Please show all work for partial credit

1. (10 points) Perform the following unit conversions:

   3,000,000 meters to km
   \[ 3 \times 10^6 \text{ m} \times \frac{1 \text{ km}}{10^3 \text{ m}} = 3 \times 10^3 \text{ km} \]

   455 cm to km
   \[ 455 \text{ cm} \times \frac{0.1 \text{ m}}{100 \text{ cm}} \times \frac{1 \text{ km}}{1000 \text{ m}} = 4.55 \times 10^{-3} \text{ km} \]

   365 yards to furlongs (5.5 yard = 1 rod, 40 rods = 1 furlong)
   \[ 365 \text{ yds} \times \frac{1 \text{ rod}}{5.5 \text{ yd}} \times \frac{1 \text{ furlong}}{40 \text{ yds}} = 1.66 \text{ furlongs} \]

   265 ft-lbs (a force) to kg-m
   \[ 265 \text{ ft-lbs} \times \frac{1 \text{ kg}}{2.2046 \text{ lbs}} \times \frac{1 \text{ yd}}{3 \text{ ft}} \times \frac{1 \text{ m}}{1.0936 \text{ yd}} = 36.6 \text{ kg-m} \]

   .564 kg/m² to lbs/in²
   \[ .564 \text{ kg/m}^2 \times \frac{2.2046 \text{ lbs}}{1 \text{ kg}} \times \left( \frac{1 \text{ m}}{1.0936 \text{ yd}} \times \frac{1 \text{ yd}}{3 \text{ ft}} \times \frac{1 \text{ ft}}{12 \text{ in}} \right)^2 = 8.02 \times 10^{-4} \text{ lbs/in}^2 \]

2. (10 points) How many significant figures are there in each of the following numbers?

   .00035 ______ 3 _____

   3.50x10^3 ______ 3 _____

   300500 ________ 4 _____

   3.00500 ________ 6 _____

   0.00350 ________ 3 _____

3. (10 points) The Periodic Table (Fill in the blanks)

   Sodium normally has a _+1___ charge in an ionic compound, and is a member of the____Alkali metal_______________ family of elements.

   Si refers to the element ____Silicon_____ and is in the _____3rd_____ period of the periodic table

   Name the halogen in the third period of the table: _____Cl______
4. (10 points) Give the names of the following compounds

- MgF$_2$ _magnesium fluoride________
- P$_4$O$_{10}$ _tetraphosphorous decaoxide
- Nb$_2$O$_5$ _niobium(V) oxide
- HNO$_2$(aq) _nitrous acid__
- Ca$_3$(PO$_4$)$_2$ _calcium phosphate

5. (10 points) Give the molecular formula of the following compounds:

- Sodium nitride _Na$_3$N________
- Potassium nitrite__KNO$_2$________
- Chlorine trifluoride___ClF$_3$ __________
- Hydrosulfuric acid___H$_2$S(aq)____________
- Nitrous acid___HNO$_2$__________

6. (10 points) How many atoms of Ni are there in 3 ng of Ni(NO$_3$)$_2$?

\[
3 \text{ng} \times \frac{1 \times 10^{-9} \text{g}}{\text{ng}} \times \frac{1 \text{mole Ni(NO}_3)_2}{58.69 + 2(14.01 + 3(16.00)) \text{g}} \times \frac{6.022 \times 10^{23} \text{atoms}}{\text{mole Ni(NO}_3)_2} = 9.89 \times 10^{12} \text{atoms}
\]
7. (10 points) Chlorine has an atomic mass of 35.45. You know that atomic masses are not nice integer numbers because all elements are composed of isotopes with different masses and different natural abundances. Suppose Chlorine had 2 major isotopes, \(^{35}\text{Cl}^\text{35}\) and \(^{37}\text{Cl}^\text{37}\). What % of the atoms of Cl would have to be \(^{35}\text{Cl}^\text{35}\) and what % of atoms would have to be \(^{37}\text{Cl}^\text{37}\) to give you this average atomic mass?

If X is the fraction of the element that has an atomic mass of 35 and Y is the fraction of the element that has an atomic mass of 37 then:

\[X(35) + Y(37) = 35.45; \quad \text{and} \quad X+Y=1\]

Two equations with two unknowns, rearrange the second equation to: \(X=1-Y\) and substitute into the first equation:

\[(1-Y)35 + Y(37) = 35.45\]
\[35-35Y +37Y = 35.45\]
\[35+2Y=35.45\]
\[2Y=35.45-35\]
\[2Y=.45\]
\[Y=.45/2 = .225 \quad \% \text{ at } 37 = 22.5\%\]
\[X = 1-.225 = .775, \quad \% \text{ at } 35 = 77.5\%\]

8. (10 points) Balance the following chemical equations:

\[
\text{Cr(s)} + \text{S}_8\text{(s)} --\text{Cr}_2\text{S}_3\text{(s)}
\]

\[16\ \text{Cr(s)} + 3\ \text{S}_8\text{(s)} --8\ \text{Cr}_2\text{S}_3\text{(s)}
\]

Silicon tetrachloride + Magnesium -- Silicon + Magnesium chloride
(Step 1 for partial credit, write the correct molecular formula for each compound)

Correct molecular formulas
\[
\text{SiCl}_4 + \text{Mg} -- \text{Si} + \text{MgCl}_2
\]

Balance
\[
1\ \text{SiCl}_4 + 2\ \text{Mg} --1\ \text{Si} + 2\ \text{MgCl}_2
\]

9. (10 points) Given the reaction:
Mg(s) + I₂ (s) → MgI₂(s)

Identify the limiting reactant in each of the following reaction mixtures

A. 0.5 mole of Mg and .4 mole of I₂

This is a 1:1 reaction moles of product = moles of reactant, so pick the reactant with the smallest number of moles

I₂

B. 0.5 g of Mg and .4 g of I₂

Still 1:1. So again we can just look for the reactant with the smallest # of moles

.5g Mg x 1 mole/24.305 = .0206 moles
.4g I₂ x 1 mole/253.8 g = .00158 mole This is the one.

C. 500 mg of Mg and .0004 kg of I₂

500 mg x 1000mg/1g = .5g
.0004kg x 1000g/kg = .4g
same as the above problem
Still 1:1. So again we can just look for the reactant with the smallest # of moles

.5g Mg x 1 mole/24.305 = .0206 moles
.4g I₂ x 1 mole/253.8 g = .00158 mole This is the one.

10. (10 points) Using the following balanced reaction, calculate the amount of F₂ needed to react with 5 g of P₄, and the amount (in grams) of PF₃ formed in the reaction.

P₄(s) + 6 F₂(g) → 4 PF₃(g)

Amount of F₂

\[
5g \text{ P}_4 \times \frac{1 \text{ mole P}_4}{4 \times 0.973g} \times \frac{6 \text{ mole F}_2}{1 \text{ mole P}_4} \times \frac{2 \times 29g}{1 \text{ mole F}_2} = 9.20g
\]

Amount PF₃ product:

Quick and Dirty: Amount of product = amount of reactants = 5+9.2 =14.2g

Long:

\[
5g \text{ P}_4 \times \frac{1 \text{ mole P}_4}{4 \times 0.973g} \times \frac{4 \text{ mole PF}_3}{1 \text{ mole P}_4} \times \frac{30.97 + (3 \times 19.00)g}{1 \text{ mole PF}_3} = 14.20g
\]