Question 1 (Points Guesstimate 4, 5, 1)

(a) (i) $MgF_{2(s)} \leftrightarrow Mg^{2+}_{(aq)} + 2F^{-}_{(aq)}$

(ii) Moles of F^{-} = $(2.4 \times 10^{-3}\ M)(0.100\ L) = 2.4 \times 10^{-4}$

Moles of Mg^{2+} = $\dfrac{2.4 \times 10^{-2}}{2} = 1.2 \times 10^{-4}$

(iii) $Ksp = [Mg^{2+}][F^{-}]^2 = (1.2 \times 10^{-3})(2.4 \times 10^{-3})^2 = 6.9 \times 10^{-9}$

(b) (i) *For CaF_2*

$Ksp = 3.5 \times 10^{-11} = [0.1][F^{-}]^2$

$[F^{-}] = 1.9 \times 10^{-5}$ = the concentration of fluoride ions that must be achieved to create a precipitate

For BaF_2

$Ksp = 1.8 \times 10^{-6} = [0.1][F^{-}]^2$

$[F^{-}] = 4.2 \times 10^{-3}$ = the concentration of fluoride ions that must be achieved to create a precipitate

Since the concentration of F^{-} needed for CaF_2 to precipitate is much smaller than that of BaF_2, and on the addition of NaF will be reached first, the CaF_2 will precipitate first.

(ii) See (b)(i)

(iii) To achieve a concentration of 1.9×10^{-5} M in a 500 mL solution, one needs to add 9.5×10^{-6} moles of F^{-}.

9.5×10^{-6} mols = (0.20 M)(volume)

volume = 0.000048 L

(c) Changing the temperature of the solution to favor the forward reaction, or disturb the equilibrium by removing product ions (i.e., favor the forward reaction).

Question 2 (Points Guesstimate 2, 1, 2, 1, 3)

(a) Moles of Al = $\dfrac{235 \text{ g}}{27.0 \text{ gmol}^{-1}}$ = 8.70 mols

Since $Al^{3+} + 3e^- \rightarrow Al$, in order to produce 4 moles of Al, 12 moles of electrons must be passed. By ratio,

$$\frac{4}{12} = \frac{8.70}{X}$$

X = 26.1 moles of electrons

(b) q = (26.1)(96500) = 152 amps (t)

t = 1.66×10^4 seconds

(c) Moles of CO_2 = (8.703)(3) / (4) = 6.53 moles of CO_2

P V = n R T

(0.952) (V) = (6.53) (0.0821)(301)

V = 170. L

(d) In the solid state the ions cannot move, but in the molten sate they can. Movement of ions is required for an ionic substance to conduct electricity.

(e) (i) +2.35 V + -0.83 V = +1.52 V

(ii) $\Delta G = - n F E$

$= - (6)(96500)(1.52) = -8.80 \times 10^5 \text{ J} = -880. \text{ kJmol}^{-1}$

Question 3 (Points Guesstimate 2, 1, 2, 2, 2)

(a) Moles of HCl in all experiments = (0.100 L) (1.0 M) = 0.100 moles

$$\text{Moles of MgO} = \frac{0.50\text{ g}}{(24.3 + 16.00)\text{ gmol}^{-1}} = 0.012\text{ moles}$$

OR

$$\text{Moles of MgO} = \frac{0.25\text{ g}}{(24.3 + 16.00)\text{ gmol}^{-1}} = 0.0062\text{ moles}$$

In all experiments, the moles of MgO required to react with 0.100 moles of HCl is 0.500 moles, and in all experiments there is insufficient MgO present. MgO is the limiting reagent.

(b) Trial 1 has a temperature change that is disproportionately small when compared to trials 2, 3 and 4. We would expect a change of closer to 2 degrees Celsius.

(c) Using trial 4

$q = (m)(c)(\Delta T)$

$= (100.50)(4.18)(4.0)$

$= 1.7 \times 10^3$ J

(d) Use moles of limiting reactant and understand this is an exothermic reaction so q is negative,

$$\frac{-\ 1700.\text{ J}}{0.012\text{ mols}} = -\ 1.40 \times 10^2\text{ kJ/mol}$$

(e) $\Delta H = \Sigma\Delta H_{f\ Products} - \Sigma\Delta H_{f\ Reactants}$

$= (-467+-286) - (-602+0) = -151$ kJ

(f) If heat were lost to the environment, ΔT would be smaller and hence q would be a negative number with a smaller magnitude. This is what has happen in the calculation in (d), so yes, this is a plausible explanation.

Question 4 (Points 5, 5, 5)

(a) (i) $3Ca^{2+} + 2PO_4^{3-} \rightarrow Ca_3(PO_4)_2$

(ii) 0.001 moles

(b) (i) $CO_2 + H_2O \rightarrow H_2CO_3$

(ii) H_2CO_3 will hydrolyze in water to yield H^+ ions (it is an acid)

(c) (i) $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$

(ii) Ethanoic acid is a weak acid whereas hydrochloric is a strong acid. The concentration of hydrogen ions in the ethanoic acid is lower, and the reaction is slower.

Question 5 (Points Guesstimate 2, 1, 1. 1, 3)

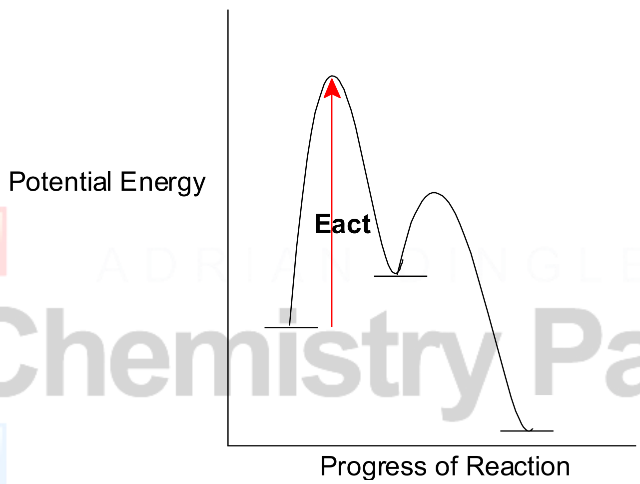
(a) At higher temperatures the kinetic energy of the gas particles increases, so the molecules hit the walls of the container more frequently, and with a greater force.

(b) In the course of the reaction, two moles of gas become one mole of gas. The pressure decreases as the number of moles decreases since the number of collisions between the molecules and the container are reduced.

(c) Rate = k [C_2H_4] [HCl]

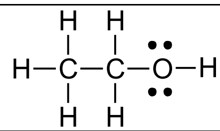
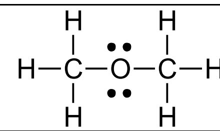
(d) $C_2H_5^+$ or Cl^-

(e) (f)



Question 6 (Points Guesstimate 2, 2, 2, 2, 1)

(a) (i) & (ii)

	
Box X	**Box Y**

(b) Box X is compound 2.

The two compounds have similar London dispersion forces (same number of electrons). Both are polar (presence of electronegative oxygen).

In addition, compound 2 has intermolecular forces that are hydrogen bonds which means it will be highly soluble in water (via hydrogen bonding interactions with H_2O), and it will have a relatively high boiling point (since hydrogen bonding is a relatively strong intermolecular force). Compound 1 does not exhibit such hydrogen bonding.

(c) Dichloromethane is a polar molecule that will attract polar water molecules making it soluble. Carbon tetrachloride is non-polar (since the dipoles cancel out) and as such, polar water will not be attracted to it.

(d) The *total* intermolecular forces present in CCl_4 are relatively strong when compared to the *total* intermolecular forces for CH_2Cl_2. The relatively large size of CCl_4 and its high polarizability, makes the sum of the London dispersion forces of CCl_4 greater than the sum of the dipole-dipole and London dispersion intermolecular forces in CH_2Cl_2.

(e)