MP19-L04 學號:_____ 姓名:_____ 系級:_____得分:_____ 總分_____

填充或計算題都必須寫出計算過程，並將答案選項填云躓獢C

Problem 14 (單選題)(a)

(單選題)____ 可嘗試次數= 2 分數= 2 The experimental data obtained from Rutherford's original α-particle scattering experiment could NOT be used to (A)Determine the trajectories of electrons within an atom (B)Determine whether the atomic nucleus is positively charged (C)Estimate the diameter of the atomic nucleus (D)Confirm the existence of a Coulomb force field surrounding the nucleus (E)Conclude that most of the atomic mass is concentrated in a very small region

(單選題)____ 可嘗試次數= 2 分數= 2 Both hydrogen atoms and helium ions (He^+) exhibit the Balmer series in their emission spectra. Let the longest wavelengths of the two Balmer series be λ_1 and λ_2, respectively. What is the relationship between them? (A)$\lambda_2 = (1/2)\lambda_1$ (B)$\lambda_2 = 2\lambda_1$ (C)$\lambda_2 = (1/4)\lambda_1$ (D)$\lambda_2 = 4\lambda$ (E)$\lambda_2 = 16\lambda_1$

(單選題)____ 可嘗試次數= 2 分數= 2 In studying the electron orbit in a hydrogen atom, assume that the force maintaining the electron in its orbit is the electrostatic attraction (ke^2/r^2) between the nucleus, carrying one elementary positive charge (e), and the negatively charged electron. When considering electrons in helium and lithium atoms, the following two facts should also be taken into account: I. A helium nucleus carries two elementary positive charges, while a lithium nucleus carries three. II. A neutral helium atom contains two negatively charged electrons; a neutral lithium atom contains three electrons, while a singly ionized lithium atom contains two electrons. Answer the following three questions.
(1) What is the ratio of the minimum orbital radii of a single electron orbiting a helium nucleus and a single electron orbiting a lithium nucleus? (A) 3 : 1 (B) 3 : 2 (C) 2 : 3 (D) 1 : 3 (E) 1 : 2

(單選題)____ 可嘗試次數= 2 分數= 2 Following the previous question, (2) consider two electrons moving in the same orbit in a neutral helium atom. Compare their orbital radius with that of the single electron in a helium ion. What is the approximate ratio of the single-electron orbital radius to the two-electron orbital radius? (A)1/2 (B)2 (C)Slightly greater than 1 (D)Slightly less than 1 (E)Equal to 1

(單選題)____ 可嘗試次數= 2 分數= 2 Following the previous questions, (3) the energy levels of a Li^{2+} ion are related to the corresponding energy levels of a hydrogen atom by a factor of (A)3 times (B)9 times (C)4 times (D)1/3 times (E)1/9 times

(單選題)____ 可嘗試次數= 2 分數= 2 Suppose a new universe is created in which the magnitude of every elementary electric charge is twice its present value. What would be the radius of a hydrogen atom in this new universe compared with its present value? (A)1/2 (B)1/4 (C)1/8 (D)2 times (E)4 times

(單選題)____ 可嘗試次數= 2 分數= 2 Which of the following statements is correct? (A)Irradiating hydrogen atoms with visible light can ionize some atoms initially in their ground state (B)The volume of an atomic nucleus is approximately $1/10^5$ of the volume of an atom (C)An individual atom cannot be observed using an optical microscope, even at very high magnification (D)When an electric current flows through a conducting wire, the free electrons inside the wire move along it at the speed of light (E)In the Compton effect, the scattered photon travels at a lower speed than the incident photon

Problem 1 (單選題)(a)

(單選題)____ 1 可嘗試次數= 2 分數= 2 拉塞福(Rutherford)當年所作α質點散射實驗所獲資料,不能(A)推算原子中電子之軌跡 (B)測知原子核之是否為正電荷 (C)推算原子核直徑之大小 (D)證實原子核周圍庫侖力場之存在 (E)推知原子中質量主要集中於一小區域內

(單選題)____ 2 可嘗試次數= 2 分數= 2 氫原子和氦離子(He^+)所發射的光譜都有Balmer系光譜。設兩者的最長光譜波長分別? λ_1及 λ_2 ,則 (A)$\lambda_2 = (1/2)\lambda_1$ (B)$\lambda_2 = 2\lambda_1$ (C)$\lambda_2 = (1/4)\lambda_1$ (D)$\lambda_2 = 4\lambda$ (E)$\lambda_2 = 16\lambda_1$

(單選題)____ 3 可嘗試次數= 2 分數= 2 研究氫原子之電子軌道,假設維繫電子在其軌道之力,為原子核所帶1基本正電荷(e)與電子所帶負電荷間之吸引力(ke^2/r^2)。當論及氦及鋰原子內之電子時,則另應注意下述二點:I.氦原子核有2個基本電荷,鋰原子核則有3個。II.在中性氦原子中有兩個電子,電子帶負電;在中性鋰原子中有三個電子 ,而單游離之鋰原子有兩個電子。回答下列3題。

(1)單獨一電子繞氦原子核及鋰原子核運轉時,其最小軌道半徑之比值? (A) 3 : 1 (B) 3 : 2 (C) 2 : 3 (D) 1 : 3 (E) 1 : 2

(單選題)____ 4 可嘗試次數= 2 分數= 2 承上，(2)將中性氦原子內繞同一軌道而轉之兩個電子之軌道半徑,與氦離子之單一電子運動半徑比較,則估計單電子與兩電子運動半徑之比? (A)1/2 (B)2 (C)略大於1 (D)略小於1 (E)等於1

(單選題)____ 5 可嘗試次數= 2 分數= 2 承上，(3)Li^{2+}離子各能階的能量是氫原子對應能階能量的 (A)3倍 (B)9倍 (C)4倍 (D)1/3倍 (E)1/9倍

(單選題)____ 6 可嘗試次數= 2 分數= 2 假設一個新的宇宙生成時,所有基本電荷的值為目前的兩倍。那麼新宇宙中 ,氫原子的半徑為目前的值的 (A)1/2 (B)1/4 (C)1/8 (D)2倍 (E)4 倍

(單選題)____ 7 可嘗試次數= 2 分數= 2 下列敘述中,那些是正確的? (A)以可見光照射氫原子,可以使其部分基態原子游離 (B)原子核的體積約為原子體積的$1/10^5$ (C)用高倍的光學顯微鏡也不能看到一個單獨的原子 (D)導線中通以電流時,其內的自由電子以光速沿導線運動 (E)在康普頓效應中被散射的光子其速率要比入射光子的速率為低

Problem 2

Realizing that the scattering equation would hold only if the α particle did not have enough energy to deform or penetrate the scattering nucleus, Rutherford systematically looked for the threshold α energy at which departures from his scattering equation occurred, the idea being that at this threshold energy the α should be just penetrating the nuclear radius at its distance of closest approach. In 1919, Rutherford was able to show a breakdown in the equation for 7.7-MeV α particles scattered at large angles from aluminum nuclei (Z = 13). Estimate the radius of the aluminum nucleus from these facts.

意識到散射方程式只有在α粒子能量不足以使散射原子核變形或穿透時才成立，盧瑟福系統性地尋找α粒子能量的閾值，在該閾值下，他的散射方程式不再成立。他的想法是，在這個閾值能量下，α粒子在其最近接近距離處應該剛好能穿透原子核的半徑。 1919年，盧瑟福證明了能量為7.7 MeV的α粒子以大角度散射鋁核（Z = 13）時，方程式不再成立。根據這些事實估算鋁核的半徑。 (01小題) 08

$R \simeq d_{min} =$_____ m 分數= 4

Problem 3

The electric field intensity at a distance r from the center of a uniformly charged sphere of radius R and total charge Q is $\frac{Qr}{4\pi\epsilon_0 R^3}$ when $r < R$. Such a sphere corresponds to the Thomson model of the atom. Show that an electron in this sphere executes simple harmonic motion about its center and derive a formula for the frequency of this motion. Evaluate the frequency of the electron oscillations for the case of the hydrogen atom and compare it with the frequencies of the spectral lines of hydrogen.

半徑為 R、總電荷量為 Q 的均勻帶電球體，其中心距離為 r 處的電場強度為 $\frac{Qr}{4\pi\epsilon_0 R^3}$，其中 $r < R$。這樣的球體對應於湯姆遜原子模型。證明該球體中的電子繞其中心做簡諧運動，並推導出該運動頻率的公式。計算氫原子中電子振盪的頻率，並與氫原子光譜線的頻率進行比較。 (01小題) 09 f=_____ Hz 分數= 4

Problem 4

What is the shortest wavelength present in the Brackett series of spectral lines? 布拉克特譜線系最短的波長是多少？ (01小題) 10 shortest wave length=_____ m 分數= 4

Problem 5

How many different wavelengths would appear in the spectrum of hydrogen atoms initially in the n = 5 state?

初始處於 n = 5 態的氫原子光譜中會出現多少種不同的波長？ (01小題) 11 the number of different wavelengths=_____ 分數= 4

Problem 6

Find the (a)wavelength of the spectral line that corresponds to a transition in hydrogen from the n = 10 state to the ground state. (b)In what part of the spectrum is this? 求：(a) 對應氫原子從 n = 10 能階躍遷到基態的譜線的波長；(b) 譜線位於光譜的哪一個部分？ (02小題) 12 (a) the wavelength λ=_____ nm 分數= 4

13 (b) 1=visible light, 2=Infared, 3=Ultra-violet, 4=X-ray, 5=Microwave 分數= 4

Problem 7

How much energy is required to remove an electron in the n = 2 state from a hydrogen atom? 從氫原子中移除一個處於 n = 2 態的電子需要多少能量？ (01小題) 14 E=____ eV 分數= 4

Problem 8

An excited hydrogen atom emits a photon of wavelength λ in returning to the ground state. (a) Derive a formula that gives the quantum number of the initial excited state in terms of λ and R. (b) Use this formula to find n_i for a 102.55-nm photon.

受激氫原子在返回基態時會發射波長為 λ 的光子。 (a) 推導一個公式，以 λ 和 R 表示初始激發態的量子數。 (b) 利用此公式求波長為 102.55 nm 的光子的 n_i。 (01小題) 15 (b) n_i=_____ 分數= 6

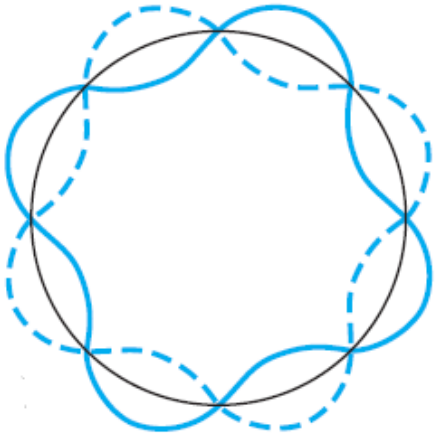
Problem 9

Calculate the two longest wavelengths of the Balmer series of triply ionized beryllium (Z = 4). 計算三電離鈹（Z = 4）巴爾末系中最長的兩個波長。 (02小題) 16 (a) the longest wavelength=_____ nm 分數= 4 17 (b) the second longest wavelength=_____ nm 分數= 4

Problem 10

What is the quantum number of the hydrogen atom for its electron in a standing wave as shown in the figure? 如圖所示，氫原子在駐波中電子的量子數是多少？ (01小題) 18

n=____ 分數= 6



Problem 11

Light of wavelength 102.6 nm is emitted by a hydrogen atom.What are the (a) higher quantum number and (b) lower quantum number of the transition producing this emission? (c) What is the name of the series that includes the transition? 氫原子發射波長為 102.6 nm 的光。產生這種發射的躍遷的 (a) 高量子數和 (b) 低量子數分別是多少？ (c) 包含該躍遷的系列名稱為何？ (03小題) 19 (a)the higher quantum number=____ 分數= 6 20 (b)the lower quantum number=____ 分數= 6 21 (c)1=Lyman, 2=Balmer, 3=Paschen, 4=Brackett, 5=Pfund 分數= 6

Problem 12

In the ground state of the hydrogen atom, the electron has a total energy of 13.6 eV.What are (a) its kinetic energy and (b) its potential energy if the electron is one Bohr radius from the central nucleus?

在氫原子的基態中，電子的總能量為 13.6 eV。如果電子距離原子核中心一個玻爾半徑，那麼（a）電子的動能和（b）電子的位能分別是多少？ (02小題) 22 (a) K=_____ eV 分數= 6 23 (b) U=_____ eV 分數= 6

Problem 13
A hydrogen atom, initially at rest in the n = 4 quantum state, undergoes a transition to the ground state, emitting a photon in the process. What is the speed of the recoiling hydrogen atom?
一個氫原子最初處於 n = 4 量子態的靜止狀態，然後躍遷到基態，並在躍遷過程中發射一個光子。反沖氫原子的速率是多少？ (01小題) 24 the speed=_____ m/s 分數= 8

Problem 14 (單選題)(a)

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