CH301—Worksheet 0 ANSWER KEY—Doing Math Without a Calculator

(Hint: It is amazing how much math you can do with a pencil and paper, like long division!!!!, or, more important, by estimating and approximating. For example, watch an experimental scientist at work using just his brain:

How many hydrogen atoms are in a can of coke? (Do it in your head.)

Answer: 3 x 10^{25} atoms of hydrogen in a can of coke

Solution: There are 455 ml in a can of coke, which is about 455 grams since coke is mostly water and water has a density of 1 g/ml. 455 g is about 500g. Water weighs about 18 g/mole which is about 20, so there are 500/20 = about 25 moles of water in a can of coke. Which means there are 50 moles of hydrogen in a can of coke (because water has 2 hydrogens). But Avagadro's number is about 6 x 10^{23}, so there are 300 x 10^{23} or 3 x 10^{25} atoms of hydrogen in a can of coke.

Pretty amazing huh? Especially since this is really close to the answer you would get with a calculator, and since both the answer you would get with a calculator and in your head are WRONG anyway given the approximations and error in the data given you in the first place.

Deep thought: If you appreciate what I just wrote, you are meant to be an experimental scientist—it a far more profound argument than the simple notion about the value of estimations, it is an appreciation that ALL DATA is uncertain, so why the heck are you using 18 places on your calculator to solve for a wrong answer?

10 Problems to do yourself without a calculator. All of this should be review.

1. Convert the following numbers to/from scientific notation
a. 10,045,200 = $1.00452\text{x}10^{7}$
b. 0.00703005 = $7.03005\text{x}10^{-3}$
c. $6.022\text{x}10^{23}$ = 602,200,000,000,000,000,000,000
d. $1.055\text{x}10^{-34}$ = 0.000 000 000 000 000 000 000 000 000 000 000 105 5

2. Complete the following exponent identities/rules
a. 10^{m} x 10^{n} = 10^{m+n}
b. $(10^{m})^{n}$ = 10^{mxn}
c. $[(10^{m})^{n}]^{0}$ = 1

3. Solve the following
a. $(6\text{x}10^{4})(7\text{x}10^{5})$ = $4.2\text{x}10^{10}$
b. $10^{5} \div 5\text{x}10^{3}$ = $2\text{x}10^{1}$
c. $10^{5} \div 2.5\text{x}10^{-2}$ = $4\text{x}10^{6}$
d. $(5\text{x}10^{-6})(9\text{x}10^{5})$ = 4.5

4. Round the following numbers to the specified number of significant figures.
a. 455, 1 - 500
b. 1.59995627, 5 - 1.6000
c. 18.01528, 1 - 20
d. 978.23, 4 - 978.2
e. 1.04, 1 - 1

5. Estimate the number of hydrogen atoms in a 16 oz bottle of coke. (Hint, you'll need to know the volume so google it or go look at a bottle of coke.)
A 16 oz bottle of coke is 473 mL. Coke is mostly water, so we'll call that 473 mL of water. We'll round that to 500 mL, and since water is about 1g/mL, that's 500 g of water. The molecular weight of water is 18 g/mol, and we'll round that to 20. 500 g of water divided by 20 g/mol, let's see, that's about 25 mols of water. Each water molecule has two hydrogen atoms, so that is 50 mols of hydrogen atoms. Avogadro's number is about $6x10^{23}$. So, that is about $3x10^{25}$ hydrogen atoms in a bottle of coke. Let's review the thought process:
The volume: 473 mL of coke □ 473 mL of water □ 500 mL of water
The mass: ~500 mL x ~1 g/mL □ 500 g of water
The moles: ~500 g ÷ ~20 g/mol □ 25 mols of water ---> ~25 mols of H_20 = ~50 mols of H
The atoms: ~50 mols of H x ~$6x10^{23}$ □ $3x10^{25}$ H atoms

6. Do the following without a calculator.
a. 3.1416 ÷ 2 = 1.5708
b. 985.6 ÷ 1.4 = 704
c. 1123.2 ÷ 3.6 = 312
d. 763236 ÷ 6 = 127206

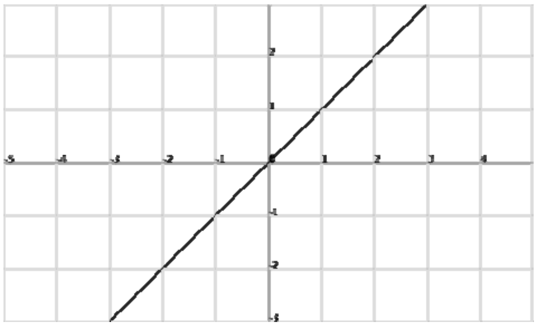
7. Do with following without a calculator.
a. 23 x 91 = 2093
b. 6.022 x 11 = 66.242
c. 18 x 55 = 990
d. 3.14*270 = 847.8

8. Simply (write as a number or a single log with no coefficient) the following logarithms
a. $\log_n(n^{15})$ = 15
b. ln(e) = 1
c. ln(x) + ln(y) = ln(xy)
d. n $\log_b(x)$ = $\log_b(x^n)$

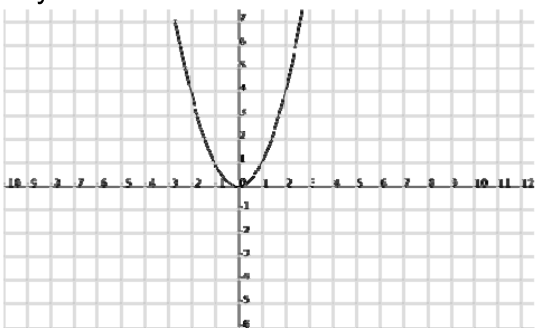
9. Estimate the number of helium atoms in the Sun, assume that the mass of the Sun is 2.0×10^{30} kg, the Sun is completely composed of hydrogen and helium, and that the *mole* ratio of hydrogen to helium is 12:1.
We must first find the mass percent of helium in order to determine the mass of helium that is present in the Sun. Since helium is approximately 4 times as massive as hydrogen, then the mass ratio of hydrogen to helium is approximately 3:1. Thus, the mass of helium in the sun is approximately $1/(3+1) * 2.0 \times 10^{30}$ kg = 5×10^{29} kg = 5×10^{32} g. Since helium has a molecular (atomic) weight of approximately 4 g/mol, then the number of moles of helium present is approximately 1.25×10^{32} mol. Multiplying this result by Avogadro's number (6×10^{23}) gives 7.5×10^{55} atoms of helium.
Review of thought process:
When given a total mass and a mole ratio, it is necessary to compute the mass ratio from the mole ratio. From the mass ratio, the mass percent can be constructed.
From the mass percent it is possible to find the mass of one component.
The number of moles present can be found by dividing the mass by the atomic weight.
The number of atoms can be found by multiplying Avogadro's number by the number of moles.

10. Sketch the following functions (a pet peeve of a particular thermodynamics professor). Include both negative and positive values for x.

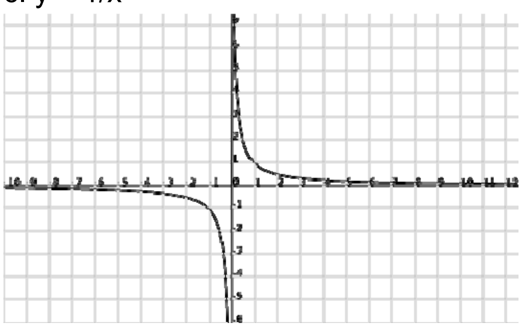
a. $y = x$



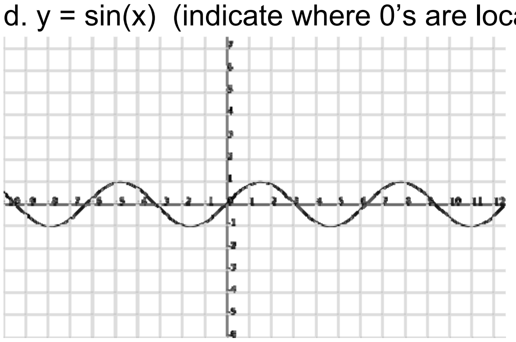
b. $y = x^2$



c. $y = 1/x$



d. $y = \sin(x)$ (indicate where 0's are located)



e. $y = \sin^2(x)$