Lesson	*Objectives*	*Material*
Intro	Introduction to course	Course documents
1.0	Introduction to Quantitative Reasoning	Introduction to Quantitative Reasoning
1.1	Review of basic arithmetic skills	Getting started
1.2	Vocabulary - Prefixes & Units	Handout material
1.3	Dimensional Analysis	Cost of Power
1.4	Percentages	Cost of Power
1.5	Scientific notation & Engineering Notation	Talking Engineering
1.6	Fractions and Ratios	Transformers

Prerequisite Assumptions
Before beginning the lesson, students should be able to;

- Multiply two fractions
- Divide two fractions
- Simplify fractions by 'canceling' or dividing common factors in the numerator and denominator
- Multiply fractions by 1 to create a common denominator.

Quantitative reasoning: You might be surprised that you are asked to write short responses to questions. This course emphasizes writing for the following two reasons:

- Writing is a learning tool. Explaining things such as the meaning of data, how you calculated the data, or how you know your answer is correct deepens your own understanding of the material.
- Communication is an important skill in quantitative literacy. Quantitative information is used widely in today's world in products such as reports, news articles, publicity materials, advertising, and grant applications.

Understanding the task: One important strategy is to make sure you understand the task. In this course, your tasks will be answering questions in the assignments, but in other life situations the task might be answering a question on a report form, following instructions from your employer, or working towards a goal that you set for yourself. To begin to write successfully, ask yourself the following questions:

- What is the question / task?
- What is the task telling me to do? Some examples are given below:
  - ✓ Reflect and describe on the process of coming up with the answer.
  - ✓ Make a prediction
  - ✓ Compare two data points or the answers to two parts of the problem
- What information am I given to help me with the task?

Does the information make sense? During this course, you will be presented with a number of problem situations. These problem situations will help you learn how to evaluate the types of quantitative information you may encounter in everyday life.

For example, math gets used every time you decide which cable package to sign up for, when you get a medical bill, and when you look at interest on your credit cards. Marketers use math sometimes to make a product seem better or more widely used than it actually is — how can you make good decisions and save money if you can't tell when they're being sneaky? Math also gets used in politics all the time. On TV they report surveys that, for instance, say 80% of people approve of something – but 80% of which people? These types of everyday math problems don't require complicated math – it's mostly addition, subtraction, division, etc. But they do require complex thinking. And this course is about using straightforward math to do complex thinking

When presented with a problem situation you should;

- Write down the question / task.
  - ✓ Reflect and write the process of coming up with the answer. You may also make a prediction at this point to develop an insight into the problem.
- Write down the information you are given
- Solve the problem.

Specific Objectives

By the end of this lesson, you should understand;

- ✓ quantitative reasoning is the ability to understand and use quantitative information. It is a powerful tool in making sense of the world
- ✓ relatively simple math can help make sense of complex situations
- ✓ 1,000,000,000, and 10^9, and 1G have the same meaning
- ✓ Engineering notation.

By the end of this lesson, you should be able to;

- ✓ identify quantitative information
- ✓ convert to and from engineering notation
- ✓ understand how to work with fractions and ratios
- ✓ understand how to calculate percentage increases and decreases
- ✓ work in groups and participate in discussion.

Problem Situation 1.2 - Cost of power – *Dimensional analysis, percentages, units*

1) A watt, named after James Watt, is a unit of power and is defined as the rate of energy transfer. An electronic device, such as a refrigerator, microwave, motor or hair dryer converts electrical energy into mechanical energy or heat. These devices consume electrical energy and typically the wattage listed on the label is the power consumption. A microwave is typically between 600 to 1200 watts, a refrigerator is about 1200 watts and light bulbs range from 5 watts to 300 watts. The watt is the rate energy is used or produced, a watt is one joule during one second, so the same quantity may be referred to as a joule per second, with the symbol J/s. A kilo Watt (kW) is 1000 Watts. Your electric bill is based on the power consumed each month in kilo Watt hours (kWh), 1000 Watts consumed in 1 hour.

   Madison Gas and Electric (MGE) has a rate seasonal rate structure with summer rates charged from June 1 through September 30 and the winter rate applies the remainder of the year.

Per kWh Rate	
Total Per-kWh Charges	
Summer – 6/1-9/30	***Winter – 10/1-5/31***
$0.141630	$0.130250

   How much would a refrigerator cost to operate annually if it runs about 45% of the 24-hour day? This refrigerator consumes 1200 Watts of power when it is running.

2) If you were to replace this refrigerator with a more efficient refrigerator that consumes 1000 W of energy and only runs 38% of the 24-hour day. How much would this refrigerator cost to operate annually?

3) If this refrigerator cost you $980, how many years would it be to get the return on your investment. Would the purchase of a new refrigerator be wise?

4) What is the percent saved over the course of a year with this new refrigerator?

5) A family has had a 19” LED for many years. It consumes about 20 Watts of energy and this household watches about 3 hours of TV a day. For Christmas, they want to purchase a 50” plasma TV that consumes about 300 Watts of energy. What is the actual cost of operating each TV at $0.141630/kWh and what is the percentage increase in energy consumption for the new 50” plasma TV over the course of a 30-day month?

Problem Situation 1.3 Talking Engineering – *Engineering notation*

Engineering notation is used quite a bit, especially in electronics. It is a form of writing and talking about really big and really small numbers easily. It is a version of scientific notation in which the exponent of ten must be divisible by three and the number left of the decimal point must be between 1 and 999 inclusive. We also use the metric prefix.

Name	Symbol	Multiplier	Value
tera	T	10^{12}	1,000,000,000,000
giga	G	10^{9}	1,000,000,000
mega	M	10^{6}	1,000,000
kilo	k	10^{3}	1,000
		10^{0}	1
milli	m	10^{-3}	0.001
micro	µ	10^{-6}	0.000001
nano	n	10^{-9}	0.000000001
pico	p	10^{-12}	0.000000000001

1) We are surrounded by digital information from digital pictures, files, music, movies, etc. These bits of data are stored in hard drives, servers and in the cloud all across the world. Digital information is stored in bits and each bit is either a zero or a one. A bit, which is the smallest unit of storage, contains information that is defined by two separate states, one or zero often considered on or off. EXAMPLE: A car door is closed / open ↔ 1 / 0.

   There are 8 bits in a group called a byte. A letter in a text message requires a byte of storage space. If your message is 19 letters, it takes 19 bytes to store.

   In 1975 a 5.25" floppy disk had a whopping capacity of 110 kilobytes. By the mid 1980's a single compact disc, CD, could hold 550 megabytes. In 2009 the first terabyte hard drive was introduced.

   Given the following digital information determine the number of bits and bytes.

Device	bytes	bits
110 kilobyte (KB) disk		
324 character text message		
2.5 Terabyte (TB) hard drive		
4 GigaByte (GB) memory		

2) There are 2 values that can be represented with 1 bit, it can either be 0 or 1. The number of values represented doubles for every additional bit. 2 bits can be 00, 01, 10, 11 - 4 potential configurations for 2 bits. Mathematically: n bits = 2^n potential values.

Bits	2^n		Potential configurations							
1 bit	2^1	2	0	1						
2 bits	2^2	4	00	01	10	11				
3 bits	2^3	8	000	001	010	011	100	101	110	111
4 bits	2^4	16								
5 bits	2^5	32								
6 bits	2^6	64								
7 bits	2^7	128								
8 bits	2^8	256								

How many configurations are there for 16 bits and 32 bits?

3) ASCII is an encoding system used to represent each type character by a number that can be stored in 1 byte. Example: A is 01000001, B is 01000010, a is 01100000 and space is 000100000. Determine how many bytes will be required to type in the message:

Math the only subject that counts.

4) We live in an analog world with all things in nature being continuous variable physical quantities. The wind, a swing, music, etc. are all analog systems. Computers and computing systems are digital therefore the analog information must be converted to digital information. The best example of this is a typical clock; analog clocks have hands that are in motion constantly and a digital clock only needs to sample the time every 1 second.

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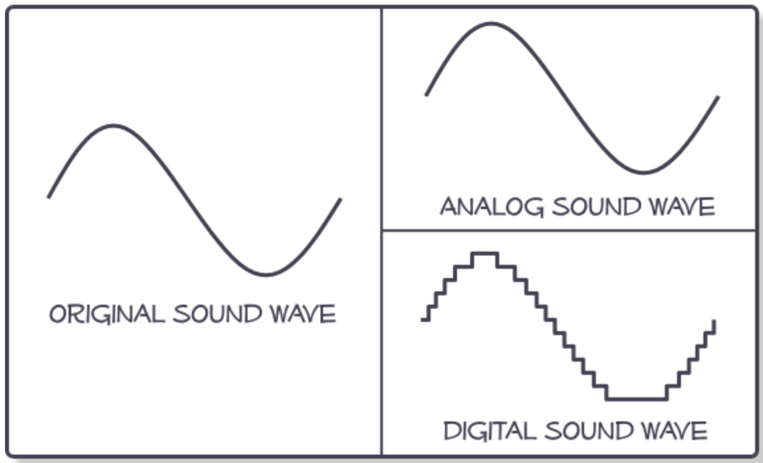
The frequency that sampling occurs is called the sampling rate and is given in samples per second with a unit of Hertz (Hz). The sampling rate of 60 Hz is 60 samples per second and the sampling rate of a 55 KiloHertz (KHz), is 55,000 samples per second.

Notice in the figure below that the analog sound wave is identical to the original sound wave, however the digital sound wave is stepped. Larger sampling rates, more samples per second, shortens each step and the wave becomes more and more like the original sound wave. If you were to sample your favorite analog song only once every second you would get a much distorted group of sounds. As the sampling rate is increased the wave distortion decreases and the sound quality improves.



Given the following table determine the missing information. The top row is an example.

Sampling Rate (samples/second)	**Sampling Rate** (time between samples)	**Frequency** (Hz)	**Frequency** (eng notation with metric prefix)
1/60 = 0.01667 samples/second	*1 sample every 60 seconds*	*0.01667 Hz*	*16.67 mHz*
	1 sample every 0.001 second		
220,000,000 samples/second			
		12,000 Hz	
			12 mHz
			920 MHz