**Handout 4.2 – Rutherford gold foil experiment simulation**

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**Object**

To determine the size of an object indirectly, without making direct measurements. This is a simulation of the classic experiment done by Rutherford.

**Procedure**

1. Make a 60-centimeter line with masking tape across the lab bench. Measure the exact length of the tape. Make another mark with tape about 1 meter away, along the bench top. This mark will be the spot where you will role marbles.
2. Put 6 marbles along the line at 10-centimeter intervals.
3. Without looking at the line of marbles, Partner A will roll a single marble toward them from 1 meter away. Partner B will record whenever there is a hit on the line of marbles. Partner C will catch the rolling marble and if it hits one of the marbles on the masking tape, Partner C will replace it. Partner C will return the single marble to Partner A. Partner A will roll the marble 100 times (100 trials) and then partners will switch so that each person in the group has a turn. Enter each person's results in **Group Results**.
4. Record the **total number** of hits and trials and record this in **Group Results**.
5. Measure the diameter of one of the marbles. This is the direct measurement for comparison with the indirect method. Return all marbles and clean up the lab bench. Marble
6. Return to the classroom and record your group's totals and all the other groups' totals in the **Class Data**.

**Data for Indirect Measurement**

**Group Results** Your group #: \_\_\_\_\_\_

|  |  |  |  |
| --- | --- | --- | --- |
| Partner | Partner's name | Number of hits | Number of trials |
| A |  |  |  |
| B |  |  |  |
| C |  |  |  |
|  |  |  |  |
| Group total | |  |  |

**Class Results**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Group | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Total |
| Number of hits |  |  |  |  |  |  |  |  |  |  |  |
| Number of trials |  |  |  |  |  |  |  |  |  |  |  |

Measured marble diameter:

**Questions**

1) The estimation for indirectly determining the marble diameter is:

Diameter = field width x # of hits

2 x number of target marble x # of trials

a) Estimate the marble diameter using your group results:

b) Estimate the marble diameter using your class results:

2) Determine the percent error of your indirect estimate compared with the measured marble

diameter for your group results and your class results.

% Error= Indirect estimate - Measured diameter x 100%

Measured diameter

3) If you changed the variables below, how would the number of hits change? Why?

a) If the marbles were smaller?

b) If the marbles were further apart?

c) If the number of trials were increased?

d) If the marble you were rolling was further away from the line of marble at the start?

4) Explain what each part of the model represents:

a) The marble that was rolled.

b) The marbles on the 60-centimeter line.

c) The 60-centimeter line.

5) Name four items which our simulation does not include compared with the original experiment.

6) What did Rutherford expect when he first did the gold foil experiment? Explain.

7) How did the actual results of the gold foil experiment surprise Rutherford? How did he

explain these unexpected results?

8) Name two scientists who worked with Rutherford on the gold foil experiment.

9) Bonus: How is the formula derived? Explain why it works.

**Sources of Error**

Describe three errors and explain how it would affect the number of hits and the indirect estimation of the marble's diameter.

**Conclusion**

What are the three most important things you learned about Rutherford's gold foil experiment?