Physical chemistry

Tutorial 3 (*16-10-2013*)

1. Consider the reaction $H_2 + Br_2 \longrightarrow 2HBr$. The reaction is carried out in a 0.25 L reaction vessel. The change in the amount of Br_2 in 0.01 s is -0.001 mol. A) What is the rate of conversion $d\xi/dt$? B) What is the rate of the reaction v? C) What are the values of $d[H_2]/dt$, $d[Br_2]/dt$, and $d[HBr]/dt$?
   (Physical Chemistry, ***Silbey, R. J.; Alberty, R. A;Bawendi, M. G.***, 4th ed.; 2006; Chapter 18, pp 643, example 18.1)

2. At 400 K, the rate of decomposition of a gaseous compound initially at a pressure of 12.6 kPa, was 9.71 Pas^{-1} when 10.0 percent had reacted. It was 7.67 Pas^{-1} when 20.0 percent had reacted. What is the order of the reaction?
   (Physical Chemistry, ***Atkins, P.W.; Paula, J. D.***, 8th ed.; Oxford: New York, 2006; Chapter 22, page 825, exercise 22.5b)

3. Radium has a half life of 1600 years. How much disintegration per sec would be undergone by 1 g of radium?

4. Specific rate of decomposition of a gas is given to be $k = 2.80 \times 10^{-3}$ dm^3 mol^{-1} s^{-1} at 30º C and 1.38×10^{-2} dm^3 mol^{-1} s^{-1} at 50º C. Calculate Arrhenius parameters for the reaction.
   (Physical Chemistry, ***Atkins, P.W.; Paula, J. D.***, 8th ed.; Oxford: New York, 2006; Chapter 22, page 826, exercise 22.14a)

5. The activation energy of a first order reaction is 1,04,600 J mol^{-1} and pre exponential factor is 5×10^{13} s^{-1}. At what temperature will the reaction have a half-life of 30 days?

6. Consider a system A consisting of subsystems A_1 and A_2, for which $W_1 = 1 \times 10^{20}$ and $W_2 = 2 \times 10^{20}$. What is the number of configurations available to the combined system? Also compute the entropies S, S_1 and S_2.

   (Atkins, P.W.; Paula, J. D. *Atkins' Physical Chemistry*, 8th ed.; Oxford: New York, 2006; Chapter 16, pp 586, Problem No: 16.1)

7. At what temperature would the population of the first excited rotational level of HCL be 1/e times its population of the ground state?

   (Atkins, P.W.; Paula, J. D. *Atkins' Physical Chemistry*, 8th ed.; Oxford: New York, 2006; Chapter 16, pp 586, Problem No: 16.9b)

8. Consider a system of distinguishable particles having only three non-degenerate energy levels separated by an energy which is equal to the value of *k*T at 25 K. At 25 K calculate a) the ratio of populations in the states, b) the molecular partition function and c) the molar internal energy.

   (Atkins, P.W.; Paula, J. D. *Atkins' Physical Chemistry*, 8th ed.; Oxford: New York, 2006; Chapter 16, pp 586, Problem No: 16.8b)

9. A certain molecule has a doubly degenerate excited state lying at 360 cm^{-1} above the non-degenerate ground state. At what temperature will 15 % of molecules be in upper state?

   (Atkins, P.W.; Paula, J. D. *Atkins' Physical Chemistry*, 8th ed.; Oxford: New York, 2006; Chapter 16, pp 586, Problem No: 16.6b)