# Cosmic Chemistry: Planetary Diversity

# Stochastic Processes: Out of Chaos

## STUDENT REPORTING/DATA SHEETS 1-2

### STUDENT REPORTING DATA SHEET

### PART 1

Names: _____

_____

Predicted vs. observed outcomes of random chance events

Marble Color Key — Data Table 1

| Marble Color Designation | Actual Marble Color |
|---|---|
| Color #1 | |
| Color #2 | |
| Color #3 | |

1. If you were to draw a single marble from the mixture, what is the probability that it will be a marble of color #1?
   a) The favored outcome is drawing a marble of color #1. How many marbles of this color are in the mixture? → ☐
   b) The possible outcomes include drawing a marble of any color. How many marbles, regardless of color, are in the mixture? → ☐
   c) What is the probability of drawing a marble of color #1 on a given draw? Show your work and present the result as fraction(numerator/denominator) and as a decimal fraction.

| Work: |
|---|
| Results: |

2. If you withdrew 30 marbles from the mixture at random, how many of the marbles are expected (predicted) to be color #1 marbles? Show your work and present the result as a fraction (numerator/denominator) and as a decimal fraction.

| Work: |
| --- |
| Results: |

3. What is the probability of drawing a marble of color #2 on a given draw? Show your work and present the result as a fraction (numerator/denominator) and as a decimal fraction.

| Work: |
| --- |
| Results: |

4. If you withdrew 15 marbles from the mixture at random, how many of the marbles are expected (predicted) to be color #2 marbles? Show your work and present the result as a fraction (numerator/denominator) and as a decimal fraction.

| Work: |
| --- |
| Results: |

5. What is the probability of drawing a marble of color #3 on a given draw? Show your work and present the result as a fraction (numerator/denominator) and as a decimal fraction.

| Work: |
| --- |
| Results: |

6. If you withdrew 60 marbles from the mixture at random, how many of the marbles are expected (predicted) to be color #3 marbles? Show your work and present the result as a fraction (numerator/denominator) and as a decimal fraction.

| Work: |
| --- |
| Results: |

Your Results

Data Table 2

| Trial # | Color of Marble | Trial # | Color of Marble | Trial # | Color of Marble |
| --- | --- | --- | --- | --- | --- |
| 1 | | 11 | | 21 | |
| 2 | | 12 | | 22 | |
| 3 | | 13 | | 23 | |
| 4 | | 14 | | 24 | |
| 5 | | 15 | | 25 | |
| 6 | | 16 | | 26 | |
| 7 | | 17 | | 27 | |
| 8 | | 18 | | 28 | |
| 9 | | 19 | | 29 | |
| 10 | | 20 | | 30 | |
| Color #1 Total | | Color #1 Total | | Color #1 Total | |
| Color #2 Total | | Color #2 Total | | Color #2 Total | |
| Color #3 Total | | Color #3 Total | | Color #3 Total | |

Observed Outcomes

Data Table 3

| | Trial # 1-10 | Trial # 11-20 | Trial # 21-30 | Total Trial #1-30 |
|---|---|---|---|---|
| **Your Data** | **# of Marbles** | | | |
| Color #1 | | | | |
| Color #2 | | | | |
| Color #3 | | | | |
| **Classmate #1** | **# of Marbles** | | | |
| Color #1 | | | | |
| Color #2 | | | | |
| Color #3 | | | | |
| **Classmate #2** | **# of Marbles** | | | |
| Color #1 | | | | |
| Color #2 | | | | |
| Color #3 | | | | |

Proportional Outcomes

Data Table 4

| Data Source | Proportion of Color #1 | Proportion of Color #2 | Proportion of Color #3 |
|---|---|---|---|
| **Your Data** | | | |
| Trial #1-10 | | | |
| Trial #11-20 | | | |
| Trial #21-30 | | | |
| **Total** Trial #1-30 | | | |
| **Classmate #1** | | | |
| **Total** Trial #1-30 | | | |
| **Classmate #2** | | | |
| **Total** Trial #1-30 | | | |
| **All Data Total** Trial #1-90 | | | |

**7.** Answer the following questions using the values presented in DATA TABLE #4.

a) Describe how the ratios of the three colors of marbles that you observed were different from those you calculated using Total of All Data (last line, DATA TABLE #4) observations.

b) Describe which of these value sets is the more reliable estimate of the actual ratio of marbles. Include a reason why you reached this conclusion.

**c)** Based on the mean of all observations, what is the probability that you randomly would withdraw a marble of color #1?

## STUDENT REPORTING DATA SHEET

## PART 2

Names: _____

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**Modeling one possible type of planetary formation process.**

[Measuring Cup = 1/3 cup]

Data Table 5

| Observation Number | Number of Color #1 Marbles | Number of Color #2 Marbles | Number of Color #3 Marbles | TOTAL Number of Marbles |
|---|---|---|---|---|
| #1 | | | | |
| #2 | | | | |
| #3 | | | | |
| #4 | | | | |
| #5 | | | | |
| SUM of All Observations | | | | |
| OBSERVED RATIO | | | | |

[Measuring Cup = 1/2 cup]

Data Table 6

| Observation Number | Number of Color #1 Marbles | Number of Color #2 Marbles | Number of Color #3 Marbles | TOTAL Number of Marbles |
|---|---|---|---|---|
| #1 | | | | |
| #2 | | | | |
| #3 | | | | |
| #4 | | | | |
| #5 | | | | |
| SUM of All Observations | | | | |
| OBSERVED RATIO | | | | |

[Measuring Cup = 1 cup]

Data Table 7

| Observation Number | Number of Color #1 Marbles | Number of Color #2 Marbles | Number of Color #3 Marbles | TOTAL Number of Marbles |
|---|---|---|---|---|
| #1 | | | | |
| #2 | | | | |
| #3 | | | | |
| #4 | | | | |
| #5 | | | | |
| SUM of All Observations | | | | |
| OBSERVED RATIO | | | | |

1. Answer the following questions using the values in Data Tables #5, #6, and #7:
   a) Which of the three ratios of marbles most closely matches the predicted ratio of marbles?
   b) Using the sum of all observation values in Data Table #5, predict the expected ratio of marble colors if a 1-cup measuring cup was used [show your calculations].
   c) How does the predicted ratio you just calculated compare with the OBSERVED RATIO values in Data Table #7?
   d) Give possible reasons for the differences in the observations.
   e) Using the sum of all observation values in Data Table #6, predict the expected ratio of marble colors if a 1-cup measuring cup was used [show your calculations].
   f) How does this predicted ratio you just calculated compare with the OBSERVED RATIO values in Data Table #7?
   g) Give possible reasons for the differences in the observations.

2. Assume that:
   a) Each of the marble colors models a different chemical element
   b) Each chemical element has the atomic mass unit value of its marble color (such as 1, 2, or 3 for marble color #1, marble color #2, or marble color #3, respectively)
   c) The original mixture of marbles models the ratio of these elements in the remnants of the solar nebula
   d) Scooping the marbles using differently sized-measuring cups models the formation of planets of different sizes

3. Using this model, answer the following questions:
   a) Describe how the elemental composition of three planets differ.
   b) Explain the source of variability that led to the difference in elemental composition among the planets in this case.
   c) What factors, other than the differences between predicted and observed outcomes of random chance events, could account for the differences in the elemental composition of the three planets?