

1). A particle is moving in one dimension between  $x=a$  and  $x=b$ . The potential energy is such that the particle cannot be outside these limits and that the wavefunction in between is  $\psi = \frac{A}{x}$

(a) Determine the normalization constant  $A$ .

(b) Calculate the average value of  $x$ . (16%)

2). Obtain an expression for the Joule-Thomson coefficient,  $\mu_{J.T.}$ , for a gas obeying the equation of state,  $P(\bar{V}-b) = RT$ . (17%)

3). Show that the fugacity of a gas can be calculated at some pressure  $P$  if compressibility factor  $Z$  is known as a function of pressure up to that particular pressure from the following equation

$$\frac{f}{P} = \exp\left[\int_0^P \frac{Z-1}{P} dP\right] \quad (17\%)$$

4). When the reaction

glucose-1-phosphate (aq)  $\rightleftharpoons$  glucose-6-phosphate (aq)  
is at equilibrium at 25°C, the amount of glucose-6-phosphate present is 95% of the total. (a) Calculate  $\Delta_r G^\circ$  at 25°C.

(b) Calculate  $\Delta_r G$  for reaction in the presence of  $10^{-2} M$  glucose-1-phosphate and  $10^{-4} M$  glucose-6-phosphate. In which direction does reaction occur under these conditions? (17%)

5). What is the rate constant for the following reaction at 500K?



The rate constant for the backward reaction at 500K is  $3.1 \times 10^8 \text{ L mol}^{-1} \text{ s}^{-1}$ . The Gibbs energies of formation for H, Cl, and HCl at 500K are 192.955, 94.191, and -97.169 kJ mol<sup>-1</sup>, respectively. (17%)

6). (a) Explain why Trouton's rule, according to which the entropy of vaporization is  $88 \text{ JK mol}^{-1}$ , holds fairly closely for normal liquids.

(b) Why do positive and negative deviations from Raoult's law occur?

(16%)