1). Calculate the osmotic pressure of a 1 mol L^{-1} sucrose solution in water from the fact that at 30°C the vapor pressure of the solution is 4.1606 kPa. The vapor pressure of water at 30°C is 4.2429 kPa. The density of pure water at this temperature (0.99564 $g cm^{-3}$) may be used to estimate $\bar{V}_1$ for a dilute solution. (12%)

2). Compare the entropy change for the system, surroundings and universe for the reversible isothermal expansion of one mole of an ideal gas from 0.010 m^3 to 0.100 m^3 at 298 K to the entropy changes for the same expansion performed irreversibly against a constant external pressure of 0.100 atm. (14%)

3). If 1.585 g of nitrogen tetroxide gives a total pressure of 1.0133 bar when partially dissociated in a 500-cm^3 glass vessel at 25°C, what is the extent of reaction ξ? What is the value of K_p? What is the extent of reaction at a total pressure of 0.5 bar? (13%)

4). (a) Calculate the work done against the atmosphere when 1 mol of toluene is vaporized at its boiling point, 111°C at 1 atm. The heat of vaporization at this temperature is 361.9 $J g^{-1}$. For the vaporization of 1 mol, calculate (b) q, ΔH, ΔU, ΔG, and ΔS (13%)

5). The two arms of a U-tube have radii of 0.05 cm and 0.10 cm. A liquid of density 0.80 $g cm^{-3}$ is placed in the tube, and the height in the narrow arm is found to be 2.20 cm higher than that in the wider arm. Calculate the surface tension of the liquid, assuming contact angle $\theta = 0$. (12%)

6). A first-order surface reaction is proceeding at a rate of 1.5×10^{-4} mol $dm^{-3} s^{-1}$ and a rate constant 2.0×10^{-3} s^{-1}. What will be the rate and the rate constant if (a) The surface area is increased by a factor of 10? (b) The amount of gas is increased tenfold at constant pressure and temperature? (12%)

7) Explain why Li^+ has a lower ionic conductivity than Na^+ and why the value for H^+ is so much higher than the values for both of these ions (12%)

8). The hydrolysis of ethyl acetate catalyzed by hydrochloric acid obeys the rate equation $v = k[\text{ester}][HCl]$, and the reaction essentially goes to completion. At 25°C the rate constant is $2.80 \times 10^{-5}\ dm^3\ mol^{-1}\ s^{-1}$. What is the half-life of the reaction if [ester] = 0.1 M and [HCl] = 0.01 M? (12%)