VANCOUVER ISLAND UNIVERSITY
EXPLORE. DISCOVER. EXCEL.

ABE Introduction to Science Module
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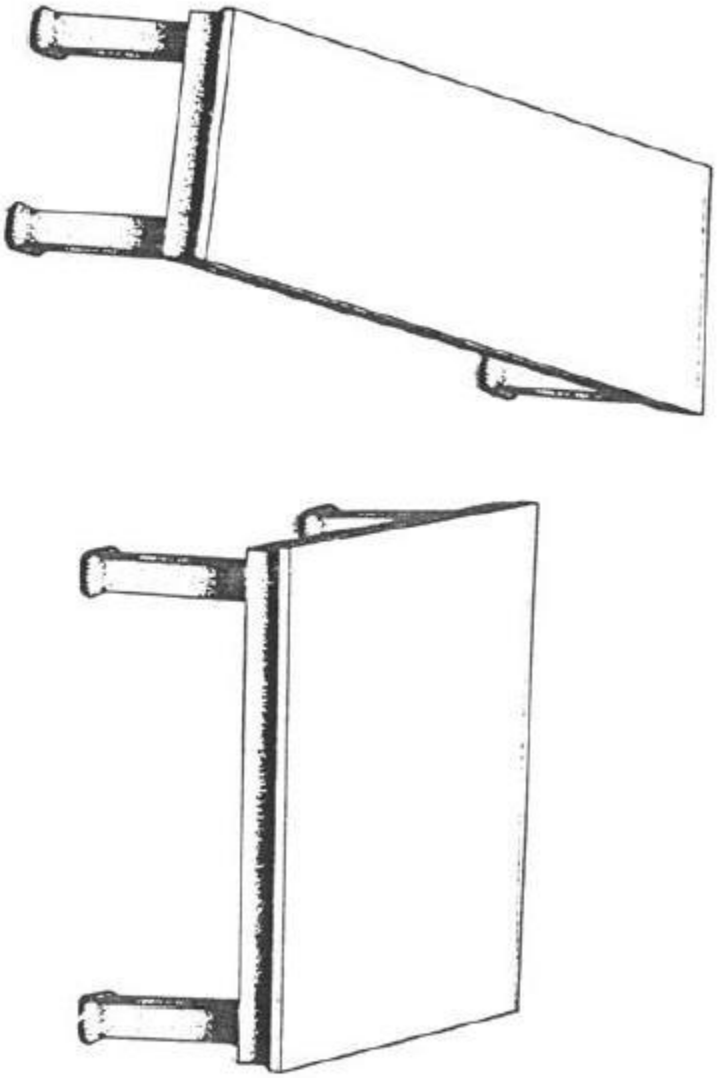
Which Table is longer?

Answer on next page



Module 1 Introduction to Science

Unit 1 Science and Its Limits

Learning Objectives:

- To understand what science is
- To understand the limits of science

Learning Materials

- Reading
- Science Knowledge Survey
- Answer key *Answer: Both tables are the same length!*

Science

Illusion vs. Reality

- ✓ Sight
- ✓ Touch
- ✓ Smell
- ✓ Hearing
- ✓ Taste

These can be fooled!

Not only can your senses be fooled but we can hardly agree among ourselves as to what *sounds* good or *tastes* good. Scientific knowledge tries to use Reason to understand the world and our perceptions of it.

For an example of how easily our senses are fooled go to the website below and do the Blind Spot activity. Everybody has a blind spot and we will use our Reason to figure it out.

Blind Spot Activity ⇒ http://serendip.brynmawr.edu/bb/blindspot1.html

- *Continue to the bottom of the page for a few more blind spot tests.*

Science Knowledge Survey

This survey is given to help you identify your understanding about the nature of science and certain basic science concepts. See page 6 for answers.

Answer Key: **T=** true, or you agree, (or you lean that way)
F= false, or you disagree (or you lean this way)

1. ______Science is primarily a method for inventing new devices.
2. ______Science can prove anything, solve any problem, or answer any question.
3. ______Science is primarily concerned with understanding how the natural world works.
4. ______Science involves dealing with many uncertainties.
5. ______Astrology (predicting your future from the arrangement of starts and planets) is a science.
6. ______Science requires a lot of creativity.
7. ______Science always provides tentative (temporary) answers to questions.
8. ______A “hypothesis” is just an “educated guess” about anything
9. ______Scientists can believe in God or a supernatural being and still do good science.
10. ______Science is most concerned with collecting facts.
11. ______Most engineers and medical doctors are practicing scientists.
12. ______Something that is “proven scientifically” is considered by scientists as being fact, and therefore no longer subject to change.
13. ______Science can be done poorly
14. ______Scientific concepts and discoveries can cause new problems for people.
15. ______Scientists have solved most of the major mysteries of nature.
16. ______Science can study things and events from millions of years ago.
17. ______Knowledge of what science is, what it can do and cannot do, and how it works, is important for all educated people to know.
18. ______Scientific experimentation usually involves trying something just to see what will happen, without predicting a likely outcome.
19. ______Anything done scientifically can be relied upon to be accurate and reliable.
20. ______Scientists assume that nature follows the same “rules” throughout the universe.
21. ______Scientists often try to disprove their own ideas.
22. ______Science can be influenced by race, gender, nationality, or religion of the scientist.
23. ______Different scientists may get different solutions to the same problem.
24. ______Disagreement between scientists is one of the weaknesses of science.
25. ______Any study done carefully and based on observation is scientific.

What Science IS and what it IS NOT

After reading the following take the Science Knowledge Survey again and see if you do better!

What science is not

1. **It's not a process in which understanding is based on faith or belief.**
   The probable explanations for natural events are always based on observations carefully analyzed and tested. The high confidence we have in science comes from the many successful applications to real-life problems (e.g. in medicine, space exploration, chemistry and technology).
2. **It's not a process which can ignore rules.**
   Science must follow certain rules; otherwise, it's not science (just as soccer is not soccer if its rules are not followed).
3. **It's not a process which seeks the truth or facts.**
   The goal of science is to come as close as we can to understanding the cause-effect realities of the natural world. It's never "truth" or "facts". "Truth" and "facts" can mean different things to different people.
1. **It's not a process which attempts to prove things.**
   The process of science, when properly applied, actually attempts to disprove ideas (tentative explanations)... a process called "testing", or "challenging". If the idea survives testing, then it is stronger, and more likely an accurate explanation.
5. **It's not a process which produces certainties, or absolute facts.**
   Science is a process which can only produce "possible" to "highly probable" explanations for natural phenomena; these are never certainties. With new information, tools, or approaches, earlier findings (theories, or even facts) can be replaced by new findings.
6. **It's not a process which can always be relied upon due to its total objectivity and internal self-correction.** Science can be done poorly, just like any other human endeavor. We are all fallible, some of us make fewer mistakes than others, some observe better than others, but we are still subjective in the end. Internal self-correction mechanisms in science merely increase the reliability of its product.

7. **It's not a process which is always properly used.**
   Unfortunately, science is all too frequently misused. Because it works so well, there are those who apply the name of science to their efforts to "prove" their favorite cause, even if the rules of science were not followed. Such causes are properly labeled "pseudoscience". Also, some scientists have been known to do fraudulent work, in order to support their pet ideas. Such work is usually exposed sooner or later, due to the peer review system, and the work of other scientists.

8. It is not a process that is free from values, opinions or bias.

Scientists are people, and although they follow certain rules and try to be as objective as possible, both in their observations and their interpretations, their biases are still there. Unconscious racial bias, gender bias, social status, source of funding, or political leanings can and do influence one's perceptions and interpretations.

9. It is not a process in which one solution is as good as another, or is simply a matter of opinion.

In science, there is a rigorous analysis and fair-test comparison of alternative explanations, using discriminate criteria, for example confirmation of your results by other scientists, leading to one "best" solution. Any experiment one scientist does should be able to be done by another scientist with the same results.

What Science IS

So, what IS science? It has been defined many ways and its meaning has changed with time. So it is understandable that "Science" is sometimes misunderstood. Some things are called science, when they are not, and some criticisms of science are based on a misunderstanding about what science is. In its most fundamental sense, modern science is a process by which we try to understand how the natural world works and how it came to be that way. This process includes such activities as collecting and studying specimens, making measurements, conducting experiments, and constructing theories that give meaning to all these data and facts. Scientific Knowledge is made up of: Measurement, Observation, Theory, Data, Prediction, and testing hypotheses.

As a process, certain rules must be followed, but *there is no one "scientific method"*, contrary to its popular treatment in textbooks. Scientific understanding can always be challenged, and even changed, with new ways of observing and with different interpretations. The same is true of scientific facts. New tools and techniques have resulted in new observations, sometimes forcing revision of what had been taken as fact in the past.

Science must follow certain rules, such as:

a. Scientific explanations must be based on careful observations and the testing of hypotheses.
b. It must be possible to attempt to disprove a hypothesis. Scientific solutions cannot be based merely upon personal opinion, belief, or judgment.
c. Scientific explanations cannot include supernatural forces (these can never be disproved).
d. The "best" hypothesis, out of the choices, must be one which best fits several explicit criteria.

If there are so many limitations and uncertainties to science, why is science so useful? It turns out that the limitations are the strengths of science. From the actual use and application of the scientific knowledge to real world problems, we have found that scientific knowledge is the most reliable knowledge we have about the natural world. In other words, most of the time, it works! This has enabled much of our work in modern medicine, agriculture and technology to be as successful as it has been.

ANSWERS:

Scientific Knowledge Survey

1. F
2. F
3. T
4. T
5. F
6. T
7. T
8. F
9. T
10. F
11. F
12. F
13. T
14. T
15. F
16. T
17. T
18. F
19. F
20. T
21. T
22. T
23. T
24. F
25. F

Module 1 Introduction to Science

Unit 2 The Scientific Method

Learning Objectives:

- To understand the purpose of the scientific method
- To identify the parts of the scientific method
- To understand the importance of a controlled experiment

Learning Materials

- Reading
- Exercise: Case study
    - Answer key
- Internet reading and experiment: http://visionlearning.com/library/module_viewer.php?mid=45 (The Leaning Tower of Pisa Experiment)
- Experiment: How Ice Melts.
    - Exercise and Answer key
- Challenge exercise: Reading: Higher Dose of Flu Vaccine Improves Immune Response in the Elderly
    - Answer key

Module 1 Introduction to Science

Unit 3 Calculations

Learning Objectives:

- To be able to add, subtract, multiply, divide and simplify fractions
- To be able to add, subtract, multiply and divide decimals
- To be able to convert fractions to and from decimals
- To understand BEDMAS
- To be able to solve simple equations involving addition, subtraction, multiplication and division

Learning Materials

- Reading
- Exercises
    - Answer key

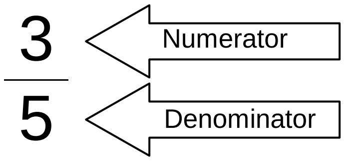
Do I really have to do math?!?!?
If you want to do science, you just gotta know the math. Here are some basics you will need!

The Basics
We are assuming you know how to add, subtract, multiply and divide. If you don't, you are going to have trouble in your science course and should take a math course first

A word of advice... If you need a calculator to add, subtract, multiply or divide simple numbers (like 5 x 12), it's time to learn your times tables! Believe it or not, but relying on a calculator is a BIG handicap when you get into upper level math!

Fractions Review

Recall that the top number in a fraction is the **numerator** and the bottom number is the **denominator**.



Simplifying Fractions

Fractions must always be put in their simplest form. For example, $\frac{2}{6}$ is not simplified. Why? Because 2 and 6 will both divide by 2. A fraction is simplified when there is no number you can divide both numerator and denominator by. To simplify a fraction we just divide:

$$\frac{2 \div 2}{6 \div 2} = \frac{1}{3}$$

Adding and Subtracting Fractions

When you are adding or subtracting fractions you must always find the **lowest common denominator (LCD).**

How? There are a few ways to do this; the method below is one easy way that always works!

Suppose you want to add $\frac{3}{10}+\frac{5}{12}$.

How to find the LCD

Multiply the larger denominator by 2, 3, etc. until you reach a number that the smaller denominator will go into.

Example 1: $\frac{3}{10}+\frac{5}{12}$

12 x 2 = 24	10 will not go into 24
12 x 3 = 36	10 will not go into 36
12 x 4 = 48	10 will not go into 48
12 x 5 = 60	10 will go into 60!

The LCD of 12 and 10 is 60

Once you find the LCD, convert both fractions to the LCD.

$$\frac{3}{10}+\frac{5}{12}$$

The LCD is 60, so we need to convert $\frac{3}{10}$ into something over 60.

To convert 10 into 60, you multiply by 6, and

Whatever you do to the denominator, you must do to the numerator.

So, we multiply both by 6!

$$\frac{3}{10}\times\frac{6}{6}=\frac{18}{60}$$

Now, we convert $\frac{5}{12}$ by multiplying numerator and denominator by 5:

$$\frac{5}{12}\times\frac{5}{5}=\frac{25}{60}$$

So… $\frac{\underline{\text{LCD (60)}}}{\text{(12)}} = 5$

$$\frac{3}{10}+\frac{5}{12} = \frac{3}{10}\times\frac{6}{6}+\frac{5}{12}\times\frac{5}{5} = \frac{18}{60}+\frac{25}{60} = \frac{43}{60}$$

Notice the last step is to add the numerators, **and don’t change the denominator!**

Example 2: $\frac{7}{12}-\frac{13}{40}$

40 x 2 = 80	12 will not go into 80
40 x 3 = 120	12 will go into 120

The LCD of 12 and 40 is 120, so the numerator and denominator in the first fraction are multiplied by 10 because 10 x 12 = 120, and the numerator and denominator in the second fraction multiplied by 3: 40 x 3 = 120

$$\frac{7}{12}-\frac{13}{40} = \frac{7}{12}\times\frac{10}{10}-\frac{13}{40}\times\frac{3}{3} = \frac{70}{120}-\frac{39}{120} = \frac{31}{120}$$

Example 3: $5\frac{1}{3}-3\frac{3}{4}$

Find the LCD: $5\frac{1}{3}-3\frac{3}{4}$ = $5\frac{4}{12}-3\frac{9}{12}$

If you subtract the numerators, you get -5! We don't want to go there, so we BORROW 1 from the 5. Instead of 5, think of it as $4\frac{12}{12}$. We then add the $\frac{4}{12}$ to the $\frac{12}{12}$ to get $\frac{16}{12}$

Now we have $4\frac{16}{12}-3\frac{9}{12}$

Subtract the fractions and subtract the whole numbers: $4\frac{16}{12}-3\frac{9}{12}$ = $1\frac{7}{12}$

$4-3=1$

$\frac{16}{12}-\frac{9}{12}=\frac{7}{12}$

Multiplying Fractions

This is easy! Just multiply the numerators together and the denominators together!

Example 1: $\frac{2}{3}\times\frac{4}{5}=\frac{8}{15}$ This can also be written as $\frac{2}{3}\left(\frac{4}{5}\right)=\frac{8}{15}$

Example 2: $\frac{2}{5}\times\frac{5}{4}=\frac{10\div10}{20\div10}=\frac{1}{2}$

Simplify!

Dividing Fractions

Dividing fractions, involves just one extra step!

1. Invert the 2nd fraction
2. Multiply

Example 1: $\frac{2}{3}\div\frac{3}{7}$

Invert the second fraction $=\frac{2}{3}\times\frac{7}{3}$

Multiply the numerators and denominators $=\frac{14}{9}$

$\frac{14}{9}$ This is called an improper fraction because the numerator is bigger than the denominator.
This should be converted to a mixed number…..

$\frac{14}{9}$ ➔ 14 ÷ 9 = 1 with 5 remainder. So, $\frac{14}{9}$ = $1\frac{5}{9}$

Example 2: $\frac{1}{2} \div \frac{1}{9}$

Invert the second fraction $= \frac{1}{2} \times \frac{9}{1}$

Multiply the numerators and denominators $= \frac{9}{2}$

Convert the improper fraction to a mixed number: 9 ÷ 2 = 4 with 1 remainder: $\frac{9}{2} = 4\frac{1}{2}$

Questions:

Simple Fractions

1) $\frac{3}{10} + \frac{4}{15}$
2) $\frac{11}{56} + \frac{3}{7}$
3) $\frac{72}{100} + \frac{1}{5}$
4) $\frac{1}{2} + \frac{3}{8}$
5) $\frac{4}{5} - \frac{1}{3}$
6) $\frac{5}{6} - \frac{1}{4}$
7) $\frac{3}{4} - \frac{1}{16}$
8) $\frac{4}{5} - \frac{2}{3}$
9) $\frac{4}{6}$ x $\frac{1}{7}$
10) $\frac{1}{8}$ x $\frac{3}{7}$
11) $\frac{1}{4}$ x $\frac{2}{9}$
12) $\frac{1}{7}$ x $\frac{2}{7}$
13) $\frac{3}{5} \div \frac{3}{5}$
14) $\frac{6}{8} \div \frac{1}{5}$
15) $\frac{3}{7} \div \frac{4}{7}$
16) $\frac{2}{6} \div \frac{1}{4}$

Mixed Numbers

1) $6\frac{2}{7} + 3\frac{1}{3}$
2) $5\frac{2}{9} + 6\frac{2}{3}$
3) $1\frac{2}{3} + 3\frac{1}{4}$
4) $2\frac{2}{5} + 3\frac{9}{20}$
5) $9\frac{2}{3} - 8\frac{1}{3}$
6) $4\frac{11}{20} - 1\frac{3}{10}$
7) $7\frac{6}{7} - 3\frac{2}{3}$
8) $8\frac{1}{2} - 2\frac{3}{10}$
9) $3\frac{1}{2}$ x $1\frac{1}{2}$
10) $2\frac{1}{2}$ x $2\frac{1}{3}$
11) $\frac{3}{8}$ x $7\frac{1}{4}$
12) 3 x $3\frac{7}{8}$
13) $\frac{5}{9} \div 2\frac{2}{3}$
14) $3\frac{3}{4} \div \frac{5}{6}$
15) $8\frac{1}{4} \div \frac{1}{4}$
16) $\frac{1}{2} \div 1\frac{1}{4}$

Subtractions where the solution is negative

1) $4\frac{1}{10} - \frac{4}{5}$

2) $9\frac{1}{8} - 6\frac{1}{2}$

3) $5\frac{1}{4} - 3\frac{2}{3}$

4) $7\frac{3}{12} - 6\frac{1}{3}$

Decimals Review

What is a decimal?

Decimals represent parts of a whole, just like a fraction does.
Decimals are similar to fractions where the denominator is a multiple of 10 (i.e. 10, 100, 1000, etc.).

Examples:

$\frac{3}{10} = 0.3$ $\frac{51}{100} = 0.56$ $\frac{7}{1000} = 0.007$

Notice there is one decimal for each zero in the denominator. For example, 1000 has three zeros in it so the decimal has three places.

Consider $\frac{31}{10}$ Ten has 1 zero, so there is one decimal: 3.1

Another way to think of this is that 31 ÷ 10 = $3\frac{1}{10}$ = 3.1

Converting Fractions to Decimals

Divide the numerator by the denominator to get the decimal answer

Example $\frac{3}{4}$ = $4\overset{.75}{\overline{)3.00}}$ = .75

Converting Decimals to Fractions

Decide on the number of zeros in the denominator - the same as the number of decimal places.

Example 1: 0.45 = $\frac{45}{100}$ (2 decimal places = two zeros)

Note: always reduce fractions to lowest terms. = $\frac{9}{20}$

Example 2: 0.02 = $\frac{2}{100}$ (2 decimal places = two zeros)

= $\frac{1}{50}$

Example 3: 4.037 = $4\frac{37}{1000}$

Example 4: 3.3300 = $3\frac{33}{100}$ Notice that trailing zeros are ignored!

Adding and Subtracting Decimals

The big trick: **Keep the decimals lined up** and add as you normally would.

Example 1 : Add 2.34 to 43.652

$$\begin{array}{r} 2.34 \\ \underline{43.652} \\ 45.992 \end{array}$$

Notice decimals line up!

Example 2: 57.32 + 31.075

$$\begin{array}{r} 57.32 \\ \underline{31.075} \\ 88.395 \end{array}$$

Multiplying and Dividing Decimals

1. Multiply the numbers, ignoring the decimals
2. Add up the decimal places in <u>both</u> numbers and your answer will have that total number of decimal places

Example 1: Multiply 2.12 by 4.2

Ignore the decimals, and multiply as if calculating 212 x 42

2.12 and 4.2 have three decimals, so your answer must have three decimal places.

$$\begin{array}{ll} 2.12 & \text{(2 places)} \\ \underline{\text{x } 4.2} & \text{(1 place)} \\ 424 & \\ \underline{8480} & \\ 8.904 & \text{(3 places)} \end{array}$$

Example 2: 0.0941 times 0.02

Multiply. Add enough zeros to show the correct number of decimal places.

$$\begin{array}{rl} .0941 & \text{(4 places)} \\ \underline{\text{x } .02} & \text{(2 places)} \\ .001882 & \text{(total = 6)} \end{array}$$

Dividing Decimals

1. Change the divisor (second number) to a whole number by moving the decimal
2. Move the decimal in the first number the same number of spaces.
3. Divide, adding zeros as necessary
4. Line up the decimal in the answer

Example 1: Divide 2.322 by .12 ← divisor

Set up the division $0.12\overline{)2.322}$

Move the decimal in the divisor two places to the right $12\overline{)2.322}$

Move the decimal in the first number two places to the right $12\overline{)232.2}$

Do the division. Line up decimal in the answer with the other decimal

Example 2: Divide 0.003 into 51

$$.003\overline{)51} \rightarrow 3\overline{)51000}$$

$$\begin{array}{l} 17000 \\ 3\overline{)51000} \\ \underline{3} \\ 21 \\ \underline{21} \\ 0 \end{array}$$

$$
\begin{array}{r}
19.35 \\
12\overline{)232.20} \\
\underline{12} \\
112 \\
\underline{108} \\
42 \\
\underline{36} \\
60 \\
\underline{60} \\
0
\end{array}
$$

Questions:

a) Change to Fractions: (Remember to reduce whenever possible)

1. 2.591   2. 25.030   3. 50.0250   4. 0.8

b) Change to Decimals: (Do not round off)

1. $\frac{7}{8}$ 2. $\frac{3}{11}$ 3. $\frac{4}{9}$ 4. $\frac{3}{5}$ 5. $\frac{4}{7}$

6. $\frac{5}{12}$ 7. $\frac{5}{6}$ 8. $\frac{2}{3}$ 9. $\frac{7}{2}$ 10. $\frac{2}{9}$

c) Addition:

1. 2.49 + .32   **2.** 0.042 plus .00982   **3.** 7.342 and 2 and 7.65

4. 1743.2 + 2.984 + 12.35   **5.** 2.76 more than 8.4590

d) Subtraction:

1) 2.036 from 4.478   **2)** 12.258 from 13   **3)** 670.1 minus 589.213

4) 0.1002 minus 0.05   **5)** 19.6 decreased by 5.349

e) Multiplication:

1) .21 by .04   **2)** .42 x .218   **3)** .5 times 132.786

4) Product of .009 and 2.003   **5)** .25 of 288

6) 9.4325 by 1000   **7)** 9.4325 by .001

f) Division:

1) 248 divided by 0.8

2) 15.47 divided by .091

3) 40.4 into 828.2

4) 0.339 divided by 1.30

5) .0025 into 1.875

6) 923.56 divided by 1000

7) 923.56 divided by .01

Solving Equations

Order of Operations

When different operations are combined in one problem, they must be done in a certain order. The acronym for remembering the order of operations is **BEMA.**

B - Brackets. All operations inside brackets must be done first.
For example: 2(3 + 5) = 2(**8**) = 16.

E - Exponents. An exponent indicates how many times to multiply a number by itself. Any exponents must be carried out first.
For example: $2(3^2 + 5) = 2(\mathbf{9} + 5) = 2\mathbf{(14)} = 28$

M - Multiplication and division must be carried out before adding and subtracting.
For example: 2 • 3 + 4 ÷ 2 = **6** + **2** = 8

A - Adding and subtracting is done last, as in the previous example.
For example: 6 + 3 • 5 -1 = 6 + **15** -1 = **21** - 1= 20

Questions:

1) $(8 - 2)(3 - 9) =$

2) $(-1)^4 + 2^3 - 10 =$

3) $8 - (2 \cdot 3 - 9) =$

4) $-7(3^4) + 18 =$

5) $6\,[\,9 - (3 - 4)] =$

6) $4 \cdot 5 - 2 \cdot 6 + 4$

7) $9 \div (-3) + 16 \cdot (-2) - 1 =$

8) $\dfrac{5^2 - 4^3}{9^2 - 2^2} =$

9) $\dfrac{(3-5)^2 - (7-13)}{(12-9)^2 + (11-14)^2} =$

10) $[\,-2(-3) - 2^3\,] - (-9)(-10) =$

11) $-2(16) - [\,2(-8) - 5^3\,] =$

12) $3(-4.5) + (2^2 - 3 \cdot 4^2) =$

SOLVING EQUATIONS - ADDITION and SUBTRACTION

An equation is solved when the unknown letter is isolated on one side of the equal sign. When isolating x, the equation must be kept balanced. To maintain balance, you must always do the same thing to both sides of the equation.

For example: Solve for x: $x+6 = 32$ to isolate x, → we must subtract 6 from the left, and thus from the right.

$x + 6 \mathbf{- 6} = 32 \mathbf{- 6}$
$x = 26$

Another example: $45 = –12 – x$
$45 + 12 = –X$
$57 = –X$ { Note: we want to solve for +x, not -x}
$–57 = X$

Questions:

Solve for the missing letter.

1) $Z – 3 = 25$
2) $a + 6.5 = 0.009$
3) $–34 = –6 – y$
4) $\frac{-3}{20} = y -6$
5) $(-x) + 4/7 = –1/3$
6) $–9.65 = 0.8 – x$
7) $436 = a – 58$
8) $–9.6 – x + 3.4 = 1/2 – 3$
9) $–(6 + X) = 2/3 + (-7)$
10) $3/4 – 7/8 = x + 0.9$

SOLVING EQUATIONS - MULTIPLICATION and DIVISION

These types of equations always have a number greater than 1 in front of the letter, or unknown. In the previous type of equation all you had to do was get your letter on one side of the equals sign and all the numbers on the other, and you were done! This is always your first step! Now, if your coefficient is greater than 1, you must divide both sides of the equal sign by the number in front of the letter. Here are three examples of how to tell what the coefficient is:

e.g. $-3x$	e.g. $\frac{3x}{5}$	e.g. $\frac{x}{4}$
coefficient = (–3)	coefficient = (3/5)	coefficient = (1/4)

In this section, we will just concentrate on the second step for solving equations. In the next section, we will combine both steps.

ex. 1) $6z = -9$	ex. 2) $\frac{1}{3}x = 5$	ex. 3) $\frac{x}{5} = \frac{4}{5}$
$6z/\mathbf{6} = -9/\mathbf{6}$	$\frac{3}{1} \bullet \frac{1}{3}x = 5 \bullet \frac{3}{1}$	$\mathbf{5/1} \bullet x/5 = 4/5 \bullet \mathbf{5/1}$
$z = -3/2$	$x = 15$	$x = 4$

Questions:

1) $2X = -16$
2) $-4y = -35$
3) $-86 = 5z$
4) $\frac{x}{2} = \frac{3}{5}$
5) $2.56b = -1.28$
6) $2/3x = 5$
7) $-\frac{1}{3}t = 7$
8) $50 = -x$
9) $-\frac{2r}{3} = -\frac{27}{4}$
10) $\frac{x}{-5} = (-12.06)$

Chapter 9: SOLVING EQUATIONS – BOTH METHODS TOGETHER

Before we look at the combination of both methods, we must first review adding and subtracting **like terms.** When adding terms that have the **same letter and same exponent, add the coefficients and carry the letter.**

e.g. **$2x + 3x = 5x$**   e.g. **$6x – x = 5x$**   e.g. **$–4y – 3y = –7y$**

<u>TWO STEPS TO SOLVE EQUATIONS:</u>:

1) COLLECT ALL NUMBERS ON ONE SIDE OF THE EQUAL SIGN, AND COLLECT ALL LETTERS ON THE OTHER SIDE.

2) SIMPLIFY AND DIVIDE BY THE NUMBER IN FRONT OF THE LETTER.

Ex. 1)

Solve:

$$\begin{aligned} 3x + 4 &= 13 \\ 3x &= 13 \bullet 4 \\ 3x &= 9 \\ \frac{3x}{3} &= \frac{9}{3} \\ x &= 3 \end{aligned}$$

Ex. 2)

$$\begin{aligned} 2x – 2 &= -3x + 3 \\ 2x - 2 + 2 &= -3X -r 3 + 2 \\ 2x &= -3x + 5 \\ 2x + 3x &= -3x + 3x + 5 \\ 5x &= 5 \\ \frac{5x}{5} &= \frac{5}{5} \\ x &= 1 \end{aligned}$$

Questions:

1) $5x + 6 = 31$
2) $8x + 4 = 68$
3) $-5y - 7 = 108$
4) $-91 = 9t + 8$
5) $5x + 7x = 72$
6) $-4y -8y = 48$
7) $x + -x = 8$
8) $5x + 3 = 2x + 15$
9) $2x-1 = 4 + x$
10) $4 + 3x - 6 = 3x + 2 - x$
11) $5y - 7 + y = 7y + 21 - 5y$

ANSWERS:

Simple Fractions

1) LCD = 30

$$\frac{9}{30} + \frac{8}{30}$$
$$= \frac{17}{30}$$

2) LCD = 56

$$\frac{11}{56} + \frac{24}{56}$$
$$= \frac{35}{56}$$
$$= \frac{5}{8}$$

3) LCD = 100

$$\frac{72}{100} = \frac{20}{100}$$
$$= \frac{92}{100}$$
$$= \frac{23}{25}$$

4) LCD = 8

$$\frac{4}{8} + \frac{3}{8}$$
$$= \frac{7}{8}$$

5) LCD = 15

$$\frac{12}{15} - \frac{5}{15}$$
$$= \frac{7}{15}$$

6) LCD = 12

$$\frac{10}{12} - \frac{3}{12}$$
$$= \frac{7}{12}$$

7) LCD = 16

$$\frac{12}{16} - \frac{1}{16}$$
$$= \frac{11}{16}$$

8) LCD = 15

$$\frac{12}{15} - \frac{10}{15}$$
$$= \frac{2}{15}$$

9) $\frac{4}{42} = \frac{2}{21}$

10) $\frac{3}{56}$

11) $\frac{2}{36} = \frac{1}{18}$

12) $\frac{2}{49}$

13) $\frac{3}{5} \text{ x } \frac{5}{3}$

$$= \frac{15}{15}$$
$$= 1$$

14) $\frac{6}{8} \text{ x } \frac{5}{1}$

$$= \frac{30}{8}$$
$$= \frac{15}{4}$$

15) $\frac{3}{7} \text{ x } \frac{7}{4}$

$$= \frac{21}{28}$$
$$= \frac{3}{4}$$

16) $\frac{2}{6} \text{ x } \frac{4}{1}$

$$= \frac{8}{6}$$
$$= \frac{4}{3}$$

Mixed Numbers

1) LCD = 21

$6\frac{6}{21} + 3\frac{7}{21} =$

$9\frac{13}{21}$

2) LCD = 9

$5\frac{2}{9} + 6\frac{6}{9} =$

$11\frac{8}{9}$

3) LCD = 12

$1\frac{8}{12} + 3\frac{3}{12} =$

$4\frac{11}{12}$

4) LCD = 20

$2\frac{8}{20} + 3\frac{9}{20} =$

$5\frac{17}{20}$

5) LCD = 3

$9\frac{2}{3} - 8\frac{1}{3} =$

$1\frac{1}{3}$

6) LCD = 20

$4\frac{11}{20} - 1\frac{6}{20} =$

$3\frac{5}{20}$

7) LCD = 21

$7\frac{18}{21} - 3\frac{14}{21} =$

$4\frac{4}{21}$

8) LCD = 10

$8\frac{5}{10} - 2\frac{3}{10} =$

$6\frac{2}{10} = 6\frac{1}{5}$

9) $3\frac{1}{2}$ x $1\frac{1}{2}$ =

$\frac{7}{2}\times\frac{3}{2} =$

$\frac{21}{4} =$

$5\frac{1}{4}$

10) $2\frac{1}{2}$ x $2\frac{1}{3}$ =

$\frac{5}{2}\times\frac{7}{3} =$

$\frac{35}{6} =$

$5\frac{5}{6}$

11) $\frac{3}{8}$ x $7\frac{1}{4}$ =

$\frac{3}{8}\times\frac{29}{4} =$

$\frac{87}{32} =$

$2\frac{23}{32}$

12) 3 x $3\frac{7}{8}$ =

$\frac{3}{1}\times\frac{31}{8} =$

$\frac{93}{8} =$

$11\frac{5}{8}$

13) $\frac{5}{9} \div 2\frac{2}{3} =$

$\frac{5}{9} \div \frac{8}{3} =$

$\frac{5}{9}\times\frac{3}{8} =$

$\frac{15}{72} =$

$\frac{5}{24}$

14) $3\frac{3}{4} \div \frac{5}{6} =$

$\frac{15}{4} \div \frac{5}{6} =$

$\frac{15}{4}\times\frac{6}{5} =$

$\frac{90}{20} =$

$4\frac{10}{20} = 4\frac{1}{2}$

15) $8\frac{1}{4} \div \frac{1}{4} =$

$\frac{33}{4}\div\frac{1}{4} =$

$\frac{33}{4}\times\frac{4}{1} =$

33

16) $\frac{1}{2} \div 1\frac{1}{4} =$

$\frac{1}{2}\div\frac{5}{4} =$

$\frac{1}{2}\times\frac{4}{5} =$

$\frac{4}{10} =$

$\frac{2}{5}$

Subtractions where the solution is negative

1) LCD = 10

$4\frac{1}{10} - \frac{8}{10} =$

$3\frac{11}{10} - \frac{8}{10} =$

$3\frac{3}{10}$

2) LCD = 8

$9\frac{1}{8} - 6\frac{4}{8} =$

$8\frac{9}{8} - 6\frac{4}{8} =$

$2\frac{5}{8}$

3) LCD = 12

$5\frac{3}{12} - 3\frac{8}{12} =$

$4\frac{15}{12} - 3\frac{8}{12} =$

$1\frac{7}{12}$

4) LCD = 12

$7\frac{3}{12} - 6\frac{4}{12} =$

$\frac{87}{12} - \frac{76}{12} =$

$\frac{11}{12}$

ANSWERS:

Conversion and Rounding Off

a) 1) $2\frac{591}{1000}$ 2) $25\frac{3}{100}$ 3) $50\frac{1}{40}$ 4) $\frac{4}{5}$

b) 1) .875 2) $.\overline{27}$ 3) $.\dot{4}$ 4) .6 5) $.\overline{571428}$

6) $.41\dot{6}$ 7) $.83$ 8) $.\dot{6}$ 9) 3.5 10) $.\dot{2}$

c) Addition:

1) 2.49 + .32 =
2.81

2) 0.042 +.0982 =
0.05182

3) 7.342 +2 +.65 =
9.992

4) 1743.2 + 2.984 + 12.35
= 1758.534

5) 2.76 +8.4590 =
19.21

d) Subtraction:

1) 4.478 - 2.036 =
2.442

2) 13 – 12.258 =
0.742

3) 670.1 - 589.213 =
80.887

4) 0.1002 - 0.05 =
0.0502

5) 19.6 - 5.349 =
14.251

e) Multiplication:

1) .21 x .04 =
0.0084

2) .42 x .218 =
0.09156

3) .5 x 132.786 =
66.393

4) .009 x 2.003 =
0.01803

5) .25 x 288 =
72

6) 9.4325 x 1000 =
9432.5

7) 9.4325 x .001 =
0.0094325

f) Division:

1) 248 ÷ 0.8 =
3100

2) 15.47 ÷ .091 =
170

3) 828.2 ÷ 40.4 =
20.5

4) 0.339 ÷ 1.30 =
0.26077

5) 1.875 ÷ 0.0025 =
750

6) 923.56 ÷ 1000 =
0.92356

7) 923.56 ÷.01 = 92356

Answers:

Order of Operations

1) -36 2) -1 3) 11 4) -549 5) 60 6) 12

7) -36 8) $-\frac{39}{77}$ 9) $\frac{5}{9}$ 10) -62 11) 109 12) -57.5

Answers:

Solving Equations: Addition and Subtraction

1) 28 2) -6.491 3) 28 4) $5\frac{17}{20}$ 5) $\frac{19}{21}$ 6) 10.45

7) 494 8) -3.7 9) 1/3 10) -1.025

Answers:

Solving Equations: Multiplication and Division

1) -8 2) 8.75 3) -17.2 4) $1\frac{1}{5}$ 5) -0.5 6) $7\frac{1}{2}$

7) -21 8) -50 9) $10\frac{1}{8}$ 10) 60.3

Answers:

Solving Equations: Both Methods Together

1) 5 2) 8 3) -23 4) -11 5) 6 6) -4

7) 6 8) 4 9) 5 10) 4 11) 7

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Module 1 Introduction to Science

Unit 4 Ratios

Learning Objectives

- To understand how to set up ratio equations
- To solve ratio equations
- To solve word problems involving ratios

Learning Materials

- Reading
- Exercises
  - Answer key

Imagine you are baking a dozen cookies. The recipe calls for 2 cups of flour. If you want to bake three dozen cookies, how many cups of flour will you need?
Most people just know that it's 6 cups. Why? Maybe you'll just say 2 times 3 is 6, but a better way to think of it is:

2 cups for 1 dozen cookies
6 cups for 3 dozen cookies

This is an example of a ratio. The ratio above is in words. In math we would write the same thing as:

$$\frac{\text{2 cups}}{\text{6 cups}} = \frac{\text{1 dozen cookies}}{\text{3 dozen cookies}}$$

Notice we've replaced the word "for" with the equal sign, and put in the lines to make fractions. It's important to understand that this makes a true mathematical statement, $\frac{2}{6}$ really does equal $\frac{1}{3}$!

You can use this idea to solve uglier questions when the answer isn't so obvious. For example, if the dozen cookies recipe calls for 1.5 cups of flour, how much flour do you need for 2.5 dozen cookies (don't ask me why you'd be baking 2.5 dozen cookies!). Think of the ratio as:

1.5 cups for 1 dozen cookies
How many cups for 2.5 dozen cookies?

In math we write:

$$\frac{\text{1.5 cups}}{\text{x cups}} = \frac{\text{1 dozen cookies}}{\text{2.5 dozen cookies}} \quad \text{or more simply,} \quad \frac{1.5}{x} = \frac{1}{2.5}$$

Note that we have replaced the words "how many" with "x" in the equation. Now all we have to do is solve the equation for x! How?

Solve for x: $\frac{4}{18} = \frac{10}{x}$

Cross Multiply and Divide: Here’s how it’s done!

$\frac{4}{18} \times \frac{10}{x}$ Cross multiply 18 times 10 and 4 times x:

$18(10) = 4x$ Then divide by 4:

$\frac{180}{4} = x$ To get the answer: x = 45

Back to the cookies question:

$\frac{1.5 \text{ cups}}{x \text{ cups}} = \frac{1 \text{ dozen cookies}}{2.5 \text{ dozen cookies}}$ or more simply, $\frac{1.5}{x} = \frac{1}{2.5}$

$1.5(2.5) = 1x$ **x = 3.75 cups!**

How do I know how to set up the ratio?

If you think about the cookie question there are two batches of cookies:

Batch 1:	2 cups of flour for 1 dozen cookies
Batch 2:	6 cups of flour for 3 dozen cookies

In each batch, there are two measurements:

1. cups of flour and
2. dozens of cookies.

When you set up your ratios you can do it any way you want as long as

1. **You keep your batches together (on top, bottom or one side)**
2. **You keep your measurements together (on top, bottom or one side)**

We set the cookie problem up like this:

$$\frac{\text{1.5 cups}}{\text{x cups}} = \frac{\text{1 dozen cookies}}{\text{2.5 dozen cookies}}$$

This works because, the batches are together:

$$\frac{\text{1.5 cups}}{\text{x cups}} = \frac{\text{1 dozen cookies}}{\text{2.5 dozen cookies}}$$

Batch 1 is on top

Batch 2 is on the bottom

And because the measurements are together:

$$\frac{\text{1.5 cups}}{\text{x cups}} = \frac{\text{1 dozen cookies}}{\text{2.5 dozen cookies}}$$

Cups of flour are on the left

Dozens of cookies are on the right

When you cross multiply, recall that you get 1x = 1.5(2.5)

This same problem can also be set up as:

$$\frac{\text{1.5 cups}}{\text{1 dozen cookies}} = \frac{\text{x cups}}{\text{2.5 dozen cookies}}$$

Notice this time, batch 1 is on the left hand side and batch 2 is on the right:

$$\frac{\text{1.5 cups}}{\text{1 dozen cookies}} = \frac{\text{x cups}}{\text{2.5 dozen cookies}}$$

Batch 1 on left

Batch 2 on right

And the cups are on top and the dozens of cookies are on the bottom.

When you cross multiply this equation, you get 1x = 1.5(2.5) the exact same equation!

Can you think of another way to set up this ratio?

Does this set up work? Why or why not?

$$\frac{\text{1.5 cups}}{\text{2.5 dozen cookies}} = \frac{\text{1 dozen cookies}}{\text{x cups}}$$

(See end of section for answers)

Exercises (Answers to exercises on page 6):

You should be able to solve at least the first 5 questions and the word problems in the ratio section if going into a Biology course. If taking a Physics or Chemistry course, you should feel comfortable with all the questions in the ratio section.

Solve:

1) $\frac{x}{45} = \frac{20}{25}$ 2) $\frac{8}{9} = \frac{32}{n}$ 3) $\frac{5}{x} = \frac{4}{10}$ 4) $\frac{2}{24} = \frac{x}{36}$ 5) $\frac{1}{7} = \frac{x}{4\frac{1}{2}}$

6) $\frac{\frac{2}{7}}{\frac{3}{4}} = \frac{\frac{5}{6}}{y}$ $\frac{10\frac{3}{8}}{12\frac{2}{3}} = \frac{5\frac{3}{4}}{y}$ 8) $\frac{x}{11} = \frac{7.1}{2}$ 9) $\frac{1.28}{3.76} = \frac{4.28}{y}$ 10) $\frac{17.36}{12.88} = \frac{y}{6.34}$

11) A book store Manager knows that 24 books weigh 15kg. How much do 40 books weigh?

12) The average human heart beats 18 times in 15 seconds. How many times does it beat in a minute?

13) When a robin flies, it beats its wings an average of 23 times per second. How many times will it beat its wings in 2 minutes?

14) Jack and Jill went up the hill to pick some apples and pears. Jack picked 10 apples and 15 pears. Jill picked 20 apples and some pears. The ratio of apples to pears picked by Jack and Jill were the same. How many pears did Jill pick?

15) a) In a school there are 4 boy scouts to every 3 girl scouts. If there are 42 girl scouts, how many boy scouts are there?

b) If there are 81 girl scouts, how many boy scouts are there?

Answers

These arrangements also work (there are others – any setup that gives 1x = 1.5(2.5) is good!):

$$\frac{x\text{ cups}}{2.5\text{ cups}} = \frac{2.5\text{ dozen cookies}}{1.5\text{ dozen cookies}} \qquad \frac{x\text{ cups}}{1\text{ cups}} = \frac{2.5\text{ dozen cookies}}{1.5\text{ dozen cookies}}$$

$$\frac{1.5\text{ cups}}{2.5\text{ dozen cookies}} = \frac{1\text{ dozen cookies}}{x\text{ cups}}$$

This arrangement doesn't work, because the cups are not together and the dozens of cookies are not together (they are diagonal to each other. When you cross multiply, you get 1.5 x = 1 (2.5) the wrong equation!!

Ratios (answers to exercises on page 4 and 5)

1) $25x = 900$

$x = \frac{900}{25}$

$x = 36$

2) $8n = 288$

$n = \frac{288}{8}$

$n = 36$

3) $50 = 4x$

$x = \frac{50}{4}$

$x = 12.5$

4) $72 = 24x$

$x = \frac{72}{24}$

$x = 3$

5) $4\frac{1}{2} = 7x$

$x = \frac{4\frac{1}{2}}{7}$

$x = 0.64$

6) $\frac{2}{7}y = \frac{15}{24}$

$\frac{2}{7}y = \frac{5}{8}$

$y = \frac{\frac{5}{8}}{\frac{2}{7}}$

$y = 2\frac{3}{16}$ or $\frac{35}{16}$

7) $10\frac{3}{8}y = 72\frac{5}{16}$

$y = \frac{72\frac{5}{6}}{10\frac{3}{8}}$

$y = 7\frac{5}{249}$ or $\frac{1748}{249}$

8) $2x = 78.1$

$x = \frac{78.1}{2}$

$x = 39.05$

9) $1.28y = 16.0928$

$y = \frac{16.0928}{1.28}$

$y = 12.5725$

10) $110.0624 = 12.88y$

$y = \frac{110.0624}{12.88}$

$y = 8.5452$

11) $24x = 600$

$x = \frac{600}{24}$

$x = 25$

12) $1080 = 15x$

$x = \frac{1080}{15}$

$x = 72$

13) $y = 2760$

14) $10y = 300$

$y = \frac{300}{10}$

$y = 30$

15) a) $168 = 3y$

$y = \frac{168}{3}$

$y = 56$

15) b) $342 = 3y$

$y = \frac{342}{3}$

$y = 108$

Module 1 Introduction to Science

Unit 5 Percent

Learning Objectives

- To understand how to set up percent equations
- To solve percent equations
- To solve word problems involving percent

Learning Materials

- Reading
  - Exercises and Answer key

Percent are just a special type of ratio. In this case, one of the fractions is always the percent. A percent is always written as a number over 100.

For example, 25% is $\frac{25}{100}$ 3% is $\frac{3}{100}$ 12.4% is $\frac{12.4}{100}$

In these exercises you are always comparing number in one fraction to the percent, which becomes the other fraction.

Fill in the blanks: Here's how it's done!

$$\frac{\%}{100} = \frac{is}{of}$$

What is 75% of 60? $\frac{75}{100} = \frac{x}{60}$ Now cross multiply and divide!

$$\frac{75 \times 60}{100} = x$$

$$x = 45$$

You should feel comfortable solving percent questions for your science courses. Solve:

1. What is 76% of 90?
2. What is 70% of 660?
3. What is 4.8% of 60?
4. \$24 is what percent of \$96?
5. 102 is what percent of 100?
6. What percent of \$480 is \$120?
7. 60% of what is 54?
8. 65.12 is 74% of what?
9. What is 62.5 % of 40?

10. A lab technician has 680 milliliters of a solution of water and acid. The acid is 3%. How many milliliters of the solution is water? How many milliliters of the solution is acid?

ANSWERS

1) $$\frac{76}{100} = \frac{x}{90}$$
$$\begin{aligned} 6840 &= 100x \\ x &= \frac{6840}{100} \\ x &= 68.4 \end{aligned}$$

2) $$\frac{70}{100} = \frac{y}{660}$$
$$\begin{aligned} 46200 &= 100y \\ y &= \frac{46200}{100} \\ y &= 462 \end{aligned}$$

3) $$\frac{4.8}{100} = \frac{x}{60}$$
$$\begin{aligned} 288 &= 100x \\ x &= \frac{288}{100} \\ x &= 2.88 \end{aligned}$$

4) $$\frac{y}{100} = \frac{24}{96}$$
$$\begin{aligned} 96y &= 2400 \\ y &= \frac{2400}{96} \\ y &= 25\% \end{aligned}$$

5) $$\frac{y}{100} = \frac{102}{100}$$
$$\begin{aligned} 100y &= 10200 \\ y &= \frac{10200}{100} \\ y &= 102\% \end{aligned}$$

6) $$\frac{x}{100} = \frac{120}{480}$$
$$\begin{aligned} 480x &= 12000 \\ x &= \frac{12000}{480} \\ x &= 25\% \end{aligned}$$

7) $$\frac{60}{100} = \frac{54}{y}$$
$$\begin{aligned} 60y &= 5400 \\ y &= \frac{5400}{600} \\ y &= 90 \end{aligned}$$

8) $$\frac{74}{100} = \frac{65.12}{x}$$
$$\begin{aligned} 74x &= 6512 \\ y &= \frac{6512}{74} \\ y &= 88 \end{aligned}$$

9) $$\frac{62.5}{100} = \frac{y}{40}$$
$$\begin{aligned} 2500 &= 100y \\ y &= \frac{2500}{100} \\ y &= 25 \end{aligned}$$

10) $$\frac{3}{100} = \frac{x}{680}$$
$$\begin{aligned} 2040 &= 100x \\ x &= \frac{2040}{100} \\ x &= 20.4 \end{aligned}$$

20.4 milliliters is acid

680 – 20.4 = 659.6

659.6 milliliters is water

Module 1 Introduction to Science

Unit 6 International System of Units (SI Units) aka The Metric System

Learning Objectives

- To understand how to how the SI is organized
- To solve converting SI units

Learning Materials

- Reading
- Exercises
- Answer key

In the 1970's Canada joined a growing group of nations switching from the Imperial System of measurement to the SI or Metric System. Unfortunately, the Imperial System is still very much with us. There are two reasons for this: it was around for a very long time, and the United States (a very large and influential country) still uses the Imperial System. The metric system, however, is the only system used today in science, anywhere in the world.

This table gives the most common metric and imperial measures – note there are others!

Measure	**Imperial**	**SI**
Distance or Length	Inch, foot, yard, mile	Meter
Weight	Ounces, pounds, tons	Gram
Volume	Pints, quarts, gallons	Liter
Temperature	Degrees Fahrenheit	Degrees Celsius

Notice that the Imperial System has many different units for each measure, while the metric system has only one. The advantage of the metric system is that you only have to remember one unit. To create other units, you use the system below, which is the same for all measures!

M	Mega	1,000,000	A Megameter is 1,000,000 liters
K	Kilo	1000	A Kilometer is 1000 meters
H	Hecto	100	A Hectometer is 100 grams
Da	Deca	10	A Decameter is 10 liters
Unit	Liter Gram Meter	1	Any unit is 1
D	Deci	$\frac{1}{10}$	A Decimeter is one tenth of a gram
c	Centi	$\frac{1}{100}$	A Centimeter is one hundredth of a meter
m	Milli	$\frac{1}{1000}$	A Millimeter is one thousandth of a liter
µ	Micro	$\frac{1}{1,000,000}$	A Micrometer is one millionth of a gram
n	Nano	$\frac{1}{1,000,000,000}$	A Nanometer is one billionth of a meter

Jump Method: Here's how it's done!
5.0 milliliters = ? Liters

Using the chart above, move your fingers from "Milli" to "Unit". This takes 3 moves up, so move the decimal point 3 places to the left.

Answer: 0.005L

6.0 Centimeters = ? Micrometers

Use the chart above again, moving your fingers from "Centi" to "Micro". This takes 4* moves, so move the decimal 4 places to the right.

Answer: 60000 µm

*Note: Mega to Kilo and Milli to Micro are counted as 3 moves. Micro to Nano is also 3 moves, so Milli to Nano would be 6 jumps.

Questions:

You should be able to solve at least the first 5 questions and the word problems in the SI section if going into a Biology course. If taking a Physics or Chemistry course, you should feel comfortable with all the questions in the SI section

1. 20.0mm =? km
2. 7.0m =? nm
3. 73.5 µm =? km
4. 16.7 Mm =? cm
5. 62.6 m = ?mm
6. 16.0mg/ml =? mg/L
7. 14.3m/s =? km/s
8. 20.0km/h =? m/h
9. 87.0mg/3L =? mg/ml
10. 0.0043g/20.0ml =? mg/ml

Answers:

1) 0.00002km
2) 700000nm
3) 0.00000735km
4) 16700000cm
5) 62600mm
6) 0.016mg/L
7) 0.143km/s
8) 20000m/h
9) $\frac{87.0}{3} = 29.0\ \text{mg/L}$

0.029mg/ml

10) $\frac{0.0043}{20.0} = 0.000215\text{g/ml}$

0.215mg/ml

Unit 6a

Ratio Solutions

1) $25x = 900$

$$x = \frac{900}{25}$$

$$x = 36$$

2) $8n = 288$

$$n = \frac{288}{8}$$

$$n = 36$$

3) $50 = 4x$

$$x = \frac{50}{4}$$

$$x = 12.5$$

4) $72 = 24x$

$$x = \frac{72}{24}$$

$$x = 3$$

5) $4\frac{1}{2} = 7x$

$$x = \frac{4\frac{1}{2}}{7}$$

$$x = 0.64$$

6) $\frac{2}{7}y = \frac{15}{24}$

$$\frac{2}{7}y = \frac{5}{8}$$

$$y = \frac{\frac{5}{8}}{\frac{2}{7}}$$

$$y = 2\frac{3}{16} \text{ or } \frac{35}{16}$$

7) $10\frac{3}{8}y = 72\frac{5}{16}$

$$y = \frac{72\frac{5}{6}}{10\frac{3}{8}}$$

$$y = 7\frac{5}{249} \text{ or } \frac{1748}{249}$$

8) $2x = 78.1$

$$x = \frac{78.1}{2}$$

$$x = 39.05$$

9) $1.28y = 16.0928$

$$y = \frac{16.0928}{1.28}$$

$$y = 12.5725$$

10) $110.0624 = 12.88y$

$$y = \frac{110.0624}{12.88}$$

$$y = 8.5452$$

11) $24x = 600$

$$x = \frac{600}{24}$$

$$x = 25$$

12) $1080 = 15x$

$$x = \frac{1080}{15}$$

$$x = 72$$

13) $y = 2760$

14) $10y = 300$

$$y = \frac{300}{10}$$

$$y = 30$$

15) a) $168 = 3y$

$$y = \frac{168}{3}$$

$$y = 56$$

15) b) $342 = 3y$

$$y = \frac{342}{3}$$

$$y = 108$$

Percent Solutions

1) $\frac{76}{100} = \frac{x}{90}$

$6840 = 100x$

$x = \frac{6840}{100}$

$x = 68.4$

2) $\frac{70}{100} = \frac{y}{660}$

$46200 = 100y$

$y = \frac{46200}{100}$

$y = 462$

3) $\frac{4.8}{100} = \frac{x}{60}$

$288 = 100x$

$x = \frac{288}{100}$

$x = 2.88$

4) $\frac{y}{100} = \frac{24}{96}$

$96y = 2400$

$y = \frac{2400}{96}$

$y = 25\%$

5) $\frac{y}{100} = \frac{102}{100}$

$100y = 10200$

$y = \frac{10200}{100}$

$y = 102\%$

6) $\frac{x}{100} = \frac{120}{480}$

$480x = 12000$

$x = \frac{12000}{480}$

$x = 25\%$

7) $\frac{60}{100} = \frac{54}{y}$

$60y = 5400$

$y = \frac{5400}{600}$

$y = 90$

8) $\frac{74}{100} = \frac{65.12}{x}$

$74x = 6512$

$y = \frac{6512}{74}$

$y = 88$

9) $\frac{62.5}{100} = \frac{y}{40}$

$2500 = 100y$

$y = \frac{2500}{100}$

$y = 25$

10) $\frac{3}{100} = \frac{x}{680}$

$2040 = 100x$

$x = \frac{2040}{100}$

$x = 20.4$

20.4 milliliters is acid

680 – 20.4 = 659.6

659.6 milliliters is water

SI Solutions

1) 0.00002km

2) 700000nm

3) 0.00000735km

4) 16700000cm

5) 62600mm

6) 0.016mg/L

7) 0.143km/s

8) 20000m/h

9) $\frac{87.0}{3} = 29.0\ \text{mg/L}$

0.029mg/ml

10) $\frac{0.0043}{20.0} = 0.000215\text{g/ml}$

0.215mg/ml

Module 1 Introduction to Science

Unit 7 Measurement

Learning Objectives

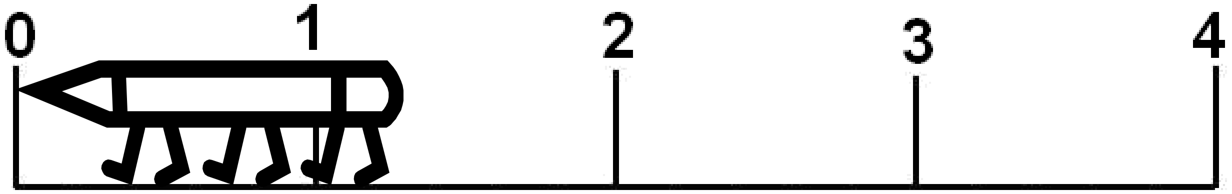
- To understand the importance of measurement
- To be able to measure accurately

Learning Materials

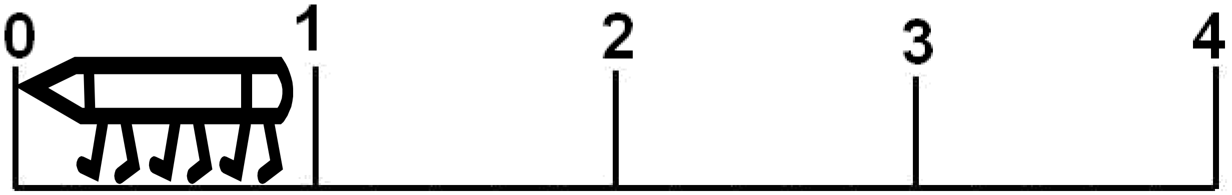
- Reading
- Metric Ruler
- Exercises
- Answer key

Scientists need to gather facts as part of the scientific process. What makes something a fact? One way is to measure it. For example, a drug company can claim their new drug helps arthritis, but how do we know it really does? The drug company does some research, takes measurements, and then says, “of 100 people who took our drug, 75 had a 50% or better increase in movement after three weeks”. This is a much stronger statement than “our drug helps arthritis” because of the measurements it contains.

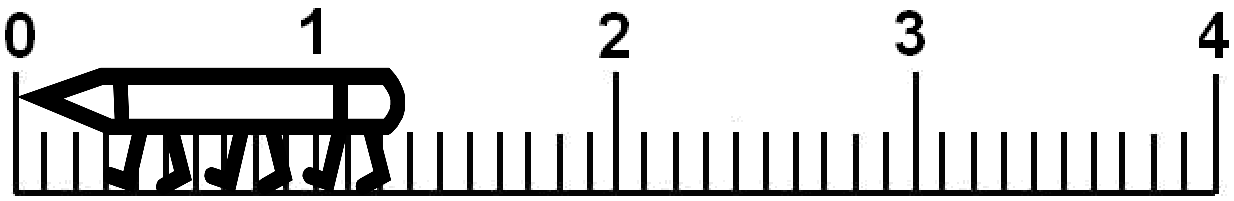
Let’s measure two pencils:
Using this ruler, you would call this pencil 1 unit long. You can’t get more precise than that. You could try to guess 1.25 or something but we **don’t want to guess**!

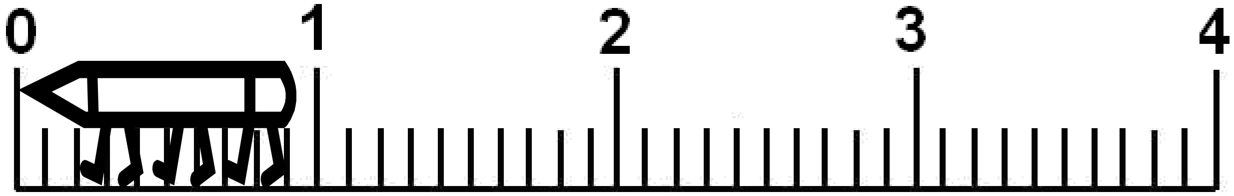


It’s important to understand that we would also call this second pencil 1 unit long! It really means that the pencil is closer to 1 than it is to 0 or 2. In other words, any pencil between 0.5 and 1.5 units long is called 1. The problem is that the ruler is not very precise.



If we measure the same two pencils with a different ruler, we can be more precise. Now we can call the first pencil 1.3 units long and the second one 0.9 units long!





The idea of precision in measurement is very important. The first ruler is divided up into units of 1. Thus, when reading off this ruler you can only use whole numbers. You cannot use any decimals with the first ruler because it's just not that precise!

The second ruler is divided up into units of 0.1. Thus, you can use one decimal (and only one decimal) when measuring with the second ruler.

Questions:

1. If I said a pen was 4 units long and was measured with the first ruler, what is the minimum actual length is could be? ____

   What is the maximum actual length it could be? ____

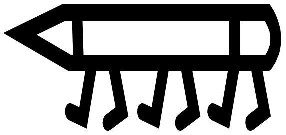
2. If I said a pen was 4 units long and was measured with the second ruler, what is the minimum actual length is could be? ____

   What is the maximum actual length it could be? ____

3. Measure the pencils below to the nearest millimeter with your metric ruler.

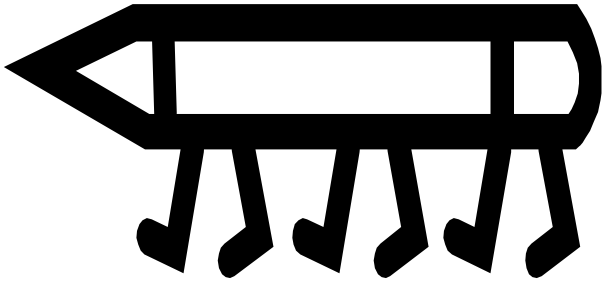
Length =

_________ mm



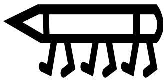
Length =

_______ mm



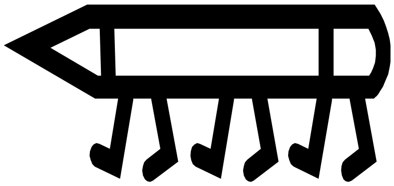
Length =

_______ mm



Length =

_______ mm



ANSWERS

1. 3.5

   4.4

2. 3.95

   4.05

3.
   a. 3.7 mm
   b. 7.9 mm
   c. 2.1 mm
   d. 5.1 mm

Module 1 Introduction to Science

Unit 8 Tables

Keep it simple...

Learning Objectives

- To know what tables are
- Be able to read a table
- Be able to make a table

Learning Materials

- Reading
- Exercises
- Answer key

What is a Table?

A table is a clear, easy-to-read way to show people numerical information (called DATA). There are different kinds of tables; we will look at two types: Database Tables and Two-dimensional Tables. Tables are frequently used when you have several bits of information about one person or thing. For example, for one person, you will have a name, age, height, weight, etc. For one car manufacturer, you could have the number of vehicles they sold and the profit they made.

Table 1: Sales performance of various car makers in 2004.

Car Maker	Number of Vehicles Sold	Profit (millions)$
Ford	123,456	4.5
Chrysler	299,434	6.3
Chevrolet	543,234	9.1
Toyota	223,458	5.2
Mazda	652,345	8.8
Honda	98,345	3.9

Parts of a Table

In this table the names of the categories of information go at the top of each column. Then the information for each car maker goes in a row.

Table 1: Sales performance of various car makers in 2004.

Car Maker	Number of Vehicles Sold	Profit (millions) $
Ford	123,456	4.5
Chrysler	299,434	6.3
Chevrolet	543,234	9.1
Toyota	223,458	5.2
Mazda	652,345	8.8
Honda	98,345	3.9

Tables have a number and a descriptive **TITLE**.

Names of categories, and put units beside categories

Two-dimensional Tables

Sometimes the numbers you want to show fall into more than one category. In this case, you might want to use a different kind of table. The table below shows the amount of sales for two categories: a) the name of the salesperson and b) the sales zone.

Table 2. Sales by zone for each salesperson.

Zone Salesperson	North ($)	South ($)	East ($)	West ($)	TOTAL
Bob	356	245	854	652	2107
Sue	458	228	254	354	1294
Mike	215	165	542	215	1137
Jane	215	652	254	452	1573
Patricia	458	225	345	169	1197
Pete	485	198	485	851	2019
TOTAL	2187	1713	2734	2693	9327

QUESTIONS

1. Refer to Table 2, above.
   a. How much did Sue sell in the South?
   b. Who sold the most in the West?
   c. Who had the highest total sales?
   d. What was the total sales for Pete
   e. How much did everyone sell in total?

2. The following information is from a news release. Place the information in an easy to read table with appropriate titles and headings.

   "For 2006, major car manufacturers announced the following profits (in millions): Ford, 4.5; Chrysler, 6.3; Chevrolet, 9.1; Toyota, 5.2; Mazda, 8.8; and Honda, 3.9. These profits were based on the following sales: Toyota, 230,000; Chrysler, 300,000; Honda, 100,000; Mazda, 650,000; Ford, 150,000; Chevrolet, 550,000.

Answers:

1. Refer to Table 2, above.
   a. How much did Sue sell in the South? $228
   b. Who sold the most in the West? Pete
   c. Who had the highest total sales? Bob
   d. What was the total sales for Pete? $2019
   e. How much did everyone sell in total? $9327

2. Table 1: 2006 Profits in the Automobile Industry Based on Cars Sold

Car Maker	Number of Vehicles Sold	Profit (millions)
Ford	150,000	4.5
Chrysler	300,000	6.3
Chevrolet	550,000	9.1
Toyota	230,000	5.2
Mazda	650,000	8.8
Honda	100,000	3.9

Module 1 Introduction to Science

Unit 9 Understanding Graphs

A picture is worth a thousand words.

Learning Objectives:

- Know what graphs are and why they are used.
- Know what line and bar graphs are and when they are used.
- Be able to read line and bar graphs.
- Be able to draw line and bar graphs.
- Understand the disadvantages of a graph.

Learning Materials:

- Reading
- Exercises
- Answer key

Why Make a Graph?

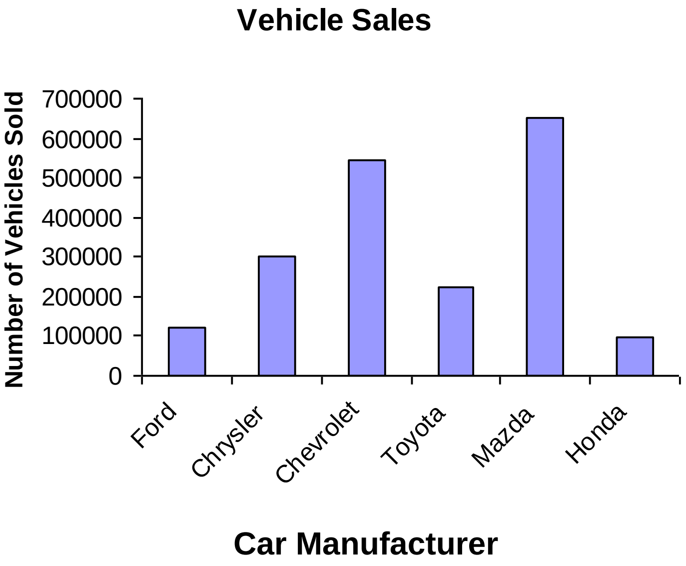
Numerical information in numbers (called DATA) can be presented in many different ways. You could write a sentence:
Last year Ford sold 123,456 vehicles, Chrysler sold 299,434 vehicles, Chevrolet sold 543,234, Toyota sold 223,458, Mazda sold 652,245 and Honda sold 98,345.

Or, you could put the data in a table, which is easier to read and understand than a sentence.

The table to the right contains the same information as the sentence, but in a simpler form.

However, you can present the same information in a graph, which is often the most clear of all. A graph is simply a "picture" of the data.

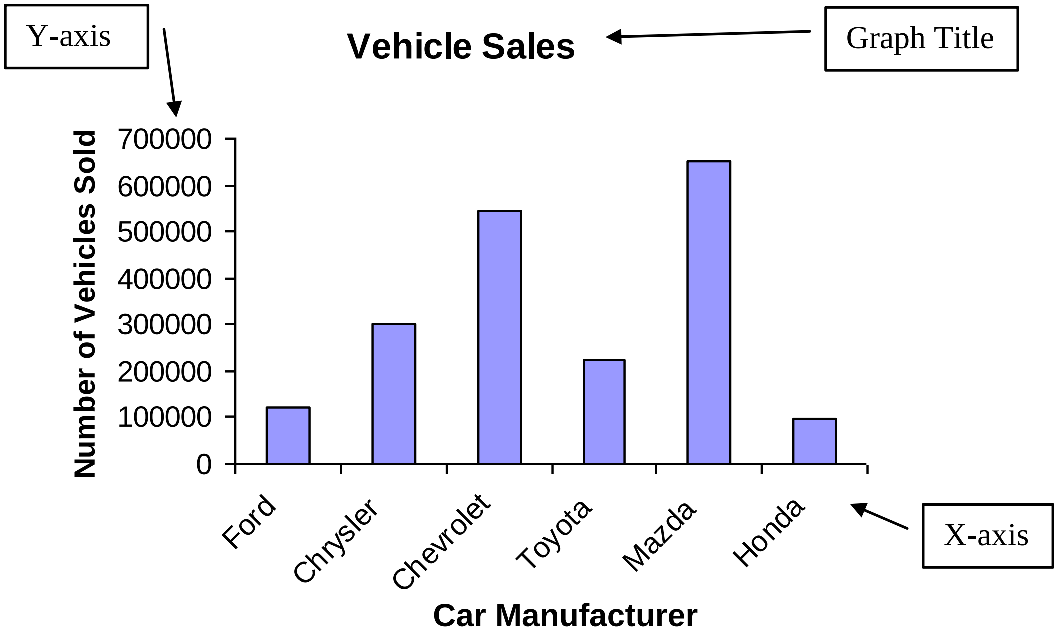
Car Maker	Number of Vehicles Sold
Ford	123456
Chrysler	299434
Chevrolet	543234
Toyota	223458
Mazda	652345
Honda	98345



This is a **bar graph**.
The bar graph makes it easier to see that Mazda and Chevrolet had the best sales, while Ford and Honda had the lowest sales. It also gives you a better feel for how big the differences are.

The two things you are graphing, i.e. the Number of Vehicles Sold, and the Car Manufacturer are called the **VARIABLES**.

Parts of a graph



All graphs have an **x-axis** and **a y-axis**, which are the vertical and horizontal lines that set up the two parts of the graph. The x-axis is always horizontal and the y-axis is always vertical.

The x-axis can be numbered just like a number line (line graph) or divided up into categories (bar graph).

The y-axis is numbered.

The numbers on the y-axis is called the **scale**. The scale is very important because how you choose to space out the number changes the look of the graph.

Both axes have a **title** and the graph itself has a title. The data points are drawn as columns in this graph but they could be dots. The dots are usually connected with a line but they don't have to be.

Reading a Graph

To read a graph, pick a point or bar on the graph. Go straight down from the point or bar to the x-axis. This will give you the x value. Go straight left to the y-axis to find the y-value.

For example, look at the second bar from the right on the Vehicle Sales graph. If you go straight down from the bar you see the word "Mazda". If you go left from the TOP of the bar, you find a number just a bit more than half way between 600,000 and 700,000. This means that Mazda sold about 650,000 cars. We will look at two main types of graphs:

We will look at two main types of graphs:

Bar Graphs and Line Graphs

Consider the following data:

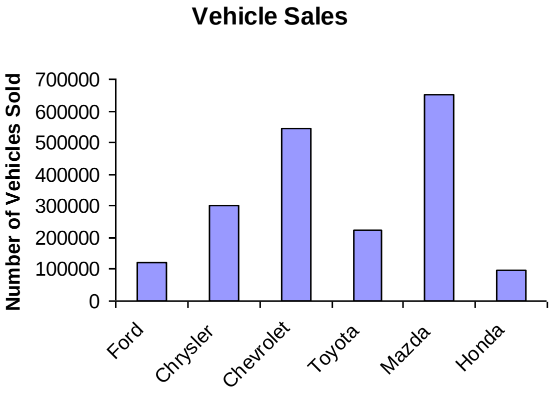
Car sales in 2003.

Car Maker	Number of Vehicles Sold
Ford	123456
Chrysler	299434
Chevrolet	543234
Toyota	223458
Mazda	652345
Honda	98345

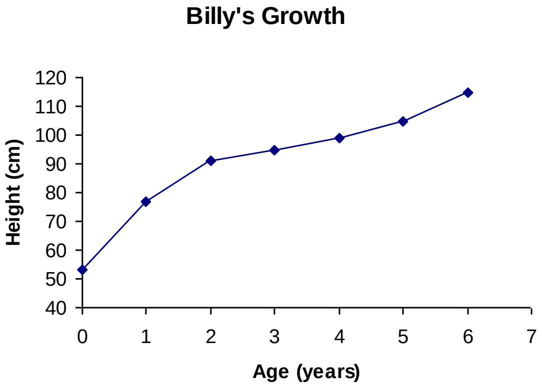
Billy height as a child

Age (years)	Height (cm)
0	53
1	77
2	91
3	95
4	99
5	105
6	115

This table should be done as a:
Bar Graph



This table should be done as a:
Line Graph



WHY?

Note there is one key difference between the data in these two graphs:

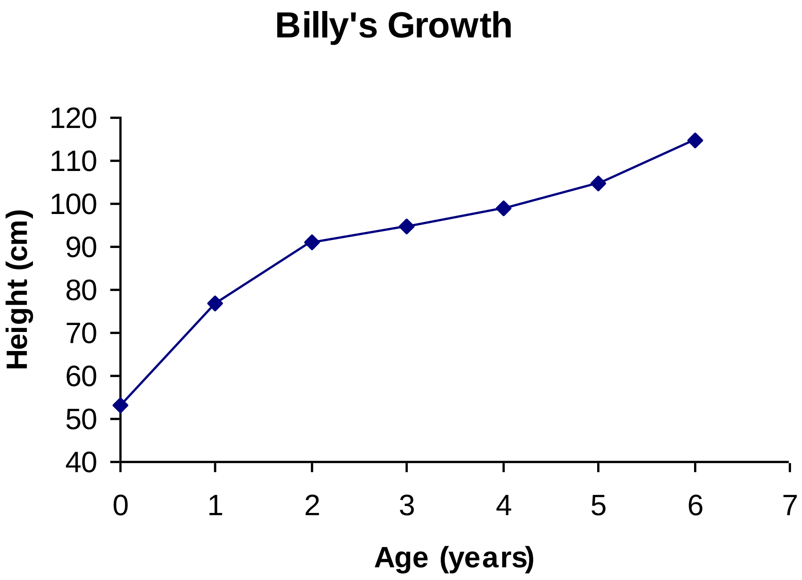
In this graph the X variable is a CATEGORY.
This is called **Categorical Data.**

In this graph the X variable is a NUMBER.
This is called **Continuous Data.**

Why does that matter?

In categories, the order we put them doesn't really matter. We could make Honda the first bar and Toyota the last. Also, there is nothing between the bars.

In this graph, order matters. One has to come before two. Also, there are ages between the ones we graphed. For example, Billy was $1^1/_2$ years old!



One of the cool things about a line graphs is that we can use it to estimate how tall Billy was at ages for which we have no data. For instance, we can estimate that at 1.5 years old Billy was about 85 cm tall.

Which variable goes on the X-axis and which on the Y-axis?

Look at this table of data. A student put a cup of water outside and timed how long it took the water to freeze.

1. What are the two variables?
2. Is the data categorical or continuous?
3. Should this be graphed as a bar graph or a line graph?
4. **Draw a graph of this data.**
   Graph on next page.

Air temperature (°C)	Time for water to freeze (min)
0	240
-5	205
-10	186
-15	157
-20	111
-25	88

Think about the experiment the student has done and ask yourself which of these statements makes sense:

1) You put a cup of water outside. The time it takes for a bucket of water to freeze depends on how cold it is outside.
2) You put a cup of water outside. How cold it is outside depends on how long it takes the bucket of water to freeze.

This is all about cause and effect. A bucket of water on your back deck will not have any effect on the air temperature, so the second statement makes no sense. However, the colder it is outside, the faster your bucket of water will freeze. Therefore, the first statement makes sense.

Answers: 1. Time and Temperature 2. Continuous, if a similar bucket of water is used each time. 3. A line graph, then we could predict times for other temperatures.

The time it takes for the water to freeze DEPENDS on how cold it is.
That is why the time it takes the water to freeze is called the **Dependent Variable**; it depends on the air temperature. The temperature is the **Independent Variable** because the air temperature does not depend on whether you have a cup of water freezing or not.

In a graph the independent variable always goes on the x-axis.
The dependent variable always goes on the y-axis.

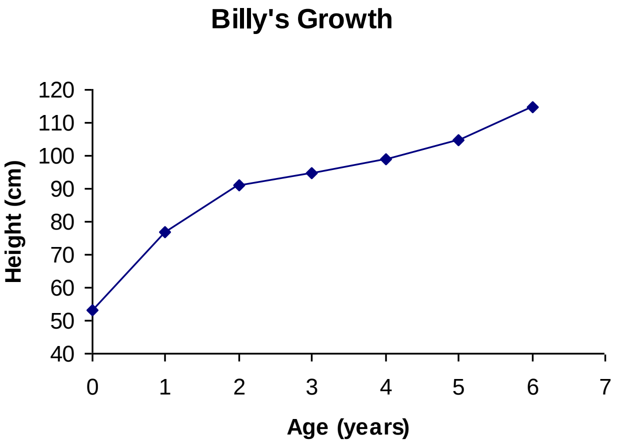
So, Temperature is going to be on the x-axis and Time will be on the y-axis.

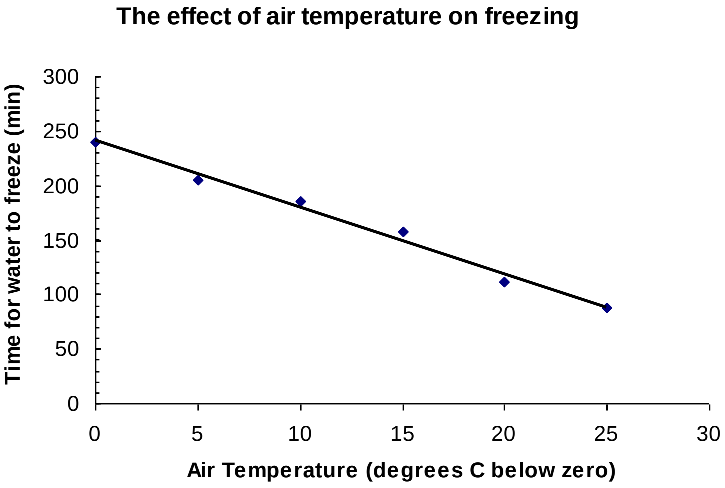
Connect the dots or line of best fit?

Compare the two line graphs below. In "Billy's Growth", the data points were connected like you're playing dot-to-dot. In "The effect of air temperature on freezing", a straight line was drawn. This is called the "line of best fit" because it comes as close as possible to all the dots.

Why the difference?

It is well known that children grow faster in their first year or two of life then start to slow down. You can see this in the graph when the dots are joined. Drawing a straight line would make it look like Billy grew at the same rate between the ages of 0 and 6!
The dots on the Freezing graph should be in a straight line. This requires some understanding to predict but usually your teacher will help you. So, we draw the best straight line possible. The dots don't form a perfect straight line because the student measuring the air temperature and time might have made small errors, or other factors might have affected the readings slightly. It is normal to have your data show small errors like this.





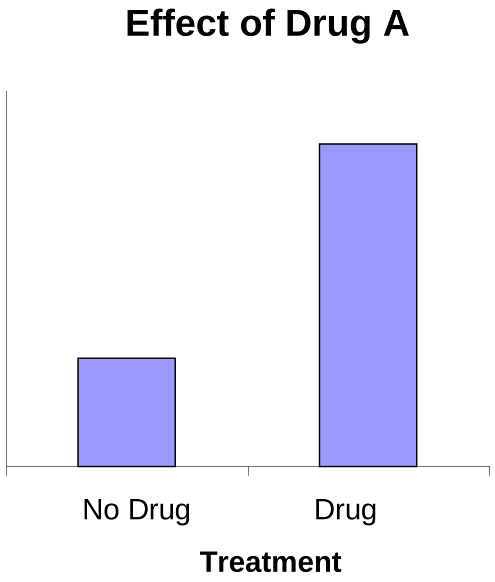
Disadvantages of Graphing

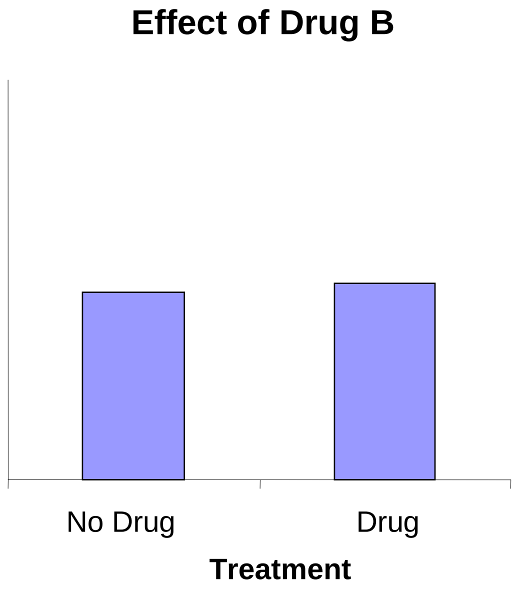
Graphs are great for showing trends, but exact data may be difficult to read off the scale.

Scale of a Graph

The numbers chosen for the y-axis (and sometimes the x-axis) is called the scale of the graph. The scale is very important because it will change the look of the graph. This is important, not only for making the graph easy for the reader to understand, but also for the accuracy of the information.

Example:
The two graphs below show the results of two drug tests.



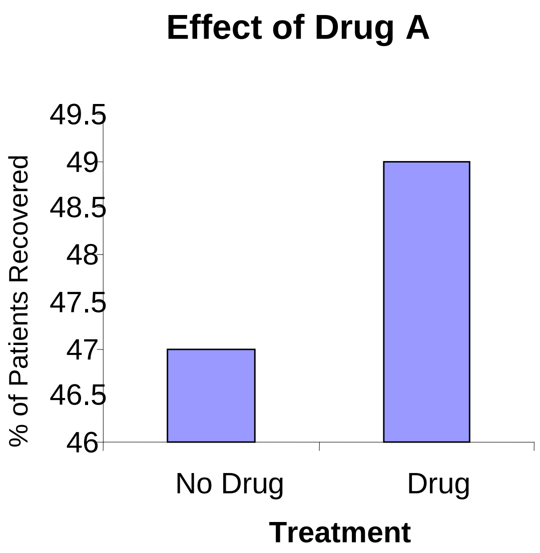


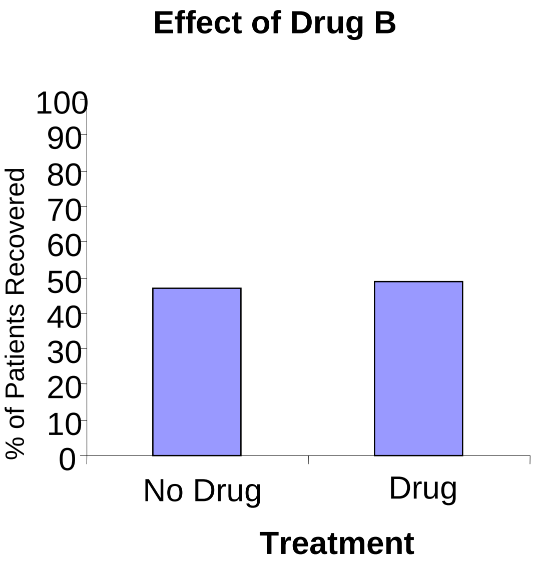
Which drug is the most effective?

Why do you think so?

Examine the two graphs below again.

Which is the most effect drug?





The four graphs in the above two examples are EXACTLY the same graph.
Here is the data table that was used to create all four graphs:

No Drug	Drug
47	49

The only thing that is different between the graphs is the scale of the y –axis.

Notice that in the first pair of graphs, the y-axis is not labeled in order to deceive the reader. It makes it look like there is a big difference where there isn't one.

Even in the second pair of graphs, where the y-axis are labeled, changing the scale of the y-axis makes it look like there is a big difference for drug A and no difference for drug B. If you look carefully, however, both graphs show a 47% recovery for No Drug and a 49% recovery with the Drug.

Graphs can deceive you (especially when not labeled properly)! The table can't!