Molar Volume -Calculations

For this lab, you measured the volume of H_2 gas evolved as several different metal elements were dissolved in acid.
You need to determine

- slope
- adjusted slope
- equivalent mass of the metal from the volume of hydrogen gas produced
- atomic mass of the metal
- percent error

The slope represents ml (gas)/g (metal).
Remember: 1 mole of a gas has a volume of 22.4 liters at STP
1 mole of a gas has a volume of about 24.0 L at 21^{o}C.
Use this value for the calculations, since the data was gathered at 21^{o}C.
(Hint: 22.4 L = 22 400 mL and 24.0 L = 24 000 mL)

Calculate Equivalent Mass

1. Write the balanced equation for the reaction
   Determine mole ratio: metal reactant / H_2 gas produced
2. Determine slope (change in y) / (change in x)
   units: (ml/mg)
3. Adjust slope for the effect of the partial pressure of water vapor
   See *Procedure* for conversion chart
   Readings at 21 ^{o}C are about 2.5% too high
   (Hint: actual slope = calculated slope – (0.025 x calculated slope)
4. Divide 24 000 ml by the actual slope
   (24 000 ml/mol) / (slope ml/mg) = equivalent mass
   (Hint: convert answer from mg to g)
5. Equivalent mass is the atomic mass if the metal loses 1 electron

Calculate Atomic Mass

1. Multiply equivalent mass by mole ratio (Metal Reactant/H_2 Product) from the balanced equation.

Determine Percent Error

1. Percent Error = ((actual value-experimental value) / (actual value)) x 100
2. Use the atomic mass from the period chart as the actual value
3. Use the atomic mass you determined above for the experimental value

Example: Magnesium
$Mg + 2H+ \rightarrow Mg^{+2} + H_2$
Mole ratio is 1 mole Ca / 1 mole H_2
Slope = (415.5-0) / (390-0) = 1.06 ml/mg
Adjusted slope = 1.06 ml/mg – (0.025 x 1.06 ml/mg) = *1.03 ml/mg*
Equivalent mass = 24 000/1.03 = 20 000 mg/mol = *23.3 g/mol*
Atomic masses = equivalent mass x 1 = 23.3 g/mol x 1 = *23.3 g/mol*
Percent Error = ((actual value - experimental value))/(actual value)
((24.3 – 23.3) / (24.3)) x 100 = *4.11%*

Here are the equations for the Molar Volume Lab:

$Mg + 2H^{+} \rightarrow Mg^{+2} + H_2$
$Mn + 2H^{+} \rightarrow Mn+2 + H_2$
$Zn + 2H^{+} \rightarrow Zn+2 + H_2$
$NaHCO_3 + CH_3COOH \rightarrow CO_2 + H_2O + NaCH_3COO$
$CaC_2 + 2H_2O \rightarrow C_2H_2 + Ca(OH)_2$

Please remember to calculate percent error.

For the sodium bicarbonate reaction, you will need to add the molar mass of water to the calculated molar mass.

For the calcium carbide reaction, you will need to subtract the molar mass of calcium hydroxide from the calculated molar mass.