第一部分 單選題（1-16），每題 5 分，共 80 分 ※注意：請於試卷首頁「選擇題作答區」作答。

1. The work done by one mole of an ideal gas in the reversible process: PV^3 = constant from 1 atm at 300 K to $2\sqrt{2}$ atm is (A) 150R, (B) 300R, (C) 75R, (D) 600R, (E) 20R.
2. What is the entropy change when 3.6 g of liquid water is completely converted into vapors at 373 K? The molar heat of vaporization is 40.85 kJ/mol. (A) 220.2 J/K, (B) 21.9 J/K, (C) 1.6 J/K, (D) 56.5 J/K, (E) 120.6 J/K.
3. The equation of state for one mole of a gas is $PV = RT + BP$, where B is a constant, independent of temperature. The internal energy of fixed amount of gas is function of temperature only. If one mole of the above gas is isothermally expanded from 12 L to 22 L at a constant external pressure of 1 bar at 400 K, then the change in enthalpy of the gas is approximately (B = 2 L/mol) (A) 0 J, (B) -3.32 J, (C) -16.6 J, (D) -166 J, (E) -332 J.
4. A piece of alloy weighing 4 kg and at a temperature of 800 K is placed in 4 kg of water at 300 K. If the specific heat capacity of water is 1.0 cal/K/g and that of alloy is 4 cal/K/g, the ΔS_{mix} is (A) 3.33 kcal/K, (B) -1.0 kcal/K, (C) -3.33 kcal/K, (D) 1.33 kcal/K, (E) 1.0 kcal/K.
5. Enthalpy of neutralization of H_3PO_3 by NaOH is -106.68 kJ/mol. If the enthalpy of neutralization of HCl by NaOH is -55.84 kJ/mol. The ΔH of H_3PO_3 dissociating into its ions is (A) 51 kJ/mol, (B) 5 kJ/mol, (C) 10 kJ/mol, (D) 2.5 kJ/mol, (E) 86 kJ/mol.
6. A volume of 4.0 L of a mixture of ethane and methane gases on complete combustion at 300 K produced 6.0 L of carbon dioxide. Find out the amount of heat evolved on burning 1 L of gaseous mixture. The heats of combustion of ethane and methane are -1573 and -890 kJ per mole, respectively, at 300 K. (A) 4926 kJ, (B) 2000 kJ, (C) 1232 kJ, (D) 200 kJ, (E) 856 kJ.
7. The polymerization of ethylene to linear polyethylene is represented by the reaction: $n CH_2 = CH_2 \rightarrow (-CH_2-CH_2-)_n$, where n has a large integral value. Given that the average enthalpies of bond dissociation for C=C and C-C at 298 K are 590 and 331 kJ/mol, respectively, the enthalpy of polymerization per mole of ethylene at 298 K is (A) -72 kJ, (B) 259 kJ, (C) -259 kJ, (D) -849 kJ, (E) 849 kJ.
8. When pressure is applied to the equilibrium system: Ice $\rightleftharpoons$ water, which of the following phenomenon will happen? (A) more ice will be formed, (B) more water will be formed, (C) ice will sublime, (D) water will evaporate, (E) equilibrium will not disturb.
9. The reaction, $ZnO(s) + CO(g) \rightleftharpoons Zn(g) + CO_2(g)$, has an equilibrium constant of 1 atm at 1500 K. If an equimolar mixture of CO and CO_2 is brought into contact with solid ZnO at 1500 K and the equilibrium is achieved at 1 atm, the equilibrium partial pressure of zinc vapor in a reaction vessel is (A) 0.68 atm, (B) 0.76 atm, (C) 0.12 atm, (D) 0.5 atm, (E) 0.24 atm.
10. At 525 K, $PCl_5(g)$ is 80% dissociated at a pressure of 1 atm. Now, sufficient quantity of an inert gas at constant pressure is introduced into the above reaction mixture to produce inert gas partial pressure of 0.9 atm. What is the percentage dissociation of $PCl_5(g)$ when equilibrium is re-established? (A) 97.3%, (B) 80%, (C) 65.6%, (D) 24.7%, (E) 86.6%.

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11. For the reaction at 300 K and constant pressure: F(g) + G(g) ⇌ H(g) + I(g) + J(g); ΔE^0 = - 30 kcal and ΔS^0 = 100 cal/K, the value of equilibrium constant is (A) e, (B) e^2, (C) $1/e$, (D) $1/e^2$, (E) 1.

12. The order of a reaction is zero. It will be definitely (A) exothermic, (B) endothermic, (C) elementary, (D) complex, (E) gaseous.

13. As the initial concentration increases from 0.75 to 1.55 M in a reaction, the time for half change $t_{1/2}$ decreases from 60 to 29 s. The order of the reaction is (A) 0, (B) 3, (C) 2, (D) 1, (E) 1.5.

14. The reaction: W(g) + 2X(g) → Y(g) + Z(g) is an elementary process. In an experiment, the initial partial pressure of W and X are P_W = 0.60 atm and P_X = 0.80 atm. When P_X = 0.20 atm, the rate of reaction relative to the initial rate is (A) 1/16, (B) 1/24, (C) 1/32, (D) 1/48, (E) 1/64.

15. For the first-order parallel reactions: P $\xrightarrow{k_1}$ Q and P $\xrightarrow{k_2}$ R, k_1 = 8 min^{-1} and k_2 = 2 min^{-1} at 300 K. If the activation energies for the formation of Q and R are 20 and 28.314 kJ/mol, respectively, find the temperature at which Q and R will be obtained in 2:1 mole ratio. (A) 379.75 K, (B) 385.5 K, (C) 400 K, (D) 412.25 K, (E) 430.28 K.

16. $SO_2Cl_2 \rightarrow SO_2 + Cl_2$ is a first-order gaseous reaction with rate constant $k = 2.5 \times 10^{-5}$ s^{-1} at 320 °C. The percentage of SO_2Cl_2 decomposed on heating for 100 min is (A) 56.2, (B) 15.0, (C) 85.0, (D) 13.8, (E) 35.0.

第二部分 非選擇題（17-20），共 20 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。

17. **(5%)** Derive the Maxwell relation $(\partial S/\partial V)_T = (\partial P/\partial T)_V$.

18. **(5%)** The equilibrium pressure of H_2 over U(s) and UH_3(s) fits the expression $\ln P = A + B/T + C \ln T$. Find an expression for the standard enthalpy of formation of UH_3(s).

19. **(5%)** Consider the following mechanism for renaturation of a double helix from its strands A and B:

$$A + B \underset{k_1'}{\overset{k_1}{\rightleftharpoons}} \text{unstable helix (fast)}$$

$$\text{Unstable helix} \xrightarrow{k_2} \text{stable double helix (slow)}$$

Derive the rate equation for the formation of the double helix and express the rate constant of the renaturation reaction in terms of the rate constants of the individual steps.

20. **(5%)** For a certain second-order reaction A + B → Products, the rate of reaction, r, may be written

$$r = \frac{dx}{dt} = k\left([A]_0 - x\right)\left([B]_0 + x\right)$$

where x is the decrease in concentration of A or B as a result of reaction. Find an expression for the maximum rate.

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