



Nutley Public Schools

Metalworking

Grades: 9-12

Unit I: Measurement	
Summary and Rationale	
<p>Measurement is the process of determining the ratio of a physical quantity, such as a length, time, or temperature (our focus being on length). Measurements are expressed with numbers, allowing the logic, precision and power of mathematics to be brought to bear on the study of nature. Measurement is the foundation on which we build STEM-literacy. Measurement may seem like a small part of the overall learning process, but in a world evermore dependent on the STEM industries, measurement has become as foundational as reading, writing, and arithmetic.</p>	
Recommended Pacing	
<p>1 week **ongoing throughout entire year**</p>	
Standards	
Career and Technical Education 9.3	
9.3.12.AC.1	Use vocabulary, symbols and formulas common to architecture and construction.
9.3.12.AC.6	Read, interpret and use technical drawings, documents and specifications to plan a project.
9.3.12.AC-DES.2	Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues.
9.3.MN-PPD.1	Produce quality products that meet manufacturing standards and exceed customer satisfaction.
9.3.ST-SM.1	Apply science and mathematics to provide results, answers and algorithms for engineering and technological activities.
Career Ready Practices	
CRP2.	Apply appropriate academic and technical skills.
CRP4.	Communicate clearly and effectively and with reason.
CRP6.	Demonstrate creativity and innovation.
CRP8.	Utilize critical thinking to make sense of problems and persevere in solving them.



Nutley Public Schools

CRP11.	Use technology to enhance productivity.
Interdisciplinary Connections	
Standard x.x	
4.9.3	Recognize the need for a uniform unit of measure.
4.9.6	Understand and incorporate estimation and repeated measures in measurement activities.
4.9.9	Determine the degree of accuracy needed in a given situation and choose units accordingly.
4.9.13	Convert measurement units from one form to another, and carry out calculations that involve various units of measurement.
4.9.19	Choose appropriate techniques and tools to measure quantities in order to achieve specified degrees of precision, accuracy, and error (or tolerance) of measurements.
Integration of Technology	
Standard x.x	
CPI #	Cumulative Progress Indicator (CPI)
Instructional Focus	
Enduring Understandings	
<ul style="list-style-type: none"> • Students will understand the history of measurements. • Students will understand dating back beyond the Roman Empire, the need to know how far, how long, how deep and how much could something hold was information people needed to accomplish many tasks. • Students will understand throughout time, people created and improved on the methods and tools used to measure, making them more and more exact. • Students will understand precision and consistency are essential to the process of manufacturing. 	
Essential Questions	
<ul style="list-style-type: none"> • What is measurement? • What is a measurement system? • How many systems of measurement are there? • What do measurement tools look like and how are they used? • What role does measurement have in manufacturing? • Is the Metric System better than the English System? 	
Evidence of Learning (Assessments)	
Successful completion of: <ul style="list-style-type: none"> • Measurement Quiz • Capstone project (Small Paper toolbox, Small Sheetmetal Toolbox, Large Sheetmetal Toolbox, Midterm, Welding Plaque, Turning Project) 	
Objectives	
Students will know:	



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- how to measure
- how to use drafting tools (square, ruler, protractor, compass)
- safely use the appropriate hand tool for the requested job

Students will be able to:

- use a ruler to 1/16” tolerance
- use a caliper to measure to 1/1000” tolerance
- layout lines, arcs and angles on material
- successfully complete measurement quiz

Integration

Technology Integration

Writing Integration

Competencies

Suggested Resources

Metalworking

Grades: 9-12

Unit II: Sheetmetal/Folding

Summary and Rationale

Sheet metal workers read plans and determine the type and amount of materials needed, and then measure, bend, cut, shape, and attach pieces of sheet metal to make the products. Sheet metal workers compete for jobs in roofing, rain gutters, siding, ventilation, heating and air-conditioning duct systems. They also assist in the development of restaurant equipment, automobiles,



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customized precision equipment, outdoor signs, handrails, column wraps, and many other products that are made from metal. They use specialized fastening devices such as bolts, rivets, screws and welding machines. Sheet Metal workers use hand and power tools and equipment including shears, breaks, punches and forming presses, edging and crimping machines, hammers, and grinders.

Recommended Pacing

60 days

Standards

[Career and Technical Education 9.3](#)

9.3.12.AC.1	Use vocabulary, symbols and formulas common to architecture and construction.
9.3.12.AC.3	Comply with regulations and applicable codes to establish and manage a legal and safe workplace.
9.3.12.AC.5	Describe the roles, responsibilities, and relationships found in the architecture and construction trades and professions, including labor/management relationships.
9.3.12.AC.6	Read, interpret and use technical drawings, documents and specifications to plan a project.
9.3.12.AC-CST.2	Describe the approval procedures required for successful completion of a construction project.
9.3.12.AC-CST.3	Implement testing and inspection procedures to ensure successful completion of a construction project.
9.3.12.AC-CST.4	Apply scheduling practices to ensure the successful completion of a construction project.
9.3.12.AC-CST.5	Apply practices and procedures required to maintain jobsite safety.
9.3.12.AC-CST.8	Demonstrate the construction crafts required for each phase of a construction project.
9.3.12.AC-CST.9	Safely use and maintain appropriate tools, machinery, equipment and resources to accomplish construction project goals.
9.3.12.AC-DES.2	Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues.
9.3.12.AC-DES.8	Apply standards, applications and restrictions pertaining to the selection and use of construction materials, components and assemblies in the project design.
9.3.12.AC-MO.1	Recognize and employ universal construction signs and symbols to function safely in the workplace.
9.3.MN.6	Demonstrate workplace knowledge and skills common to manufacturing.
9.3.MN-HSE.1	Demonstrate the safe use of manufacturing equipment.



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9.3.MN-HSE.4	Evaluate a system of health, safety and/or environmental programs, projects, policies or procedures to determine compliance.
9.3.MN-LOG.2	Demonstrate proper handling of products and materials in a manufacturing facility.
9.3.MN-MIR.5	Implement a preventative maintenance schedule to maintain manufacturing equipment, tools and workstations.
9.3.MN-PPD.1	Produce quality products that meet manufacturing standards and exceed customer satisfaction.
9.3.MN-PPD.5	Develop procedures to create products that meet customer needs.
9.3.MN-PRO.4	Coordinate work teams when producing products to enhance production process and performance.
9.3.MN-QA.1	Evaluate production operations for product and process quality.
<u>Career Ready Practices</u>	
CRP6.	Demonstrate creativity and innovation.
CRP7.	Employ valid and reliable research strategies.
CRP8.	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP9.	Model integrity, ethical leadership and effective management.
CRP10.	Plan education and career paths aligned to personal goals.
CRP11.	Use technology to enhance productivity.
CRP12.	Work productively in teams while using cultural global competence.
Interdisciplinary Connections	
Standard x.x	
Integration of Technology	
Standard x.x	
CPI #	Cumulative Progress Indicator (CPI)
Instructional Focus	
Enduring Understandings	
<ul style="list-style-type: none"> ● Students will understand the different tools of manufacturing ● Students will understand the different tools used in production. ● Students will understand the responsibilities of the tool operator. ● Sheetmetal is a versatile material often used in place of wood. ● There are various ways of bonding materials together. 	



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Essential Questions
<ul style="list-style-type: none">● How do OSHA rules and regulations apply to machine shop safety?● Why is a thorough understanding of tools' proper operation so vital?● How do tools allow you to perform better?● What different tools can be used in production?● What are the responsibilities of the operator?● How has technology influenced the progression of material working?● In what occupations is a knowledge of sheet metal work important?
Evidence of Learning (Assessments)
<p>Successful completion of:</p> <ul style="list-style-type: none">● Capstone project:<ul style="list-style-type: none">○ Small Paper toolbox○ Small Sheetmetal Toolbox○ Large Sheetmetal Toolbox● Midterm● Safety Quizzes (Stepping Shear, Pan Brake, Press Notcher, Spot Welder)
Objectives
<p>Students will know:</p> <ul style="list-style-type: none">● the difference in assembly techniques● how to safely use the appropriate power or hand tool for the requested job● how to solve problems logically● how to read a bill of materials● the proper progression of sanding grits● how to apply paint to a project● how to self evaluate● how to appropriately manage time● basic machine diagnostics <p>Students will be able to:</p> <ul style="list-style-type: none">● layout fold and cut lines on material● layout fastener locations on material● create rough cuts to approximate length● make finish cuts to perfect size● file/sand material to desired size and finish● assemble projects using mechanical fasteners● assemble projects using resistance welding techniques● hole repair with epoxy/body filler● prepare project for painting● complete a rubric● follow procedural calendar to stay on task and track their progress● proper and appropriate usage of hand tools: Hammer, Punch, Tin Snips, Hand Drill, Awl/Scratcher● proper and appropriate setup and usage of machinery: Stepping Shear, Pan Brake, Press Notcher, Spot Welder
Integration



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Technology Integration
Writing Integration
Competencies
Suggested Resources

Metalworking

Grades: 9-12

Unit III:

Arc Welding

Summary and Rationale

Arc welding is one of several fusion processes for joining metals. By applying intense heat, metal at the joint between two parts is melted and caused to intermix - directly, or more commonly, with an intermediate molten filler metal. Upon cooling and solidification, a metallurgical bond is created. Since the joining is an intermixture of metals, the final weldment potentially has the same strength properties as the metal of the parts. This is in sharp contrast to non-fusion processes of joining (i.e. soldering, brazing etc.) in which the mechanical and physical properties of the base materials cannot be duplicated at the joint. A good journeyman welder will be able to join metal in such a way that it is not able to be parted unless it is cut. Welding is an absolutely essential component of industries such as the automotive industry, the construction industry and even the aviation industry.

Recommended Pacing

1 Marking Period

Standards

[Career and Technical Education 9.3](#)

9.3.12.AC.1	Use vocabulary, symbols and formulas common to architecture and construction.
9.3.12.AC.3	Comply with regulations and applicable codes to establish and manage a legal and safe workplace.



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9.3.12.AC.5	Describe the roles, responsibilities, and relationships found in the architecture and construction trades and professions, including labor/management relationships.
9.3.12.AC.6	Read, interpret and use technical drawings, documents and specifications to plan a project.
9.3.12.AC-CST.2	Describe the approval procedures required for successful completion of a construction project.
9.3.12.AC-CST.3	Implement testing and inspection procedures to ensure successful completion of a construction project.
9.3.12.AC-CST.4	Apply scheduling practices to ensure the successful completion of a construction project.
9.3.12.AC-CST.5	Apply practices and procedures required to maintain jobsite safety.
9.3.12.AC-CST.8	Demonstrate the construction crafts required for each phase of a construction project.
9.3.12.AC-CST.9	Safely use and maintain appropriate tools, machinery, equipment and resources to accomplish construction project goals.
9.3.12.AC-DES.2	Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues.
9.3.12.AC-DES.8	Apply standards, applications and restrictions pertaining to the selection and use of construction materials, components and assemblies in the project design.
9.3.12.AC-MO.1	Recognize and employ universal construction signs and symbols to function safely in the workplace.
9.3.MN.6	Demonstrate workplace knowledge and skills common to manufacturing.
9.3.MN-HSE.1	Demonstrate the safe use of manufacturing equipment.
9.3.MN-HSE.4	Evaluate a system of health, safety and/or environmental programs, projects, policies or procedures to determine compliance.
9.3.MN-LOG.2	Demonstrate proper handling of products and materials in a manufacturing facility.
9.3.MN-MIR.5	Implement a preventative maintenance schedule to maintain manufacturing equipment, tools and workstations.
9.3.MN-PPD.1	Produce quality products that meet manufacturing standards and exceed customer satisfaction.
9.3.MN-PPD.5	Develop procedures to create products that meet customer needs.
9.3.MN-PRO.4	Coordinate work teams when producing products to enhance production process and performance.



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9.3.MN-QA.1	Evaluate production operations for product and process quality.
<u>Career Ready Practices</u>	
CRP6.	Demonstrate creativity and innovation.
CRP7.	Employ valid and reliable research strategies.
CRP8.	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP9.	Model integrity, ethical leadership and effective management.
CRP10.	Plan education and career paths aligned to personal goals.
CRP11.	Use technology to enhance productivity.
CRP12.	Work productively in teams while using cultural global competence.
<u>Interdisciplinary Connections</u>	
Standard x.x	
<u>Integration of Technology</u>	
Standard x.x	
CPI #	Cumulative Progress Indicator (CPI)
Instructional Focus	
<u>Enduring Understandings</u>	
<ul style="list-style-type: none"> ● The use of electricity can produce heat significantly higher than the combustion of gas mixtures. ● An understanding of different arc welding techniques, settings, and equipment will greatly improve one's ability to arc weld on variety of metals including their thickness, position, and joint type. ● The fusing of two or more metals together is a process of safely and correctly blending heat, shielding element and filling materials. ● Basic welding beads and padding are the basic building blocks for more advanced welding skills. 	
<u>Essential Questions</u>	
<ul style="list-style-type: none"> ● How do OSHA rules and regulations apply to machine shop safety? ● In what occupations is a knowledge of arc welding important? ● What are the benefits of arc welding over other adhesion processes? ● What are the limitations of arc welding? ● What is the effect of electrical shock on the human body? ● How can quality control be used as a learning process? ● How does current and polarity affect the weld? ● How do the various welding positions affect the settings for a welding machine? ● Why is the skill of running flat beads necessary and helpful when you begin welding more advanced techniques? 	
<u>Evidence of Learning (Assessments)</u>	
Successful completion of:	



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- Safety Quiz Electric Arc Welder
- Capstone project (Practice welding plates: Starting dots, Connecting dots to form beads, Creating “donuts” or circular beads, Creating Letters, Welding Plaque Project)

Objectives

Students will know:

- how the process of welding occurs
- the difference between AC, DC+, and DC-- welding machines
- the different parts of a welding machine
- the different protective gear: beanie/hat, welding mask, leather coat, gloves, apron, boot covers
- how to safely use the appropriate power tool for the requested job
- how to identify the type of welding rod required
- how to set the proper operating amperage for the requested job
- the three weld patterns for creating a bead (circular, zigzag, and step)
- about slag: what is it? why is it formed? what is its purpose?
- the purpose of arc force, and how the angle of the rod affects the penetration of weld depth
- the difference in flat, vertical, horizontal, and overhead welding
- how to identify common welding defects and how to address them
- the proper progression of sanding/grinding grits
- how to self evaluate
- how to appropriately manage time
- basic machine diagnostics

Students will be able to:

- start an arc
- maintain an arc
- create a weld bead
- finish a weld bead correctly
- clean a weld bead
- inspect a weld bead
- grind welds flat
- create a butt joint
- complete a rubric
- follow procedural calendar to stay on task and track their progress
- proper and appropriate setup and usage of machinery (arc welder, angle grinder, bench grinder and/or wire wheel, power hacksaw and/or bandsaw)

Integration

Technology Integration

Writing Integration

Competencies

Suggested Resources



Nutley Public Schools

Metalworking

Grades: 9-12

Unit IV: Metal Turning	
Summary and Rationale	
Turning is a machining process in which a cutting tool, typically a non-rotary tool bit, describes a helical toolpath by moving more or less linearly while the workpiece rotates. The tool's axes of movement may be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear (in the nonmathematical sense). Students will be introduced to several different machining processes including: turning, facing, drilling, boring, reaming, knurling, and threading.	
Recommended Pacing	
1 Marking Period	
Standards	
Career and Technical Education 9.3	
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9.3.12.AC-CST.4	Apply scheduling practices to ensure the successful completion of a construction project.
9.3.12.AC-CST.5	Apply practices and procedures required to maintain jobsite safety.
9.3.12.AC-CST.8	Demonstrate the construction crafts required for each phase of a construction project.
9.3.12.AC-CST.9	Safely use and maintain appropriate tools, machinery, equipment and resources to accomplish construction project goals.
9.3.12.AC-DES.2	Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues.



Nutley Public Schools

9.3.12.AC-DES.8	Apply standards, applications and restrictions pertaining to the selection and use of construction materials, components and assemblies in the project design.
9.3.12.AC-MO.1	Recognize and employ universal construction signs and symbols to function safely in the workplace.
9.3.MN.6	Demonstrate workplace knowledge and skills common to manufacturing.
9.3.MN-HSE.1	Demonstrate the safe use of manufacturing equipment.
9.3.MN-HSE.4	Evaluate a system of health, safety and/or environmental programs, projects, policies or procedures to determine compliance.
9.3.MN-LOG.2	Demonstrate proper handling of products and materials in a manufacturing facility.
9.3.MN-MIR.5	Implement a preventative maintenance schedule to maintain manufacturing equipment, tools and workstations.
9.3.MN-PPD.1	Produce quality products that meet manufacturing standards and exceed customer satisfaction.
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Career Ready Practices	
CRP6.	Demonstrate creativity and innovation.
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CRP11.	Use technology to enhance productivity.
CRP12.	Work productively in teams while using cultural global competence.
Interdisciplinary Connections	
Standard x.x	
Integration of Technology	
Standard x.x	
CPI #	Cumulative Progress Indicator (CPI)



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Instructional Focus
Enduring Understandings <ul style="list-style-type: none">● A Dial Caliper and Micrometer are the industry standard for measuring round parts accurately.● An understanding of the lathe, the safety rules associated with them, the types of products that can be made with them and how to properly use them are necessary skills for the Machining and Engineering Students.
Essential Questions <ul style="list-style-type: none">● How do OSHA rules and regulations apply to machine shop safety?● Why is plan reading important to machining?● How does turning speed and feed rate affect the surface finish of a product?● How does safety in the Metals Shop translate to safety outside of school?
Evidence of Learning (Assessments)
Successful completion of: <ul style="list-style-type: none">● Safety Quiz Metal Lathe● Capstone project (Turning project)
Objectives
Students will know: <ul style="list-style-type: none">● and identify internal and external operations● the different parts of a metal lathe● the purpose of cutting oil/lubricant for machining operations● how feed rate effects finish quality of material● how to safely use the appropriate power tool for the requested job● how to set the proper operating speeds for the requested job● the three types of tool holder orientations (left hand, right hand, straight)● and identify 2 types of tool posts (compound, quick change)● how to file/sand their product● how to self evaluate● how to appropriately manage time● basic machine diagnostics Students will be able to: <ul style="list-style-type: none">● set proper speed/feed rates● chuck their part in a lathe● Internal Operations:<ul style="list-style-type: none">○ drilling○ boring○ reaming○ chamfering○ threading● External Operations<ul style="list-style-type: none">○ rough turning○ finish turning○ contour○ taper○ facing



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- chamfering
- knurling
- threading
- polishing
- complete a rubric
- follow procedural calendar to stay on task and track their progress
- proper and appropriate setup and usage of machinery (lathe, power hacksaw and/or bandsaw)

Integration

Technology Integration

Writing Integration

Competencies

Suggested Resources