Dimensional Analysis

a.k.a. Factor Label Method

a.k.a. "glorified" proprotions

How many centimeters are in 28 inches?

using proportions:

there is one inch for every 2.54 cm

$$\frac{1 \text{ inch}}{2.54 \text{ cm}} = \frac{x}{28 \text{ inches}}$$

Jan 7-1:33 PM

Dimensional Analysis

1. Define the "given" and "goal"
   underline circle

How many centimeters are in 28 inches?

2. Identify equivalence relationships
   a.k.a. unit conversion factors
   a.k.a. ratios or rates

$$\frac{2.54\text{ cm}}{1\text{ inch}} \qquad \frac{1\text{ inch}}{2.54\text{ cm}}$$

2.54 cm = 1 inch

3. Arrange conversion factors so **units cancel**, leaving new desired unit

How many centimeters are in 27 inches?

"given" start with what you know

$$28\text{in} \times \frac{2.54\text{ cm}}{1\text{ inch}} =$$

"goal" (units)

chemists use "picket fence"

$$28\text{ in.} \left| \frac{2.54\text{ cm}}{1\text{ inch}} \right. =$$

Why does this work?

$$12 \times \frac{754}{754} =$$

$$12 \times 1 = 12$$

units cancel like numbers (factor out)

$$\frac{25}{7} \times \frac{7}{5} =$$

How many eggs in 4.75 dozen?

How many atoms in 3.5 moles?

$1 \text{ mole} = 6.02 \times 10^{23}$ atoms, molecules or particles

Sep 17-8:31 AM

Use dimensional analysis or proportions:

55 mm = _____ m

1000 mm = 1 m

$$55\text{ mm} \times \frac{1\text{ m}}{1000\text{ mm}} = 0.055\text{ m}$$

D.A. (dimensional analysis) is easier with multistep conversions.

The largest single rough diamond ever found, the Cullinan diamond, weighed 3106 carats; how much does the diamond weigh in milligrams?

given

goal

conversions:

1 carat = 0.2 g

1000 mg = 1 g

$$3106\text{ carats} \times \frac{0.2\text{ g}}{1\text{ carat}} \times \frac{1000\text{ mg}}{1\text{ g}} = \text{mg}$$

patterns...

what patterns are present?

Convert 35 meters to miles.

$$\frac{35\text{ m}}{} \left|\frac{100\text{ cm}}{1\text{m}}\right| \frac{1\text{ in}}{2.54\text{cm}} \left|\frac{1\text{ ft}}{12\text{ in}}\right| \frac{1\text{ mile}}{5280\text{ ft}} =$$

Cross out units that cancel above.

Describe the relationship of top and bottom number:

(top must = bottom in each section)

Jan 7-3:02 PM

Computer memory is measured in units of bytes, where one byte is enough memory to store one character (a letter or number). How many typical pages of text can be stored on a 16 gigabyte drive. Assume that one typical page of text contains 2000 characters.
One gigabyte = 1,000,000,000 bytes.

Given:

Goal:

Conversions:

$$\frac{16\ \text{GB}}{} \left| \frac{1 \times 10^9\ \text{bytes}}{1\ \text{GB}} \right| \frac{1\text{char}}{1\text{bytes}} \left| \frac{1\ \text{page}}{2000\ \text{char}} \right. = \square$$

1 hr = 60 min	1 min = 60 sec	1 ton = 2000 lbs	7 days = 1 week
24 hrs = 1 day	1 kg = 2.2 lbs	1 gal = 3.79 L	264.2 gal = 1 cubic meter
1 mi = 5,280 ft	1 kg = 1000 g	1 lb = 16 oz	20 drops = 1 mL
365 days = 1 yr	52 weeks = 1 yr	2.54 cm = 1 in	1 L = 1000 mL
0.621 mi = 1.00 km	1 yd = 36 inches	1 cc is 1 cm^3	1 mL = 1 cm^3

1.) How many miles will a person run during a 10 kilometer race?

2.) The moon is 250,000 miles away. How many feet is it from earth?

3.) A family pool holds 10,000 gallons of water. How many cubic meters is this?

1 hr = 60 min	1 min = 60 sec	1 ton = 2000 lbs	7 days = 1 week
24 hrs = 1 day	1 kg = 2.2 lbs	1 gal = 3.79 L	264.2 gal = 1 cubic meter
1 mi = 5,280 ft	1 kg = 1000 g	1 lb = 16 oz	20 drops = 1 mL
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0.621 mi = 1.00 km	1 yd = 36 inches	1 cc is 1 cm^3	1 mL = 1 cm^3

4.) The average American student is in class 330 minutes/day. How many hours/day is this?

How many seconds is this?

5) How many seconds are there in 1 year?

6) Lake Michigan holds 1.3×10^{15} gallons of water. How many liters is this?

Mathematical Relationships

Linear relationships and Ratios

Relationship: 55mph or 55 miles/1hour or 55m/h

a. If a person is traveling at 55mph how long were they in the car?

b. If a person is traveling at 55mph how far did they travel?

c. On the back of this paper you will find a graph paper. Create a data table and a graph (distance vs. hours). Pick some reasonable time frames for the graph. (55 mph)

d. Next to that graph make another graph of someone traveling at 30mph.

e. What are some similarity and different characteristics?

both linear, positive slope

Each has different slopes and rates

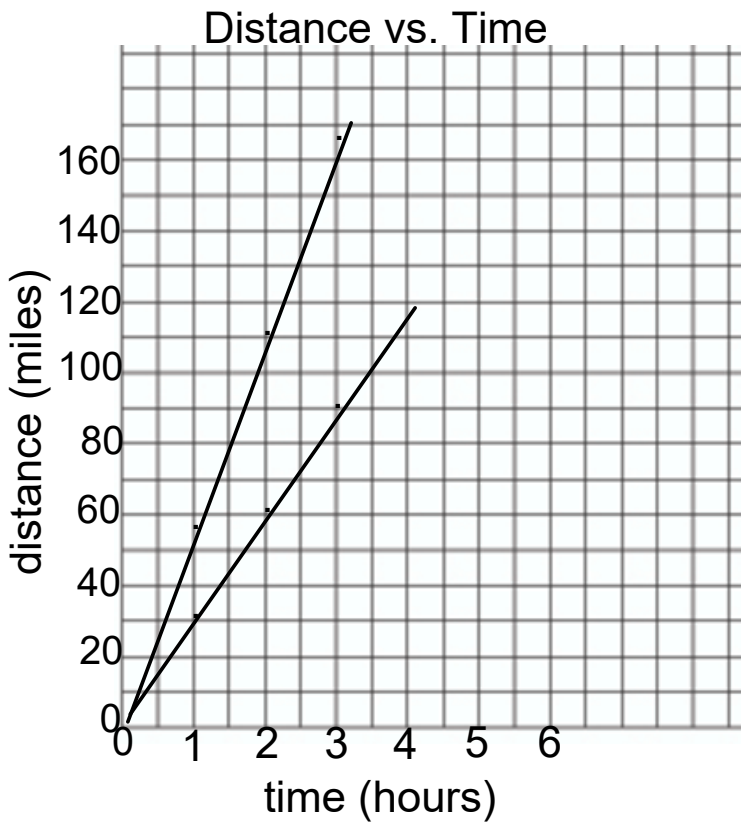
f. Using proportions calculate the following

i. How far did one travel if moving at 30mph for 95min.?

$$\frac{30\text{mi}}{60\text{ min}} = \frac{x}{95\text{min}} \qquad \frac{95\text{min}}{} \left| \frac{30\text{mi}}{60\text{ min}} \right. = 47.5 \text{ mile}$$

ii. How long was a person in the car if traveling at 90mph for 100 miles?

$$\frac{90\text{mi}}{1\text{ hour}} = \frac{100\text{mi}}{x} \qquad \frac{100\text{ mi}}{} \left| \frac{1\text{ hr}}{90\text{mi}} \right. = 0.9 \text{ hours}$$



Jan 9-4:22 PM

Mathematical Relationships

Linear relationships and Ratios

2. A Nurse is making $26.50/hour. Make a graph on the back spanning 40 hours.

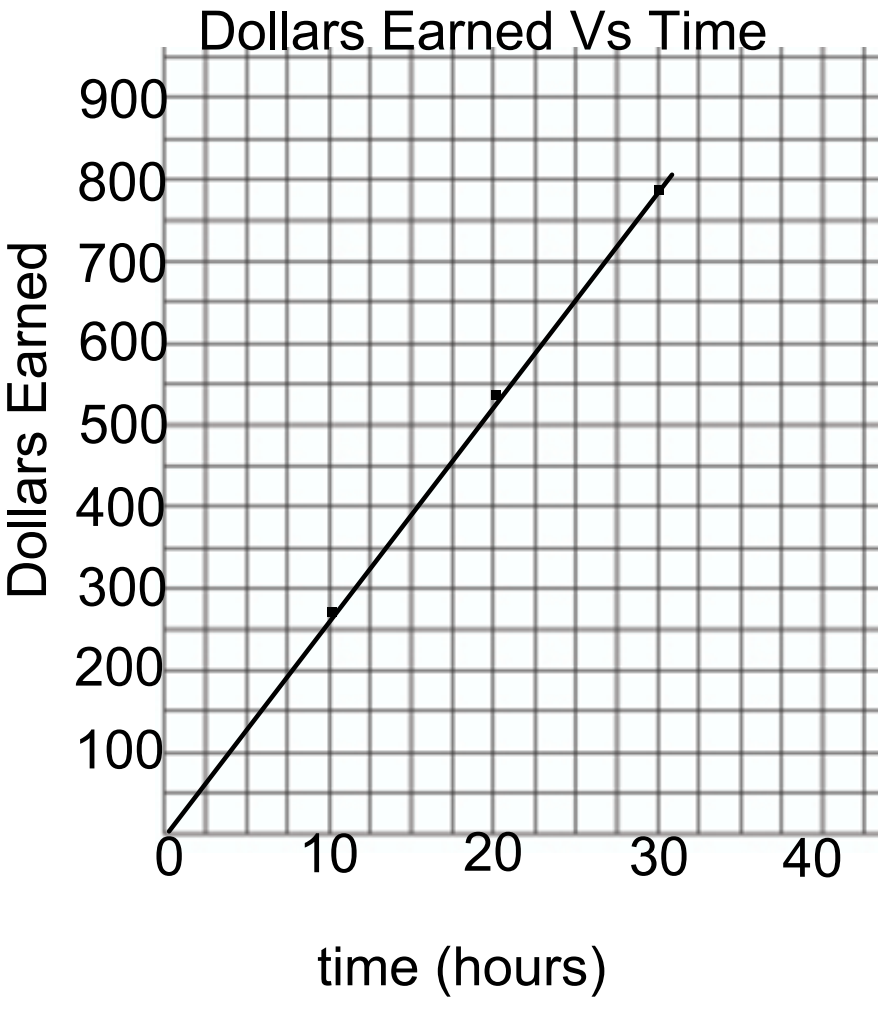
   a. How much has the nurse earned in 1 minute (use a proportion)?

$$\frac{\$26.50}{60\ \text{min.}} = \frac{x}{1\ \text{min}} \qquad x = \$0.44$$

   b. How much has the nurse earned in 52 weeks or 1 year of 40 hours/week.

52 x 40= 2080 hours $\quad \frac{\$26.50}{1\ \text{hr}} = \frac{x}{2080\ \text{hr}} \quad x=\$55,120$

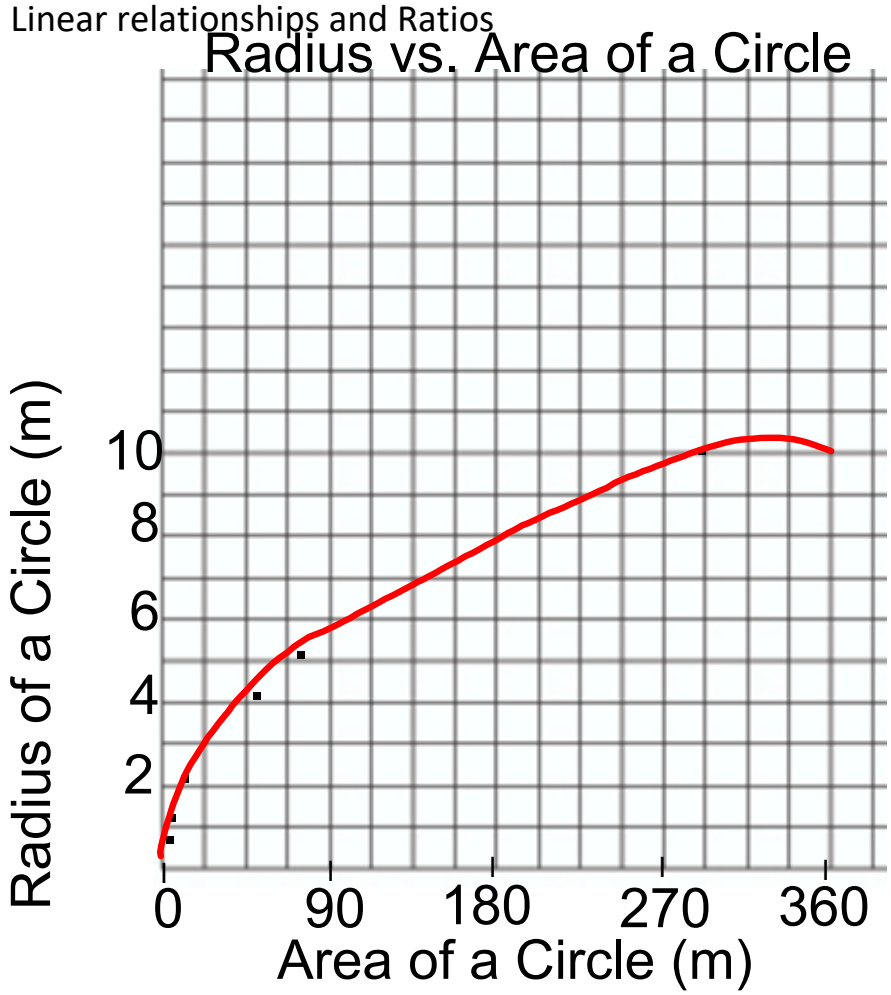
$$\frac{52\ \text{weeks}}{} \left| \frac{40\ \text{hours}}{1\ \text{week}} \right| \frac{\$26.50}{1\ \text{hr}} = \$55,120$$



Jan 9-4:22 PM

Mathematical Relationships

Linear relationships and Ratios



πr^2

3. Area of a circle?

   a. Complete a graph on the back with the following information

   b. Is this a linear relationship? Why or why not?

NO not proportional

Radius of circle (m)	.5	1	2	4	5	10
Area of the circle (m^2)	.4	3.	12.	50	78	314

Jan 9-4:22 PM

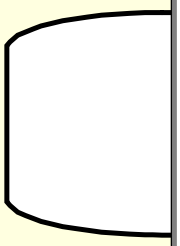
D.A. -- changing multiple units:

A car travels 55mph. How fast is it traveling in km/sec?

$$\frac{\text{miles}}{\text{hour}} \text{ to } \frac{\text{km}}{\text{sec}}$$

conversions:
1 min = 60 sec
1 km = 0.62 mile
1 hr= 60 min

$$\frac{55 \text{ miles}}{1 \text{hour}} \left| \frac{1 \text{ km}}{0.62 \text{ mile}} \right| \frac{1 \text{ hour}}{60 \text{ min.}} \left| \frac{1 \text{ min.}}{60 \text{ sec}} \right| = $$



Speed of sound = 450 m/sec. Convert to miles/min.

1000 m =l km
0.62mi = 1km

16.74 mi/ min

Feb 4-8:07 AM

Cooking Factor Label

This assignment uses cooking to assess factor label techniques.

Table 6.1 - **Cream of Tomato –** recipe produces 5 cups of soup

1 Tbs butter	Freshly ground blk pepper	28 oz pureed tomatoes
1 ½ cups chopped onion	½ tsp celery salt	1 tsp honey
2 bay leaves	½ tsp allspice	1 cup milk
½ tsp salt	2 Tbs flour	Swiss cheese

I. Use the above recipe to answer the following questions.

1. If Billy Bob (BB for short) uses 2 tsp of allspice, how much soup will he produce?

2. If BB uses 1.5 cups of milk, how much soup will he produce?

3. If BB has 13 guests and want to make 14 cups of soup, how much flour must he use?

4. How many oz of pureed tomatoes would BB need in problem # 3?

5. If BB could only find 11 oz of pureed tomatoes, how many cups of soup can he make?

Table 6.2 – **Volume Conversions**

1 teaspoon (tsp) = 5 mL	1 Tablespoon (Tbs) = 15 mL
4 cups = 1 quart	8 fluid ounces (oz) = 1 cup
1 Tbl = 3 tea	16 Tbl = 1 Cup

II. Use Table 6.1 and 6.2 to answer the following questions.

1. If Billy Bob (BB for short) uses 6 mL of celery salt, how much soup can he make (in cups)?

2. If BB uses 3.5 bay leaves, how much flour must he use (in mL)?

Jan 9-4:17 PM

Name
Cooking Factor Label

This assignment uses cooking to assess factor label techniques.

Table 6.1 - **Cream of Tomato** – recipe produces 5 cups of soup

1 Tbs butter	Freshly ground blk pepper	28 oz pureed tomatoes
1 ½ cups chopped onion	½ tsp celery salt	1 tsp honey
2 bay leaves	½ tsp allspice	1 cup milk
½ tsp salt	2 Tbs flour	Swiss cheese

I. Use the above recipe to answer the following questions.

1. If Billy Bob (BB for short) uses 2 tsp of allspice, how much soup will he produce?

$$2\ \text{tsp allspice} \left| \frac{5\ \text{c. soup}}{\frac{1}{2}\ \text{tsp allspice}} \right. = 20\ \text{c. soup}$$

2. If BB uses 1.5 cups of milk, how much soup will he produce?

$$1.5\ \text{c. milk} \left| \frac{5\ \text{c. soup}}{1\ \text{c. milk}} \right. = 7.5\ \text{c. soup}$$

3. If BB has 13 guests and want to make 14 cups of soup, how much flour must he use?

$$14\ \text{c. soup} \left| \frac{2\ \text{Tbs flour}}{5\ \text{c. soup}} \right. = 5.6\ \text{Tbs flour}$$

4. How many oz of pureed tomatoes would BB need in problem # 3?

$$14\ \text{c. soup} \left| \frac{28\ \text{oz tomato}}{5\ \text{c. soup}} \right. = 78.4\ \text{oz tomato}$$

5. If BB could only find 11 oz of pureed tomatoes, how many cups of soup can he make?

$$11\ \text{oz tomato} \left| \frac{5\ \text{cups}}{28\ \text{oz tomato}} \right. = 1.96\ \text{cups soup}$$

Table 6.2 – **Volume Conversions**

1 teaspoon (tsp) = 5 mL	1 Tablespoon (Tbs) = 15 mL
4 cups = 1 quart	8 fluid ounces (oz) = 1 cup
1 Tbl = 3 teaspoon	16 Tbl = 1 Cup

II. Use Table 6.1 and 6.2 to answer the following questions. mL → tsp

1. If Billy Bob (BB for short) uses 6 mL of celery salt, how much soup can he make (in cups)?

$$6\text{mL celery salt} \left| \frac{1\ \text{tsp}}{5\ \text{mL}} \right| \frac{5\ \text{c. soup}}{\frac{1}{2}\ \text{tsp celery salt}} = 12\ \text{cups soup}$$

2. If BB uses 3.5 bay leaves, how much flour must he use (in mL)?

$$3.5\ \text{bay leaves} \left| \frac{2\ \text{Tbs flour}}{2\ \text{bay}} \right| \frac{15\ \text{ml}}{1\ \text{Tbs}} = 52.5\ \text{ml flour}$$

10

1000 g = 1 kg