Basic Math Review for PSYC 2321: Data Analysis for Psychology

This document is designed to help students understand the basic level of mathematics needed to succeed in PSYC 2321, an introductory statistics course for psychology students. In this course, you will work with statistical theories, concepts, and methods, and apply them to psychological research questions. A solid foundation in basic math will support your success throughout the course.

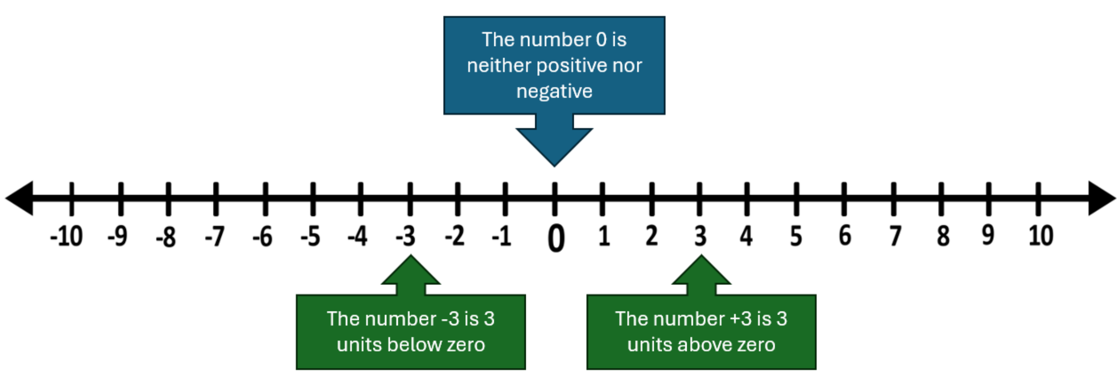
Note: You are welcome to use a basic or scientific calculator to help with these types of problems, and you will be allowed to use one throughout the course.

Part 1: Basic Concepts, Symbols and Notation

Symbol	Meaning	Example
$+$	Addition	$2 + 6 = 8$
$-$	Subtraction	$6 - 2 = 4$
x or ( )	Multiplication	$6\ x\ 2 = 12$ or $(6)(2) = 12$
$\div$ **or** /	Division	$6 \div 2 = 3$ or $6/2 = 3$ or $\frac{6}{2} = 3$
$>$	Greater than	$6 > 3$
$<$	Less than	$6 < 8$
$\neq$	Not equal to	$6 \neq 8$
$\boldsymbol{x^2}$	Square or power of 2	$3^2 = 9$
$\boldsymbol{\sqrt{x}}$	Square root of	$\sqrt{16} = 4$

Positive and Negative Numbers

Positive numbers are greater than zero (e.g., +3 or just 3). Negative numbers are less than zero (e.g., –3). Numbers without a sign in front of them are positive. You can think of numbers as units away from zero, in either the positive or negative direction: +3 is 3 units above zero and -3 is 3 units below zero. They are the same distance from 0 (3 units) but in opposite directions.



Absolute Values

The absolute value of a number is its distance from zero, no matter the direction. It's always positive. For example, the absolute value of 4 is 4, and the absolute value of –4 is 4. You may see this written using vertical bars: |–4| = 4 and |4| = 4.

In statistics, we often care about how *strong* something is, not whether it's positive or negative. For example, you may remember from introductory psychology that a correlation of –0.8 is *stronger* than a correlation of +0.3, because |–0.8| = 0.8 and |+0.3| = 0.3.

Practice 1.1: Understanding Absolute Values in Psychology

1. Let's say you're comparing the strength of relationships between different psychological variables. Here are some hypothetical sample correlations. Which relationship is the strongest based on the absolute value of the correlation?

a) Correlation between stress and sleep: $\mathrm{r} = -0.75$

b) Correlation between motivation and academic performance: $\mathrm{r} = +0.62$

c) Correlation between caffeine intake and anxiety: $\mathrm{r} = -0.45$

Tip: Use the absolute value to compare strength. Ignore the plus or minus for now.

(Answers to practice questions can be found at the end of this document)

Addition

When adding numbers, the sign (+ or –) tells you the direction. Positive numbers move you up or forward; negative numbers move you down or backward.

Adding a positive number increases the total: 4 + 3 = 7

Adding a negative number decreases the total: 4 + (–3) = 1

Tip #1: Use parentheses to keep track of signs, especially when adding or subtracting negative numbers. For example:

(–2) + (–5) = –7

(–2) + 5 = 3

Reminder: A calculator can help with these calculations—just remember to use parentheses around negative numbers to avoid errors. For example, you will need to type 4 + (–3) rather than 4 + –3, which might give an error.

Tip #2: Adding a negative number is the same as subtracting. For example, 7 + (–3) is the same as 7 – 3 = 4. Just be careful not to *switch* operations unless you're sure — use parentheses to stay organized!

Subtraction

When subtracting, the sign of the number you're subtracting affects the direction.

Subtracting a positive number decreases the total: 7 – 3 = 4

Subtracting a negative number increases the total (because you're taking away a negative): 7 – (–3) = 10

Tip #3: Subtracting a negative number is the same as adding. You can think of it a bit like this: 7 – (–3) is the same as 7 + 3 = 10.

Tip #4: Don't forget to use parentheses to keep track of the signs and avoid mistakes—especially when subtracting negative numbers. Your calculator might get confused without them. For example, type 7 – (–3) rather than 7 – –3.

Practice 1.2: Adding and Subtracting Positive and Negative Numbers

Try these sample questions.

1. $6 + (-2) =$
2. $-4 - 5 =$
3. $-3 - (-7) =$
4. $8 + (-3) - (-4) =$
5. $-10 + 4 - (-6) - 2 =$

(Answers to practice questions can be found at the end of this document)

Multiplication

Multiplication is a shortcut for repeated addition. Instead of adding the same number over and over, you can multiply. For example, 3 + 3 + 3 + 3 = 12 is the same as 3 × 4 = 12. You may see multiplication written as 3 x 4 or 3(4) or (3)(4).

When multiplying numbers, the signs matter.

- Multiplying a positive by a positive = positive: 3 × 4 = 12
- Multiplying a positive by a negative or a negative by a positive = negative: 2 x (-5) = -10 or (–3) × 4 = –12
- Multiplying a negative by a negative = positive: (–3) x (–4) = 12

There is a key rule here: If the signs are the **same**, the result is **positive.** If the signs are **different**, the result is **negative.**

Division

Division is the opposite of multiplication. It tells you how many times one number fits into another, or how something is split into equal parts. For example, 12 ÷ 3 = 4. This means when 12 is split into 3 equal parts, each part is 4.

Just like multiplication, the signs matter when dividing:

- Dividing a positive by a positive = positive: 10 ÷ 2 = 5
- Dividing a positive by a negative or a negative by a positive = negative: 10 ÷ (-2) = -5 or (–10) ÷2 = 5
- Dividing a negative by a negative = positive: (–10) ÷ (-2) = 5

This means the same key rule we used for multiplication applies to division as well: If the signs are the **same**, the result is **positive.** If the signs are **different**, the result is **negative.**

Practice 1.3: Multiplying and Dividing Positive and Negative Numbers

Try these sample questions.

1. $12 \text{ x } 3 =$

2. $-20 \div 4 =$

3. $18 \div (-3) =$

4. $(-3)(-5) =$

5. $8(3) =$

6. $21/(\text{-}3) =$

(Answers to practice questions can be found at the end of this document)

Exponents and Roots

An **exponent** is a way to show repeated multiplication of the same number.

- 2^2 means 2 × 2 = 4
- 2^3 means 2 × 2 × 2 = 8

The small number (called the exponent) tells you how many times to multiply the base number by itself. When the exponent is 2, we call it 'squaring' the number.

A negative number squared will be positive:

- $(-3)^2 = (-3) \times (-3) = 9$

But a negative number multiplied three times will be negative:

- $(-3)^3 = (-3) \times (-3) \times (-3) = -27$

The **square root** is the opposite of squaring a number. It tells you what number was multiplied by itself to get a certain value. For example, because $5^2 = 5 \times 5 = 25$, that means that: $\sqrt{25} = 5$

Most calculators—basic or scientific—can handle exponents and square roots. Here are some suggestions for entering them correctly, but keep in mind that calculator layouts can vary. It's a good idea to practice consistently on the same calculator so you can become familiar with how it works.

(Note: we can only take the square root of positive numbers, since a negative x a negative is a positive.)

Squaring (example: 4^2)

- On a basic calculator, multiply the number by itself: 4 x 4 = 16.
- On a scientific calculator, look for a button like x^2. Then enter 4 and the x^2 button. The answer should be 16.
  - You can also use the button that looks like ^ but will need to enter the value for the exponent. Type 4, then ^, then 2. This should give you 16.

Square Root (example: $\sqrt{25}$)

- Basic and scientific calculators should have a square root button: √ or √x. Depending on the calculator:
  - Press the square root button and then 25: √ then 25 = 5
  - Press the number and then the square root button: 25, then √ = 5

Important: Use parentheses for negatives! When squaring a negative number, always use parentheses: $(–3)^2 = 9$. Entering $–3^2 = –9$, which is wrong - this squares the 3 first, then adds the negative.

Practice 1.4: Exponents and Roots

Try these sample questions.

1. $5^2 =$

2. $\sqrt{36} =$

3. $(-4)^2 =$

(Answers to practice questions can be found at the end of this document)

Order of Operations

When solving math problems that have more than one operation (like addition, subtraction, multiplication, or division), it's important to follow the **order of operations** so everyone gets the same answer. The order can be remembered with the acronym **BEDMAS**, which stands for:
Brackets → **E**xponents → **D**ivision → **M**ultiplication → **A**ddition → **S**ubtraction.

- Begin with anything in a bracket (or parentheses). These always come first—they help organize steps and make your work clearer.
- Then work from left to right for division and multiplication.
- Then work left to right for addition and subtraction.

Let's look at some examples:

Example 1: 3 + 4 × 2 =
In this case, the multiplication comes before the addition (4 x 2 = 8) then add 3 (8 + 3 = 11).

Example 2: (3 + 4) × 2 =
We need to do what is in the bracket or parenthesis first: (3 + 4 = 7), then multiply (7 x 2 = 14).

Tip: Parentheses can change the entire meaning of a problem. Use them often to make sure your calculator and your brain are doing the same thing!

Let's look at another example, this time with an exponent:

Example 3: $(6 - 2)^2 + 3 =$
We need to do what is in the parenthesis first (6 -2 = 4). Then comes the exponent ($4^2 = 16$). Finally, add 3 (16 + 3 = 19).

Practice 1.5: Following the Order of Operations

Try these sample questions. Don't worry if you don't get them right on the first try – it takes a while to get used to this system.

1. $5 + 3 \times 2 =$

2. $(8 - 3)^2 \div 5 =$

3. $4 + (3 - 6)^2 \times 3 =$

(Answers to practice questions can be found at the end of this document)

Fractions, Decimals, and Percents:

These are all different ways to represent parts of a whole.

- **Fractions** are written as one number over another. For example, you may see something like $\frac{1}{2}$ or $\frac{3}{4}$.
- **Decimals** use a decimal point to show part of a whole. For example, changing the above fractions to decimals would look like 0.5 or 0.75.
- **Percents** show parts out of 100. For example, you may see 50% or 75%.

In psychology, you will see all three of these at different times, and it's important to be able to convert between formats to help interpret results.

- To convert a fraction to a decimal: divide the top by the bottom (e.g., 3 ÷ 4 = 0.75).
- To convert a decimal to a percent: move the decimal two places right (0.75 = 75%). This is the same as taking the decimal and multiplying by 100 to get a percent (0.75 x 100 = 75%).
- To convert a percent to a decimal: move the decimal two places left (25% = 0.25). This is the same as taking the percent and dividing by 100 (25% ÷ 100 = 0.25).
- To convert a decimal to a fraction:
  - If the decimal has only one value behind the decimal place, think of it as a 'tenth' (e.g., 0.6 is "6 tenths" or 6/10)
  - If the decimal has two values behind the decimal place, think of it as a 'hundredth' (e.g., 0.25 is "25 hundredths" or 25/100)

- Then, if possible, simplify the fraction by dividing both numbers by small values (2, 5, 10). (e.g., 6/10 = 3/5, since 6/2 = 3 and 10/2 = 5).

Note: Most calculators don't have a function to help you move from a decimal to fraction. Don't worry too much about converting decimals to fractions. We will focus more on converting fractions to decimals and percents.

Practice 1.6: Converting Fractions, Decimals, and Percents

Complete the following table to practice converting between formats:

Fraction	Decimal	Percent
$\frac{1}{2}$		
	0.2	
		60%
		45%

(Answers to practice questions can be found at the end of this document)

Tip for Using Your Calculator:
When multiplying or dividing with fractions or percents, it's easiest to **convert everything to decimals first**. Most calculators handle decimals much more smoothly than fractions or percents. Once everything is in decimal form, you can multiply or divide as usual.

Part 2: Basic Algebra (Solving for an unknown)

In statistics, you'll often need to solve equations to find an unknown value — for example, solving for a missing score or mean. For these examples, we're going to try to solve for X (as is often used in algebra).

Solving an unknown with Addition/Subtraction and Multiplication/Division

Most of the time, we'll start with formulas where the unknown is already **isolated** (or is alone on one side of the equation). For example:

$X = 3 + 7$

$X = 10$

But sometimes our X isn't isolated. This will be our goal: We need to isolate X. To do this, we must keep the equation balanced: if we add to one side of the = sign, we need to add to the other side. For example:

$X + 3 = 7$

To isolate X, I must subtract 3 from both sides of the equation:

$X + 3 - 3 = 7 - 3$

$X = 7 - 3$

$X = 4$

Alternatively:

$X - 4 = 10$

Now I need to add 4 to both sides of the equation:

$X - 4 + 4 = 10 + 4$

$X = 10 + 4$

$X = 14$

You can then start to skip the middle step by using inverse operations: we simply do the opposite of what is being done to X. In our first example, since we had an addition, we subtracted. In our second example, when we had a subtraction, we added.

The same goes for multiplication and division: we need to do the opposite operation on the other side of the equal sign:

$3X = 12$

To get X alone, I need to divide 3X by 3:

$3X \div 3 = 12 \div 3$

$X = 12 \div 3$

$X = 4$

Or, if I understand how to use the inverse operation:

$3X = 12$

$X = 12 \div 3$

$X = 4$

For a questions with division, I need to use multiplication:

To get X alone, I need to divide 3X by 3:

$X \div 4 = 5$

$X \div 4 \times 4 = 5 \times 4$

$X = 5 \times 4$

$X = 20$

Again, we can simply things if we go straight to using the inverse operation:

$X \div 4 = 5$

$X = 5 \times 4$

$X = 20$

Tip: While we all want to do things faster (especially homework), sometimes it's best to do things step-by-step. If you're not familiar with the inverse operations, don't worry about it – just add in that extra step.

When you have more than one operation when solving an unknown

Sometimes an equation has more than one operation — for example:

$2x + 6 = 14$

In these cases, your goal is still to **get X alone**, but you need to "undo" the operations in the reverse order of the usual order of operations. This is one of the most confusing parts of algebra, because we need to **start from the outside in**. Let's take a look at our example:

$2x + 6 = 14$

To isolate x, we need to get rid of the 6 on the left side of the equation. As we know, we do that by subtracting 6 from each side:

$$2x + 6 - 6 = 14 - 6$$

$$2x = 8$$

Now we need to get x alone by dividing each side by 2:

$$2x \div 2 = 8 \div 2$$

$$x = 4$$

For another example:

$$\frac{x}{3} - 5 = 7$$

Begin by adding 5 to both sides to start to isolate the x:

$$\frac{x}{3} - 5 + 5 = 7 + 5$$

$$\frac{x}{3} = 12$$

And then do your multiplication:

$$\frac{x}{3} \times 3 = 12 \times 3$$

$$x = 36$$

Finally, let's imagine this:

$$\frac{x - 3}{5} = 4$$

Again, I need to **work from the outside in**. I can't start with the subtraction here, because that is 'inside' the division. I need to deal with the division first, then the subtraction.

$$\frac{x - 3}{5} \times 5 = 4 \times 5$$

$$x - 3 = 20$$

Now, I can deal with the subtraction:

$$x - 3 + 3 = 20 + 3$$

$$x = 23$$

Tip: When solving for X, think of the equation in **layers**. Start with the outermost operation and work **one step at a time**, undoing each layer before moving to the next. Don't try to do multiple steps at once — tackling one layer at a time helps prevent mistakes and keeps your work organized.

Practice 2.1: Solving an Unknown Part 1

Try these sample questions.

1. $x + 7 = 12$

2. $3x = 15$

3. $\frac{x-4}{2} = 5$

4. $2x + 5 = 12$

5. $-3x + 7 = 16$

(Answers to practice questions can be found at the end of this document)

Solving an unknown with Exponents and Roots

Sometimes equations involve exponents or square roots. These two operations are inverses of each other, just like addition/subtraction and multiplication/division.

For example:

$X^2 = 25$

To get X isolated, I need to take the square root of both sides:

$\sqrt{X} = \sqrt{25}$

$X = \sqrt{25}$

$X = \pm 5$

(Why do I have a plus or minus sign beside the 5? Because it could be either: both 5 x 5 and (-5) x (-5) = 25).

And if I have a square root, I can use the exponent:

$\sqrt{X} = 4$

$\sqrt{X}^2 = 4^2$

$X = 4^2$

$X = 16$

Again, we need to think in **layers**. For example, for:

$\sqrt{x} - 3 = 5$

We first add 3 to both sides:

$\sqrt{x} - 3 - 3 = 5 - 3$

$\sqrt{x} = 8$

Then square both sides:

$\sqrt{x}^2 = 8^2$

$x = 64$

Practice 2.2: Solving an Unknown Part 2

Here are a few questions that add in exponents/square roots:

1. $x^2 = 49$

2. $\sqrt{x} = 6$

3. $\frac{\sqrt{x}}{3} = 4$

(Answers to practice questions can be found at the end of this document)

Substituting Known Values to Solve for the Unknown

In many formulas, you'll see more than one symbol — for example:

$Y = 3x + 2$

Each symbol represents a variable, and sometimes you'll be given the value of one variable and need to **solve for the other**.

To do this:

1. **Substitute** the known value into the equation.
2. **Simplify** using the order of operations.
3. **Solve** for the unknown variable, just like any other algebra problem.

For example, if I have the above equation, and I am given the information x = 4, I can substitute that information in to solve the problem:

$Y = 3x + 2$

$Y = 3(4) + 2 = 12 + 2 = 8$

Now, let's change the equation by adding a negative and imagine I am given the value for Y = 11 (and no value for X):

$Y = -3x + 2$

$11 = -3x + 2$

I need to use the algebra we discussed above to solve the problem:

$11 - 2 = -3x + 2 - 2$

$9 = -3x$

$9 \div (-3) = -3x \div (-3)$

$-3 = x$ or we can change this around to $x = -3$

Practice 2.3: Substituting Known Values to Solve an Unknown

Try this last set of practice questions:

1. $Y = 3x + 2$ and $x = 4$

2. $Y = \frac{(x-5)}{2} + 7$ and $x = 4$

3. $Y = \frac{(x+3)^2}{4} - 5$ and $Y = 11$

(Answers to practice questions can be found at the end of this document)

Tip: In class, we may go through some of this math fairly quickly to cover all the material. If you ever get lost during a demonstration, don't worry. Take the time after class to go through the steps on your own, replaying each step with your calculator. If you still can't figure things out, ask for help – from your instructor, a tutor, or a classmate.

Answers to Practice Questions

Practice 1.1: Understanding Absolute Values in Psychology

1. The absolute values are: |–0.75| = 0.75, |+0.62| = 0.62, |–0.45| = 0.45. The strongest relationship is between stress and sleep because it has the largest absolute value: 0.75 (Answer = a).

Practice 1.2: Adding and Subtracting Positive and Negative Numbers

1. Start at 6 and add –2 (which means move 2 units down): 6 + (–2) = 4.
2. Start at –4 and subtract 5 more (move further down): –4 – 5 = –9.
3. Subtracting a negative is the same as adding: –3 – (–7) = –3 + 7 = 4
4. Start by adding -3 (moved 3 units down): 8 + (–3) = 5. Then add 4: 5 – (–4) = 5 + 4 = 9.
5. Start by adding 4 or moving up the number line: –10 + 4 = –6. Then add 6 (move up the number line): –6 – (–6) = –6 + 6 = 0. Finally, subtract 2: 0 – 2 = –2.

Practice 1.3: Multiplying and Dividing Positive and Negative Numbers

1. Both numbers are positive: result is positive. 12 x 3 = 36.
2. Negative ÷ positive: result is negative. –20 ÷ 4 = -5.
3. Positive ÷ negative: result is negative. 18 ÷ (–3) = -6.
4. Both numbers are negative: result is positive. (–3)(–5) = (-3) x (-5) = 15.
5. Both numbers are positive: result is positive. 8(3) = 8 x 3 = 24.
6. Positive ÷ negative: result is negative. 21/(-3) = 21 ÷ (-3) = -7.

Practice 1.4: Exponents and Roots

1. $5^2 = 5 \text{ x } 5 = 25$
2. $\sqrt{36} = 6$ (because 6 x 6 = 36)
3. $(-4)^2 = 16$ (remember, a negative x a negative = a positive)

Practice 1.5: Following the Order of Operations

1. $5 + 3 \times 2 = 5 + (6) = 11$
2. $(8-3)^2 \div 5 = 5^2 \div 5 = 25 \div 5 = 5$
3. $4 + (3-6)^2 \times 3 = 4 + (-3)^2 \times 3 = 4 + 9 \times 3 = 4 + 27 = 31$

Practice 1.6: Converting Fractions, Decimals, and Percents

Fraction	Decimal	Percent
$\frac{1}{2}$	0.5	50%
$\frac{2}{10}=\frac{1}{5}$	0.2	20%
$\frac{6}{10}=\frac{3}{5}$	0.6	60%
$\frac{45}{100}=\frac{9}{20}$	0.45	45%

Tip: If you're ever unsure about whether you simplified your fraction properly, you can always check your work (for example, dividing 9 ÷ 20 will get you 0.45).

Practice 2.1: Solving an Unknown Part 1

1. $x+7=12$
   $x+7-7=12-7$
   $x=5$

2. $3x=15$
   $3x\div 3=15\div 3$
   $x=5$

3. $\frac{x-4}{2}=5$
   $\frac{x-4}{2}\times 2=5\times 2$
   $x-4=10$
   $x-4+4=10+4$
   $x=14$

4. $2x+5=12$
   $2x+5-5=12-5$
   $2x=7$
   $2x\div 2=7\div 2$
   $x=3.5$

5. $-3x + 7 = 16$
   $-3x + 7 - 7 = 16 - 7$
   $-3x = 9$
   $-3x = 9 \div (-3)$
   $x = -3$

Practice 2.2: Solving an Unknown Part 2

1. $x^2 = 49$
   $\sqrt{x^2} = \sqrt{49}$
   $x = 7 \text{ } or \text{ } x = -7$

2. $\sqrt{x} = 6$
   $\sqrt{x}^2 = 6^2$
   $x = 36$

3. $\frac{\sqrt{x}}{3} = 4$

   $$\frac{\sqrt{x}}{3} \times 3 = 4 \times 3$$
   $\sqrt{x} = 12$
   $\sqrt{x}^2 = 12^2$
   $x = 144$

Practice 2.3: Substituting Known Values to Solve an Unknown

1. $Y = 3x + 2$ and $x = 4$
   $Y = 3(4) + 2$
   $Y = 12 + 2$
   $Y = 14$

2. $Y = \frac{(x-5)}{2} + 7$ and $x = 4$
   $$Y = \frac{(4-5)}{2} + 7$$
   $$Y = \frac{(-1)}{2} + 7$$
   $Y = -0.5 + 7$
   $Y = 6.5$

3. $Y = \frac{(x+3)^2}{4} - 5$ and $Y = 11$

$11 = \frac{(x+3)^2}{4} - 5$

$11 + 5 = \frac{(x+3)^2}{4} - 5 + 5$

$16 = \frac{(x+3)^2}{4}$

$16(4) = \frac{(x+3)^2}{4}(4)$

$64 = (x+3)^2$

$\sqrt{64} = \sqrt{(x+3)^2}$

$\pm 8 = (x+3)$

$\pm 8 - 3 = x + 3 - 3$

$5 = x$ OR $-11 = x$

So, $x = 5$ or $x = -11$

Note: Because the square root of 8 can be both positive 8 or negative 8, we come up with two equally plausible answers.