

Chemistry 2850 Practice Test 2

Time: 50 min

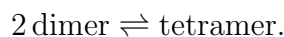
Marks: 49

Aids permitted: calculator, one 8.5×11 -inch formula sheet

1. Give one statement of the third law of thermodynamics. [2 marks]
2. What is wrong with the following statement? [2 marks]

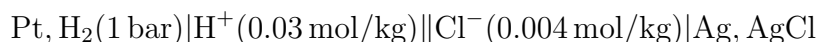
ΔG gives the maximum work which a system can perform at constant temperature and pressure.

3. (a) Write down an expression for $d(\Delta G^\circ)$ in terms of dP and dT . [1 mark]
(b) Suppose that we increase the pressure on a system at equilibrium holding the temperature constant. What determines the sign of the change in ΔG° ? [2 marks]
(c) Suppose that, for a given system, an increase in pressure causes an increase in ΔG° . What effect does this have on the equilibrium constant? Is your answer consistent with Le Chatelier's principle? Explain briefly. [6 marks]
4. Derive an equation for the cubic expansion coefficient of an ideal gas. Write your answer in terms of P , T and n . [4 marks]
5. Haemoglobin Howick (HH) is a naturally occurring mutant form of haemoglobin. It normally exists in solution as a dimer (two copies of the protein associated together) but can also form a tetramer:



The equilibrium constant for this reaction is 3.3×10^5 (standard state = 1 mol/L) for deoxygenated HH. If a solution of $100 \mu\text{mol/L}$ of HH monomers is made, what are the equilibrium concentrations of dimer and tetramer? [8 marks]

6. What emf (voltage) would be generated by the cell



at 25°C assuming ideal behavior? [8 marks]

7. The standard enthalpy of formation of carbon dioxide is -393.51 kJ/mol . Calculate the standard free energy of formation of carbon dioxide. [6 marks]
8. Consider the following equilibrium vapor pressure data for benzene:

$T/^\circ\text{C}$	3.0	35.3	72.6	80.1
P/mmHg	30	150	600	760

Determine the enthalpy of vaporization of benzene from these data. [10 marks]

Hint: Start by writing a chemical reaction representing the process.

Useful data

$$F = 96\,485.3383\text{ C/mol}$$

$$R = 8.314\,472\text{ J K}^{-1}\text{mol}^{-1}$$

$$1\text{ bar} = 750\text{ mmHg}$$

To convert degrees Celsius to Kelvin, add 273.15.

Standard Entropies at 25°C and 1 bar	
Species	$\bar{S}^\circ/\text{J K}^{-1}\text{mol}^{-1}$
C _(s) (graphite)	5.74
CO _{2(g)}	213.785
O _{2(g)}	205.152

Reduction process	$\mathcal{E}^\circ/\text{V}$
$2\text{H}_{(\text{aq})}^+ + 2\text{e}^- \rightarrow \text{H}_{2(\text{g})}$	0
$\text{AgCl}_{(\text{s})} + \text{e}^- \rightarrow \text{Ag}_{(\text{s})} + \text{Cl}_{(\text{aq})}^-$	0.222 33