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## A Martian Cookbook: Mathematics, Chemistry and Physics in Action!

If Earthlings go to Mars, we will need to eat. In order to eat on Mars, we need to learn to cook on Mars where the air pressure is very low. Earthlings do know some things about cooking when atmospheric pressure changes. On our planet, the atmospheric pressure changes enough when you go to the mountains that recipes need to be changed. We would need to change them even more to make the recipes work on Mars. Making recipes work is a combination of mathematically guessing how to adjust the ingredients and then experimenting with your guesses. Speaking Martian in the kitchen is totally cool!

For example, cake baking is greatly affected by atmospheric pressure. At sea level, recipes correctly tell you how much air to beat into a cake or how much leavening (an ingredient that causes the batter to ferment and rise) to add so that you get a light tasty cake. Lower atmospheric pressure allows batter to expand faster during baking and to rise too high; the cake then falls and is crumbly and cracked. When cooking in low atmospheric pressure areas, use fresh double acting baking powder (sodium aluminum sulfate) and do not use as much! Other leavening agents include baking soda, cream of tartar, and egg whites. Sugar (carbon hydrogen oxide) is also a problem; it weakens the cell structure of the cake, again making it crumbly. Martian chefs will need to use less sugar. Low atmospheric pressure also causes liquid to evaporate more quickly. Martian cooks will need to use more water.

What to do? Well, in the United States on planet Earth we adjust recipes by

- **decreasing sugar** by about 1 tablespoon for every 2000 feet of elevation.
- **increasing liquid** by about 1 tablespoon for every 2000 feet of elevation.
- **increasing cake flour** by about 1 tablespoon for every 2000 feet of elevation starting after 2000 feet.
- **increasing the baking temperature** about 3 degrees fahrenheit for every 1000 feet of elevation.
- **reducing the leavening agent** by about one-fourth of the original measurement for every 2000 feet of elevation.

Now, are you ready to write your Martian cookbook? Check this out. A millibar is the unit of measure we use to describe how heavy the gases are above you. On Mars, the atmospheric pressure near the planet's surface is about 6 millibars. On Earth, the atmospheric pressure at sea level is about 1000 millibars. The air pressure drops as

you go to higher altitudes (there less air at the top of a mountain than there is at its base). When you're 10,000 feet above sea level on Earth, the atmospheric pressure is 700 millibars. The atmospheric pressure on Mars is about the same as the pressure would be on Earth at 90,000 feet above sea level!

What does this mean? Well, it means that, in theory, you could take an Earth recipe and adjust it for an altitude of 90,000 feet and it should work! How would you do that? Like this...Let's say the recipe calls for 1 cup of flour. Your chart suggests adding 1 tablespoon of flour for every 2000 feet. Divide 90,000 by 2000 and you get 45. That means you should add 45 tablespoons more of flour to your recipe. How much is that? Well, there are 16 tablespoons in a cup so...45 divided by 16 equals about 2 3/4 cups of flour. Your new recipe would have a total of 3 3/4 cups flour.

Try adjusting the temperature. The temperature needs to increase by 3 degrees for every 1000 feet. So, 90,000 divided by 1000 equals \_\_\_\_\_. Multiply your answer by three to get the increase in temperature for baking on the Red Planet!

You will also need to know this information about measurements in the United States:

3 teaspoons = 1 tablespoon	4 tablespoons = 1/4 cup
16 tablespoons = 1 cup	1/2 cup = 1 gill (really!)
2 cups = 1 pint	4 cups = 1 quart
2 pints = 1 quart	4 quarts = 1 gallon

Here is a chance to write the first cake recipe for astronauts on Mars! Here is the recipe designed for sea level on Earth. You will need to adjust it for Mars:

### Earthling Chocolate Chip Cake

2 cups flour  
1 1/2 cups sugar  
3 teaspoons baking powder  
1 teaspoon salt  
1/2 teaspoon baking soda  
1/2 cup unsalted butter  
1/2 cup mini-chocolate chips  
1 teaspoon vanilla  
1/2 teaspoon cinnamon  
3 eggs  
1 cup buttermilk  
1/4 cup sour cream

- Directions:
1. Preheat oven to 350 degrees fahrenheit.
  2. Grease and flour two nine inch pans or one 8 X12 inch pan.
  3. Cream the butter and the sugar. Blend all remaining ingredients

except for the chocolate chips in a large bowl using the electric mixer. Beat for two minutes and then scrape the sides with a spatula. Beat for 3 more minutes at high speed. Add the chips.

4. Pour into the pans and bake for 40 minutes.

5. Cool before removing from the pan. Frost with your favorite frosting.

**WARNING! DO NOT USE THIS RECIPE ON ANY PLANET OTHER THAN EARTH!**

Now, use that mathematical mind and change this recipe to

### **Martian Chocolate Chip Cake**

Measurement	Ingredient
	flour
	sugar
	baking powder (a leavening)
	salt
	baking soda (a leavening)
	unsalted butter
	mini-chocolate chips
	vanilla
	cinnamon
	eggs
	buttermilk
	sour cream

Directions: 1. Preheat oven to \_\_\_\_\_ degrees fahrenheit.

2. Grease and flour 4 nine inch pans or two 8 X 12 inch pans.

3. Cream the butter and the sugar. Blend all remaining ingredients except for the chocolate chips in a really large bowl using the solar powered electric mixer. Beat for two minutes and then scrape the sides with a spatula. Beat for 3 more minutes at high speed. Add the chocolate chips.

4. Pour batter into the pans and bake for 40 minutes.

5. Cool before removing from the pan. Frost with your favorite frosting.

**WARNING: DO NOT TRY THIS RECIPE ON ANY PLANET OTHER THAN MARS!**

Now, the ultimate challenge - find a cake recipe that you like and convert it to Martian!