

科目：物理化學 適用：應化系

編號：494

考生注意：

1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分。
3. 限用藍、黑色筆作答；試題須隨卷繳回。

本試題

共 1 頁

第 1 頁

1. A copper ball of mass $m = 0.5$ kg and specific heat $c = 390$ J/kg·K is at a temperature $T_1 = 90$ °C. The ball is throw into a large lake at $T_2 = 10$ °C, which stays constant. Find the change in entropy of (a) the ball (8 pts); (b) the lake (7 pts); (c) the universe (5 pts).
2. Consider a sample containing 5 mol of a monatomic ideal gas at 25 °C and an initial pressure of 10 atm. Suppose that the external pressure is lowered to 1 atm in a reversible manner. (a) Calculate the final pressure and volume of the gas sample (10 pts); (b) Compute the work for the process (5 pts).
3. The hydrogen atom has a radius on the order of 0.05 nm. Assume that we know the position of an electron to an accuracy of 1% of the hydrogen radius. (a) Calculate the uncertainty in the velocity of the electron using the Heisenberg uncertainty principle (10 pts); (b) Then compare this value with uncertainty in the velocity of a ball of mass 0.2 kg and radius 0.05 m whose position is known to an accuracy of 1% of its radius (10 pts).
4. Assume that an electron is confined to a one-dimensional box 1.5 nm in length. (a) Calculate the lowest three energy levels for this electron (10 pts); (b) Calculate the wavelength of light necessary to promote the electron from the ground state to the first excited state (10 pts).
5. The 1s orbital of the hydrogen atom is $\psi_{1s} = \frac{1}{\sqrt{\pi a_0^3}} e^{-\frac{r}{a_0}}$, calculate the average r from the nucleus of an electron in the 1s orbital (Hint: $\left[\int_0^\infty e^{-ar} r^n dr = \frac{n!}{a^{n+1}} \right]$; a_0 is constant) (20 pts).
6. Write down the Schrödinger equation (5 pts).