

Lincoln Machine, Inc.
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Contact: Chad Lichtenberg – Vice President

Lincoln Machine was founded in 1972 by John Laux. The company's original name was Lincoln Machine and Marine. John grew the business and in the 80's moved the business location so that eventually he would have a facility of 24,000 sq. ft.

The present owners, Linda and Bob Lichtenberg, took ownership of Lincoln Machine in 1991. They continued to grow the business and acquired additional manufacturing space. It was during this time that Lincoln Machine began the equipment design/build division, LMI Automation. In 2001 Lincoln Machine moved to a new facility of 60,000 sq. ft. at its present location, 6401 Cornhusker Hwy. Lincoln, NE.

Lincoln Machine's skilled employees are responsible for it's growth and customer satisfaction. These artisans and engineers, daily step forward and give the customer superior service. With over 750 man-years of machinist, tool maker and engineering experience, Lincoln Machine can find solutions for your needs.

Website:

<http://www.lincolnmachine.com/index.html>

Shop Cameras:

<http://www.lincolnmachine.com/cams.html>

Technical Information: <http://www.lincolnmachine.com/technical_information.html>

## “Our mission is business growth and customer satisfaction. Quality service is necessary to achieve these goals. Each employee is the source of quality.”

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Grade Level: High School



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Website: Lincolnmachine.com - “Challenge the Machine” with low volume/high precision work

Problem 1:

Strands: Number Operations 11.1.2.c, Data Analysis 11.4.2.a

Grade Level: 10-12

Problem #1

Employees at Lincoln Machine have unlimited overtime available and are compensated at 1.5 times the hourly wage for those hours worked beyond the 40-hour work week. Suppose a 22-year old worker is making $23.50 hourly. Being a motivated young adult, he works 52 hours a certain week, 49 hours the next week, 42 hours the following week, and finishes the month off with a 60 hour work week.

1. What is the worker’s gross earnings for that month?
2. What was the average number of hours worked per week during the 4 week period?
3. Suppose the highly motivated worker continues to work at the same pace over the course of a year. Forecast his gross earnings over the period of a full 52-week year.
4. It’s tax time! Let’s assume this 22-year old worker is single. Below is a chart for 2015 federal taxes (source: taxes.about.com). How much should be paid in federal taxes?

|  |
| --- |
|  |
| **2015 Tax Rate** | **Single** | **Head of Household** | **Married Filing Separately** | **Married Filing Jointly** |
| *Ordinary Income* | *Long Term Capital Gains and Qualified Dividends* | *Taxable Income over* | *to* | *Taxable Income over* | *to* | *Taxable Income over* | *to* | *Taxable Income over* | *to* |
| 10% | 0% | $0 | $9,225 | $0 | $13,150 | $0 | $9,225 | $0 | $18,450 |
| 15% | 0% | 9,225 | 37,450 | 13,150 | 50,200 | 9,225 | 37,450 | 18,450 | 74,900 |
| 25% | 15% | 37,450 | 90,750 | 50,200 | 129,600 | 37,450 | 75,600 | 74,900 | 151,200 |
| 28% | 15% | 90,750 | 189,300 | 129,600 | 209,850 | 75,600 | 115,225 | 151,200 | 230,450 |
| 33% | 15% | 189,300 | 411,500 | 209,850 | 411,500 | 115,225 | 205,750 | 230,450 | 411,500 |
| 35% | 15% | 411,500 | 413,200 | 411,500 | 439,000 | 205,750 | 232,425 | 411,500 | 464,850 |
| 39.6% | 20% | 413,200 | -- | 439,000 | -- | 232,425 | -- | 464,850 | -- |

1. Let’s not forget the state income tax. The most current tax code for State of Nebraska is given below (source: [www.revenue.nebraska.gov](http://www.revenue.nebraska.gov)) for a single taxpayer. How much should be paid in state income tax?

Individual Income Tax 2014

|  |  |  |
| --- | --- | --- |
| If income is over- | But not over –  | The Nebraska income tax is: |
| $ 0 | $ 3,000 | 2.46% of Nebraska Taxable Income |
| 3,000 | 18,000 | $ 73.80 + 3.51% of the excess over $3,000 |
| 18,000 | 29,000 | $ 600.30 + 5.01% of the excess over $18,000 |
| 29,000 | –– | $ 1,151.40 + 6.84% of the excess over $29,000 |

1. What is this worker’s net annual earnings once federal and state taxes are deducted?



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Grade Level: 10-12

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1. What is the worker’s gross earnings for that month?

$5,275.75 ($3,760 regular wage + $1.515.75 overtime wage)

1. What was the average number of hours worked per week during the 4 week period?

50.75 hours/wk (203 hours ÷ 4 weeks)

1. Suppose the highly motivated worker continues to work at the same pace over the course of a year. Forecast his gross earnings over the period of a full 52-week year.

$68,584.88 ($1,318.94 weekly x 52 weeks)

1. It’s tax time! Let’s assume this 22-year old worker is single. Below is a chart for 2015 federal taxes (source: taxes.about.com). How much should be paid in federal taxes?

|  |
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| **2015 Tax Rate** | **Single** | **Head of Household** | **Married Filing Separately** | **Married Filing Jointly** |
| *Ordinary Income* | *Long Term Capital Gains and Qualified Dividends* | *Taxable Income over* | *to* | *Taxable Income over* | *to* | *Taxable Income over* | *to* | *Taxable Income over* | *to* |
| 10% | 0% | $0 | $9,225 | $0 | $13,150 | $0 | $9,225 | $0 | $18,450 |
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| 39.6% | 20% | 413,200 | -- | 439,000 | -- | 232,425 | -- | 464,850 | -- |

$12,939.97 federal taxes ($922.50 + $4,233.75 + $7,783.72)

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Individual Income Tax 2014

|  |  |  |
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| 29,000 | –– | $ 1,151.40 + 6.84% of the excess over $29,000 |

 $3,859.01 state income taxes ($1,151.40 + $2,707.61)

1. What is this worker’s net annual earnings once federal and state taxes are deducted?

$51,785.90 net income ($68,584.88 - $12,939.97 - $3,859.01)

Additional Teacher Notes: Follow-up discussion could include budgeting--Dave Ramsey could be a great source at [www.daveramsey.com](http://www.daveramsey.com) to have students investigate how much of their take-home pay should go to housing, food, car, etc.



LINCOLN MACHINE – Ben Welsch, Jill Krienke, Phyllis Severson

STRAND – MA 11.2.3.a

Grade Level – HS

Mathematical Processes – Modeling, Communication, & Connections

Problem #2

Paul comes to your machinist shop and needs 5,000 ellipse shaped washers to use in his fencing business. He wants to know how much it will cost and how long it will take. What cost and time options do you give Paul to complete his order? Each workday at your machinist shop is 8 hours.

A mold needs to be created to fabricate each ellipse washer. Each mold takes 30 minutes to make and costs $15. Once the molds are created, each washer takes 4 minutes to set and costs 35 cents.

Problem 2: TEACHER NOTES:

How many molds do I need to make?

* cost $15 per mold
* time is 30 minutes per mold

 (16 molds per day = $240)

How fast can I make the washers with *x* molds?

* 15 washers per mold per hour

 ($1,750 for 5,000 washers)

Students can trade answers to pick which option is best (Time vs. Money)

Sample Answers:

|  |  |  |  |
| --- | --- | --- | --- |
| 32 molds | 24 molds | 16 molds | 8 molds |
| $2230 | $2110 | $1990 | $1870 |
| 26.5 hours | 26 hours | 29 hours | 46 hours |



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Strands- Tolerance Interval 12.3.3.b

Grade Level: 10-12

Problem #3

Quality control at Lincoln Machine is a process which occurs in a temperature controlled environment of 68 degrees Fahrenheit due to expansion of materials that can occur in heat. In turn, the customer gets an accurate product with precision 1/20th the width of a hair or better. Suppose an order for a clamp cylinder root adapter part needs accuracy of 0.0003 inch tolerance. Quality control specialists determine that the part is 0.00028 inch too long.

1. Does the part make the cut or does it get rejected? Explain your reasoning.
2. Lincoln Machine has the ability to reverse engineer most parts brought in from customers. Suppose a customer comes into Lincoln Machine with a request for a part similar to the one he has in hand, but he wants it to be 20% larger for his next project. If the part he has in hand has a diameter of 6.2 inches, how big should the diameter be for the enlarged part? Assuming the tolerance is 0.0003 inch, give a possible acceptable range for this larger diameter.



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1. Does the part make the cut or does it get rejected? Explain your reasoning.

It makes the cut! 0.00028 inch is less than 0.0003 inch.

1. Lincoln Machine has the ability to reverse engineer most parts brought in from customers. Suppose a customer comes into Lincoln Machine with a request for a part similar to the one he has in hand, but he wants it to be 20% larger for his next project. If the part he has in hand has a diameter of 6.2 inches, how big should the diameter be for the enlarged part? Assuming the tolerance is 0.0003 inch, give a possible acceptable range for this larger diameter.

7.44 inches for 20% larger diameter (6.2 inches + 1.24 inch) with an acceptable range of 7.4397 inches to 7.4403 inches (7.44 – 0.0003 inch and 7.44 + 0.0003 inch)

Additional Teacher Notes: A hook for students could be for the teacher to show a video of a measuring tool called the FaroArm which can be found at [www.faro.com](http://www.faro.com) to give the students exposure to this technology used. The FaroArm is a portable coordinate measuring machine (CMM) that allows manufacturers easy verification of product quality by performing 3D inspections and reverse engineering.



LINCOLN MACHINE – Ben Welsch, Jill Krienke, Phyllis Severson

STRAND – MA 11.3.3.d

Grade Level – HS

Mathematical Processes – Problem Solving & Modeling

Problem #4

You are finishing a lathe project for your friend Mary at the machinist shop. The piece needs a hemisphere removed from the bottom of the cylinder block to create a new steel cap. After the piece is finished it needs to be moved to the threader machine. You can only lift 50 pounds per safety regulations at the shop or you must use a lift to move the piece. Find how much the finished steel cap weighs and if you need a lift to move the steel cap safely. Steel weighs 0.284 lb/in3.

Dimensions of the cylinder block:

 height of block – 6 inches

 diameter of block – 10 inches

Problem 4 TEACHER NOTES:

Volume of the cylinder: πr2h = π x 52 x 6 = 471.23 in3

Volume of hemisphere:  =  =  = 261.8 in3

Volume of steel cap: 471.23 – 261.8 = 209.43 in3

Weight of steel cap: 209.43 in3 x 0.284 lb/in3 = 59.48 lbs

Yes, you need to use the lift.



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Strands- Geometry Measurement 11.3.3.a, 11.3.3.d

Grade Level: 10-12

Problem #5

Lincoln Machine has a CNC machine which weighs 75,000 pounds on its own and can hold 25,000 pounds on its table. The table dimensions are 10 feet along the x-axis, 7 feet along the y-axis, and 3 feet along the z-axis. This large CNC machine is still highly accurate at 0.005 inch tolerance.

1. Lifting materials to such a large machine can have its own challenges for workers, and they must be able to estimate weights of items so they can determine the load capacity they need to use to lift the load to the table. For instance, in order to approximate the weight of stainless steel, a worker should multiply the volume of a load in cubic inches by a constant of 0.284. Suppose a rectangular prism load of stainless steel measures 5.4 feet x 3.6 feet x 1.8 feet. What is the approximate weight of this load of stainless steel?
2. Aluminum is much lighter than stainless steel. In order to approximate the weight of a load of aluminum, the worker would multiply the volume by a constant of 0.098 for each cubic inch. Suppose a load of aluminum measures 6 feet x 4.3 feet x 1.8 feet. If the capacity load for a machine is limited to lifting 5 tons, should the worker use that machine to lift this load of aluminum? Explain your reasoning.



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17,172.4 pounds (5.4 ft x 3.6 ft x 1.8 ft x 0.284 lb per cubic inch x 12 in x 12 in x 12 in)

1. Aluminum is much lighter than stainless steel. In order to approximate the weight of a load of aluminum, the worker would multiply the volume by a constant of 0.098 for each cubic inch. Suppose a load of aluminum measures 6 feet x 4.3 feet x 1.8 feet. If the capacity load for a machine is limited to lifting 5 tons, should the worker use that machine to lift this load of aluminum? Explain your reasoning.

Go for it! It is less than 10,000 pounds of aluminum (approx 7,864.3 pounds of aluminum: 6 ft x 4.3 ft x 1.8 ft x 0.098 pound per cubic inch x 12 in x 12 in x 12 in), which is well below the 5 ton pound limit for the machine.



LINCOLN MACHINE – Ben Welsch, Jill Krienke, Phyllis Severson

STRAND – MA 7.2.2.c

Grade Level – MS

Mathematical Processes – Problem Solving

Problem #6

In setting up the lathe to fabricate new aluminum table legs, Geoff needs to pick the correct Speed, rpm (revolutions per minute) of the lathe, and Feed (inches per minute) of the cutter tool. Using the Speed and Feed formulas, find the Speed (revolutions per minute) and Feed (inches per minute).

 & 

Part Diameter = 2 inches

SFM (surface feet per minute) = 500 ft/min

IPR (inches per revolution) = 0.015 in/rev

Problem 6 TEACHER NOTES:

 =  = 955 rev/min

 =  = 14.325 in/min



Lincoln Machine Problem 8- Team Members: Jill Krienke- Columbus Lakeview, Ben Welsch- Hastings, Phyllis Severson- Exeter Milligan

Strand: Algebra MA 11.2.3.a

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Melissa needs to find the currents used in the above network at Lincoln Machine. She knows that by Kirchoff’s Current Law that $I\_{1}-I\_{2}-I\_{3}=0$ and by Kirchoff’s Voltage Law as well as Ohm’s Law that $2I\_{1}+5I\_{3}-40=0$ and $10I\_{2}-5I\_{3}-30=0.$ Using any method to solve systems of equations determine the voltage of each current to the nearest thousandth amp.



Working with the above electrical network write and solve a new system of equations to determine the voltage of each current.

Teacher Page-Lincoln Machine Problem 8- Team Members: Jill Krienke- Columbus Lakeview, Ben Welsch- Hastings, Phyllis Severson- Exeter Milligan

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Working with the above electrical network write and solve a new system of equations to determine the voltage of each current.

 