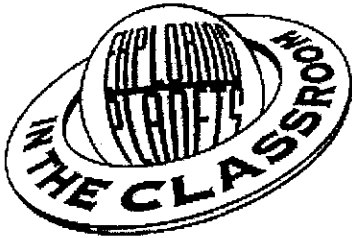


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	<h1>How Much Rock is in an Icy Moon?</h1>
	<p>Purpose</p> <p>To calculate the percentages of rock and ice in the moons of the outer planets.</p>
<p>Key Words</p> <p>satellite</p> <p>moon</p> <p>rock</p> <p>ice</p> <p>density</p> <p>Materials</p> <p>pencil</p> <p>calculator</p> <p>"Percent Rock Graph"</p> <p>"Percent Rock Chart"</p>	<p>Background</p> <p>The outer planets (Jupiter, Saturn, Uranus, Neptune, and Pluto) have icy, rocky satellites (moons). Given the densities of the satellites, you can calculate the percentage of rock and ice in the compositions.</p> <p>Procedure</p> <ol style="list-style-type: none"> 1. Begin by looking at the density values given for various moons in the "Percent Rock Chart." 2. Are the densities all the same? 3. Rock has a density of about 3.5 grams per cubic centimeter. Are any of the moons composed entirely of rock? If so, which ones? 4. Water ice has a density of about 0.9 grams per cubic centimeter. Are any of the moons composed entirely of ice? If so, which ones? 5. We can make a graph to help figure out the percentages of rock and ice in the moons of the outer planets. Use the equations shown below to compute the density resulting from different percentages of rock and ice. Write your answers in the table below.

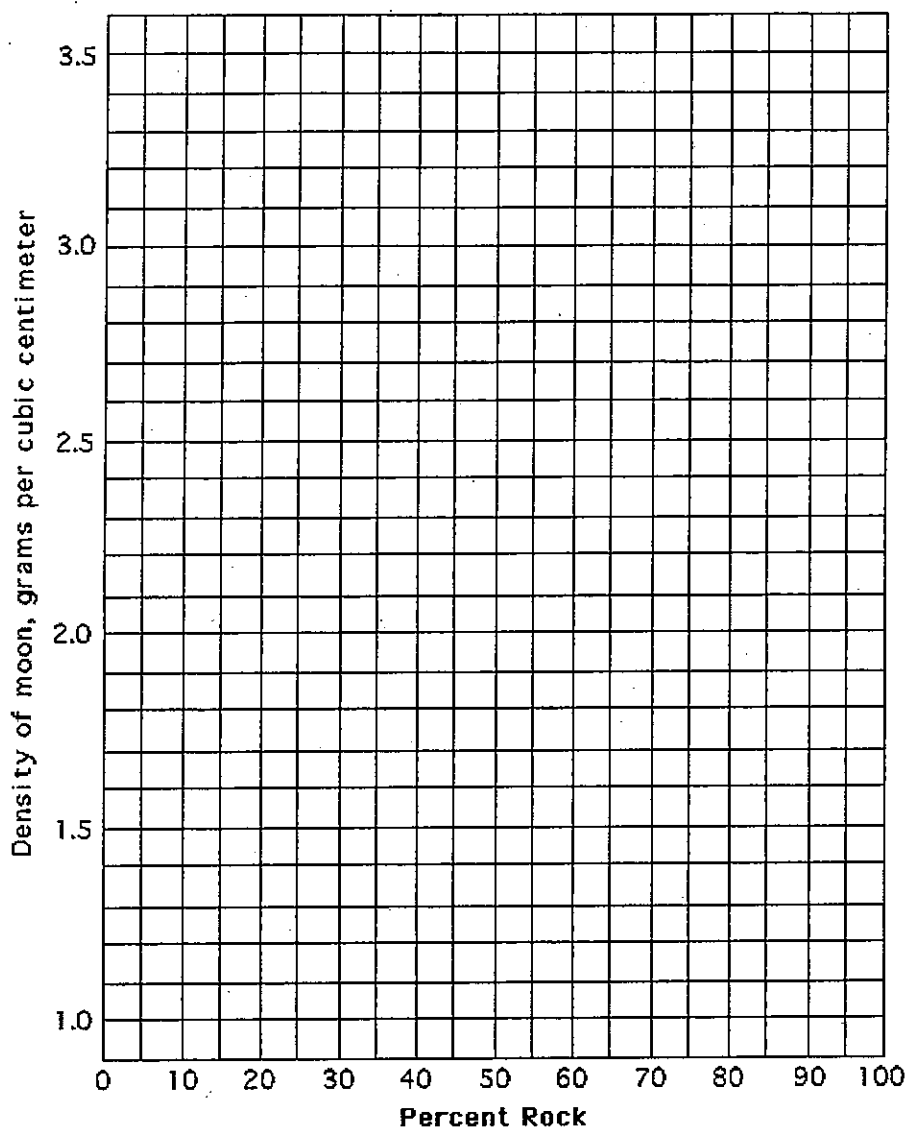
$$\text{Density} = \frac{(\text{Percentage of rock} \times \text{Density of rock}) + (\text{Percentage of ice} \times \text{Density of ice})}{100}$$

$$D_{\text{moon}} = \frac{(P_{\text{rock}} \times D_{\text{rock}}) + (P_{\text{ice}} \times D_{\text{ice}})}{100} = \frac{(P_{\text{rock}})(3.5) + (P_{\text{ice}})(0.9)}{100}$$

Percent Rock	Percent Ice	Density of moon
100	0	
80	20	
60	40	
40	60	
20	80	
0	100	

6. Plot the density values from the table above onto the "Percent Rock Graph" below.

Percent Rock Graph



7. Use your graph to determine the percentages of rock in each moon. Complete the "Percent Rock Chart."

Percent Rock Chart

Planet	moon	density (g/cc)	Percentage of rock
Jupiter	Io	3.5	%

	Europa	3.0	%
	Ganymede	1.9	%
	Callisto	1.8	%
Saturn	Mimas	1.2	%
	Dione	1.4	%
	Rhea	1.3	%
	Titan	1.9	%
Uranus	Miranda	1.4	%
	Ariel	1.7	%
	Umbriel	1.5	%
Neptune	Triton	2.1	%
Pluto	Charon	2.0	%

8. How do you think the ice and rock are distributed inside the moons?
9. Earth has a density of 5 g/cc. Why is it so large? Does it contain something more dense than rock?
10. Can you think of a way to determine the percentages of the rock and the dense material in Earth?

Extension

1. Making a graph would be a lot of trouble if you wanted to determine the percentage of rock in just one moon, say in Callisto. Can you think of a way to determine the percentage of rock in Callisto? Hint: algebra is fun!

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