Name _____ Date _____ Class _____

Escape the Attraction

If gravity pulls objects towards Earth, how can we send spacecraft to faraway places in the universe? You will conduct an experiment to understand the requirements needed to get outside the Earth's orbit (or another object's orbit).

A. Activity Prep (Day 1: 10 minutes)

1. Pass one end of the string through the metal spring of the clothespin and tie a double knot so the clothespin is hanging from the end of the string.
2. Clip the "beanbag" onto the clothespin (make sure the "beanbag" is supported and does not fall easily).
3. Make sure your group has a stopwatch (use the stopwatch on one student's smartphone or the one provided by the teacher).
4. Each group should have a worksheet or science notebook to record observations and results and, if available, a digital device to record each of the trials of the experiment.

B. Data Collection (Day 1: 35 minutes)

1. To ensure consistency, for each test, use the measuring tape to measure the length of the string from the clothespin to where it is being held.
2. Have one of your group members stand away from the rest of the group so they can swing the "beanbag" without hitting anyone.
3. Conduct the first test by having the group member with the string start slowly swinging the "beanbag" in a circle (but still fast enough that the "beanbag" is off the ground). They should swing the "beanbag" for 10 seconds. Have another group member keep track of the time with the stopwatch while the rest of the group counts how many times the "beanbag" travels around the student during those 10 seconds.
4. Make sure to record your observations (the number of times the "beanbag" goes around in the 10 seconds).
5. Repeat this procedure for the rest of the tests, having the student with the string speed up the rotations slightly each time until the "beanbag" comes off the clothespin.
6. After your group completes the tests, exchange roles so different members swing the "beanbag."

Observations:

Student Name	Length of the String	First Test # of Rotations	Second Test # of Rotations	Third Test # of Rotations	Fourth Test # of Rotations

C. Data Analysis (Day 2: 25 minutes)

1. Calculate the escape velocity of each of the tests:

   Circumference = Diameter x Pi = (2 x length of your string) x 3.14

   $\frac{\text{\# of Rotations}}{\text{Time}}$ x Circumference = **Escape Velocity**

Student Name	# of Rotations at Final Speed (When the "beanbag" was released)	Time (seconds)	Circumference (feet)	Escape Velocity (feet/second)

2. Answer the following questions (use complete sentences).

Explain what happened to the space object ("beanbag") as the rotation speed changed.

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Explain what you think would happen if you repeated the experiment and increased the weight of the "beanbag." *Hint: Think about how the components of the escape velocity equation would change with a heavier "beanbag."*

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When a spacecraft or a space object gets far away from Earth, does the magnitude of Earth's "pull" on the object change? Are other forces acting on the object too? *Hint: Think about the components of the solar system and how they relate to each other.*

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