Experimental Design Tests & Tips

This guide is intended to help first-time Experimental Design competitors succeed at the event. It contains a list of helpful tips, along with 5 sample prompts with 5 sample experiments each. I would encourage new competitors to look at the lists of materials and attempt to brainstorm multiple experiments and choose the simplest one, as this is often the most challenging part of the event for new competitors.

Tips

1. The most important part of this event is the rubric. Memorize it, and make sure you that you understand what each point is for.
2. On your write-up, make sure you address each point on the rubric. Underline or highlight key words that indicate where you're addressing each point so that the graders can easily see that your work aligns with the rubric.
3. Before you take the test, meet with your partners, and determine which sections of the write-up each person will be responsible for.
4. Do not spend a large amount of time brainstorming an experiment. You are not graded on the quality of your experiment, so don't worry about it being inventive.
5. While you're brainstorming an experiment, make sure that you have enough materials to accommodate 3 levels of Independent Variable and 1 Standard of Comparison. This is necessary to gain all points on the rubric.
6. Make sure your experiment has clear, measurable Independent and Dependent Variables.
7. Numeric values are always better than categorical values.
8. Spend no more than 5 minutes brainstorming an experiment at the beginning of the timeslot.
9. If your team brainstorms multiple experiments, choose the simplest experiment that allows you to test a measurable outcome.
10. Before you take the test at a competition for the first time, practice with your partners so you have an idea of who the best person is for each role.
11. When practicing with this guide, make sure to brainstorm experiments on your own before looking at the 5 sample experiments. There are numerous possibilities for each set of materials; "good" experiments are not limited to the 5 shown.
12. After your team practices and writes a sample write-up, ask somebody else to grade it according to the rubric. This is good practice for a competition, as the person grading your write-up may not be knowledgeable about the event.
13. Don't worry if you don't know much about a topic. Usually, the items you are given will point you towards a certain type of experiment. Don't try to think of an experiment that's excessively out-of-the-box: Do an experiment that's simple to understand and measure.
14. If two teams are tied based on points, the graders may break ties based on technical writing skills. It's important to practice good technical writing: Don't use words such as "thing," "bad," "good," etc, and avoid fluff.

Scenario 1: Absorption

Using the following materials, create an experiment and fill out the Student Report Form according to the Experimental Design checklist.

Materials:

- ½ cup of oil
- 4 different brands of paper towels, 1ft x 1ft square
- Paper
- Paper clips
- Rubber bands
- Scale
- Scissors
- String
- Teaspoon, Tablespoon measuring cups
- Timer
- Unlimited supply of water

Possible Sample Experiments

Statement of Problem	Hypothesis	Independent Variable	Dependent Variable
How does the size of a paper towel square affect the amount of water it is able to absorb?	If the size of the paper towel is increased, then it will be able to absorb more water.	Size of the paper towel square	Maximum amount of water absorbed
How does the amount of water affect the time it takes for a 2”x2” square of paper towel to absorb it?	If the amount of water is increased, the paper towel will be able to absorb it more quickly.	Amount of water used	Time taken for the paper towel square to absorb the water
How does the thickness of a 2”x2” square of paper towel affect the amount of water it is able to absorb?	If the paper towel square is thicker, it will be able to absorb more water.	Thickness of the paper towel square (use different brands)	Maximum amount of water absorbed
How does the viscosity of a mixture affect the time taken for a 2”x2” square of paper towel to absorb it?	If the mixture is more viscous, the paper towel square will absorb it more slowly.	Viscosity of the mixture (mix progressively more oil with the water)	Time taken for the paper towel square to absorb the water
How does the number of folds in a 2”x2” square of paper towel affect the amount of water it is able to absorb?	If the number of folds increases, the amount of water the paper towel can absorb will decrease.	Number of folds in the paper towel	Amount of water the paper towel can absorb

Scenario 2: Drag

Using the following materials, create an experiment and fill out the Student Report Form according to the Experimental Design checklist.

Materials:

- 4 sheets of notebook paper
- 4 sheets of cardstock
- 4 sheets of printer paper
- 4 sheets of construction paper
- 5 paper clips
- 1 plastic shopping bag
- 1 zip-loc bag
- Scissors
- 4' of string
- 1 pad of Post-It notes
- Glue
- Tape
- Scale
- Yard stick

Possible Sample Experiments

Statement of Problem	Hypothesis	Independent Variable	Dependent Variable
How does the thickness of a paper airplane affect how far it can fly?	If the thickness of a paper airplane is increased, the distance it can fly will decrease.	Thickness of a paper airplane	Distance the plane flies
How does the size of a piece of paper used to create a paper airplane affect how far it can fly?	If the size of a paper airplane is increased, the distance it can fly will increase.	Size of the paper used to create the paper airplane	Distance the plane flies
How does the weight of a paper airplane affect how far it can fly?	If the weight of a paper airplane is increased, the distance it can fly will decrease.	Weight of the paper airplane	Distance the plane flies
How does the weight of a paper airplane affect its flight time?	If the weight of a paper airplane is increased, the flight time of the airplane will decrease.	Weight of the paper airplane	Flight time
How does the surface area of a piece of paper dropped affect how long it takes to hit the ground?	If the surface area of a piece of paper increases, the time it takes to hit the ground will increase.	Surface area of a piece of paper	Time the paper takes to hit the ground after being dropped

Scenario 3: Elasticity

Using the following materials, create an experiment and fill out the Student Report Form according to the Experimental Design checklist.

Materials:

- 4 rubber bands of varying thickness
- 4 ponytail holders
- 1 toothpick
- 1 slinky
- Scissors
- 4 marbles of different weights
- An electronic balance scale
- 4 bar magnets
- 4, 10g weights with hooks

Possible Sample Experiments

Statement of Problem	Hypothesis	Independent Variable	Dependent Variable
How does the thickness of a rubber band affect the amount by which it is stretched when loaded with 10g of weight?	If the thickness increases, the amount by which the rubber band stretches will decrease.	Thickness of the rubber band	Distance by which the rubber band stretches
How does the amount of weight added to a rubber band affect the amount by which the rubber band will stretch?	If the amount of weight added to the rubber band increases, the distance by which the rubber band stretches will increase.	Amount of weight added to the rubber band	Distance by which the rubber band stretches
How does the weight of a rubber band affect the maximum amount by which it can stretch without breaking?	If the weight of the rubber band increases, the amount by which it can stretch without breaking will increase.	Weight of a rubber band (weigh each rubber band using the electronic scale)	Maximum amount the rubber band can stretch without breaking.
How does the thickness of a rubber band affect the amount by which the rubber band will bend when held at constant tension, impacted by a marble rolling at constant speed?	If the thickness of the rubber band increases, the amount by which it bends will increase.	Thickness of the rubber band	Amount by which the rubber band bends when held at constant tension

Scenario 4: Buoyancy

Using the following materials, create an experiment and fill out the Student Report Form according to the Experimental Design checklist.

Materials:

- 20 pennies
- 20 nickels
- 20 dimes
- 20 quarters
- 1, 4”x4” square of tinfoil
- 1, 4”x4” square of printer paper
- 1, 4”x4” square of tissue paper
- 1, 4”x4” square of cardstock
- 1, 4”x4” square of construction paper
- 1 large clear plastic storage bin
- A supply of water
- 1 hairdryer
- Scissors
- 1 sharpie
- Scale

Possible Sample Experiments

Statement of Problem	**Hypothesis**	**Independent Variable**	**Dependent Variable**
How does the surface area of the bottom of a boat affect the number of pennies it can hold without sinking?	If the surface area of the bottom of the boat increases, it will be able to hold more pennies without sinking.	Surface area of the bottom of the boat	Number of pennies the boat can hold without sinking
How does the amount of weight added to a boat affect the percent of the boat’s volume that becomes submerged?	If more weight is added to the boat, then the percentage of the boat’s volume that is submerged will increase.	Amount of weight added to the boat	Percentage of the boat’s volume that becomes submerged
How does the surface area of the bottom of a boat affect the percentage of the boat’s volume that will be submerged when 20 pennies are added to the boat?	If the surface area of the bottom of the boat is increased, the percentage volume submerged will decrease	Surface area of the bottom of the boat	Percentage of the boat’s volume that becomes submerged
How does the weight of a boat affect the number of coins it can hold before sinking?	If the weight of the boat is increased, it will be able to hold more coins without sinking	Weight of the boat	Number of coins the boat can hold without sinking

Scenario 5: Dispersion

Using the following materials, create an experiment and fill out the Student Report Form according to the Experimental Design checklist.

Materials:

- Red food coloring
- Blue food coloring
- Yellow food coloring
- Green food coloring
- Unlimited water
- 4 tablespoons of cooking oil
- 4, 5-cup containers of water
- Timer
- 4 sheets of paper towel

Possible Sample Experiments

Statement of Problem	Hypothesis	Independent Variable	Dependent Variable
How does the amount of water affect the rate at which a drop of red food coloring will fully disperse into the water?	If the amount of water increases, the time taken to disperse will increase.	Amount of water used	Time taken for the food coloring to disperse
How does the amount of food coloring used affect the amount of time it will take to disperse in 1 cup of water?	If the amount of food coloring increases, the time taken to disperse will increase.	Amount of food coloring	Time taken for the food coloring to disperse
How does the viscosity of a solution affect the amount of time 1 drop of food coloring will take to disperse in 1 cup of water?	If the viscosity increases, the amount of time it will take a drop of food coloring will increase.	Viscosity of the solution (vary by adding different amounts of oil to water)	Time taken for the food coloring to disperse
How does the color of the food coloring affect the amount of time a drop will take to disperse in 1 cup of water?	As the color of the food coloring varies, the amount of time a drop will take to disperse in 1 cup of water will be unaffected.	Color of the food coloring	Time taken for the food coloring to disperse
How does the presence of paper towels in water affect the amount of time 1 drop of food coloring will take to fully disperse?	As more paper towels are added, the amount of time 1 drop of food coloring will take to fully disperse will increase.	Number of paper towels added	Time taken for the food coloring to disperse