

# How Much Rock is in an Icy Moon?

**Purpose:** To calculate the percentages of rock and ice in the moons of the outer planets.

**Background:** The outer planets have icy, rocky moons. Given the densities of the satellites, you can calculate the percentage of rock and ice in the compositions.

**Materials:**

- Pencil
- Calculator
- Percent Rock Graph created in Excel or other spreadsheet software
- Percent Rock Chart created in Excel or other spreadsheet software
- Excel or other Spreadsheet

**Procedure:**

1. Begin by looking at the density values given for various moons in the Percent Rock Chart below.
2. ***Are the densities the same? (1)***
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? (1)***
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? (1)***
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. Use a data program like Excel or other spreadsheet to create a table and graph.

For example, if a moon is 100% rock then we would solve as

$$=3.5g/cm^3$$

**Density Chart (5 Points)**

Percent Rock	Percent Ice	Density of Moon
100	0	3.5g/cm <sup>3</sup>
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. **(5 Points)**

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

### Percent Rock Chart (12 Points)

Planet	Moon	Density g/cm <sup>3</sup>	Percentage of Rock
<i>Jupiter</i>	Io	3.5	
	Europa	3.0	
	Ganymede	1.9	
	Callisto	1.8	
<i>Saturn</i>	Mimas	1.2	
	Dione	1.4	
	Rhea	1.3	
<i>Uranus</i>	Titan	1.9	
	Miranda	1.4	
	Ariel	1.7	
	Umbriel	1.5	
<i>Neptune</i>	Triton	2.1	

1. 8. **How do you think the ice and rock are distributed inside the moons?** (look back over the notes and you should see a pattern) **(1)**
2. 9. **Earth has a density of 5g/cm<sup>3</sup>. Why is it so large? Does it contain something more dense than rock? (1)**
3. 10. **Can you think of a way to determine the percentages of the rock and the dense material in Earth?(1)**

**Conclusion:** Think back to Kepler's Laws and Newton's Law of Universal Gravitation. How do you think the density of these different moons can be determined? Obviously we can't go put them on a giant balance and measure them. **(2 Points)**

**Activity from Georgia Virtual Learning Astronomy**