Pre-build "*Cool It Down*"

1. **Objective.**
   Your objective is to build a device, hereafter referred to as the "cooler", capable of lowering the temperature of a test copper plate, protruding from the exterior of the device, from room temperature to as low as possible, in the course of a 1-minute operation window.

2. **Device.**
   The cooler must include the following features and satisfy the following constraints.

   A. *General construction*. The device should look something like this:

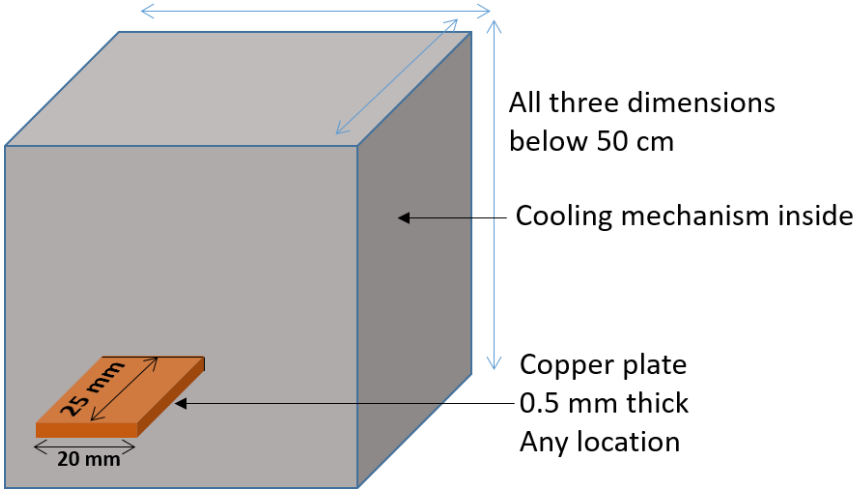

Figure 1. General construction of the pre-built cooler.

   B. *Size*. The device **does not have to be enclosed in a box** (shown above for illustration purposes only), but its size must not exceed 50 cm in height, width, or length, not including the protruding copper plate (described below). This size limitation must be maintained throughout the whole time of operation, i.e., all moving parts must be contained within this volume. If anything is ejected from the main body of the cooler during its operation (other than air!), the ejected parts must also be contained within the initial apparatus volume.

   C. *Weight*. There are no weight limitations, other than the team should be able to carry their device by themselves! Also, note that in the event of a tie, the lightest cooler wins.

   D. *Cold terminal*. Somewhere around the exterior, the device must have a "cold terminal" – a copper plate, sticking out and easily accessible by the judges. The plate must be 0.5 mm thick (24 gauge); slightly thinner (down to 0.25 mm) **BUT NOT THICKER than 0.51 mm** plates will be allowed. Terminal's size must be around 25 mm x 20 mm, with allowed variations of $\pm$ 5mm in each dimension. The plate must be a solid flat chunk of untreated copper (e.g., no alloys, no coatings, no internal channels or structures of any sort). It may extend into the

interior of your device for any length. Inside, it may change width, thickness, material composition, etc., and connect to other parts of your device. The above size and material limitations pertain only to the external 25x20 mm terminal part only.

As an option, two copper plates of suitable thickness are available on Amazon.ca for $17.49 – see link below.

2 Pcs 99.9%+ Pure Copper Sheet, 6" x 6", 24 Gauge(0.51mm) Thickness, No Scratches, Film Attached Copper Plates : Amazon.ca: Industrial & Scientific

E. *Activation mechanism*. The cooler must have a simple activation procedure, e.g., a switch, a valve or a mechanical lever, which team members should be able to trigger on judges' command. Activating the device may not be accomplished by inserting a foreign object into the interior of the cooler (e.g., pouring water into the device from the outside will not be allowed as an activation procedure). Once activated, no foreign objects or materials (other than air) should be entering or exiting the cooler.

F. *Internal components*.
   i. The device must not include any pre-cooled elements (i.e. no ice, cold water or frozen parts of any type). All internal parts will be inspected for being at room temperature.
   ii. The only allowed gas is air. Pre-compressed air is not allowed, but compressing air during the operation by means of eligible power sources is permitted.
   iii. The only allowed liquid is clean room-temperature water, provided by the judges. If needed, a few buckets with water will be available near the main stage to "arm" the device before its activation. The water may not flow out of the cooler during its operation.
   iv. The device must not include any commercially available cooling systems (e.g., a fish tank chiller). Purchasing a mechanical or electrical component, which is sold specifically as part of a cooling device may be allowed, but **must be approved** by judges. Email Dr. Valery Milner (vmilner@phas.ubc.ca) to check if a particular cooling element can be used.

G. *Energy sources.* The cooler may be powered by any number and combination of only the following sources of energy.
   a) Gravitational: hanging, falling or swinging weights are allowed as long as the constraints on the overall size are complied with.
   b) Elastic: any combination of elastic bands, springs and bent/twisted objects is allowed.
   c) Gyroscopic: powering the cooler by a spinning gyro is allowed as long as the gyro is spun by hand, prior to the activation of the device.
   d) Electrical: electrical sources (e.g. batteries) are **NOT permitted, unless you generate that electrical power inside your device** by means of non-electrical power sources, described in points a), b) or c) above.

   NOTE: Chemicals (e.g., volatile liquids) or chemical sources of energy (e.g. exothermic or endothermic reaction of any type) are **NOT** permitted.

3. **Test setup.**
The performance of your pre-built cooler will be tested by means of a setup schematically shown below.

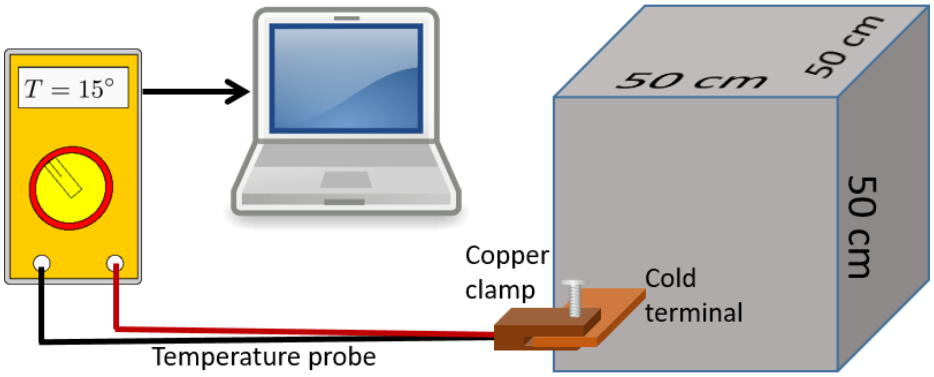

Figure 2. Illustration of the test setup.

A. *Thermometer.* We will clamp a temperature probe to the end of the cold terminal on your device. The probe will be connected to the digital thermometer, and the temperature readout will be recorded on a computer.

B. *Thermal contact.* Terminal's thickness of 0.5 mm will ensure the best thermal contact. Good contact with much thinner terminals is not guaranteed. **Terminals thicker than 0.51 mm (24 gauge) will not fit into the clamp**, so make sure you comply with the thickness requirement!

4. **Setting up and scoring procedure.**

A. Arming the cooler. Arming the cooler, e.g., by stretching a spring or adjusting an internal weight, should be done in front of the judge and take no longer than one minute. If your device uses water, you will have to fill it at this time from the provided buckets with clean room-temperature water.

B. *Starting the cooler.* When the team is ready, the judge will start recording the temperature and a few (~3-5) seconds later, will ask you to turn the cooler ON using a single switch or a single mechanical action on your device.

C. Recording the temperature. From the time your cooler has been turned ON, the judge will continue recording the temperature for exactly 1 minute.

D. Scoring the performance.
To assess the performance of your device, we will calculate **the difference between the initial (room) temperature of the cold terminal and the lowest recorded temperature during the 1-minute measurement window**. The larger the difference, i.e., the higher the temperature drop delivered by your device, the higher the score. Note, that the lowest temperature does not have to be registered at the end of the recording, but may appear in the recorded data at any moment inside the 1-minute measurement window.