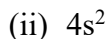
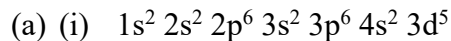


Question 1



(b) $62.673 - 61.262 = 1.411 \text{ g}$

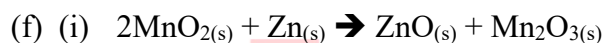
(c) $1.411 \text{ g} / 35.45 \text{ gmol}^{-1} = 0.03980 \text{ mols}$

(d) Formula is a ratio of the moles,

$$0.03980 \text{ mols Cl} : 0.0199 \text{ mols of Mn} = 2 \text{ Cl} : 1 \text{ Mn}$$



(e) Less than. If MnCl_2 is lost then the final mass of the beaker and contents will be less, so the calculated mass of the Cl will be too small, and the calculated moles of Cl will be too small.



(ii) $0.15 \text{ V} + 1.28 \text{ V} = 1.43 \text{ V}$

(iii) $\Delta G^\circ = -nFE^\circ = (2)(96485)(1.43) = -276 \text{ kJ/mol}_{\text{rxn}}$

(iv) Disagree. Any loss of mass of reactants will be compensated for by a gain in mass of products, and nothing can escape the sealed container.

Question 2

(a) Moles of Cl is three times that of AlCl_3 (from balanced equation) = $(3)(1.25) = 3.75$ mols

$$\text{Mass} = (3.75)(35.45) = 133 \text{ g}$$

(b) Flip reaction 2, add reaction 3, add reaction 4 x 1.5

$$583 + 326 + ((1.5)(243)) = 1274 \text{ kJ/mol}_{\text{rxn}}$$

(c) (i) 200 pm

(ii) Similar shaped curve, but with a trough at -425 on y-axis and 220 on x-axis.

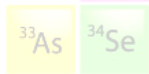
(d) (i) Diagram 2. 3BP and 1LP around central atom creates a trigonal pyramidal shape.

(ii) Diagram 1. All atoms have a formal charge of 0. Not true for other structures.

(e) $K_p = (\text{pp Al}_2\text{Cl}_6)/(\text{pp AlCl}_3)^2$

(f) $\text{pps} = (\text{mole fraction})(\text{total pressure})$

$$K_p = (3/10 * 22.1)/(7/10 * 22.1)^2 = 0.0277$$



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Question 3



- (b) The time taken for small chunks should be between 22 and 114 seconds since we know that under other identical conditions, small chunks will react more quickly than large chunks but more slowly than fine powder.
- (c) Large surface area in trial 2 means a greater number of successful collisions between the calcium carbonate solid and the aqueous acid, so a faster rate of reaction.
- (d) Disagree. Changing the concentration of HCl is affecting the rate which is inconsistent with a zero order for HCl.
- (e) Moles of HCl reacted is twice that of calcium carbonate (from balanced equation) = $(2)(1.00/100.09) = 0.0200$ mols of HCl

$$\text{Moles of HCl initially} = (0.0500)(1.00) = 0.0500 \text{ mols}$$

$$\text{Moles in of HCl in XS} = \text{Initial} - \text{Reacted} = 0.0500 - 0.0200 = 0.0300 \text{ mols}$$

$$\text{Concentration at end of experiment} = (0.0300)/(0.0500) = 0.600 \text{ M}$$

- (f) Exothermic. The temperature of the surroundings increases, meaning the system (reaction) is releasing energy.

(g) (i) $q = m c \Delta T = (51.0)(4.0)(21.90 - 21.20) = 140 \text{ J}$

(ii) Exothermic reaction has a negative ΔH° so $\Delta H^\circ = -140 \text{ J}/(1000 \text{ J/kJ}) = -0.14 \text{ kJ}$

$$\text{Moles of CaCO}_3 = (1.00/100.09) = 0.0100 \text{ mols}$$

$$\Delta H^\circ = -0.14 \text{ kJ}/0.0100 \text{ mols} = -14 \text{ kJ/mol}_{\text{rxn}}$$

Question 4

(a) $(0.00250)(67.518) = 0.169 \text{ g}$

(b) Step 1: Place weighing paper on electronic balance and 'zero' (tare) the balance. Transfer the solid to the paper using the small spatula to a mass of 0.169 g.

Step 4: Rinse buret with 0.100 M CH_3NH_2 solution and fill with the same. Record starting volume.

(c) Equal to. The ratio of the moles of the conjugate base and acid is the same in both solutions, i.e., nothing changes in the Henderson-Hasselbalch equation used to calculate the pH of a buffer.



Question 5

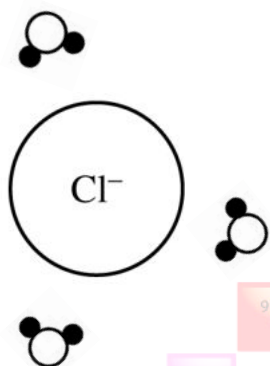
(a) (i) $PV = nRT = (7.45)(6.00) = n(0.08206)(296)$

$$n = 1.84 \text{ mols}$$

(ii) $P_1/T_1 = P_2/T_2 = (7.45)/(296) = (P_2)(271)$

$$P_2 = 6.82 \text{ atm}$$

(b)



(c) HNO_2 . It is a weak acid so would have relatively few HA molecules dissociated. The other acids are strong, with relatively huge K_a values, and would be completely dissociated.

Question 6

(a) HBr: London dispersion forces, dipole-dipole forces

HF: London dispersion forces, dipole-dipole forces, hydrogen bonding

(b) (i) The sum of the intermolecular forces for HF is greater than the sum of the IMFs for HBr so more energy is required to separate the molecules of HF from one another.

(ii) $(6.85/(20.008))(25.2) = 8.63 \text{ kJ}$

(c) Bond length can be thought of as the distance between the nuclei of the atoms in a molecule. H is common to both, but the Br atom is much larger than the F atom since it has two more occupied principal quantum levels when compared to F.



Question 7

(a) Incorrect ratio of positive to negative ions.

(b) (i) Ratio of hydroxide ions to strontium ions is 2:1 (from balanced equation) = $(2)(0.043)$
0.086 M

(ii) $K_{sp} = (0.043)(0.086)^2 = 3.2 \times 10^{-4}$

(c) Less than. $[Sr^{2+}]$ is greatly increased from the nitrate solution, and with a fixed K_{sp} at a fixed temperature, $[OH^-]$ must decrease to produce the same K_{sp} value.

