1). For an electron in a cubical box of side 1.00×10^{-9} m, find the energy and the degeneracy of the level in which the state corresponding to (1, 2, 3) occurs. (16%)

2). The enthalpy of vaporization of a certain liquid is found to be 14.4 $kJ\cdot mol^{-1}$ at 180K, its normal boiling point. The molar volumes of the liquid and the vapour at the boiling point are 115 $cm^3\cdot mol^{-1}$ and 14.5 $dm^3\cdot mol^{-1}$ respectively. Estimate dP/dT from the Clapeyron equation and estimate the percentage error in its value if the Clausius-Clapeyron equation is used instead. (16%)

3). The free energy change for the reaction $S(rhombic) = S(monoclinic)$ over the limited temperature range 298 to 369 K at standard pressure is given by the equation

$$\Delta G_T^\circ = 83.68 - 0.356\,T\ln T + 2.389\,T - (1.38\times10^{-3})\,T^2 \quad J\cdot mol^{-1}$$

What is the value of ΔH° at 325 K? (17%)

4). Calculate the number of collisions per square centimeter per second of oxygen molecules with a wall at a pressure of 1 bar and 25°C. (17%)

5) At 18°C the total volume of a solution formed from $MgSO_4$ and 1.000 kg of water fits the expression

$$V/cm^3 = 1001.21 + 34.69\,(m - 0.070)^2$$

Calculate the partial molar volumes of the salt and the solvent when $m = 0.050\ mol\cdot kg^{-1}$. (17%)

6). The isotope $^{32}_{15}P$ emits β radiation and has a half-life of 14.3 days. Calculate the decay constant in s^{-1}. What percentage of the inital activity remains after (a) 20 days, (b) 100 days? (17%)

Notes: Planck constant, $h = 6.6261\times10^{-34}$ J·s
Electron rest mass, $m_e = 9.109\times10^{-31}$ kg