1. Cisplatin is a drug that is used to treat testicular cancer. Cisplatin, \( \text{Pt(NH}_3\text{)}_2\text{Cl}_2 \), can be made by the reaction of \( \text{K}_2\text{PtCl}_4 \) with ammonia, \( \text{NH}_3 \). Besides cisplatin, the other product is \( \text{KCl} \).

(a) Write a balanced equation for this reaction.

\[
\text{K}_2\text{PtCl}_4 + 2\text{NH}_3 \rightarrow \text{Pt(NH}_3\text{)}_2\text{Cl}_2 + 2\text{KCl}
\]

(b) In order to obtain 2.50 g of cisplatin, what masses in grams of \( \text{K}_2\text{PtCl}_4 \) and ammonia do you need?

\[
\begin{align*}
\text{n}_{\text{cisplatin}} &= (2.50 \text{ g}) \times \left( \frac{1 \text{ mol}}{300.0468 \text{ g}} \right) = 0.008332 \text{ mol cisplatin} \\
\text{m}_{\text{K}_2\text{PtCl}_4} &= (0.008332 \text{ mol cis}) \times \left( \frac{1 \text{ mol } \text{K}_2\text{PtCl}_4}{1 \text{ mol cis}} \right) \times \left( \frac{415.08869 \text{ g}}{1 \text{ mol } \text{K}_2\text{PtCl}_4} \right) = 3.46 \text{ g } \text{K}_2\text{PtCl}_4 \\
\text{m}_{\text{NH}_3} &= (0.008332 \text{ mol cis}) \times \left( \frac{2 \text{ mol } \text{NH}_3}{1 \text{ mol cis}} \right) \times \left( \frac{17.0304 \text{ g}}{1 \text{ mol } \text{NH}_3} \right) = 0.284 \text{ g } \text{NH}_3
\end{align*}
\]

2. The ceramic silicon nitride, \( \text{Si}_3\text{N}_4 \), is made by heating silicon and nitrogen at an elevated temperature:

\[
3 \text{Si}(s) + 2 \text{N}_2(g) \rightarrow \text{Si}_3\text{N}_4(s)
\]

How many grams of silicon must combine with excess \( \text{N}_2 \) to produce 1.0 kg of \( \text{Si}_3\text{N}_4 \) if this process is 92% efficient? (In other words, you get a 92% yield.)

\[
\% \text{ yield} = 92\% \quad \text{actual yield} = 1.0 \text{ kg}
\]

\[
\begin{align*}
\text{theor. yield} &= \frac{\text{actual yield}}{\% \text{ yield}} \times 100 = \frac{1.0 \text{ kg}}{92} \times 100 = 1.087 \text{ kg } \text{Si}_3\text{N}_4 \\
\text{n}_{\text{Si}_3\text{N}_4} &= (1.087 \text{ kg } \text{Si}_3\text{N}_4) \times \left( \frac{1 \text{ kmol } \text{Si}_3\text{N}_4}{140.2833 \text{ kg}} \right) = 0.007749 \text{ kmol } \text{Si}_3\text{N}_4 \\
\text{n}_{\text{Si}} &= (0.007749 \text{ kmol } \text{Si}_3\text{N}_4) \times \left( \frac{3 \text{ mol } \text{Si}}{1 \text{ kmol } \text{Si}_3\text{N}_4} \right) = 0.02325 \text{ kmol } \text{Si} \\
\text{m}_{\text{Si}} &= (0.02325 \text{ kmol } \text{Si}) \times \left( \frac{28.0855 \text{ kg}}{1 \text{ kmol } \text{Si}} \right) = 0.65 \text{ kg } \text{Si}
\end{align*}
\]

3. The following diagram represents the reaction of \( \text{A}_2 \) (shaded spheres) with \( \text{B}_2 \) (unshaded spheres). Write a balanced equation that best describes this reaction.

\[
2 \text{A}_2 + 6 \text{B}_2 \rightarrow 4 \text{AB}_3
\]

\( \text{B}_2 \) is limiting reactant (used up)

4. How many moles of product can be make from 1.0 mol of \( \text{A}_2 \) and 1.0 mol of \( \text{B}_2 \) for the reaction in #3?

\[
\text{mol} = (1.0 \text{ mol } \text{B}_2) \left( \frac{4 \text{ mol } \text{AB}_3}{6 \text{ mol } \text{B}_2} \right) = 0.67 \text{ mol } \text{AB}_3
\]
5. An oxybromate compound, KBrO\(_x\), where \(x\) is unknown, is analyzed and found to contain 52.92% Br. What is the value of \(x\)?

Assume that you have 100.00 g of the sample. We know then that 52.92 g of it is Br. We also know (from the formula of the compound) that there is a 1:1 ratio between Br and K. So we can determine how much K we have from that mole ratio.

\[
\text{mol Br in sample} = (52.92 \text{ g Br})(1 \text{ mol Br} / 79.904 \text{ g}) = 0.662295 \text{ mol Br}
\]

\[
\text{mol K in sample} = (0.662295 \text{ mol Br})(1 \text{ mol K} / 1 \text{ mol Br}) = 0.662295 \text{ mol K}
\]

Now we can find out what the mass of K is in the sample.

\[
\text{mass of K in sample} = (0.662295 \text{ mol K})(39.0983 \text{ g K} / 1 \text{ mol}) = 25.855 \text{ g K}
\]

Now that we know the mass of K in the sample and the mass of Br in the sample and we know that the total sample mass is 100.00 g – we can determine the mass of O in the sample. This will allow us to get the number of moles of O in the sample.

\[
\text{mass of K + Br in sample} = 52.92 \text{ g Br} + 25.855 \text{ g K} = 78.77 \text{ g}
\]

\[
\text{mass of O in sample} = 100.00 \text{ g} – 78.77 \text{ g} = 21.23 \text{ g O}
\]

\[
\text{mol of O in sample} = (21.23 \text{ g O})(1 \text{ mol} / 15.9994 \text{ g}) = 1.3266 \text{ mol O}
\]

So now we have all the numbers of moles in the sample – just like we get with a percentage composition problem:

\[
\begin{align*}
\text{mol Br} &= 0.662295 \text{ mol} \\
\text{mol K} &= 0.662295 \text{ mol} \\
\text{mol O} &= 1.3266 \text{ mol}
\end{align*}
\]

Dividing through by the smallest number of moles (0.662295 mol) gives the mole ratio:

\[
\begin{align*}
\text{Br} &= 0.662295 \text{ mol} / 0.662295 \text{ mol} = 1 \\
\text{K} &= 0.662295 \text{ mol} / 0.662295 \text{ mol} = 1 \\
\text{O} &= 1.3266 \text{ mol} / 0.662295 \text{ mol} = 2
\end{align*}
\]

The formula is KBrO\(_2\).

6. An element X forms an iodide (XI\(_3\)) and a chloride (XCl\(_3\)). The iodide is quantitatively converted to a chloride when it is heated in a stream of chlorine:

\[
2 \text{XI}_3 + 3 \text{Cl}_2 \rightarrow 2 \text{XCl}_3 + 3 \text{I}_2 \quad \text{Balanced Equation}
\]

If 0.5000 g of XI\(_3\) is treated, 0.2360 g of XCl\(_3\) is obtained.

a. Calculate the atomic weight of the element X.

To determine the mass of XCl\(_3\) obtained (the number given above) we would do the following conversion:

\[
\text{mass XI}_3 \rightarrow \text{moles XI}_3 \rightarrow \text{moles XCl}_3 \rightarrow \text{mass XCl}_3
\]

We don’t know the atomic weight of X so we can treat it as a variable (x) in the following equation:

\[
\text{mass of XCl}_3 \text{ formed} = \frac{(0.5000 \text{g})}{x \text{ g/mol} } \left( \frac{1 \text{ mol XI}_3}{126.90447 \text{ g/mol}} \right) \left( \frac{1 \text{ mol XCl}_3}{1 \text{ mol XI}_3} \right) \left( \frac{x \text{ g/mol} + (3 \times 35.453 \text{ g/mol})}{1 \text{ mol XCl}_3} \right) = 0.2360 \text{ g}
\]

Solve for x to get the molar mass of X.

\[
x = 138.9 \text{ g/mol}
\]

b. Identify the element X.

La