The Memorandum Report

1. Name
Lab Time: (for example, Tuesday or Wednesday 2:00 PM)
Lab Group (1-4)
MSE 227 Lab # (2, 4, 6 & 7, 8, 9) – Title of report

2. **Abstract**
Similar to a summary, helps a busy reader decide whether to read the whole report. Since the abstract gives a thumbnail sketch of the report, an abstract of a memo-report should run no longer than half a page; frequently one paragraph describing the entire report (100 words or less) will suffice. Also the abstract should indicate the conclusions (results) of the work so that the reader will be able to evaluate the relevance of the work.

3. **Description of Work (Procedure)**
A brief description of the actual work performed to explain where and how the data in the report was obtained. Do not copy the manual word for word; you should remember what you did in lab.

4. **Results and Discussion**
May include answers to specific questions and outcome of lab in this section. If required, should include the data (preferably in a tabulated form) and graphs

Tables

- Every table should carry a description title at its top.
- A table should fit onto a single page, if possible.
- A table should be numbered and always referred to in the results and discussion section.
- A table should always show units in the column headings.

Figures

- Independent variables should be plotted on the horizontal axis (abscissa) while the vertical axis is only used for the dependent variables.
- The axes should be labeled with the proper units on each. Use a convenient scale on each axis in such a way that the plot will fill roughly half the page.
- A legend box should accompany each graph, especially if more than one plot is included in the figure.
- Each figure must be consecutively numbered and titled at the bottom.
- All labeling of graphs should be done neatly using textboxes in Excel.

Sample calculations
Include a sample calculation for each nontrivial type of calculation.

Additional info

1. **Typewritten, single spaced on 8 ½ x 11 paper.**
2. **Attach appropriate rubric to front of Memo report**.
3. Reference sources only if they are used

The following is an example of a memorandum report.

Hardness and tensile strength of a cartridge brass sample were measured as a function of percent cold work (0-60%CW). Both properties increased with the increased percentage of cold work. Recovery, recrystallization, and grain growth characteristics of a 50%CW brass was also investigated by measuring Rockwell Hardness (B Scale) of specimens annealed for 1/2 hour in the temperature range of 200- 700°C. A typical curve with the three distinct regions was obtained. The grain size was also determined for the three highest annealing temperatures and a dramatic increase in the average grain size with temperature was observed.

Procedure

The initial hardness and tensile strength of 70/30 cartridge brass were measured using the Rockwell hardness tester (B scale) and the Instron machine, respectively. The thickness of the samples was successively reduced by rolling up to 60%, while hardness and ultimate tensile strength (UTS) measurements were determined at the different stages of cold work. A 50% CW brass strip was then cut into eight pieces, each was annealed at 200, 250, 300, 350, 400, 500, 600, and 700 °C for 1/2 hr, followed by water quench. The hardness of each sample was finally measured using the Rockwell tester.

Samples for the metallographic observation were polished, etched and observed in a light optical microscope at magnification x 100. The ASTM grain size number, n was determined by comparing the microstructure with a standard ASTM grid, and consequently the average grain size was computed.

Results and Discussion

The data on hardness and tensile strength as a function of the degree of cold work are shown in Table 1. Figures 1 and 2 show the reduction in hardness in terms of inches and percentage of original thickness. The hardness has increased from about 15 to 78 on the Rockwell B scale as a result of 60% CW. The tensile strength has also varied in a similar trend with the increased amount of cold work. The scatter of the data is very small since both properties were taken as the average of several readings under the same test conditions. Furthermore, the data obtained was in rather good agreement with those published in the literature. Process annealing of the cold worked samples below 250 °C reduced the hardness very slightly.

An abrupt decrease in hardness was observed in the temperature range 250-500°C. Above 500°C the hardness continued to decrease at a very small rate until 700^{o}C has been reached. The three stages of the annealing process, namely recovery, recrystallization, and grain growth, have been established accordingly. This is shown clearly by plotting the data in Table 2. The hardness values at high temperatures exhibited greater scatter as is expected when approaching the lower limit of the B scale on the hardness tester. Minor scatter in the values is observed as a result of the statistical errors involved in such measurements. However, the results in general are in good agreement with the literature.

Table 1: Rockwell Hardness and Tensile Strength of Cartridge Brass at Different Percentages of Cold Work

% CW	R_B*	UTSx10^{-7} (N/m^2)
0	15	34
10	50	38
20	65	43
30	70	48
40	73	54
50	75	60
60	78	65

* Average of four hardness readings on Rockwell B scale.

Table 2: Hardness and Grain Size of 50% CW Cartridge Brass as a Function of Annealing Temperature.

Temperature °C	<R_B>*	Grain size (mm)
25	75	
200	73	
250	71	
300	52	
350	40	
400	25	0.010
500	17	0.041
600	18	0.060
700	10	0.154

* Average of four hardness readings.

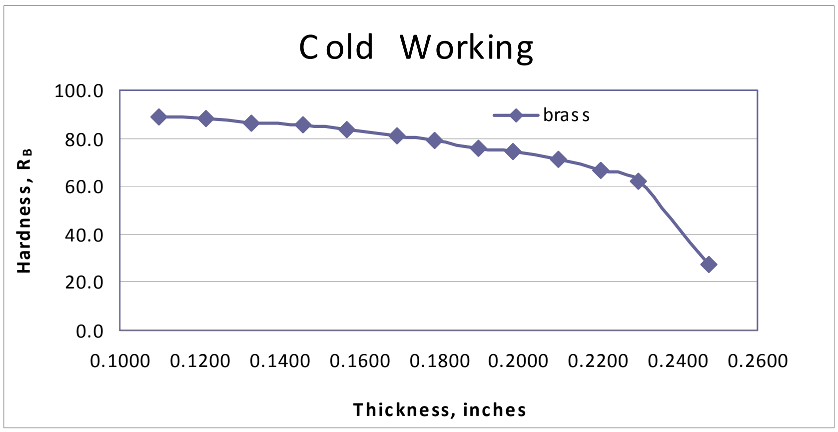

Figure 1: Cold Worked Brass showing reduction in thickness versus R_B hardness.

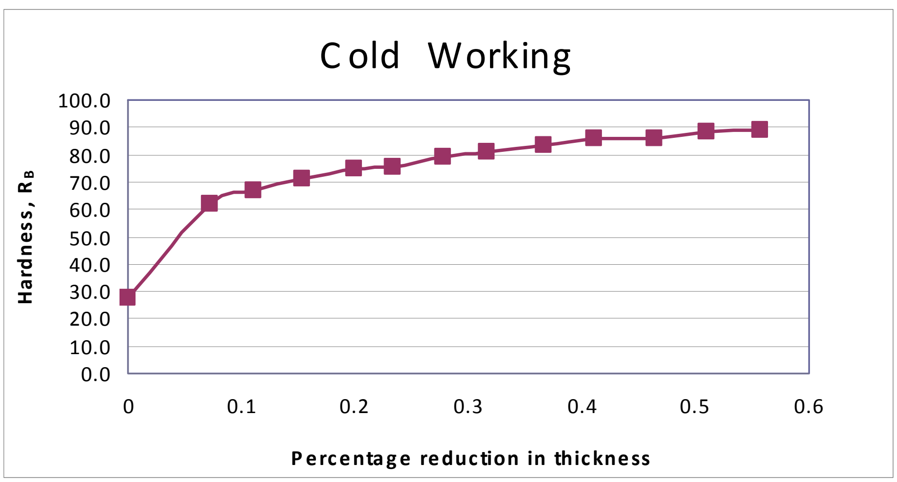

Figure 2: Cold worked brass percent reduction in thickness versus R_B hardness.

References
1. L. H. Van V lack, "Elements of Materials Science and Engineering," Addison Wesley, Inc., 1975.
2. R. A. and P. K. Trojan, "Engineering Materials and Their Applications," Houghton Mifflin Co., 1975.
3. A. G. Guy, "Introduction to Materials Science," McGraw Hill Book Co., 1972.
4. Metals Handbook, ASM, edited by T. Lyman, 1948.