
NIMS Machining Level I Preparation Guide

Job Planning, Benchwork, and Layout

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Overview

Introduction

This preparation guide or test advisor is intended to help machinists study and prepare for the National Institute for Metalworking Skills (NIMS) written credentialing exam. The sample test will help prepare machinists to take the actual credentialing exam. None of the questions are duplicates from the actual exam. However, this preparation guide is a useful tool for reviewing technical knowledge and identifying areas of strength and deficiency so that the student has what is needed to do well on the exam.

Achieving a NIMS credential is a means through which machinists can prove their abilities to themselves, to their instructors or employers, and to the customer. By passing the NIMS credentialing exam you will earn a valuable and portable credential. Because the test is tough, you will have the satisfaction of proving to yourself and others that you have reached a level of competency that is accepted nationally.

Who Wrote the Questions

A panel of technical experts, from all areas of the metalworking industry, wrote the questions used on the credentialing exam. The panel of experts ranged from company presidents and owners, to engineers and quality personnel, to actual working machinists. Exam questions are designed to test the knowledge skills needed for entry-level machinists. They are written to deal with practical problems, computations, and decisions machinists encounter in their day-to-day work.

The technical experts must first validate the exam questions. Then, before the questions become part of the credentialing exam, qualified machinist and industry personnel again validate them on a national level. Rejected questions are then rewritten or discarded altogether.

How to Prepare for the Credentialing Exam

Become familiar with the exam content and question format by utilizing the tools provided in this test preparation guide. The **Exam Specifications** portion of this guide contains a summary description of the content covered by the actual credentialing exam. The **Task List** describes competencies for each particular area associated with the credentialing area.

Each question on the sample test is linked to a particular task or set of tasks found in the **Task List**. Therefore, a review of the **Task List**, with an eye on judging whether you know how to perform each task listed, will provide you with valuable information as you prepare for the exam.

The questions are multiple-choice. Note instructions that may accompany some questions. Be sure to read each question carefully (twice, if necessary) so that you know exactly what is being asked. Check each answer and your work since an error in computation or understanding may make a wrong answer appear correct.

The following four steps are suggested for effective preparation:

- Step 1: Study the content list for each exam you will attempt.
- Step 2: Carefully read the **Task List** for each section.
- Step 3: Review the sample test to become familiar with subject matter and question type. This is a very important step.
- Step 4: Repeat steps 1 through 3 and identify area(s) where you need additional study. Use the preparation guide as a self-diagnostic tool.

Areas of Knowledge Measured by the Exam

The knowledge and skills you will need to pass the credentialing exam are as follows:

Exam Sections

The exam is divided into three sections. They are:

- **Job Planning and Management Tasks**
- **Layout Tasks**
- **Benchwork Tasks**

Following is a list of the basic knowledge areas assessed by the exam.

- **Basic Mathematics:** The exam will assess basic math knowledge from whole number computations and algebra to basic geometry. Application of formulas involving tapping, tapers, speeds and feeds, and threading will be evaluated.
- **Applying the *Machinery's Handbook*:** The machinist must be able to reference and apply information found in the handbook to solve application problems. Referencing limits, tolerance, and parameters of a material or process are essential skills.
- **Basic Measurement:** The exam will test interpretation of basic measuring instruments, resolution, and applicability of basic measuring tools for given situations. Students must demonstrate knowledge of the differences and similarities of semi-precision and precision measurement.
- **Basic Machining Theory:** The machinist must understand basic types of tooling materials, applications of tooling and processes for drilling, milling, sawing, turning, and proper procedures using hand tools. A basic understanding of fits and allowances, as well as defining surface finish and machining operation/surface finish relationships is expected.
- **Layout:** The exam will evaluate an understanding of basic and precision layout equipment and procedures. The machinist should have a basic knowledge of print reading and orthographic projection. Knowledge of the layout of linear, angular, and circular dimensions will be assessed.

Before the Exam

Try to be well rested for the exam. Being well rested will make you more alert and efficient when taking the credentialing exam. Review any course material from your instructor. Review the test advisor information and sample test. Bring at least two sharpened (#2) soft leaded pencils and an eraser. In addition, bring a calculator and the *Machinery's Handbook*. Become familiar with the procedure for taking a Scantron test. If you wish to pace yourself, bring a watch, or be aware of the location of clocks at the test site. Make sure to bring some form of identification, any necessary paperwork from NIMS, and arrive at the test site at least 10 to 15 minutes prior to the specified exam time.

At the Testing Site

When you arrive at the test center, wait in the assigned area until the proctor begins the test orientation and administration. The proctor will instruct you in the proper procedure for filling out any information on the answer sheet and will tell you the amount of time allotted for the exam, reference materials that can be used and if a calculator is permissible.

Once the exam has begun, keep track of time. Avoid spending too much time on any one question. Answer the questions you know the answers to and then go back those you had difficulty with if time allows. Repeat this process for each section. Again, do not spend an excessive amount of time on any one question.

It is to your advantage to answer every question. Do not leave any answers blank. Answers that are left blank will be counted as incorrect. Your score will be based on the number of correct answers.

Exam Content and Sample Question Summary

Exam Content and Sample Question Overview

The following material is designed to help machinists prepare for and obtain a NIMS credential in the areas of Job Planning, Benchwork, and Layout. This section begins with an **Exam Specifications**. The **Exam Specifications** will list the main categories covered on the exam for Job Planning, Benchwork, and Layout. This section will also list the name of the topic, the number of questions pertaining to that topic and the percentage of the exam devoted to that topic.

The **Task List** describes competencies a machinist must have in order to receive a credential for Job Planning, Benchwork, and Layout. The **Task List** has a two-fold purpose. The first purpose is to prepare machinist for credentialing. The second is to encourage instructors to apply the **Task List** as a measurement of the effectiveness of their curricula.

The number of questions in each content area may not be equal to the number of tasks listed. Some of the tasks are more complex and broader in scope and may be covered by several questions. Other tasks are simple and narrower in scope and one question may cover several tasks. The main objective in listing the tasks is to describe accurately what is done on the job, not to make each task correspond to a particular test question.

Sample questions follow the **Task List**. Although these same questions will not appear on the actual exam, they are in the same format as the actual questions. All questions on the credentialing exam are in the multiple-choice format. Some concepts evaluated on the credentialing exam are assessed in greater depth in the sample test questions. The sample test questions are developed to evaluate conceptual knowledge of machining rather than specific competencies.

Answers to the sample questions are located at the end of the sample test. Work with your instructor to identify weak areas and evaluate answers. Use the sample test as a study guide and diagnostic tool.

Exam Specification – Job Planning, Benchwork, and Layout

Content Area	No. of Questions	% of Test
Taper Problems	5	7.4
Machinery Handbook Applications	5	7.4
Speeds and Feeds Formulas and Terms	6	8.8
Math Applications	5	7.4
Tolerance, Fits, and Allowances	3	4.4
Reaming	5	7.4
Measurement (semi-precision)	4	5.9
Measurement (precision)	5	7.4
Threads and Tapping	6	8.8
Layout (semi-precision)	6	8.8
Layout (precision)	1	1.5
Drilling	3	4.4
Milling	2	2.8
Materials	1	1.5
Sawing	2	2.8
Filing	4	5.9
Blueprint Reading	3	4.4
Machining Theory	1	1.5
Knurling	1	1.5
	Total of 68	100 %

Task List

Job Planning, Benchwork, and Layout

Reading this **Task List** will allow machinists to focus preparation on those subject areas that need attention. The instructor can use the **Task List** to fine-tune the curricula to meet the standards. If you feel comfortable with your knowledge about a particular task, you are probably ready to answer the questions on that subject matter. If, on the other hand, you have any doubts, you and your instructor can work on these areas to build up proficiencies. Many texts and other resources are available to provide information on the various subject areas.

Taper Problems

- Applying taper terminology and trigonometry to set a compound rest to cut a taper on the lathe
- Calculating the taper per inch given parameters found in the *Machinery's Handbook*, page 685, 26th Edition
- Calculating a taper per foot
- Finding the angle to the centerline when given a taper per foot
- Given a taper per foot, finding the included angle
- Applying a taper per foot formula

Sample questions:

- 1) Applying the formula below, find the taper per foot for a workpiece with a large diameter of 3.5 inches and a small diameter of 2.75 inches with a taper length of 5.5 inches.

$$TPF = \frac{(D-d)}{\text{Length of taper}} \times 12$$

- a) 3.5 inches
- b) 1.64 inches
- c) 3.27 inches
- d) 1.75 inches

- 2) Use a calculator to determine the included angle for a taper of 0.550 inches per foot.
 - a) 1.313 degrees
 - b) 2.614 degrees
 - c) 2.626 degrees
 - d) 5.248 degrees

- 3) What is the taper per foot for a piece 7.5 inches long with a 0.056 taper?
 - a) 0.0896 inch taper per foot
 - b) 0.1125 inch taper per foot
 - c) 5.0439 inch taper per foot
 - d) 0.0560 inch taper per foot

Machinery's Handbook

- Find a tap drill size
- Keyway and keyseat calculations
- Steel identification system (SAE)
- Angle to the centerline of a taper given the taper per foot
- Finding thread parameters (minor diameter, pitch diameter, etc.)

Sample questions:

- 1) Referring to the *Machinery's Handbook*, what is the minimum pitch diameter for an external thread 7/16-14 UNC - 2A?
 - a) 0.3862 inches
 - b) 0.3909 inches
 - c) 0.385 inches
 - d) 0.3876 inches

- 2) Referring to the *Machinery's Handbook*, what is the tap drill for a 5/16-18 UNC thread with a 75% thread engagement?
 - a) 0.272-inch diameter drill
 - b) 0.257-inch diameter drill
 - c) 0.2983-inch diameter drill
 - d) 0.201-inch diameter drill

Speeds and Feeds

- Definition and acronym for surface feet per minute
- Drilling – how the feed rate is designated
- Applying the surface feet per minute formula to find rpm
- Calculating cutting time
- Calculating the feed rate for a milling operation
- Calculating the rpm for a drilling operation

Sample questions:

- 1) The feed rate on a lathe is given in:
 - a) IPR
 - b) IPM
 - c) RPM
 - d) SFM

- 2) Calculate the rpm for a drilling operation with a cutting speed of 150 SFM applying a 1/4" diameter drill with a feed rate of 0.005 inches per revolution.
 - a) 2400 RPM
 - b) 7500 RPM
 - c) 4800 RPM
 - d) 3750 RPM

- 3) The time required to make three turning passes over a piece of stainless steel 8.5 inches in length at 350 rpm with a 0.006" feed is approximately _____ minutes.
 - a) 26.7 minutes
 - b) 12.1 minutes
 - c) 10.7 minutes
 - d) 4.1 minutes

Math Applications

- Basic trigonometric applications
- Value of Pi
- Application of diagonals and diameters (largest or smallest square from round stock)
- Metric conversion
- Applications of formulas

Sample questions:

- 1) The largest square that can be machined from a 2.5-inch diameter piece of steel would be:
 - a) 2.5 inches per side
 - b) 1.767 inches per side
 - c) 3.535 inches per side
 - d) 1.250 inches per side

- 2) To convert inches to millimeters, a machinist would use a constant of _____.
 - a) 25.4
 - b) 2.54
 - c) 0.254
 - d) 254

- 3) What is the angle to the centerline for an 8.375-inch taper that has a large diameter of 3.470 inches and a small diameter of 2.955 inches?
 - a) 1.761 degrees
 - b) 3.522 degrees
 - c) 3.519 degrees
 - d) 7.038 degrees

Tolerance, Fits, and Allowances

- Converting inch tolerance to the metric equivalent
- Understanding bilateral tolerancing
- Allowance between mating parts for various types of fits
- Assembly with a shrink fit

Sample questions:

- 1) Convert the tolerance **range** ± 0.005 inches into millimeters rounded to the nearest hundredth of a millimeter (0.01).
 - a) 0.01 mm
 - b) 0.13 mm
 - c) 0.02 mm
 - d) 0.25 mm
- 2) Apply the *Machinery's Handbook* to determine the hole size for a Class FN2 force fit if the shaft diameter is 1.625 inches.
 - a) 1.6181 to 1.6250 inches
 - b) 1.6258 to 1.6274 inches
 - c) 1.6203 to 1.6262 inches
 - d) 1.6226 to 1.6242 inches

Reaming

- Comparing the rpm for reaming and drilling
- Stock allowance for machine reamers
- Identification of hand reamers
- Stock allowance for hand reamers

Sample questions:

- 1) The feed rate for reaming a hole on a drill press should be _____ that of drilling.
 - a) 1/2
 - b) 2 times
 - c) 4 times
 - d) 1/8th
- 2) The stock allowance for reaming a 0.375 diameter hole is:

- a) 0.003 inches
 - b) 0.060 inches
 - c) 0.012 inches
 - d) 0.032 inches
- 3) The stock allowance for a hand reamer with a 0.500-inch diameter is:
- a) 0.015 inches
 - b) 0.009 inches
 - c) 0.004 inches
 - d) 0.032 inches

Measurement (Semi-precision)

- Scale measurements to 1/100th of an inch
- Combination set applications
- Scale measurements to 1/64th of an inch
- Application of a plate protractor

Sample questions:

- 1) The most accurate method of measuring an angle is a:
- a) Angle plate
 - b) Dial caliper
 - c) Plate protractor
 - d) Combination set
- 2) Which type of head for a combination set is the best choice for finding the center of a shaft?
- a) Square
 - b) Center
 - c) Bevel center
 - d) Protractor

Measurement (Precision)

- Divisions around a thimble on a micrometer
- Solid square angularity
- Reading a vernier scale on a caliper
- Divisions on the spindle of a micrometer
- Discrimination of a vernier caliper

Sample questions:

- 1) A solid square has two sides that form an angle of _____ degrees that checks _____.
 - a) 180, parallelism
 - b) 90, perpendicularity
 - c) 360, flatness
 - d) 45, total runout

- 2) The resolution of a micrometer with a vernier scale is:
 - a) 0.0001 inches
 - b) 0.00001 inches
 - c) 0.001 inches
 - d) 0.01 inches

- 3) The micrometer spindle has _____ threads per inch with a lead (amount of travel in one revolution) of _____ inches.
 - a) 40, 0.025 inches
 - b) 20, 0.050 inches
 - c) 10, 0.100 inches
 - d) 80, 0.125 inches

Thread Terminology and Tapping

- Tap drill diameter
- Basic thread terminology
- Application of the three wire formula for checking threads
- Types of taps in a tap set
- Hole preparation for tapping
- Importance of countersinking the hole to be tapped
- Tool for removal of a broken tap
- Basic tapping procedure and tap back-off rationale
- Threads per inch on an inch micrometer
- Tap used to obtain maximum threads for a blind hole

Sample questions

- 1) The most common type of tap found in a toolroom for creating threads for machine screws is a _____ tap.
 - a) Plug
 - b) Bottoming
 - c) Taper
 - d) Pipe
- 2) In order to start a tap and maintain perpendicularity, the best practice is to _____ the hole edge.
 - a) Ream
 - b) Spotface
 - c) Counterbore
 - d) Countersink
- 3) The proper tool(s) for removing a broken tap is a:
 - a) Center punch and hammer
 - b) Center punch, hammer, and tweezers
 - c) Screw press and pin
 - d) Tap extractor

Layout (Semi-precision)

- Layout instrument for layout of circles
- Layout of angles with a combination set
- Application of trammel points
- Purpose and application of layout die
- Function of a scribe

Sample questions:

- 1) The purpose of a scribe is to:
 - a) Layout fine lines on a metal surface
 - b) Provide a starting point for a drill
 - c) Measure the angularity of a surface with a sine bar
 - d) Extract filings from a file

- 2) For layout of an angle other than 45° or 90° , the _____ head of a combination set would be applied.
 - a) Center
 - b) Square
 - c) Bevel Center
 - d) Protractor

- 3) Which of the following is the best application for trammel points?
 - a) Layout of a very small circle
 - b) Layout of a very large square surface or parallelogram
 - c) Layout of a very large circle
 - d) Layout of chamfers on bores and holes

Layout (Precision)

- Precision layout tools used with a surface plate

Sample questions:

- 1) The instrument that is used on a surface plate for accurate layout of details is called a:
 - a) Combination set
 - b) Sine bar and scribe
 - c) Machinist square and hermaphrodite caliper
 - d) Vernier height gage
- 2) Which of the following combinations of layout instruments, or which individual layout instrument provides the most accurate layout?
 - a) Center punch and divider
 - b) Digital height gage with a scribe attachment
 - c) Scribe and steel rule
 - d) Vernier caliper tip

Drilling

- Various drilling operations such as counterboring, countersinking, reaming, etc.
- Drilling feed rate terms
- Calculating rpm for a drilling operation using the cutting speed formula
- Included angle for countersinking a flat-head screw

Sample questions:

- 1) The feed rate on a drill press is given in:
 - a) IPM
 - b) SFM
 - c) IPR
 - d) RPM

- 2) Identify the machining process that has the ability to enlarge an existing hole and adjust hole perpendicularity to a surface.
 - a) Reaming
 - b) Drilling
 - c) Boring
 - d) Countersinking

- 3) The machining process used to seat a flat head screw is:
 - a) Spotfacing
 - b) Boring
 - c) Reaming
 - d) Countersinking

Milling

- Climb milling and conventional milling characteristics
- Harder and softer materials and their correlation to cutting speed
- Milling a square from round stock
- Milling feed rate calculations

Sample questions:

- 1) Identify the statement that best describes the relationship between type of material, cutting speed, and rpm for milling operations with high-speed steel tooling?
 - a) Softer materials require higher cutting speeds and lower rpm
 - b) Harder materials require lower cutting speeds and lower rpm
 - c) Softer materials require lower cutting speeds and higher rpm
 - d) Harder materials require higher cutting speeds and higher rpm

- 2) An end mill cutter capable of starting a hole is a:
 - a) Four flute gashed end mill
 - b) Two flute end mill
 - c) Roughing end mill
 - d) Fly cutting end mill attachment

- 3) Identify a major **disadvantage** to applying a climb milling procedure:
- The work is pressed against the table during a horizontal milling operation
 - Excessive backlash might pull the cutter into the workpiece
 - Less power is required
 - The cutter will always cut undersize by 5%

Materials

- Materials and cutting speeds (relating to sfm and rpm)
- SAE steel identification system

Sample questions:

- 1) A piece of steel is identified as 1070 steel in the SAE system of steel identification. What do the last two digits (70) represent?
 - Type of alloying material
 - The amount of manganese
 - The carbon content in hundredths of one percent
 - The specific gravity in tenths of one percent

- 2) Using the *Machinery's Handbook*, identify the major alloying element of 4140 steel.
 - Plain carbon
 - Nickel - vanadium
 - Free machining sulfur
 - Chromium - molybdenum

Sawing

- Materials that can be cut with an abrasive cutoff saw
- Proper hacksawing procedures and strokes per minute

Sample questions:

- 1) Abrasive cutoff machines can cut:
 - a) hardened steel
 - b) glass
 - c) brick
 - d) all of the above
 - e) only a and c

- 2) On a hacksaw, the teeth should point away from the handle cutting on the _____ stroke.
 - a) Forward
 - b) Backward
 - c) Side
 - d) Oscillating

Filing

- Proper procedure and tool used to clean a file
- Filing to a layout line
- Post processing a surface after filing
- How to keep a file from loading up

Sample questions:

- 1) The best way to clean the filings from a file is to apply:
 - a) A solvent and air blast
 - b) A file card
 - c) Back filing against the file cutting edges
 - d) Emery cloth with an oil medium

- 2) Deep scratches found in the workpiece after filing is the result of:
 - a) A very sharp file
 - b) Pinning (filings edged in the teeth)
 - c) Excessive cutting pressure
 - d) Using chalk as a dry lubricant

Blueprint Reading

- Types of lines used in print reading
- Functions of each type of line
- Surface finish symbols and interpretation

Sample questions:

- 1) Centerlines **cannot** show which of the following:
 - a) Symmetry
 - b) Path of motion or alternate position
 - c) Details that cannot be seen in that view
 - d) Center of a shaft

- 2) A line convention that shows the outline or shape of an object is an:
 - a) Object line
 - b) Section line
 - c) Cutting plane line
 - d) Hidden line

Machine Theory

- Advantages of carbide-tipped cutters over high-speed steel
- Types of tools that produce holes (drills, saws, etc.)

Sample questions:

- 1) Which of the following tools is **not** used to start and manufacture a hole?
 - a) Boring tool
 - b) Twist drill
 - c) Spade drill
 - d) Spotting drill

- 2) Which one of the following statements is **false** pertaining to the advantages of applying carbide-tipped milling cutters?
 - a) Carbide is more expensive than high-speed steel
 - b) Higher rpm can be used with carbide
 - c) Lower cutting speeds must be applied with carbide
 - d) Carbide is harder than high-speed steel
 - e) Carbide tooling has greater tool life than high-speed steel tooling

Knurling

- Definition of knurling
- Machine used for knurling operations

Sample questions:

- 1) The process of knurling:
 - a) Cuts metal with relatively low pressure
 - b) Cuts metal with relatively high pressure
 - c) Forms metal with relatively low pressure
 - d) Displaces metal with relatively high pressure

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- 2) Metal flaking during a knurling operation means that:
- a) More lubrication is needed
 - b) The material has work-hardened
 - c) Knurling should not be done with that particular material
 - d) Proper knurling action is taking place and the flakes must be cleaned off

Job Planning, Benchwork, and Layout

Sample Test Answers

Taper Problems

1. B
2. C
3. A

Machinery's Handbook Applications

1. C
2. B

Speeds and Feeds Formulas

1. A
2. A
3. B

Math Applications

1. B
2. A
3. A

Tolerance, Fits, and Allowances

1. D
2. D

Reaming

1. B
2. C
3. C

Measurement (Semi-precision)

1. D
2. B

Measurement (Precision)

1. B
2. A
3. A

Threads and Tapping

1. A
2. D
3. D

Layout (Semi-precision)

1. A
2. B
3. C

Layout (Precision)

1. D
2. B

Drilling

1. C
2. C
3. D

Milling

1. B
2. B
3. B

Materials

1. C
2. D

Sawing

1. D
2. A

Filing

1. B
2. B

Blueprint Reading

1. C
2. A

Machining Theory

1. A
2. C

Knurling

1. D
2. B