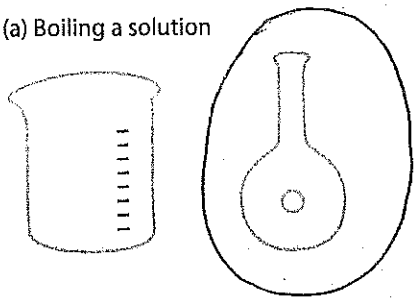
1.1 Staying Safe Around Matter

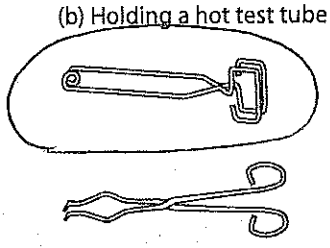
Warm Up (p. 2)

- Examine each of the following pairs of equipment.
- Consider how the structure of each piece relates to its function.
- Circle the better piece of equipment for each task.

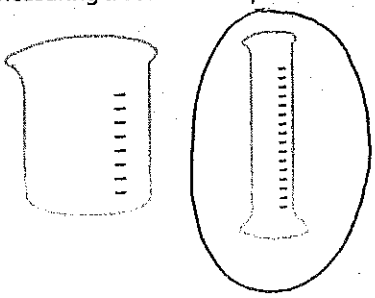
(a) Boiling a solution



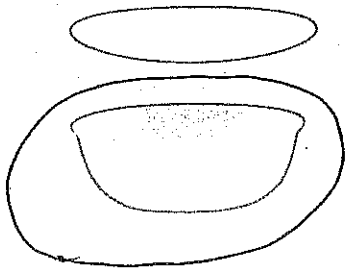
(b) Holding a hot test tube



(c) Measuring a volume of liquid



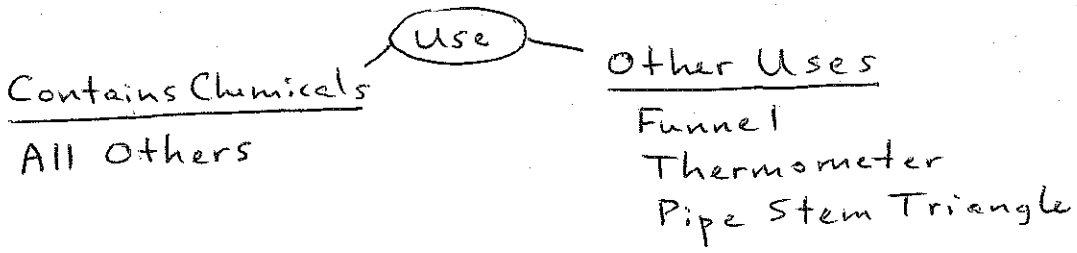
(d) Evaporation over a hot flame



Quick Check (pg 4)

Working with a partner, design a classification scheme and use it to put the glassware into groups according to common characteristics.

For Example:

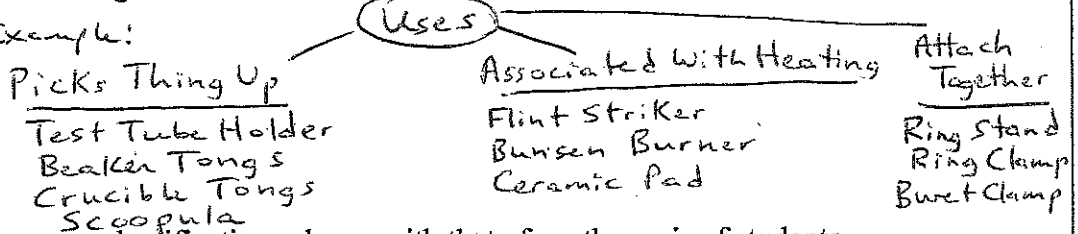


Compare your classification scheme with that of another pair of students.

Quick Check (pg 6)

Working with a partner, design a classification scheme and use it to put the hardware into groups according to common characteristics.

For Example:



Compare your classification scheme with that of another pair of students.

Quick Check (pg 7)

An excerpt from an MSDS for hydrochloric acid solution follows the questions below. This is only an excerpt. An actual MSDS may contain more than 15 sections, each of which may be quite detailed. Read this abbreviated excerpt carefully and answer these questions.

1. What WHMIS labels would you expect to find on hydrochloric acid?
   - corrosive
   - dangerously reactive
   - poison (Div 1)
2. Give a synonym for hydrochloric acid.
   Muriatic Acid
3. What are the chemicals that make up hydrochloric acid?
   HCl, H_2O
4. What are the hazards of spilling hydrochloric acid on the skin?
   Corrosive, irritant, itching, reddening, scales, blisters.
5. How should you treat a person who has ingested hydrochloric acid?
   - Do not cause vomiting
   - Medical Attention
   - Loosen tight clothes

corrosive product

poisonous product

Quick Check (pg 8)

What household labels would you expect to find on a container of muriatic acid?

Quick Check (pg 11)

1. How would you deal with each of the following accidents should it occur during a lab you are performing this year?

   (a) While heating a small amount of alcohol in a beaker, it bursts into flame.
   Smother with a cover (ceramic pad)

   (b) Your partner hands you a piece of hot glass they've just bent after heating over a Bunsen burner.
   ICE, cold water

   (c) A test tube full of concentrated hydrochloric acid is dropped and broken on the floor. (1st) Notify teacher and neighbours (2nd) Neutralize acid with baking soda, wipe up with paper towel, sweep up glass-put in disposal marked "GLASS."

2. How could you have prevented each accident from happening to begin with?
   1) Heat with hot plate
   2) Bring hand close
   3) Hold carefully (test tube holder/take care)

1.1 Activity: Safety in the Laboratory (p. 13)

Students' answers will vary.

1.1 Review Questions (p. 14)

1. Where is the closest fire alarm to your chemistry laboratory? For example,

   By 1st staircase to the right (B228)

2. Outline the route you should follow in case of a fire alarm while you are in chemistry class.

   For example: Right
   Down stairs
   Out to oval

3. How many fire extinguishers are in your laboratory? What are their classifications? For example,

   One
   ABC

4. Knowing you have lab on a particular school day, describe how you should dress.

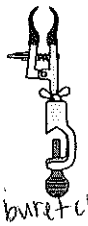
   Closed toe shoes, natural fibres, no dangling/loose clothes or jewelry

5. Give the *name* and *use* of each of the following pieces of equipment:

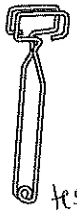
Erlenmeyer flask (holds liquid)

graduated cylinder (measure liquids) volume

crucible (heat)



buret clamp (clamp buret)



test tube holder (holds test tubes)

6. List three things you should do before beginning any chemistry experiment.

   Read lab/ know safety procedures/
   Safety glasses

7. Give three uses for the fume hood.

   Vent toxic fumes, odours, smoke,
   store organics, shield

8. What is the most common injury in the chemistry lab? How might you avoid this injury? How would you treat this injury?

   – burns
   – bring hand near
   – ice

9. How would you assist your lab partner in each of the following cases?

   (a) Partner has spilled a chemical into his or her eyes.

   10-15 min in eye wash

   (b) Partner's clothing has caught fire.

   Stop drop roll / fire blanket

   (c) Partner has spilled concentrated acid onto the floor.

   notify / neutralize with baking soda

   (d) Partner took more chemical than required for the lab.

   Share / proper disposal

   (e) Partner has broken a test tube on the floor.

   notify / sweep up – place in glass disposal

10. What is the meaning of each of the following labels?

Dangerously Reactive

Poisonous Product

compressed gas

Corrosive Product

corrosive

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11. Outline a three-step procedure for cleaning glassware at the end of the period.

Wash with soap (+ scrubble / brush)
Rinse
Air Dry

12. Why should long hair always be secured back during lab?

Avoid contact with flame / chemicals

13. Why do you suppose food and drink are not allowed during lab?

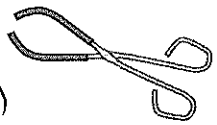
contamination / may drink wrong thing

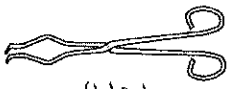
14. What do you think is safer: the laboratory or your kitchen? Explain why.

more safety equipment vs.
more hazards.

15. Give the name and use of each of the following pieces of equipment:

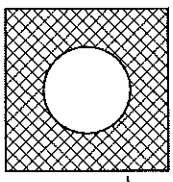
beaker tongs (pick up beaker)





crucible tongs (pick up crucible)

ring stand and ring (holds ceramic pad or safety ring)



ceramic pad (sits on ring for heating)

16. Where should binders, book bags, and backpacks be stored during the lab?

under bench – out of the way

17. What is an MSDS? Where might an MSDS be found in your school?

material Safety Data Sheet

Binder in store room.

18. Where would you dispose of each of the following?

(a) a few milliliters of excess dilute acid

Sink (run water before + after)

(b) a sample of heavy metal precipitate

Disposal jar

(c) an excess piece of glass tubing

glass disposal

(d) used litmus paper

garbage can

(e) a few milliliters of excess acetone (nail polish remover)

organic disposal in fume hood

19. What is the meaning of each of the following labels?

explosive container

poison level II
biohazard

flammable contents (product)

poison division II

oxidizing material

20. Give four things to keep in mind while heating a test tube half-filled with liquid.

Clamp near top of test tube
45°C
keep moving
point away

1.2 Laboratory + Reporting Skills

① Warm-up (p. 16)

Observation: Melting pt. of paradichlorobenzene is 53.5°C - QUANTITATIVE
Mercury(II) oxide is a deep red powder - QUALITATIVE
The density of scandium metal is $2.989 g/cm^3$ - QUANTITATIVE
Copper metal may be pulled into a wire. - QUALITATIVE (it is ductile)
Silver metal forms a black layer of tarnish over time - QUALITATIVE
Zinc has a specific heat capacity of $388 \frac{J}{kg \cdot K}$ - QUANTITATIVE
Oxygen gas supports combustion - QUALITATIVE

① Quick Check (p. 17)

1) Law - general statement of fact, theory - set of explanations from a series of experiments
2) Observation, hypothesis, experimentation, theory
3) Event: Balance used to weigh products not zeroed - MISTAKE
Product weighed was damp - SOE
Balance used to weigh product is only precise to the nearest centigram - SOE
Student read the value for the mass incorrectly - MISTAKE
Student made a math error determining mass - MISTAKE

② Quick Check (p. 18)

1) (a) 2750
(b) 0.05143
2) (a) 6.9547×10^4
(b) 1.68×10^{-3}

① Problems - Multiplication and Division in Scientific Notation (p. 20)

1) 8×10^7
2) 3.0×10^2
3) $[18.6 \times 10^3] \div (2.0 \times 10^5) = 9.3 \times 10^{-2}$
4) $1.0 \times 10^9 \div 5.0 \times 10^6 = 0.2 \times 10^3 = 2.0 \times 10^2$
5) $[3.0 \times 10^8] \times (2.5 \times 10^{-6}) = 7.5 \times 10^2$

③ Quick Check (p. 20) See next page for the complete chart.

1) 6.01451×10^{5}
2) 1.6×10^{4}
3) 3.83253×10^{-2}
4) 4.196×10^{-3}

② Problems – Addition & Subtraction in Scientific Notation (p. 22)

1) 7.654×10^{8}
2) 5.2248×10^{-3}
3) 4.9011×10^{2}

Quick Check (p. 23) See next page for answers.

Practice Problem -- Determination of a Relationship from Data (p. 25)

a) Exponential Relationship
b) Inverse Relationship
c) Linear Relationship

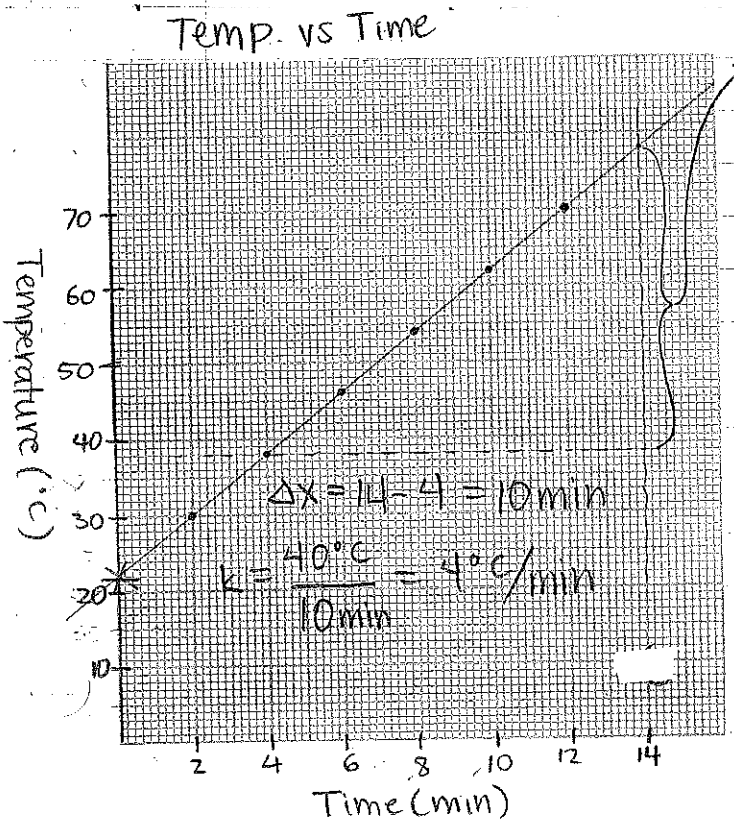
$\Delta x = 7 - 3 = 4s$

$\Delta y = 70 - 30 = 40m$

$k = \frac{40m}{4s} = 10 m/s \Rightarrow d = (10 m/s)t$

1.2 Activity: Graphing Relationships (p. 26)

Results and Discussion



1) Linear
2) 4°C/min
3) 42°C
4) Temp = (4°C/min) time + 22°C
5) $T = (4°C/min)t + 22°C$

$(4°C/min)t = T - 22°C$

$\therefore t = \frac{T - 22°C}{4°C/min} = \frac{80°C - 22°C}{4°C/min} = 14.5min$

6) Temperature of water in the beaker to start (Room Temp.)
7) Uneven heating.

Quick Check (p. 20)

	Given Value	Proper Notation	Expanded Form	Expanded Answer
1.	$6\,014.51 \times 10^{2}$	6.01451×10^{5}	601 451	601 451
2.	$0.001\,6 \times 10^{7}$	1.6×10^{4}	16 000	16 000
3.	$38\,325.3 \times 10^{-6}$	3.83253×10^{-2}	0.038 325 3	0.038 325 3
4.	0.4196×10^{-2}	4.196×10^{-3}	0.004 196	0.004 196

Return to previous page for answers to the Practice Problems on p. 22.

Quick Check (p.23)

1. $(10^{3})^{5}$ 10^{15}

2. $(2 \times 10^{2})^{3}$ 8×10^{6}

3. $(5 \times 10^{4})^{2}$ 2.5×10^{9}

4. $(3 \times 10^{5})^{2} \times (2 \times 10^{6})^{2}$ 3.6×10^{19}

Return to previous page for the answers to the Practice Problems on p. 25 and the 1.2 Activity on p. 26.

1.2 Review Questions (p. 27)

1. Use the steps of the scientific method to design a test for the following hypotheses:
   a) If a person takes vitamin C daily, then they will get fewer colds.
   b) If cyclists ride titanium bicycles, then they will win more races.

2. Complete the following table for the listed observations by checking the appropriate columns.

Property Observed	Chemical	Physical	Qualitative	Quantitative
Freezes at 52.0 °C.		✓		✓
Dissolves in ethylene glycol.		✓	✓	
Fractures into cubic crystals.		✓	✓	
5.4 moles dissolve in each litre.		✓		✓

3. Complete the following table for the listed observations by checking the appropriate columns.

Property Observed	Chemical	Physical	Qualitative	Quantitative
Attracts to a magnet.	✓		✓	
Changes to $Br_2(l)$ at -7.2 °C.		✓		✓
Has a density of 4.71 g/mL.		✓		✓
Is a bright orange solid crystal.		✓	✓	

4. Convert the following numbers from **scientific to expanded notation** and vice-versa (be sure the scientific notation is expressed correctly).

Scientific Notation	Expanded Notation
3.08×10^4	30800
9.6×10^2	960
4.75×10^{-3}	0.00475
4.84×10^{-4}	0.000 484
0.0062×10^5	620

5. Give the product or quotient of each of the following problems (express all answers in proper form scientific notation). Do **not** use a calculator.
   a) $(8.0 \times 10^3) \times (1.5 \times 10^6) = (8.0 \times 1.5) \times 10^{(3+6)} = 12 \times 10^9 \Rightarrow 1.2 \times 10^{10}$
   b) $(1.5 \times 10^4) \div (2.0 \times 10^2) = (1.5 \div 2.0) \times 10^{(4-2)} \Rightarrow 0.75 \times 10^2 \Rightarrow 7.5 \times 10^1 \ (75)$
   c) $(3.5 \times 10^{-2}) \times (6.0 \times 10^5) = (3.5 \times 6.0) \times 10^{(-2+5)} \Rightarrow 21 \times 10^3 \Rightarrow 2.1 \times 10^4$
   d) $(2.6 \times 10^7) \div (6.5 \times 10^{-4}) =$
   $\Rightarrow (2.6 \div 6.5) \times 10^{(7-(-4))} \Rightarrow 0.4 \times 10^{11} \Rightarrow 4.0 \times 10^{10}$

6. Give the product or quotient of each of the following problems (express all answers in proper form scientific notation). Do **not** use a calculator.
   a) $(3.5 \times 10^4) \times (3.0 \times 10^5) = (3.5 \times 3.0) \times 10^{(4+5)} \Rightarrow 10.5 \times 10^9 \Rightarrow 1.05 \times 10^{10} \ (1.1 \times 10^{10})$
   b) $(7.0 \times 10^6) \div (1.75 \times 10^2) = (7.0 \div 1.75) \times 10^{(6-2)} \Rightarrow 4.0 \times 10^4$
   c) $(2.5 \times 10^{-3}) \times (8.5 \times 10^{-5}) =$
   d) $(2.6 \times 10^5) \div (6.5 \times 10^{-2}) =$

c) $(2.5 \times 8.5) \times 10^{(-3-5)} \Rightarrow 21.25 \times 10^{-8} \Rightarrow 2.13 \times 10^{-7} \ (2.1 \times 10^{-7})$

d) $(2.6 \div 6.5) \times 10^{(5-(-2))} \Rightarrow 0.40 \times 10^7 \Rightarrow 4.0 \times 10^6$

7. Solve the following problems, expressing the answer in scientific notation, *without* using a calculator. Repeat the questions using a calculator and compare your answers.

a. 4.034×10^5

-2.12×10^4

403400

− 21200

382200 → 3.822×10^5

b. 3.114×10^{-6}

$+2.301 \times 10^{-5}$

0.00000311 4

0.00002301

0.00002612 4 → 2.612×10^{-5}

c. 26.022×10^2

$+ 7.04 \times 10^{-1}$

2602.2

+ 0.704

2602.904 → 2602.9

8. Solve the following problems, expressing the answer in scientific notation, *without* using a calculator. Repeat the questions using a calculator and compare your answers.

a. 2.115×10^8

-1.11×10^7

2.00×10^8

b. 9.332×10^{-3}

$+6.903 \times 10^{-4}$

0.009332

+0.0006903

0.0100223 → 1.0022×10^{-3}

c. 68.166×10^2

$+ \quad \times 10^{-1}$

6816.6

+ 0.1

6816.7 ⇒ 6.6167×10^3

9. Solve each of the following problems *without* a calculator. Express your answer in correct form scientific notation. Repeat the questions using a calculator and compare.

a. $(10^{-4})^3$ b. $(4 \times 10^5)^3$ c. $(7 \times 10^9)^2$ d. $(10^2)^2 \times (2 \times 10)^3$

$10^{-4 \times 3} \Rightarrow 10^{-12} \Rightarrow 1 \times 10^{-12}$

$4^3 \times 10^{15} \Rightarrow 64 \times 10^{15} \Rightarrow 6.4 \times 10^{16}$

$7^2 \times 10^{18} \Rightarrow 49 \times 10^{18} \Rightarrow 4.9 \times 10^{19}$

$10^4 \times 2^3 \times 10^3 \Rightarrow 8 \times 10^7$

10. Solve each of the following problems *without* a calculator. Express your answer in correct form scientific notation. Repeat the questions using a calculator and compare.

a. $(6.4 \times 10^{-6} + 2.0 \times 10^{-7}) \div (2 \times 10^6 + 3.1 \times 10^7)$ $\quad \frac{6.6 \times 10^{-6}}{3.3 \times 10^7} = 2.0 \times 10^{-13}$

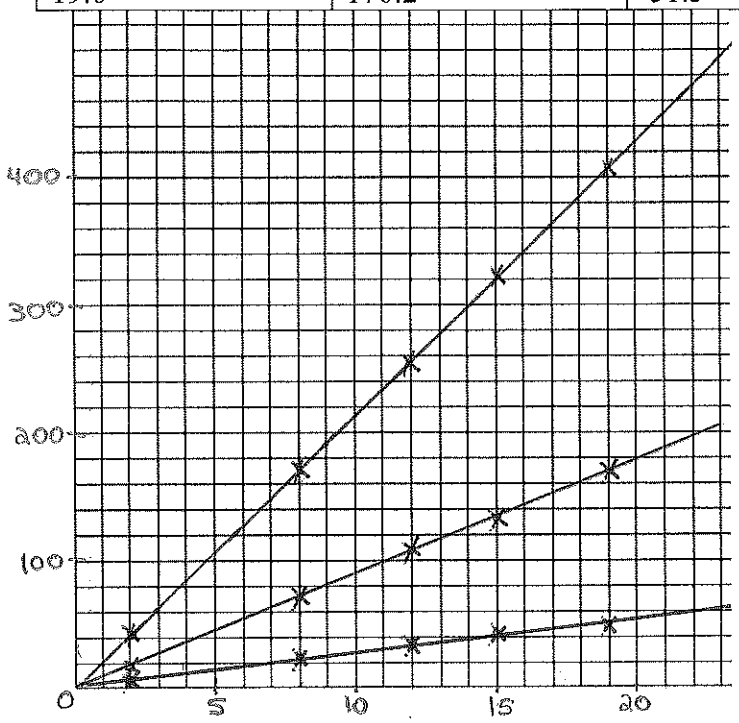
b. $\dfrac{3.4 \times 10^{-17} \times 1.5 \times 10^4}{1.5 \times 10^{-4}}$ $\quad \frac{5.1 \times 10^{-13}}{1.5 \times 10^{-4}} = 3.4 \times 10^{-9}$

c. $(2 \times 10^3)^3 \times [(6.84 \times 10^3) \div (3.42 \times 10^3)]$ $\quad 8 \times 10^9 \times 2 = 1.6 \times 10^{10}$

d. $\dfrac{(3 \times 10^2)^3 + (4 \times 10^3)^2}{1 \times 10^4}$ $\quad \frac{7 \times 10^6}{1 \times 10^4} = 7 \times 10^2$

11. Use the axes provided to plot graphs of mass against volume for a series of metal pieces with the given volumes. Plot all three graphs on the same set of axes with the independent variable (volume in this case) on the x-axis. Use a different colour for each.

Volume	Copper	Aluminum	Platinum
2.0 mL	17.4 g	5.4 g	42.9 g
8.0	71.7	21.6	171.6
12.0	107.5	32.4	257.4
15.0	134.4	40.5	321.8
19.0	170.2	51.3	407.6



– copper – platinum
– aluminum

a. Copper: $\frac{180 - 80\,g}{20 - 9\,mL} = 9.1\,g/mL$

Aluminum: $\frac{60 - 20\,g}{22 - 7\,mL} = 2.0\,g/mL$

Platinum: $\frac{340 - 20\,g}{16 - 1\,mL} = 21\,g/mL$

b. platinum is most dense

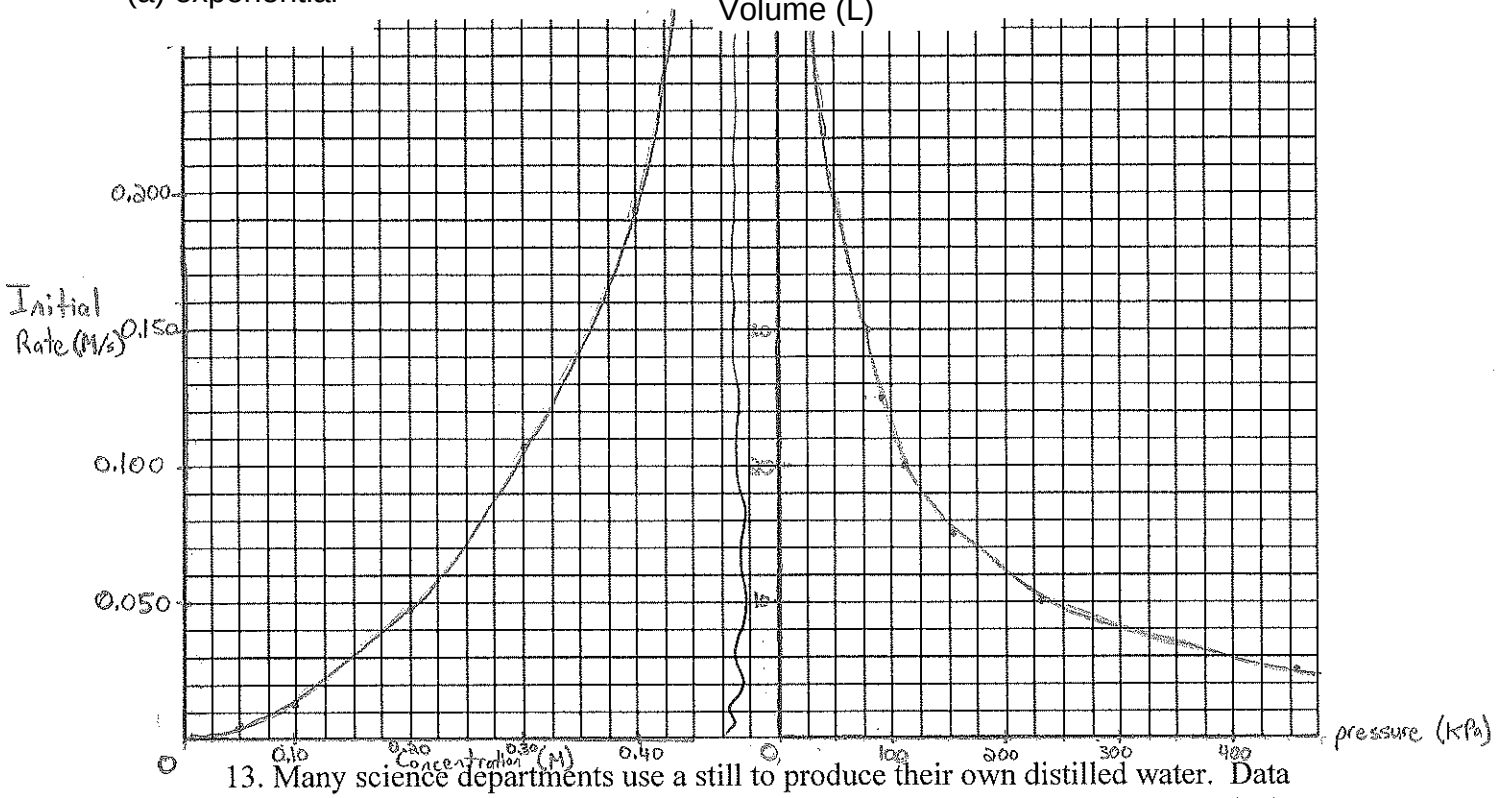
a) Determine the constant for each metal:
b) The constant represents each metal's density. Which metal is most dense?

12. Use the grid provided to plot two separate graphs, a and b, for each the following sets of data. Be sure to draw a *smooth curve* through the points. Indicate the type of relationship represented by each graph.

Initial Rate (y)	**Concentration**		**Volume** (y)	**Pressure**
0.003 mol/L/s	0.05 mol/L		5.0 L	454 kPa
0.012	0.10		10.0	227
0.048	0.20		15.0	151
0.075	0.25		20.0	113
0.108	0.30		25.0	91
0.192	0.40		30.0	76

(a) exponential

(b) inverse



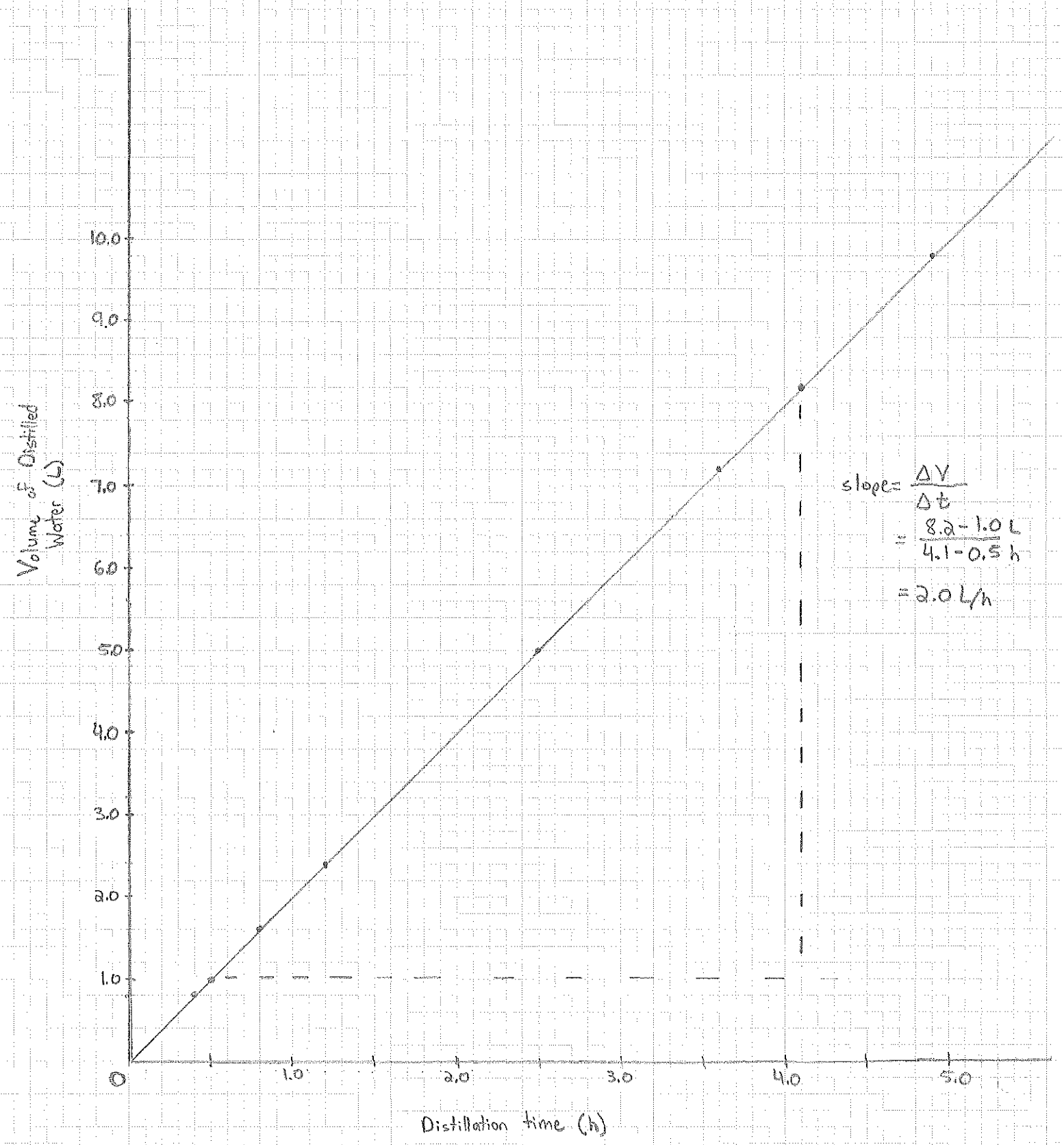
13. Many science departments use a still to produce their own distilled water. Data representing the volume of distilled water produced over a particular period of time might look like this:

Volume of Distilled Water	Distillation Time
0.8 L	0.4 h
1.6	0.8
2.4	1.2
5.0	2.5
7.2	3.6
9.8	4.9

a) Plot this data on your own piece of graph paper. Where should time be plotted? x-axis
b) Determine the constant for your graph. Show all work on the graph.
c) Determine the relationship between volume and time. linear $V = 2.0t$
d) Assume the still was left on overnight. What volume of water would be collected if a period of fourteen hours passed? $V = 2.0(14) = 28$ L
e) How long would it take to produce 12.5 L of water with this still?

$12.5 = 2.0t$

$t = 6.25$ h


Volume of Distilled Water (L)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
1.0
2.0
3.0
4.0
5.0
Distillation time (h)
slope = ΔV / Δt
= 8.2 - 1.0 L / 4.1 - 0.5 h
= 2.0 L/h

1.3 Measuring and Recording Significant Data Key

① Warm Up (p. 32)

SI measured value	Equivalent Everyday Measured Quantity
1 millimetre	thickness of one dime
100 kiloPascals	pressure exerted by the Earth's atmosphere
1 Litre	volume of 1000mL of milk
1 gram	mass of one raisin
1 kilometre	length of ten football fields
1 metre	distance from your fingertips to your nose
1 second	one sixtieth of one minute in time
1 centimetre	width across a small fingernail

① Quick Check (p. 33)

1) kilos ⇒ kg
2) 1/2 c.m. ⇒ 0.5cm
3) Ml ⇒ mL, gms ⇒ g, 4°c ⇒ 4° C, weight ⇒ mass
4) litres ⇒ L, c.c. ⇒ cm^3
5) .9C° ⇒ 0.9°C

② Quick Check (p. 34)

1) syringe
2) graduated cylinder
3) No
4) Syringe is the most precise of all b/c it is the most exact one, giving the most number of decimal places.
Graduated Cylinder is the least precise.

③ Quick Check (p. 35)

1) Group 1 & 3 → low precision, points are spread apart
Group 2 & 4 → high precision, the points are close together (within close range)
2) Group 1 & 2 → low accuracy, far from the assumed true point
Group 3 & 4 → high accuracy, points are around the assumed true point
3) Group 1, group 2
4) Group 3, Group 4

④ Quick Check (p. 36)

1) $42.4\text{mL} \pm 0.4\text{mL}$

2) $12.6\text{mL} \pm 0.4\text{mL}$

⑤ Quick Check (p. 37)

1) $+0.11\text{g}$

2) $\frac{0.11\text{g}}{2.46\text{g}} \times 100\% = 4.5\%$

3) uncertainty of measurement

① Practice Problems (p. 39)

1. (a) 3 (c) 3 (e) 2

(b) 5 (d) 3

2. a) 30.5 s c) 4.5 m

b) 0.290 g d) $1.0 \times 10^2\ ^\circ\text{C}$

⑥ Quick Check (p. 40)

1) $1.96 \rightarrow 2.0\text{m}^2$

2) $1105.8824\ldots \rightarrow 1100\text{ g/mL}$

3) $0.0490909\ldots \rightarrow 0.049\text{ g/s}$

⑦ Practice Problems (p. 41)

1) 22.11mL

2) 0.33g

3) $758.001\text{m} \rightarrow 760\text{m}$

② Quick Check (p. 41)

1) $0.2137405 \rightarrow 0.21\%$

2) $804.08\text{g} \div (424.4\text{mL} + 42.8\text{mL}) = \frac{804.08\text{g}}{467.2\text{mL}} = 1.721\text{ g/mL}$

3) $\frac{15.3696\ \text{m}^2}{9.1\ \text{min}} = \frac{(15.4\ \text{m}^2)}{9.1\ \text{min}} = 1.7\ \text{m}^2/\text{min}$

4) $6.71 \times 10^3\text{ s}$ or 6710 s

Round at End only!

1.3 Activity: Connecting Significant Figures with Uncertainty (p. 42)

①

Procedure

1. $4.4 \times 5.3 = 23.32\,cm^2$
2. $4.8 \times 5.7 = 27.36\,cm^2$
3. $(23.32 + 27.36) \div 2 = 25.34\,cm^2$

Results and Discussion

1 & 2. $25.34 \pm 2.02 \rightarrow 25\,cm^2 \pm 3\,cm^2$ (must include max and min area)

3. same

1.3 Review Questions (p. 43)

1) (a) 750 Gm → 750g
(b) km per hour → km/h, 10 sec → 10s
(c) ML → mL, cc → mL
(d) gms → g, inch → in.

2) Not accurate, but precise (consider both meanings)

3) Absolute error $= -0.0054\,g/cm^3$
% error $= \frac{0.0054\,g/cm^3}{0.1733\,g/cm^3} \times 100\% = 3.1\%$

4) (same/opposite direction)
|error| of $0.72g = 0.04g$
|error| of $0.63g = -0.04g$
} % error = 6%

5) $\frac{5.00}{100}(1.44) = 0.0720\,g/cm^3$
Maximum: $1.512 \rightarrow 1.519\,g/cm^3$
Minimum: $1.368 \rightarrow 1.37\,g/cm^3$

6) $84.08g \pm 0.05g$

7) $35 - 24 = 11m$

8) max: $20.0 \times 2.5 = 50.0\,cm^2$
min: $19.8 \times 2.3 = 45.54\,cm^2$
average: $47.77 \pm 2.23\,cm^2$
∴ $48 \pm 3\,cm^2$

9) (a) $14.3\ mL \pm 0.5\ mL$ (for example) (b) $112°F \pm 2°F$ or $44°C \pm 1°C$

10) (a) 4 (b) 4 (c) 5 (d) 2 (e) 2
(f) 7 (g) 2 (h) 1 (i) 2 (j) 3

11) (a) $4.907 \times 10^3 L$, ④ (b) $5.2 \times 10^{-5} m$, ②
(c) $7.9 \times 10^3 g$, ② (d) $6.030 \times 10^{-2} ft$, ④
(e) $7.900 \times 10^2 lb$, ④

12) (a) $1700\ cm^3$
(b) $3100\ m^3$

13) $8.9\ g/mL$

14) $96\ g$

15) (a) $615.05 \rightarrow 615\ g$
(b) $444.2\ mL$
(c) $6656.7 \rightarrow 6660\ s$
(d) $0.127\ m$

16) $0.88 + 0.772 + 190.7 = 192.3991 \rightarrow 192.4\ g/mL$

17) (a) $5.2\ g$
(b) $(2.69 \times 10^{-47} u^2) \div (2.9 \times 10^{-9} u) = 9.3 \times 10^{-39}$ units
(c)
$$\begin{bmatrix} 5.9 \times 10^{-12} \\ +0.780 \times 10^{-12} \\ \hline 6.68 \times 10^{-12}\ u \end{bmatrix} \div \begin{bmatrix} 0.4 \times 10^{13} \\ 6.700 \times 10^{13} \\ \hline 7.1 \times 10^{13}\ u \end{bmatrix} = \frac{6.7 \times 10^{-12}\ u}{7.1 \times 10^{13}\ u} = 9.4 \times 10^{-26}$$
(Carry all figures - attending to SF position - round at the end.)

18) (a) $\frac{(28.0 - 25.0)\ mg}{25.0\ mg} \times 100\% = \frac{3.0\ mg}{25.0\ mg} \times 100\%$
$= 12\%$
(b) NO (too high)

1.4 Answer Key

(p. 45) WarmUp: Larger: Kg butter / 5 mile trail

1 L milk / 12 in ruler

15 oz bar / 22 °C

(p. 49)

Practice Problems: 1 step & 2 step

1) $16\,s \cdot \frac{1\,ks}{10^3\,s} = 1.6 \times 10^{-2}\,ks$

2) $75\,000\,mL \cdot \frac{10^{-3}\,L}{1\,mL} = 75\,L$

3) $457\,ks \cdot \frac{10^3\,s}{1\,ks} \cdot \frac{1\,ms}{10^{-3}\,s} = 4.57 \times 10^8\,ms$

4) $5.6 \times 10^{-4}\,Mm \cdot \frac{10^6\,m}{1\,Mm} \cdot \frac{1\,dm}{10^{-1}\,m} = 5600\,dm$

(p. 50)

Practice Problems: Derived Unit Conv

1) $\frac{2.67\,g}{1\,mL} \cdot \frac{1\,kg}{10^3\,g} \cdot \frac{1\,mL}{10^{-3}\,L} = 2.67\,kg/L$ $\frac{1}{10^3} \cdot \frac{1}{10^{-3}} = 1$, Therefore, numerical value does not change

2) $\frac{8.9994 \times 10^{-4}\,mg}{1\,mL} \cdot \frac{10^{-3}\,g}{1\,mg} \cdot \frac{1\,kg}{10^3\,g} \cdot \frac{1\,mL}{10^{-3}\,L} = 8.9994 \times 10^{-7}\,kg/L$

3) $\frac{35\,mi}{1\,h} \cdot \frac{5280\,ft}{1\,mi} \cdot \frac{12\,in}{1\,ft} \cdot \frac{2.54\,cm}{1\,in} \cdot \frac{10^{-2}\,m}{1\,cm} \cdot \frac{1\,h}{60\,min} \cdot \frac{1\,min}{60\,s} = 16\,m/s$

(p. 51)

Practice Problems: Rate & Density Conv Factor

1) $2.5\,L\,Hg \cdot \frac{1\,mL}{10^{-3}\,L} \cdot \frac{13.6\,g}{1\,mL} = 34\,000\,g\,Hg$

2) $16.5\,kg\,Pb \cdot \frac{10^3\,g}{1\,kg} \cdot \frac{1\,cm^3}{11.2\,g} \cdot \frac{1\,mL}{1\,cm^3} \cdot \frac{10^{-3}\,L}{1\,mL} = 1.47\,L\,Pb$

3) $8.29\,min \cdot \frac{60\,s}{1\,min} \cdot \frac{3.0 \times 10^{10}\,cm}{1\,s} \cdot \frac{10^{-2}\,m}{1\,cm} \cdot \frac{1\,km}{10^3\,m} = 1.5 \times 10^8\,km$

(p. 52)

Practice Problems: Conv Factors Exp

1) $4.3\ dm^3 \cdot \left(\frac{10^{-1}\ m}{1\ dm}\right)^3 \cdot \left(\frac{1\ cm}{10^{-2}\ m}\right)^3 = 4300\ cm^3$

a) $\frac{14.7\ lb}{in^2} \cdot \frac{454\ g}{1\ lb} \cdot \left(\frac{1\ in}{2.54\ cm}\right)^2 = 1030\ g/cm^2$

3) $\frac{8.21\ kg}{m^3} \cdot \frac{10^3\ g}{1\ kg} \cdot \frac{1\ lb}{454\ g} \cdot \left(\frac{10^{-2}\ m}{1\ cm}\right)^3 \cdot \left(\frac{2.54\ cm}{1\ in}\right)^3 \cdot \left(\frac{12\ in}{1\ ft}\right)^3 = 0.51\ lb/ft^3$

(p. 54)

Practice Problems: Conv Units Temp

1) $(28.4^{\circ}C \cdot \frac{1.8^{\circ}F}{1^{\circ}C}) + 32^{\circ}F = 83.1^{\circ}F$

a) $(-319^{\circ}F - 32^{\circ}F) \times \frac{1^{\circ}C}{1.8^{\circ}F} = -195^{\circ}C$

3) $(0K - 273\ K) \times \frac{1^{\circ}C}{1\ K} = -273^{\circ}C$

$(-273^{\circ}C \times \frac{1.8^{\circ}F}{1^{\circ}C}) + 32^{\circ}F = -459^{\circ}F$

(p. 55) 1.4 Activity: Our Life in the Metric System -- Students' answers will vary.

(p. 56)

1.4 Review Ques: 1) Grain of salt's mass: $415\ \mu g \cdot \frac{10^{-6}\ g}{1\ \mu g} = 4.15 \times 10^{-4}\ g$

Earth to the moon's distance: $384.4\ Mm \cdot \frac{10^6\ m}{1\ Mm} = 3.844 \times 10^8\ m$

Mass of a nickel: $3.976\ g \cdot \frac{1\ \mu g}{10^{-6}\ g} = 3.976 \times 10^6\ \mu g$

Volumetric pipet length: $4.5\ dm \cdot \frac{10^{-1}\ m}{1\ dm} = 0.45\ m$

Smoke particle's mass: $1.05 \times 10^{-12}\ g \cdot \frac{1\ ng}{10^{-9}\ g} = 1.05 \cdot 10^{-3}\ ng$

Distance from UBC to SFU: $24.99\ km \cdot \frac{10^3\ m}{1\ km} = 24\,990\ m$

2) Energy to heat a grande latte to 65°C: $83.60\ kJ \cdot \frac{10^3\ J}{1\ kJ} \cdot \frac{1\ MJ}{10^6\ J} = 0.08360\ MJ$

Mass of a college chemistry text: $2.54\ kg \cdot \frac{10^3\ g}{1\ kg} \cdot \frac{1\ cg}{10^{-2}\ g} = 2.54 \times 10^5\ cg$

Average lightbulb wattage: $600.0\ dW \cdot \frac{10^{-1}\ W}{1\ dW} \cdot \frac{1\ nW}{10^{9}\ W} = 6.00 \times 10^{10}\ nW$

Volume of a can of soda: $355\ mL \cdot \frac{10^{-2}\ L}{1\ mL} \cdot \frac{1\ cL}{10^{-2}\ L} = 35.5\ cL$

Average time to send one text message: $185\ das \cdot \frac{10^{1}\ s}{1\ das} \cdot \frac{1\ ms}{10^{-3}\ s} = 1.85 \times 10^6\ ms$

Distance from Prince George to Trail: $987\ km \cdot \frac{10^3\ m}{1\ km} \cdot \frac{1\ dm}{10^{-1}\ m} = 9.87 \times 10^6\ dm$

3) $\frac{14.25\ km}{1\ L} \cdot \frac{10^3\ m}{1\ km} \cdot \frac{1\ cm}{10^{-2}\ m} \cdot \frac{1\ in}{2.54\ cm} \cdot \frac{1\ ft}{12\ in} \cdot \frac{1\ mi}{5280\ ft} \cdot \frac{4.23\ L}{1\ gal} = 37.45\ mi/gal$

4) $\frac{110\ km}{1\ h} \cdot \frac{10^3\ m}{1\ km} \cdot \frac{1\ h}{60\ min} \cdot \frac{1\ min}{60\ s} = 31\ m/s$

5) $\frac{16.7\ g}{mL} \cdot \frac{1\ kg}{10^3\ g} \cdot \frac{2.21\ lb}{1.00\ kg} \cdot \frac{1\ mL}{10^{-3}\ L} = 36.9\ lb/L$

6) $\frac{5.47 \times 10^3\ kWh}{1\ year} \cdot \frac{1\ year}{365\ days} \cdot \frac{1\ GJ}{277.8\ kWh} = 0.00539\ GJ/day$

7) $\frac{22.68\ kg}{1\ dm^3} \cdot \frac{10^3\ g}{1\ kg} \cdot \left(\frac{1\ dm}{10^{1}\ m}\right)^3 \cdot \left(\frac{10^{-2}\ m}{1\ cm}\right)^3 = 22.68\ g/cm^3$

8) $1.00\ L \cdot \frac{1\ mL}{10^{-3}\ L} \cdot \frac{13.6\ g}{1\ mL} \cdot \frac{1\ kg}{10^3\ g} = 13.6\ kg$

9) $120\ dL \cdot \frac{10^{-1}\ L}{1\ dL} \cdot \frac{14.25\ km}{1\ L} = 170\ km$

10) $6.00\ g \cdot \frac{1\ cm^3}{10.5\ g} \cdot \frac{1\ mL}{1\ cm^3} = 0.571\ mL$

11) $2.3\ kg \cdot \frac{10^3\ g}{1\ kg} \cdot \frac{1\ lb}{454\ g} \cdot \frac{1\ gal}{8.34\ lb} \cdot \frac{4.23\ L}{1\ gal} \cdot \frac{1\ mL}{10^{-3}\ L} = 2600\ mL$

12) $4 \text{ Pitt Bulls} \cdot \frac{3 \text{ Collies}}{1 \text{ Pitt Bull}} \cdot \frac{5 \text{ Poodles}}{2 \text{ Collies}} \cdot \frac{7 \text{ dobermans}}{3 \text{ Poodles}} \cdot \frac{9 \text{ German}}{1 \text{ doberman}} =$ 630 German Sheep dogs

13) $2 \text{ Calico} \times \frac{5 \text{ Siamese}}{1 \text{ Calico}} \cdot \frac{7 \text{ Persians}}{2 \text{ Siamese}} \cdot \frac{8 \text{ Tabby's}}{3 \text{ Persians}} \cdot \frac{6 \text{ Heinz Fifty}}{1 \text{ Tabby}} = \text{Sevens}$ 560 Heinz Fifty Sevens

14) $325 \text{ in}^3 \cdot \left(\frac{2.54 \text{cm}}{1 \text{in}}\right)^3 \cdot \left(\frac{10^{-2} \text{m}}{1 \text{cm}}\right)^3 \cdot \left(\frac{1 \text{dm}}{10^{-1} \text{m}}\right)^3 \cdot \frac{1 \text{L}}{1 \text{dm}^3} =$ 5.33 L

15) $\frac{14.7 \text{lb}}{\text{in}^2} \cdot \frac{454 \text{g}}{1.00 \text{lb}} \cdot \frac{1 \text{kg}}{10^3 \text{g}} \cdot \left(\frac{1 \text{in}}{2.54 \text{cm}}\right)^2 =$ 1.03 kg/cm²

16) $\frac{400 \text{ ft}^2}{1 \text{ gal}} \cdot \left(\frac{12 \text{in}}{1 \text{ft}}\right)^2 \cdot \left(\frac{2.54 \text{cm}}{1 \text{in}}\right)^2 \cdot \left(\frac{10^{-2} \text{m}}{1 \text{cm}}\right)^2 \cdot \left(\frac{1 \text{gal}}{4.23 \text{L}}\right) =$ 8.79 m²/L

17) $(451^\circ\text{F} - 32^\circ\text{F}) \cdot \frac{1^\circ\text{C}}{1.8^\circ\text{F}} =$ 233 °C

18) $\left(1.9\text{K} - 273\text{K}\right) \cdot \frac{1^\circ\text{C}}{1\text{K}} \cdot \frac{1.8^\circ\text{F}}{1^\circ\text{C}}\right) + 32^\circ\text{F} =$ −456.0 °F

19) $\left(-89^\circ\text{C} \cdot \frac{1.8^\circ\text{F}}{1^\circ\text{C}}\right) + 32^\circ\text{F} =$ −128 °F

20) $\left(9.0^\circ\text{C} \times \frac{1.8^\circ\text{F}}{1^\circ\text{C}}\right) + 32^\circ\text{F} =$ 48.2°F

1.3 Measuring and Recording Significant Data

Warm Up page 32

SI measured value	Equivalent Everyday Measured Quantity
1 millimetre	thickness of one dime
100 kiloPascals	pressure exerted by the Earth's atmosphere
1 litre	volume of 1000 mL of milk
1 gram	mass of one raisin
1 kilometre	length of ten football fields
1 metre	distance from your fingertips to your nose
1 second	one sixtieth of one minute in time
1 centimetre	width across a small fingernail

Quick Check page 33

1) kilo → kg
2) ½ c.m. → 0.5 cm
3) Ml → mL, gms → g, 4 °c → 4 °C , weight → mass
4) litres → L, c.c. → cm^3
5) .9 C° → 0.9 °C

Quick Check page 34

1) Syringe
2) Graduated cylinder
3) No
4) Syringe is the most precise of all because it is the most exact one, giving the greatest number of decimal places. Graduated cylinder is the least precise.

Quick Check page 35

1) Group 1,3 → low precision, points are spread apart
   Group 2,4 → high precision, the points are close together (within close range)
2) Group 1,2 → low accuracy, far from the assumed true point
   Group 3,4 → high accuracy, points are around the assumed true point
3) Group 1, group 2
4) Group 3, group 4

Quick Check page 36

1) 42.4 mL ± 0.4 mL
2) 12.6 mL ± 0.4 mL

Quick Check page 37

1) +0.11 g
2) $\frac{0.11\ g}{2.46\ g} \times 100\ \% = 4.5\ \%$
3) uncertainty of meaurement

Practice Problems page 39

1. a) 3
   b) 5
   c) 3
   d) 3
   e) 2

2. a) 30.5 s
   b) 0.290 g
   c) 4.5 m
   d) $1.0*10^2$ °C

Quick Check page 40

1) 2.0 m^2
2) 1100 g/mL
3) 0.049 g/s

Practice Problems page 41

1) 22.11 mL
2) 0.33 g
3) 760 m

Quick Check page 41

1) 0.21%
2) $\frac{804.08\ g}{467.2\ mL} = 1.721$ g/mL
3) $\frac{15.3696\ m^2}{9.1\ min} = 1.7\ m^2/min$
4) $6.71x10^3$ s **OR** 6710 s

1.3 Activity: Connecting Significant Figures with Uncertainty page 42

Procedure

1) 4.4 cm x 5.3 cm = 23.32 cm^2
2) 4.8 cm x 5.7 cm = 27.36 cm^2
3) $\frac{23.32\ cm^2 + 27.36\ cm^2}{2} = 25.34\ cm^2$

Results and Discussion

1) 3 cm^2

2) 25 cm^2 ± 3 cm^2
3) same number of significant figures

1.3 Review Questions page 43

1. a) 750 Gm → 750 g
   b) km per hour → km/h ; 10 sec → 10 s
   c) ML → mL ; cc → mL
   d) gms → g ; inch → in

2. Not accurate, but precise (consider both meanings)

3. Absolute error = -0.0054 g/cm^3
   % error = $\frac{0.0054\ g/cm^3}{0.1733\ g/cm^3}$ x 100% = 3.1%

4. Percent errors are the same. Absolute errors have opposite signs (+/-).
   lerrorl of 0.72 g = 0.04 g
   lerrorl of 0.63 g = -0.04 g
   % error = 6%

5. 1.44 g/cm^3 x $\frac{5.00}{100}$ = 0.0720 g/cm^3
   Maximum: 1.5**1**2 g/cm^3 → 1.51 g/cm^3
   Minimum: 1.3**6**8 g/cm^3 → 1.37 g/cm^3

6. 84.08 g ± 0.05 g

7. 35 m – 24 m = 11 m

8. max: 20.0 cm x 2.5 cm = 50.0 cm^2
   min: 19.8 cm x 2.3 cm = 45.54 cm^2
   average: 47.77 cm^2 ± 2.33 cm^2
   ➔ 48 cm^2 ± 3 cm^2

9. a) 14.3 mL ± 0.5 mL
   b) 112 °F ± 2 °F or 44 °C ± 1 °C

10. a) 4
    b) 4
    c) 5
    d) 2
    e) 2
    f) 7

g) 2
h) 1
i) 2
j) 3

11. a) 4.907×10^{3} L , 4
b) 5.2×10^{-5} m, 2
c) 7.9×10^{3} g, 2
d) 6.030×10^{-2} ft, 4
e) 7.900×10^{2} lb, 4

12. a) 1700 cm^3
b) 3100 m^3

13. 8.9 g/mL

14. 96 g

15. a) 615.05 g ➔ 615 g
b) 444.2 mL
c) 6656.7 s ➔ 6660 s
d) 0.127 m

16. 0.88 g/mL + 0.772 g/mL + 190.7 g/mL = 192.3991 g/mL ➔192.4 g/mL

17. a) 5.2 g
b) $\frac{(2.69 \times 10^{-47}\ u^2)}{(2.9 \times 10^{-9}\ u)} = 9.3 \times 10^{-39}$ units
c) $\frac{6.680 \times 10^{-12}\ u}{7.1 \times 10^{13}\ u} = 9.4 \times 10^{-26}$

18. a) $\frac{(28.0 - 25.0)\ mg}{25.0\ mg} \times 100\% = \frac{3.0\ mg}{25.0\ mg} \times 100\% = 12\%$

b) No (too high)

1.4 Answer Key

Warm Up: p 45

Metric Quantity		**Imperial Quantity**	
A kilogram of butter	X	A pound of butter	
A 5-kilometre hiking trail		A 5-mile mountain bike trail	X
One litre of milk	X	One quart of milk	
A 12-centimetre ruler		A 12-inch ruler	X
A 15-gram piece of chocolate		A 15-ounce chocolate bar	X
A temperature of 22 ^{o}C	X	A temperature of 22 ^{o}F	

Practice Problems – One and Two Step Metric Conversions p 49

1) $16\ s \times \frac{1\ ks}{10^3\ s} =$ **1.6×10^{-2} ks**

2) $75\ 000\ mL \times \frac{10^{-3}\ L}{1\ mL} =$ **75 L**

3) $457\ ks \times \frac{10^3\ s}{1\ ks} \times \frac{1\ ms}{10^{-3}\ s} =$ **4.57×10^8 ms**

4) $5.6 \bullet 10^{-4}\ Mm \times \frac{10^6\ m}{1\ Mm} \times \frac{1\ dm}{10^{-1}\ m} =$ **5600 dm**

Practice Problems – Derived Unit Conversions p 50

1) $\frac{2.67\ g}{1\ mL} \times \frac{1\ kg}{10^3\ g} \times \frac{1\ mL}{10^{-3}\ L} =$ **2.67 kg/L**
(Note: $\frac{1}{10^3} \times \frac{1}{10^{-3}} = 1$; therefore, numerical value does not change)

2) $\frac{8.9994 \bullet 10^{-4}\ mg}{1\ mL} \times \frac{10^{-3}\ g}{1\ mg} \times \frac{1\ kg}{10^3\ g} \times \frac{1\ mL}{10^{-3}\ L} =$ **8.9994×10^{-7} kg/L**

3) $\frac{35 mi}{1\ h} \times \frac{5280\ ft}{1\ mi} \times \frac{12\ in}{1\ ft} \times \frac{2.54\ cm}{1\ in} \times \frac{10^{-2}\ m}{1\ cm} \times \frac{1\ h}{60\ min} \times \frac{1\ min}{60\ s} =$ **16 m/s**

Practice Problems – Use of Rate and Density as Conversion Factors p 51

1) $2.5\ L\ Hg \times \frac{1\ mL}{10^{-3}\ L} \times \frac{13.6\ g}{1\ mL} =$ **34 000 g Hg**

2) $16.5\ kg\ Pb \times \frac{10^3\ g}{1\ kg} \times \frac{1\ cm^3}{11.2\ g} \times \frac{1\ mL}{1\ cm^3} \times \frac{10^{-3}\ L}{1\ mL} =$ **1.47 L Pb**

3) $8.29\ min \times \frac{60\ s}{1 min} \times \frac{3.0 \bullet 10^{10}\ cm}{1\ s} \times \frac{10^{-2}\ m}{1\ cm} \times \frac{1\ km}{10^3\ m} =$ **1.5×10^8 km**

Practice Problems – Use of Conversion Factors Containing Exponents p 52

1) $4.3\ dm^3 \times \frac{(10^{-1}\ m)^3}{(1\ dm)^3} \times \frac{(1\ cm)^3}{(10^{-2}\ m)^3} = \mathbf{4300\ cm^3}$

2) $\frac{14.7\ lb}{1\ in^2} \times \frac{454\ g}{1\ lb} \times \frac{(1\ in)^2}{(2.54\ cm)^2} = \mathbf{1030\ g/cm^2}$

3) $\frac{8.2\ kg}{1\ m^3} \times \frac{10^3\ g}{1\ kg} \times \frac{1\ lb}{454\ g} \times \frac{(10^{-2}\ m)^3}{(1\ cm)^3} \times \frac{(2.54\ cm)^3}{(1\ in)^3} \times \frac{(12\ in)^3}{(1\ ft)^3} = \mathbf{0.51\ lb/ft^3}$

Practice Problems – Conversion Between Units of Temperature p 54

1) $(28.4\ °C \times \frac{1.8\ °F}{1\ °C}) + 32\ °F = \mathbf{83.1\ °F}$

2) $(-319\ °F - 32\ °F) \times \frac{1\ °C}{1.8\ °F} = \mathbf{-195\ °C}$

3) $(0\ K - 273\ K) \times \frac{1\ °C}{1\ K} = \mathbf{-273\ °C}$

$(-273\ °C \times \frac{1.8\ °F}{1\ °C}) + 32\ °F = \mathbf{-459\ °F}$

1.4 Review Questions p 56

1)

Measurement	Given Unit	Calculation	Required Unit
Grain of salt's mass	415 ug	$415\ ug \times \frac{10^{-6}\ g}{1\ ug} = \mathbf{4.15 \times 10^{-4}\ g}$	g
Earth to the Moon's distance	384.4 Mm	$384.4\ Mm \times \frac{10^6\ m}{1\ Mm} = \mathbf{3.844 \times 10^8\ m}$	m
Mass of a nickel	3.976 g	$3.976\ g \times \frac{1\ ug}{10^{-6}\ g} = \mathbf{3.976 \times 10^6\ ug}$	ug
Volumetric pipette length	4.5 dm	$4.5\ dm \times \frac{10^{-1}\ m}{1\ dm} = \mathbf{0.45\ m}$	m
Smoke particle's mass	$1.05 \cdot 10^{-12}$ g	$1.05 \cdot 10^{-12}\ g \times \frac{1\ ng}{10^{-9}\ g} = \mathbf{1.05 \times 10^{-3}\ ng}$	ng
Distance from UBC to SFU	24.99 km	$24.99\ km \times \frac{10^3\ m}{1\ km} = \mathbf{24\ 990\ m}$	m

2)

Measurement	Given Unit	Calculation	Required Unit
Energy to heat a grande latte to 65°C	83.60 kJ	$83.60\ \text{kJ} \times \frac{10^3\ \text{J}}{1\ \text{kJ}} \times \frac{1\ \text{MJ}}{10^6\ \text{J}} = \mathbf{0.08360\ MJ}$	MJ
Mass of a college chemistry text	2.54 kg	$2.54\ \text{kg} \times \frac{10^3\ \text{g}}{1\ \text{kg}} \times \frac{1\ \text{cg}}{10^{-2}\ \text{g}} = \mathbf{2.54 \times 10^5\ cg}$	cg
Average light bulb wattage	600.0 dW	$600.0\ \text{dW} \times \frac{10^{-1}\ \text{W}}{1\ \text{dW}} \times \frac{1\ \text{nW}}{10^{-9}\ \text{W}} = \mathbf{6.000 \times 10^{10}\ nW}$	nW
Volume of a can of soda	355 mL	$355\ \text{mL} \times \frac{10^{-3}\ \text{L}}{1\ \text{mL}} \times \frac{1\ \text{cL}}{10^{-2}\ \text{L}} = \mathbf{35.5\ cL}$	cL
Average time to send one text message	185 das	$185\ \text{das} \times \frac{10^1\ \text{s}}{1\ \text{das}} \times \frac{1\ \text{ms}}{10^{-3}\ \text{s}} = \mathbf{1.85 \times 10^6\ ms}$	ms
Distance from Prince George to Trail	987 km	$987\ \text{km} \times \frac{10^3\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{dm}}{10^{-1}\ \text{m}} = \mathbf{9.87 \times 10^6\ dm}$	dm

3)

$$\frac{14.25\ \text{km}}{1\ \text{L}} \times \frac{10^3\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{cm}}{10^{-2}\ \text{m}} \times \frac{1\ \text{in}}{2.54\ \text{cm}} \times \frac{1\ \text{ft}}{12\ \text{in}} \times \frac{1\ \text{mi}}{5280\ \text{ft}} \times \frac{4.546\ \text{L}}{1\ \text{gal}} = \mathbf{40.25\ mi/gal}$$

4) $\frac{110\ \text{km}}{1\ \text{h}} \times \frac{10^3\ \text{m}}{1\ \text{km}} \times \frac{1\ \text{h}}{60\ \text{min}} \times \frac{1\ \text{min}}{60\ \text{s}} = \mathbf{31\ m/s}$

5) $\frac{16.7\ \text{g}}{1\ \text{mL}} \times \frac{1\ \text{kg}}{10^3\ \text{g}} \times \frac{2.21\ \text{lb}}{1.00\ \text{kg}} \times \frac{1\ \text{mL}}{10^{-3}\ \text{L}} = \mathbf{36.9\ lb/L}$

6) $\frac{5.47 \cdot 10^2\ \text{kWh}}{1\ \text{year}} \times \frac{1\ \text{year}}{365\ \text{days}} \times \frac{1\ \text{GJ}}{277.8\ \text{kWh}} = \mathbf{0.00539\ GJ/day}$

7) $\frac{22.68\ \text{kg}}{1\ \text{dm}^3} \times \frac{10^3\ \text{g}}{1\ \text{kg}} \times \frac{(1\ \text{dm})^3}{(10^{-1}\ \text{m})^3} \times \frac{(10^{-2}\ \text{m})^3}{(1\ \text{cm})^3} = \mathbf{22.68\ g/cm^3}$

8) $1.00\ \text{L} \times \frac{1\ \text{mL}}{10^{-3}\ \text{L}} \times \frac{13.6\ \text{g}}{1\ \text{mL}} \times \frac{1\ \text{kg}}{10^3\ \text{g}} = \mathbf{13.6\ kg}$

9) $120\ \text{dL} \times \frac{10^{-1}\ \text{L}}{1\ \text{dL}} \times \frac{14.25\ \text{km}}{1\ \text{L}} \times \frac{10^3\ \text{m}}{1\ \text{km}} = \mathbf{170\ 000\ m}$

10) $6.00\ \text{g} \times \frac{1\ \text{cm}^3}{10.5\ \text{g}} \times \frac{1\ \text{mL}}{1\ \text{cm}^3} = \mathbf{0.571\ mL}$

11) $2.3\ \text{kg} \times \frac{10^3\ \text{g}}{1\ \text{kg}} \times \frac{1\ \text{lb}}{454\ \text{g}} \times \frac{1\ \text{gal}}{8.34\ \text{lb}} \times \frac{4.546\ \text{L}}{1\ \text{gal}} \times \frac{1\ \text{mL}}{10^{-3}\ \text{L}} = \mathbf{2\ 800\ mL}$

12) 4 Pitt Bulls $\times \frac{3 \text{ Collies}}{1 \text{ Pitt Bull}} \times \frac{5 \text{ Poodles}}{2 \text{ Collies}} \times \frac{7 \text{ Dobermans}}{3 \text{ Poodles}} \times \frac{9 \text{ German}}{1 \text{ Doberman}} =$

630 German sheep dogs

13) 2 Calico $\times \frac{5 \text{ Siamese}}{1 \text{ Calico}} \times \frac{7 \text{ Persians}}{2 \text{ Siamese}} \times \frac{8 \text{ Tabbies}}{3 \text{ Persians}} \times \frac{6 \text{ Heinz}}{1 \text{ Tabby}} =$ **560** Heinz Fifty-Sevens

14) $325 \text{ in}^3 \times \frac{(2.54 \text{ cm})^3}{(1 \text{ in})^3} \times \frac{(10^{-2} \text{ m})^3}{(1 \text{ cm})^3} \times \frac{(1 \text{ dm})^3}{(10^{-1} \text{ m})^3} \times \frac{1 \text{ L}}{1 \text{ dm}^3} =$ **5.33 L**

15) $\frac{14.7 \text{ lb}}{1 \text{ in}^2} \times \frac{454 \text{ g}}{1.00 \text{ lb}} \times \frac{1 \text{ kg}}{10^3 \text{ g}} \times \frac{(1 \text{ in})^2}{(2.54 \text{ cm})^2} =$ **1.03 kg/cm^2**

16) $\frac{400. \text{ ft}^2}{1 \text{ gal}} \times \frac{(12 \text{ in})^2}{(1 \text{ ft})^2} \times \frac{(2.54 \text{ cm})^2}{(1 \text{ in})^2} \times \frac{(10^{-2} \text{ m})^2}{(1 \text{ cm})^2} \times \frac{1 \text{ gal}}{4.546 \text{ L}} =$ **8.17 m^2/L**

17) $(451 \text{ °F} - 32 \text{ °F}) \times \frac{1 \text{ °C}}{1.8 \text{ °F}} =$ **233 °C**

18) $((1.9 \text{ K} - 273 \text{ K}) \times \frac{1 \text{ °C}}{1 \text{ K}} \times \frac{1.8 \text{ °F}}{1 \text{ °C}}) + 32 \text{ °F} =$ **-456.0 °F**

19) $(-89 \text{ °C} \times \frac{1.8 \text{ °F}}{1 \text{ °C}}) + 32 \text{ °F} =$ **-128 °F**

20) $(9.0 \text{ °C} \times \frac{1.8 \text{ °F}}{1 \text{ °C}}) + 32 \text{ °F} =$ **48.2 °F**