1. Hydrazine, H2NNH2, is used as a rocket fuel. For liquid hydrazine at 25°C, $\Delta H°f = 50.63$ kJ.mol and S° is 121.2 J/K.mol. Can hydrazine be prepared from the reaction?

N2(g) + 2H2(g) ----> H2NNH2(l)

At 25°C, S° for N2(g) = 0.192 J/K.mol and S° for H2(g) = 130.68 J/K.mol.

2. Use the data that is provided below to calculate the standard free-energy change for the thermal decomposition of calcium carbonate at 25°C. Is the reaction spontaneous under these conditions? Explain your answer.

CaCo3(s) ----> CaO(s) + CO2(g)

ΔH°f(kJ/mol)	-1206.9	-635.1	-393.5
S°(J/K.mol)	92.9	39.7	213.6

3. Calculate the free energy change, ΔG, for the formation of ethylene (C2H4) from carbon and hydrogen at 25°C when the partial pressures are 10 atm H2 and 2.0 atm C2H4, then tell whether the reaction is spontaneous in the forward direction or not.

2C(s) + 2H2(g) ----> C2H4(g), $\Delta G° = 68.1$ kJ

4. Consider the following anaerobic fermentation reaction of glucose:

C6H12O6(aq) ----> 3CH4(g) + 3CO2(g), $\Delta G° = -418$ kJ.

If ΔG° for CH4 is -50.8 kJ/mol and -394.2 kJ/mol for CO2, what is ΔG° for C6H12O6?

5. Calculate ΔG°f and Kp for NH3 at 25°C given that for ΔG° for the reaction is -31.0 kJ:

N2(g) + 3H2(g) <----> 2NH3(g)

6. Consider the galvanic cell that uses the reaction:

2Ag^+(aq) + Cu(s) ----> Cu^2+(aq) + 2Ag(s)

Clearly sketch the experimental set-up, write down the anode and cathode half-reactions, and give the shorthand notation for the cell.

7. Write a balanced equation for the overall cell reaction, and calculate the standard free energy change at 25°C for the following cell:

Zn(s)|Zn^2+ (1.00 M)||H^+ (1,00 M)|H2 (1.0 atm)|Pt(s)

8. Calculate the standard cell potential E°, for each of the following reactions and predict whether or not reaction will take place spontaneously under standard conditions:

(a) Al(s) + Cr^3+(aq) ----> Al^3+(aq) + Cr(s)

(b) 2Fe(s) + 6H^+(aq) ----> 2Fe^2+(aq) + 3H2(g)

(c) O2(g) + 4Fe^2+(aq) + 4H^+(aq) ----> 4Fe^3+(aq) + 2H2O(l)

9. Consider the following galvanic cell that uses the reaction:

Fe(s) + 2Fe^3+(aq) ----> 3Fe^2+(aq)

What is the potential of a cell at 25°C that has the following ion concentrations?

[Fe^3+] = 0.3 M, [Fe^2+] = 0.15 M

10. Consider the following cell:

Pt(s)|H2(g, p1)|H^+(aq, **pHa**)||H^+(aq, **pHa**)|H2(g, p2)|Pt(s)

Where pHa is the pH of the aqueous solution in the anode half-cell and pHb is the pH of the aqueous solution in the cathode half-cell. (They both say pHa. I'm pretty sure the one on the right is pHb.) If the partial pressure of H2(g) is the same for both half-cells, (p1 = p2), what is E for the cell at 25°C?

(Hint: Use the Nernst equation and remember pH = -log([H^+]).

Standard Reduction (Electrode) Potentials at 25°C:

2H+(aq) + 2e- ----> H2(g) E° = 0 V

Al^3+(aq) + 3e- ----> Al(s)E° = -1.66 V

Fe^3+(aq) + e- ----> Fe^2+(aq) E° = 0.77 V

Cr^2+(aq) + 3e- ----> Cr(s) E° = -0.74 V

Fe^2+(aq) + 2e- ----> Fe(s) E° = -0.44 V

O2(g) + 4H^+(aq) + 4e- ----> 2H2O(l) E° = 1.23 V

$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$ $E° = -0.76$ V

$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$ $E° = 0.34$ V