

2011 ESO Coaches Manual

Barge Building

In Barge Building, students will be given various materials to build a barge that floats and can carry the most "cargo."

The flotation of the barge will be supplied by a standard sandwich sized zip-lock bag. No other size or type of bag will be used in the competition. A straw will be provided to inflate the plastic bag. To inflate the bag, insert the straw and seal up the zip-lock as tight against the straw as possible. Blow into the straw and inflate to the desired amount and quickly withdraw the straw and finish sealing the bag. For sanitary reasons, have only one student blow on the straw. One variable in this event is how fully inflated is the bag. A fully inflated bag provides more floatation, but is less stable for cargo, especially if the cargo can roll like marbles. Have the kids experiment with various types of cargo. Start with things that will not easily roll like pennies, wood blocks or dice. Then try items that roll in a single direction like pencils or K'nex pieces. For a challenge try marbles.

Making sure the zip-lock is completely sealed is very important!

The next component of the barge is the stiffener. The type of stiffeners that could be used are straws, popsicle sticks, or pipe cleaners. (Only one of these will be provided at the competition. No other types of stiffeners will be used.) Stiffeners are used to provide shape to the barge and to help keep the cargo on board.

The next component of the barge is used to attach the stiffeners to the plastic bag. This can be various types of tapes, paper clips or string. (Again, only one type will be provided at the competition, and it will come from this list.)

Lastly, have the kids practice loading the barge with various types of cargo. The maximum loading of a sandwich bag is 500g-700g, so make sure you have sufficient cargo to insure sinking the barge. During the tournament there is a time limit of three minutes to complete the loading.

Rule Clarification:

Under "The Competition," item #4 should read:

"The Group must predict the number of pieces of cargo that the barge will hold. Any cargo that drops in the water without landing on the barge, bounces off the barge as it is being loaded, or causes the barge to sink will not count in the total cargo. Sinking occurs when water enters the barge, cargo falls off the barge into the water, or cargo gets wet."

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Metric Mastery

The purpose of Metric Mastery is to teach the students how to accurately make measurements and familiarize them with the metric system through basic estimation. Since the event will be done in stations, it is best to practice using stations for the different measures. With a station setup, there are time limits to complete their tasks, and they cannot go back to a station once it has passed.

Length:

Using rulers and/or tape measures, students will be asked to measure an object or interpolate between two marks. Students may also be asked to estimate a distance given a visual standard. Answers will be specified either in mm (millimeters), cm (centimeters), or m (meters). Students should know the abbreviations and relationship between the different units (i.e. $1000 \text{ mm} = 100 \text{ cm} = 1 \text{ m}$).

Possible Exercises:

- Use a small ruler to measure a much larger object (e.g., a ruler, commonly marked in both inches (12 inches) and cm (30 cm), to measure a 6 ft table in cm).
- Using a string and a ruler measure, measure a curved surface like the circumference of a circle by wrapping the string around the object and using the ruler to measure the length of string.
- Using a ruler with only marks in cm, interpolate the measure of an object to the nearest mm. (You will probably will have to make one with a stick and a marker. Doing this could be part of the test.)
- Using a 1 meter long rod (with no other divisions on it), measure the distance between two marks on the floor (a couple of meters apart) to the nearest cm.
- Let the students see a 1 meter long rod and without using it like a ruler estimate the length of the room.

Important concepts:

- Know what interval is between the smallest division of the ruler in metric units.
- Estimate between the smallest divisions of the ruler when possible.
- It is best not to assume the edges of a ruler are exact-on the scale of a ruler. Start measuring from one unit in and then subtract one unit from the total measurement.
- Need to measure along straight lines when moving a ruler along an object.
- Sometimes edges of an object are not well defined. Carefully measure where an object starts and ends.
- If string is used to measure, tension can change the length of the string.

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Metric Mastery (continued)

Mass/Weight:

While there is a real technical difference in the terms “mass” and “weight,” it is far too subtle to worry about explaining to this age group. For this event we will work exclusively in grams, a unit of mass and will avoid using the term weight. (In the English system, pounds is a unit of weight.)

You will need a common postal scale and an electronic bathroom scale for this part of the event. Postal scales that are accurate to 1g are available for about \$20 but are limited to objects less than 1 kg (about 2.2 pounds). Most new electronic bathroom scales have settings to indicate kg for larger objects. Use this setting and have kids find their mass in kg. Using a digital scale, determine the mass of an object, or estimate how much of a substance is needed to make a given mass. Answers will be specified either in g (grams) or kg (kilograms). Students should know the abbreviations and relationship between the different units (i.e. $1000\text{ g} = 1\text{ kg}$).

Possible Exercises:

- Determine the mass of liquid or fine powder where a container is needed to hold the substance to be massed.
- Given a lot of similar objects with different masses (for example, gravel), have the students weigh out (as near as possible) a specified amount like 200.0 g.
- Give the students a reference mass, like 100 g, set the reference aside and have them fill a cup with a substance (pennies, sand, water, rocks) so that the cup and substance are as close to the reference mass as possible.

Important Concepts:

- Check that the pan or platter of the scale is clean before turning it on.
- Check that the scale reads zero when nothing is on it. (Some scales automatically zero themselves, but this can cause problems if the pan is dirty to begin with.)
- Check the scale for maximum mass that it can measure, as well as what the smallest difference it can measure.
- If a container is used to mass a substance, the mass of the clean empty container must be determined and subtracted out of the final mass. The mass of the empty container is called the “tare weight.”

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Metric Mastery (continued)

Volume:

Students should be able to determine the volume of a liquid, fine powder, or the volume of an irregular solid. Plastic graduated cylinders are preferable as they have finer markings, but it is acceptable to use plastic measuring cups that have markings in ml. Answers will be specified either in ml (milliliters) or l (liters). Students should know the abbreviations and relationship between the different units (i.e. $1000\text{ ml} = 1\text{ l}$). Plastic graduated cylinders of 250 ml volume are available from science supply houses for \$10. You could also use a commonly available kitchen measuring cup with milliliter markings.

Possible Exercises:

- Given a container of liquid, measure the volume of liquid by pouring it into a graduated cylinder.
- Determine the volume of a heavy solid by dunking (or “immersing”) it in a graduated cylinder filled partially with water and measuring volume of the water before and after immersion.
- Determine the volume of a solid that floats in water.
- Determine the volume of a certain amount of coarse sand or small rocks. (If you feel your students are up to it, you can add a measured volume of water to the rocks and determine how much of the volume is rock and how much is empty air space.)
- While it will NOT be done for the tournament, for more advanced students you can combine mass and volume to find the density of an object.

Important Concepts:

- Know how much volume is given by the smallest division of the graduated cylinder or measuring cup.
- For narrow tubes, such as graduated cylinder below 100 ml, the water level is not a flat line across the tube. (The curvature of the line is called the “meniscus.”) Measure the level of the liquid by the lowest level of the “meniscus.”
- How to carefully pour a liquid into a cylinder without spilling or leaving any behind.
- The volume of a lot of small objects has to take into account that air gaps exist between the objects. (Demonstration: Fill cylinder with small rocks, then sand, then water.)
- Measuring cups with markings in both oz and ml are great for comparing English and metric measurements.

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Paper Rockets

The Paper Rocket event is a test to design a rocket which flies BOTH long and straight.

Students may use any type of design to build their rocket including the one shown in the rules, but they will only be given the materials listed in the rules. The tube of the rocket may begin by making a tube out of the 8.5" x 1" piece of paper or by wrapping the paper in a spiral around the pencil. It is important to close off the nose of the tube with tape so air blown through the tube launches the rocket. For sanitary reasons, have only one student blow on each tube.

Using additional paper, students can either make fins (as shown) or construct wings so the rocket flies more like a plane. Students may construct a rocket with any number of fins or wings. They need to experiment with the size of these to get the maximum distance and accuracy. It is certainly allowable for the rocket to have no wings or fins at all! You may want to have students try out such a rocket.

To get the rocket to fly straight it is important to have all the fins the same size and to be evenly distributed around the rocket tube. Most rockets have 3 or 4 fins. Why would 1 or 2 be too few and more than 4 too many?

There are several items that deal with launching the rocket that should be considered. Each component will have a varying degree of influence on the flight distance.

- **Launch angle:** If the rocket is parallel to the ground when it is launched, it will usually not go as far as one that is pointed at an upward angle. If the angle is too steep, it will go in an upward direction at the cost of lateral distance. Theoretically, a 45° angle should produce the farthest flight.
- **Elevation:** Given the same amount of thrust, a rocket launched from a higher altitude (i.e. from a taller student) will have a longer trajectory than one launched from a lower altitude because it has more distance to fall.
- **Thrust:** This is the amount of power that moves the rocket by blowing on the straw. A quick powerful burst of air will be far more effective than a slow steady blow. Athletes and musicians of wind instruments typically have greater lung capacity.
- **Mass:** A rocket with less mass (lighter weight) will always go farther if all other variables are the same.

Advanced concept: To achieve greater accuracy, bullets spin in flight. To get the rocket to spin or spiral, bend the tail end of each fin just a little and all in the same direction. While spinning will increase accuracy, it also increases drag, reducing the length of the flight, so it is a compromise between length and accuracy.

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Pondering Powders

Clark College policy states that students MUST wear closed toed shoes and long pants in all laboratories. Students not properly attired will NOT BE ALLOWED TO PARTICIPATE IN PONDERING POWDERS. They will be able to participate in all other events.

Materials: Reagents

- water - buy distilled water from any grocery store, usually \$1/gallon
- vinegar - use white vinegar from any grocery store, usually \$1/quart
- iodine - iodine/potassium iodine solution available from chemical/science supply places for about \$9/500ml. Tincture of iodine will work fine and is available from most pharmacies (usually with ointments for cuts) at \$3-\$4 for 2oz. (Notes: Will need a dropper for these solutions. Touch applicators that come with tincture of iodine solutions will not work well with this test.) Also, tincture of iodine bottles are labeled as TOXIC MATERIALS. These warnings are emphasized because tincture of iodine is 50% denatured alcohol. The concern is people see alcohol and think they can drink it to get a buzz. **DO NOT** buy Providone Iodine or colorless tincture of iodine.

Materials: "Unknowns"

- Vitamin C (ascorbic acid) has been substituted this year for plaster. (Samples of ascorbic acid will be supplied in the starter kit.) If you need more vitamin C, use the powder form available in health food aisles of most super stores, not tablets, as tablets have other binder compounds. Also reagent grade material supplied from chemical supply stores are ground to a fine powder eliminating the ability to see crystal structure.
- Gelatin - use Knox unflavored gelatin. Any Jell-O product contains lots of other materials that could interfere with various tests.
- Salt - use non-iodized salt.
- Sugar - use regular crystalline or granulated sugar, not powdered sugar which has cornstarch added to decrease clumping.
- White sand - some sands may contain impurities that give false positive tests. The sand should not react in any way with any test done for this event. Most will work fine, but you should test with iodine and vinegar before distributing it to students.
- Baking soda - do not use baking powder.
- Cornstarch - any brand will do.
- Flour - white flour only. Doesn't matter if it is bleached or not.

What Teams can/need to bring: (Coaches can distribute these at the beginning of the event.)

- One page (8.5" x11", one side only) chart of observations for each powder done prior to event may be brought for each Group. (See Sample Observation Chart.)
- One conductivity tester for each Group. (Parts and instructions supplied in starter kit.)
- One 5X magnifying glass or jeweler's lope for each Group.
- Safety goggles will be provided, but you may bring your own if you prefer.

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Pondering Powders (continued)

Visual Inspection:

- Helpful to have a magnifying glass or jeweler's lope with at least 5x magnification.
- Most powders are too fine to discern any crystal structure.
- Sugar and salt have the most regular cubic crystal structure.
- Ascorbic acid has various sized crystals, some large enough to see a distinct square planar structure.
- White sand is noticeably crystalline but comes in all sorts of shapes, sizes and colors.
- Gelatin is noticeably off white in color.

Water Solutions:

- Use small samples of powders. Large samples with just a little water will not dissolve enough to be noticeable.
- Start with just enough water to wet sample. This will help in identifying the reaction with gelatin.
- Now add enough water to completely cover the powder to a depth of about a centimeter and stir to indentify which powders dissolve.
- NOTE: Sometimes it takes a couple of minutes for samples to dissolve.
- White sand most notably sinks to the bottom and doesn't dissolve at all.
- Flour and cornstarch do not dissolve, but the particles are so small and light that they can remain suspended in solution. The solution for these powders will be noticeably opaque/cloudy. Powders that actually dissolve will have clear solutions.
- Some powders form ions in solution, in which case the solution conducts electricity. This is tested for using the conductivity meter (see below). Ascorbic acid, baking soda, and salt all yield conductive solutions. Gelatin and sugar solutions will not be conductive. (White sand, flour, and cornstarch, as they do not dissolve, also will not be conductive.)

Vinegar Test:

- The vinegar test is an acid base reaction with vinegar (a weak acid) reacting with carbonate (baking soda is sodium bicarbonate) to release carbon dioxide gas.
- Only need a couple of drops of vinegar for test.
- Vinegar should only react with baking soda producing very noticeable bubbling.

Iodine Test:

- The iodine test is a colorimetric test changing color depending on the powder.
- Only need one drop of iodine solution for test.
- Iodine solution is naturally an amber or brown solution.
- When starch is present, iodine will react and turn a dark blue to black. You will see this reaction in both flour and cornstarch.
- Ascorbic acid also reacts with iodine and will turn completely clear.

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Pondering Powders (continued)

Proper Laboratory Techniques:

When trying to identify powders, students need to take care not to cross contaminate samples which could lead to false identifications. Proper techniques include:

- Never put leftover sample back into the original sample container.
- When taking a sample of powder/liquid, use either a clean spatula/dropper or use the same spatula/dropper each time with the same powder/liquid.
- Label spatulas/droppers for each powder/liquid. Different color tape works well for this.
- Never use the same spatula/dropper to sample different powders/liquids.
- Spatulas/droppers used to transfer materials should either be placed back in the container they came from or on a clean paper towel.
- Never lay a spatula or dropper on a table (where it can pick up contaminants) and then reuse it.
- Use a separate spatula for stirring. Do not use the same spatulas/droppers for transferring materials as those used for stirring.
- Never mix chemicals that you are not instructed to mix.
- Use small amounts of sample or reagents (vinegar and iodine) as instructed.
- Dispose of all powders and solutions as instructed.

Sample Observation Chart for Pondering Powders

(Students may complete and bring to event, one per Group)

Powder	What does it look like?	What happens when water is added?	Conductive (Y/N)	What happens when vinegar is added?	What happens when iodine is added?	Other observations
baking soda						
corn starch						
flour						
gelatin						
salt						
sand						
sugar						
vitamin C						