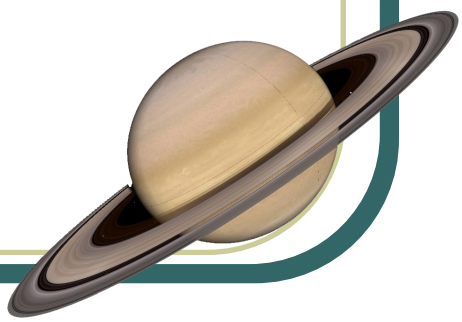
Basic Description

Adorned with thousands of beautiful ring-lets, Saturn is unique among the planets. All four gas giant planets have rings -- made of chunks of ice and rock -- but none are as spectacular or as complicated as Saturn's. Like the other gas giants, Saturn is mostly a massive ball of hydrogen and helium.

AR marker for Saturn

Facts & Figures

Orbit Size Around Saturn (semi-major axis)	Metric: 1,426,666,422 km English: 886,489,415 miles Scientific Notation: 1.4266664 x 10^9 km (9.53667594 A.U.)
Perihelion (closest)	Metric: 1,349,823,615 km English: 838,741,509 miles Scientific Notation: 1.34982 x 10^9 km (9.023 A.U.)
Aphelion (farthest)	Metric: 1,503,509,229 km English: 934,237,322 miles Scientific Notation: 1.50351 x 10^9 km (1.005 x 10^1 A.U.)
Mean Radius	Metric: 58,232 km English: 36,183.7 miles Scientific Notation: 5.8232 x 10^4 km
Mean Circumference	Metric: 365,882.4 km English: 227,348.8 miles Scientific Notation: 3.65882 x 10^5 km
Volume	Metric: 827,129,915,150,897 km^3 English: 198,439,019,647,006 mi^3 Scientific Notation: 8.2713 x 10^{14} km^3
Mass	Metric: 568,319,000,000,000,000,000,000,000 kg Scientific Notation: 5.6832 x 10^{26} kg
Density	Metric: 0.687 g/cm^3
Surface Area	Metric: 42,612,133,285 km^2 English: 16,452,636,641 square miles Scientific Notation: 4.2612 x 10^{10} km^2
Surface Gravity	Metric: 10.4* m/s^2 English: 34.3 ft/s^2
Escape Velocity	Metric: 129,924 km/h English: 80,731 mph Scientific Notation: 3.609 x 10^4 m/s



NEPTUNE

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Basic Description

Dark, cold and whipped by supersonic winds, Neptune is the last of the hydrogen and helium gas giants in our solar system. More than 30 times as far from the sun as Earth, the planet takes almost 165 Earth years to orbit our sun. In 2011 Neptune completed its first orbit since its discovery in 1846.

AR marker for Neptune

Facts & Figures

Orbit Size Around Earth (semi-major axis)	Metric: 4,498,396,441 km English: 2,795,173,960 miles Scientific Notation: 4.4983964 x 10^9 km (3.0069923 x 10^1 A.U.)
Perihelion (closest)	Metric: 4,459,753,056 km English: 2,771,162,074 miles Scientific Notation: 4.45975 x 10^9 km (2.981 x 10^1 A.U.)
Aphelion (farthest)	Metric: 4,537,039,826 km English: 2,819,185,846 miles Scientific Notation: 4.53704 x 10^9 km (3.033 x 10^1 A.U.)
Mean Radius	Metric: 24,622 km English: 15,299.4 miles Scientific Notation: 2.4622 x 10^4 km
Mean Circumference	Metric: 154,704.6 km English: 96,129.0 miles Scientific Notation: 1.54705 x 10^5 km
Volume	Metric: 62,525,703,987,421 km^3 English: 15,000,714,125,712 mi^3 Scientific Notation: 6.25257 x 10^{13} km^3
Mass	Metric: 102,410,000,000,000,000,000,000,000 kg Scientific Notation: 1.0241 x 10^{26} kg
Density	Metric: 1.638 g/cm^3
Surface Area	Metric: 7,618,272,763 km^2 English: 2,941,431,558 square miles Scientific Notation: 7.6183 x 10^9 km^2
Surface Gravity	Metric: 11.15 m/s^2 English: 36.6 ft/s^2
Escape Velocity	Metric: 84,816 km/h English: 52,702 mph Scientific Notation: 2.356 x 10^4 m/s