



For decades, astronomers thought that the only geologically active object in our entire solar system was Earth. During the last 50 years of spacecraft studies, we now know that there are many locations where recent and even current volcanism can be found.

This image, taken by the Cassini spacecraft, shows plumes of gas and dust ejected from cracks in the surface of Saturn's moon Enceladus. Similar plumes have been found in Jupiter's satellite Io, and Neptune's moon Triton. They are called cryovolcanos because the temperatures are so low, only 100 kelvins (173 Celsius), and instead of rocky lava they eject water, methane or other frozen gases.

A simple 'square-root' formula relates the height of a plum,  $h$ , and its ejection speed,  $V$ , to the surface gravity of the body,  $g$  :

$$V = (2gh)^{1/2}$$

where  $h$  is in meters,  $V$  is in meters/sec and  $g$  is the acceleration of gravity at the surface in meters/sec<sup>2</sup>.

**Problem 1** – Complete the following table to estimate the ejection speeds and heights of volcanic plumes on the indicated bodies.

Object	Type	G (m/s <sup>2</sup> )	V (m/s)	H (m)
Venus	Volcano	8.8	100	
Earth	Volcano	9.8		8,000
Earth	Geyser	9.8	35	
Mars	Volcano	3.8	100	
Io	Volcano	1.8		200,000
Enceladus	Geyser	0.1	60	
Titan	Volcano	1.4	100	
Triton	Geyser	0.8		5,000

**Problem 2** – If 1 meter/sec = 2.2 miles/hr, which objects have the fastest and slowest ejection speeds in mph?

**Problem 3** - Calculate the average ejection speeds for Volcanos and geysers. What do you notice about the kind of event and its ejection speed?

**Problem 1** – Complete the following table to estimate the ejection speeds and heights of volcanic plumes on the indicated bodies.

Object	Type	G (m/s <sup>2</sup> )	V (m/s)	H (m)
Venus	Volcano	8.8	100	<b>570</b>
Earth	Volcano	9.8	<b>400</b>	8,000
Earth	Geyser	9.8	35	<b>63</b>
Mars	Volcano	3.8	100	<b>1,300</b>
Io	Volcano	1.8	<b>850</b>	200,000
Enceladus	Geyser	0.1	60	<b>18,000</b>
Titan	Volcano	1.4	100	<b>3600</b>
Triton	Geyser	0.8	<b>89</b>	5,000

**Problem 2** – If 1 meter/sec = 2.2 miles/hr, which objects have the fastest and slowest ejection speeds in mph?

Answer: Fastest is Io at 850 m/s or 1,870 mph. Slowest is Earth geyser at 35 m/s or 77 mph.

**Problem 3** - Calculate the average ejection speeds for Volcanos and geysers. What do you notice about the kind of event and its ejection speed?

Answer: Volcanos:  $(100+400+100+850+100)/5 = 310$  m/sec (682 mph).  
 Geysers:  $(35+60+89)/3 = 61$  m/sec (134 mph.)

Volcanos have the highest speeds. This is because they are produced by intense pressure of magma trapped in rocky 'pipes' that reach hundreds of kilometers below the surface, while geysers are created by more modest pressures in the surface crust.