Lesson/Unit Title	**Math for a Digital Age**
Day(s)	5 days
Grade Levels	10-12
Curriculum Areas	Introduction to Information Technology or related courses
Website(s)	**www.crucial.com** and **www.kingston.com** Websites to help you find the right memory for your computer! **http://www97.intel.com/discover/JourneyInside/TJI_Microprocessors_lesson2/default.aspx** Intel's "Journey Inside a Computer!" Above link is Lesson 2, but check out Lessons 1-6 for other interactive, computer-related lesson plans! **http://compnetworking.about.com/od/basicnetworkingconcepts/l/blconvertbases.htm** Binary & decimal number converter **http://vlaurie.com/computers2/Articles/hexed.htm** Hexadecimal numbers explained
Teacher Resources	• Discovering Computers 2004, Shelly, Cashman, Vermatt • Cisco Networking Academy Program IT Essentials I (available from **www.ciscopress.com**) • "*Math in a Digital Age*" PowerPoint (attached) • Computers for students to dismantle • Computers with Internet access
Unit Overview	This unit introduces students to math concepts related to computers. Basically every operation performed by computers utilizes numbers and mathematical concepts. Computer data is made up of a series of "ones" and "zeros" utilizing the binary, hexadecimal, and other similar systems. Computer programming utilizes many mathematical concepts, functions and applications. This unit focuses on number-related terminology and number systems. At the end of the unit, students will: • Explain and identify measurement related technology terminology • Understand how a computer represents data • Be able to convert decimal numbers to binary and hexadecimal numbers • Determine the current configuration of memory on a computer and determine the maximum amount of memory the computer can contain
Nebraska Frameworks Essential Learnings	**Information Technology** **Computer Hardware and Operating Systems BE 12.14.1** Students will understand current and emerging hardware and operating systems. They will demonstrate competency by indentifying and describing various types of hardware components, operating systems, software and utilities.
Link to Nebraska Standards	**Reading/Speaking/Listening** • Students will use multiple forms to write for different audiences

	Mathematics • Students will solve theoretical and applied problems using numbers in equivalent forms, radicals, exponents, scientific notation, absolute values, fractions, decimals, and percents, ratios and proportions, order of operations, and properties of real numbers
NBEA Curriculum Standards	**Information Technology:** **V Application Software** **Level 3 Performance Expectations** • Use advanced features of common application software **Information Technology:** **XIV Technical Support and Training** **Level 2 Performance Expectations** • Tutor others in information technology skills in a cooperative and collaborative manner • Identify, evaluate, and use resources for problem identification and resolution
National Economics Standards	N/A
National Personal Finance Standards	N/A
Nebraska Math Standards	**12.2 Computation/Estimation** 12.2.1 Solve theoretical and applied problems using numbers in equivalent forms 12.2.3 Perform estimations and computations of real numbers mentally, with paper and pencil and with technology
Teaching Strategies, Procedures and Activities	***Day 1*** ***Step 1:*** Bell ringer—Students will blog on the topic "Can computers think?" ***Step 2:*** *"Math In A Digital Age"* powerpoint introducing the system unit and an overview of components ***Step 3:*** Students in groups of two will open computer case and identify the components of the system unit ***Day 2*** ***Step 1:*** Bell ringer—Students will identify system unit components removed from a computer ***Step 2:*** PowerPoint discussing processors focusing on processors and how they work ***Step 3:*** Students in groups of two will take out processors of test computers and reinstall processors ***Day 3*** ***Step 1:*** Bell ringer—Students review how processors work **http://www97.intel.com/discover/JourneyInside/TJI_Microprocessors_lesson2/default.aspx** ***Step 2:*** "*Math In A Digital Age*" powerpoint discussing how computers represent data and covering decimal to binary and hexadecimal conversion

<table>
<tr><td></td><td>Step 3: Students will complete Number Conversion and Number Systems Worksheets 1 and 2 (attached)

Day 4
Step 1: Bell ringer—Students will use Binary and Decimal Number Converter to practice converting numbers (http://compnetworking.about.com/od/basicnetworkingconcepts/l/blconvertbases.htm)
Step 2: PowerPoint discussing memory and measurement related terminology
Step 3: Students will open system units and locate memory and determine total amount of memory in computer and total amount computer could hold
Step 4: Students complete “Memory Challenge”

Day 5
Step 1: Bell ringer—Students will share their experiences using the web sites crucial.com and kingston.com and offer tips to students on which site they prefer to use to find memory for their computer
Step 2: Students will finish “Memory Challenge”
Step 3: Review of memory and number conversion</td></tr>
<tr><td>Assignments</td><td>Worksheet 1: Number Conversion
Worksheet 2: Number Systems
Memory Challenge Assignment: NOTE: “Memory Challenge” answers vary, depending on computer(s) used</td></tr>
<tr><td>Math Applications</td><td>Students will convert numbers from decimal to binary and hexadecimal. (See Number Conversion and Number Systems handouts)
Students will calculate amount of memory needed to upgrade computer (see Memory Challenge handout)</td></tr>
<tr><td>Assessment</td><td>Students will be assessed in the following areas:
<table>
<tr><th>Unit Evaluation Criteria</th><th>Points</th></tr>
<tr><td>Bell ringers</td><td>0- 5</td></tr>
<tr><td>Student participation in discussion</td><td>0-10</td></tr>
<tr><td>Identification of system unit parts</td><td>0-10</td></tr>
<tr><td>Removal/installation of processor</td><td>0-10</td></tr>
<tr><td>Number Conversion Worksheet</td><td>0-25</td></tr>
<tr><td>Memory Challenge</td><td>0-40</td></tr>
<tr><td>Points Possible</td><td>100</td></tr>
<tr><td colspan="2">Grading Scale: Instructor Comments:
A = 100-90
B = 80-89
C = 70-79
D = 60-69
F = 0- 59</td></tr>
</table></td></tr>
<tr><td>Teacher</td><td>Mickie Mueller</td></tr>
<tr><td>School</td><td>Norfolk Senior High</td></tr>
</table>

Worksheet 1: Number Conversion

Converting Numbers Overview **Estimated Time:** 25 Minutes

Objective
Upon completion of this lab, the student will be able to identify the places in binary and decimal numbers and know the value of each. Also, the student will work with powers often and relate them to decimal places, as well as work with powers of two and relate them to binary places. Finally, the student will manually convert between simple binary umbers and decimal numbers and describe the differences between binary and decimal umber systems.

Scenario
Having sharp skills in number systems will aid in a career as an IT professional. With the ability to convert numbers without the use of a calculator, the student will be able to solve problems that may arise quickly and easily.

Procedures
This lab will help the student learn to work with the binary number system. The student will convert binary numbers (Base 2) to decimal numbers (Base 10) and then from decimal to binary. Computers and networking equipment, such as routers, use binary numbers. A binary number is a series of BITS (short for Binary Digits) that are either ON (a binary 1) or OFF (a binary 0). They are encoded internally in the PC on microchips and on the computer motherboard bus as electrical voltages. Understanding binary numbers and how they relate to decimal numbers is critical to understanding how computers work internally.

Step 1
The decimal number system is based on powers of ten. This exercise will help to develop and understand how the decimal number system is constructed. With Base 10, the rightmost place has a value of one (as with Base 2). Each place moving to the left is valued ten times more. Ten to the zero power is one ($10^0 = 1$), 10 to the first power is 10 ($10^1 = 10$), 10 to the second power is 100 ($10^2 = 10\times10 = 100$), ten to the third power is 1000 ($10^3 = 1000$), and so on. Just multiply the number in each place with the value of each place (for example, $400 = 4\times10^2 = 4\times100$). Remember that any number (other than zero) to the zero power is one.

The following chart shows how the decimal number system represents the number 352,481. This will help in understanding the binary number system.

Exponent	10^5	10^4	10^3	10^2	10^1	10^0
Expanded	100000	10000	1000	100	10	1
Numeral	3	5	2	4	8	1
	3 x 100,000	5 x 10,000	2 x 1,000	4 x 100	8 x 10	1 x 1

The number 352,481, if read from left to right in expanded decimal form, is (3 x 100,000) + (5 x 10,000) + (2 x 1,000) + (4 x 100) + (8 x 10) + (1 x 1), for a total of 352,481 (a six digit number).

Here is another way to look at it that makes it easier to add up the decimal number values:

Position of digit (from right)	**Value of bit position (10^X or ten to the power of)**	**Number value from 0 to 9**	**Calculation**	**Decimal Value**
1st Decimal Digit	10^0 or 1	1	1 x 1	1
2nd Decimal Digit	10^1 or 10	8	8 x 10	80
3rd Decimal Digit	10^2 or 100	4	4 x 100	400
4th Decimal Digit	10^3 or 1,000	2	2 x 1,000	2,000
5th Decimal Digit	10^4 or 10,000	5	5 x 10,000	52,000
6th Decimal Digit	10^5 or 100,000	3	3 x 100,000	300,000
Decimal Value (Total of 6 digits)				352,481

Step 2
Binary means “two” and each digit in a binary number can only have two values (0 or 1). Understanding Binary numbers is key to understanding how computers work. The value of each binary digit, or bit, is based on powers of two.

This exercise will help develop an understanding of powers of two, which is what all computers and data communications use. With Base 2, the right-most place has a value of 1 (as with Base 10). Each place moving to the left is valued two times more. Two to the zero power is one (20 = 1), two to the first power is two (21 = 2), two to the second power is four (22 = 4), two to the third power is eight (23 = 8), and so on. Just multiply the number in each place (either a 0 or a 1) by the value of each place (for example, 8 = 23 = 1×8) and add up the total. Remember that any number (except zero) to the zero power is one.

Binary Number Conversion Example
The following table shows the detailed calculations (starting from the right side) to convert the binary number 10011100 into a decimal number.

Position of digit (from right)	**Value of bit position (two to the power of)**	**Is bit a One (on) or a Zero (off)**	**Calculation**	**Decimal Value**
1st Binary Digit	2^0 or 1	0	0 x 1	0
2nd Binary Digit	2^1 or 2	0	0 x 2	0
3rd Binary Digit	2^2 or 4	1	1 x 4	4
4th Binary Digit	2^3 or 8	1	1 x 8	8
5th Binary Digit	2^4 or 16	1	1 x 16	16
6th Binary Digit	2^5 or 32	0	0 x 32	0
7th Binary Digit	2^6 or 64	0	0 x 64	0
8th Binary Digit	2^7 or 128	1	1 x 128	128
Decimal Value (Total of 6 digits)				156

Step 3

Look at the binary number bit status. If there is a "1" in a given position, add the value shown. If there is a "0" in a given position, do not add a value.

Solve for the decimal equivalent values:

Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Bit Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1
Binary Number Bit Status	1	0	0	1	1	1	0	0

Decimal Value =

Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Bit Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1
Binary Number Bit Status	1	1	1	0	0	0	1	1

Decimal Value =

Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Bit Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1
Binary Number Bit Status	0	1	1	1	0	0	0	0

Decimal Value =

Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Bit Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1
Binary Number Bit Status	1	1	0	1	1	0	1	0

Decimal Value =

Step 4

Convert the decimal values of 209, 114, 58, and 165 to the binary equivalents. To do this, look at the decimal value and then subtract binary values starting from 128 (the highest value binary bit for these number). If the number is larger than 128 then put a 1 in the 128 (or 2^7) column. Subtract 128 from the number and then see if there is 64 or greater left over. If there is, put a one there. Otherwise, put a zero and see if there is 32 or greater left over. Continue until all eight bits are defined as either a zero or a one.

Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Bit Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1
Binary Number Bit Status								

Used with permission. Norfolk High School, Nebraska.

Binary value of 209 =

Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Bit Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1
Binary Number Bit Status								

Binary value of 114 =

Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Bit Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1
Binary Number Bit Status								

Binary value of 58 =

Exponent	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Bit Position	8	7	6	5	4	3	2	1
Value	128	64	32	16	8	4	2	1
Binary Number Bit Status								

Binary value of 156 =

Step 5
Check the answers by converting the numbers back to decimal.

Troubleshooting
Learning how to calculate binary numbers without the use of a calculator is an important skill in the IT Industry. The ability to perform number conversions can save time, especially in the field where calculators are not always available.

Reflection
Using the system learned to solve decimal to binary conversion, convert the decimal number 255 to binary.

Binary value of 255 =

Worksheet 2: Number Systems

1. **Define the following**:

Decimal:

Binary:

Hexadecimal:

2. **Explain how binary and hexadecimal numbers are used with computers.**

3. **Without using a calculator, convert the binary numbers into decimal numbers:**

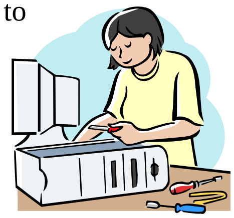
A	**01111011 =**	F	**00000111 =**
B	**11110000 =**	G	**10101010 =**
C	**01010101 =**	H	**10010011 =**
D	**00111001 =**	I	**11111111 =**
E	**11010101 =**	J	**10000000 =**

4. **Convert these decimal numbers into binary numbers**:

A **23 =**	D **131 =**
B **3 =**	E **234 =**
C **79 =**	F **199 =**

Updated 6/06

Memory Challenge Exercise



One of the least expensive and easiest upgrades for anyone to do to a computer is to increase the amount of memory in the computer. Increasing the amount of memory in a computer will speed up a computer and make it capable of handling graphics, gaming and additional programs. Increasing the memory in a computer will involve purchasing the memory and installing it.

1. Determine amount of memory currently installed. To do this, go to Start→Programs→Accessories→System Information

   Answer the following questions by visiting **www.crucial.com** or **www.kingston.com**

2. Determine the amount of memory your computer can contain. Determine the number of memory slots your computer has:

   Determine the maximum size of memory module your computer can hold:

3. Take the number of *memory slots* X *the maximum size of memory module* to determine total memory:

4. Determine how much memory you want to add:

5. Look inside the system unit to determine your current memory configuration. The current memory configuration will determine what new memory modules you should buy to increase the memory amount to the amount determined in Step 4. Memory modules come in different amounts. Typical amounts are 128 MB, 256 MB, 512 MB, 1 GB or 2 GB. If your computer has four memory slots and currently has 512 MB of memory, it could have one 512 MB module with three empty slots; it could have two 256 MB modules with two empty slots; it could have four 128 MB modules with no empty slots. If you want to be able to upgrade your memory again, buy bigger modules and fill fewer slots.

   Current memory configuration:

6. Determine the type of memory to buy for your system. It is important that you buy memory that is designed for your system. Look in your documentation or visit the web sites above to determine the type of memory you need:

7. How much will it cost to upgrade your system to your desired amount of memory (Step 4)?

Memory Challenge (Page 2)

Additional Exercises:

1. Assume you have a computer that contains 256 MB of memory. It contains four memory slots. Each slot can contain 128 MB or 256 MB memory modules. Two slots contain 128 MB memory modules. What memory modules would you buy to increase the memory on the computer to 512 MB? What is the maximum memory on the computer?

2. Assume you have a computer that contains 1GB of memory. It contains four memory slots. Each slot can contain 128 MB, 256 MB, 512 MB or 1 GB memory modules. Currently, each slot contains a 256 MB memory module. What combinations of memory modules will satisfy your memory upgrade to 2 GB? Visit one of the web sites listed above to determine which of these combinations is the least expensive.