Print Reading: Thread Design

Unit: Graphic Agility

Problem Area: Print Reading—Lines and Symbols

Lesson: Print Reading: Thread Design

Student Learning Objectives.

Instruction in this lesson should result in students achieving the following objectives:

1. **Use standard terminology to describe thread design.**
2. **Analyze standard thread series.**
3. **Draw threads and note specifications.**

Resources.

The following resources may be useful in teaching this lesson:

E-unit(s) corresponding to this lesson plan. CAERT, Inc. http://www.mycaert.com.

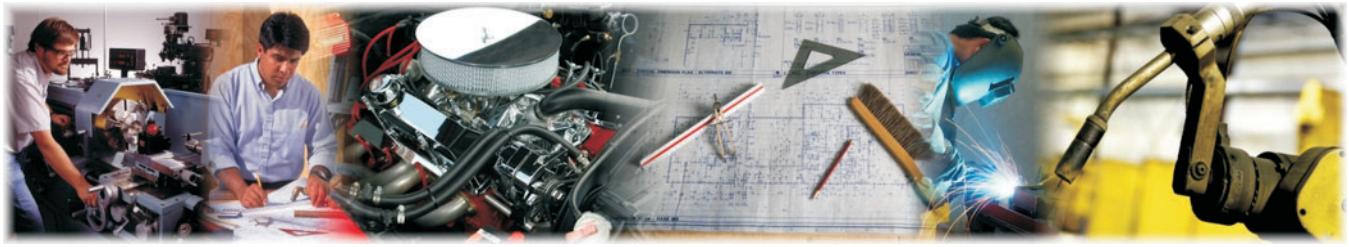
Bolt Science. Accessed Sept. 29, 2013. http://www.boltscience.com/pages/info.htm.

DU PONT®. "Mechanical Print Reading," Accessed Sept. 29, 2013. http://ecom.training.dupont.com/PTR099-INT-ENG(CoastalU)/IS(Basic%20Skills%20Training)/en-US/productdetails_us/Mechanical-Training.aspx, 2006.

"Manufacturing Print Reading," SouthBayMachine.com. Accessed Sept. 29, 2013. http://www.southbaymachine.com/MTT2.htm.

Oberg, Erik. *Machinery's Handbook*, 28th ed. Industrial, 2008.

"Screw Threads," *Efunda.* Accessed Sept. 29, 2013. http://www.efunda.com/designstandards/design_home.cfm.



Equipment, Tools, Supplies, and Facilities

- ✓ Overhead or PowerPoint projector
- ✓ Visual(s) from accompanying master(s)
- ✓ Copies of sample test, lab sheet(s), and/or other items designed for duplication
- ✓ Materials listed on duplicated items
- ✓ Computers with printers and Internet access
- ✓ Classroom resource and reference materials

Key Terms. The following terms are presented in this lesson (shown in bold italics):

- British Standard Pipe Thread (BSP)
- British Standard Whitworth (BSW)
- class of fit
- crest
- fastening threads
- flanks
- jointing threads
- major diameter
- minor diameter
- National Pipe Tapered Thread (NPT)
- pitch diameter
- root
- screw thread
- thread
- thread allowance
- thread angle
- thread classes 1A and 1B
- thread classes 2A and 2B
- thread classes 3A and 3B
- thread fit
- threading
- thread pitch
- thread tolerance
- threading
- threads per inch
- Unified National Coarse (UNC)
- Unified National Extra Fine (UNEF)
- Unified National Fine (UNF)

Interest Approach. Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

> *Explain the following to your students: Thread design is straightforward and extremely standardized. Only a few elements are adjusted to create all types of fasteners. Once the fundamentals of how basic parts relate to each other are understood, it is simple to design and specify threads. Then conduct a pre-assessment of the key terms in this lesson.*

CONTENT SUMMARY AND TEACHING STRATEGIES

Objective 1: Use standard terminology to describe thread design.

Anticipated Problem: What terms best describe thread designs?

I. Standard thread design terminology: ***Threading*** is the process used to create a screw thread. A ***screw thread*** is a ridge wrapped around a uniform section in the form of a helix on the external or internal surface of a cylinder. It is also known as a ***thread***. A screw thread is sometimes referenced by a gender. For instance, a thread on the external surface of the cylinder is a male thread. In contrast, a thread on the internal surface is a female thread. The thread form is determined by its profile or section view. All necessary terms or specifications can be determined and noted in the thread's profile.

A. A thread is composed of three basic parts: crests, roots, and flanks.
   1. The ***crest*** is the top point of the thread or the prominent part of the thread.
   2. The ***root*** is the bottom portion of the groove.
   3. The ***flanks*** are the two sides that form the groove of the thread; they connect the crest to the root.

B. The relationship of these three basic parts determines the thread's design. This includes the thread pitch, the thread angle, threads per inch, major diameter, minor diameter, and pitch diameter.
   1. ***Thread angle*** is the space between two flanks and is measured in an axial plane section (or profile section).
   2. ***Thread pitch*** is the distance measured parallel to its axis between corresponding points on adjacent threads.
   3. ***Threads per inch*** are the number of full threads along one inch of the threaded length. This is one way to designate unified screw threads.

C. Major and minor diameters

1. On an external thread, the ***major diameter*** is the diameter between crests. Meanwhile, the ***minor diameter*** is the diameter between roots.
2. On an internal thread, the ***major diameter*** is the diameter between roots. Meanwhile, the ***minor diameter*** is the diameter taken between crests.

D. ***Pitch diameter*** (effective diameter) is the diameter taken through a theoretical cylinder that exists between the thread's crest and root.

Teaching Strategy: *Many techniques can be used to help students master this objective. Lead a classroom discussion of all the standard terms used to describe a thread. Use VM–A and VM–B to facilitate a discussion. Assign LS–A.*

Objective 2: Analyze standard thread series.

Anticipated Problem: What are the leading standard thread series?

II. Thread series

A. Two main types of thread series are used for manufacturing and construction. One type is used for fasteners, nuts, and bolts. The other type is used for pipes that transmit liquid or gas.

B. Fasteners, nuts, and bolts

1. The International Standards Organization (ISO) metric thread is the most commonly used thread series around the world for general-purpose screw threads. Metric screw threads have been an ISO standard since 1947, and screw threads were among the first standards disseminated by ISO. The other major screw-threading standard is the American or Imperial series.
2. The Unified Thread Standard is the most common thread series defined by the ANSI. It is used in the United States and Canada and includes the following types: UNC, UNF, and UNEF. All have a "V" profile at a 60-degree angle. In the following definitions, the terms coarse, fine, and extra fine refer to the pitch of the threading rather than to the product's finished quality. A coarse thread has a large pitch or few threads per length. In contrast, a fine thread has a small pitch or more threads per length.
   a. ***Unified National Coarse (UNC)*** is a coarse thread used in lower strength materials (e.g., soft copper, aluminum, mild steel, and cast iron). It is the most common form used in bolts, nuts, and screws.
   b. ***Unified National Fine (UNF)*** is a fine thread required for higher tensile strength materials. UNF is typically used in thinner walled (material) applications.
   c. ***Unified National Extra Fine (UNEF)*** is an extra-fine thread required for full contact in very thin-walled (material) applications.

3. ***British Standard Whitworth (BSW)*** is a basic screw thread that uses standards for bolt heads and nut hexagonal sizes. Its "V" profile to the thread has a 55-degree angle.

C. Pipe threads

1. Most pipe threads have a slightly different form than screw or bolt threads. They have a tapered edge. Pipe threads must make a mechanical joint and a leak-proof hydraulic seal. This is accomplished with the tapered thread form of the male part matching the tapered thread form of the female part via the use of pipe sealant.
2. Pipe threads are organized into two general types: jointing and fastening.
   a. ***Jointing threads*** are pipe threads that enable a joint to be made pressure tight; this occurs by mating (joining) two threads together. Jointing threads have a tapered external thread, and the internal thread can be tapered or parallel.
   b. ***Fastening threads*** are parallel pipe threads that create a pressure-tight joint by the compression of a soft material onto the external thread or a flat gasket.
3. ***National Pipe Tapered Thread (NPT)*** is the standard U.S. tapered thread used on pipes and fittings. It has a threaded male and female form and is usually sealed with Teflon tape or jointing compound. The bottom of the thread is tapered (e.g., a cone) and not on a cylinder. The taper is $^{1}/_{16}$ of an inch per inch.
4. ***British Standard Pipe Thread (BSP)*** is a family of screw threads for interconnecting and sealing pipe ends by joining an external male with an internal female thread.

Teaching Strategy: *Many techniques can be used to help students master this objective. Demonstrate the different types and series of threads by bringing in examples of a full range (e.g., bolts, nuts, fasteners, and pipes). Use VM–C and VM–D.*

Objective 3: Draw threads and note specifications.

Anticipated Problem: How are threads specified?

III. Thread specifications

A. Several basic elements exist for thread designs and specifications. ANSI thread specifications (or those in inches) include the following elements: major diameters, pitches, thread series, classes of fit (thread fit), and types of thread. One standardized way exists to specify and note an ANSI thread.

1. ***Class of fit*** is the measure of tightness or looseness between the allowance and the tolerance. It is also known as ***thread fit***.
   a. ***Thread allowance*** is the intentional clearance between joining threads, such as between a nut and bolt.

b. ***Thread tolerance*** is the specific dimensions permitted in variance during manufacturing.

2. The thread type used on a specification note lets the reader know if the thread is internal or external. Type "A" is used for external threads, and a type "B" is used for internal threads.
3. Six standard classes exist for thread fitting. For instance, 1B, 2B, and 3B are used to designate internal threads, and 1A, 2A, and 3A are used to designate external threads.
   a. ***Thread classes 1A and 1B*** are a loose thread tolerance. These classes are used for quick assembly projects.
   b. ***Thread classes 2A and 2B*** are a normal and optimal thread tolerance. These classes represent almost 90 percent of all threads used today.
   c. ***Thread classes 3A and 3B*** are very tight thread tolerances. These classes are used to ensure safety considerations for specific installations.

B. Drawing thread representations

1. There are three common ways to represent thread specifications in a drawing. They are similar for internal and external threads.
   a. Detail representation drawings show the angle of the threads.
   b. Schematic representation drawings show the threads as parallel lines only.
   c. Simplified representation drawings note only the location of the threads.
2. Lines used to note threads relate to specific diameters.
   a. Visible or solid lines represent the major or outer diameter of the thread.
   b. Hidden or dashed lines represent the minor or inner diameter of the thread.

> **Teaching Strategy:** *Many techniques can be used to help students master this objective. Demonstrate how to draw threads and how to write (notate) their specifications. Use VM–E through VM–I to illustrate various ways to draw thread specifications. Assign LS–B.*

Review/Summary. Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at the ends of chapters in the textbook may be used in the Review/Summary.

Application. Use the included visual master(s) and lab sheet(s) to apply the information presented in the lesson.

Evaluation. Evaluation should focus on student achievement of the objectives for the lesson. Various techniques can be used, such as student performance on the application activities. A sample written test is provided.

Answers to Sample Test:

Part One: Completion

1. crest
2. root
3. flanks
4. thread angle
5. thread pitch
6. major diameter

Part Two: Matching

1. c
2. f
3. e
4. b
5. a
6. d

Part Three: Short Answer

1. The three types of threads in the Unified Thread Standard series are:
   a. Unified National Coarse (UNC)
   b. Unified National Fine (UNF)
   c. Unified National Extra Fine (UNEF)
2. The difference between Unified National Coarse (UNC) and Unified National Fine (UNF) is:
   a. A coarse thread has a larger pitch; this means there are fewer threads per length.
   b. A fine thread has a smaller pitch; this means there are more threads per length.

Sample Test

Name _____

Print Reading: Thread Design

Part One: Completion

Instructions: **Provide the word or words to complete the following statements.**

1. The top point or the prominent part of the thread is called the _____.
2. The bottom portion of the groove is called the _____.
3. The two sides that form the groove of the thread and connect the crest to the root are called the _____.
4. The angle between two flanks measured in an axial plane section (or profile section) is called the _____.
5 The distance measured parallel to its axis between corresponding points on adjacent threads is called the _____.
6. On an external thread, the _____ is the diameter between crests.

Part Two: Matching

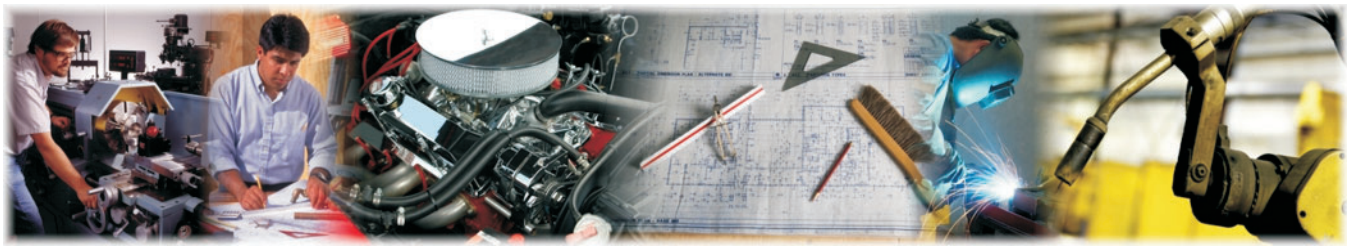
Instructions: **Match the term with the correct definition.**

a. fastening threads
b. jointing threads
c. thread tolerance
d. minor diameter
e. thread allowance
f. class of fit

_____1. The specific dimensions permitted in variance during manufacturing

_____2. The measure of tightness or looseness between the allowance and the tolerance

_____3. The intentional clearance between joining threads, such as between a nut and bolt



_____4. Pipe threads that enable a joint to be made pressure tight by joining two threads together

_____5. Parallel pipe threads that create a pressure-tight joint by the compression of a soft material onto the external thread or a flat gasket

_____6. The diameter between roots on an external thread

Part Three: Short Answer

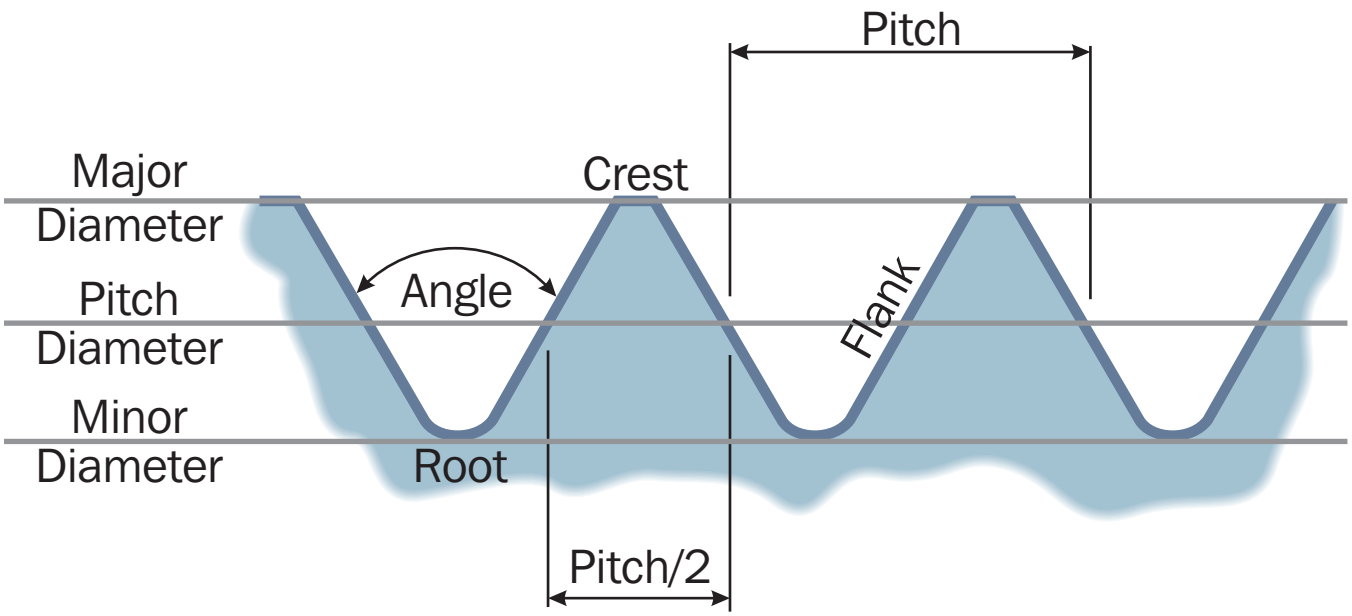
Instructions: **Answer the following.**

1. List three types of threads in the Unified Thread Standard series.

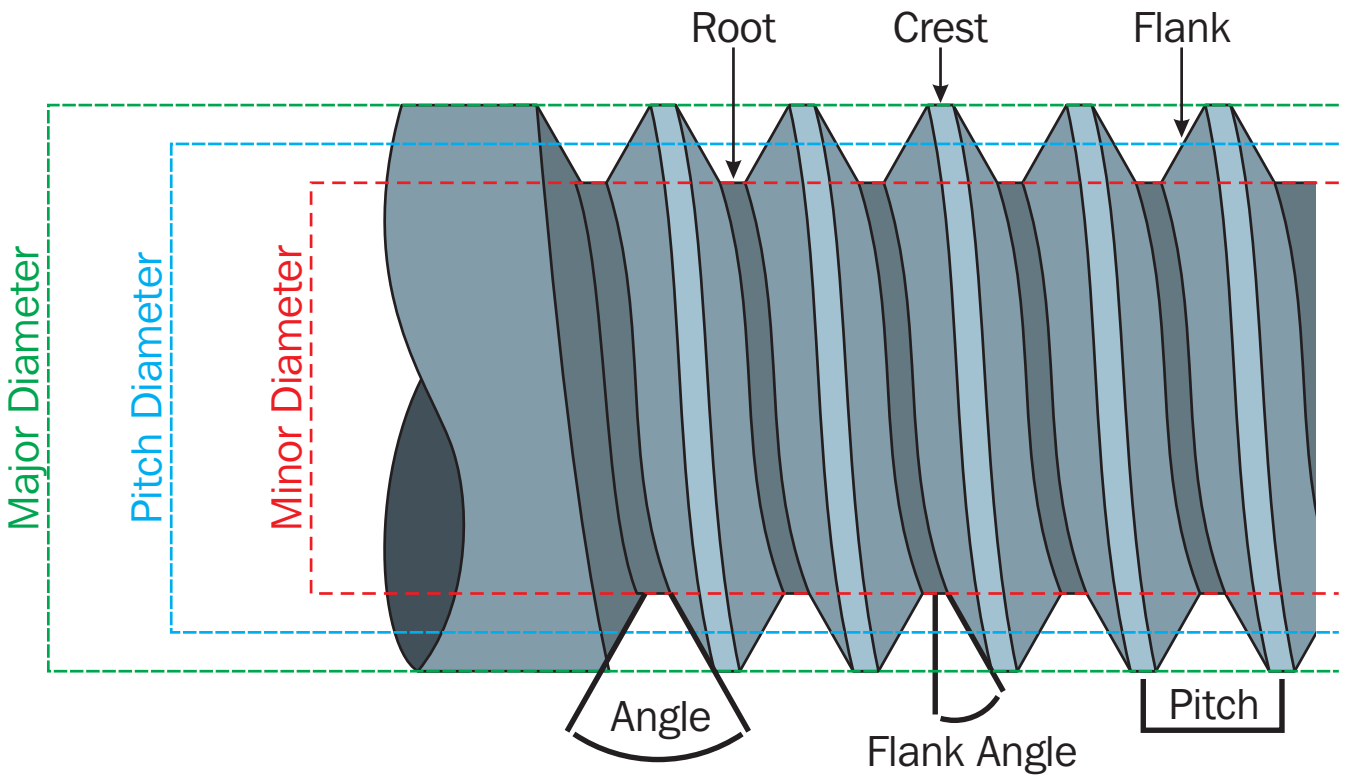
2. What is the difference between the Unified National Coarse (UNC) and the Unified National Fine (UNF)?

THREAD TERMINOLOGY AND PROFILES

Basic Thread Terms

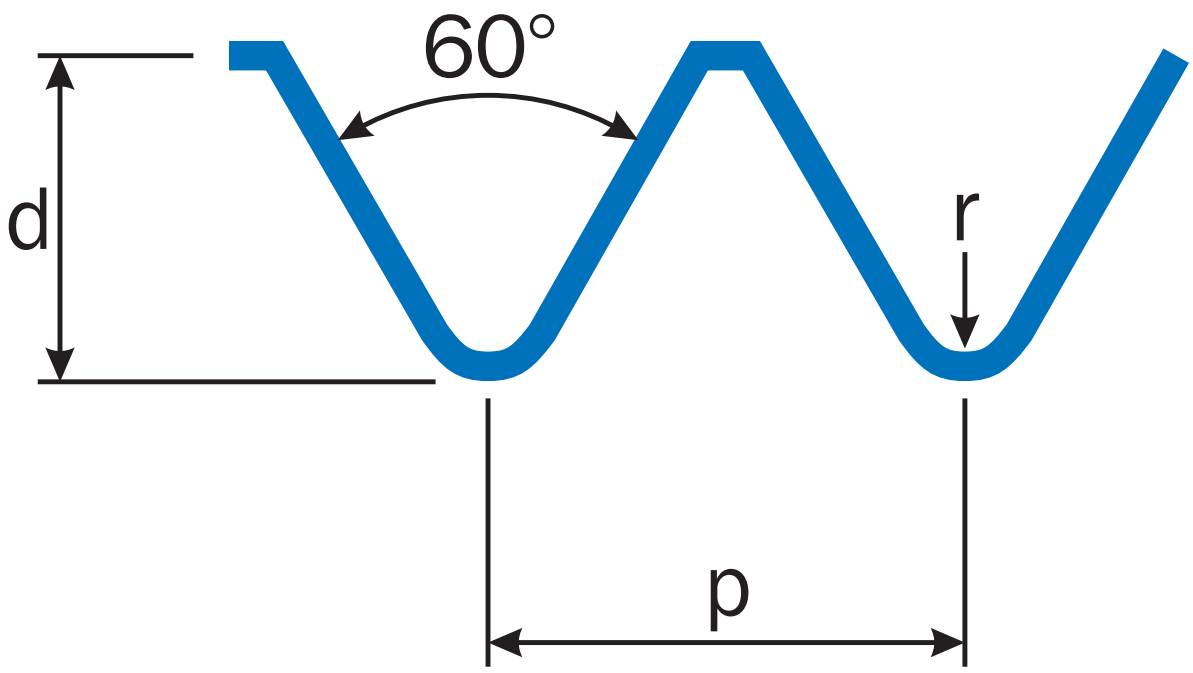


THREAD TERMINOLOGY AND PROFILES



TYPICAL THREAD ANGLE

Unified Thread Standard and ISO

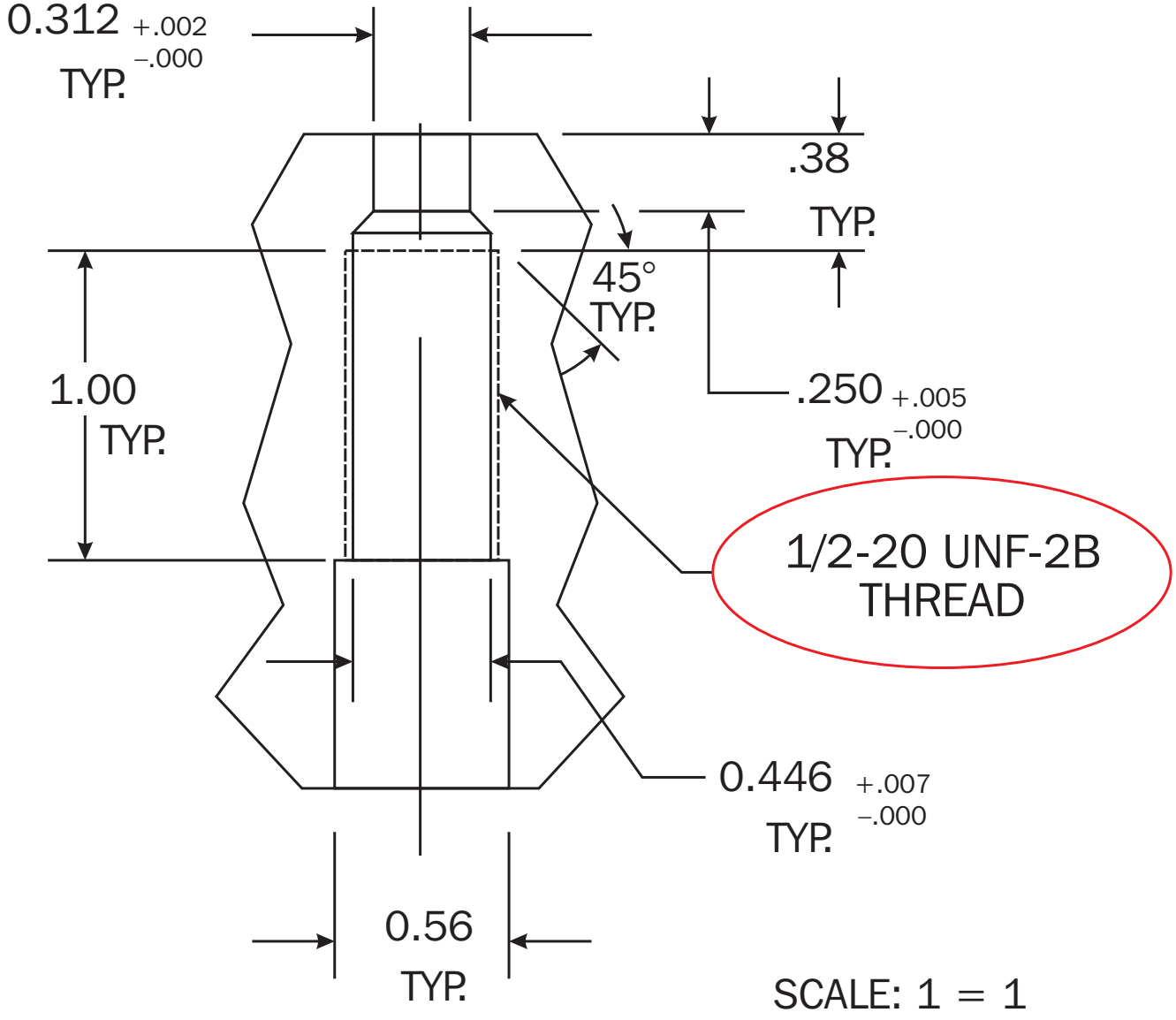


COARSE AND FINE THREADS

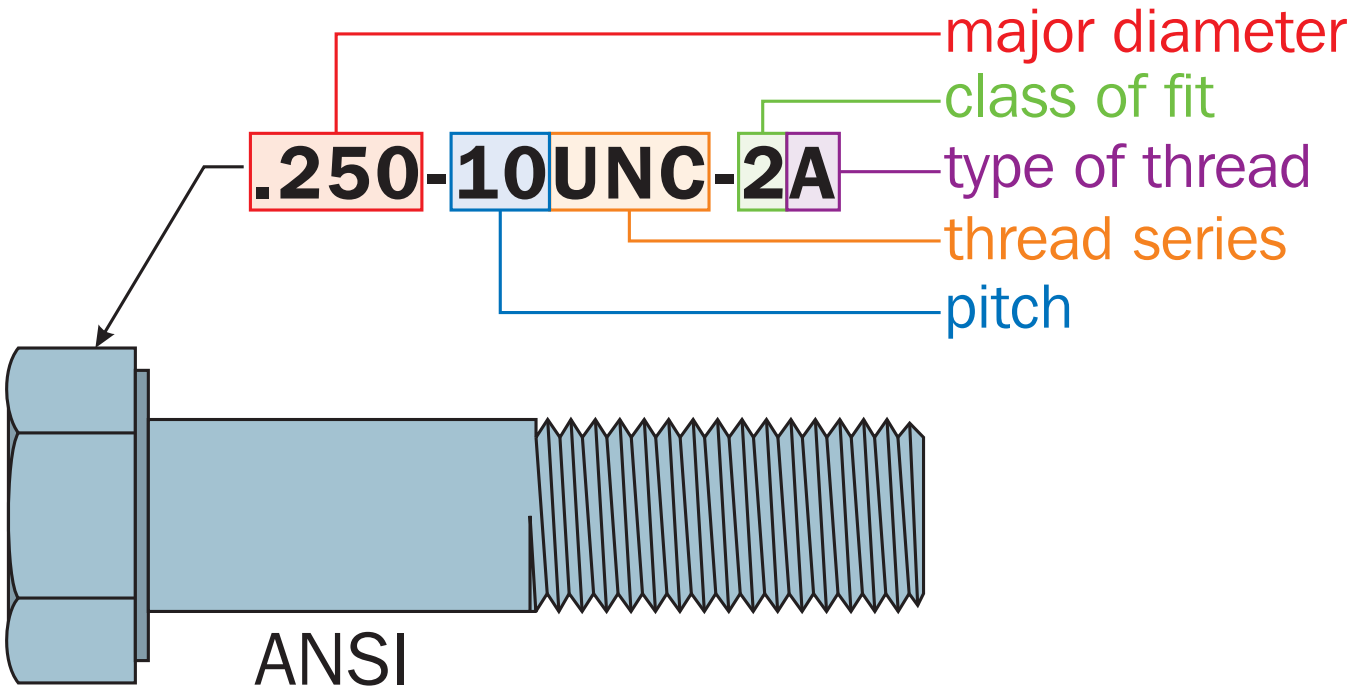
THREAD NOTES

Thread notes communicate important information to the blueprint reader.

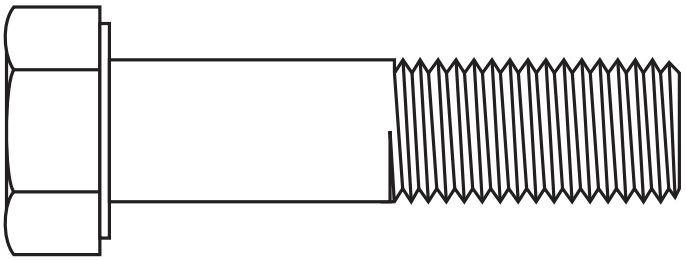
PRESSURE TAP DETAIL



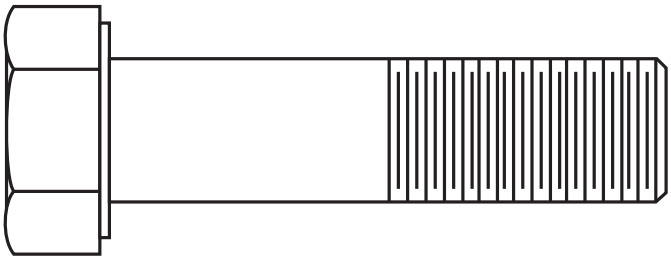
THREAD SPECIFICATIONS FOR DRAWINGS



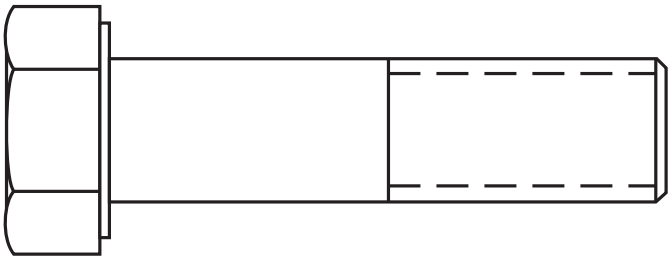
THREAD REPRESENTATIONS: DETAILED, SCHEMATIC, AND SIMPLIFIED



Detailed Representation (External)

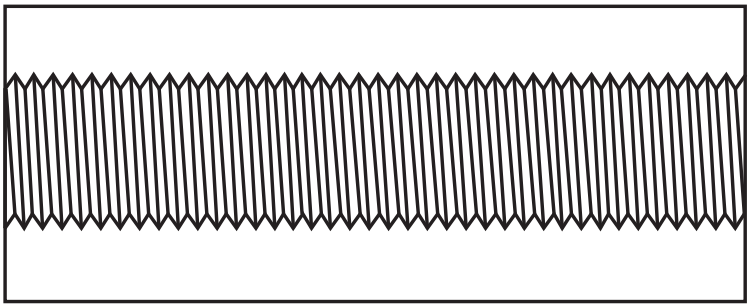


Schematic Representation (External)

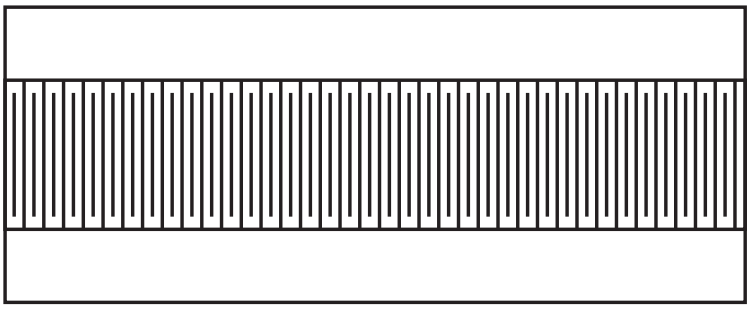


Simplified Representation (External)

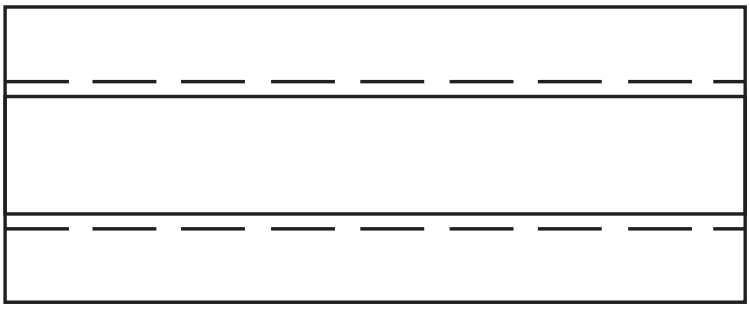
THREAD REPRESENTATIONS: DETAILED, SCHEMATIC, AND SIMPLIFIED



Detailed Representation (Internal)



Schematic Representation (Internal)



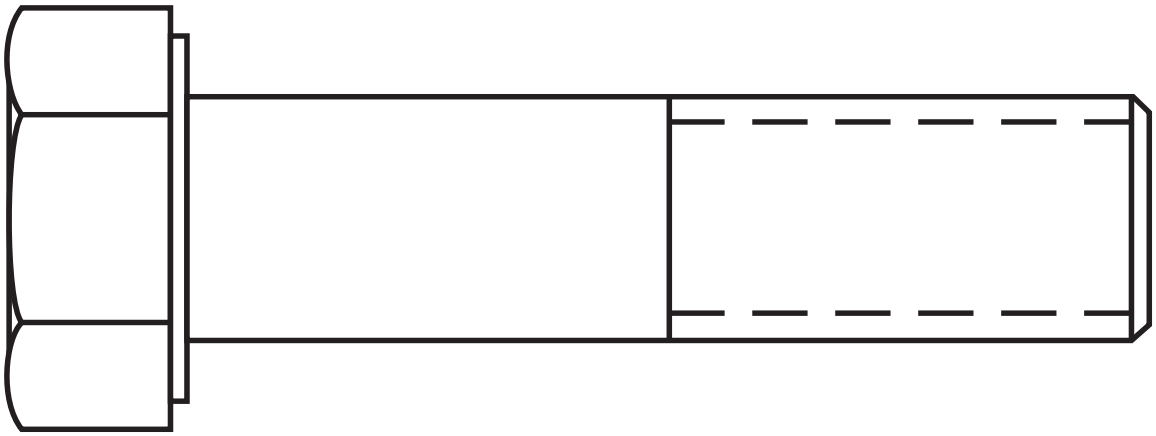
Simplified Representation (Internal)

SIMPLIFIED THREAD REPRESENTATIONS

Thread specifications are usually shown by a simplified representation.

External Threads

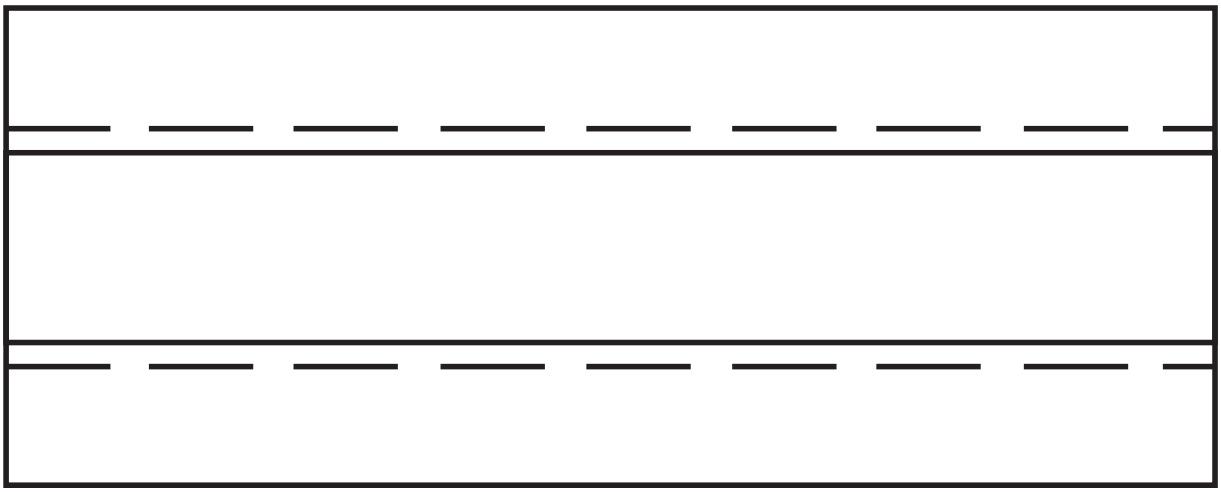
- Visible lines represent the major diameter.
- Hidden lines represent the minor diameter.



Simplified Representation (External)

Internal Threads

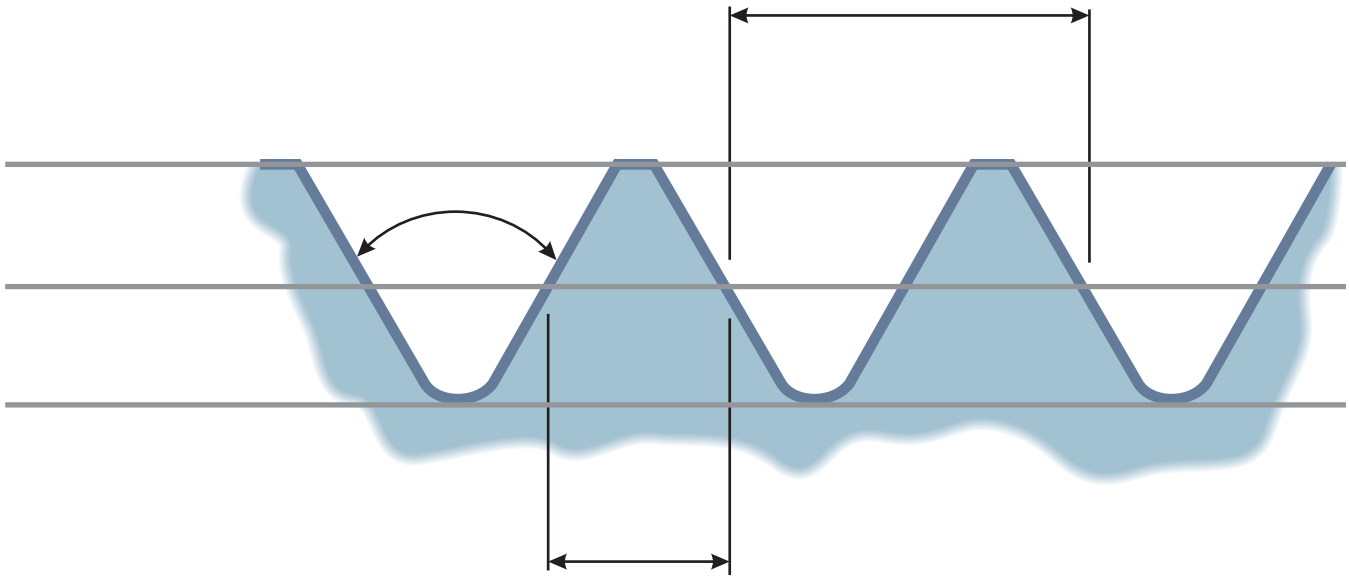
- Visible lines represent the minor diameter.
- Hidden lines represent the major diameter.



Simplified Representation (Internal)

THREAD TERMINOLOGY TEMPLATE

Basic Thread Terms



LS–A

Name _____

Draw and Label a Thread Design

Purpose

The purpose of this activity is to draw and label a thread design.

Objectives

1. Review basic thread terms.
2. Draw and label a sketch of the Basic Thread Terms template.

Materials

- writing utensil
- paper
- VM–J
- class notes

Procedure

1. Work independently.
2. Redraw VM–J on your lab sheet. The Basic Thread Terms template shows a partial section through a thread.
3. Then label your sketch with the following terms; include an arrow to indicate each term's location.
   a. Major diameter
   b. Pitch diameter
   c. Minor diameter
   d. Angle
   e. Root
   f. Crest
   g. Flank
   h. Pitch
4. When your drawing is labeled, ask your instructor to check your work.
5. Make any edits suggested by your instructor.
6. Turn in your completed lab sheet to your instructor.

LS–B

Name _____

Thread Print Reading

Purpose

The purpose of this activity is to expand knowledge of how to read thread prints.

Objectives

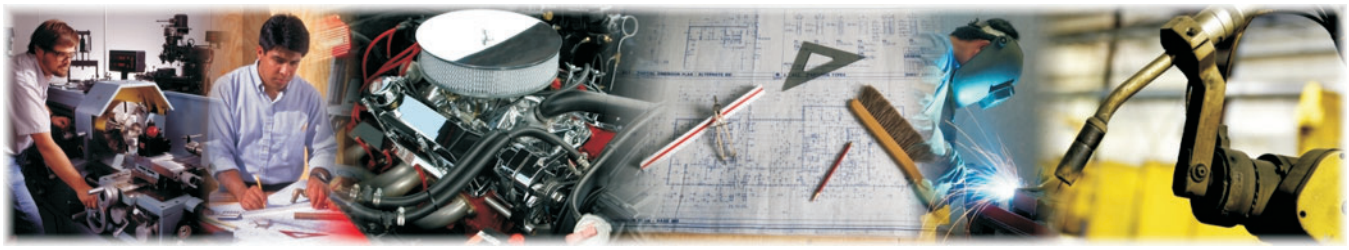
1. Review your notes about thread specification.
2. Draw a thread.
3. Note the thread specifications.
4. Create a thread print.

Materials

- writing utensil
- paper
- textbook
- class notes

Procedure

1. Work independently.
2. Draw a thread. Follow examples you have been shown and/or examples from your text. Then note the thread specifications.
   a. Use a scale ruler to draw a bolt (one with a standard hexagonal-shaped head) that is 3 inches long with a 2-inch threaded area. Make the bolt diameter ½ inch.
   b. Now draw the threads at 10 threads per inch. Use the "schematic representation" form.



c. Write the specification for your drawing in the correct format and order.
   (1) Show the major diameter using the information you were given.
   (2) Show the pitch; use “10.”
   (3) Show the thread series. Use one that was mentioned in your writing and talked about in class.
   (4) Show the class of fit (or thread fit). Use one mentioned in your writing and talked about in class.
   (5) Show the type of thread. Since this is a bolt, it has external threads. Use the appropriate letter for this type.
3. When your drawing is complete, ask your instructor to check your work.
4. Make any edits suggested by your instructor.
5. Turn in your completed lab sheet to your instructor.