Info: \( PV = nRT \) \( R = 0.0821 \text{ L atm, mole}^{-1} \text{K}^{-1} \) or 62.4 L torr mole\(^{-1}\) K\(^{-1}\) \( \text{STP} = 1 \text{ atm} = 101 \text{ kPa} = 760 \text{ mm Hg} \) \( @ \ 273 \text{ K} \) \( Q = mc \Delta T \) \( c_{\text{H}_2\text{O}} = 1 \text{ cal g}^{-1} \text{K}^{-1} \) or 4.184 J g\(^{-1}\) K\(^{-1}\) \( \text{Avog} \# = 6.022 \times 10^{23} \) \( \text{molar volume of gas @ STP} = 22.4 \text{ L} \) \( \text{Electronegativities: } B : 2.0, \text{ H : 2.1, C : 2.5, N : 3.0, O : 3.5, F : 4.0} \) \( \text{Cl : 3.0 , S : 2.5, Br : 2.8 , I : 2.5} \)

Show a neat complete setup showing units for each problem involving calculations; show answers with all Units, to the appropriate # of significant figures. No answer without a setup will be credited.

1. a) A hydrocarbon compound, contains 92.3% C and 7.70% H. What is its empirical formula?

15

b) This same substance is a gas with a density of 1.25 g/L at 127°C and a pressure of 400 torr. What is its molar mass?

20

c) What is the molecular formula of the compound?

5

2. How many liters of CO\(_2\) can be produced by combustion of 5.80 g butane with 15.0 liters of oxygen. All gases measured at STP.

25
Info: \( PV = nRT \) \( R = 0.0821 \text{ L atm, mole}^{-1} \text{ K}^{-1} \) or \( 62.4 \text{ L torr mole}^{-1} \text{ K}^{-1} \) \( \text{STP} = 1 \text{ atm} = 101 \text{ kPa} = 760 \text{ mm Hg} \) @ 273 K
\( Q = m \Delta T \) \( c_{\text{H}_2\text{O}} = 1 \text{ cal g}^{-1} \text{ K}^{-1} \) or \( 4.184 \text{ J g}^{-1} \text{ K}^{-1} \) \( \text{Avog} \# = 6.022 \times 10^{23} \) molar volume of gas @ STP = 22.4 L
Electronegativities: B : 2.0, H : 2.1, C : 2.5, N : 3.0, O : 3.5, F : 4.0, Cl : 3.0, S : 2.5, Br : 2.8, I : 2.5

Show a neat complete setup showing units for each problem involving calculations; show answers with all units, to the appropriate # of significant figures. No answer without a setup will be credited.

1. a) A hydrocarbon compound, contains 85.7% C and 14.4% H. What is its empirical formula?

b) This same substance is a gas with a density of 1.346 g/L at 127°C and a pressure of 400 torr. What is its molar mass?

c) What is the molecular formula of the compound?

2. How many liters of CO\(_2\) can be produced by combustion of 3.00 g ethane with 8.00 liters of oxygen. All gases measured at STP.
3. How many mL of 0.200 M barium hydroxide will be required to completely react with 0.0300 g of acetic acid \((\text{HC}_2\text{H}_3\text{O}_2)\)? (note only one H will react with OH\(^-\))

4. What is the molarity of a 5.00% solution of acetic acid (vinegar), given that the density of the solution is 1.00 g/mL?

5. Predict products and balance these reactions. Assume they do react.
   a) nitrous acid reacts with nickel(III) hydroxide
   b) combustion of methanol
   c) aluminum reacts with aqueous cobalt (II) sulfate
   d) sulfur dioxide reacts with water
3. How many mL of 0.300 M barium hydroxide will be required to completely react with 0.0600 g of acetic acid \((\text{HC}_2\text{H}_3\text{O}_2)\). (note only one H will react with \(\text{OH}^-\))

4. What is the molarity of a 4.00 % solution of acetic acid (vinegar), given that the density of the solution is 1.00 g/mL?

5. Predict products and balance these reactions. Assume they do react.
   a) perchloric acid reacts with cobalt(III) hydroxide
   b) combustion of ethanol
   c) zinc reacts with aqueous nickel (III) sulfate
   d) sulfur trioxide reacts with water
6.a) Write the electron configuration of europium (Eu) starting with the noble gas configuration \([\text{ ]}\) notation.

   b) How many unpaired electrons do we find in this element?

   c) Is this element paramagnetic or diamagnetic? What fundamental property of electrons explains this behavior?

   d) Write the symbol of an ion that can form, of europium. Explain why you chose this and which electrons were transferred.

7a) Write the Lewis formulas, describe the electron geometry (VSEPR), bond angles and molecular shape. Sketch the molecule with its correct molecular shape. State whether the molecule is polar or non-polar. You don’t have to show the polarity arrows but for 2 pts extra, show them and the resultant vector (if any) clearly on the sketch.

\[
\text{SeO}_2^{2-}
\]

2 pt bonus – name this ion
6.a) Write the electron configuration of rhenium (Re) starting with the noble gas configuration [ ] notation.

b) How many unpaired electrons do we find in this element?

c) Is this element paramagnetic or diamagnetic? What fundamental property of electrons explains this behavior?

d) Write the symbol of an ion that can form, of rhenium. Explain why you chose this and which electrons were transferred.

7a) Write the Lewis formulas, describe the electron geometry (VSEPR), bond angles and molecular shape. Sketch the molecule with its correct molecular shape. State whether the molecule is polar or non-polar. You don’t have to show the polarity arrows but for 2 pts extra, show them and the resultant vector (if any) clearly on the sketch.

BO$_3$$^{3-}$

2 pt bonus – name this ion
7b) Characterize this molecule, as in 7a).

\[ \text{PO}_2^{-1} \]

8. How many microliters are present in 0.003 cm\(^3\)
7b) Characterize this molecule, as in 7a).

\[ \text{TeO}_2^{-2} \]

8. How many cm\(^3\) are present in 3000 microliters?