1) The equation for the first reaction is:

\[
\text{CaCO}_3(s) + 2\text{HCl}(aq) \rightarrow \text{CaCl}_2(aq) + \text{H}_2\text{O}(l) + \text{CO}_2(g)
\]

The second equation is, in net ionic form:

\[
\text{Ca}^{2+} + \text{C}_2\text{O}_4^{2-} \rightarrow \text{CaC}_2\text{O}_4(s)
\]

All the calcium we detect in the final calcium oxalate came from the bone sample. If we obtain 1.437 g CaC_2O_4 (M_m = 128.0996 g/mol), we have

\[
\frac{1.437 \text{ g}}{128.0996 \text{ g/mol}} = 1.122 \times 10^{-2} \text{ moles}
\]

of CaC_2O_4 and therefore of CaCl_2 in the solution, so we have a molarity, \[M = \frac{1.122 \times 10^{-2} \text{ moles}}{0.050 \text{ L}} = 0.224 \text{ M} \]

This number of moles is also that of Ca^{2+}, so we have (0.0122 moles)(40.08 g/mol) = 0.4496 g of Ca, giving a percentage = 22.48%.

2) We are told we get 7.964 g of AgCl, and, from the balanced equation, see that we get 2 AgCl for every 1 MCl_2. We can therefore determine the number of moles of MCl_2, and, given the mass of MCl_2 we have, the M_m, and eventually, both the mass and identity of M. Here we go.

The M_m of AgCl is (107.868 + 35.453) = 143.321 g/mol. Therefore we have

\[
\frac{7.964 \text{ g}}{143.321 \text{ g/mol}} = 0.0556 \text{ moles of AgCl}
\]

This result means we have 0.0278 moles of MCl_2, and, since there is 1 M atom per 1 MCl_2 molecule, 0.0278 moles of M. This 0.0278 moles of M is represented by 2.434 g of M, so the atomic mass of M = \[
\frac{2.434 \text{ g}}{0.0278 \text{ mole}} = 87.55 \text{ g/mol}
\]

which leads us to M = Sr.

3) Here is our general (not balanced!) equation: CaCO_3/MgCO_3 + 2 HCl → CaCl_2/MgCl_2 + H_2O + CO_2, although we can not use this equation to do the problem.

\[
\text{CaCO}_3/\text{MgCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2/\text{MgCl}_2 + \text{H}_2\text{O} + \text{CO}_2
\]

45.68 mL 0.2100 g combined salts

0.08750 M

3.997 \times 10^{-3} \text{ moles} \]

which is the number of moles of Cl\(^{-}\) available.

Let x = g CaCO_3 and y = g MgCO_3 so we can say:
$$\left( \frac{x}{100.0872 \text{ g}} \right) \times (110.984 \text{ g}) + \left( \frac{y}{84.314 \text{ g}} \right) \times (95.211 \text{ g}) = 0.2100 \text{ g}$$

moles CaCO$_3$  $M_m$(CaCl$_2$)  moles MgCO$_3$  $M_m$(MgCl$_2$)  combined mass of chlorides;

this simplifies to: 1.10887$x + 1.1292y = 0.2100$ g --call this equation A

Also realize that each MCl$_2$ species uses 2Cl$^-$ ions, so we can say:

$$\left( \frac{2x}{100.0872 \text{ g}} \right) + \left( \frac{2y}{84.314 \text{ g}} \right) = 3.997 \times 10^{-3} \text{ moles}$$

moles Cl$^-$ from CaCl$_2$  moles Cl$^-$ from MgCl$_2$

total moles Cl$^-$

1.998258 $x \times 10^{-2} + 2.3721 \times 10^{-2} y = 3.997 \times 10^{-3}$ --call this equation B.

From A: 0.2100 - 1.1292 $y = 1.10887 \times x$, which leads to: $x = (0.2100-1.1292y)/(1.1087)$; substituting this into B, we get:

$$1.998258 \times 10^{-2} ((0.2100 - 1.1292y)/1.10887) + 2.3721 \times 10^{-2} y = 3.997 \times 10^{-3}$$

Solving, this leads to: $4.407 \times 10^{-3} y = 2.127 \times 10^{-4}$ and $y = 0.0632 \text{ g} = \text{mass MgCO}_3$

Substituting again, $x = 0.1251 \text{ g} = \text{mass CaCO}_3$

Total mass = 0.1883 g and $\%\text{CaCO}_3 = (0.1251 \text{ g}/0.1883 \text{ g}) \times 100 = 66.4\%$.

4) You know the procedure; here are just the answers:

a) $16\text{MnO}_4^- + 40\text{H}_2\text{S} \rightarrow 5\text{S}_8 + 16\text{Mn}^{2+} + 16\text{H}_2\text{O} + 48 \text{OH}^-$

b) $4\text{Zn} + 2\text{NO}_3^- + 10\text{H}^+ \rightarrow 4\text{Zn}^{2+} + \text{N}_2\text{O} + 5\text{H}_2\text{O}$

c) $3\text{MnO}_4^{2-} + 2\text{H}_2\text{O} \rightarrow 2\text{MnO}_4^- + \text{MnO}_2 + 4\text{OH}^-.$

d) $3\text{Br}_2 + 3\text{H}_2\text{O} \rightarrow 5\text{Br}^- + \text{BrO}_3^- + 6\text{H}^+$

5) No, I would not expect a precipitation reaction, since the ionic compound that is not an electrolyte is also probably not soluble. Since reactions occur in solution, without solubility, no reaction.