Jacksonville State University
College of Education and Professional Studies
Department of Technology and Engineering

Fundamentals for Students of Technology and Engineering

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Guidelines for Student Papers

Papers should be prepared using the rules provided in The Chicago Manual of Style, Fifteenth Edition, 2003. An excellent, inexpensive guide to the Style Manual is **A Manual for Writers of Term Papers, Theses, and Dissertations, sixth edition, 1996, by Kate L. Turabian** (referred to hereafter as Turabian). Turabian is available through the JSU Bookstore for those wishing to purchase a copy. Both the Style Manual and Turabian are also available in the Library.

The brief information in these guidelines is directly from Turabian, but you should obtain either Turabian or the Style Manual and become familiar with the many subjects not covered here. The page numbers listed in these guidelines all refer to Turabian. Do not use older editions of Turabian, information from other books, or handout directions from other courses as a substitute for rules from the Style Manual or Turabian.

You will find the following sections of Turabian particularly helpful:

> Chapter 1, Parts of the Paper is at pages 1 through 13.
>
> Chapter 5, Quotations is at pages 73 through 86.
>
> Chapter 6, Tables and Chapter 7, Figures are also helpful.
>
> Chapter 14, Formats and Sample Layouts is at pages 251 through 281 and contains many examples for your guidance.

Parts of a Paper:

- Front Matter (preliminaries)
  - Title Page
  - Table of Contents
  - List of Illustrations (if needed)
  - List of Tables (if needed)
  - Abstract
- Text
  - Introduction
  - Parts or Chapters
- Back Matter (references)
  - Appendix (if needed)
  - Bibliography or Reference List

Basic Guidelines to Problem Solving and Decision Making

Much of what managers, supervisors, and designers do is solve problems and make decisions. It is helpful to have an organized approach to problem solving and decision making. Not all problems can be solved and decisions made using the following approach. However, it will at least get you started. Don't be intimidated by the length of the list of guidelines. After you've practiced them a few times, they'll become second nature to you -- enough that you can deepen and enrich them to suit your own needs and nature.

We suggest a seven step approach to problem solving and decision making, as follows:

1. Define the problem
2. Look at potential causes for the problem
3. Identify alternatives for approaches to resolve the problem
4. Select an approach to resolve the problem
5. Implement the selected approach (this is your action plan)
6. Monitor implementation of the plan
7. Verify that the problem has been resolved

1. **Define the problem -** This is often where people struggle. They react to what they think the problem is. Instead, seek to understand more about why you think there's a problem.

Defining the problem: (with input from yourself and others)
Ask yourself and others, the following questions:
a. What can you *see* that causes you to think there's a problem?
b. Where is it happening?
c. How is it happening?
d. When is it happening?
e. With whom is it happening? (HINT: Don't jump to "Who is causing the problem?" When we're stressed, blaming is often one of our first reactions. To be effective, you need to address issues more than people.)
f. Why is it happening?
g. Write down a five-sentence description of the problem in terms of "The following should be happening, but isn't ..." or "The following is happening and should be: ..." As much as possible, be specific in your description, including what is happening, where, how, with whom and why.

Defining complex problems:
a. If the problem still seems overwhelming, break it down by repeating steps a-f until you have descriptions of several related problems.

Verifying your understanding of the problems:
a. It helps a great deal to verify your problem analysis by conferring with a peer or someone else.

Prioritize the problems:
a. If you discover that you are looking at several related problems, then prioritize which ones you should address first.
b. Note the difference between "important" and "urgent" problems. Often, what we consider to be important problems to consider are really just urgent problems. Important problems deserve more attention. For example, if you're continually answering "urgent" phone calls, then you've probably got a more "important" problem and that's to design a system that screens and prioritizes your phone calls.

Understand your role in the problem:
a. Your role in the problem can greatly influence how you perceive the role of others. For example, if you're very stressed out, it'll probably look like others are, too, or, you may resort too quickly to blaming and reprimanding others. Or, you are feeling very guilty about your role in the problem, you may ignore the accountabilities of others.

2. **Look at potential causes for the problem**

a. It's amazing how much you don't know about what you don't know. Therefore, in this phase, it's critical to get input from other people who notice the problem and who are effected by it.
b. It's often useful to collect input from other individuals one at a time (at least at first). Otherwise, people tend to be inhibited about offering their impressions of the real causes of problems.
c. Write down your opinions and what you've heard from others.
d. Regarding what you think might be performance problems associated with an employee, it's often useful to seek advice from a peer or your supervisor in order to verify your impression of the problem.
e.Write down a description of the cause of the problem and in terms of what is happening, where, when, how, with whom and why.

3. **Identify alternative approaches to resolve the problem**

a. At this point, it's useful to keep others involved (unless you're facing a personal and/or employee performance problem). Brainstorm for solutions to the problem. Very simply put, brainstorming is collecting as many ideas as possible, then screening them to find the best idea. It's critical when collecting the ideas to not pass any judgment on the ideas -- just write them down as you hear them.

4. **Select an approach to resolve the problem -** When selecting the best approach, consider:
a. Which approach is the most likely to solve the problem for the long term?
b. Which approach is the most realistic to accomplish for now? Do you have the resources? Are they affordable? Do you have enough time to implement the approach?
c. What is the extent of risk associated with each alternative?

5. **Implement the selected approach (this is your action plan)**

a. Carefully consider "What will the situation look like when the problem is solved?"
b. What steps should be taken to implement the selected approach to solving the problem? What systems or processes should be changed in your organization, for example, a new policy or procedure? Don't resort to solutions where someone is "just going to try harder".
c. How will you know if the steps are being followed or not? (these are your indicators of the success of your plan)
d. What resources will you need in terms of people, money and facilities?
e. How much time will you need to implement the solution? Write a schedule that includes the start and stop times, and when you expect to see certain indicators of success.
f. Who will be primarily responsible for ensuring implementation of the plan?
g. Write down the answers to the above questions and consider this as your action plan.
h. Communicate the plan to those who will be involved in implementing it and, at least, to your immediate supervisor.
(An important aspect of this step in the problem solving process is continually observation and feedback.)

6. **Monitor implementation of the plan**

Monitor the indicators of success:
a. Are you seeing what you would expect from the indicators?
b. Will the plan be done according to schedule?
c. If the plan is not being followed as expected, then consider: Was the plan realistic? Are there sufficient resources to accomplish the plan on schedule? Should more priority be placed on various aspects of the plan? Should the plan be changed?

7. **Verify that the problem has been resolved**

One of the best ways to verify if a problem has been solved or not is to resume normal operations in the organization. Still, you should consider:
a. What changes should be made to avoid this type of problem in the future? Consider changes to policies and procedures, training, etc.
b. Lastly, consider "What did you learn from this problem solving?" Consider new knowledge, understanding and/or skills.
c. Consider writing a brief memo that highlights the success of the problem solving effort, and what you learned as a result. Share it with your supervisor, peers and subordinates.

Revised from material written by Carter McNamara, MBA, PhD.
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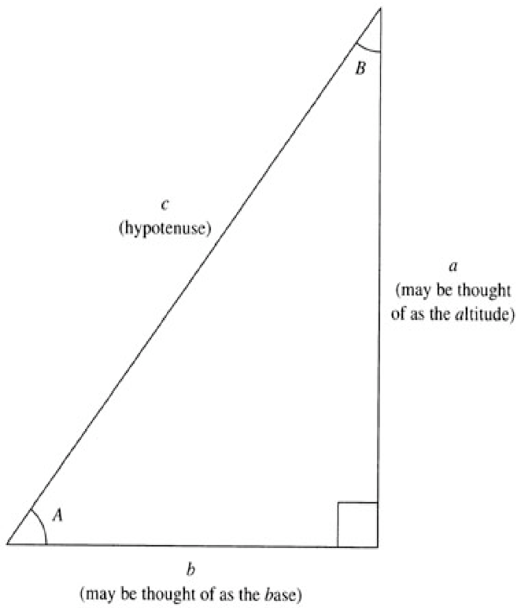
Helpful Relationships in Trigonometry



The trigonometric functions are defined for the right triangle.

Trigonometric functions for the right triangle (designated as shown) are:

$\sin A = \dfrac{a}{c}$ = sine of the angle A

$\cos A = \dfrac{b}{c}$ = cosine of the angle A

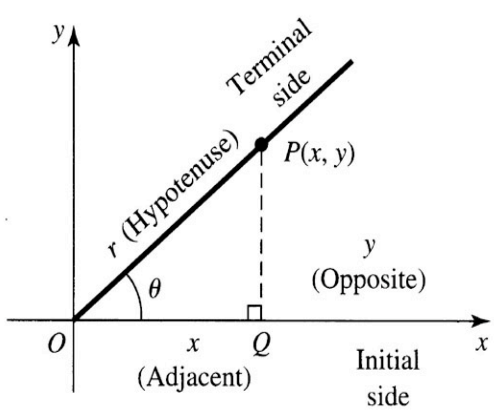
$\tan A = \dfrac{a}{b}$ = tangent of the angle A

For any right triangle, the relationship between the lengths of the sides (The Pythagorean Theorem) is:

$$a^2 + b^2 = c^2$$

For any right triangle, the relationship between the angles of the triangle is:

$$A^0 + B^0 = 90^0$$



We view the magnitude of a vector "r" as being the hypotenuse of a right triangle as shown in this figure. We can resolve it into its components on the "y" (same as side a of our standard right triangle) and "x" (same as side b of our standard right triangle) axes using:

$$x = r \times \cos\theta$$
$$y = r \times \sin\theta$$

Once we have "x" (side b) and "y" (side a), we can solve for the vector angle _ using the tangent formula. .

If we have more than one vector, we resolve each into its "x" and "y" components, add the respective components, and solve for the resultant vector magnitude and angle.

Measurement Systems and Conversion of Units

Nearly every number with which we deal in engineering and technology represents the quantity plus the units in which it was measured; i.e., inches, degrees Centigrade, millivolts, minutes, etc.. One of the fundamental tasks we face is converting from the units of measurement to the units in which we need the number for calculation, analysis, and interpretation. Sometimes this involves converting from one system of measurement to another; e.g., from US Customary (feet) to SI (centimeters). More often, we need to convert from one unit to another within a system: e.g., cubit feet to cubic yards (US Customary) or watts to kilowatts (SI).

Conversion is based on a single principle. Write down the units you have, write down the units you need, and look for ratios as multipliers. The ratios have values of 1 with the needed units in the numerator (or denominator) and the desired units in the denominator (or numerator). This is easier to illustrate than explain.

<u>Example 1</u> Convert feet per second to miles per hour. $\left(\frac{ft}{\sec} to \frac{mi}{hr}\right)$

$$\frac{ft}{\sec}\times\frac{60\sec}{\min}\times\frac{60\min}{hr}\times\frac{mi}{5280\,ft}=\frac{ft}{\sec}\times\frac{60\times60}{5280}=\frac{ft}{\sec}\times 0.68=\frac{mi}{hr}$$

In this example, we use three ratios to progressively convert seconds to minutes, minutes to hours, and feet to miles. The multiplier has the value of 0.68 and has the meaning that 1 ft/sec = 0.68 mi/hr. Thus, to convert, we multiply the given number of ft/sec to obtain the equivalent number of mi/hr.

<u>Example 2</u> Convert cubic feet to (cubic) yards as in quantities of concrete $\left(ft^3\ to\ yd^3\right)$.

$$ft^3\times\left(\frac{yd}{3\,ft}\right)^3 = ft^3\times\frac{1}{27} = ft^3\times 0.037 = yd^3$$

In this example, we cube the ratio to balance the units.

<u>Example 3</u> Convert the time standard minutes per piece to pieces per hour

$$\left(\frac{\min}{piece} to \frac{pieces}{hr}\right)$$

In this example, the units we have give time in the numerator and pieces in the denominator; the units we need have pieces in the numerator and time in the denominator. Thus, we need to invert the units we have by dividing into 1.

Measurement Systems and Conversion of Units (continued)

$$\frac{1}{\min/piece} \times \frac{60\min}{hr} = \frac{60\min/hr}{\min/piece} = \frac{60}{\min/piece} = \frac{pieces}{hr}$$

Le Systeme International d'Unites, known worldwide as SI, is a modernized metric system incorporating many advanced unit concepts. A useful Internet resource for the SI system is http://physics.nist.gov/cuu/Units/.

The SI system has seven base units of measurement; meter, kilogram, second, ampere, Kelvin, candela, and mole. The SI system has a series of approved prefixes and symbols for decimal multipliers of the base units, as shown in the following table.

SI System prefixes and symbols

10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deka	da
10^{0}	base unit	
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p

Examples:
3 TBits = 3 x 10^{12} Bits
6 cg = 6 x 10^{-2} g (g = grams)
5 µm = 5 x 10^{-6} m (m = meter)
7 mA = 7 x 10^{-3} A (A = Ampere)

SIGNIFICANT FIGURES

What are significant figures?

All measurements have some degree of uncertainty. How great the uncertainty is depends on both the accuracy of the measuring device and the skill of its operator. On a triple-beam platform balance for example, the mass of a sample substance can be measured to the nearest 0.1 g mass. Differences less than this cannot be detected on this balance. We might therefore indicate the mass of a dime measured on this balance as 2.2 ± 0.1 g; the ± 0.1 (read plus or minus 0.1) is a measure of the accuracy of the measurement. It is important to have some indication of how accurately any measurement is made. The ± notation is one way to accomplish this. However, it is common to drop the ± notation with the understanding that there is uncertainty of at least one unit in the last digit of the measured quantity; that is, measured quantities are reported in such a way that only the last digit is uncertain. All of the digits, including the uncertain one, are called significant digits or, more commonly, significant figures. The number 2.2 has two significant figures, while the number 2.2405 has five significant figures.

How can we determine how many significant numbers a measurement has?

The following rules apply to determining the number of significant figures in a measured quantity:

1. All nonzero digits are significant. Examples are 457 cm (three significant figures) and 0.25 g (two significant figures).

2. Zeros between nonzero digits are significant. Examples are 1005 kg (four significant figures) and 1.03 cm (three significant figures).

3. Zeros to the left of the first nonzero digits in a number are not significant; they merely indicate the position of the decimal point. Examples are 0.02 g (one significant figure) and 0.0026 cm (two significant figures).

4. When a number ends in zeros that are to the right of the decimal point, they are significant. Examples are 0.0200 g (three significant figures) and 3.0 cm (two significant figures).

5. When a number ends in zeros that are not to the right of a decimal point, the zeros are not necessarily significant. Examples are 130 cm (two or three significant figures); 10,300 g (three, four, or five significant figures). The way to remove this ambiguity is described below.

SIGNIFICANT FIGURES (continued)

Use of standard exponential notation avoids the potential ambiguity of whether the zeros at the end of a number are significant (rule 5). For example, a mass of 10,300 g can be written in exponential notation showing three, four, or five significant figures:

1.03×10^4 g	(three significant figures)
1.030×10^4 g	(four significant figures)
1.0300×10^4 g	(five significant figures)

In these numbers all the zeros to the right of the decimal point are significant (<u>rules 2 and 4</u>).

<u>How do we work with significant figures?</u>

In carrying measured quantities through calculations the rule used is that <u>the accuracy of the result is limited by the least accurate measurement.</u>

<u>Addition and Subtraction</u>

When adding or subtracting, the number of digits to the right of the decimal point in the answer is determined by the measurement that has the least number of digits to the right of the decimal point.

e.g. adding:

26.46 ← this has the least digits to the right of the decimal point (2)
<u>+ 4.123</u>
30.583 <u>rounds off to*</u> → 30.58 2 digits to the right
of the decimal point

e.g. subtracting:

26.46
<u>- 4.123</u>
22.337 <u>rounds off to</u> → 22.34

The above rule is based on the fact that the last digit retained in the sum or difference is determined by the first doubtful figure (which is underlined in the following example).

37.2<u>4</u>
+10.<u>3</u>
____
47.<u>54</u> <u>rounds off to</u> → 47.<u>5</u>

SIGNIFICANT FIGURES (continued)

We may report the first doubtful figure but no more.

Multiplication and Division

In multiplying or dividing, the number of significant figures in the answer--regardless of the position of the decimal point equals that of the quantity that has the smaller number of significant figures.

e.g. multiplying:

$$\begin{array}{l} 2.61 \\ \underline{\times 1.2} \quad \text{this has the smaller number of significant figures (2)} \\ 3.132 \quad \underline{\text{rounds off to}} \rightarrow 3.1 \quad \text{has 2 significant figures} \end{array}$$

e.g. dividing: $2.61 \div 1.2 = 2.175$ rounds off to → 2.2

*When rounding off do the following: When the number to be dropped is less than 5, it is just dropped (e.g., 6.34 rounds off to 6.3). When it is more than 5, the preceding number is increased by 1 (e.g., 5.27 rounds off to 5.3). When the number to be dropped is five, the preceding number is not changed when it (the preceding number) is even (i.e., 4.45 rounds off to 4.4). When the preceding number is odd, it is increased by 1 (i.e., 4.35 rounds off to 4.4). In fairness, we must note that the even-odd rules for rounding terminal 5's are sometimes ignored; instead, the preceding number is increased by 1 when a 5 is dropped.

Again this rule has been based on the fact that we may report only one doubtful figure. For example, if we underline each uncertain figure as well as each figure obtained from an uncertain figure the step-by-step multiplication gives

$$\begin{array}{r} 12.3\underline{4} \\ \underline{\times \quad 1.23} \leftarrow \text{this has the lowest number of significant figures (3)} \\ \underline{37}\ \underline{02} \\ 246\ \underline{8} \\ 123\underline{4} \\ \hline 15.\underline{1782} = 15.\underline{2} \leftarrow \text{The answer must have 3 significant figures} \end{array}$$

The primary source of the significant figures material is: THE STUDENT LEARNING ASSISTANCE CENTER (SLAC), Southwest Texas State University, 1999