CHEM& 161 PLACEMENT EXAM – PREPARATION PROBLEMS

CHEM& 161 is a course that requires prerequisite knowledge in math and chemistry. The purpose of the placement exam is to ensure that you are entering at a level that will allow you to succeed in CHEM& 161 and beyond.

You will be provided a periodic table (similar to the one on the last page). You are permitted to use a calculator, but you must bring one to use. No cell phones will be allowed.

These problems reflect the nature of the exam in terms of content, but the exam will be multiple choice (whereas the problems below are not). The level of difficulty of these problems are similar to those on the placement exam.

For the purposes of practicing, do this exam twice. You should first use it as a guide for studying and reviewing material. Show all of your work and check it using the answer key. Then wait a sufficient period (so as not to remember the answers) and do these problems in "exam mode" – no help, 60 minutes timed, no interruptions. Grade your exam and see where you need to review.

1. Calculate: $\dfrac{2.5\times10^{-2}}{4.8\times10^{-7}}$

2. Without a calculator, determine: log(1000) = ?

   Convert 62 μm into Mm and express as scientific notation.

3. $x^2 - 3.4x + 0.0038 = 0$. Solve for x.

4. Solve for $\mathbf{n_1}$ given the following expression: $\dfrac{x_1 y_1}{n_1 m_1} = \dfrac{x_2 y_2}{n_2 m_2}$

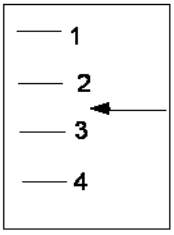
5. Convert 16.5 miles per gallon into km per liter.
   1km = 0.621 miles
   1 gallon = 3.785 liters

6. Convert 2.15×10^{-4} L into rundlets.
   1 cm^3 = 1.47×10^{-5} rundlets.

7. Given the following data points, sketch a graph that presents the data. Draw a best fit line and determine the slope and y-intercept for the graph. Then write the equation of the line.

x	y
1	4
2	7
3	10

8. Report the following measurement with the appropriate number of significant figures.



9. I have 3.4 moles of $Mg(CN)_2$. How many total moles of carbon atoms do I have?

10. Balance the following reaction:
$C_8H_{18}(l)$ + $O_2(g)$ ---> $CO_2(g)$ + $H_2O(l)$

11. The density of gold is 19.1 g/cm^3. What is the mass of 16 liters of solid gold?

12. How many electrons are found in one mole of the ion F^- ?

13. How many protons are in the radioisotope Iodine-131?

14. Name me: **SiO_2**.

15. What is the ground state electron configuration of sodium?

16. What is the volume of a sphere, with a radius of 43 pm?

17. How much, in total, do 15 atoms of iron weigh, in grams?

18. I have 14 grams of solid magnesium chloride. How many moles of chlorine atoms are contained in this solid?

19. 14.3 grams of natural gas burns in the presence of excess oxygen. How much $CO_2(g)$ will be produced as a result of this burning? *The balanced chemical equation is given below:*

$$CH_4(g) + \mathbf{2}O_2(g) \text{ ---> } CO_2(g) + \mathbf{2}H_2O(l)$$

20. A substance X has a mass of 2.50 pounds and a volume of 3000. mm^3. What is its density in g/cm^3? (453.6 grams = 1 lb)

21. What is the volume (mL) of ethanol required for a mass of 7.55×10^{-1} kg? The density of ethanol is 0.789 g/mL at 25°C.

22. What is the number of (a) protons, (b) neutrons, and (c) electrons in $^{65}_{30}Zn^{2+}$?

23. How many molecules of water are present in 1 pound (453.6 g) of water?

24. How many moles of methane (CH_4) are required to produce 18 moles of H_2O based on the following balanced chemical equation for its combustion?

$$CH_4(g) + \mathbf{2}O_2(g) \text{ ---> } CO_2(g) + \mathbf{2}H_2O(l)$$

25. What is the correct chemical formula for an ionic compound that contains only calcium ions (Ca^{2+}) and nitrate ions (NO_3^-)?

26. How many milligrams is 4×10^{-6} kg?

27. A Toyota Prius has a fuel tank that can hold about 11.9 gallons. How many liters is this? (1 liter = 0.264 gallons)

28. The temperature of a nice warm day in Europe is 30°C. What is this temperature in °F?

29. What is the symbol for an ion with 8 protons, 10 neutrons, and 10 electrons? Use A/Z notation (see #23).

30. An unknown isotope, X, has the symbol $^{37}_{17}X$. What element is "X"?

31. What is the chemical formula for lead (II) phosphate?

32. If I have 4.567 grams of Na_2CO_3, how many moles of Na_2CO_3 is this?

33. Balance the following chemical equation:

$$AgNO_3\ (aq)\ +\ CuCl_2\ (aq)\ \text{--->}\ Cu(NO_3)_2\ (aq)\ +\ AgCl\ (s)$$

34. What is the average atomic mass of two hypothetical isotopes with the following isotopic masses and natural abundances: isotope 1 (45.967 amu, 36.34%) and isotope 2 (48.976 amu, 63.66%)

35. Draw an acceptable Lewis structure for the following molecular (covalent) compounds, including all lone pairs.

    (a) water, H_2O (b) ammonia , NH_3 (c) carbon dioxide, CO_2 (d) cyanide ion, CN^{-1}

36. How many moles of nitric acid (HNO_3) is obtained from 25.00 mL of a 3.00 M solution of HNO_3?

37. Convert 4.5×10^3 in^3 into cm^3. (1.00 in = 2.54 cm)

38. You have a cylinder with a volume of 750 mL that is 30. cm in height. What is the diameter of its base in cm? (1 mL = 1 cm^3)

39. A medical doctor gives the order to administer dopamine at a rate of 3.0 mcg / kg·min (mcg is the abbreviation for microgram in a medical context). The dopamine is supplied as a mixture of 400. mg dopamine in 250. mL of a dopamine solution. The patient weighs 73 kg. What is the infusion rate of the dopamine into her body (in units of mL/hour)?

Periodic Table of the Elements

	1A	2A	3B	4B	5B	6B	7B	←	8B	→	1B	2B	3A	4A	5A	6A	7A	8A
1	1 H 1.00794																	2 He 4.00260
2	3 Li 6.941	4 Be 9.01218											5 B 10.811	6 C 12.01115	7 N 14.0067	8 O 15.9994	9 F 18.99840	10 Ne 20.1797
3	11 Na 22.98977	12 Mg 24.305											13 Al 26.9815	14 Si 28.0855	15 P 30.97376	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
4	19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.922	34 Se 78.96	35 Br 79.909	36 Kr 83.80
5	37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.9055	46 Pd 106.42	47 Ag 107.868	48 Cd 112.41	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30
6	55 Cs 132.9054	56 Ba 137.33	57 La* 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 B i 208.980	84 Po (210)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	89 Ac** (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Und (269)	111 Une (272)	112 Unn (277)						

*Lanthanides	58 Ce 140.12	59 Pr 140.907	60 Nd 144.24	61 Pm (147)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.924	66 Dy 162.5	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97
**Actinides	90 Th 232.038	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (254)	103 Lw (257)

Key

1. Calculate: $\frac{2.5\times10^{-2}}{4.8\times10^{-7}} = 5.2\times10^{4}$

2. Without a calculator, determine: $\log(1000)$ → $10^{y}=1000$, $y=3$

3. Convert 62 μm into Mm and express as scientific notation. $62\,\mu m \times \frac{1\,m}{1\times10^{6}\,\mu m} \times \frac{1\,Mm}{1\times10^{6}\,m} = 6.2\times10^{-11}\,Mm$

4. $x^2 - 3.4x + 0.0038 = 0$. Solve for x. $a=1$, $b=-3.4$, $c=0.0038$

$\frac{-b\pm\sqrt{b^2-4ac}}{2a}$ $\frac{3.4\pm\sqrt{(3.4)^2-4(1)(0.0038)}}{2(1)} = \frac{3.4\pm3.3977}{2}$

4. $x_+ = 3.3989$, $x_- = 0.001118$

5. Solve for n_1 given the following expression: $\frac{x_1y_1}{n_1m_1} = \frac{x_2y_2}{n_2m_2}$

$n_1 = \frac{x_1y_1n_2m_2}{x_2y_2m_1}$

6. Convert 16.5 miles per gallon into km per liter.

1km = 0.621 miles

1 gallon = 3.785 liters

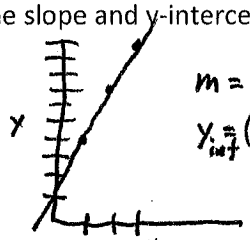
$\frac{16.5\,miles}{1\,gallon} \rightarrow \frac{km}{\ell}$ $\frac{16.5\,miles}{1\,gallon} \times \frac{1\,km}{0.621\,miles} \times \frac{1\,gallons}{3.785\,L} = \frac{7.02\,km}{L}$

7. Convert 2.15×10^{-4} L into rundlets. $L \rightarrow ml \rightarrow cm^3 \rightarrow$ rundlets

1 $cm^3 = 1.47\times10^{-5}$ rundlets. $2.15\times10^{-4}\,L \times \frac{1000\,ml}{1\,L} \times \frac{1\,cm^3}{1\,ml} \times \frac{1.47\times10^{-5}\,rundlets}{1\,cm^3} = 3.16\times10^{-6}\,rundlets$

8. Given the following data points, sketch a graph that presents the data. Draw a best fit line and determine the slope and y-intercept for the graph. Then write the equation of the line.

x	y
1	4
2	7
3	10

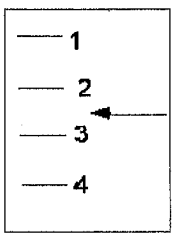


$m = \frac{7-4}{2-1} = 3$

$y_{int} = (0, 1)$

$y = 3x + 1$

9. Report the following measurement with the appropriate number of significant figures.



2.5 units ... ml?

10. I have 3.4 moles of $Mg(CN)_2$. How many total moles of carbon atoms do I have?

6.8 moles C

11. Balance the following reaction:

2 $C_8H_{18}(l)$ + 25 $O_2(g)$ ---> 16 $CO_2(g)$ + 18 $H_2O(l)$

KEY

$D = \frac{m}{V}$ $16\,L = 16000\,ml = 16000\,cm^3$ $19.1\,g/cm^3 = \frac{x}{16000\,cm^3}$ $x = 3.1 \times 10^5\,g$

12. The density of gold is 19.1 g/cm^3. What is the mass of 16 liters of solid gold?

13. How many electrons are found in one mole of the ion F^-? F^- = 10 electrons each × 1 mol = 10 mol E$^-$

$10\,mol\,E^- \times \frac{6.022 \times 10^{23}\ things}{1\,mol} = 6.022 \times 10^{24}\ elec.$

14. How many protons are in the radioisotope Iodine-131?

Iodine = 53 protons, always

15. Name me: SiO_2.

Silican dioxide

16. What is the ground state electron configuration of sodium? $1s^2 2s^2 2p^6 3s^1$

17. What is the volume of a sphere, with a radius of 43 pm?

$V_O = \frac{4}{3}\pi r^3 = 3.3 \times 10^5\,pm^3$

18. How much, in total, do 15 atoms of iron weigh, in grams? atoms → mol → g

$15\,atoms \times \frac{1\,mol}{6.022 \times 10^{23}\,atoms} \times \frac{55.859\,g\,Fe}{1\,mol} \simeq 1.4 \times 10^{-21}\,g$

4 sig. fig. is "15" is considered exact

19. I have 14 grams of solid magnesium chloride. How many moles of chlorine atoms are contained in this solid? $14\,g\,NaCl \times \frac{1\,mol\,NaCl}{58.44\,g} \times \frac{1\,mol\,Cl^-}{1\,mol\,NaCl} = 0.24\,mol\,Cl^-$

20. 14.3 grams of natural gas burns in the presence of excess oxygen. How much $CO_2(g)$ will be produced as a result of this burning? *The balanced chemical equation is given below:*

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

14.3 g — excess — 39.2 g

0.891 mol → 0.891 mol

$14.3\,g \times \frac{1\,mol\,CH_4}{16.04\,g} = 0.891\,mol\,CH_4 \times \frac{1\,mol\,CO_2}{1\,mol\,CH_4} = 0.891\,mol\,CO_2$

$0.891\,mol\,CO_2 \times \frac{44.01\,g\,CO_2}{1\,mol} = 39.2\,g\,CO_2$

Key

21. A substance X has a mass of 2.50 pounds and a volume of 3000. mm^3. What is its density in g/cm^3? (453.6 grams = 1 lb)

① $2.5\,lb \times \left(\frac{453.6\,g}{1\,lb}\right) = 1134\,g$ (3 sig figs)

② $3000.\,mm^3 \times \left(\frac{1\,cm^3}{10^3\,mm^3}\right) = 3.000\,cm^3$

③ $d = \frac{1134\,g}{3.000} = \boxed{378\,g/cm^3}$

22. What is the volume (mL) of ethanol required for a mass of 7.55×10^{-1} kg? The density of ethanol is 0.789 g/mL at 25°C.

→ 755 g

$d = \frac{m}{V}$ so $V = \frac{m}{d} = \frac{755\,g}{0.789\,g/mL} = \boxed{957\,mL}$

23. What is the number of (a) protons, (b) neutrons, and (c) electrons in $^{65}_{30}Zn^{2+}$?

p+n → 65 ; # p → 30 ; Zn^{2+} ; ← # p − charge = # e

(a) 30 (c) 28
(b) 35

24. How many molecules of water are present in 1 pound (453.6 g) of water?

$453.6\,g\ H_2O \times \left(\frac{1\ mole\ H_2O}{18.02\,g\ H_2O}\right) \times \left(\frac{6.022 \times 10^{23}\ molecules}{1\ mole\ H_2O}\right) = \boxed{1.516 \times 10^{25}\ molecules}$ (or 2×10^{25})

25. How many moles of methane (CH_4) are required to produce 18 moles of H_2O based on the following balanced chemical equation for its combustion?

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

$18\ moles\ H_2O \times \left(\frac{1\ mole\ CH_4}{2\ moles\ H_2O}\right) = \boxed{9\ moles\ CH_4}$

26. What is the correct chemical formula for an ionic compound that contains only calcium ions (Ca^{2+}) and nitrate ions (NO_3^-)?

1:2 ratio to balance ⊕ and ⊖ { Ca^{2+} $(NO_3)^{-1}$ } { $(NO_3)^{-1}$ } → $\boxed{Ca(NO_3)_2}$

27. How many milligrams is 4×10^{-6} kg?

$4. \times 10^{-6}\,kg \times \left(\frac{1000\,g}{1\,kg}\right) \times \left(\frac{1000\,mg}{1\,g}\right) = \boxed{4\,mg}$

28. A Toyota Prius has a fuel tank that can hold about 11.9 gallons. How many liters is this? (1 liter = 0.264 gallons)

$11.9\,gal \times \left(\frac{1\ liter}{0.264\,gal}\right) = \boxed{45.1\ liters}$

Key

29. The temperature of a nice warm day in Europe is 30°C. What is this temperature in °F?

$°F = \frac{9}{5}°C + 32 = \frac{9}{5}(30°C) + 32 = \boxed{86°F}$

30. What is the symbol for an ion with 8 protons, 10 neutrons, and 10 electrons? Use A/Z notation (see #23).

$\boxed{{}^{18}_{8}O^{2-}}$

31. An unknown isotope, X, has the symbol ${}^{37}_{17}X$. What element is "X"?

atomic # = # of protons

$\boxed{{}^{17}Cl}$ (chlorine)

32. What is the chemical formula for lead (II) phosphate?

Pb^{2+} PO_4^{3-} $\longrightarrow$ $\boxed{Pb_3(PO_4)_2}$

33. If I have 4.567 grams of Na_2CO_3, how many moles of Na_2CO_3 is this?

$4.567\,g\ Na_2CO_3 \times \left(\frac{1\ mole}{105.99\,g\ Na_2CO_3}\right) = \boxed{0.04309\ moles\ Na_2CO_3}$

34. Balance the following chemical equation:

$\underline{2}\ AgNO_3\ (aq) + CuCl_2\ (aq) \dashrightarrow Cu(NO_3)_2\ (aq) + \underline{2}AgCl\ (s)$

35. What is the average atomic mass of two hypothetical isotopes with the following isotopic masses and natural abundances: isotope 1 (45.967 amu, 36.34%) and isotope 2 (48.976 amu, 63.66%)

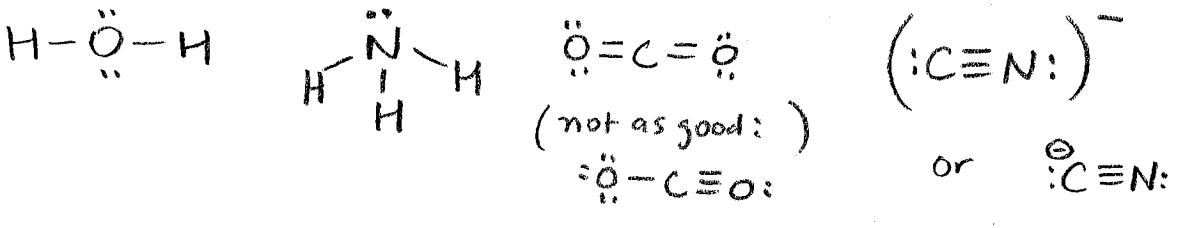
$0.3634\,(45.967\,amu) + 0.6366\,(48.976\,amu)$

$= (16.70 + 31.178)\,amu$

$= \boxed{47.88\ amu}$

36. Draw an acceptable Lewis structure for the following molecular (covalent) compounds, including all lone pairs.

(a) water, H_2O (b) ammonia, NH_3 (c) carbon dioxide, CO_2 (d) cyanide ion, CN^{-1}



means 3.00 moles / 1 L

1 key

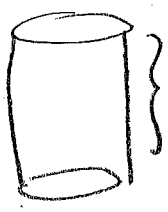
37. How many moles of nitric acid is obtained from 25.00 mL of 3.00 M HNO_3?

$$(0.02500\ \text{L}) \times \left(\frac{3.00\ \text{moles}}{1\ \text{L}}\right) = \boxed{0.0750\ \text{moles}\ HNO_3}$$

38. Convert $4.5 \times 10^3\ \text{in}^3$ into cm^3. (2.54 cm = 1.00 in)

$$4.5 \times 10^3\ \text{in}^3 \times \left(\frac{2.54^3\ \text{cm}^3}{1^3\ \text{in}^3}\right) = \boxed{7.4 \times 10^4\ \text{cm}^3}$$

39. You have a cylinder with a volume of 750 mL that is 30. cm in height. What is the diameter of its base in cm?



$V = A \cdot h$

↑ Volume ↑ area ↑ height

$A = V/h = 750\ \text{cm}^3 / 30.\ \text{cm} = 25\ \text{cm}^2$

$A = \pi r^2$

$r = 2.82$

$d = 2r = \boxed{5.6\ \text{cm}}$

40. A medical doctor gives the order to administer dopamine at a rate of 3.0 mcg / kg·min (mcg is the abbreviation for microgram in a medical context). The dopamine is supplied as a mixture of 400. mg dopamine in 250. mL of a dopamine solution. The patient weighs 73 kg. What is the infusion rate of the dopamine into her body (in units of mL/hour)?

Want mL/hr

Info:

→ 73kg

→ 400. mg / 250. mL

→ $\frac{3.0\ \text{mcg}}{\text{kg} \cdot \text{min}}$

$$73\ \text{kg}\left(\frac{3.0\ \text{mcg}}{1\ \text{kg}\cdot\text{min}}\right)\left(\frac{1\ \text{mg}}{1000\ \text{mcg}}\right)\left(\frac{250\ \text{mL}}{400\ \text{mg}}\right)\left(\frac{60\ \text{min}}{1\ \text{hr}}\right)$$

$$= \boxed{8.2\ \text{mL/hr}}$$