

Required Homework Format

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Why Is There a Required Homework Format?

Effective written communication of calculations and problem solutions is one of the most important skills a novice engineer must master. The format described in this document allows engineers to effectively document the method of solution of typical “closed-ended problems” as well as allow other engineers to double-check the work for correctness. It also allows faculty and graders to be effective in locating technical errors and other types of mistakes and provide effective feedback to the student (developing engineer). The document also includes information concerning the standards to be applied to calculation, tables and graphs.

It is recognized that each company, industry or agency may have different required formats for recording engineering work. The fact that these variations exist does not make one format correct and the others incorrect but rather supports the idea that familiarity and adherence to a particular format facilitates the communication of engineering work.

Herein presented are those format elements that the Department of Chemical Engineering at Auburn University has adopted. These standards should be considered to be a requirement for homework submitted in all courses offered by the department.

A homework problem or assignment that does not adhere to the required format will have points deducted from the problem’s or assignment’s point value. At the instructor’s discretion, the amount of the deduction may be from 20% to 100% of the value (regardless of the correctness of the work submitted).

It is recognized that during examinations and quizzes, time considerations will not allow for all elements of the required format to be followed. Professors will indicate which format elements must be followed on their exams and quizzes. Appropriate deductions will be made for failure to adhere to these specified elements (regardless of the correctness of the work submitted).

Note: Technical reports, lab reports, design reports, etc. may have additional format requirements. These will be discussed by the instructor. Again, appropriate deductions will be made for failure to adhere to these specified elements (regardless of the correctness of the work submitted).

General Appearance and Identification Issues

- "Engineering paper" (National 42-182, 5 square or equivalent) is required unless the instructor has approved the use of “lined paper”.
- All paper must be of the same size, ruling and color.

- Do not write on the back side of the paper.
- Assignments must be stapled if they consist of more than one page. LOOSE PAPERS, PAPER CLIPS, DOG-EARS, ETC., ARE NOT ACCEPTABLE. If the assignment is thicker than staples can secure, employ appropriate binder-clips, etc.
- Pages may NOT be ripped out of notebooks (left edge of paper must be smooth).
- Papers should NOT be folded. Submit your work as flat 8½ x11” pages.
- Homework assignments must be turned in at the beginning of class.
- On the first page of the assignment, put the following identifying information on the upper left side of the page (shown on “Engineering paper”):
 - Name (First Last)
 - Course and Section
 - Assignment Information (list either the specific problems or the assignment number)
 - Date Due

Staple			Felder 2-5 (initials)	1/6
	Mary Doe CHEN2100 Sect 002 Felder 2-5,7,8 Due: 12/31/08		<i>“Note initials above (on all pages)”</i>	
	<i>“Begin working first problem of assignment here (underneath assignment identification information).”</i>	<i>“This identification information only goes on first page of the assignment. “</i>	<i>“On subsequent pages, do not provide this identification information.”</i>	

- Provide your initials on each page to the right on the problem number (in case papers get separated).
- Place the problem number (e.g., Felder 2-5) on each page of your solution as indicated in the example above.
- Start each problem on a new page unless several short problems can be displayed on a single page.
- Number all sheets consecutively in the format: “2/6” (e.g., page 2 of 6 total pages)
- In the case of large tables or figures, orient the table or figure such that the holes are located on top edge.

- The work presented to your professor is an engineering communication. Your goal should be to clearly show your analysis, results, conclusions, and recommendations.
- Your work must be legible and neat. Writing must be of sufficient darkness and size to be easily readable.
- Work may be done in pencil or pen.
- Strike outs and obvious erasures are not allowed.
- All straight lines must be drawn with a ruler, triangle or straight-edge. It is suggested a 6 inch clear plastic ruler be purchased for this purpose. This ruler is also an aid for reading tables and figures.
- A template of common drawing shapes (squares, circles, etc.) is also recommended.
- Circles and other curved shapes should be drawn with a template or other instrument (e.g., French curve, ship's curve, etc).
- Freehand curves and freehand straight lines are not acceptable.
- Final answers must be clearly identified by either underlining the result twice or "box the result" (as shown below).
- Final answers consist of "symbol", "value", and appropriate "units".

$T_1 = 102.3 \text{ K}$

Accuracy and Precision

In performing rigorous data analysis, formal rules should be employed to determine the correct number of significant figures to employ in expressing intermediate calculations and final answers. Those rules are beyond the scope of this document. These matters will be fully discussed in CHEN3820 and CHEN4860 Unit Operations Labs.

The following general guidelines should be used in performing "standard homework" calculations.

- Recognize that there is a difference between what your calculator shows on the display and what one writes down on homework or a report. Carry all significant figures during calculations to avoid round-off and truncation errors.
- Store intermediate calculations in your calculator's memory rather than reentering a lower precision value that was written down.
 - Suppose you have an 8 **inch** diameter pipe and need to convert this value to **feet**. The exact value would be $D = 8/12 = 0.6666666666666666...$ If you write down and then later employ in subsequent calculation $D = 0.66$ (or $D = 0.67$), the accuracy of those calculations is incorrect by 0.006 out of 0.6666666666666667 or almost 1%. Hence, no more than 2 significant digits of accuracy can be claimed although the original data value was exact.
- When you report intermediate calculations or values, avoid writing down excessive significant figures from your calculator. Generally 4-5 significant figures is appropriate.
- Data items such as physical constants, molecular weights, conversion factors, etc.) should be written down and entered in calculations using 4-5 significant figures.
- Final answers should reflect no greater than 0.1% accuracy (i.e., 3-4 significant figures).

3 Significant Figures	4 Significant Figures
345.	1.070
3.45	107.0
0.0345	0.0001070
3.45×10^{-5}	1.070×10^{13}

Units and Conversions

Many unnecessary mistakes occur when students fail to properly use units in calculations. This does not mean merely writing down the units but "using them" (i.e., canceling units to determine the final units).

The method used to convert and/or cancel units is called the "railroad track method" or "factor-label method." This format (including showing cancellation of units) must be used in all calculations.

- Start by drawing a horizontal line and add vertical lines to separate the various unit conversions.
- Place the "base number" including units at the beginning of the "railroad track."
- In each subsequent space, place an appropriate conversion factor and cancel units.
- Invert conversion factors as necessary.

Example: If dividing by 60 min/h it is entered as: $\frac{1 \text{ h}}{60 \text{ min}}$

- Put complex conversion factors (those with multiple levels in the numerator and/or denominator) into "single numerator-denominator" form.

Example: Suppose you look up the following conversion factor: $\left(\frac{1 \text{ lb}}{\text{ft}^3}\right) = \left(\frac{16.018 \text{ kg}}{\text{m}^3}\right)$

First, write the numerator and denominator separately (inverting the denominator):

$$\frac{1 \text{ lb}}{\text{ft}^3} \quad \left| \quad \frac{\text{m}^3}{16.018 \text{ kg}}\right.$$

Then combine these as a single factor in your unit conversion:

$$\frac{1 \text{ lb m}^3}{16.018 \text{ ft}^3 \text{ kg}}$$

Example 1:

Convert 9.8 miles → kilometers

$$\frac{9.8 \cancel{\text{mi}}}{1 \cancel{\text{mi}}} \quad \left| \quad \frac{5280 \cancel{\text{ft}}}{1 \cancel{\text{ft}}}\right. \quad \left| \quad \frac{12 \cancel{\text{in}}}{1 \cancel{\text{ft}}}\right. \quad \left| \quad \frac{2.54 \cancel{\text{cm}}}{1 \cancel{\text{in}}}\right. \quad \left| \quad \frac{1 \cancel{\text{m}}}{100 \cancel{\text{cm}}}\right. \quad \left| \quad \frac{1 \text{ km}}{1000 \cancel{\text{m}}} = 15.77 \text{ km}^*$$

* Note: The particular conversion factors employed made this much harder than necessary.

Example 2:

Convert 8.3 scf per minute of a gas containing 107.2 ppm (parts per million by volume) NO_x → grams NO_x per hour.

Note: MW_{NO_x} = 46.01 and scf = standard cubic foot

$$\frac{107.2 \cancel{\text{scf}}}{10^6 \cancel{\text{scf}}} \times \frac{8.3 \cancel{\text{scf}}}{1 \cancel{\text{min}}} \times \frac{60 \cancel{\text{min}}}{1 \text{ h}} \times \frac{46.01 \cancel{\text{lb}}}{\cancel{\text{lb-mole}}} \times \frac{453.6 \text{ g}}{1 \cancel{\text{lb}}} \times \frac{1 \cancel{\text{lb-mole}}}{379.48 \cancel{\text{scf}}} = 2.936 \text{ g NO}_x/\text{h}$$

Problem Solving Methodology

Using a rational standardized approach to solving problems allows one to obtain the solution with a minimum of effort. It also allows faculty and GTA's (and reviewers in industry) to easily follow your method of solution and to assess the correctness of your answers.

The particular methodology required by the department is called the “Given-Find-Solution-Answer” (GFSA) format. It is widely followed by many engineering departments as well as practicing engineers.

Note: Variations on this method are employed in different courses (for example, see “General Procedure for Single-Unit Process Material Balance Calculations,” Felder for CHEN2100) but the general principles presented here should be applied to all courses.

Given:	Restate significant information from problem statement. Do not repeat the entire problem statement verbatim. Include the given problem sketch (if provided) only if needed to clarify the problem statement
Find:	State unknowns that are to be determined and assign a symbolic representation for each. For example: <i>Find the outlet temperature, T_{out}</i>
Solution:	Draw an appropriate sketch showing the major features of the problem. Draw additional sketches to show details or other features of the problem as necessary. Use a nomenclature that is convenient and well accepted. State assumptions. List required physical properties and other related data (stating sources). Reference any tables and figures used to determine properties. Write governing equation(s). Simplify equations algebraically. Do not substitute values into equations until the equation is solved for the variable of interest. Substitute known values for symbolic variables into final equations. Solve for unknown quantities (complete calculations). Work problem in the unit system given. Do not needlessly convert from one system to another and then back to the original system. <i>Eng → SI → Eng</i> Underline major intermediate answers.
Answer:	After complete calculations, highlight answer in box or double underline. Include symbol, answer, and units in your answer. THINK and REFLECT!!

<p><i>What do your solutions indicate? Are your results reasonable?</i></p>

Graphs, Plots and Other Figures

The major format elements of a graph (figure) are shown in the example on the next page:

- Use the appropriate graph axes (e.g. arithmetic, semilog, log-log, etc.) to aid the reader in obtaining accurate data from the graph. Usually this will be obtained by selecting axes which "straighten out" curves as much as possible.
- When drawing graphs for homework, you may use graphing software (such as the built-in graphing capability of MS Excel™ other approved graphing programs) or provide hand drawn graphs. Hand drawn graphs should be drawn neatly using straight edge and curve guide instruments. Freehand curves are not allowed.
- Each graph or figure must be appropriately labeled. Provide the figure number and a *descriptive title* centered underneath the figure.

Appropriate: Figure 1 – Enthalpy-concentration diagram for $\text{H}_2\text{SO}_4\text{-H}_2\text{O}$

Inappropriate: Figure 1 – Enthalpy diagram. (*Not sufficiently descriptive*)

- Sources for figures or graphical information external to the assignment must be identified by an appropriate citation (*see References*)

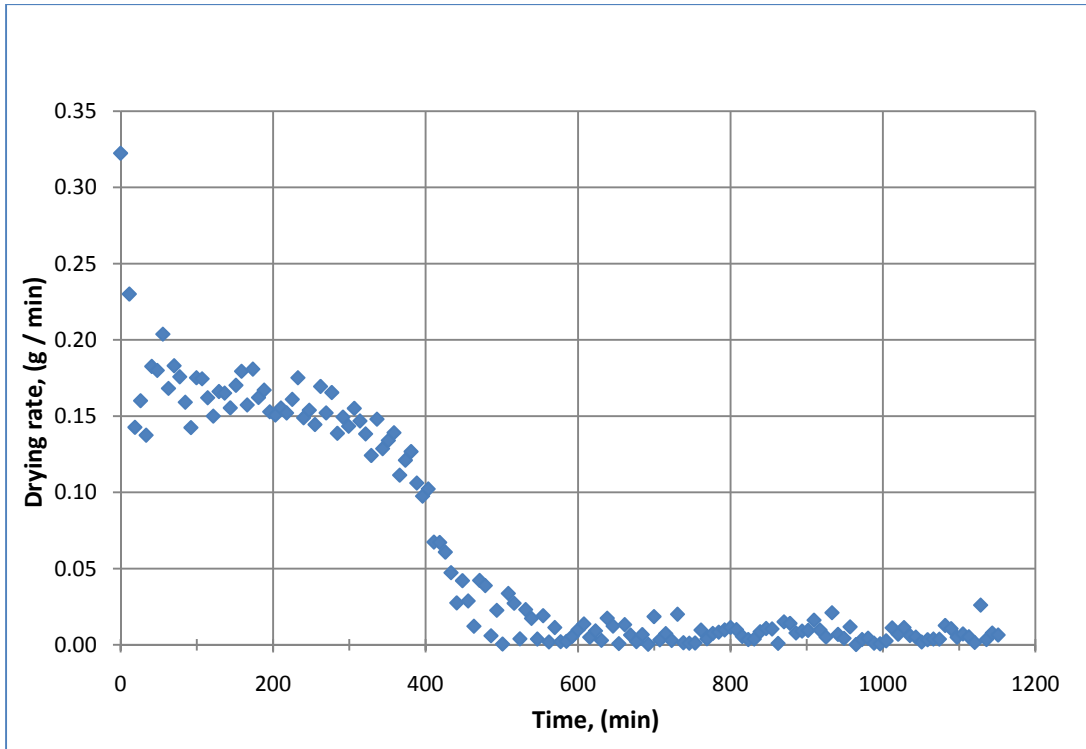


Figure 3 – Drying rate v time (experimental data from Group 3 Run 4)

- Measured data points are indicated by symbols (e.g., circles, triangles, squares).
- Do not connect the measured data points dot-to-dot with straight lines.
- Theoretical lines and regression lines are plotted as smooth curves or straight lines. Do not show the calculated points used to draw the curve.
- Completely label each graph axis, including the plotting variable name and its units.
- If a calculation is graphical in nature, the method of usage of graphs should be clearly indicated by an example with the appropriate lines sketched in and labeled for illustration.

Tables

The major format elements of a table are shown in the following example:

Table 1 – Data collected from manometer experiment.

T (°C)	Mercury Level	
	Right arm (mm)	Left arm (mm)
42.7	138	862
58.9	160	840

68.3	182	818
77.9	213	787
88.6	262	738
98.3	323	677

- Each table must have a number and a *descriptive* title. Center the table number and title above the body of the table.
 - Appropriate: Table 1 – Integral heats of solution and mixing at 25 °C.
 - Inappropriate: Table 1 – Results (*Not sufficiently descriptive*)
- The body of the table is usually delimited by horizontal lines above and below it. Sometimes these lines are bold or double.
- Tables never have vertical lines to delimit the left and right edges of the table.
- The body is divided into rows and columns. The columns always have headings, and the headings must include a verbal description of the quantity tabulated and its units. In some tables, the rows also have headings.
- Column and row headings are separated from the tabulated quantities by solid horizontal and vertical lines, respectively. *The vertical lines are often deleted if they make the table too busy and interfere with the reader's comprehension.*
- Generally, column headings and column data are centered in the column. When the data has a decimal point, values should be aligned on the decimal point.

References

- The source of all data and information used in your solution should be referenced, except for data contained in the problem statement.
- References must contain enough information so that the professor or your supervisor could easily look up your referenced data. For example, (Felder, Table B.1) or (Perry's Handbook, 7th Ed, p. 15-4) are sufficient if unambiguous.
- Web references should contain a complete URL and provide the date accessed, for example: <http://www.ultrasmartstudents.com/cornflakes.html> (January 13, 2008)