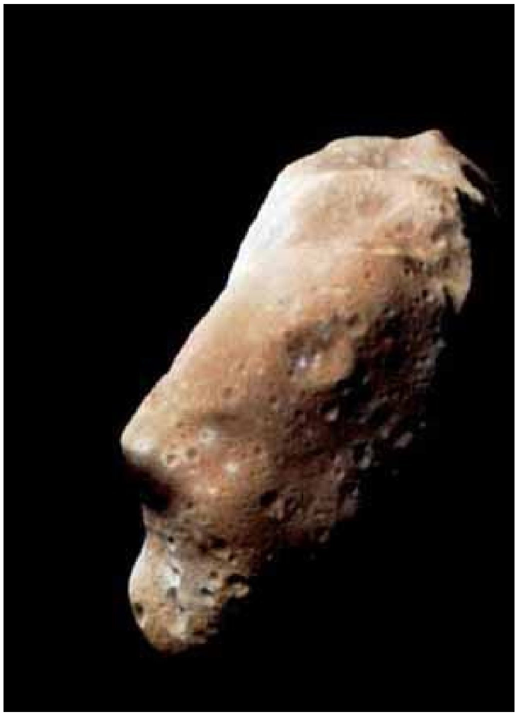
Asteroid Gaspara

Astronomers studying the asteroid 24-Themis detected water-ice and carbon-based organic compounds on the surface of the asteroid.

NASA detects, tracks and characterizes asteroids and comets passing close to Earth using both ground and space-based telescopes.

NASA is particularly interested in asteroids with water ice because this resource could be used to create fuel for interplanetary spacecraft.

On October 7, 2009, the presence of water ice was confirmed on the surface of this asteroid using NASA's Infrared Telescope Facility. The surface of the asteroid appears completely covered in ice. As this ice layer is sublimated, it may be getting replenished by a reservoir of ice under the surface. The orbit of the asteroid varies from 2.7 AU to 3.5 AU so it is located withint the asteroid belt. The asteroid is 200 km in diameter, has a mass of 1.1 x 10^{19} kg, and a density of 2,800 kg/m^3 so it is mostly rocky material similar in density to Earth's.

By measuring the spectrum of infrared sunlight reflected by the object, the NASA researchers found the spectrum consistent with frozen water and determined that 24 Themis is coated with a thin film of ice. The asteroid is estimated to lose about 1 meter of ice each year, so there must be a sub-surface reservoir to constantly replace the evaporating ice.

Problem 1 – Assume that the asteroid has a diameter of 200 km. How many kilograms of water ice are present in a layer 1-meter thick covering the entire surface, if the density of ice is 1,000 km/$meter^3$? (Hint: Volume = Surface area x thickness)

Problem 2 – Suppose that only 1% by volume of the 1-meter-thick 'dirty' surface layer is actually water-ice and that it evaporates 1 meter per year, what is the rate of water loss in kg/sec?

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Answer: Volume = surface area x thickness.

$SA = 4 \pi r^2$

$= 4 (3.14) (100,000 \text{ meters})^2$

$= 1.3 \times 10^{11} \text{ meters}^2$

$\text{Volume} = 1.3 \times 10^{11} \text{ meters}^2 \times 1 \text{ meter}$

$= 1.3 \times 10^{11} \text{ meters}^3$

Mass of water = density x volume

$= 1,000 \text{ kg/meter}^3 \times 1.3 \times 10^{11} \text{ meter}^3$

= **1.3×10^{14} kg** (or 130 billion tons)

Problem 2 – Suppose that only 1% by volume of the ‘dirty’ 1-meter-thick surface layer is water-ice and that it evaporates 1 meter per year, what is the rate of water loss in kg/sec?

Answer: The mass of water in the outer 1-meter layer is 1% of 1.3×10^{14} kg or 1.3×10^{12} kg. Since 1 year = 365 days x 24h/day x 60m/hr x 60 sec/min = 3.1×10^7 seconds, the mass loss is just 1.3×10^{12} kg / 3.1×10^7 sec = **42,000 kg/sec or 42 tons/sec**.