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) $(8.0 \times 10^3) \times (1.5 \times 10^6) = (8.0 \times 1.5) \times 10^{(3+6)} = 12 \times 10^9 \Rightarrow \boxed{1.2 \times 10^{10}}$
   b) $(1.5 \times 10^4) \div (2.0 \times 10^2) = (1.5 \div 2.0) \times 10^{(4-2)} \Rightarrow 0.75 \times 10^2 \Rightarrow \boxed{7.5 \times 10} \; (75)$
   c) $(3.5 \times 10^{-2}) \times (6.0 \times 10^5) = (3.5 \times 6.0) \times 10^{(-2+5)} \Rightarrow 21 \times 10^3 \Rightarrow \boxed{2.1 \times 10^4}$
   d) $(2.6 \times 10^7) \div (6.5 \times 10^{-4}) =$
   $\Rightarrow (2.6 \div 6.5) \times 10^{(7+4)} \Rightarrow 0.4 \times 10^{11} \Rightarrow \boxed{4.0 \times 10^{10}}$

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) $(3.5 \times 10^4) \times (3.0 \times 10^5) = (3.5 \times 3.0) \times 10^{4+5} \Rightarrow 10.5 \times 10^9 \Rightarrow \boxed{1.05 \times 10^{10} \; (1.1 \times 10^{10})}$
   b) $(7.0 \times 10^6) \div (1.75 \times 10^2) = (7.0 \div 1.75) \times 10^{(6-2)} \Rightarrow \boxed{4.0 \times 10^4}$
   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) $(2.5 \times 8.5) \times 10^{(-3-5)} \Rightarrow 21.25 \times 10^{-8} \Rightarrow \boxed{2.13 \times 10^{-7} \; (2.1 \times 10^{-7})}$

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

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

$\underline{-2.12 \ \times 10^4}$

403400
$\underline{- \ 21200}$
382200 → (3.822×10^5)

b. 3.114×10^{-6}

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

0.000003114
0.00002301
$\underline{0.000026124}$ → 2.612×10^{-5}

c. 26.022×10^2

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

2602.2
$\underline{+ \quad 0.704}$
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

$\underline{-1.11 \ \times 10^7}$

2.00×10^8

b. 9.332×10^{-3}

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

0.009332
$\underline{+0.0006905}$
0.0100223 → 1.0022×10^{-3}

c. 68.166×10^2

$\underline{+ \qquad \times 10^{-1}}$

6816.6
$\underline{+ \quad 0.1}$
6816.7 → 6.8167×10^3

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. $(10^{-4})^3$

$10^{-4 \times 3} \to 10^{-12}$
→ 1×10^{-12}

b. $(4 \times 10^5)^3$

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

c. $(7 \times 10^9)^2$

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

d. $(10^2)^2 \times (2 \times 10)^3$

$10^4 \times 2^3 \times 10^3$
→ 8×10^7

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. $(6.4 \times 10^{-6} + 2.0 \times 10^{-7}) \div (2 \times 10^6 + 3.1 \times 10^7)$

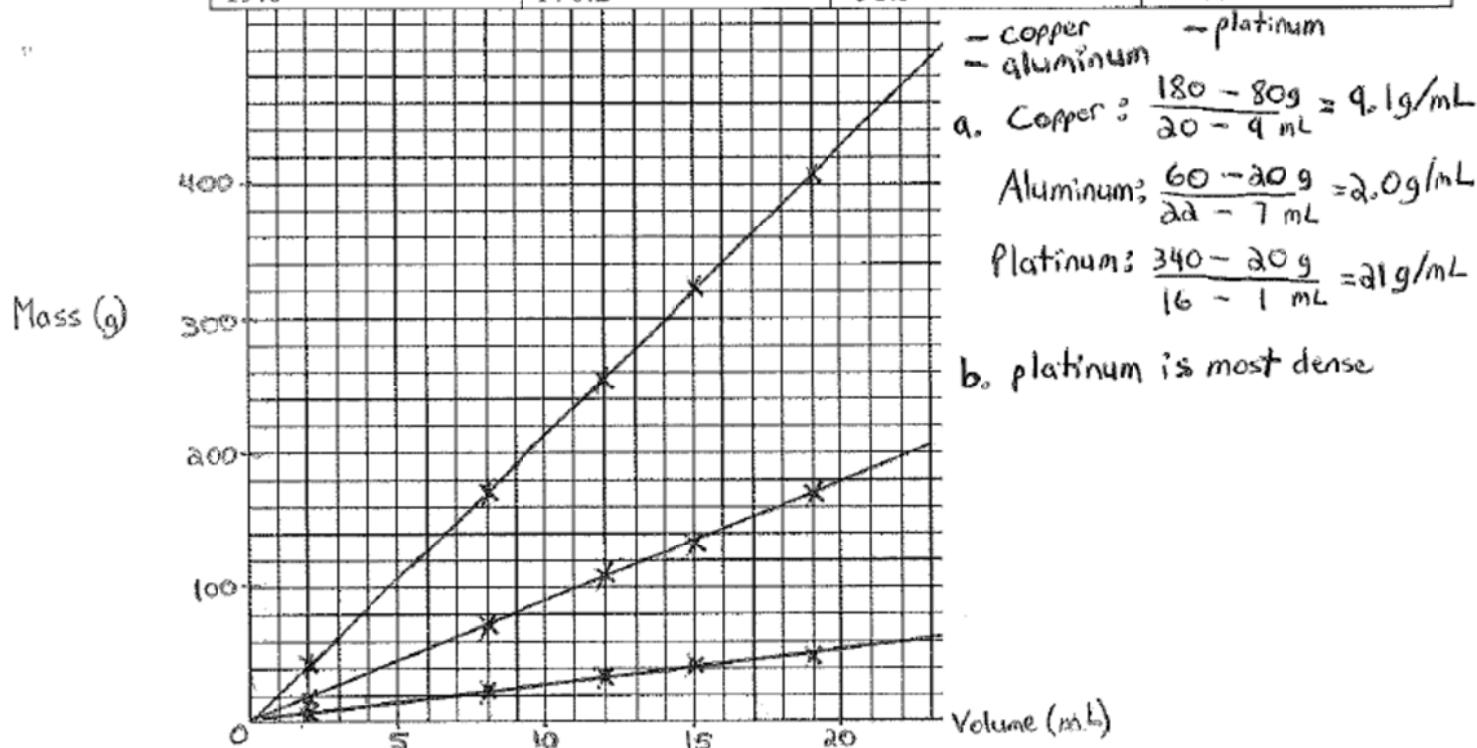$\dfrac{6.6 \times 10^{-6}}{3.3 \times 10^7} = 2.0 \times 10^{-13}$

b. $\dfrac{3.4 \times 10^{-17} \times 1.5 \times 10^4}{1.5 \times 10^{-4}}$

$\dfrac{5.1 \times 10^{-13}}{1.5 \times 10^{-4}} = 3.4 \times 10^{-9}$

c. $(2 \times 10^3)^3 \times [(6.84 \times 10^3) \div (3.42 \times 10^3)]$

$8 \times 10^9 \times 2 = 1.6 \times 10^{10}$

d. $\dfrac{(3 \times 10^2)^3 + (4 \times 10^3)^2}{1 \times 10^4}$

$\dfrac{7 \times 10^6}{1 \times 10^4} = 7 \times 10^2$

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

Mass (g)

— copper   — platinum
— aluminum

a. Copper: $\frac{180 - 80 \, g}{20 - 4 \, mL} = 9.1 \, g/mL$

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

Volume (mL)

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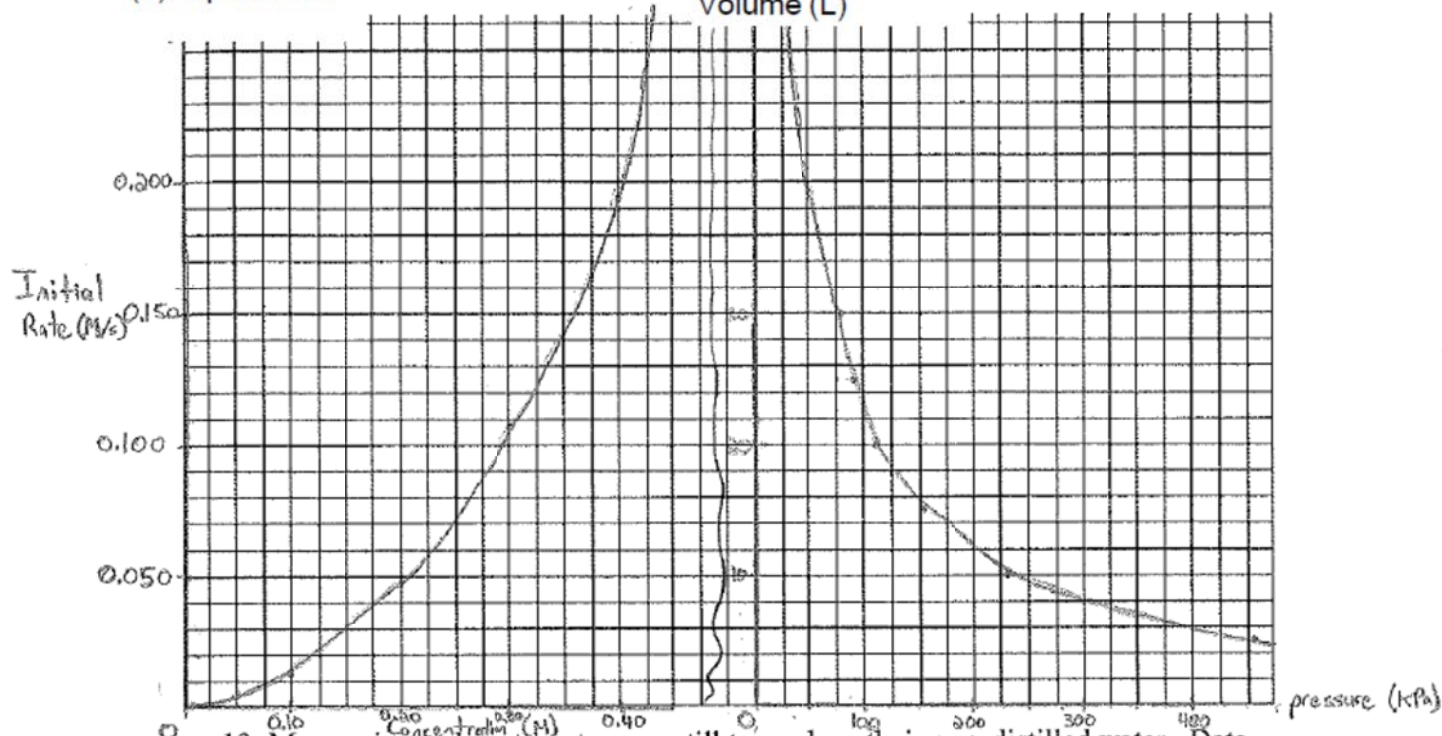b) The constant represents each metal's density. Which metal is most dense?

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
Volume (L)

Initial
Rate (M/s)

0.200

0.150

0.100

0.050

0.10   0.20   0.30   0.40   Concentration (M)

pressure (kPa)

100   200   300   400

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 = 2.0 t
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?

$$12.5 = 2.0 t$$
$$t = 6.25 h$$

Graph: Volume of Distilled Water (L) vs. Distillation time (h)

y-axis: Volume of Distilled Water (L) — marked 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0

x-axis: Distillation time (h) — marked 1.0, 2.0, 3.0, 4.0, 5.0

$$\text{slope} = \frac{\Delta V}{\Delta t}$$

$$= \frac{8.2 - 1.0 \text{ L}}{4.1 - 0.5 \text{ h}}$$

$$= 2.0 \text{ L/h}$$