1-Meas, Err, Sig Figs

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Measurement, Error and Significant Figures

Accuracy: The measure of how close a measurement is to the true value.

Precision: The measure of how consistent a set of measurements are.

Accuracy: High
Precision: Low

Accuracy: Low
Precision: High

Accuracy: High
Precision: High

Types of Errors

Systematic Errors:

A set of errors that always affect the measurement by the same quantity.

How to fix systematic errors:

Use the difference between two measurements (or) modify lab technique/device calibration

How to address systematic errors in lab reports:

- Identify the source of error
- Suggest methods of improvement if you were unable to account for it using the difference method

Random Errors:

A set of errors that affect the measurement by a random quantity with each attempted measurement.

How to fix random errors:

Take many measurements and average them.

How to address random errors in lab reports:

- Identify the source of error and then use the above method.

Scientific Notation

Some of the numbers we will use may be very big or very small. Scientific notation is a useful way to shorten how we write those numbers. We base it off of exponents of ten.

$8 \times 10^0 = 8$

$8 \times 10^1 = 80$

$8 \times 10^2 = 800$

$\vdots$

$8 \times 10^5 = 800000$

Following the pattern

$8.26 \times 10^{9} = 8260000000$ (9 digits)

or you can count/move in the reverse

$8.26 \times 10^{-3} = 0.00826$

Standard organization of scientific notation:

One digit . the Rest $\times 10^{\text{Exponent}}$

Ex.

$145.2 \times 10^6 = 1.452 \times 10^8$

+2 to exponent

move the decimal this way + to exponent

move the decimal this way − to exponent

Percent Error

Percent error or percent difference it the proportion something is away from an accepted or averaged value.

Formula:

$$\frac{|\text{Measured Value} - \text{Accepted Value}|}{\text{Accepted Value}}$$

This is often a useful value as it helps you understand the *proportion* a measurement or calculation is away from the accepted value. This can be helpful to determine whether a measurement has been precise or not.

Jerry measures a 1m long stick as 98cm.

$$\frac{|0.98 - 1.00|}{1.00} = 2\%$$

Jerry has 2% error in his measurement.

Uncertainty and Significant Figures

Make a random mark on the line

Measure how far that mark is from the end

How far is it?

2.50 cm
2.55 cm

I'm certain to about ½ of a mm

2.5 cm
2.6 cm

I'm certain to about 1mm

2.5431721

I'm certain to about one millionth of a mm.

This is probably ridiculous.

These digits are insignificant.

Significant Figure Rules:

1. Start counting digits when you get your first non-zero digit

2. Nonzero numbers are always significant

   1–9 → significant

   0 → Maybe significant

3. Zero is significant if:

   a. It is sandwiched between significant digits

Ex. 7207100 (5 sig figs) 0.0031000 4 (6 sig figs)

   b. A decimal point is present in a number greater than or equal to one.

Ex. 320.0 (4 sig figs) 7.100 (4 sig figs) 70180. (5 sig figs) 3000 (1 sig fig) * No decimal point

   c. Numbers less than 1: All zeroes that follow after your first significant digit.

Ex. 0.00210 (3 sig figs) 0.009000 (4 sig figs) 0.00000320400 (6 sig figs)

   d. ~~Numbers greater than 1~~

2-SigFigs

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Significant Figures

Review:

How many significant figures are in:

5.430 4

0.0043 2

760400 4

320. 3

15.0 3

1.54×10^{3} 3

7.55×10^{-7} 3

1.10×10^{2} 3

Multiplying and Dividing Numbers

When combining measurements into a result, you can only be as confident in your result as you are in your measurements. Your result will be as certain as your LEAST certain measurement.

- Use the same number of significant figures in your results as the Least number of significant figures that are multiplying or dividing.

Examples:

$34.03 \times 1400 =$

$145.04 \div 1.5 =$

$6.332\times10^{-4} \times -3.21\times10^{2} =$

$1.6\times10^{4} \div 1.24\times10^{2} =$

Adding and Subtracting Numbers

When adding or subtracting measurements, the smallest place value (ones, tens, tenths, etc.) that both values have in common will be the last digit used as a significant figure.

Examples:

$530.007 + 23.1 =$

$76100 - 5360.82 =$

$1.73\times10^{4} + 55.6 =$

$5.53\times10^{6} - 4.32\times10^{5} =$

When to Round

Rounding only occurs at the VERY end of any set of operations. Keep all figures and consider the number of significant figures there should be at the end.

Examples:

$(5.553 \times 21.213) \div (3.38 \times 1.5) =$

$3.04 \times 1.2 + 16.1 =$

$(1.332 - 14.32) \times 15.8 =$

4-DimAna

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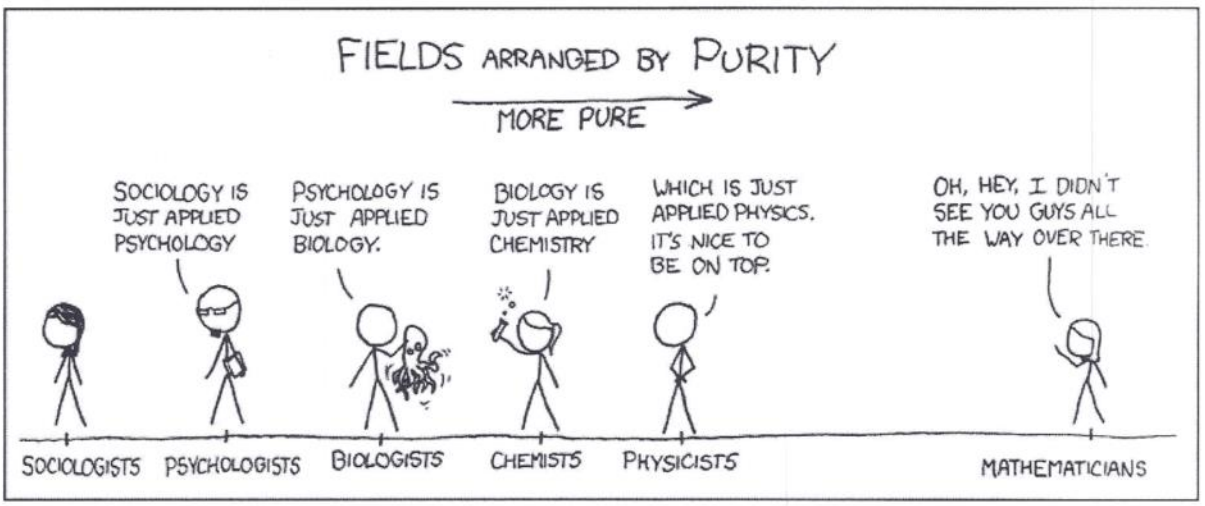
Name_____

Unit Conversions and Dimensional Analysis



Rubric for LS 6

Learning Standards	Performance Indicators
LS 6: Students will be able to quantify a chemical reaction using dimensional analysis and the concept of a mole.	6.1 Convert units using dimensional analysis 6.2 Analyze the chemical composition of a substance using the concept of a mole. 6.3 Quantify a chemical reaction using stoichiometry.

6.1 Convert units using dimensional analysis

4.0	3.0	2.0	1.0	0
Student is able to do all of "3.0" and:	Student is able to:	Student is inconsistently able to:	Student is unable to:	Student shows no evidence of being able to:
Convert units using dimensional analysis for complex unit conversions.	Convert units using dimensional analysis for simple unit conversions.			

LS 6.1 : Problem Solving in Chemistry and other subjects too

Dimensional Analysis

- Used in conversion problems.

  Example: How many seconds are there in 3 weeks?

- A method of keeping track of the units.

Conversion Factor

- A ratio of units that are related to one another.

  Examples: 1 min/ 60 sec (or 60 sec/ 1 min)

  7 days/ 1 week (or 1 week/ 7 days)

  1000 m/ 1 km (or 1 km/ 1000 m)

- Sometimes the conversion factors are provided to you, and other times, the conversion factors are determined by reading the information given in the problem. (See practice problems for examples.)

T	G	M	k	-	c	m	μ (micro)	n	p	= 1
$\times 10^{12}$	$\times 10^{9}$	$\times 10^{6}$	$\times 10^{3}$	-	$\times 10^{-2}$	$\times 10^{-3}$	$\times 10^{-6}$	$\times 10^{-9}$	$\times 10^{-12}$	

How to Use Dimensional Analysis to Solve Conversion Problems

- Step 1: Identify the "Have". This is typically the only number given in the problem. This is your starting point. Write it down! Then write "x _____". This will be the first conversion factor ratio.
- Step 2: Identify the "Want". This is what are you trying to figure out.
- Step 3: Identify the conversion factor
- Step 4: By using these conversion factors, plan a solution to convert from the given to the unknown.
- Step 5: When your conversion factors are set up, multiply all the numbers on top of your ratios, and divide by all the numbers on bottom.

If the units did not match up correctly, you've messed up!

2

Have x _____ = Want

Have × — = Want

Practice Problems:

(1)How many hours are there in 3.25 days?

$\frac{24 \text{ hours}}{1 \text{ day}}$ $3.25 \text{ days} \times \frac{24 \text{ hours}}{1 \text{ day}} = 78 \text{ hours}$

(2) How many yards are there in 504 inches?

$\frac{12 \text{ in}}{1 \text{ ft}}$ and $\frac{3 \text{ ft}}{1 \text{ yd}}$ $504 \text{ in} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ yd}}{3 \text{ ft}} = 14 \text{ yds}$

(3) Convert 55 miles per hour into miles per minute?

$\frac{1 \text{ hr}}{60 \text{ min}}$ $\frac{55 \text{ mi}}{1 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} = \frac{11}{12} \frac{\text{mi}}{\text{min}}$

Converting Complex Units

- A complex unit is a measurement with a unit in the numerator and denominator
  *Example: 55 miles/hour 17 meters/sec 18 g/mL
- To convert complex units, simply follow the same procedure as before by converting the units on top first. Then convert the units on bottom next.

Practice Problems: (1) The speed of sound is about 330 meters/sec. What is the speed of sound in units of miles/hour? (1609 m = 1 mile)

(2) The density of water is 1.0 g/mL. What is the density of water in units of lbs/gallon? (2.2 lbs = 1 kg) (3.78 L = 1 gal)

(3) Convert 33,500 in^2 to m^2 (5280 ft = 1609 m) (12 inches = 1 foot)

$33500 \text{ in}^2 \times \left(\frac{1 \text{ ft}}{12 \text{ in}}\right)^2 \times \left(\frac{1609 \text{ m}}{5280 \text{ ft}}\right)^2 = 33500 \text{ in}^2 \times \frac{1 \text{ ft}^2}{144 \text{ in}^2} \times \frac{1609^2 \text{ m}^2}{5280^2 \text{ ft}^2} = 21.6 \text{ m}^2$

- Find the conversion factors in each of the following word problem.

(1) If we want to buy a single head of cabbage that weighs 12 ounces. How many dollars will the head of cabbage cost if the price is 5 cents per pound? (16 ounces = 1 pound)

(2) Jane is buying pizza for class. Each person will get 2 pieces of pizza. There are 30 kids in the class. Each pizza costs $5 and the pizza will be cut into 8 slices. How many pizzas will Jane need to buy?

$\frac{2 \text{ pieces}}{1 \text{ kid}}$ $\frac{\$5}{1 \text{ pizza}}$ $\frac{8 \text{ pieces}}{1 \text{ pizza}}$

$30 \text{ kids} \times \frac{2 \text{ pieces}}{1 \text{ kids}} \times \frac{1 \text{ pizzas}}{8 \text{ pieces}} = 7.5 \text{ pizzas}$

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Name: _____

Nonsense Conversion Problems

1) Conversion Factors: 3 apples = 5 bananas 6 cookies = 7 apples 2 doughnuts = 1 banana

How many doughnuts are equal to 20 cookies?

2) Conversion Factors: 1 elephant = 13 farmers 23 gorillas = 4 horses 5 farmers = 2 horses

How many elephants are equal to 10 gorillas?

3) Conversion Factors:

3 Icelanders = 4 Jamacians 2 Lithuanians = 3 Moroccans 1 Korean = 3 Jamaicans 3 Koreans = 5 Lithuanians

How many Moroccans are equal to 1 Icelander?

4) Conversion Factors: 2 Nighthawks = 5 Orioles 1 Oriole = 15 Parrots 4 Quail = 3 Parrots

How many nighthawks are equal to 3 quail?

5) Conversion Factors:
3 Rams = 8 Vikings 4 Titans = 5 Chargers 7 Titans = 3 Seahawks 9 Vikings = 1 Charger

How many Seahawks are equal to 2 Rams?

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Name: _____

Worksheet #1: Conversion Problems

1) 3 holits = 5 gorfs 7 gorfs = 2 queets

How many queets are there in 43 holits?

2) 5 pliggles = 7 cammies 1 cammie = 3 kacks 15 kacks = 9 ploofs

How many ploofs are there in 22 pliggles?

3) 2 borks = 1 grog 4 deebs = 3 loggits 8 grogs = 1 poff 3 poffs = 10 deebs

How many loggits are there in 44 borks?

4) How many seconds are there in one millennium? (1,000 years = 1 millennium)

5) How fast is 250 miles/hour in units of kilometers/second? (1.609 km = 1 mile)

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Name_____

The English system is silly!

1) Volume (Going from a small volume to a big volume)

Convert 10,000 mL to kL

Convert 10,000 teaspoons to gallons

2) Length (Going from a small length to a big length)

Covert 10,000 mm to km

Covert 10,000 in to miles

3) Mass (Going from a small mass to a big mass)

Convert 10,000 mg to kg

Convert 10,000 oz to lbs

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Name: _____

1 and 2 Step Conversion Problems

Convert the following "one step" conversion problems:

1) How many grams of helium are there in 2.7 moles of helium? (4.0 grams of He = 1 mole of He)

2) How many mm of mercury are there in 25.0 in. of mercury? (29.92 in. of Hg = 760 mm of Hg)

3) How many liters of oxygen are there in 4.5 moles of oxygen? (1 mole of O_2 = 22.4 Liters of O_2)

4) How many grams of neon are there in 75.0 liters of neon? (20.2 grams of Ne = 22.4 Liters of Ne)

5) How many mi/hr are there in 36.9 mi/day? (24 hours = 1 day)

Convert the following "two step" conversion problems:

6) How many miles are there in 4.3 light-years? (9.46×10^{15} m = 1 light-year) (1609 m = 1 mile)

7) How many weeks are in 9,500 hours? (1 week = 7 days) (24 hours = 1 day)

8) How many miles/hour are there in 186,000 miles/second? (60 sec. = 1 min.) (1 hr = 60 min.)

9) How many miles/hour is 340 meters/sec? (3,600 sec = 1 hour) (1609 m = 1 mile)

10) How many liters of hydrogen can be made from decomposing 13.0 moles of ammonia?
(2 moles of ammonia = 3 moles of hydrogen) (1 mole of hydrogen = 22.4 liters of hydrogen)

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Name_____

Conversions and Toxicity

Instructions: Use conversion factors to convert the following. Circle the correct answer. Information found from MSDS LD50 on rats.

Your Weight: _____lbs

1) Convert your weight into kilograms: (1kg = 2.2lbs)

Your Weight: _____ kg

2) Knowing that water's toxicity is 90 mL water per 1 kg body weight how many mL of water will kill you if you drink it?

Using your answer from above, drinking how many gallons of water will kill you? (1000 ml in 1 L, 1 gallon is 3.78 L)

3) Knowing that caffeine's toxicity is 150 mg caffeine to 1 kg body mass how much caffeine will kill you?

How many cups of coffee will kill you if there is 100 mg caffeine per cup of coffee?

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4) Don't tell your parents I told you this one. Oranges contain Vitamin C (ascorbic acid) which is necessary for our survival. If the toxicity of vitamin C is 3,367 mg per 1 kg of body weight and there is 70 mg of vitamin C in an orange, how many oranges could you eat before you died?

5) Cyanide is a commonly known family of poisons. Hydrogen cyanide (HCN) is the most deadly with a toxicity of 3.7×10^{-3} g/ 1 kg of body mass. How much hydrogen cyanide would kill you?

6) Thallium is the most poisonous element. How much thallium would kill you if the toxicity is 0.00045 g/ 1 kg of body mass?

7) The deadliest neurotoxin comes from the bacteria called Botulism. Botulinum harvested from this disease is also commonly called Botox. If the toxicity of Botulinum is 1.60×10^{-7} g/ 1 kg, how much would kill you?

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Name: _____

Worksheet #2: More Conversion Problems

1) The speed of light is 3.0×10^8 m/sec. How fast is this in miles/hour? (1609 m = 1 mile)

2) How many hours of class does a student attend in H.S.? (Here re your assumptions: Assume perfect attendance; 4 years to graduate; 50 minute classes; 7 classes per day; each year of H.S. is 180 days of class; ignore the fact that there are late start days, half days, exam days, etc.)

3) A person drives a car that gets 30 miles per gallon of gasoline. Each gallon of gas cost $3.15 and the car is driven 320 miles. How much money is needed for gasoline?

4) Fifteen people are going to a cookout. If each person eats 2 hot dogs and there are 8 hot dogs in each package.
   a. How many packages will need to be purchased for the cookout?

   b. If each package costs $1.89, how much money will it cost to buy the hot dogs?

5) Convert 72.6 cm into m . (1 m = 100 cm)

6) Convert 583 mm into in . (2.54 cm = 1 in.) (10 mm = 1 cm)

Name_____

Fun Conversion Problems!

Make sure you label your answer and put units!

1) How many doughnuts stacked end to end (like "OOOO") will it take to reach the moon? Assume that each doughnut has a diameter of 0.04m and the distance from Central High School to the moon is 384,403 m.

   A dozen day old doughnuts cost $1.25 at Meijer. How much would it cost to make our doughnuts reach the moon?

2) How many Jell-O pudding packages would you need to fill an Olympic size swimming pool? The dimensions of the pool are 50m x 25m x 2m and each pudding package makes 112 mL of pudding. (Hint: convert m^3 to cm^3 and remember that 1 cm^3 is the same as a mL!)

3) How many days would it take to watch every Family Guy episodes to date? As of January 9, 2013 there are 194 episodes. Assume that each Family Guy episode is 23 minutes.

4) If everyone in the world stood on each other's head, would we be able to touch the sun? The moon? Assume that the average height of humans on earth is 169.25 cm and that there are 7,021,836,029 people on earth (as of writing this paper). The distance to the sun is 1 AU or 1.49×10^8 km and the distance to the moon is written in problem 1.

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Chemistry Conversions Quiz Review

Here are the conversion factors you need plus a few extra just for fun!

365 days= 1 year	7days= 1 week	24 hours= 1 day	60 seconds=1 minute
60 minutes = 1 hour	16 tablespoons = 1 cup	3 teaspoons=1 tablespoons	
4 quarts= 1 gallon	5280 feet= 1 mile	12 inches= 1 foot	3 feet= 1 yard
0.625 miles = 1 km	1000 m = 1 km		

Show your work! Make sure you use units and label your final answer!

1) How many seconds are there in 1.25 days?

2) It is Muffin Friday! Mr. T is making his famous bacon muffins. However, he can only find a teaspoon! How many teaspoons does Mr. T have to measure out to be equivalent to 12 cups of flour?

3) How much money will it cost to provide cake for 52 students if each student eats 3 pieces of cake, each cake has 16 pieces, and each cake costs $4.75?

4) NASA has sent many instruments to explore the planet Mars. In order to safely land on the planet's surface a Mars Rover must be going under 23,455 feet/ second before the parachute is deployed. However, since NASA uses the metric system you need to convert the speed to km/hour or the Rover will crash!

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Chapter 4-Chemistry Conversions Test Review

Show your work! Make sure you use units and label your final answer!

1) How many inches are in 3.9 miles? (12 inches = 1 foot, 1 yards= 3 feet, 5,260 feet = 1 mile)

2) Mr. T has been dating his girlfriend for one year, nine months, and six days. How many hours has Mr. T been in a relationship? (Assume Mr. T put "in a relationship" on Facebook the second they started dating)

3) On October 15, 1997 Andy Green set the land speed record with the ThrustSSC getting up to 1223.657 km/hour. What is this speed in miles/hour? (1km =0.625 miles)

4) A student drinks 3 cans of Mt. Dew per day. What is this student's rate of consumption in terms of cases/year? Hint: Start off with 3cans/day.
(12 cans = 1 case) (365days = 1 year)

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Scalars and Vectors

Scalar: a measurement that has magnitude (size)

Vector: a measurement that has magnitude and direction

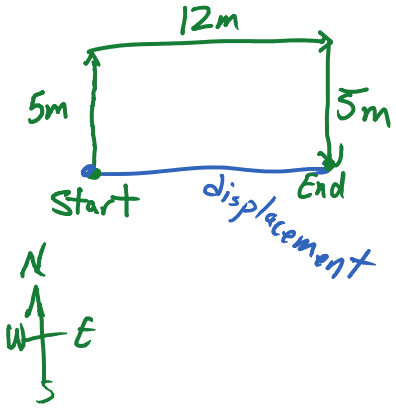
Scalars	Vectors
distance	displacement
speed	velocity
mass	Force
time	acceleration
Volume	momentum
Energy	

Distance vs. Displacement

Distance: the total length an object travels

Displacement: the total length an object is from its initial position.

Example 1: Hailey is walking as shown.



a) What DISTANCE did Hailey walk?

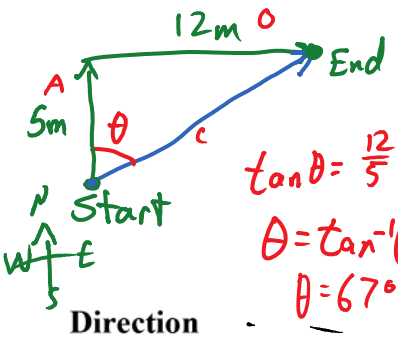
5+12+5 = 22m

b) What was Hailey's DISPLACEMENT?

12m East

SOHCAHTOA

Example 2: Steve walked with Hailey part of the way.



a) What DISTANCE did Steve walk?

17m

b) What was Steve's DISPLACEMENT?

$5^2+12^2=c^2$

$25+144=c^2$

$169=c^2$

$c=13$

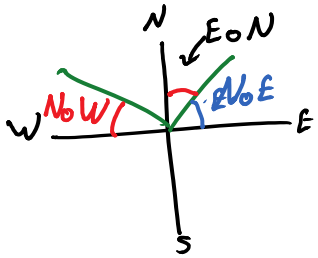
$\tan\theta=\frac{12}{5}$

$\theta=\tan^{-1}\left(\frac{12}{5}\right)$

$\theta=67^\circ$

13m @ 67° E of N

Direction



① Draw your angle arc

② The axis attached to your arc is #2

③ The direction you move to get to the line is #1

#1 of #2

Scalar and Vector Symbols

Distance - d

Speed - v

Time - t

Mass - m

Volume - V

Energy – E (U or T) (kinetic, potential)

Displacement – $\vec{d}$

Velocity – $\vec{v}$

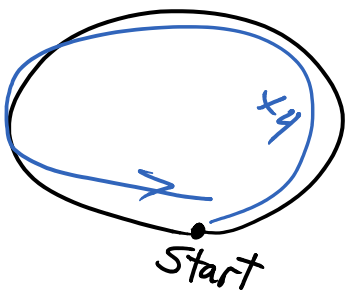
Acceleration – $\vec{a}$

Force – $\vec{F}$

Momentum – $\vec{p}$

Example 3:

Dylan runs four laps around a 400m circular track.



a) What DISTANCE did Dylan run?

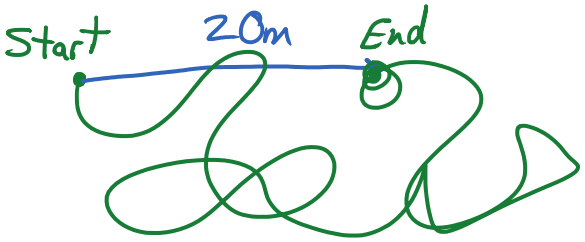
$d=4\times400=1600m$

b) What was Dylan's DISPLACEMENT?

$\vec{d}=0m$

Example 4:

Jamie is on fire. She runs around as shown below. Calculate Jamie's displacement.



$\vec{d} = 20\text{m East}$

Vector Addition

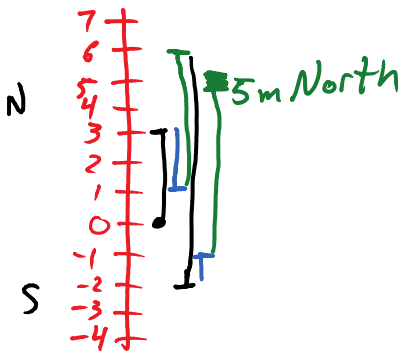
Principle of Superposition: all vectors of a single type can be added to make a single resulting vector.

Draw it out or Algebraic/Trigonometric

- Separate perpendicular motions
- Add the parts together
- Bring the final perpendicular vectors together

Example 5:

Justin walks 3m N, then 2m S, then 5m N, then 8m S, then 1m N, then 6m N. What is Justin's displacement?



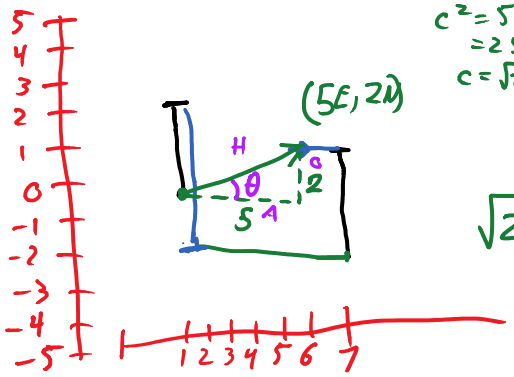
+ North − South

$\vec{d} = +3-2+5-8+1+6 = +5\text{m}$

5m North

Example 6:

Valerie walks ~~3m N~~, ~~5m S~~, ~~7m E~~, ~~4m N~~, and ~~2m W~~. What is Valerie's displacement?



$c^2 = 5^2 + 2^2$
$= 25 + 4$
$c = \sqrt{29}$

$\tan\theta = \frac{2}{5}$

$\theta = \tan^{-1}\left(\frac{2}{5}\right) = 21.8$

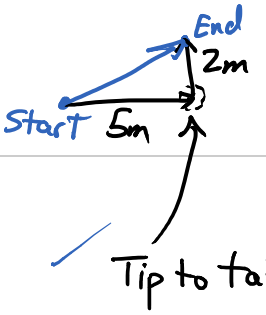
+ N − S

$\vec{d}_{NS} = +3-5+4$
$= +2\text{m}$ North

$\sqrt{29}$ @ 21.8° NoE

+ E − W

$\vec{d}_{EW} = +7-2$
$d_{EW} = +5\text{m}$ East



Tip to tail