

第一部分 單選題 (1-15)，每題 5 分，共 75 分 ※注意：請於試卷首頁「選擇題作答區」作答。

- Which of the following graphs does not give a straight line for an ideal gas? (A) V vs T , (B) T vs P , (C) P vs $1/V$, (D) n vs $1/T$, (E) n vs $1/P$.
- Consider the reaction: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. At equilibrium at a certain temperature, the concentrations of $NH_3(g)$, $H_2(g)$ and $N_2(g)$ are 0.94 M, 1.60 M, and 0.52 M respectively. The equilibrium constant for the reaction is (A) 0.415, (B) 1.13, (C) 1.06, (D) 0.664, (E) 1.27.
- The activation energy for the isomerization of cyclopropane to propene is 274 kJ/mol. By what factor does the rate of reaction increase as the temperature rises from 500 °C to 550 °C, assuming all else remains constant? (A) 1, (B) 13, (C) 2.6, (D) 400, (E) 52.
- A large flask of water is placed on a heater and 100 J of energy is transferred reversibly to the water at 298 K. What is the change in entropy of the water? (A) -0.336 J/K, (B) 2.98 J/K, (C) 0.336 J/K, (D) -2.98 J/K. (E) There is not enough information given to answer the question.
- Which of the following statements is a true statement concerning a reaction that has reached a state of equilibrium? (A) A system has reached equilibrium when the concentrations of reactants and products correspond to the stoichiometric ratios determined by the balanced equation. (B) A system has reached equilibrium when the reaction has stopped and no more products are formed. (C) A system has reached equilibrium when the concentrations of reactants and products remain constant. (D) A system has reached equilibrium when the rate constant for the forward reaction equals the rate constant of the reverse reaction. (E) None of the options is correct.
- A reaction decays via first order kinetics with a rate constant given by $5 \times 10^{-2} \text{ s}^{-1}$. The half life of the reaction is (A) 13.8 s, (B) 138 s, (C) 138 hours, (D) 1.38 s, (E) 0.138 s.
- For the reaction $CO_2 \rightleftharpoons CO + 1/2O_2$, the equilibrium constant is $10^{-3} \text{ atm}^{1/2}$ at 2000 K and ΔS° is 21 cal/K/mol ($\Delta C_p = 0$). Assume ΔH° and ΔS° do not change with temperature. ΔG° at 298 K is (A) 27.4 kcal/mol, (B) 14.6 kcal/mol, (C) 102.6 kcal/mol, (D) 63.1 kcal/mol, (E) 5.6 kcal/mol.
- An ideal gas ($\gamma = 1.40$) is used in a Carnot cycle as a working substance. In an adiabatic expansion, the gas volume increases 2.75 times. The efficiency of the cycle is (A) 12%, (B) 67%, (C) 50%, (D) 25%, (E) 33%.
- A monoatomic gas expands isobarically. The percentage of heat supplied that increases the thermal energy and that involved in doing work for the expansion is (A) 50:50, (B) 60:40, (C) 40:60, (D) 75:25, (E) 80:20.
- A spontaneous reaction is impossible if (A) both ΔH and ΔS are negative, (B) both ΔH and ΔS are positive, (C) ΔH is negative and ΔS is positive, (D) ΔH is positive and ΔS is negative. (E) None of the options is correct.
- The enthalpy of formation of methane, $C(s) + 2H_2(g) \rightarrow CH_4(g)$, at constant pressure and 300 K is -18500 cal/mol. The enthalpy of formation at constant volume is (A) -19700, (B) -17300, (C) -18200, (D) -18500 (E) -18800 cal/mol.
- The enthalpies of solutions of $BaCl_2(s)$ and $BaCl_2 \cdot H_2O(s)$ are -20.6 kJ/mol and 8.8 kJ/mol, respectively. ΔH for the hydration of $BaCl_2(s)$ to $BaCl_2 \cdot H_2O(s)$ is (A) -38.2, (B) -11.8, (C) 29.4, (D) 11.8, (E) -29.4 kJ/mol.
- Which of the following statements about catalysts is false? (A) Catalysts do not appear in the balanced equation. (B) Catalysts reduce the activation energy for a reaction. (C) Biological catalysts are called enzymes. (D) Catalysts do not alter the mechanism of the reaction and never appear in the rate law. (E) Since catalysts are recycled, even a small amount of catalyst can accelerate a reaction.
- Consider the consecutive first-order reaction $P \xrightarrow{k_1} Q \xrightarrow{k_2} R$. If $k_1 = 0.01 \text{ min}^{-1}$ and $k_2 = 0.02 \text{ min}^{-1}$, after what time from the start of reaction, the concentration of Q will be maximum? (A) 70 min, (B) 140 min, (C) 35 min, (D) 700 min, (E) 5 min.
- According to the collisions theory, the rate of reaction increases with temperature due to (A) increase in number of collisions between reactant molecules, (B) increase in speed of reacting molecules, (C) increase in the number of molecules having sufficient energy for reaction, (D) decrease in activation energy of reaction. (E) None of the options is correct.

見背面

第二部分 非選擇題 (16-19)，共 25 分 ※注意：請於試卷上「非選擇題作答區」作答，並註明作答之題號。

16. (6%) Derive a mathematical expression for the work done on the surroundings when a gas that has the equation of state $PV = nRT - n^2a/V$ expands reversibly from V_i to V_f at constant temperature.
17. (6%) In the reaction, $A_2 \rightleftharpoons 2A$, the ideal gas A_2 undergoes partial dissociation to the ideal gas A . The equilibrium constant, given in terms of partial pressures, is K . Derive a mathematical expression for the degree of dissociation α of A_2 in terms of K and the total pressure P (total pressure of A_2 and A).
18. (6%) Given that solid A does not float on liquid A , explain whether the melting point of the solid will be raised or lowered by pressure.
19. (7%) The hydrogenation of ethylene, $C_2H_4 + H_2 \rightarrow C_2H_6$, in the presence of mercury vapor is thought to proceed through the following steps:



Assuming that H and C_2H_5 attain equilibrium, determine the rate of formation of C_2H_6 in terms of the rate constants and concentrations $[Hg]$, $[H_2]$ and $[C_2H_4]$.

試題隨卷繳回