Question 1

a- Classify the following as extensive property or intensive property.
   i- Volume  Extensive property
   ii- Density  Intensive property
   iii- Temperature  Intensive property
   iv- Mass  Extensive property
   v- Melting Point  Intensive property

b- The price of gasoline in Northern Cyprus is 1,450,000 T.L. / L. A man drives 55 km per day in order to go to his job and return home. Assuming he works 260 days per year, and if his car goes 10 km per liter of gasoline, calculate the cost of gasoline for this man per year in dollars. (1 dollar = 1,300,000 T.L)

\[
\frac{260 \text{ working days}}{\text{year}} \times \frac{55 \text{ km}}{\text{day}} \times \frac{1 \text{ L}}{10 \text{ km}} \times \frac{1,450,000 \text{T.L}}{\text{L}} \times \frac{1 \text{ dollar}}{1,300,000 \text{T.L}} = 1595 \text{ dollars}
\]

c- Write the chemical formula of the following compounds
   i- Ammonium Sulfate \( (\text{NH}_4)_2 \text{SO}_4 \)
   ii- Calcium Phosphate \( \text{Ca}_3(\text{PO}_4)_2 \)
   iii- Sodium Bromide \( \text{NaBr} \)
   iv- Dichlorine Heptaoxide \( \text{Cl}_2\text{O}_7 \)
   v- Xenon Hexafluoride \( \text{XeF}_6 \)
Question 2

Vitamin C has the molecular formula C₆H₈O₆. It reacts with oxygen to undergo a combustion reaction and produces carbon dioxide gas and water.

a- Calculate the mass percent of carbon in Vitamin C.

Molar Mass C₆H₈O₆ = 176.124 g/mol

\[ \% \text{C} = \left( \frac{6 \times 12.01 \text{ g}}{176.124 \text{ g}} \right) \times 100 = 40.9 \% \text{ by mass} \]

b- What is the number of carbon atoms in 1000 mg Vitamin C?

100 g Vitamin C \quad 40.9 g C
1 g " \quad ? → 0.409 g C

\[ \text{# of C atoms} = \frac{0.409 \text{ g C} \times 1 \text{ mol C}}{12.01 \text{ g C}} \times \frac{6.022 \times 10^{23} \text{ C atom}}{1 \text{ mol C}} = 205 \times 10^{20} \text{ C atom} \]

c- Write down a balanced chemical equation for the combustion of one mole of vitamin C.

C₆H₈O₆(s) + 5 O₂(g) → 6 CO₂(g) + 4 H₂O(l)

d- How many grams of carbon dioxide would be produced from the combustion of a 1.50 g tablet that is 90% Vitamin C?

100 g tablet \quad 90 g Vitamin C
1.50 g " \quad ? 1.35 g Vitamin C

\[ \text{mol Vitamin C} = \frac{1.35 \text{ g}}{176.124 \text{ g/mol}} = 7.66 \times 10^{-3} \text{ mol} \]

1 mol Vitamin C \quad 6 mol CO₂
7.66 \times 10^{-3} \text{ mol Vitamin C} \quad 0.0459 \text{ mol CO₂}

\[ \text{Mass of CO₂} = 0.0459 \text{ mol CO₂} \times \frac{44.01 \text{ g CO₂}}{1 \text{ mol CO₂}} = 2.02 \text{ g CO₂} \]
Question 4

i- Consider the combustion of two moles carbon monoxide, CO(g) which yields carbon dioxide, CO$_2$(g) at 1 atm and 25°C.

(ΔH$^\circ$$_r$CO$_2$(g) = -393.5 kJ/mol, ΔH$^\circ$$_r$CO(g) = -110.5 kJ/mol)

a- Calculate ΔH$^\circ$

\[
2\text{ CO(g)} + \text{O}_2(g) \rightarrow 2\text{ CO}_2(g)
\]

\[
\Delta H^\circ = 2\text{ mol} \times \Delta H^\circ_{f CO_2(g)} - [2\text{ mol} \times \Delta H^\circ_{f CO(g)} + 1\text{ mol} \times \Delta H^\circ_{f O_2(g)}]
\]

\[
= 2\text{ mol} \times -393.5 \text{ kJ/mol} - (2\text{ mol} \times -110.5 \text{ kJ/mol} + 0)
\]

\[
= -787 \text{ kJ} + 221 \text{ kJ} = -566 \text{ kJ}
\]

b- Calculate ΔE

\[
\Delta E = \Delta H^\circ - \Delta n g R T = -566 \text{ kJ} - (-1\text{ mol} \times 8.31 J/K \cdot \text{mol} \times 298 K \times 10^3)
\]

\[
\Delta E = -563.5 \text{ kJ}
\]

ii- The work done when a gas is compressed in a cylinder is 462 J. During this process, there is a heat transfer of 128 J from the gas to the surroundings. Calculate the energy change (ΔE) for this process.

\[
\Delta E = q + w = 462 \text{ J} - 128 \text{ J} = 334 \text{ J}
\]
Question 5
Consider the following data on substance A:

Vapor pressure at 25°C = 106.7 mmHg
Normal melting point = 5°C
Molar Mass = 78 g/mol

Critical point = 289°C at 47 atm
ΔH_vaporization = 30.8 kJ/mol
Properties: Insoluble in water, nonconductor of electricity

a- What type of a substance is this (ionic, molecular, metallic or network covalent)?

Molecular

b- Would it exist as a liquid or as a gas at 300°C and 300 atm? Why?

It would exist as a gas.
Because at p = 48 atm, T_{\text{critical}} = 289°C
c- If 1.0 g of this substance is placed in a 1.0 L flask, how many grams of it would remain in the liquid state after liquid-vapor equilibrium is reached?

\[ n_{\text{gas}} = \frac{P_{\text{gas}} V}{RT} = \frac{(106.7/760) \text{ atm} \cdot \text{L} \cdot \text{mol}^{-1} \cdot \text{L} \cdot \text{mol}^{-1}}{0.0821 \text{ L atm \cdot mol}^{-1} \text{ K}^{-1}} = 0.00574 \text{ mol} \]

\[ m_{\text{gas}} = 0.00574 \text{ mol} \cdot 78.9 \text{ g} = 0.447 \text{ g} \]

\[ m_{\text{liquid}} = (1 - 0.147) \text{ g} = 0.553 \text{ g} \]

d- Calculate the normal boiling point of A in °C

\[ \ln \frac{P_2}{P_1} = \frac{\Delta H_{\text{vap}}}{R} \left( \frac{T_2 - T_1}{T_2 \cdot T_1} \right) \]

\[ P_1 = 106.7 \text{ mm Hg} \quad T_1 = 298 \text{ K} \]

\[ P_2 = 760 \text{ mm Hg} \]

\[ \ln \frac{760}{106.7} = \frac{30.8 \times 10^3 \text{ J/mol} \cdot \text{K}}{8.314 \text{ J/mol \cdot K}} \left( \frac{T_2 - 298}{T_2 \cdot 298} \right) \]

\[ T_2 = 354 \text{ K} = 81 \text{ °C} \]
Question 6

The concentrated sulfuric acid we use in the laboratory is 98 percent H₂SO₄ by mass. The density of the solution is 1.83 g/ml.

a-Calculate the molarity of this solution.

\[
\text{In 100 g solution 98 g H₂SO₄ exist}
\]

Molar mass H₂SO₄ = 98 g/mol

\[
\frac{n_{\text{H₂SO₄}}}{98 \text{ g}} = 1 \text{ mol}
\]

\[
V_{\text{solution}} = 100 \text{ g} \times \frac{1 \text{ L}}{183 \text{ g}} \times \frac{1 \text{ L}}{10^3 \text{ mL}} = 0.055 \text{ L}
\]

\[
M_{\text{H₂SO₄}} = \frac{n_{\text{H₂SO₄}}}{\text{liter solution}} = \frac{1 \text{ mol}}{0.055 \text{ L}} = 18.2 \text{ M}
\]

b- Calculate its molality.

\[
m_{\text{H₂SO₄}} = \frac{n_{\text{H₂SO₄}}}{\text{kg solvent}}
\]

\[
= \frac{1 \text{ mol}}{2 \times 10^{-3} \text{ kg}} = 500 \text{ m}
\]

\[
\text{In 100 g solution 2 g solvent exist}
\]

c-How would you prepare 3 L of 3 M H₂SO₄ from the concentrated solution?

\[
M_1 \times V_1 = M_2 \times V_2
\]

\[
18.2 \text{ mol/L} \times V_1 = 3 \text{ mol/L} \times 3 \text{ L}
\]

\[
V_1 = 0.5 \text{ L}
\]

Take 0.5 L from the concentrated solution and dilute it up to 3 L.