

說明：1. 請依題序作答並標明題號

2. $k = 1.381 \times 10^{-23} \text{ JK}^{-1}$

$R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1} = 0.082 \text{ l atm K}^{-1} \text{ mol}^{-1}$

$h = 6.626 \times 10^{-34} \text{ Js}$

3. 可使用一般計算機

4. 選擇題答錯，倒扣 5 分之 1 題分

- (1) The reaction $A \rightarrow 2B$ is spontaneous when (a) $\mu_A = \mu_B$ (b) $\mu_A = 2\mu_B$ (c) $\mu_A > \mu_B$ (d) $\mu_A < \mu_B$ (e) $\mu_A > 2\mu_B$ (μ : chemical potential) (5%)
- (2) The speed of a projectile of mass $1 \times 10^{-27} \text{ kg}$ is known to within $1 \mu\text{m s}^{-1}$. Calculate the minimum uncertainty in its position. (a) 0.017 (b) 0.031 (c) 0.053 (d) 0.080 (e) 0.089 m (5%)
- (3) A particle moves in a circular path of radius r . The wavefunction for this particle is $\psi_m(\phi) = N e^{im\phi}$. What is the normalization constant N ? (a) 1 (b) π (c) 2π (d) $(\pi)^{0.5}$ (e) $(2\pi)^{-0.5}$ (5%)
- (4) What is the magnitude of the orbital angular momentum of a 3d electron? (a) 0 (b) $\sqrt{3} \hbar$ (c) 2 (d) $\sqrt{5} \hbar$ (e) $\sqrt{6} \hbar$ (5%)
- (5) Estimate the entropy change when He at 300 K and 1 atm in a container of 0.5 liter is allowed to expand to 1.0 liter and is simultaneously heated to 375 K. (a) 0.235 (b) 0.160 (c) 0 (d) 0.125 (e) 0.175 JK^{-1} (10%)
- (6) Calculate the temperature for 1 mol CO_2 gas at 100 atm and 0.366 liter by treating it as a van der Waals gas (van der Waals coefficients: $a = 3.610 \text{ atm liter}^2 \text{ mol}^{-2}$, $b = 0.043 \text{ liter mol}^{-1}$). (a) 300 (b) 350 (c) 400 (d) 450 (e) 500 K (10%)
- (7) The half-life of a first-order reaction is 10 min. How much time is required for this reaction to be 75% complete? (a) 20 (b) 30 (c) 40 (d) 60 (e) 80 min (10%)
- (8) Assuming that a X-H chemical bond stretches with a parabolic potential. The mass of H is $1.7 \times 10^{-27} \text{ kg}$ which is much smaller than that of X. The force constant of this bond is 340 Nm^{-1} . Calculate the energy required to make a transition from the vibrationally ground state to the first excited state. (a) 4.7×10^{-20} (b) 8.1×10^{-20} (c) 2.8×10^{-21} (d) 3.8×10^{-21} (e) $6.0 \times 10^{-22} \text{ J}$ (10%)
- (9) Calculate the fraction of X_2 molecules in their first excited state at 25 °C. The vibrational wavenumber is 214.6 cm^{-1} . (a) 0.65 (b) 0.42 (c) 0.23 (d) 0.15 (e) 0.02 (10%)

(背面仍有題目,請繼續作答)

- (10) Let a gas expand adiabatically through a porous barrier from one constant pressure (P_i) to another (P_f). Prove that this process is isenthalpic. (10%)
- (11) Explain fluorescence in detail. (10%)
- (12) Construct an O_2 molecular orbital energy level diagram, based on O_{2s} and O_{2p} atomic orbitals, to explain the paramagnetic property of O_2 . (10%)