



Tasmanian Science Talent Search 2008

(an initiative of the Science Teachers' Association of Tasmania)

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TSTS Newsletter June 2008: Technology Section

Many teachers will use the TSTS Technology section challenge as an opportunity for their students to work through the procedure of “Design, make and appraise”, with some of them going on to enter in the actual TSTS judging process.

Southern Region Judging Day: August 10 CSIROSEC 36 Church ST North Hobart 7000

Northern Region Judging Day: August 17 Science Building UTAS Newnham,

NW Judging: TBA, if required.

The following notes were presented at the TSTS Technology Workshop at CONSTAT (Conference of the Science Teachers assoc of Tas) earlier this year. They may help teachers get ideas to set their students off on this pursuit.

TSTS 2008 Topic: Design, make and evaluate a Thermometer to measure the temperature of water.

This activity presents a great opportunity to not just “do” the TSTS Tech Challenge, but to creatively investigate and develop an understanding of heat, expansion, “particle theory” and states of matter (solids, liquids, gases), density, floatation etc, as well as enhancing the importance of measurement and quantitative results in science.

A “Thermometer” measures temperature, which relates directly to the amount of heat present. To show a wide range of possible ways of approaching this topic, we briefly considered 4 different methods of doing this at the TSTS Technology Workshop at CONSTAT...some far more practical, others more challenging. I have listed a few URL's from the net, but if you “Google” it you will find countless more.

Background Science:

Method 1:

Increased heat leads to expansion due to increased Kinetic Energy of the molecules (particles) of the substance. The particles move faster, therefore further apart and the substance expands. This therefore decreases the density as the same MASS is distributed over a larger VOLUME. Some easy explanations of this for Primary classrooms can be found on the website www.climatechangematters.net.au and click on “Science Explained” on homepage banner. Follow “physics” logo, and then to heating etc

This expansion is seen most in gases as the strength of the inter-molecular forces is least :

eg.i) a balloon of air put in hot water expands in circumference. However this is difficult to “see”(unless it pops) and measure exactly, but this is an easy and good introductory activity relating to expansion

ii) Soda Straw thermometer <http://hop.concord.org/h1/mess/h1ma4.html>(Again shows expansion of gases)

iii) Particles in solids are held most closely together therefore show relatively less expansion on heating...though this can be seen in bi-metal strips, ball and ring apparatus, or simply removing tight metal screw caps from jars etc...

iv) Liquids though can expand considerably on heating and this property can be used to make a simple thermometer using a bottle, colored water, and a narrow piece of tubing(see refs below). This is straightforward and easy for Primary students. The further “science” then comes in calibrating it against known temperatures.

http://www.windows.ucar.edu/tour/link=teacher_resources/therm_edu.html

<http://www.weatherwizkids.com/thermometer.htm>

<http://www.energyquest.ca.gov/projects/thermometer.html>

<http://www.teachervision.fen.com/weather/lesson-plan/4131.html>

Note the level of the liquid at different water temperatures (calibrate against a “real” thermometer), eg. very cold (0 degrees ie. a mixture of water and ice), lukewarm (about 35) and very hot (approaching 100) and as many other temperatures in between as possible. Remember to stress replication for accuracy.

Encourage students to record their results accurately, perhaps graph temp v height of column, and to report on any structural changes to their “thermometer” and the benefits (or otherwise) of the changes. **Ie. What variables might make the thermometer more accurate? Volume of liquid, type of liquid, size of container, diameter of tube, ?? Let them work through these considering the background science with each new modification.**

Refer the students to the Judges Comments (2006, 2007) on the website to maximize their efforts!

Method 2: (fascinating, but not very practical?)

Thermochromic dyes, eg used in tapes around LPG bottles, fish tanks, “mood bracelets” etc. reversibly change colour at different temperatures.

Eg. Leuco dyes become colourless by a chemical reaction requiring heat

Liquid crystal films change colour with heat.

Students find this a very interesting study in relation to heat, but it is difficult to use this to make an accurate, wide temperature range “thermometer”. Samples of indicator thermochromic dye papers are available through Prof. Bunsen Science www.profbunsen.com.au

Method 3:

A thermistor is a device that changes its electrical property, resistance, when heat is added or removed. To observe this, connect each end of the thermistor to one terminal of a multimeter and record results at various known temperatures.:

<http://depts.washington.edu/rural/RURAL/resources/temperature.tml>

Method 4:

The operation of the Galilean Thermometer is based on the decreasing density of water with increasing temperature.

<http://www.madsci.org/posts/archives/1998-05/895288936.Eg.r.html>

For water above 4 deg C, but below boiling, water expands at the rate of about 0.2 cc per kg per deg C. An object that just barely floats at 25 deg. will sink at 35 deg C if it doesn't expand much (its temperature is increasing too so use a rigid object which won't expand much itself). Measure the displacement volume of some small glass bottles accurately, as well as using accurate scales to measure mass and thus determine their density. With reference to a table of water density versus temperature, you could weight the different bottles to get to the same average densities for different water temperatures. Excellent activity for secondary students to work with the density/ floatation concept but needs careful and dedicated work. A great challenge! For students who haven't seen a Galilean Thermometer, decorative ones for home use can be purchased at some gift shops, Harris Scarffe, Nat Geog shops etc. for \$30-\$50 depending on size. Encourage any students who have one at home to bring it along (but remind them that they are very delicate!)

Introduce these various methods (and their underlying scientific explanations) depending on the ages and skills of students and the equipment available, remembering that judging weighting is given to students who use “recycled” resources rather than simply use standard laboratory apparatus. However it might be easier to use lab equipment first to cover the concepts involved, then design one of their own.

Their “journal” is an integral part of the design/make/evaluate process and careful recording should be stressed by teachers so that all students can show evidence of improvement. This “improvement” is rewarding in itself, so this gives all students praise and encouragement, whether or not they chose to finally enter the TSTS judging or simply use the “journey” as a learning experience.

Again I remind you: the Judges Comments on the website are invaluable for teachers and students alike!

Remember: TSTS exists as an initiative of the Science Teachers association of Tasmania to benefit both teachers and students.

Please contact us (stsearch@bigpond.net.au) if you want assistance, clarification, ideas etc.

Regards,

Margaret Hosford

Director TSTS 2008.