Metric Mastery
Grandville Science Olympiad Invitational
February 2, 2013

This answer key will present the process you were expected to use to obtain each answer. It also begins with a few suggestions on competing well in this event.

Very Important Notes About Metric Mastery:

1. READ THE RULES. 50 times. Make sure you know the exact process of the event, and especially be sure you know how to take measurements to the resolution the rules require. Also, be sure to check www.soinc.org for official rules clarifications and FAQ's.
2. Very important part of the rules: In the measurement portion you MUST measure to the smallest graduation or markings on the instrument plus one estimated digit. For example, on a standard ruler with millimeter markings, you must report centimeter measurements with two decimal places. If the correct answer is 9.11 cm, then 9.1 cm would be incorrect. (9cm + .1 mm + .01 estimated mm) If the correct answer is 9.00 cm, then 9 cm would be incorrect. (9cm + .0 mm + .00 estimated mm) (**NOTE:** In this test, I did not penalize competitors for omitting an estimated digit on measurements made with devices with electronic readouts, such as an electronic balance or a stopwatch.)
3. Keep in mind that the rules are very finicky for the measurement portion - you must be within 3 of the estimated digit at Regionals to receive any points, which is quite precise. If the answer is 12.01 cm and you responded with 12.05, you would receive zero points. Precision is key to this event!
4. Make sure you practice every type of measurement possible: mass, volume, density, area, force, distance, time, and temperature.
5. Learn the formulas for calculating the area and volume of many shapes and figures, including parallelograms, trapezoids, triangles, circles, rectangular prisms, spheres, cones, and cylinders.
6. Learn all metric units of measurement for each property as well as the metric prefixes.
7. Come up with reference items in your mind you can imagine with which to compare the length, area, or volume of objects for the estimation part.
8. Learn the meaning behind terms such as precision, accuracy, and significant figures, and read about the history of some units of measure. It may not be directly related to the event performance, but extra knowledge is always great to have!

Station A

- Temperature of water on a hot plate in degrees Celcius
- Be familiar with the Celcius scale - it was hot but not boiling, so it should be between room temperature (~20 degrees) and boiling (100 degrees). That's a large range, so the only way to improve accuracy is by practice. Today the water was 55.0 degrees Celcius.
- This was measured with a thermometer which had 1-degree markings, so you needed to measure to a precision of .1 degrees Celcius.

Station B

- Wooden block volume in cm^3
- Volume of a rectangular prism = Length x Width x Height
- This was measured with a standard ruler, so for each measurement you should have measured to a precision of .01 cm

Station C

- Pendulum period in seconds
- A period is the time for a pendulum to swing back and forth one time. For a given pendulum, the period is always the same, no matter how high it is swinging.
- The best way to measure period is to record the time for multiple periods, and then divide the time by the number of periods that have passed. For example, (Time for 10 periods)/10=(Time for one period)
- The stopwatch has precision to hundredths of a second. You were not penalized for not estimating one extra digit on this station. Precision to .01 or .001 seconds was acceptable.

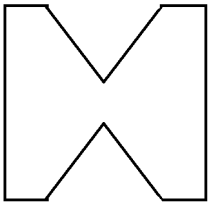
Station D

- Width of small letter cube in mm.
- This was measured with a caliper accurate to 1 mm, so for each measurement you should have measured to an accuracy of .01 mm
- If you have difficulty using a caliper, find a tutorial.

Station E

- Mass of Science Olympiad State Gold Medal in grams.
- If you want to touch one of these again, practice and work hard for the State Tournament in April! (They're really cool; I have a few.)
- The spring scale has a grams side and a newtons side. You should have used the grams side for this station.
- The spring scale for this station had an accuracy to 10 grams, so your answer should have been accurate to 1 gram.

Station F



- Area in cm^3
- How do you make an elephant sculpture? You take a block of marble, and chip off all the parts that don't look like an elephant.
- The easiest way to measure the area is to measure find the area o the entire large rectangle containing the triangles, and then subtrac the area of the triangles
- The formula for the area of a rectangle is Area = Base X Height.
- The formula for the area of a triangle is Area = ½ x Base X Height.
- This was measured with a standard ruler, so for each measurement you should have measured to an accuracy of .01 cm

Station G

- Mass of cup and sugar in kilograms (kg).
- Triple-beam balances are very annoying and difficult to use quickly. The best solution is to practice using them quickly.
- The Triple-beam measures grams. 1000 grams = 1 kg.
- Triple-beam balance had markings to .1 g, or .0001 kg, so your answer should have been precise to .00001 kg.

Station H

- Length of looped string in cm
- Carefully follow the curves of the string with the ruler.
- This was measured with a standard ruler, so for each measurement you should have measured to an accuracy of .01 cm.

Station I

- Volume of a marble in mL
- Fill the graduated cylinder to a certain level. Then insert the marble. Read the new measurement. The difference between the final and initial measurements is the volume of the marble. If the initial level was 10.0 mL, and the final level was 15.3 mL, then the volume of the marble would be 15.3 mL - 10.0 mL = 5.3 mL. This is known as displacement.
- The graduated cylinder was marked by 1 mL, so your answer should have been precise to .1 mL.

Station J

- Room temperature in Kelvin.
- Room temperature is around 20 degrees Celcius usually. Your estimation should be based on whether the room is a little chillier than normal or warmer than normal.
- Today the room was pretty chilly, at 16.0 degrees Celcius.
- In general, to convert to Kelvin from degrees Celcius, add 273.15 to the degrees Celcius measurement. In this case you are measuring to .1 degrees Celcius, so add 273.2.
- For example, if room temperature is 20.0 degrees Celcius, 20.0 + 273.2 = 293.2 K
- This was measured with a thermometer which had 1-degree markings, so you needed to measure to a precision of .1 Kelvin.

Station K

- Area of notecard in cm^2
- The formula for the area of a rectangle is Area = Base X Height.
- This was measured with a standard ruler, so for each measurement you should have measured to a precision of .01 cm

Station L

- Gravitational force on a hanging mass in newtons (N)
- Gravitational force or weight is the force Earth exerts on an object, as well as the force the object exerts on Earth.
- To calculate the weight of an object, multiple its mass in kg by *g*, the acceleration due to gravity on Earth. (g =9.81 m/s^2)
- To estimate the weight of an object, multiply your estimated mass of the object in kg by 10 m/s^2, a close approximation of *g*.
- The spring scale has a grams side and a newtons side. You should have used the newtons side for this station.
- The spring scale for this station had a precision to .2 newtons, so your answer should have been precise to .1 newtons.

Station M

- Density of a wooden block in g/cm^3
- The formula for density is Density = Mass/Volume
- Volume of a rectangular prism = Length x Width x Height
- A ruler and an electronic balance were used in this station. The electronic balance was the least precise instrument, only precise to .1 g. For this station a precision of .1 g/cm^3 was accepted.

Station N

- Area of notecard in square meters (m^2)
- The formula for the area of a rectangle is Area = Base X Height.
- The ruler was in cm. Conversion from cm to m is 100 cm = 1 m.
    - Conversion from cm^2 to m^2 is 10,000 cm^2 = 1 m^2
- This was measured with a standard ruler, so for each measurement you should have measured to a precision of .0001 m.

Station O

- Period of blinking eye gif in milliseconds (ms).
- 1 millisecond = .001 seconds. “milli-” means one thousandth.
- The best way to measure period is to record the time for multiple periods, and then divide the time by the number of periods that have passed. For example, (Time for 10 periods)/10=(Time for one period)
- The stopwatch has precision to 10 ms. You were not penalized for not estimating one extra digit on this station. Precision to 10 or 1 milliseconds was acceptable.

Station P

- Distance between two pieces of tape in meters.
- The tape measure was in cm. Conversion from cm to m is 100 cm = 1 m
- The tape measure was precise to .001 m, so for each measurement you should have measured to a precision of .0001 m.