The Gummy Bear Project PROJECT WORKSHEET

Read this group worksheet and the grading rubric before starting your experiment!!!!
Note: Please delete any parts of this worksheet that are in color once you have completed the section.

Group Name: _____ Members: _____

The purpose of this experiment is to provide you the opportunity to practice the principles of experimental design and statistical inference. Project:

1. design a **well-controlled** experiment to test a factor that will affect how far gummy bears will "fly" from a catapult
2. carry out statistical inference procedures
3. prepare a typed statistical report of findings

- **Materials given**: tongue depressors, rubber band, pencil used as fulcrum, masking tape, a flat surface, gummy bears (25 for each treatment & 2 for trial runs), and tape measure.
  - *markers & pencils are provided by the group
  - *No other materials may be used without prior approval by Ms. Groves
- Plan for Your Launch Day
  - **Submit completed worksheet for approval by Ms. Groves the class period prior to your launch date.**
  - Once this worksheet is approved you can launch the following class.
  - You must complete your to launch in 1 class period.
    - It will take you most of the period to do this correctly.
    - You must turn in your bears used in the experiment at the end of period.

Response variable (and explain how it will be measured) is **(fill in)** and units of measure will be **(fill in)** .

Factor tested will be the angle of catapult.

(Delete) this table after you define the factor and treatments. Factors to consider for your experiment:
• In 2015+, angle of catapult is the only factor allowed. Choose angles - 0, 30, 45, 60, or 75 degrees. • For teams of 2 choose 2 angles. • For teams of 3 choose 3 angles.
• Position of catapult on the launch ramp
• Number of rubber band windings
• Position of gummy bear on the catapult
• Position of fulcrum in the catapult

Describe the ***Treatments*** **(how many and what they are)**

•

Describe the ***Experimental Units***.

• The experimental units are **(fill in)** and each treatment will have 30 experimental units.

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I. EXPERIMENTATAL DESIGN

Describe your experimental design you will use? *A well-designed experiment must incorporate 3 design components - Control, Replication, and Randomization.*

Explain importance of each components and how you will incorporate them into this experiment:

1. **Randomization**:
   - Explain in your words why randomization is important
   - Explain how will you set up your random sample? Describe the process you will use to randomly assign your treatments.

2. **Control**:
   - Explain in your words why control is important
   - Refer to Appendix 1 "Experimental Controls" for a detailed list of controls for this experiment.

3. **Replication**:
   - Explain in your words why replication is important and how it will be applied in this experiment

II. INFERENCE ANALYSIS

To analyze the results of this experiment, we will conduct 2 inference analyses. *We will calculate a confidence interval and perform a hypothesis test. To ensure that our analyses are statistically reliable, we have outlined them below and explained the necessary conditions needed to calculate the statistics.*

A. Hypothesis Test

- Name the Hypothesis Test:
- Name the Test Statistic:
- Define population parameters:
  μ_1=
  μ_2=
  μ_3=…. **(if applicable, for teams of 3)**

- Define hypothesis (null and alternative in both symbols and words):
  (For teams of 3, define 3 TOH's - μ_1 vs.μ_2, μ_1 vs. μ_3, μ_2 vs. μ_3)
  H_o:
  H_a:

- Define your significance level:

- Check Conditions(if applicable): **Remember to check conditions for all treatment groups**
  - Random
  - Independent
  - Normal

B. Confidence Interval to Support your Hypothesis (For teams of 3, create CI's that match your TOH)

- Name the Confidence Interval:
- Name the Test Statistic:
- Define the Confidence Level :
- Check Conditions (if applicable and/or state the condition was check in TOH):
  - Random
  - Independent
  - Normal

III. YOUR PREDICTIONS

What could possibly go wrong?

1) …
2) …
3) …

What do you expect to happen?

- …

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Appendix 1: Experimental Controls

TIP: Make sure to do enough test launches while you are designing your experiment to ensure you have a well-designed controlled experiment. Modify these control suggestions for your experiment.

A. **Controls for the Catapult Design**:
- Gummy Bear placement (location, bear horizontal or vertical)
- Catapult (tongue depressors) placement on the board
- Fulcrum(pencil) location
- Rubber bands (number and placement)
- Treatment controls to secure EACH angle of launch pad *(i.e., compass placement, what will you use to change the catapult for the angle, how will you switch when and how to change the angle elevation, etc)* will be:
  - Angle (fill in) will be set up…
  - Angle (fill in) will be set up…
- Other Design Controls

B. **Controls for Consistent Launching and Assigning Treatments**:
- How will you control that each launch is consistent?
  - Shooter
  - Measurer
  - Board placement and how you will secure it so it does not move
  - Other controls for consistent launching
- How will you control for consistent measurement of how far Gummy Bear goes?
  - Starting measurement location
  - Ending measurement location (i.e. initial landing position or final landing position)
  - How will you mark the starting and ending locations?
  - How will you set up your tape measure?
  - Units of measurement
  - Other controls for consistent measurements

C. **Environment**: How will you control your environment from extraneous factors (i.e. bears hitting walls, students walking on bears, etc.)?
- **(fill in)**…

D. **Subjects**: How will you control that your subjects (Gummy Bears) are safe and assigned to the correct treatment?
- **(fill in)**…

E. Other Controls

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Appendix 2a: The Launch and Collecting Data

1) Have your **Raw Data Table** ready to collect the data
2) Do a few test launches to check you have a well-controlled experimental design
3) Make sure Ms. Groves observes the first few trials of your launch (or you will have to relaunch)

Raw Data Table: In a well-organized table including treatments, assigned random number for each experimental unit, response variable and note any outliers. Use the template below.
See sample: http://www.brunswick.k12.me.us/pgroves/files/2013/05/Gummy-Bear-Sample-Raw-Data-Table.jpg

Title (table with 2 treatments)

	TREATMENT 1 (DESCRIBE)		TREATMENT 2 (DESCRIBE)	
TRIAL #	SUBJECT #	DISTANCE (UNITS)	SUBJECT #	DISTANCE (UNITS)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

***Note any outliers:**

Appendix 2b: The Launch and Collecting Data

Title (table with 3 treatments)

TREATMENT 1: (fill in)
TREATMENT 1: (fill in)
TREATMENT 1: (fill in)

	TREATMENT 1		TREATMENT 2		TREATMENT 3	
TRIAL #	SUBJECT #	DISTANCE (UNITS)	SUBJECT #	DISTANCE (UNITS)	SUBJECT #	DISTANCE (UNITS)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

*Note any outliers:

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Appendix 3:

What must be include in the Final Report (all parts must be typed)

See my website for samples

I. Introduction
- Written in paragraph form (**about 2 paragraphs**) –
  - explain the purpose of the experiment (and describe the experimental units, factors, treatments)
  - explain the 3 key components of a well-designed experiment (and how you implemented them in your design)
  - identify all inference procedures you did in your analysis (the details will be in the Inference Analysis Section)

II. Raw data
- In a well-organized table including treatments, assigned random number for each experimental unit, response variable and note any outliers.

III. Summary Statistics
- In a well-organized table including mean, standard deviation, n, 5-number summary, IQR, and note any outliers.

IV. Graphs
- Box plot and histogram for each treatment.

V. Inference Analysis – Confidence Intervals
- Written in paragraph form (in English not symbols) summarize your confidence intervals. Include the name of your confidence interval, conditions checked to calculate the interval, confidence level, and confidence interval. Interpret your confidence interval in context. You do NOT need any formulas in your write up.

VI. Inference Analysis – Test of Hypothesis
- Written in paragraph form (in English not symbols) summarize your test of hypothesis. Include the name of test, explain your hypothesis, conditions checked to perform test, significance level(a), test statistic, p-value, reject/do not reject. Interpret test of hypothesis in context. You do NOT need any formulas in your write up.

VII. Conclusions
- Written in paragraph form summarize the results of your experiment to someone without a statistical background (**about 3 paragraphs**). Include the following
  - Clearly compare your treatments (Remember CUSS and BS).
  - Clearly explain hypothesis and whether the statistical analyses (Both TOH and CI) support it.

VIII. Reflections on Your Experiment
- Written in paragraph form with a **minimum of 5 sentences**–
  - What went wrong? No experiment is perfect!
  - What you would do differently if you were to do this experiment again.