國立政治大學　101　學年度研究所 碩士班招生考試試題

考試科目	近代物理	所別	應用物理研究所 (8162, 8163)	考試時間	2 月 25 日(六) 第四節

說明:

Fill in each underlined blank in the statements of all the problems, referring to the key words or key constants listed below, and answer the questions.

Bohr, Galilean; Hartree; Weinberg; Einstein; Maxwell; Feymann; Thomas; Newton; Lorentz; Larmor; Stern-Gerlach;de Broglie; Compton; Schroedinger; g-factor; Stefan-Boltzmann factor; Planck constant; Sommerfeld; de Broglie; Rayleigh-Jeans; Rydberg; Raman; Zeeman; Rutherfold; Thomson; orbital; spin; inertial; black-body; magneton;

6.67×10^{-11} N-m^2/kg^2 ; 6.626×10^{-34} J-s; 1.381×10^{-23} J/K; 8.617×10^{-5} eV/K; 4.136×10^{-15} eV-s; 1.602×10^{-19} C; 9.109×10^{-31} Kg; 8.854×10^{-12} F-m; 1.257×10^{-6} H/m; 5.292×10^{-11} m; 1.097373×10^{7} m^{-1}

Example:

Write down the equation for the law of gravitation which is discovered by the 23-year-old _____ in 1665.

Answer: $F = G\frac{m_1 m_2}{r^2}$; Issac Newton

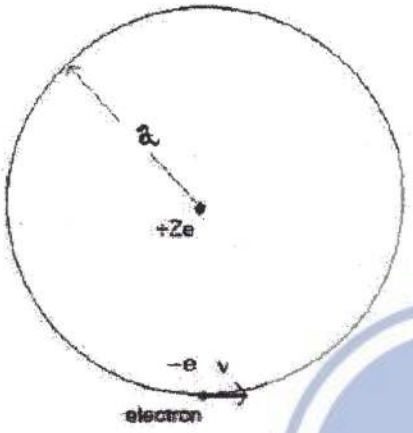
備註	試題隨卷繳交

考試科目	近代物理	所別	應用物理研究所 (8162, 8163)	考試時間	2月25日(六)第四節

(1) (26%)

(a) In _____'s model, the orbital angular momentum L of an electron in an atom is postulated to be quantized. (2%)

$L=n\hbar$ $(n=1,2,\ldots)$



(b) The energy levels are then

$$E_n = -R_\infty \frac{Z^2 hc}{n^2}$$

Find the expression and the value of the _____ constant R_∞ . (8%)

(c) In quantum mechanics, the energy levels are obtained by finding the eigenvalues of the _____ equation. (2%) Write down the time-independent equation for one-electron atom. (6%)

(d) A model of one-dimension one-electron atom in the effective potential

$$V(z)=\begin{cases} -\frac{A e^2}{4}\frac{1}{z} & \text{if } z>0 \\ \infty & \text{if } z<0 \end{cases}$$

can be used to find the energy levels of an electron trapped by the induced electric field on the surface of liquid helium. The energy levels are $E_n = -\frac{R^*}{n^2}$ $(n=1,2,\ldots)$

Find R*=? . (8%)

備註	試題隨卷繳交

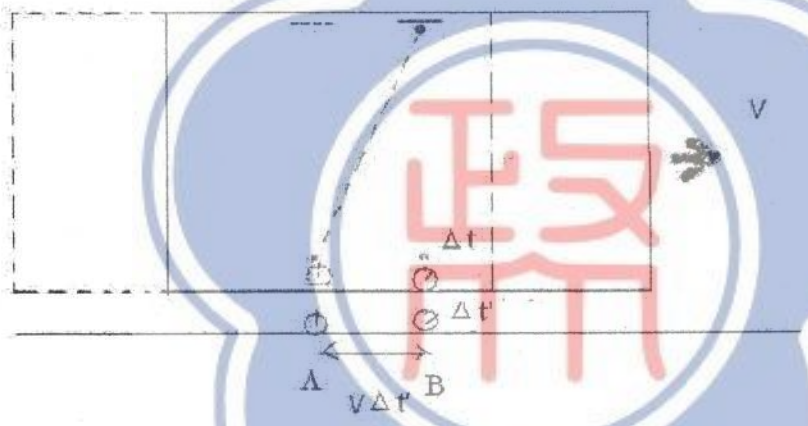
考試科目	近代物理	所別	應用物理研究所 (8162, 8163)	考試時間	2 月 25 日（六）第四節

(2) (20%)

(a) Basic postulates of special theory of relativity: the speed of light as well as the physical laws are the same in all _____ reference frames. (2%)

A train is moving forward with speed v in the $+x$ direction relative to the observer on the ground. A light signal is sent from a source on the floor of the train, in the $+z$ direction, and reaches the ceiling of the train after time Δt. For the observe on the ground, the signal takes time $\Delta t'$ from the source to the ceiling. The speed of light is c in both the frame S on the train and the frame S' on the ground.

(b) Find the relation between Δt and $\Delta t'$?(4%)



(c) During time $\Delta t'$, the light source on the train has moved a distance L' from label A to label B marked on the ground. For an observer on the train, the distance between A and B is L. Find the relation between L and L'. (4%)

(d) The coordinates (x,y,z,t) in S are related to the coordinates (x',y',z',t') in S' by the _____ transformation. (2%)

Write down the transformation equations for the case when an event at t=0 and x=0,y=0,z=0 in S is observed to occur at t'=0, x'=0, y'=0, z'=0 in S'.(4%)

(e) What are the equations for the transformation between the velocities for a particle moving at velocity (u_x, u_y, u_z) observed in S and at (u'_x, u'_y, u'_z) observed in S' ?(4%)

備註	試題隨卷繳交

考試科目	近代物理	所別	應用物理研究所 (8162, 8163)	考試時間	2 月 25 日（六）第四節

(3)(28%)

(a) An electron moving circularly around the nucleus. The relation between the magnetic dipole moment $\vec{\mu_l}$ produced by the motion and its angular momentum $\vec{L}$ is

$\vec{\mu_l} = -\frac{g_l \mu_b}{\hbar}\vec{L}$, where $\mu_b = \frac{e\hbar}{2m}$ is called the _____, and its the value is _____ where the _____ g-factor, g_l=_____. (8%)

(b) The motion of the electron in presence of the magnetic field produced by the nucleus, is in analogy to a spinning top. The phenomena is called _____ precession. The relativistic effect, on the other hand, causes the _____ precession, that the magnetic dipole arisen from the internal degree of freedom is expressed as

$\vec{\mu_s} = -\frac{g_s \mu_b}{\hbar}\vec{S}$, where $\vec{S}$ is _____ and g_s =____. (10%)

(c) The energy levels of an atom in a uniform magnetic field $\vec{B}$ split according to the angular momentum quantum numbers . This is called _____ effect. (2%)
The energy splitting is $\Delta E = g\mu_b B m_z$. Express g in terms of the quantum numbers of the total angular momentum, *j*, its component in the direction of $\vec{B}$, m_z, the total orbital angular momentum, *l*, and the total spin angular momentum, *s*. (6%)

(d) The beams of atoms in a non-uniform magnetic field are separated according to their angular momentum states in the _____ experiments. (2%)

備註	試題隨卷繳交

考試科目	近代物理	所別	應用物理研究所 (8162, 8163)	考試時間	2 月 25 日(六) 第四節

(4) (16%)

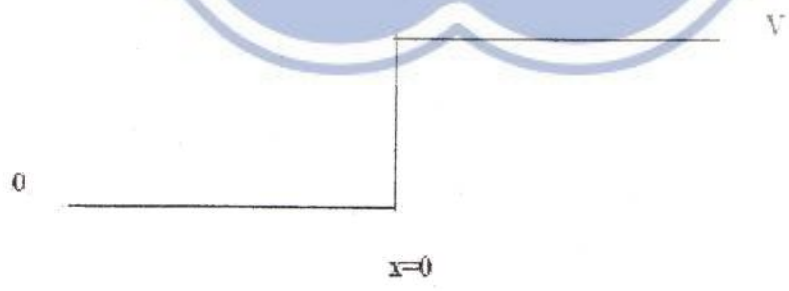
(a)In proposing the idea that electromagnetic waves are quantized as photons, the physicists _____ postulated that the photon energy E of frequency ν is _____, _____ proposed that the momentum p and wave vector k are related by_____ . _____ used the same relations to propose the idea of material waves.

(10%)

(b) A beam of neutrons that emerges from a nuclear reactor contains neutrons with a variety of energies. To obtain neutrons with an energy of 0.06 eV, the beam is passed through a crystal whose atomic planes are 20 Å apart. At what angle relative to the original beam will the desired neutrons be diffracted? (6%)

(5) (10%)

Find the transmission and reflection coefficients for the quantum waves in a one-dimensional step potential.



備註	試題隨卷繳交