說明：1.請依序作答並標明題號
2.計算題必須寫出計算過程，只寫答案不給分
3. $R = 8.314\ J\ mol^{-1}K^{-1} = 1.987\ cal\ mol^{-1}K^{-1}$

1. Comparing two reactions with different activation energies, for which will the rate increase more rapidly with temperature ? why ? (5%)

2. If a first-order reaction is 20% complete in 20 minutes, how long will it take to be 90% complete ? (6%)

3. The overall rate constant of a reaction is related to the rate constants of three elementary reactions as $k = k_1\sqrt{k_2}/k_3$. How is the Arrhenius activation energy of the overall rate constant related to those of the elementary reactions ? (10%)

4. An electronically excited atom can either fluoresce or lose its energy by collision with some other molecules. For example,

$$Hg^* \xrightarrow{k_1} Hg + h\nu$$
$$Hg^* + Ar \xrightarrow{k_2} Hg + Ar$$

These reactions are elementary processes. What is the rate law of each ? What is the expression for the fraction of atoms lost by fluorescence at a given pressure of Ar ? (14%)

5. Calculate ΔG° for each of the following transformations :
a. $H_2O\ (\ell, 100\ ^\circ C) \rightleftharpoons H_2O\ (g, 100\ ^\circ C)$, the vapor pressure of H_2O at 100 °C is 101.325 kPa (5%)
b. $H_2O\ (\ell, 25\ ^\circ C) \rightleftharpoons H_2O\ (g, 25\ ^\circ C)$, the vapor pressure of H_2O at 25 °C is 3.17 kPa (10%)

6. Calculate K (equilibrium constant) at 25 °C for the reaction

$$NO_{(g)} + 1/2\ O_{2\,(g)} = NO_{2\,(g)}$$

where $\Delta G^\circ = -8.33$ kcal/mol. Which factor, enthalpy or entropy, makes K greater than unity and thereby provides the principal driving force for the reaction ? (14%)

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7. For the process A → B, the value ΔG is 30 KJ at 25 °C, and 30.02 KJ at 26 °C. Estimate ΔS for the process. (6%)

8. For the process A → B, the function ΔH = −50 KJ and ΔS = −100 JK^{-1} At what temperature is A in equilibrium with B ? (5%)

9. Give the ground-state electron configuration, bond order, and term state for H_2^- (6%)

10. Please answer the following questions: (12%)
(a) de Broglie wavelength
(b) time-independent Schrödinger equation
(c) Bohr correspondence principle
(d) Born-Oppenheimer approximation
(e) Franck-Condon principle
(f) commute of two operators

11. Please describe hard-sphere potential and Lennard-Jones potential (7%)