Isotopes in the Hydrogeologic System Exercise - in class

**Part 1: Calculating Atomic Mass**

In the red cup for your group, you will find plain, peanut, and almond M&Ms. We are going to pretend that each of these is an isotope of “M&Mium”. Follow the directions below to calculate the atomic mass of the “M&Mium”.

a) Separate the almond, peanut, and plain isotopes.

b) Determine the total mass of each isotope (mass of all of the almonds together, peanuts together, and plain together) (you can include the mass of the cup in each of the measurements). Fill in mass in chart.

c) Count the number of “atoms” of each type of isotope and record in chart.

d) Divide the total mass of each type of isotope by the number of “atoms” of that isotope to determine the average mass of each isotope.

e) Determine the percent of each isotope present in the sample by dividing the number of atoms of an isotope by the total number of M&Ms and multiplying by 100.

f) Express the percent abundance as relative abundance (decimal percent).

g) Calculate the average atomic mass of M&Mium by using the average mass and the relative abundance.

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| Isotope of M&Mium | Total mass of each isotope | # of atoms of each isotope | Average mass of each isotope | Percent of each isotope present | Relative abundance of each Isotope |
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**Part 2: Fractionation in Stable Isotopes**

Each group has been given an “ocean” of M&Ms (only containing peanut and plain). We are going to be simulating oxygen and hydrogen isotopic fractionation during the hydrologic cycle (although our numbers will be a little different). During this section you will be calculating the delta notation for the isotopic ratios. Our standard will be similar the SMOW (standard mean ocean water), therefore it will be the ocean ratio of peanut/plain. Remember how to calculate the delta notation: **R = (# atoms of the heavy isotope)/ (# of atoms of the light isotope)**

**δ = (Rsample – Rstandard) / Rstandard ] \*1000**

**Procedure:** (remember preferences of the heavy vs light isotopes).

-Count the number of M&M atoms of each kind in the ocean. This is your standard ratio.

-Evaporation from the ocean: Grab two handfuls of M&Ms from the ocean and place into the vapor/cloud bowl. Count the number of both types of M&Ms and record. Calculate the delta “peanut M&M” of the “cloud/evaporation”.

-First Rain from the cloud: Grab one handful of M&Ms and place into first rain bowl. Count the number of both types of M&Ms and record. Calculate the delta “peanut M&M” of the “first rain”.

-Remaining Vapor: Count the number of both types of M&Ms leftover in the vapor/cloud and record. Calculate the delta “peanut M&M” of the “remaining cloud/evaporation”.

-Second Rain from the cloud: Grab one handful of M&Ms and place into second rain bowl. Count the number of both types of M&Ms and record. Calculate the delta “peanut M&M” of the “second rain”.

- Remaining Vapor: Count the number of both types of M&Ms leftover in the vapor/cloud and record. Calculate the delta “peanut M&M” of the “remaining cloud/evaporation”.

A)

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| --- | --- | --- | --- | --- |
| Part of Hydro Cycle | # of Peanut M&Ms | # of Plain M&Ms | R = (Peanut/Plain) | Delta Peanut M&M |
| Ocean |  |  |  |  |
| Cloud/Evap from ocean |  |  |  |  |
| First Rain |  |  |  |  |
| Remaining Vapor after 1st rain |  |  |  |  |
| Second Rain |  |  |  |  |
| Remaining Vapor after 2nd rain |  |  |  |  |

B) How does the “delta peanut M&Ms” change throughout the hydrologic cycle?

C) Is the final vapor more enriched or more depleted compared to the standard?