第一部分 單選題（1-8），每題 5 分，共 40 分 ※注意：請於試卷首頁「選擇題作答區」作答。

1. Determine the number of degrees of freedom for the equilibrium system $FeO(s) + CO(g) \leftrightarrow CO_2(g) + Fe(s)$.
(A) 0, (B) 1, (C) 2, (D) 3, (E) 4.

2. The average osmotic pressure of human blood is 7.8×10^5 Pa at 37 °C. What is the concentration of an aqueous NaCl solution that could be used in the bloodstream? Assume ideal solution behavior.
(A) 0.04 M, (B) 0.08 M, (C) 0.15 M, (D) 0.30 M, (E) 0.45 M.

3. For a system KNO_3-$NaNO_3$-H_2O, a ternary point exists at 5 °C at which the two anhydrous salts are in equilibrium with a saturated solution containing 9.04% by weight of KNO_3 and 41.01% $NaNO_3$. Determine the maximum percentage of KNO_3 which could be recovered pure from a salt mixture containing 70 g of KNO_3 and 30g of $NaNO_3$ by crystallization from an aqueous solution at 5 °C.
(A) 9.45%, (B) 18.06%, (C) 81.9%, (D) 90.5%, (E) 100%.

4. What will be the temperature difference needed in a hot-air balloon to lift 1.00 kg of mass? Assume that the volume of the balloon is 100 m^3, the temperature of the ambient air is 25 °C, the pressure is 1.00 bar, and air is an ideal gas with an average molar mass of 29 g/mol.
(A) 3 °C, (B) 8 °C, (C) 15 °C, (D) 20 °C, (E) 30 °C.

5. The *escape velocity*, the velocity required by an object to escape from the gravitational field of a body, is given by $v_e = (2gr)^{1/2}$, where $r = 6.37 \times 10^6$ m for Earth. At what temperature will the root-mean-square speed v_{rms} of a N_2 molecule attain the escape velocity?
(A) 6.8×10^3 K, (B) 1.0×10^4 K, (C) 1.5×10^4 K, (D) 1.4×10^5 K, (E) 2.2×10^5 K.

6. Consider an ideal refrigerator operating between 0 °C and 25 °C. The refrigerator is used to produce 1.0 g of ice each second at 0 °C from water at 0 °C. How much work must be done? The molar heat of fusion of water is 6.0095 kJ/mol.
(A) 5 W, (B) 30 W, (C) 330 W, (D) 504 W, (E) 540 W.

7. Molecular Cl_2 crystallizes in a face-centered orthorhombic unit cell with $a = 0.629$ nm, $b = 0.450$ nm, and $c = 0.821$ nm. Calculate the theoretical density of Cl_2 crystals.
(A) 1.62 g/cm^3, (B) 2.03 g/cm^3, (C) 2.86 g/cm^3, (D) 3.43 g/cm^3, (E) 3.98 g/cm^3.

8. Calculate the change of the freezing point of water at a depth of 10.0 cm below the surface of water. The molar heat of fusion of water is 6.0095 kJ/mole. The density of ice is 0.9168 g/cm^3 and that of liquid water is 0.9998 g/cm^3.
(A) -7.26×10^{-5} K, (B) -4.03×10^{-6} K, (C) -4.03×10^{-7} K, (D) 4.03×10^{-6} K, (E) 7.26×10^{-5} K.

見背面

第二部分 非選擇題（9-13），共 60 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。

9. (10%) A flask containing 0.06 mole of $F_2(g)$ at 1000 K is allowed to equilibrate with F(g):
$F_2(g) \leftrightarrow 2F(g)$　　$K = 9.59 \times 10^{-3}$
What are the mole fractions of the gases once equilibrium has been reached? The total pressure of the gases at equilibrium is 2.07 bar. Assume ideal gas behavior.

10. (10%) The cell Ag(s) | AgCl(s) | HCl(0.1 M) | glass | $H^+(C)$ | KCl(sat) | Hg_2Cl_2(s) | Hg(l) is used to measure pH. Given $E^0 = 0.2873$ V for AgCl/Ag, $E^0 = 0.2415$ V for Hg_2Cl_2/Hg, and the mean activity coefficient $\gamma_\pm = 0.796$ for 0.1 M HCl, derive the cell potential as a function of pH.

11. (10%) Derive the rate law for the decomposition of N_2O_5,
$2\,N_2O_5(g) \rightarrow 4\,NO_2(g) + O_2(g)$
on the basis of the following mechanism:
$N_2O_5 \rightarrow NO_2 + NO_3$　　k_a
$NO_2 + NO_3 \rightarrow N_2O_5$　　k_a'
$NO_2 + NO_3 \rightarrow NO_2 + O_2 + NO$　　k_b
$NO + N_2O_5 \rightarrow NO_2 + NO_2 + NO_2$　　k_c

12. At 20 °C, the surface tensions of water and mercury are 72.8 and 483 dynes/cm, respectively, while the interfacial tension between the two is 375 dynes/cm. Calculate
(a) (4%) the work of cohesion of mercury.
(b) (4%) the work of adhesion between water and mercury.
(c) (7%) the spreading coefficient of water on mercury. Will water spread on mercury?

13. A real solution in which the molecules of component 1 and component 2 are nearly the same size is known as a regular solution. For such a solution, the total mixing free energy is

$$\Delta G = RT\left(n_1 \ln\frac{n_1}{n_1+n_2} + n_2 \ln\frac{n_2}{n_1+n_2}\right) + \frac{n_1 n_2}{n_1+n_2}\chi$$

where n_i is the moles of component i and χ is a constant parameter that corrects for the non-ideal behavior.
(a) (8%) Prove that the change in chemical potential for component 1 can be expressed as

$$\Delta\mu_1 = RT\ln\frac{n_1}{n_1+n_2} + \left(\frac{n_2}{n_1+n_2}\right)^2\chi$$

(b) (7%) Derive the activity coefficient for component 1.

試題隨卷繳回