1. (8) Name the following elements given their symbols.
   a) Mn Manganes
e   b) Au Gold
   c) K Potassium
   d) Na Sodium

2. (8) Convert 65 µg to grams and write your answer in proper scientific notation.

   \[
   65 \text{ mg} \times \frac{1 \text{ g}}{1 \times 10^5 \text{ mg}} = 0.0000065 \text{ g} \quad \text{or} \quad 6.5 \times 10^{-5} \text{ g}
   \]

3. a)(6) For \(^{39}\text{K}\), give the number of
   - Protons 19
   - Neutrons 20
   - Electrons 19

   b)(6) For \(^{40}\text{Ca}^{2+}\) give the number of
   - Protons 20
   - Neutrons 20
   - Electrons 18

4. (6) Write the chemical formula for iron(II) sulfide

   \[
   \text{FeS}
   \]
5.(8) Predict the chemical formula for the compound formed by the combination of Na$^+$ and PO$_4^{3-}$.

Na$_3$PO$_4$

6.(20) Determine the empirical formula of caffeine which contains by mass 49.5\% C, 5.15\% H, and 28.9\% N, and 16.5\% O.

Assume a 100 g sample

49.5 g C x \(\frac{1 \text{ mole C}}{12.01 \text{ g C}}\) = 4.12 moles C

5.15 g H x \(\frac{1 \text{ mole H}}{1.01 \text{ g H}}\) = 5.08 moles H

28.9 g N x \(\frac{1 \text{ mole N}}{14.01 \text{ g N}}\) = 2.06 moles N

16.5 g O x \(\frac{1 \text{ mole O}}{16.01 \text{ g O}}\) = 1.03 moles O

\[
\frac{\text{moles C}}{\text{moles O}} = \frac{4.12}{1.03} = 4.00
\]

\[
\frac{\text{moles H}}{\text{moles O}} = \frac{5.08}{1.03} = 4.95 \text{ round up to 5}
\]

\[
\frac{\text{moles N}}{\text{moles O}} = \frac{2.06}{1.03} = 2.00
\]

C$_{4}$H$_{5}$N$_{2}$O
7.(12) Ascorbic acid or Vitamin C (C₆H₈O₆) is an essential vitamin. It cannot be stored by the body and must be present in the diet. If a typical Vitamin C tablet contains 500 mg of Vitamin C, how many moles of Vitamin C does it contain?

\[
\text{Molar Mass Vitamin C} = (6 \times 12.01) + (8 \times 1.01) + (6 \times 16.0) = 176.14 \text{ g/mol}
\]

\[
500 \text{ mg} \times \frac{1 \text{ g}}{1000 \text{ mg}} = 0.500 \text{ g Vitamin C} \times \frac{1 \text{ mole Vitamin C}}{176.14 \text{ g Vitamin C}} = 2.84 \times 10^{-3} \text{ moles Vitamin C}
\]

8.(20) Carbon monoxide (CO) can be reacted with hydrogen (H₂) to form methanol (CH₄O). Given the following unbalanced equation

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

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

If 68.5 g of CO and 8.6 g of hydrogen are mixed and reacted to form methanol, calculate the theoretical yield of methanol and identify the limiting reactant.

Yield of methanol if 68.5 g CO completely converted:

\[
68.5 \text{ g CO} \times \frac{1 \text{ mole CO}}{28.0 \text{ g CO}} = 2.45 \text{ moles CO} \times \frac{1 \text{ mole CH}_4\text{O}}{1 \text{ mole CO}} = 2.45 \text{ moles CH}_4\text{O}
\]

Yield of methanol if 8.6 g H₂ completely converted:

\[
8.6 \text{ g H}_2 \times \frac{1 \text{ mole H}_2}{2.02 \text{ g H}_2} = 4.26 \text{ moles H}_2 \times \frac{1 \text{ mole CH}_4\text{O}}{2 \text{ moles H}_2} = 2.13 \text{ moles CH}_4\text{O}
\]

Less CH₄O is made from conversion of all H₂, so it must be the limiting reactant (it would run out before the CO was all used up)

H₂ = Limiting Reactant

Theoretical Yield: 2.13 moles CH₄O \times \frac{32.05 \text{ g CH}_4\text{O}}{1 \text{ mole CH}_4\text{O}} = 68.3 \text{ g CH}_4\text{O}