

Pilot Math

Skills



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About the Author **Brian Johnson**



Hi, my name is Brian Johnson and flying on a Professional level has always been a dream of mine since childhood. I attended North Carolina Central University where I double majored in History and Geography. I have been proudly serving in the military for over 13 years. I got my start in aviation at a small FBO in Durham, NC at the age of 17. In April of 2008, I earned the opportunity to attend Airline Transport Professionals flight school in Panama City, FL. During my stay in Florida, I received the best flight instruction and gained valuable flight experience, which provided me with a solid foundation for my start as a Professional Pilot. After flight school, I felt compelled to impart my knowledge of flying to the masses, and so Pilot Up Gear & Apparel was founded to take on the mission of helping pilots become better pilots by giving them the information and tools they need to succeed. "We Are Here For Your Success!"

Introduction

A pilot's Proficiency

Whether you are a student pilot or a veteran pilot, you understand the need to be on your game every time you go flying. When we preflight an aircraft, we have been taught since day one to check weather and NOTAMS.

As our flight training progresses, we see the value of having a solid foundation of basic math skills all the more. As a pilot you should sharpen your mathematical knife and keep it sharp.

This eBook is designed to help you become a more precise pilot.

By doing pilot math drills you will gain the ability to understand basic math concepts of addition, division, subtraction, and multiplication. How well you execute these basic concepts in the aircraft depends on your constant practice of the pilot math drills. Just like anything you want to excel at, you must practice repeatedly until it becomes second nature. The purpose of pilot math drills is to give you the tools to solve math problems that we use as pilots in your head.

Today you can practice basic multiplication, division, addition, and subtraction concepts when you buy food, pay bills, pump gas, or calculate the TIP amount for outstanding service at your favorite restaurant.

To improve your speed at calculating problems, you should purchase or make your own flash cards. Time yourself and try your best to get faster and faster each time.

Write down the formulas I will provide you in this book and practice them. Memorize the formulas and then create your own set of math problems and do them in your head. Repeat this process until you no longer have the need to use a calculator, paper or any other writing instruments.

As you may well know, perfect practice makes perfect. So, Practice, Practice, Practice! Studies have shown that if you have a good grasp on basic math skills, you will show a noticeable increase in performance. At the end of this eBook I will provide you with a series of pilot math drills to help you study and fine tune those Pilot Math Skills. Take the challenge, become a more precise and professional pilot. Improve your Pilot Math Skills with Pilot Math Drills.

Aerial Calculations

Reciprocal Heading

Calculating your reciprocal heading is an easy thing to do. But if you haven't practiced this, you may find it difficult to come up with an answer when you need it most. And if you have to pull out a pen and paper or calculate while you're flying, then you have unnecessarily increased your workload.

I have setup a table that will help you practice this technique.

Initial Heading	Reciprocal Heading
360	180
140	320
050	230
090	270
250	070
120	300

I use this formula every time I need to come up with a reciprocal heading.

Initial HDG < 180

Initial heading + 200 - 20 = Reciprocal

Initial HDG > 180

Initial heading - 200 + 20 = Reciprocal

Keep in mind that the addition and subtraction symbols change between the two formulas. This is done because our initial headings will either be greater than 180 or less than 180 at the start of the formula.

Check out these examples:

>180 080+200- 20= 260

<180 350-200+ 20= 170

Sometimes when you use this formula, you may initially receive a number greater than 360 or less than 200 when adding or subtracting 200. Once you complete the second step of adding or subtracting 20 your answer will be back into the acceptable range of 001-360. When calculating your reciprocal heading, it's important to note that the last digit always stays the same.

Check out these examples:

$$<180 \quad 185-200+20= 035$$

$$>180 \quad 027+200-20= 207$$

Another easy way to figure out your Reciprocal heading is to look at your heading indicator and read off the reciprocal. Or buy the reciprocal heading and then proceed to turn and fly in that direction.

Fahrenheit to Celsius & Vice versa

Every Pilot should know how to convert Fahrenheit to Celsius as well as Celsius to Fahrenheit. I have included a table to help you come up with estimates of converting F to Celsius. I have also included the formula for more precise conclusions of F-C.

Celsius	Fahrenheit
38	100
15	59
21	70
27	80
7	45
4	40

$$F = \left(\frac{9}{5} \times ^\circ C \right) + 32$$

$$C = (^\circ F - 32) \times \frac{5}{9}$$

Temp Lapse rate calculating & Deviations

The standard temperature at sea level is 15 °c or 59 °F. The standard temperature lapse rate is 2°c or 3.5 °F for every 1000 feet change in altitude—up to and including 38,000 feet MSL. By knowing this you can calculate deviations from standard calculations during your climb and cruise phases of flight. To start, multiply the altitude in thousands of feet MSL by 2 (Note: 2°c standard temp lapse rate); subtract

15°C (note: 15°C standard temp at sea level); the answer you get will be the estimated standard temperature at 6000ft.

(6000ft drop the zeros)

$$6 \times 2 = 12$$

$$15 - 12 = 3^\circ\text{C}$$

Standard temp at 6000ft is 3°C

In order to calculate the deviation at altitude, simply determine the difference between the standard temp and actual temp.

Altitude	Standard Temp	Actual Temp	Temp Dw
6000ft MSL	?	30°C	
9000ft MSL	?	10°C	
FL 230	?	-15°C	
FL 370	?	-50°C	

Conversion's Galore???

Throughout our flying careers we often have to convert statute miles to nautical miles, statute miles to kilometers, MPH to Knots, and MPH to KPH. Here is a chart with some really simple conversion information that will help you make the necessary conversion calculations.

1 statute mile= 0.87 nautical mile *NM	1 Nautical mile= 1.15 statute mile *SM
1 MPH=0.8 Knots	1 knot= 1.15 Mph
1 statute mile=1.61 kilometers *KM	1 km= 0.62 statute miles
1MPH=1.61 Kilometer per hour *Kph	1KM= 0.62 miles
1NM= 1.85 KM	1Kph= .62 Mph
1 Knot= 0.51 meters per second Mps	1 KM= 0.54 NM
1 Knot= 1.85 Kph= 0.51 Mps	1Mps= .54 knots

Feet	Measurement	Meters
5280ft	Statute Mile	1609

6076ft	Nautical Mile	1852
3208ft	Kilometers	1000

GOT Fuel?

Making sure you have enough fuel for your flight is an intrinsic part of your pre-flight planning. If you're flying VFR day or night or IFR day or night, make sure you have enough fuel to be legal for that flight. While you're flying you may also want to check if your planned fuel burn is consistent with your actual fuel burn. Needless to say planning and calculating your fuel burn is very important to every flight.

VFR Rules		IFR Rules
2+20	ETE	3+15
N/A	Alternate	0+40
30 or 45	Day Night	45 45
2+50 3+05	Total Fuel Needed	4+40

Okay! Now that you have calculated your estimated time en route, let's convert those hours into gallons and pounds of fuel needed to complete the flight.

Check out these formulas:

Total Avgas in pounds	Total Avgas in gallons
(#Gallons) x (6.0lbs per gallon)	(Pounds Avgas) ÷ (6lbs per gallon)

Wet Compass: Know How to Fly It

The Magnetic Compass is a reliable source of heading information, as long as you understand its limits. The limitations I will refer to in this eBook will be its Acceleration Errors and Timing Errors.

- 1) Magnetic Compass Acceleration Error: On east or west headings, when the accelerating compass shows a turn to the north and when the decelerating compass shows a turn to the south.
- 2) Turning Error: Lag North— Lead South.

3) Planned Roll out from the turn

30°before the compass gets to the northerly heading.

30°after the compass gets to the southerly heading.

Start Heading	Desired Heading	Latitude	Head Point
270	360	30N	325
270	180	30N	155
090	010	40N	058
090	190	40N	222

What's Your True Airspeed?

It's always a good thing to know how fast the aircraft you're flying in is traveling through the air. In order to figure that out we must calculate our true airspeed. Your true airspeed is an increase-indicated airspeed by 2% for each 1000ft above sea level. The formula to calculate true airspeed is this:

$$\text{TAS} = \text{IAS} + [\text{IAS} \times (\text{Altitude} - \text{drop the zeros}) \times 2\%]$$

Distance, Speed& Time Conversions

Speed	Miles per Min
30	.5
60	1
90	1.5
120	2
150	2.5
180	3

210	3.5
240	4
270	4.5
300	5
330	5.5
360	6
390	6.5
420	7
450	7.5

Commit this chart to memory! This chart should help you figure out how many miles you're covering across the ground without the use of a calculator or the use of paper and pencil. It's important to note that we must add or subtract the headwind or tailwind component to true airspeed to get our ground speed.

The formula to figure that out is:

$$\text{TAS} \pm \text{wind} = \text{GS}$$

Basic Distance, Speed, & Time formula:

$$(\text{GS}) \times \text{Time} = \text{Distance}$$

At What Speed Will My Aircraft Hydroplane?

There is always a risk for hydroplaning on a wet runway no matter what kind of aircraft you have. As pilots, it's very important to be aware of this fact and plan the takeoffs and landings accordingly. To calculate your hydroplaning speed you must first know what the pressure is for the main landing gear. After you have that information, use this formula:

$$V_{Hp} = 9 \sqrt{\text{Tire Pressure}}$$

Figuring Out Pressure Altitude

How do you figure out your pressure altitude using your airport elevation and an altimeter setting that is not standard? We can start by knowing that for every .01.in.Hg.altimeter setting in the Kollsman window, your pressure altitude reading changes 10ft.

For example:

The altimeter setting at your airport is 29.82in.Hg. and the local airport elevation is 500ft. What would be your pressure altitude?

You must figure out the difference between 29.82 and 29.92 which is .10in.Hg. This difference converts to 100' ft. Now simply add 100ft to the airport elevation of 500'ft and your pressure altitude will be 600ft.

Descent Planning

As pilots, when we work on descent planning in the aircraft, we utilize a series of quick methods to plan out our descents so we can arrive at a targeted altitude at a specified point from our current position. Your descent point is where you initially begin your descent. If you're flying a non-pressurized aircraft, figuring out your rate of descent is easy because there is only a small acceptable range in a non-pressurized aircraft. For this reason we will use a standard 500 feet per minute rate of descent.

Descent Point

Let's say you have a ground speed of 120K/S, this means that the aircraft is traveling at 2nm per minute. $120\text{nm per hour} \div 60 \text{ minutes per hour} = 2\text{nm per minute}$. With a standard 500feet per minute rate of descent, your aircraft will travel 4nm every 1000ft on your descent. $1000\text{ft} \div 500\text{fpm} = 2\text{min}$; $2\text{min} \times 2\text{nm per minute} = 4\text{nm}$.

We must now figure out the distance from a waypoint at which we should begin our descent. In order to do this we must take our altitude change in thousands of feet, drop the zeros and multiply it by five.

$$\begin{array}{r} \text{Alt Altitude Change (drop the zeros)} \\ \times 5 \text{ 500fpm rate of Decent} \\ \hline \text{nm Distance from waypoint} \end{array}$$

Altitude	- Assigned	=Descent Required	× 5 = Distance
800	2000	6000	30nm
7000	2000	5000	25nm
6000	2000	4000	20nm

While approaching the airport maintaining 100kts airspeed within 10nm of the approach environment allows for a glide slope ratio of 3 to 1, while maintaining a 500fpm rate of descent.

Approach Descent
$\frac{\text{nm Distance from Airport} \times 3}{\text{Alt Desired Altitude (AGL)}} = \text{3° Glideslope}$

100K/S	
Distance from Airport	× 3 = <i>Desired Altitude</i>
10nm	3,000' AGL
6nm	1,800' AGL
4nm	1,200' AGL

When using this formula keep in mind that ATC or obstacles along your route of flight may require you to fly at a higher altitude.

Proficiency is key, so practice, practice, practice! I cannot emphasize this enough. You owe it to yourself to perfect your craft and practicing basic math skills is one way to do that. A good pilot is always learning as well as constantly getting better. Keep those pilot skills sharp and impart your newfound knowledge to other pilots you come across.

Pilot Math Drills

PILOT UP!

GEAR & APPAREL



Division

Pilot Math Drills

$8 \overline{)24}$ $10 \overline{)90}$ $5 \overline{)10}$ $4 \overline{)8}$ $5 \overline{)35}$ $9 \overline{)18}$ $3 \overline{)18}$ $2 \overline{)12}$ $2 \overline{)16}$ $7 \overline{)56}$

$3 \overline{)9}$ $7 \overline{)28}$ $10 \overline{)50}$ $8 \overline{)48}$ $9 \overline{)81}$ $6 \overline{)24}$ $9 \overline{)63}$ $3 \overline{)30}$ $4 \overline{)40}$ $9 \overline{)54}$

$3 \overline{)27}$ $6 \overline{)36}$ $4 \overline{)16}$ $6 \overline{)30}$ $5 \overline{)25}$ $10 \overline{)70}$ $2 \overline{)18}$ $2 \overline{)14}$ $3 \overline{)21}$ $6 \overline{)54}$

$10 \overline{)20}$ $9 \overline{)72}$ $2 \overline{)8}$ $7 \overline{)70}$ $3 \overline{)12}$ $5 \overline{)50}$ $4 \overline{)36}$ $4 \overline{)24}$ $7 \overline{)63}$ $9 \overline{)36}$

$8 \overline{)64}$ $6 \overline{)60}$ $7 \overline{)14}$ $7 \overline{)42}$ $5 \overline{)15}$ $10 \overline{)40}$ $7 \overline{)49}$ $7 \overline{)35}$ $3 \overline{)24}$ $8 \overline{)40}$

Time: _____ minutes **Score:** _____ out of 50

ANSWER KEY

Pilot Math Drills

$$\begin{array}{r} 3 \\ 8 \overline{)24} \end{array} \quad \begin{array}{r} 9 \\ 10 \overline{)90} \end{array} \quad \begin{array}{r} 2 \\ 5 \overline{)10} \end{array} \quad \begin{array}{r} 2 \\ 4 \overline{)8} \end{array} \quad \begin{array}{r} 7 \\ 5 \overline{)35} \end{array} \quad \begin{array}{r} 2 \\ 9 \overline{)18} \end{array} \quad \begin{array}{r} 6 \\ 3 \overline{)18} \end{array} \quad \begin{array}{r} 6 \\ 2 \overline{)12} \end{array} \quad \begin{array}{r} 8 \\ 2 \overline{)16} \end{array} \quad \begin{array}{r} 8 \\ 7 \overline{)56} \end{array}$$

$$\begin{array}{r} 3 \\ 3 \overline{)9} \end{array} \quad \begin{array}{r} 4 \\ 7 \overline{)28} \end{array} \quad \begin{array}{r} 5 \\ 10 \overline{)50} \end{array} \quad \begin{array}{r} 6 \\ 8 \overline{)48} \end{array} \quad \begin{array}{r} 9 \\ 9 \overline{)81} \end{array} \quad \begin{array}{r} 4 \\ 6 \overline{)24} \end{array} \quad \begin{array}{r} 7 \\ 9 \overline{)63} \end{array} \quad \begin{array}{r} 10 \\ 3 \overline{)30} \end{array} \quad \begin{array}{r} 10 \\ 4 \overline{)40} \end{array} \quad \begin{array}{r} 6 \\ 9 \overline{)54} \end{array}$$

$$\begin{array}{r} 9 \\ 3 \overline{)27} \end{array} \quad \begin{array}{r} 6 \\ 6 \overline{)36} \end{array} \quad \begin{array}{r} 4 \\ 4 \overline{)16} \end{array} \quad \begin{array}{r} 5 \\ 6 \overline{)30} \end{array} \quad \begin{array}{r} 5 \\ 5 \overline{)25} \end{array} \quad \begin{array}{r} 7 \\ 10 \overline{)70} \end{array} \quad \begin{array}{r} 9 \\ 2 \overline{)18} \end{array} \quad \begin{array}{r} 7 \\ 2 \overline{)14} \end{array} \quad \begin{array}{r} 7 \\ 3 \overline{)21} \end{array} \quad \begin{array}{r} 9 \\ 6 \overline{)54} \end{array}$$

$$\begin{array}{r} 2 \\ 10 \overline{)20} \end{array} \quad \begin{array}{r} 8 \\ 9 \overline{)72} \end{array} \quad \begin{array}{r} 4 \\ 2 \overline{)8} \end{array} \quad \begin{array}{r} 10 \\ 7 \overline{)70} \end{array} \quad \begin{array}{r} 4 \\ 3 \overline{)12} \end{array} \quad \begin{array}{r} 10 \\ 5 \overline{)50} \end{array} \quad \begin{array}{r} 9 \\ 4 \overline{)36} \end{array} \quad \begin{array}{r} 6 \\ 4 \overline{)24} \end{array} \quad \begin{array}{r} 9 \\ 7 \overline{)63} \end{array} \quad \begin{array}{r} 4 \\ 9 \overline{)36} \end{array}$$

$$\begin{array}{r} 8 \\ 8 \overline{)64} \end{array} \quad \begin{array}{r} 10 \\ 6 \overline{)60} \end{array} \quad \begin{array}{r} 2 \\ 7 \overline{)14} \end{array} \quad \begin{array}{r} 6 \\ 7 \overline{)42} \end{array} \quad \begin{array}{r} 3 \\ 5 \overline{)15} \end{array} \quad \begin{array}{r} 4 \\ 10 \overline{)40} \end{array} \quad \begin{array}{r} 7 \\ 7 \overline{)49} \end{array} \quad \begin{array}{r} 5 \\ 7 \overline{)35} \end{array} \quad \begin{array}{r} 8 \\ 3 \overline{)24} \end{array} \quad \begin{array}{r} 5 \\ 8 \overline{)40} \end{array}$$

#2

$\frac{16}{\div 4}$	$\frac{15}{\div 3}$	$\frac{3}{\div 1}$	$\frac{10}{\div 5}$	$\frac{15}{\div 5}$	$\frac{4}{\div 1}$	$\frac{12}{\div 3}$	$\frac{20}{\div 5}$	$\frac{15}{\div 3}$	$\frac{6}{\div 2}$
$\frac{12}{\div 4}$	$\frac{9}{\div 3}$	$\frac{8}{\div 4}$	$\frac{12}{\div 4}$	$\frac{4}{\div 2}$	$\frac{12}{\div 4}$	$\frac{3}{\div 1}$	$\frac{8}{\div 4}$	$\frac{9}{\div 3}$	$\frac{9}{\div 3}$
$\frac{12}{\div 3}$	$\frac{25}{\div 5}$	$\frac{8}{\div 4}$	$\frac{4}{\div 2}$	$\frac{20}{\div 4}$	$\frac{6}{\div 3}$	$\frac{20}{\div 5}$	$\frac{4}{\div 2}$	$\frac{12}{\div 3}$	$\frac{2}{\div 2}$
$\frac{20}{\div 5}$	$\frac{20}{\div 5}$	$\frac{3}{\div 3}$	$\frac{1}{\div 1}$	$\frac{5}{\div 1}$	$\frac{2}{\div 2}$	$\frac{20}{\div 5}$	$\frac{2}{\div 1}$	$\frac{8}{\div 2}$	$\frac{8}{\div 4}$
$\frac{1}{\div 1}$	$\frac{15}{\div 3}$	$\frac{3}{\div 1}$	$\frac{8}{\div 4}$	$\frac{15}{\div 3}$	$\frac{5}{\div 5}$	$\frac{9}{\div 3}$	$\frac{15}{\div 3}$	$\frac{2}{\div 1}$	$\frac{15}{\div 5}$
$\frac{15}{\div 3}$	$\frac{12}{\div 3}$	$\frac{15}{\div 5}$	$\frac{10}{\div 5}$	$\frac{10}{\div 5}$	$\frac{15}{\div 3}$	$\frac{4}{\div 2}$	$\frac{2}{\div 2}$	$\frac{12}{\div 3}$	$\frac{4}{\div 4}$

Answer Key

$\frac{16}{\div 4}$	$\frac{15}{\div 3}$	$\frac{3}{\div 1}$	$\frac{10}{\div 5}$	$\frac{15}{\div 5}$	$\frac{4}{\div 1}$	$\frac{12}{\div 3}$	$\frac{20}{\div 5}$	$\frac{15}{\div 3}$	$\frac{6}{\div 2}$
4	5	3	2	3	4	4	4	5	3
$\frac{12}{\div 4}$	$\frac{9}{\div 3}$	$\frac{8}{\div 4}$	$\frac{12}{\div 4}$	$\frac{4}{\div 2}$	$\frac{12}{\div 4}$	$\frac{3}{\div 1}$	$\frac{8}{\div 4}$	$\frac{9}{\div 3}$	$\frac{9}{\div 3}$
3	3	2	3	2	3	3	2	3	3
$\frac{12}{\div 3}$	$\frac{25}{\div 5}$	$\frac{8}{\div 4}$	$\frac{4}{\div 2}$	$\frac{20}{\div 4}$	$\frac{6}{\div 3}$	$\frac{20}{\div 5}$	$\frac{4}{\div 2}$	$\frac{12}{\div 3}$	$\frac{2}{\div 2}$
4	5	2	2	5	2	4	2	4	1
$\frac{20}{\div 5}$	$\frac{20}{\div 5}$	$\frac{3}{\div 3}$	$\frac{1}{\div 1}$	$\frac{5}{\div 1}$	$\frac{2}{\div 2}$	$\frac{20}{\div 5}$	$\frac{2}{\div 1}$	$\frac{8}{\div 2}$	$\frac{8}{\div 4}$
4	4	1	1	5	1	4	2	4	2
$\frac{1}{\div 1}$	$\frac{15}{\div 3}$	$\frac{3}{\div 1}$	$\frac{8}{\div 4}$	$\frac{15}{\div 3}$	$\frac{5}{\div 5}$	$\frac{9}{\div 3}$	$\frac{15}{\div 3}$	$\frac{2}{\div 1}$	$\frac{15}{\div 5}$
1	5	3	2	5	1	3	5	2	3
$\frac{15}{\div 3}$	$\frac{12}{\div 3}$	$\frac{15}{\div 5}$	$\frac{10}{\div 5}$	$\frac{10}{\div 5}$	$\frac{15}{\div 3}$	$\frac{4}{\div 2}$	$\frac{2}{\div 2}$	$\frac{12}{\div 3}$	$\frac{4}{\div 4}$
5	4	3	2	2	5	2	1	4	1

Addition

Pilot Math Drills

$\begin{array}{r} 10 \\ + 10 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ + 5 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ + 8 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ + 7 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ + 4 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ + 7 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ + 2 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ + 9 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ + 8 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ + 9 \\ \hline \end{array}$
$\begin{array}{r} 3 \\ + 6 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ + 9 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ + 5 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ + 4 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ + 7 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ + 2 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ + 4 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ + 3 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ + 5 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ + 4 \\ \hline \end{array}$
$\begin{array}{r} 7 \\ + 3 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ + 10 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ + 6 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ + 2 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ + 6 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ + 8 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ + 3 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ + 4 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ + 6 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ + 7 \\ \hline \end{array}$
$\begin{array}{r} 10 \\ + 2 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ + 9 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ + 5 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ + 8 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ + 6 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ + 7 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ + 7 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ + 2 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ + 4 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ + 2 \\ \hline \end{array}$
$\begin{array}{r} 2 \\ + 6 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ + 2 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ + 3 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ + 3 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ + 5 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ + 5 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ + 9 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ + 9 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ + 3 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ + 3 \\ \hline \end{array}$

Time: _____ minutes Score: _____ out of 50

ANSWER KEY

Pilot Math Drills

$\begin{array}{r} 10 \\ + 10 \\ \hline 20 \end{array}$	$\begin{array}{r} 3 \\ + 5 \\ \hline 8 \end{array}$	$\begin{array}{r} 9 \\ + 8 \\ \hline 17 \end{array}$	$\begin{array}{r} 2 \\ + 7 \\ \hline 9 \end{array}$	$\begin{array}{r} 2 \\ + 4 \\ \hline 6 \end{array}$	$\begin{array}{r} 5 \\ + 7 \\ \hline 12 \end{array}$	$\begin{array}{r} 6 \\ + 2 \\ \hline 8 \end{array}$	$\begin{array}{r} 5 \\ + 9 \\ \hline 14 \end{array}$	$\begin{array}{r} 5 \\ + 8 \\ \hline 13 \end{array}$	$\begin{array}{r} 8 \\ + 9 \\ \hline 17 \end{array}$
$\begin{array}{r} 3 \\ + 6 \\ \hline 9 \end{array}$	$\begin{array}{r} 6 \\ + 9 \\ \hline 15 \end{array}$	$\begin{array}{r} 2 \\ + 5 \\ \hline 7 \end{array}$	$\begin{array}{r} 9 \\ + 4 \\ \hline 13 \end{array}$	$\begin{array}{r} 7 \\ + 7 \\ \hline 14 \end{array}$	$\begin{array}{r} 7 \\ + 2 \\ \hline 9 \end{array}$	$\begin{array}{r} 8 \\ + 4 \\ \hline 12 \end{array}$	$\begin{array}{r} 8 \\ + 3 \\ \hline 11 \end{array}$	$\begin{array}{r} 4 \\ + 5 \\ \hline 9 \end{array}$	$\begin{array}{r} 7 \\ + 4 \\ \hline 11 \end{array}$
$\begin{array}{r} 7 \\ + 3 \\ \hline 10 \end{array}$	$\begin{array}{r} 7 \\ + 10 \\ \hline 17 \end{array}$	$\begin{array}{r} 4 \\ + 6 \\ \hline 10 \end{array}$	$\begin{array}{r} 2 \\ + 2 \\ \hline 4 \end{array}$	$\begin{array}{r} 7 \\ + 6 \\ \hline 13 \end{array}$	$\begin{array}{r} 7 \\ + 8 \\ \hline 15 \end{array}$	$\begin{array}{r} 9 \\ + 3 \\ \hline 12 \end{array}$	$\begin{array}{r} 5 \\ + 4 \\ \hline 9 \end{array}$	$\begin{array}{r} 10 \\ + 6 \\ \hline 16 \end{array}$	$\begin{array}{r} 8 \\ + 7 \\ \hline 15 \end{array}$
$\begin{array}{r} 10 \\ + 2 \\ \hline 12 \end{array}$	$\begin{array}{r} 7 \\ + 9 \\ \hline 16 \end{array}$	$\begin{array}{r} 10 \\ + 5 \\ \hline 15 \end{array}$	$\begin{array}{r} 10 \\ + 8 \\ \hline 18 \end{array}$	$\begin{array}{r} 8 \\ + 6 \\ \hline 14 \end{array}$	$\begin{array}{r} 9 \\ + 7 \\ \hline 16 \end{array}$	$\begin{array}{r} 10 \\ + 7 \\ \hline 17 \end{array}$	$\begin{array}{r} 8 \\ + 2 \\ \hline 10 \end{array}$	$\begin{array}{r} 6 \\ + 4 \\ \hline 10 \end{array}$	$\begin{array}{r} 4 \\ + 2 \\ \hline 6 \end{array}$
$\begin{array}{r} 2 \\ + 6 \\ \hline 8 \end{array}$	$\begin{array}{r} 9 \\ + 2 \\ \hline 11 \end{array}$	$\begin{array}{r} 4 \\ + 3 \\ \hline 7 \end{array}$	$\begin{array}{r} 10 \\ + 3 \\ \hline 13 \end{array}$	$\begin{array}{r} 9 \\ + 5 \\ \hline 14 \end{array}$	$\begin{array}{r} 5 \\ + 5 \\ \hline 10 \end{array}$	$\begin{array}{r} 9 \\ + 9 \\ \hline 18 \end{array}$	$\begin{array}{r} 4 \\ + 9 \\ \hline 13 \end{array}$	$\begin{array}{r} 2 \\ + 3 \\ \hline 5 \end{array}$	$\begin{array}{r} 5 \\ + 3 \\ \hline 8 \end{array}$

#2

$6 + 2 =$	$9 + 8 =$	$0 + 0 =$	$7 + 5 =$	$5 + 7 =$
$4 + 4 =$	$8 + 4 =$	$1 + 2 =$	$5 + 3 =$	$8 + 2 =$
$3 + 3 =$	$3 + 1 =$	$2 + 0 =$	$7 + 2 =$	$8 + 6 =$
$7 + 5 =$	$8 + 7 =$	$3 + 8 =$	$8 + 1 =$	$4 + 3 =$
$8 + 9 =$	$8 + 7 =$	$3 + 0 =$	$0 + 8 =$	$3 + 8 =$
$1 + 6 =$	$1 + 5 =$	$8 + 4 =$	$5 + 5 =$	$7 + 4 =$
$1 + 4 =$	$9 + 0 =$	$2 + 3 =$	$9 + 0 =$	$4 + 3 =$
$4 + 3 =$	$2 + 2 =$	$0 + 5 =$	$2 + 0 =$	$4 + 6 =$
$9 + 6 =$	$3 + 1 =$	$1 + 1 =$	$5 + 7 =$	$7 + 2 =$

Answer Key

$6 + 2 = 8$	$9 + 8 = 17$	$0 + 0 = 0$	$7 + 5 = 12$	$5 + 7 = 12$
$4 + 4 = 8$	$8 + 4 = 12$	$1 + 2 = 3$	$5 + 3 = 8$	$8 + 2 = 10$
$3 + 3 = 6$	$3 + 1 = 4$	$2 + 0 = 2$	$7 + 2 = 9$	$8 + 6 = 14$
$7 + 5 = 12$	$8 + 7 = 15$	$3 + 8 = 11$	$8 + 1 = 9$	$4 + 3 = 7$
$8 + 9 = 17$	$8 + 7 = 15$	$3 + 0 = 3$	$0 + 8 = 8$	$3 + 8 = 11$
$1 + 6 = 7$	$1 + 5 = 6$	$8 + 4 = 12$	$5 + 5 = 10$	$7 + 4 = 11$
$1 + 4 = 5$	$9 + 0 = 9$	$2 + 3 = 5$	$9 + 0 = 9$	$4 + 3 = 7$
$4 + 3 = 7$	$2 + 2 = 4$	$0 + 5 = 5$	$2 + 0 = 2$	$4 + 6 = 10$
$9 + 6 = 15$	$3 + 1 = 4$	$1 + 1 = 2$	$5 + 7 = 12$	$7 + 2 = 9$

Subtraction

Pilot Math Drills

$\begin{array}{r} 8 \\ -5 \end{array}$	$\begin{array}{r} 9 \\ -9 \end{array}$	$\begin{array}{r} 6 \\ -2 \end{array}$	$\begin{array}{r} 4 \\ -4 \end{array}$	$\begin{array}{r} 10 \\ -4 \end{array}$	$\begin{array}{r} 13 \\ -8 \end{array}$	$\begin{array}{r} 4 \\ -3 \end{array}$	$\begin{array}{r} 15 \\ -8 \end{array}$	$\begin{array}{r} 14 \\ -8 \end{array}$	$\begin{array}{r} 14 \\ -5 \end{array}$
$\begin{array}{r} 15 \\ -7 \end{array}$	$\begin{array}{r} 11 \\ -2 \end{array}$	$\begin{array}{r} 4 \\ -2 \end{array}$	$\begin{array}{r} 7 \\ -5 \end{array}$	$\begin{array}{r} 13 \\ -4 \end{array}$	$\begin{array}{r} 7 \\ -7 \end{array}$	$\begin{array}{r} 14 \\ -6 \end{array}$	$\begin{array}{r} 13 \\ -6 \end{array}$	$\begin{array}{r} 11 \\ -6 \end{array}$	$\begin{array}{r} 12 \\ -5 \end{array}$
$\begin{array}{r} 3 \\ -2 \end{array}$	$\begin{array}{r} 5 \\ -5 \end{array}$	$\begin{array}{r} 6 \\ -6 \end{array}$	$\begin{array}{r} 9 \\ -5 \end{array}$	$\begin{array}{r} 9 \\ -6 \end{array}$	$\begin{array}{r} 6 \\ -5 \end{array}$	$\begin{array}{r} 9 \\ -3 \end{array}$	$\begin{array}{r} 11 \\ -3 \end{array}$	$\begin{array}{r} 5 \\ -2 \end{array}$	$\begin{array}{r} 13 \\ -7 \end{array}$
$\begin{array}{r} 13 \\ -5 \end{array}$	$\begin{array}{r} 9 \\ -8 \end{array}$	$\begin{array}{r} 15 \\ -9 \end{array}$	$\begin{array}{r} 15 \\ -6 \end{array}$	$\begin{array}{r} 11 \\ -7 \end{array}$	$\begin{array}{r} 12 \\ -8 \end{array}$	$\begin{array}{r} 11 \\ -9 \end{array}$	$\begin{array}{r} 10 \\ -7 \end{array}$	$\begin{array}{r} 8 \\ -8 \end{array}$	$\begin{array}{r} 7 \\ -6 \end{array}$
$\begin{array}{r} 10 \\ -2 \end{array}$	$\begin{array}{r} 5 \\ -4 \end{array}$	$\begin{array}{r} 3 \\ -3 \end{array}$	$\begin{array}{r} 11 \\ -8 \end{array}$	$\begin{array}{r} 6 \\ -3 \end{array}$	$\begin{array}{r} 16 \\ -8 \end{array}$	$\begin{array}{r} 10 \\ -9 \end{array}$	$\begin{array}{r} 7 \\ -2 \end{array}$	$\begin{array}{r} 14 \\ -7 \end{array}$	$\begin{array}{r} 9 \\ -2 \end{array}$

Time: _____ minutes Score: _____ out of 50

ANSWER KEY

Pilot Math Drills

$\frac{8}{-5}$	$\frac{9}{-9}$	$\frac{6}{-2}$	$\frac{4}{-4}$	$\frac{10}{-4}$	$\frac{13}{-8}$	$\frac{4}{-3}$	$\frac{15}{-8}$	$\frac{14}{-8}$	$\frac{14}{-5}$
$\frac{-5}{3}$	$\frac{-9}{0}$	$\frac{-2}{4}$	$\frac{-4}{0}$	$\frac{-4}{6}$	$\frac{-8}{5}$	$\frac{-3}{1}$	$\frac{-8}{7}$	$\frac{-8}{6}$	$\frac{-5}{9}$
$\frac{15}{-7}$	$\frac{11}{-2}$	$\frac{4}{-2}$	$\frac{7}{-5}$	$\frac{13}{-4}$	$\frac{7}{-7}$	$\frac{14}{-6}$	$\frac{13}{-6}$	$\frac{11}{-6}$	$\frac{12}{-5}$
$\frac{-7}{8}$	$\frac{-2}{9}$	$\frac{-2}{2}$	$\frac{-5}{2}$	$\frac{-4}{9}$	$\frac{-7}{0}$	$\frac{-6}{8}$	$\frac{-6}{7}$	$\frac{-6}{5}$	$\frac{-5}{7}$
$\frac{-2}{1}$	$\frac{-5}{0}$	$\frac{-6}{0}$	$\frac{-5}{4}$	$\frac{-6}{3}$	$\frac{-5}{1}$	$\frac{-3}{6}$	$\frac{-3}{8}$	$\frac{-2}{3}$	$\frac{-7}{6}$
$\frac{13}{-5}$	$\frac{9}{-8}$	$\frac{15}{-9}$	$\frac{15}{-6}$	$\frac{11}{-7}$	$\frac{12}{-8}$	$\frac{11}{-9}$	$\frac{10}{-7}$	$\frac{8}{-8}$	$\frac{7}{-6}$
$\frac{-5}{8}$	$\frac{-8}{1}$	$\frac{-9}{6}$	$\frac{-6}{9}$	$\frac{-7}{4}$	$\frac{-8}{4}$	$\frac{-9}{2}$	$\frac{-7}{3}$	$\frac{-8}{0}$	$\frac{-6}{1}$
$\frac{10}{-2}$	$\frac{5}{-4}$	$\frac{3}{-3}$	$\frac{11}{-8}$	$\frac{6}{-3}$	$\frac{16}{-8}$	$\frac{10}{-9}$	$\frac{7}{-2}$	$\frac{14}{-7}$	$\frac{9}{-2}$
$\frac{-2}{8}$	$\frac{-4}{1}$	$\frac{-3}{0}$	$\frac{-8}{3}$	$\frac{-3}{3}$	$\frac{-8}{8}$	$\frac{-9}{1}$	$\frac{-2}{5}$	$\frac{-7}{7}$	$\frac{-2}{7}$

#2

$\begin{array}{r} 11 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 12 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -6 \\ \hline \end{array}$	$\begin{array}{r} 16 \\ -7 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 13 \\ -9 \\ \hline \end{array}$
$\begin{array}{r} 7 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 11 \\ -8 \\ \hline \end{array}$	$\begin{array}{r} 14 \\ -8 \\ \hline \end{array}$	$\begin{array}{r} 1 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -7 \\ \hline \end{array}$	$\begin{array}{r} 15 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ -7 \\ \hline \end{array}$	$\begin{array}{r} 2 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 13 \\ -5 \\ \hline \end{array}$
$\begin{array}{r} 9 \\ -7 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 15 \\ -8 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ -6 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 13 \\ -6 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 14 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ -8 \\ \hline \end{array}$
$\begin{array}{r} 15 \\ -7 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 10 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 18 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 12 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 11 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 6 \\ -3 \\ \hline \end{array}$
$\begin{array}{r} 17 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 9 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ -6 \\ \hline \end{array}$	$\begin{array}{r} 3 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 11 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ -3 \\ \hline \end{array}$	$\begin{array}{r} 7 \\ -6 \\ \hline \end{array}$	$\begin{array}{r} 14 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 16 \\ -9 \\ \hline \end{array}$	$\begin{array}{r} 12 \\ -7 \\ \hline \end{array}$
$\begin{array}{r} 10 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -4 \\ \hline \end{array}$	$\begin{array}{r} 8 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 14 \\ -5 \\ \hline \end{array}$	$\begin{array}{r} 15 \\ -6 \\ \hline \end{array}$	$\begin{array}{r} 0 \\ -0 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -2 \\ \hline \end{array}$	$\begin{array}{r} 4 \\ -1 \\ \hline \end{array}$	$\begin{array}{r} 17 \\ -8 \\ \hline \end{array}$	$\begin{array}{r} 5 \\ -3 \\ \hline \end{array}$

Answer Key

$\frac{11}{-9}$ $\frac{2}{3}$	$\frac{12}{-9}$ $\frac{3}{1}$	$\frac{3}{-2}$ $\frac{1}{1}$	$\frac{7}{-6}$ $\frac{1}{1}$	$\frac{16}{-7}$ $\frac{9}{1}$	$\frac{5}{-4}$ $\frac{1}{3}$	$\frac{8}{-5}$ $\frac{1}{1}$	$\frac{1}{-0}$ $\frac{9}{1}$	$\frac{9}{-0}$ $\frac{4}{1}$	$\frac{13}{-9}$ $\frac{4}{1}$
$\frac{7}{-3}$ $\frac{4}{3}$	$\frac{11}{-8}$ $\frac{3}{6}$	$\frac{14}{-8}$ $\frac{6}{0}$	$\frac{1}{-1}$ $\frac{0}{0}$	$\frac{7}{-7}$ $\frac{0}{6}$	$\frac{15}{-9}$ $\frac{1}{1}$	$\frac{8}{-7}$ $\frac{2}{2}$	$\frac{2}{-0}$ $\frac{5}{8}$	$\frac{8}{-3}$ $\frac{13}{8}$	$\frac{13}{-5}$ $\frac{8}{0}$
$\frac{9}{-7}$ $\frac{2}{1}$	$\frac{6}{-5}$ $\frac{1}{7}$	$\frac{15}{-8}$ $\frac{4}{1}$	$\frac{4}{-3}$ $\frac{2}{0}$	$\frac{8}{-6}$ $\frac{5}{7}$	$\frac{5}{-5}$ $\frac{10}{8}$	$\frac{13}{-6}$ $\frac{14}{5}$	$\frac{10}{-2}$ $\frac{8}{0}$	$\frac{14}{-9}$ $\frac{8}{3}$	$\frac{8}{-8}$ $\frac{0}{3}$
$\frac{15}{-7}$ $\frac{8}{8}$	$\frac{8}{-0}$ $\frac{9}{0}$	$\frac{9}{-9}$ $\frac{10}{5}$	$\frac{10}{-5}$ $\frac{18}{9}$	$\frac{4}{-0}$ $\frac{12}{9}$	$\frac{-0}{4}$ $\frac{11}{8}$	$\frac{-3}{9}$ $\frac{7}{4}$	$\frac{-3}{8}$ $\frac{6}{3}$	$\frac{-3}{4}$ $\frac{3}{3}$	$\frac{-3}{3}$ $\frac{3}{3}$
$\frac{17}{-9}$ $\frac{8}{7}$	$\frac{9}{-2}$ $\frac{8}{2}$	$\frac{3}{-6}$ $\frac{3}{1}$	$\frac{11}{-5}$ $\frac{8}{5}$	$\frac{7}{-6}$ $\frac{14}{9}$	$\frac{8}{-3}$ $\frac{16}{7}$	$\frac{7}{-6}$ $\frac{12}{5}$	$\frac{14}{-5}$ $\frac{12}{5}$	$\frac{14}{-9}$ $\frac{12}{5}$	$\frac{16}{-9}$ $\frac{12}{5}$
$\frac{10}{-2}$ $\frac{8}{0}$	$\frac{4}{-4}$ $\frac{8}{7}$	$\frac{14}{-1}$ $\frac{14}{9}$	$\frac{15}{-6}$ $\frac{0}{0}$	$\frac{5}{-2}$ $\frac{4}{3}$	$\frac{0}{-0}$ $\frac{4}{3}$	$\frac{5}{-2}$ $\frac{17}{9}$	$\frac{-1}{3}$ $\frac{5}{2}$	$\frac{-8}{9}$ $\frac{5}{2}$	$\frac{-3}{2}$ $\frac{5}{2}$

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