說明：1. 請依序作答並標明題號。

2. $R=8.314\ J\ K^{-1}mol^{-1}$；$h=6.626\times10^{-34}\ J\ s$；$k=1.38\times10^{-23}\ J\ K^{-1}$；$N_A=6.022\times10^{-23}\ mol^{-1}$
electron mass $=9.11\times10^{-28}$ g；electron charge $=1.602\times10^{-19}$ C

1. Calculate the average molar mass of air at sea level and 0°C if the density of air is 1.29 kg m^{-3}. (6%)

2. Use simple equations and statements to describe the three laws of thermodynamics. (9%)

3. One mole of nitrogen at 25°C and 1 bar is expanded reversibly and isothermally to a pressure of 0.132 bar. (8%)
   (a) What is the value of *w* ?
   (b) What is the value of *w* if the nitrogen is expanded against a constant pressure of 0.132 bar?

4. Calculate the entropy change when 1 mol of ice heated from 250 K to 300 K. Take the heat capacities ($C_{p,m}$) of water and ice to be constant at 75.3 and 37.7 J K^{-1} mol^{-1}, respectively, and the latent heat of fusion of ice as 6.02 kJ mol^{-1}. (10%)

5. At 3000 K the equilibrium partial pressure of CO_2, CO, and O_2 are 0.6, 0.4, and 0.2 atm, respectively. For the reaction $2CO_2 \rightleftharpoons 2CO + O_2$, (10%)
   (a) Calculate ΔG^o (standard state: 1atm).
   (b) Calculate K_x at 1 atm.

6. Calculate the de Broglie wavelength of an electron that has been accelerated by a potential of (a) 100V, and (b) 1000 V. (6%)

7. Calculate, for the light of 325-nm wavelength, (12%)
   (a) the frequency and the wavenumber
   (b) the photon energy in J and eV
   (c) the momentum of the photon.

8. A particle is moving in one dimension between $x = a$ and $x = b$. The potential energy is such that the particle cannot be outside these limits and that the wave function in between is $\psi = A / x$. (12%)
   (a) Determine the normalization constant *A*.
   (b) Calculate the average value of *x*.

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9. Determine the angle of reflection when copper K_α radiation (0.154 nm) is incident on a cubic crystal with a lattice constant d of 0.400 nm. (5%)

10. Ammonia (considered to be an ideal gas) initially at 25°C and 1 bar pressure is heated at constant pressure until the volume has trebled. The variation of the molar heat capacity with absolute temperature is given by
$\bar{C}_p = 25.895 + 32.999 \times 10^{-3}\,T - 30.46 \times 10^{-7}\,T^2$ where $\bar{C}_p$ in $J\,K^{-1}\,mol^{-1}$.
Calculate (a) q per mol, (b) w per mole, (c) $\Delta\bar{H}$, (d) $\Delta\bar{U}$, and (e) $\Delta\bar{S}$. (10%)

11. For the reaction A → B + C, the following data were obtained at 30°C:

[A], M	0.170	0.212	0.357
Rate, mol $L^{-1}\,s^{-1}$	6.68×10^{-3}	1.04×10^{-2}	2.94×10^{-2}

(a) What is the order of the reaction with respect to [A], and what is the rate equation?
(b) What is the rate constant? (12%)