八十六學年度 生命科學 系（所） 丙 組碩士班研究生入學考試

科目 近代物理 科號 1102 共 2 頁第 1 頁 *請在試卷【答案卷】內作答

1. A spin system consists of n_1 and n_2 particles whose energy levels are given by E_1 and E_2. Please find the temperature of the system and explain how it is possible to reach negative temperature. (10%)

2. Design an experiment to measure osmotic pressure of a sugar solution in a semi-permeable membrane. (10%)

3. Consider a gas of uniform and constant density and temperature with an average velocity given by
   $U_x = A + By$
   $U_y = U_z = 0$
   Let F be the friction force across a plane perpendidular to the y axis, please find its viscosity. (10%)

4. Define and give specific example for the phase transition of the second kind and of the first kind (10%)

5. Describe Stern-Gerlach experiment, normal and anomalous Zeeman effect, and parity violation (10%)

6. Describe physical process responsible for Rayleigh scattering and multiatomic resonance fluorescence. Please also give examples of natural phenomena involving these processes (10%).

7. Use the uncertainty principle to estimate the ground-state energy for a particle of mass m moving in the potential well $U(x) = k|x|$, where $k > 0$ (10%).

8. Prove that the quantity τ defined by $\tau = t_{1/2} / \ln 2$ is the mean life time of the decaying nuclei (10%).

9. Suppose that $\nu = 5.0 \times 10^{14}$ Hz and T = 3000 K. According to Planck, what is the average energy of the oscillator? (10%).

10. According to a simple model, the energy of a free electron in a crystal is the following function of the wave number: $E = A - B\cos ka$ where A and B are constants, and a is the distance between adjacent atoms. What value of the effective mass can you deduce from this formular (10%).

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Gravitational constant	$G = 6.67 \times 10^{-8}$ dyn cm^2 gm^{-2}
Speed of light	$c = 3 \times 10^{10}$ cm sec^{-1}
Electronic charge	$e = 4.8 \times 10^{-10}$ esu $= 1.6 \times 10^{-19}$ C
Planck's constant	$h = 6.625 \times 10^{-27}$ erg sec
	$\hbar = h/2\pi = 1.05 \times 10^{-27}$ erg sec
Fine-structure constant	$\alpha = e^2/\hbar c = 1/137$
Electron mass	$m_e = 9.1 \times 10^{-28}$ gm $= 0.51$ MeV
Muon mass	$m(\mu) = 207\, m_e = 106$ MeV
Pion mass	$m(\pi) = 270\, m_e = 140$ MeV
Proton mass	$M = 1.6 \times 10^{-24}$ gm $= 938$ MeV
Bohr radius	$a_0 = \hbar^2/me^2 = 0.53 \times 10^{-8}$ cm
Classical electron radius	$r_e = e^2/mc^2 = 2.82 \times 10^{-13}$ cm
Bohr magneton	$\mu_B = e\hbar/2m_ec = 0.927 \times 10^{-20}$ erg gauss^{-1}
Nuclear magneton	$\mu_N = e\hbar/2Mc = 0.505 \times 10^{-23}$ erg gauss^{-1}
Boltzmann constant	$k = 1.38 \times 10^{-16}$ erg (°K)$^{-1}$
Stephan-Boltzmann constant	$\sigma = (\pi^2/60)(k^4/\hbar^3c^2)$
	$= 5.7 \times 10^{-5}$ erg cm^{-2} sec^{-1} × (°K)$^{-4}$
Avogadro's number	$N_0 = 6.02 \times 10^{23}$ mole^{-1}
Gas constant	$R = N_0k = 2$ cal·mole^{-1}·°K^{-1}
	$= 8.3 \times 10^7$ ergs·mole^{-1} °K^{-1}
Proton magnetic moment	$\mu_p = 2.79$ nm
Neutron magnetic moment	$\mu_n = -1.91$ nm