Dear Students,

Congratulations on being accepted into the WIMU Regional Program in Veterinary Medicine at Utah State University!

The following veterinary medical math (VMM) packet is intended to help you sharpen your math skills and prepare you for an easier transition into the program. During the first week of classes you will be given a math skills exam to help you gauge your own understanding of the prerequisite mathematical skills necessary for both the WIMU program, and your future career as a veterinarian. Following the initial exam, students who do not score a 90% or higher on the VMM exam will be required to take an online module course until they are able to successfully pass the VMM math exams.

While this is not intended to make you worry, adequate preparation for the math skills exam is highly recommended. The exam consists of mathematical concepts from high school and undergraduate college math classes (outlined on the following page). Though only students who do not perform at a sufficient level on the initial exam will be required to participate in the online modules, participation is strongly encouraged for all students—even the students who perform well.

I would like to stress that the math skills exam is mandatory, and you will be expected to achieve a passing score, either on the initial exam that is given the first week of classes, or after completion of the math modules. Do not take this exam lightly. I recommend jumping to the practice problems in each section of this packet first. If you find yourself struggling to answer these questions correctly, study all of the material in that section, and revisit the practice problems. Being able to answer these questions easily will help you prepare for the exam.

I wish you the best in your preparations for the beginning of the program, and I am looking forward to meeting you in person this Fall.

Best regards,

Michael S. Bishop

Introduction

In an article called "How Do Veterinarians Use Math in Their Jobs?" (see https://work.chron.com/veterinarians-use-math-jobs-17548.html) by Stephanie Fagnani, she writes:

"Veterinarians receive an education that is heavily focused on science and math to practice their trade. Whether they decide to treat only dogs and cats or less common pets such as guinea pigs and birds, they need to know how to use math to properly calculate billing charges, medication doses and surgical procedures to preserve the health of their patients."

To help you meet those needs and prepare for the math skills exam, this packet contains reference material for the following applicable math skills and topics:

I. Basic Algebraic Operations
II. Unit Conversions
III. Scientific Notation & Significant Digits
IV. Dosage Calculations
V. Fluid and Solution Calculations
VI. Basic Statistics

Preparing for the math skills exam will be left up to you during the remainder of the summer. Be advised, the topics listed above were provided mainly by your professors for your first two years of the program and have been selected as topics that, when understood, will greatly help you in your academic endeavors, as well as in your professional career.

Unit 1- Basic Algebraic Operations

I. Multiplication and Division

1. Multiplication and division of two or more positive numbers:

   When two or more positive numbers are multiplied or divided, the result will be a positive number.

   Examples: 25 x 5 = 125

   25 ÷ 5 = 5 **or** $\frac{25}{5} = 5$

2. When two negative numbers are multiplied or divided, the result will be a positive number.

   Examples: (-3) x (-3) = 9

   (-15) ÷ (-3) = 5

   (Remember: two negatives become a positive)

3. When positive and negative numbers are multiplied or divided together, the result will be a negative number.

   Examples: (-15) x (3) = -45

   (-20) ÷ (4) = -5

4. When an equation contains numbers within parentheses, that mathematical operation should be performed first.

   Examples: (5 - 3) x (-4 ÷ 2) = (2) x (-2) = -4

   (5 x 2) ÷ (-10 ÷ 5) = (10) ÷ (-2) = -5

II. Order of Operations

Above we saw some basic examples of some of the possible operations in equations, but which one do we do first? Given the following numeric statement: 4 * 5 + 2 = ? what would be the solution? Would we add first then multiply?

$$4 * 5 + 2 = 4 * 7 = 28$$

Or would we multiply first, then add?

$$4 * 5 + 2 = 20 + 2 = 22$$

If you chose the second one, you chose correctly. There is a set order to the way we perform our operations within some numerical expression (as you can see, without a set order we can get very different answers).

In the numerical world there is a set hierarchy or ranking of operations, and we perform the top tier first, followed by the second tier, and so on, it looks like this:

1. Perform parts involving Parenthesis
2. Execute any form of Exponents
3. Manipulate any operation involving Multiplication and/or Division
4. Perform any sort of Addition and/or Subtraction

III. Solving for Unknown Variables

The same basic rules apply when you have an unknown variable, as when we are simply given integers, or any number really. The only difference is that we need to remember to keep track of our variable.

1. To solve for an unknown variable when given an addition or subtraction problem, we simply need to get the variable by itself, by "undoing" what was done to it.

   Examples, solve for X:

   $$X + 2 = 5$$

   $X + 2 = 5$ is given, so we know that whatever X is, we will need to add 2 to it to make 5. So, if we took away 2 from both sides, we will be left with just X (we will have solved for X).

   Thus, we do exactly that, then we are left with: which yields our result:

   $$X + 2 = 5 \qquad X + 2 - 2 = 5 - 2 \qquad X = 3$$
   $$-2 \quad -2$$

2. The same concept of "undoing" what has been done to our variable goes on to apply to multiplication and division as well. All we are trying to do is get our variable alone on

one side of the equals sign. We undo multiplication by division, we undo division by multiplication; they are inverses of one another.

Examples, solve for X: $$\frac{4X}{5} = 4$$

Here, we have been given a problem that has 2 parts, multiplying 4 times X, and dividing that quantity by 5, yielding a result of 4. So, following our process of "undoing", lets first multiply both sides by 5 (getting rid of the division):

$$5 * (\frac{4X}{5}) = 5 * (4)$$

This then simplifies to the following:

$$4X = 20$$

Now, we are left with simply 4 times the quantity X yields 20, so to get rid of multiplication, we will divide both sides of the equality by 4:

$$\frac{(4X)}{4} = \frac{(20)}{4}$$

In doing so, we are left simply with:

$$X = 5$$

IV. Ratios

In an effort to include something on ratios for your later classes, why not do it here at the beginning? Ratios are used to compare two groups (such as number of men to women in a room) and can be written as values separated by a colon (:), or in a form that looks like a fraction. But, ratios and fractions are different; fractions such as ½ compare the 1 desired group to the total, not comparing two groups. For instance, when we have a room with 30 people in it, 10 men and 20 women, using fractions, we can say men represent 10/30 people, or reduced, men represent 1/3 of the people in the room. However, we would say that the room has a man:woman ratio of 1:2 or ½ (ratios are always reduced, we got 1:2 after reducing 10 men : 20 women). For more information, please see: http://www.purplemath.com/modules/ratio.htm.

V. Exponential and Logarithmic Equations

Exponential and logarithmic functions differ from algebraic functions, and have some special properties associated with them. Algebraic functions will have the variable in the base and the constant in the exponent. Some examples of algebraic functions are:

$$y = x^2$$

$$y = x^{1/3}$$

Exponential functions have the constant in the base, and the variable in the exponent. Some examples of exponential functions are:

$$y = 2^x$$

$$y = e^x$$

Logarithmic functions can be defined as inverses of exponential functions. Some examples of logarithmic functions are:

$$y = \log_3 x$$

$$y = \ln x$$

Two logarithmic bases that are frequently seen are base 10 and base e. If a logarithm has a base 10, it is called the **common logarithmic function**, and is usually written as $\log x$ (rather than $\log_{10} x$). The logarithm with base e is called the **natural logarithmic function** and is written as $\ln x$ (rather than $\log_e x$).

* Note: e represents an irrational number, which is approximately equal to 2.718.

To solve exponential or logarithmic equations, we rely on their properties to help us solve for the variable, x. A table of exponential and logarithmic properties has been provided for you below.

Properties of Exponents		
Let $a, b, m,$ and n be any real numbers and $m > 0, n > 0$, and $b \neq 0$; then the following are true:		
1. $b^m \cdot b^n = b^{m+n}$	**2.** $b^{-m} = \frac{1}{b^m} = \left(\frac{1}{b}\right)^m$	**3.** $\frac{b^m}{b^n} = b^{m-n}$
4. $(b^m)^n = b^{mn}$	**5.** $(ab)^m = a^m \cdot b^m$	**6.** $b^0 = 1$
7. $b^1 = b$		

Properties of Logarithms	
If $b, M,$ and N are positive real numbers, where $b \neq 1$, and p and x are real numbers, then the following are true:	
1. $\log_b 1 = 0$	**2.** $\log_b b = 1$
3. $\log_b x = x$	**4.** $b^{\log_b x} = x$
5. $\log_b MN = \log_b M + \log_b N$	*Product rule:* Log of a product is the sum of the logs.
6. $\log_b \left(\frac{M}{N}\right) = \log_b M - \log_b N$	*Quotient rule:* Log of a quotient is the difference of the logs.
7. $\log_b M^p = p \log_b M$	*Power rule:* Log of a number raised to an exponent is the exponent times the log of the number.

You should also be aware of these one-to-one properties:

if $b^x = b^y$, then $x = y$

if $\log_b x = \log_b y$, then $x = y$

Example 1:

Solve $4^{7-x} = 64$ for x.

Solution:

Substitute $64 = 4^3$.	$4^{7-x} = 4^3$
Use the one-to-one property.	$7 - x = 3$
Solve for x.	$\boxed{x = 4}$

Example 2:

Solve $5^{3x} = 16$ for x.

Solution:

Take the natural logarithm of both sides.	$\ln 5^{3x} = \ln 16$
Use the power property on the left side.	$3x \ln 5 = \ln 16$
Divide both sides by $3 \ln 5$.	$\boxed{x = \dfrac{\ln 16}{3 \ln 5}}$

You could go further and get a decimal approximation, but since we don't use calculators in this class, we will leave the answer in exact form.

Example 3:

One thing you need to be aware of for logarithmic functions is the domain. The argument of a logarithm must be greater than zero. This means that when we plug in our solution for x into the original equation, we don't end up trying to take the log of zero or a negative number.

Solve the equation $\log_4(4x - 3) = \log_4 2 + \log_4(x - 2)$.

Solution:

Apply the product property on the right side.	$\log_4(4x - 3) = \log_4[2(x - 2)]$
Apply the property of one-to-one functions.	$4x - 3 = 2(x - 2)$
Distribute.	$4x - 3 = 2x - 4$

Add 3 and subtract $2x$ from both sides of equation. $2x = -1$

Divide both sides by 2. $x = -\frac{1}{2}$

Check solution by plugging in $-\frac{1}{2}$ for x on the left side. $\log_4\left[4\left(-\frac{1}{2}\right) - 3\right]$

Simplify. $\log_4(-5)$

There is no need to check our other argument, as -5 is not in the domain of our function. Therefore, there is no solution.

VI. Practice Problems (to be done without a calculator)

Simplify (Solve) the following mathematical statements:

1. 24 x 12 =
2. 150 x (-4) =
3. 230 ÷ 5 =
4. (19 + 5 - 3) ÷ (-7) =
5. ((-40) ÷ (-20)) x 16 =
6. 0.0005 + 1.2 + 170.23 + 15 =
7. 12.18 – 0.00906 =
8. 22 + 11 ÷ 11 =
9. 15.05 × 0.1 =
10. $\frac{25}{5} * 3 =$

Solve for the missing variable, simplify your answer.

11. (2y – 5) = 7
12. (2v – 5v) ÷ 3 = 1
13. 23a – 7 = 2a + 14
14. 3(2x) – 5 = 7
15. $\frac{3x}{5} = \frac{5}{3}$

Simplify the following relations, express each situation as a ratio.

16. 12:24
17. 3:9
18. 5/25
19. A certain recipe calls for three times as much flour as water.
20. There are 38 people in a room; 24 men and 14 women.

Solve the exponential equations for *x*.

21. $2^{x^2} = 16$
22. $3e^x - 8 = 7$
23. $3e^{2x} = 18$

Solve the logarithmic equations for *x*.

24. $\log_3(2x + 1) = 2$
25. $\log(x - 3) + \log(4x) = \log(4x^2 + 2)$
26. $\ln x^2 - \ln 9 = 0$

VI. Answers

1. 288
2. -600
3. 46
4. -3
5. 32
6. 186.4305
7. 12.17094
8. 23
9. 1.505
10. 15
11. y = 6
12. v = -1
13. a = 1
14. x = 2
15. x = 25/9
16. 1:2
17. 1:3
18. 1/5
19. 3:1 or 3/1
20. 12:7 or 12/7
21. $x = -2,\ x = 2$
22. $x = \ln 5$
23. $x = \frac{\ln 6}{2}$
24. $x = 4$
25. No solution
26. $x = -3,\ x = 3$

Unit 2- Unit Conversions

I. General Idea

The main purpose of converting units is to start with some amount in one unit and to try to find some equivalent amount in a different set of units for a specific purpose. We will get into the more practical applied problems in the later units, but for now we need to understand the general idea.

Units, such as: gallons, cups, ounces, inches, liters, grams, etc. all have a specific and set meaning as well as an amount fixed to them. If we have 1 gallon of a solution, but we want to know how many quarts it is, we cannot just change the units and say that we then have 1 quart of the solution. It just doesn't work (and it should be clear why since 1 gallon of a solution does not equal 1 quart of the same solution). We need to actually convert the units; keep in mind that all we are really doing is changing the way the numbers look, we should still have the same amount that we had to start with.

II. Relations

As stated above, units give us a clear understanding of the amount, weight, mass, distance, etc. of something, so our units themselves are pre-defined. That being said, we can have a decent idea of the relationship between 2 such units. For instance: it is a fact that 1 gallon of a substance = 4 quarts of that same substance, 1 liter of a substance = 1000 milliliters of the same substance. The number and unit name may look different, but the actual amount they are describing is the same. That is the key to unit conversion.

III. The Number One

From the previous review unit (and from previous mathematics classes your whole life through) you have been taught that the number 1 can take on all sorts of different disguises, it can look many different ways, but it always holds the same value.

For instance, we know that: $\frac{1}{1} = 1$ $\frac{4}{4} = 1$ $\frac{-0.24}{-0.24} = 1$ $\frac{3.1415.....}{3.1415.....} = 1$

All of the above instances (and infinitely more) all equal 1. Even though they can look many different ways, it all boils down to dividing a number by itself, and it will always result in the answer 1: nothing more, nothing less.

Now for the fun part; we talked about the concept of relations, we said that 1 gallon of a substance = 4 quarts of the same substance, right? And that 1 liter of a substance = 1000 milliliters. So, what if we divided 1 gallon by 4 quarts of the same substance? Well, since we said they were equal (by pre-set definition), if we divided 1 gallon by 4 quarts, following our logic from above, we get 1 as our answer:

$$\frac{1\text{ gal}}{4\text{ qt}} = 1$$

To prove it, if we multiplied both sides of the equality by 4 quarts (called "undoing" the division in unit 1), we observe the following:

$$4\ \text{qt} * \left(\frac{1\ \text{gal}}{4\ \text{qt}}\right) = 4\ \text{qt} * (1)$$

Which simplifies to our starting definition:

$$1\ \text{gal} = 4\ \text{qt}$$

IV. Multiplying (or Dividing) by One

Well, at this point in your educational career there shouldn't be much to mention on this topic, it is something you should know. When you multiply (or divide) something by one, you retain its original value, no matter how that specific "one" may look (and we know from above that it can look infinitely many ways).

V. The "Aha!" Moment

Let's say that I have 2 liters of water (we'll be boring for now), and I want to know how many milliliters of water I have (tada! a unit conversion problem!).

Well this is what we are given: $2\ \text{L} = ?\ \text{mL}$

Then we think of what we know: $1\ \text{L} = 1000\ \text{mL}$ *and* $\frac{1000\ \text{mL}}{1\ \text{L}} = 1$

We then think of the concept of one, and our multiplication (and division) by 1 rule:

$$2\ \text{L} * 1 = ?\ \text{mL}$$

$$2\ \text{L} * \left(\frac{1000\ \text{mL}}{1\ \text{L}}\right) = ?\ \text{mL}$$

We cancel the units that need cancelling (thinking as $\frac{\text{liter}}{\text{liter}} = 1$), and we have simple multiplication problem:

$$2 * \left(\frac{1000\ \text{mL}}{1}\right) = ?\ \text{mL}$$

Which reduces to: $2 * 1000\ \text{mL} = 2000\ \text{mL}$

Thus, the final answer to our query is that if we have 2 liters of water, we have 2000 milliliters of water (an obvious result, but the thought process applies to harder/less straightforward conversions).

VI. Some Basic Facts

Here is a list of a few basic definition conversions, for more, you can search the web (some common metric ones are listed on the site: http://lamar.colostate.edu/~hillger/common.html):

*Volumes (U.S. to metric)	Volumes (U.S.)	Volumes (metric to metric)	Weights (metric to U.S.)
1 gal = 3.786 L	1 gal = 4 qt	1 L = 1,000 mL	1 kg = 2.2 lb
1 qt = 0.9465 L	1 qt = 2 pt	1 dL = 100 mL	1 g = 0.03527 oz
1 oz = 29.577 mL	1 pt = 2 cup	1 mL = 1,000 mcL	
1 tsp = 5 mL	1 cup = 8 oz		

(*Credit for the conversion table goes to Dr. Ralph Meyer)

Metric conversion prefixes can be seen below, they apply to grams (g), liters (L), or meters (m), shown on the "(Base)" line.

Prefix	Symbol	Factor	Prefix as Numeric Relation to Base	Name
Giga-	G	10^{9}	1 000 000 000	billion
Mega-	M	10^{6}	1 000 000	million
Kilo-	k	10^{3}	1 000	thousand
(Base)	g, L or m	10^{0}	1	one
Deci-	d	10^{-1}	0.1	tenth
Centi-	c	10^{-2}	0.01	hundredth
Milli-	m	10^{-3}	0.001	thousandth
Micro-	μ or mc	10^{-6}	0.000 001	millionth
Nano-	n	10^{-9}	0.000 000 001	billionth

VII. Practice Problems (to be done without a calculator)

1. 4 L = ? mL
2. 25 lb = ? kg
3. 47 kg =? mg
4. 4500 mcL = ? mL
5. 500 nm = ? mcm
6. 35 kg = ? g
7. 4 gal = ? L
8. 12 oz = ? g
9. 5 dL = ? mcL
10. 2 gal = ? mL

VIII. Answers

1. 4,000 mL
2. 11.4 kg
3. 4.7×10^7 mg = 47,000,000 mg
4. 4.5 mL
5. 0.5 mcm
6. 35,000 g
7. 15.144 L
8. 340.23 g
9. 500,000 mcL
10. 7572 mL

Unit 3- Scientific Notation & Significant Digits

I. Overview

To this point, all we have really dealt with is whole numbers, and small ones at that. But, we would be naive to think that the world we live and work in always dealt us numbers that were so easy to keep track and to calculate. What if we wanted to apply everything we have done to this point, just with numbers that are a little more complicated, or harder to keep track of? Well, we could just plug right on through and hopefully not make any mistakes, trying to be as accurate as possible with our values and decimals that seem to go on forever, or we can implement generally accepted notation and principles to make our work so much easier.

II. The Large and Small

As stated above, there is a widely accepted notation across the sciences that helps our lives become easier when dealing with both large and small numbers, it is called 'Scientific Notation'. To boil it all down, it lets us take a large or small number that may be easily misread, say: 1000000000000 (see it's easy to lose track of the zeroes, and hard to know exactly what number we are dealing with), and it transforms that number in a way that looks like: $1x10^{12}$.

The same pattern is also true with extremely small numbers such as 0.00000009, which would be represented as: $9x10^{-8}$. Please note that we use a base 10 power to multiply a number that is between 1 and 10 (including 1), and that we use a positive exponent on the base 10 to indicate a large number, and a negative exponent to indicate a small number. This will make more sense as we move on.

III. A Review of Powers

At this point, let's take a quick interlude to review powers. Back to Unit 1, when we were handling simple multiplication of numbers, we simply multiplied two numbers together and called it good, but what if our problems became a little more complicated? What if we were told to multiply or represent the following in a neater form? 7 x 7 x 7 x 7 x 7 x 7 x 7 x 7, well we could start by multiplying the first two numbers, so 7x7=49, then we are left with something a little cleaner: 49 x 7 x 7 x 7 x 7 x 7 x 7, and if we continued that pattern, we'd have 49 x 49 x 49 x 49 and keep going. But, if all we want to do is represent the value in a cleaner form, we could say that we have 7, eight times, or 49 four times and write them as: 7^8 and 49^4 respectively, giving us again, some tidier notation.

But wait, it gets better. Base 10 is unique and actually quite easy to work with and use, hence why we use it to simplify our lives in scientific notation. The unique thing about base 10 is that it controls the number of zeroes the number has, i.e. controls the position of the digits.

Example:

$10^0 = 1,$
$10^1 = 10,$
$10^2 = 100,$
$10^3 = 1000$

Do you see the pattern? The same holds true in the opposite direction for small numbers.

Example:

$10^{-3} = 0.001,$
$10^{-2} = 0.01,$
$10^{-1} = 0.1,$
$10^0 = 1$

So, using a base 10 in a number can help us to quickly know the magnitude of the number, exactly how big or small it is, quite quickly, then we simply multiply by the value of the leading digits.
Example:

$95070 = 9.507 \times 10^4$ and $0.0000456 = 4.56 \times 10^{-5}$

Note: When dealing with powers that are in terms of fractions, it refers to roots, which can "undo" powers,

Example: $2^2 = 4, \quad \sqrt{4} = 4^{1/2} = 2, \quad 2^3 = 8, \quad 8^{1/3} = \sqrt[3]{8} = 2$

For more information, see the following site: http://www.intmath.com/numbers/4-powers-roots-radicals.php

IV. Multiplying and Dividing

For values expressed in scientific notation, it is quite easy to multiply and divide them, due to the nature of powers having the same base. We won't get in to a lot of the details but know that we can treat each of the portions of the numbers (in scientific notation) separately.

Example:

Multiplication: $(3 \times 10^4) \times (2 \times 10^1) = (6 \times 10^5)$
Check: $30000 \times 20 = 600000$

We already know how to multiply the leading terms (the $3 \times 2 = 6$ part) but we need to keep in mind, that because powers represent multiplication of their bases already, when we multiply powers of like bases we are simply adding the powers together ($10^4 \times 10^1 = 10^5$).

For division of values expressed in scientific notation, it works much the same way. We initially divide our leading terms like normal, and then on our base 10 powers section, we will subtract the powers instead of adding them.

Example:

Division: $(3 \times 10^4) \div (2 \times 10^1) = (1.5 \times 10^3)$
Check: $30000 \div 20 = 1500$

V. The Rules of Scientific Notation (A Summary)

1. In scientific notation, the number we are trying to express is written in a way that it is larger than (or equal to) 1 but smaller than 10 and is multiplied by a power of base 10.
2. Exponents or powers in scientific notation may be positive or negative numbers. Negative exponents indicate that the original number is less than 1, whereas positive numbers indicate that the original number is greater than one.
3. To obtain the original number again (getting out of scientific notation) simply move the decimal point to the left for a negative exponent, or to the right for a positive exponent (the usefulness of base 10), the indicated number of times, as shown in the power.
4. In a number expressed in scientific notation with a 0 exponent on the base 10, then simply multiply the number by 1 to obtain the original (as $10_0=1$).
5. Operations such as multiplication and division can easily be done in scientific notation, but when performing addition and subtraction, it is best to convert all the numbers in the calculation to their original (non-scientific notation) state before performing the addition or subtraction.

VI. Rounding (An Introduction)

We all know there are times when we need to give a specific mixed number or decimal solution to a problem, and sometimes after a calculation we end up with some number that has a ton of decimals (or it goes on forever, like pi). What do we do? We typically round the number, but there are sets of rules and convention that we need to follow when rounding. First, we need to understand that rounding is a tradeoff, we may gain clarity and usability by rounding, but we also give up exactness or accuracy in our solution.

To illustrate this, we need to understand that values and numbers have certain placeholders for their digits, and we can round any value to any of these placeholders. These placeholders have specific names, and work the way you might expect:

Just remember that the decimal places count off to the right in the same order as the counting numbers count off to the left. That is, for regular numbers, you have the place values:

- ...(ten-thousands) (thousands) (hundreds) (tens) (ones) (decimal point)

For decimal places, you don't have a "oneths", but you do have the other fractions:

- (decimal point) (tenths) (hundredths) (thousandths) (ten-thousandths) ...

The distinction as to where our value is being rounded to is very important, as we can then know the accuracy of our reported value. For instance, if we rounded to the nearest tenth of a unit, then we could say that our measurement is accurate within one tenth of a unit. A simple example is to say that we measured the side of a cabinet to be 14.5 inches, rounded to the nearest half inch, meaning, that we are asserting that the actual length of the side of the cabinet is within a half inch of 14.5 inches. For some things, we need to be much more precise, such as patient drug dosages, while others it is not as necessary to be so precise (such as estimating the surface area of a cabinet, before purchasing paint to paint it).

VII. Basic Rules

As far as basic rules go, it is convention when rounding a number ending in (or having a digit after the desired rounding place) of a 0-4, to round it down to 0, a number 5-9 round it up to 10 in that place. To make sense of what was just said, we can use an example:
If we want to round 7891 to the nearest 10, we would round down, and get 7890 (because the digit following the tens place was a one).
If we want to round 7891 to the nearest 100, we would round up, and get 7900 (because the digit following the hundreds place was a 9).

VIII. Significant Digits

One more thing to keep in mind when rounding is to round to an appropriate number of "significant digits". Significant digits are the digits that tell us something about the reported value. The best way to explain them, is probably by example:

The number 3.14159 has six significant digits, meaning all digits used give us useful information,

Whereas:

The number 1000 has only one significant digit. Only the 1 gives us any information, we don't know anything for sure about the hundreds, tens or ones positions. The zeroes indicated in those places may just be placeholders, left there due to rounding.

The number 1000.0 has five significant digits. Do you see why? Once again, it has to do with what the represented number is telling us. Because the value has a .0 at the end of it, we can rather safely assume that the actual value is 1000, and that it has a decimal value that was rounded and is within one tenth (actually .05) of 1000.0.

Significant digits make it easier to view accuracy and to ensure the accuracy of what we are doing, for instance, when calculating an area (going back to the cabinet example) if we measure one side to be 14.5 inches and the other to be 20.5 inches (rounded to the nearest tenth of an inch for this example), then by multiplying the two numbers together, we get the estimated area of 297.25 square inches, but as we only originally had 3 significant digits in our measurements, we can only actually report that the estimated area is 297 square inches. For more information on this topic you may view the link:
https://www.khanacademy.org/math/arithmetic/decimals/significant_figures_tutorial/v/multiplying-and-dividing-with-significant-figures

IX. Significant Digits Rules (A Summary)

To summarize everything down, we can really break significant digits down into three basic rules, all digits that don't abide by these rules are considered insignificant.
Rules:

1) All nonzero digits are significant.
2) All zeroes between significant digits are significant.
3) All zeroes, both to the right of the decimal point and to the right of all non-zero significant digits, are themselves significant. (Trailing Zeroes)

X. Practice Problems (to be done without a calculator)

Write the following numbers in scientific notation:

1. 1001
2. 53
3. 6,926,300,000
4. -392
5. 0.00361

Convert the following numbers in scientific notation back to decimals:

6. 1.92×10^{3}
7. 3.051×10^{0}
8. -4.29×10^{2}
9. 8.317×10^{-2}
10. 6.251×10^{9}

Use Scientific Notation (and only scientific notation) to find the answer to the following problems (solutions given with correct number of significant digits in answer section):

11. $(4.1357 \times 10^{-15}) * (5.4 \times 10^{2})$
12. $(1.695 \times 10^{4}) \div (1.395 \times 10^{15})$
13. $(4.367 \times 10^{5}) * (1.96 \times 10^{11})$
14. $(6.97 \times 10^{3}) * (2.34 \times 10^{-6}) + (3.20 \times 10^{-2})$
15. $(5.16 \times 10^{-4}) \div (8.65 \times 10^{-8}) + (9.68 \times 10^{4})$

For the following, solve and write each response in scientific notation with the correct number of significant digits.

16. $(2.386 \times 10^{-1}) * (1.10 \times 10^{6}) =$
17. $3.0001 * 5 =$
18. $(1.12 \times 10^{5}) * (6.06 \times 10^{5}) =$
19. $(2.200 \times 10^{3}) * (1.9376 \times 10^{2}) =$
20. $(2 \times 10^{1}) * (3.0 \times 10^{1}) =$
21. $(5.56 \times 10^{8}) / (2.21 \times 10^{8}) =$
22. $(2.75 \times 10^{-4}) / (4.75 \times 10^{4}) =$
23. $5 / (8.14 \times 10^{2}) =$
24. $(4.92 \times 10^{2}) / (3.82 \times 10^{-4}) =$

XI. Answers

1. $1.001x10^{3}$
2. $5.3x10^{1}$
3. $6.9263x10^{9}$
4. $-3.92x10^{2}$
5. $3.61x10^{-3}$
6. 1920
7. 3.051
8. -429
9. 0.08317
10. 6,251,000,000
11. 2.2×10^{-12}
12. 1.215×10^{-11}
13. 8.56×10^{16}
14. 4.83×10^{-2}
15. 1.03×10^{5}
16. 2.62×10^{5}
17. 2×10^{1}
18. 6.79×10^{10}
19. 4.263×10^{5}
20. 6×10^{2}
21. 2.52×10^{0}
22. 5.79×10^{-9}
23. 6×10^{-3}
24. 1.29×10^{6}

Unit 4- Dosage Calculations

I. Overview

This section is intended to apply what we have learned in the other sections in a more functional manner, specifically related to the field of Veterinary Science. The instructional portion of this section will be smaller, however, if you have a firm understanding of the previous units, this section should be a capstone in a way.

Dosage calculations are essentially unit conversion problems that may involve multiple steps or conversions to get to the target units and, from there, calculate the correct dose for a specific patient.

II. Further Depth

This is not intended to scare you off, but these calculations can become quite messy if we do not think through them in a careful and organized manner. We, just as before, need to keep an eye on our units. We will tend to have a situation in which we have starting units, transitional units and ending units (our goal). We need to work with what we have to start, look at what the goal or ending desired units are, and find some sort of linking conversion that lets you get from start to finish. If that was confusing, the following example should clear things up.

Example:

You are going to do a dental extraction on a mini horse and would like to do a local block with bupivacaine. The mini horse weighs 185 lb. and you choose to use a total bupivacaine dose of 1.8 mg/kg. The bupivacaine solution concentration is 0.5% (5 mg/mL). How many mg will the patient receive? How many mL is that? Round all decimals to the nearest tenth of a unit.

This problem could seem quite mind boggling at first, but let's break it down into our different parts:
The Initial Information:

Weight: 185 lb.
Total Solution Dose: 1.8 mg/kg
Solution Concentration: 0.5% (5 mg/mL)

We know our initial weight in pounds (because we are in the U.S.) the given solution dose is in kg, so we will need to first figure out how heavy the horse is in kg. To do that, we need to know the intermediate conversion/fact that 1 kg is approximately 2.2 lb. Using that known conversion or definition, we can get the weight of the mini horse in kg.

Step 1:

185 lb = ? kg mini horse

We are multiplying by 1, keeping the represented value the same 1 lb = 2.2 kg, so:

$$\frac{1\text{ kg}}{2.2\text{ lb}} = 1$$

Therefore, we can insert it into our equation:

$$185 \text{ lb} * \left(\frac{1 \text{ kg}}{2.2 \text{ lb}}\right) = 84.1 \text{ kg}$$

Step 2:

We now know that the mini horse weighs 84.1 kg, now we need to figure out the total dose it should receive in mg. Again, we look at the given information, we have a dose of 1.8 mg/kg, and want to find out the total mg dose for this specific mini horse.

We should think:

84.1 kg is what we have, and our rate is 1.8 mg/kg so, it is a simple multiplication problem.

$$84.1 \text{ kg} * \left(\frac{1.8 \text{ mg}}{1 \text{ kg}}\right) = 151.4 \text{ mg}$$

We have found the solution to the first of the 2 questions asked; our patient (the mini horse) is receiving a 151.4 mg dose of bupivacaine.

Step 3:

To address the second question, how many mL we will be delivering to our patient for the desired dose, we will go through a similar thought process as in the first portion of the problem. We see that we have a dose of 151.4 mg and our ending units need to be mL, we need the transitional or linking information to convert our dose in mg to the amount of mL to be given.

151.4 mg = ? mL solution dose

Looking at our given information, we see that our solution concentration is 0.5%, or 5 mg/mL. We know that for this case of conversion, we have 5 mg of bupivacaine for every 1 mL of solution. We can re-write this as:

$$\frac{5 \text{ mg}}{1 \text{ mL}} = 1 = \frac{1 \text{ mL}}{5 \text{ mg}}$$

Since both sides (through multiplication) both equal 1, we can insert it into our equation:

$$151.4 \text{ mg} * \frac{1 \text{ mL}}{5 \text{ mg}} = 30.3 \text{ mL}$$

Thus, the answer to the second question is that our patient will receive 30.3 mL of the bupivacaine solution.

III. Practice Problems (to be done without a calculator)

1. A patient is ordered 45 mg of a drug by injection. The drug is available in 20 mg/5 mL. How many mL should be administered?

2. A drug dose is ordered for a patient for a total of 14 g. The drug is available as 0.006 kg/10 mL. How much would be administered (in mL)?

3. A 50-pound dog ingested 200 g of candy that contains 40% dark chocolate. Dark chocolate contains approximately 127 mg theobromine per ounce of chocolate. Estimate the exposure dose to theobromine (in mg/kg).

4. The doctor has ordered 40 mg of a specific drug be administered to a patient. The vial for the drug comes as 125 mg/2 mL. How many mL will you give?

5. Your patient is a diabetic and requires insulin for blood sugar coverage. The patient's blood sugar is 234 and requires 4 units for coverage. The vial contains 1,000 units of insulin in 100 mL. How many mL will you administer to the patient?

IV. Answers (Final answers rounded to 2 decimal places where rounding was necessary)

1. 11.25 mL
2. 23.33 mL
3. 15.77 mg/kg
4. 0.64 mL
5. 0.4 mL

Unit 5- Fluid and Solution Calculations

I. Introduction

This will be probably one of the mathematics skills that you will use most in your future career as a veterinarian, as fluid and solution rates are dramatically important. In your classes (specifically in Veterinary Gross Anatomy your first few semesters) you will learn how to properly palpate animals and test for hydration as part of a regular physical examination of the animal. In class, or through other means, you will become accustomed to testing for hydration and gain a working knowledge base so that you are able to diagnose any form of hydration issues through a simple skin test. But, what do we do after; do we give all patients the same dose of fluids? No. We will be covering hydration calculations in this section, we will leave the diagnosis methods up to you and the class.

II. Maintenance vs. Replacement Fluid Rates

First, we need to establish a simple baseline for understanding. We will be talking about 2 different rates for fluids, a maintenance fluid rate and a replacement fluid rate. Maintenance fluid is administered to patients that are currently adequately hydrated, but may lose their ability to continue to stay hydrated (i.e. they are going in for surgery and cannot eat or drink for the duration of the surgery). The maintenance rate is used to replace any water loss due to natural bodily functions, such as respiration. The maintenance fluid rate that you should become very familiar with (and is used at USU and WSU), is **50 mL/kg/day**, that is that over the course of a day, we will administer 50 mL of water per kg weight of the patient. Often times, we will need to calculate this further into the hourly rate, but we will get to that later on.

Should we however find that our patient is dehydrated, we will need to administer fluids at a replacement fluid rate, meaning that we will be administering fluids at a rate greater than their body is naturally expelling the moisture, so we will be administering a dose greater than the maintenance fluid rate (50 mL/kg/day). The degree or amount that the replacement fluid rate is greater than the normal maintenance rate differs depending on the degree of dehydration (or attributing ailment such as: vomiting, bleeding, etc.), we will calculate this in the next section, keeping in mind that our diagnosis of the degree of dehydration (such as 5% dehydrated) refers to the amount of extra fluid needed in addition to the maintenance fluid rate, based on the subject's weight.

III. Calculating a Maintenance Fluid Rate

To start off simply, lets calculate the maintenance fluid rate necessary for our patient "Bailey", a dog. Bailey has been brought to our office to be spayed, even though Bailey showed a normal level of hydration, when conducting the surgery, we will still administer fluids, just to make sure she stays hydrated throughout the procedure. Our drip IV system needs to be calibrated based on an hourly dose, so we will need to find the hourly maintenance fluid rate for our patient. During the pre-op, we found that our patient weighs in at 25 kg (we weighed in kg, but if it had been in pounds, remember that 1 kg = 2.2 lb approximately).

Calculate the hourly maintenance fluid rate for Bailey. How much fluid will be administered to Bailey over the course of 30 minutes?

Solution:

Start with our standard fluid maintenance rate:
50 mL/kg/day

We know that our specific patient weighs 25 kg, so we can set up a multiplication problem to multiply our 50 mL/kg/day by 25 kg:

$$25\ \text{kg} * 50\ \text{mL/kg/day} = 1250\ \text{mL/day}$$

We then see that our maintenance dose specific to Bailey (all 25 kg of her) results in a rate of 1250 mL/day. But, we aren't quite finished yet; we need to figure out the hourly rate for the fluid, not the daily. Thus, we then convert our units from mL/day to mL/hour (re-visiting unit 2).

We know that 1 day = 24 hrs, thus we know that: $\frac{1\ \text{day}}{24\ \text{hrs}} = 1$

Now, it is in the form of 1, so we can use it in our unit conversion:

$$\left(\frac{1250\ \text{mL}}{1\ \text{day}}\right) * \left(\frac{1\ \text{day}}{24\ \text{hrs}}\right) = 52\ \text{mL/hr}$$

Thus, we found Bailey's hourly fluid maintenance rate of approximately 52 mL/hr

To answer the second portion of the question, (how much will Bailey receive during the 30 min procedure) we will show the thought process step by step, even though in this case the numbers work out nicely that you probably already know the answer.

First, we will start with our hourly fluid rate: 52 mL/hr, then we will convert it over to the unit mL/min, as we want to know how many mL Bailey will receive over the course of 30 min.

So, we need to know that 1 hr = 60 min, thus also knowing that: $\frac{1\ \text{hr}}{60\ \text{min}} = 1$

We follow the same procedure above:

$$\left(\frac{52\ \text{mL}}{1\ \text{hr}}\right) * \left(\frac{1\ \text{hr}}{60\ \text{min}}\right) = 0.87\ \text{mL/min}$$

Now, we remember that we want to know the total amount after 30 minutes, so we multiply 0.87 mL/min by 30 min:

$$\left(\frac{0.87\ \text{mL}}{1\ \text{min}}\right) * 30\ \text{min} = 26\ \text{mL}$$

Thus, over the course of the surgery Bailey will receive 26 mL of fluids.

IV. Calculating a Replacement Fluid Rate

Ok for this example, we will stick with our good old pal Bailey the dog, the same information applies: Bailey is 25 kg and comes in for a visit to our clinic. This time though, Bailey hasn't been feeling as well, and we notice that she is 5% dehydrated, thus we will need to put her on a replacement fluid rate or regimen. From above, we know that a replacement fluid rate will be more than a maintenance fluid rate (it makes sense, we aren't just maintaining fluid levels, we are adding more fluid to our patient because they are dehydrated), so it is one way to double check our answer.

First step, we calculate Bailey's maintenance fluid rate like before (in this case, we will skip the computations; if confused see above), yielding a maintenance fluid rate of 1250 mL/day, which is 52 mL/hr.
Second step, we need to calculate how much replacement fluid to give Bailey, extra fluid being fluid added to the maintenance fluid rate in order to compensate for the level of dehydration.

Since Bailey is 5% dehydrated, we will take her weight in kilograms (25 kg) and multiply that by the percent of dehydration (5% = 0.05):

$$\left(\frac{0.05}{1\text{ day}}\right) * 25\text{ kg} = \left(\frac{1.25\text{ kg water}}{1\text{ day}}\right)$$

Thus, we need to replace 1.25 kg worth of water per day, since our instruments measure the water in terms of mL/hr, we will need to convert 1.25 kg water into mL water. For that, we need to look at our fact sheet and see that 1 kg water = 1000 mL water, thus:

$$\left(\frac{1000\text{ mL water}}{1\text{ kg water}}\right) = 1$$

Which gives us:

$$\left(\frac{1.25\text{ kg water}}{1\text{ day}}\right) * \left(\frac{1000\text{ mL water}}{1\text{ kg water}}\right) = \left(\frac{1250\text{ mL water}}{1\text{ day}}\right)$$

Once again, we have our answer in terms of mL water/day, and we want it per hour, thus, we will divide it by 24 hours, as 1 day = 24 hours.

$$\left(\frac{1250\text{ mL}}{1\text{ day}}\right) * \left(\frac{1\text{ day}}{24\text{ hrs}}\right) = 52\text{ mL/hr}$$

Thus, we have our extra fluid rate portion (to replace the 5% dehydration), and it coincidentally (not always the case) is the same as our maintenance fluid rate. To get our final replacement fluid rate all we need to do is add these two together, as we need to maintain what we have as well as add extra fluid.

Our final replacement fluid rate: $52\text{ mL water/hr} + 52\text{ mL water/hr} = 104\text{ mL water/hr}$

V. Practice Problems (to be done without a calculator, maintenance rate = 50 mL/kg/day)

1. You have an order to give a patient a 1 liter solution over 2 hours, then 100 mL/hr for 12 hours. What is the total mL of fluid the patient will receive over the first 6 hours?
2. Calculate the hourly maintenance fluid rate for our patient (in mL/hr) if our patient weighs 66 pounds (1 kg = 2.2 lb). How much fluid will be administered to the patient over the course of two and a half hours?
3. Calculate the hourly replacement fluid rate in (mL/hr) for the patient in question #2, if they are found to be 7% dehydrated.
4. Calculate the hourly replacement fluid rate in mL/hr of a patient who is 95 lb. and found to be 3% dehydrated.

VI. Answers (Final Solutions rounded to 2 decimal places where rounding was necessary)

1. 1400 mL
2. 62.5 mL/hr, 156.25 mL in first 2.5 hours
3. 150 mL/hr
4. 144 mL/hr

Unit 6- Basic Statistics

I. Introduction

What is statistics? The American Statistical Association (or ASA) posted a quote on their webpage (http://www.amstat.org/careers/whatisstatistics.cfm) answering that very question:

"Statistics is the science of learning from data, and of measuring, controlling, and communicating uncertainty; and it thereby provides the navigation essential for controlling the course of scientific and societal advances (Davidian, M. and Louis, T. A., 10.1126/science.1218685)."

Keeping that in mind, statistics is a broad field that keeps expanding, and has applications in almost every field of development, research and decision-making. Acknowledging the immense scope of the topic, we will only be able to cover a very small overview of general statistics.

II. Experiments and Studies

Statistics is a field that is used largely in decision making and gleaning of knowledge in order to answer a question, which is often done through experiments and/or studies. These two terms do not carry the same weight; they are different. Studies, specifically observational studies are done when a person or team observes a set of responses or variables and records results, generally over a period of time. An experiment is more hands on, first certain specific variables are selected for study and the experiment is designed in a way to eliminate as much bias as possible, keeping all variables the same throughout the experiment except for the ones in question, the ones specifically selected to have differences. The result or effect of these planned differences is monitored and recorded. Probably the biggest difference between observational studies and designed experiments is the issue of *association* versus *causation*. Since observational studies don't control any variables, the results can only be *associations* between observed variables. Because variables are controlled in a designed experiment, we can have conclusions of *causation* between two or more variables. At this point we will not go into detail on the many different types or designs of experiments and studies, but know that there are a wide variety that serve different purposes.

III. Descriptive and Inferential Statistics

In general, there are two types of statistics, or reasons that statistics are performed that being descriptive statistics and inferential statistics. Descriptive statistics provide a concise summary of data. You can summarize data numerically or graphically, it just takes some sort of data, such as the tracked data for surgery wait times for pet owners in your clinic over a 2-week period and organizes it in a way that is easy to read and understand, in order to glean some sort of information from it. Inferential statistics use a random sample of data taken from a population, to describe and make inferences about the population. Inferential statistics are valuable when it is not convenient or possible to examine each member of an entire population. These types of statistics are widely used in such things as quality control, where it would be impractical to measure all products produced, but due to a random sample of the product, we can make assumptions or inferences about the population.

IV. Mean

When describing certain aspects, we use terms such as the mean, or average to get an idea of the central tendency of the data, meaning what some of the middle and expectedly more common outcomes are. Note, the mean is highly affected by outliers and skewed distributions, under certain conditions, such as a normal distribution (looks like a bell curve) the mean and median will be roughly the same. To calculate the mean, we will add up all of our observed values, and divide them by the total number of observed values.

Calculation: Mean= $\frac{n1 + n2 + ... + nN}{N}$

Where n1, n2, etc. are individual observed values, and N is the total number of observed values.

V. Median

The median, like the mean, grants insight into central tendencies of the data, meaning it shows us roughly where the middle value is, suggesting that it would likely be the most common value (depending on the distribution). The median is much more robust to skewedness and outliers, meaning that it is not affected or swayed from the middle of the distribution of data as easily as the mean due to these factors. To calculate the median, we will line all the observed values up in numerical order and select the middle value (or an average of the 2 middle values if there is an even number of observations).

VI. Mode

The mode is very helpful in identifying tendencies in the data when our data is categorical, rather than numerical (such as people's reported favorite color, rather than their height). Continuing with the color example, we would list all of the available colors that had "votes" as being people's favorite, and the one that was the most favorite, i.e. had the most votes, and would be the mode. Mode has to do with a variable's frequency of being observed.

VII. Range

The range has to do with, well exactly that, the range of the data. So, when you arrange the data from least to most (when numerical), it is easy to pick out your maximum value and your minimum value. After having done that, if we subtract our minimum value from our maximum value, it will give us an idea of the spread of the data, the range.

Range Calculation: $MaxValue - MinValue = Range$

VIII. Basic Charts

In some of your courses, you will need to create, or at least interpret basic charts to represent your data. When doing statistics on a project or experiment, it is most helpful if we can organize our data in a simple, yet clear to read chart for ourselves, as well as those around us. Below is an example of a simple chart for an experiment:

	Vaccinated	Un-Vaccinated	Totals
Tested +	10	40	50
Tested -	400	160	560
Totals	410	200	610

On the chart above, I just made a generic chart with made-up data, but it makes it very easy to see different rates and totals. We have our column of vaccinated patients, our column of un-vaccinated patients, and our column of totals (the two cells to the left of the total cell add together to make up the total for that row, such as 10+40=50 in the example above). Also, we have our results, so the top row would be the patients who tested positive for some disease (i.e. 50 out of the 610 in the experiment) and patients who tested negative for the disease (560 out of 610), as well as a row of totals for the individual groups. The table above is in a format that is easy to view and summarizes our findings well. In your courses you will be expected to be able to read and interpret basic charts such as the one above.

IX. Tests

Sometimes we want to run a cheap or inexpensive test in order to see if more treatments are needed for a specific patient, these tests are not often 100% reliable, as there tends to be some room for random chance error in all things. Below is another chart, but this one is a little different, on one side, we will have the results of the test, on the top we will have the actual status of the animal, to show if the test was correct or not in detecting the disease or ailment.

	True Status		
	Pos	Neg	Total
Test Pos	1675	325	2000
Test Neg	225	2775	3000
Total	1900	3100	5000

We can view right away that the test we ran on the 5000 subjects was not 100% accurate; we can see that we had a total of 1900 patients with the specified disease, and the test reported that 2000 had the disease (some of which really did not have it, this would be a false positive) out of our 5000. It is a similar story for the reported negative amounts.

Above, we saw a case, when we had some false positives and false negatives, shouldn't there be some statistic to let us know how good a test is? There are, they are called sensitivity and specificity. (see https://en.wikipedia.org/wiki/Sensitivity_and_specificity for more information)

X. Sensitivity

Sensitivity is the **percent** out that were true positives, in other words, it measures as a percent, the proportion of those subjects that were reported sick by the test, out of those that were actually sick. In our example above, we had 1675 that the test reported sick (true positives), and we know that in truth, there were 1900 that were actually sick, so the computation for the sensitivity of the test is as follows:

$$Sensitivity = \frac{NumberTruePositives}{NumberSickIndividuals} = \frac{1675}{1900} = 0.88$$

XI. Specificity

Specificity relates to how well the test is able to correctly detect patients without a condition or disease. In our example above, we have 2775 patients that the test reported as true negatives, in other words, the test reported they did not have a disease, and in truth, they did not have the disease. We also had a reported number of 3100 whom actually and truly did not have the disease.

Thus, the calculation is as follows:

$$Specificity = \frac{NumberTrueNegatives}{NumberWellIndividuals} = \frac{2775}{3100} = 0.90$$

XII. Practice Problems (to be done without a calculator)

Identify if the following situations are experiments or studies and explain why:

1. A researcher asks college students how many hours of sleep they get on an average night and examines whether the number of hours of sleep affects students' grades.
2. A Parks Department employee wants to know if latex paint is more durable than non-latex paint. She has 50 park benches painted with latex paint and has 50 park benches painted with non-latex paint.
3. To test the redesign of its website, an online bookseller assembled 96 users of the site and randomly divided them into two groups. One group used the new website to make an online purchase and one group used the old website to do the same transaction. Users of the new site were able to complete the purchase 22% faster.

Use the following dataset to identify or calculate the desired information.

Ages of study participants: 24, 28, 39, 32, 55, 43, 36, 40, 38, 39, 22, 26, 39, 42, 39.

4. What was the mean age of the participants?
5. What was the median age of the participants?
6. Treating each age as a separate category, what was the mode for the data set?
7. What is the range of the data set?

Given the chart below, answer the following questions.

	True Status		
	Pos	Neg	Total
Test Pos	3,467	765	4,232
Test Neg	1,039	5,643	6,682
Total	4,506	6,408	10,914

8. Calculate the sensitivity of the given test (above).
9. Calculate the specificity of the given test (above).

XIII. Answers

1. The researcher gathers data without controlling the individuals or applying a treatment. The situation is an observational study.
2. A treatment (painting benches with latex paint) is applied to some of the individuals (benches) in the study. The situation is an experiment.
3. Experiment; a treatment (use of a new Web site) is imposed on some individuals (Web site users).
4. 36.13 or 36 years old
5. 39 years old
6. 39 years old
7. 33 years
8. 0.77 or about 77%
9. 0.88 or about 88%