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: \[
\frac{2.5 \times 10^{-2}}{4.8 \times 10^{-7}}
\]

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 \(n_1\) given the following expression: \[
\frac{x_1 y_1}{n_1 m_1} = \frac{x_2 y_2}{n_2 m_2}
\]

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

6. Convert 2.15x10⁻⁴ L into rundlets.
   - 1 cm³ = 1.47x10⁻⁵ 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.

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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:
    \[ C₈H₁₈(ℓ) + O₂(g) \rightarrow CO₂(g) + H₂O(ℓ) \]

11. The density of gold is 19.1 g/cm³. 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: SiO₂.

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 CO₂(g) will be produced as a result of this burning? The balanced chemical equation is given below:
    \[ CH₄(g) + 2O₂(g) \rightarrow CO₂(g) + 2H₂O(ℓ) \]
20. A substance X has a mass of 2.50 pounds and a volume of 3000 mm³. What is its density in g/cm³? (453.6 grams = 1 lb)

21. What is the volume (mL) of ethanol required for a mass of 7.55x10⁻¹ 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 (CH₄) are required to produce 18 moles of H₂O based on the following balanced chemical equation for its combustion?

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

25. What is the correct chemical formula for an ionic compound that contains only calcium ions (Ca²⁺) and nitrate ions (NO₃⁻)?

26. How many milligrams is 4x10⁻⁶ 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$_2$CO$_3$, how many moles of Na$_2$CO$_3$ is this?

33. Balance the following chemical equation:

\[
\text{AgNO}_3 \text{ (aq)} + \text{CuCl}_2 \text{ (aq)} \rightarrow \text{Cu(NO}_3\text{)}_2 \text{ (aq)} + \text{AgCl (s)}
\]

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$_2$O  (b) ammonia, NH$_3$  (c) carbon dioxide, CO$_2$  (d) cyanide ion, CN$^{-}$

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 $4.5 \times 10^3 \text{ in}^3$ 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

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* *Lanthanides*  
** *Actinides*  

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1. Calculate: \( \frac{2.5 \times 10^{-2}}{4.8 \times 10^{-7}} = 5.2 \times 10^4 \)

2. Without a calculator, determine:
   \[ \log(1000) \]
   \[ 10^y = 1000 \]
   \[ y = 3 \]

3. Convert 62 \( \mu m \) into Mm and express as scientific notation.
   \[ \frac{62 \mu m}{1 \times 10^6 \mu m} = 6.2 \times 10^{-11} \text{ Mm} \]

4. \( x^2 - 3.4x + 0.0038 = 0 \). Solve for \( x \).
   \[ x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \]
   \[ x = \frac{3.4 \pm \sqrt{(3.4)^2 - 4(1)(0.0038)}}{2(1)} \]
   \[ x = 3.3989 \text{ or } x = 0.00119 \]

5. Solve for \( n_1 \) given the following expression:
   \[ n_1 = \frac{x_1y_1}{x_2y_2} \cdot \frac{n_1m_1}{n_2m_2} \]

6. Convert 16.5 miles per gallon into km per liter.
   \[ 1 \text{ km} = 0.621 \text{ miles} \]
   \[ 1 \text{ gallon} = 3.785 \text{ liters} \]

7. Convert 2.15 \( \times 10^{-4} \) L into rundlets.
   \[ 1 \text{ cm}^3 = 1.47 \times 10^5 \text{ rundlets} \]

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.
   \[ x \] \[ y \]
   \[ 1 \] \[ 4 \]
   \[ 2 \] \[ 7 \]
   \[ 3 \] \[ 10 \]
   \[ m = \frac{2 - 4}{2 - 1} = 3 \]
   \[ y = 3x + 1 \]

9. Report the following measurement with the appropriate number of significant figures.
   \[ 2.5 \text{ units} \]

10. I have 3.4 moles of Mg(CN)\(_2\). How many total moles of carbon atoms do I have?
    \[ 6.8 \text{ moles of } C \]

11. Balance the following reaction:
    \[ 2 \text{ C}_6\text{H}_{12}(l) + 25 \text{ O}_2(g) \rightarrow 6 \text{ CO}_2(g) + 18 \text{ H}_2\text{O}(l) \]
12. The density of gold is 19.1 g/cm³. What is the mass of 16 liters of solid gold?

13. How many electrons are found in one mole of the ion F⁻?

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

15. Name me: SiO₂, __silicon dioxide__

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

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

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

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

20. 14.3 grams of natural gas burns in the presence of excess oxygen. How much CO₂(g) will be produced as a result of this burning? _The balanced chemical equation is given below:_

\[ \text{CH}_4(g) + 2\text{O}_2(g) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(l) \]

\[ 14.3 \text{ g} \quad \frac{1 \text{ mol CH}_4}{16.0 \text{ g}} = 0.89 \text{ mol CH}_4 \times \frac{1 \text{ mol CO}_2}{1 \text{ mol CH}_4} = 0.89 \text{ mol CO}_2 \]

\[ 0.89 \text{ mol CO}_2 \times \frac{44.01 \text{ g CO}_2}{1 \text{ mol}} = 39.2 \text{ g CO}_2 \]
21. A substance X has a mass of 2.5 pounds and a volume of 3000 mm³. What is its density in g/cm³? (453.6 grams = 1 lb)

\[ 0.0001134 \text{ g} \times \frac{2.5 \text{ lb}}{453.6 \text{ g}} = 3.000 \text{ cm}^3 \]

\[ \frac{3.000 \text{ cm}^3}{10^3 \text{ mm}^3} = 3.000 \text{ g/cm}^3 \]

22. What is the volume (mL) of ethanol required for a mass of 7.55x10⁻⁴ kg? The density of ethanol is 0.789 g/mL at 25°C.

\[ d = \frac{m}{V} \quad so \quad V = \frac{m}{d} = \frac{7.55 \times 10^{-4} \text{ g}}{0.789 \text{ g/mL}} = 957 \text{ mL} \]

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

\[ \# P + n \rightarrow 65 \text{ Zn}^{2+} \]

\[ \# P \rightarrow 30 \text{ Zn} \]

\[ \# P - \text{charge} = \# e \]

(a) 30

(b) 35

(c) 28

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

\[ 453.6 \text{ g H}_2\text{O} \times \left( \frac{1 \text{ mole H}_2\text{O}}{18.02 \text{ g H}_2\text{O}} \right) \times \left( \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mole H}_2\text{O}} \right) = 1.516 \times 10^{25} \text{ molecules} \]

25. How many moles of methane (CH₄) are required to produce 18 moles of H₂O based on the following balanced chemical equation for its combustion?

\[ \text{CH}_4(g) + 2\text{O}_2(g) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(l) \]

\[ 18 \text{ moles H}_2\text{O} \times \left( \frac{1 \text{ mole CH}_4}{2 \text{ moles H}_2\text{O}} \right) = 9 \text{ moles CH}_4 \]

26. What is the correct chemical formula for an ionic compound that contains only calcium ions (Ca²⁺) and nitrate ions (NO₃⁻)?

\[ \text{1:2 ratio to balance} \left\{ \begin{array}{c} \text{Ca}^{2+} \quad (\text{NO}_3)^{-1} \\
\end{array} \right\} \]

\[ \text{Ca(NO}_3\text{)}_2 \]

27. How many milligrams is 4x10⁻⁶ kg?

\[ 4 \times 10^{-6} \text{ kg} \times \left( \frac{1000 \text{ g}}{1 \text{ kg}} \right) \times \left( \frac{1 \text{ g}}{1 \text{ g}} \right) = 4 \text{ mg} \]

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)

\[ 11.9 \text{ gal} \times \left( \frac{1 \text{ liter}}{0.264 \text{ gal}} \right) = 45.1 \text{ liters} \]
29. The temperature of a nice warm day in Europe is 30°C. What is this temperature in °F?

\[ 0^\circ F = \frac{9}{5} \times 30^\circ C + 32 = \frac{9}{5} \times 30^\circ C + 32 = 86^\circ F \]

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

\[
\begin{array}{c}
\text{18} \\
\text{8}
\end{array}
\quad \text{O}^{2-}
\]

31. An unknown isotope, X, has the symbol \(^{37}\text{X}\). What element is "X"?

\[
\text{Cl} \quad \text{(chlorine)}
\]

atom #: \# of protons

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

\[
Pb^{2+} + PO_4^{3-} \rightarrow Pb_3(PO_4)_2
\]

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

\[
4.567 \text{g Na}_2\text{CO}_3 \times \left( \frac{1 \text{ mole}}{105.99 \text{ g Na}_2\text{CO}_3} \right) = 0.04309 \text{ moles Na}_2\text{CO}_3
\]

34. Balance the following chemical equation:

\[
2\text{AgNO}_3 (aq) + \text{CuCl}_2 (aq) \rightarrow \text{Cu(NO}_3)_2 (aq) + 2\text{AgCl (s)}
\]

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%)

\[
0.3634 \times 45.967 \text{ amu} + 0.6366 \times 48.976 \text{ amu}
\]

\[
= 16.70 + 31.178 \text{ amu}
\]

\[
= 47.88 \text{ amu}
\]

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

(a) water, H\textsubscript{2}O  (b) ammonia, NH\textsubscript{3}  (c) carbon dioxide, CO\textsubscript{2}  (d) cyanide ion, CN\textsuperscript{-}
37. How many moles of nitric acid is obtained from 25.00 mL of 3.00 M HNO₃?

\[
(0.02500 \text{ L}) \times \left( \frac{3.00 \text{ moles}}{1 \text{ L}} \right) = 0.0750 \text{ moles HNO₃}
\]

38. Convert 4.5 x 10³ in³ into cm³. (2.54 cm = 1.00 in)

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

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?

\[
\text{Volume} = \pi r^2 \cdot h = 750 \text{ cm}^3
\]

\[
i = \text{Area} \cdot h = 750 \text{ cm}^3
\]

\[
r = \frac{i}{\pi h} = \frac{750}{30 \pi} \approx 7.92 \text{ cm}
\]

\[
d = 2r = 15.8 \text{ cm}
\]

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)?

\[
\text{Info:}
\]

\[
\rightarrow 73 \text{ kg}
\]

\[
\rightarrow 400 \text{ mg} / 250 \text{ mL}
\]

\[
\rightarrow 3.0 \text{ mcg} / \text{ kg·min}
\]

\[
73 \text{ kg} \times \left( \frac{3.0 \text{ mcg}}{1 \text{ kg·min}} \right) \times \left( \frac{1 \text{ mg}}{1000 \text{ mcg}} \right) \times \left( \frac{250 \text{ mL}}{400 \text{ mg}} \right) \times \left( \frac{60 \text{ min}}{1 \text{ hr}} \right)
\]

\[
= 8.2 \text{ mL/hr}
\]