

Novare Science Experiment Parts List

Text: *Physics: Modeling Nature*

Compiled by John D. Mays



This parts list was compiled to make more convenient the materials procurement for the experiments designed to accompany *Physics: Modeling Nature*, particularly for homeschoolers researching parts options. In the parts list, *Favorite Experiments* refers to my book *Favorite Experiments for Physics and Physical Science*. This book describes all the details about the five experiments used with *Physics: Modeling Nature*. The same descriptions are included in *Experiments for Physics Modeling Nature*. (The content about the five experiments in these two books is the same, but *Favorite Experiments* includes additional material on demonstrations, as well as experiments and demos for our 9th grade physics courses.) Both these books are available at Classical Academic Press. These books offer significantly more detail about equipment specifications and sourcing options. A number of the items of apparatus specified in *Favorite Experiments* are items from the Flinn Scientific catalog. Flinn sells only to institutions; they do not sell to private individuals. In the parts list below, I have specified alternatives accessible to homeschoolers.

In the following parts list, HST refers to HomeScienceTools.com. HST sells a kit containing many of the necessary items. (Note that HST is not affiliated with Novare Science or Classical Academic Press, and CAP receives no revenue from sales of HST kits.) The HST column in the parts list below indicates whether the item is included in the HST kit and notes are added where comments on the HST-supplied parts are warranted. For more information about the HST kits, visit homesciencetools.com.

Finally, as a science educator, seeking ways to make high school science experiments more accurate is one of my favorite hobbies. As they are described in *Favorite Experiments*, the experiments are designed to use equipment and apparatus that will give the highest possible accuracy and precision possible, while using a simple setup at a budget accessible to most schools. The fabrication requirements are also accessible to schools where there is a community of people available with the necessary tools and know-how. The purpose of this list is to provide advice and alternatives for those who need them. It makes little sense for a homeschool family to spend hundreds of dollars on a digital timing system that will only be used once or twice. A school will use the same system multiple times per year for many years and can justify the expense (and store the equipment appropriately). There are always different methods that can be used that make use of different items of equipment. However, making changes to the experimental procedure or the equipment will almost always reduce the accuracy of the results. For schools, I recommend doing the experiments exactly as described in *Favorite Experiments*. The alternatives included in the list below are for those who must work with a lower budget and need advice on reasonable compromises that can be made.

Here are a few heads-up comments on the specific experiments for *Physics: Modeling Nature* (see *Favorite Experiments* for details):

Experiment 1: Requires a 24-inch ramp made of metal bookshelf bracket by grinding off the end at a sharp angle.

Experiment 2: Requires a brass plate and brass block that must be obtained from a metal supply company (or in the HST kit). The brass block will need two holes drilled through it, regardless of where you source it from. Also, this experiment is mostly designed by the students, so additional parts and hardware may be needed based on the students' designs.

Experiment 3: Requires another metal bookshelf bracket, bent into an S-shape, and fastened to a support bracket. The support bracket is cut and fabricated from aluminum structural shapes. All these are readily available, as noted below, but do require some effort to assemble.

Experiment 4: Requires handy access to an oven and a freezer. It also requires making modifications to two specific heat specimens (copper cylinders) that involve removing the non-copper hook and drilling a hole in the side of one of specific heat specimens. This experiment also requires a means of measuring temperatures inside the oven and freezer—thermometers don't work well in the freezer because of the speed at which the temperature changes when you open the door. The modifications described in *Favorite Experiments* are based on using a digital multimeter with a thermocouple (so you can read the temperature with the freezer door closed). The experimental design requires use of two aneroid dry calorimeters.

Experiment 5: There are no fabrications or modifications for this experiment. Note, however, that this experiment needs to be performed in the middle of a large, empty, grassy field, away from the noise of traffic, construction, and lawn maintenance (not easy to find these days), away from large buildings, and on a day when the wind is calm.

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Common Household Items				
Item		Experiment		Notes
masking tape		1		
cleaning cloths		2		
WD-40		2		
duct tape		5		
Common Tools and Hardware—Available at hardware stores.				
Item	Quantity	Experiment		Notes
carpenter's level	1 for class	1, 3		A 24-inch level is optimum.
small clamp	1 per group	1		Any clamp that can attached to a ring stand will do.
nylon cord	48" length per group	1, 2		Commonly sold as brightly colored "mason twine" for about \$5/roll.
plumb bob	1 per group	1		Home Depot has an 8" brass plumb bob for under \$10.
structural aluminum pieces		3		See <i>Favorite Experiments</i> .
JB Weld epoxy		3, 4		See <i>Favorite Experiments</i> .
needle-nose pliers	1 for class	4		
Apparatus				
Item	Quantity	Experiment	Included in HST Kit?	Notes
steel ball, 1" diameter	1 per group	1, 3	yes	Also available separately from HST.
ring stand	1 per group	1	yes	Also available separately from HST.
shelving support rail, metal, 5/8" wide × 3/8" deep × 24" long	1 per group See notes.	1, 3	no	Search online for "bookcase shelf support rail." At CabinetParts.com, their item KV #255 Steel Pilaster Strip-Zinc 24" is under \$2. For experiment 1, modify by grinding or filing the ends of the rails as shown in <i>Favorite Experiments</i> . One additional piece of this material is needed for the apparatus used by the entire class in experiment 3.
stop watch	1 per group	1	yes	Also available separately from HST.
meter stick	1 per group	1	yes	Also available separately from HST.
target (photocopied)	1 per group	1	no	This is found in <i>Favorite Experiments</i> .
carbon paper	1 sheet for the class	1	yes	Available from online office supply stores.
brass plate, 10" × 4" × 5/16"	1 per group	2	yes	The item in the HST kit is 8" long, which should be adequate. See also <i>Favorite Experiments</i> . My source was industrialmetalsupply.com.
brass flat bar, 1" × 1" × 1.25"	1 per group	2	yes	The HST kit item does not have the required holes drilled. See also <i>Favorite Experiments</i> . My source was industrialmetalsupply.com.
waterproof polishing paper, 4 grades	1 set per group	2	yes	See <i>Favorite Experiments</i> . My source was abrasivesales.com.
weigh scale	1 for class	2, 4	no	The HST Digital Platform Scale, 300 g × 0.01 g costs about \$35 and is recommended for experiments in our other courses. HST has a triple-beam balance as an expensive option, but this is unnecessary.
drafter's triangle	1 for class	3	yes	The orange Alvin triangles are available at amazon.com for \$6.

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Apparatus				
Item	Quantity	Experiment	Included in HST Kit?	Notes
micrometer	1 for class	3	yes	Amazon.com has several models of digital caliper that will suffice for both the micrometer and the dial caliper listed next. Avoid the super cheap ones, but several are in the \$25–\$35 range that will suffice.
dial caliper	1 for class	3	yes	See above note.
digital timer	1 set for class	3		See <i>Favorite Experiments</i> . For classrooms, I recommend the items described in <i>Favorite Experiments</i> . But for homeschoolers and schools for whom funds are an issue, one can simply set up a smart phone to video record the steel sphere passing between two taped marks beside or behind the track, placed 10 cm apart. To avoid spacial distortion from the camera lens, position the phone some distance from the track (about 6 feet) and use the zoom set at max. With good lighting and clear tape markers, the video will give you the data you need. The standard video frame rate is 30 frames per second, giving a precision in the timing measurement of 1/30 second, or 0.033 s. Some phones allow setting the video frame rate to 60 fps, increasing the precision to 1/60 s, or 0.017 s. View the video with a video editing app to look at the time stamps as the steel sphere passes the two timing marks. Subtract these times to get the transit time of the steel sphere through the timing zone.
photogates and hardware	1 set for class	3	no	See notes above for previous item.
calorimeter	2 for class	4	yes	The aneroid dry calorimeters recommended in <i>Favorite Experiments</i> will give far more accurate results than the ones in the HST kit, and are thus recommended. A similar model is available at Fisher Scientific (fishersci.com) for about \$31. Homeschoolers can get by with only one of these by conducting the two parts of the experiment a few hours apart so the calorimeter has time to return to room temperature between trials.
copper specific heat cylinders	2 for class	4	sort of	The HST kit contains one set of specimens (one each of 5 different metals) instead of the two copper ones the experiment requires. Homeschoolers can get around this by using the copper one for both trials.
thermometer	3 for class	4	yes	The thermometers in the HST kit are inexpensive plastic ones. For better accuracy, I recommend their 12” lab thermometer instead for \$3.25 each. Homeschoolers using a single calorimeter only need one thermometer to place in the calorimeter. The multimeter listed below can be used for the temperature measurements in the freezer and oven.
fishing line	24”	4	no	Available from stores such as Wal-Mart and Academy.
digital multimeter with thermocouple for temperature measurement	1 for class	4	no	The meter referenced in <i>Favorite Experiments</i> is professional grade and expensive. The Triplet 1101-B meter (available from frys.com) costs about \$41 has a Type-K thermocouple probe that will do the job just fine. This thermocouple can be used to measure temperatures in both oven and freezer.

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Apparatus				
Item	Quantity	Experiment	Included in HST Kit?	Notes
oven	1 for class	4	no	I recommend a laboratory oven for classrooms. Homeschoolers can use an ordinary kitchen oven.
freezer	1 for class	4	no	
sound pressure level meter	1 for class	5	no	There are apps available for smart phones that can measure SPL and will work fine for this. I have tested the Decibel X app with an iPhone SE and it worked well. The Decibel X app also can apply the weighting curves described in <i>Favorite Experiments</i> .
piezo siren	1 for class	5	yes	The item from Radio Shack specified in <i>Favorite Experiments</i> has a new part number, 2730079. The HST kit includes a piezo buzzer instead of a siren, so it is not as loud. I prefer the louder siren because with a louder sound source ambient noises are quieter relative to the sound source and are thus less of a problem.
measuring tape, 20 meters	1 for class	5	no	Amazon.com has an AmazonBasics 30-meter Open Reel Fiberglass Tape Measure for under \$15. The 3-m tape in the HST kit is of no use.
lantern battery, 6 V	1 for class	5	yes	
copper tubing or conduit, 1/2" × 6 ft	1 for class	5	no	Any light-weight pole 5 or 6 feet long can be used for this, including a broom handle, a piece of electrical conduit, a section of 1/2" or 3/4" in copper tubing, a piece of 1 × 2 pine, etc. The short section of tubing in the HST kit is of no use.
alligator clip test leads, 36-inch	2 for class	5	yes	These need to be long enough to connect the piezo siren to the battery. If you want to try to tape the battery to the siren support pole right under the siren, then then leads can be shorter, 12" or so.
folding step stool	1 for class	5	no	A short ladder will also work.
disposable ear plugs	1 pair per person	5	no	These are available at drug stores in packages of various quantities.