## Experiment #3: Mechanical Properties

**Overview.** The hardness of a material is defined as its resistance to indentation. In this experiment, you will use two methods – the Rockwell test and the Vickers test – to determine hardness.

### Procedure 1: Rockwell hardness test

You will perform this initial testing on three materials: bronze, brass, and steel. For each sample, you will acquire three measurements of hardness (by repeating the steps described below).

**Bronze**



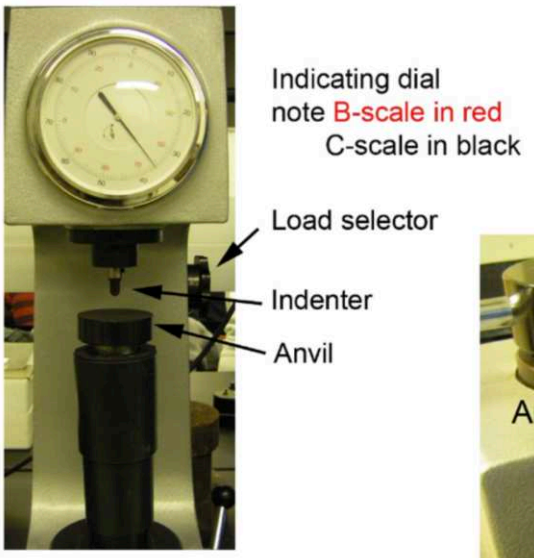
**Brass**



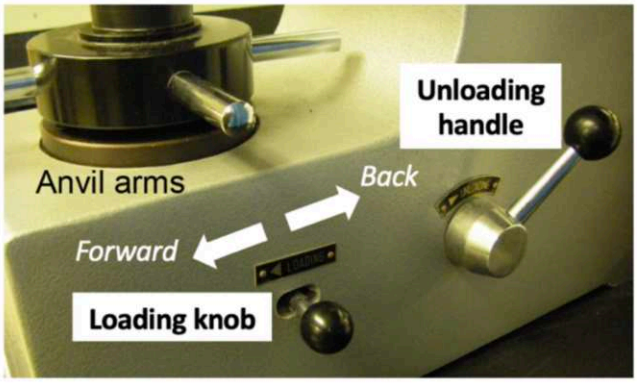
**Stainless Steel**



1. Set the unloading handle and loading knob to the back position.
2. Place the sample at the center of the stage.
3. Adjust the sample height by rotating the adjustment bars on the bottom until the sample touches the indenter tip.
4. While looking at the small indicator needle, continue adjusting the height until the needle rests on (or points to) the small red dot.
5. Rotate the silver-colored frame/scale surrounding the large indicator needle so that the needle points to the red "B."
6. Pull the loading knob forward. The unloading handle will automatically begin moving forward. After the indicator and unloading handle stop moving, wait 10 seconds.
7. Push the unloading handle back to the rear position. The large indicator needle will come to rest on the hardness value. The **red scale gives HRB** (Rockwell hardness on B scale).
8. Depending on the scale used (HRC or HRB, we'll use the latter), add or subtract the calibration value written on the instrument. Record the final result.
9. Lower the stage by rotating the adjustment bars to disengage the indenter tip, then reposition the sample and repeat the process (× 3 for each sample).




**How to use the Rockwell Tester**




**Procedure 2: Vickers hardness test**

In this case, you will measure the hardness of three types of brass:

- As-received (no annealing)
- Annealed at 400 °C for 12 hours
- Annealed at 800 °C for 12 hours

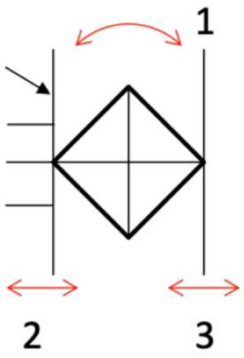
You will also use three different testing parameters on each sample:

- Load: 100 gf, Dwell time: 10 s
- Load: 100 gf, Dwell time: 20 s
- Load: 200 gf, Dwell time: 20 s

For each set of testing parameters and each sample, perform three separate measurements by following the steps described below. **(Note:** this means **27 measurements** in total)

1. Place the sample on the stage.
2. Bring the sample surface into focus using the microscope by rotating the knob to adjust the stage height.
3. Use the ***x*** and ***y*** micro-gauges on the stage to determine the loading position.
4. Set the load (gf) and dwell time (sec) on the screen.

5. Press Start. The tester will begin indentation. Wait until the indentation process is fully complete before moving to the next step.
6. After indentation, locate the indentation mark with the microscope and bring it into focus. Measure its size (both diagonals) using the microscope measurement tool.




   a. Adjust the rotation angle of the line indicators. Do this by rotating the eyepiece to align the line indicators parallel to the diagonals of the diamond indentation.
   b. Using the left knob, align the baseline with the far-left edge of the mark.
   c. Using the right knob, move the other baseline to the left edge of the mark until it perfectly overlaps with the first baseline.
   d. Once the two baselines completely overlap, use this as the reference point and press “Reset” for zero calibration.
   e. Using the right knob, move the measurement marker to the opposite edge.
   f. With the baselines aligned to the edges as illustrated, press “Read” to determine the diagonal length. The resulting measurement (D1) will show on the display.
   g. Rotate the eyepiece 90 degrees, then repeat the above process (steps a-f) to measure the other diagonal (D2).
   h. The HV value will be displayed on the screen. Record it.
   i. Find another clean surface and repeat the process.






**How to use the Vickers Tester**