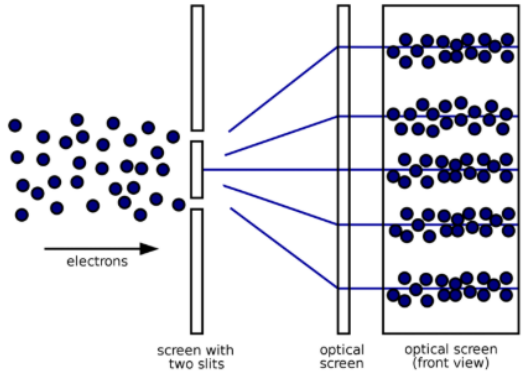
MP19-L03 學號:_____ 姓名:_____ 系級:_____得分:_____ 總分_____

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 1 (單選題)(a)

(單選題)____ 1 可嘗試次數= 2 分數= 2 1927年，柯林頓·戴維森與雷斯特·革末在貝爾實驗室將電子射向鎳結晶 ，發現其繞射圖譜，這個實驗結果證實了哪一個想法? (A)光具有粒子的特性 (B)光具有波動的特性 (C)粒子具有波的特性 (D)波具有粒子的特性

(單選題)____ 2 可嘗試次數= 2 分數= 2 1961年Claus Jonsson的電子雙狹縫實驗發現，電子只能走左邊或右邊這兩條路徑，最後抵達屏幕記錄下來，屏幕累積20分鐘(記錄了12000顆電子，如圖)，此實驗在2002年被Physics World雜誌讀者選為最美麗的物理實驗。這個實驗證實了 (A)電子滿足牛頓運動定律 (B)電子滿足狹義相對論的運動描述 (C)電子具有物質波的特性 (D)電子發生輻射現象 (E)電子的角動量空間量子化



(單選題)____ 3 可嘗試次數= 2 分數= 2 根據德布洛依物質波理論，一個質量為m，動量為p，的質點，其質波的波長為下列哪一個公式? (A)$\lambda = hp$ (B)$\lambda = p/h$ (C)$\lambda = h/p$ (D)$\lambda = \frac{mh}{p^2}$ (E)$\lambda = \frac{h^2}{mp}$

(單選題)____ 4 可嘗試次數= 2 分數= 2 一個帶電質點它的質量是m，電量q，最初靜止。受電位差V加速後，求德布羅意波長=? (A)$\sqrt{2mqV}$ (B)$\frac{h}{\sqrt{2mqV}}$ (C)$h\sqrt{2mqV}$ (D)$\frac{2h}{\sqrt{mqV}}$

(單選題)____ 5 可嘗試次數= 2 分數= 2 Evidence for the wave nature of matter is[物質波動性的證據是]: (A) electron diffraction experiments of Davisson and Germer (B) Thompson's measurement of e/m (C) Young's double slit experiment (D) the Compton effect (E) Lenz's law

(單選題)____ 6 可嘗試次數= 2 分數= 2 Consider the following three particles:
1. a free electron with kinetic energy K 2. a free proton with kinetic energy K 3. a free proton with kinetic energy 2K. Rank them according to the wavelengths of their waves, least to greatest.[考慮以下三種粒子：
1. 動能為 K 的自由電子 2. 動能為 K 的自由質子 3. 動能為 2K 的自由質子 依其波的波長從小到大排序。] (A) 1, 2, 3 (B) 3, 2, 1 (C) 2, 3, 1 (D) 1, 3, 2 (E) 1, then 2 and 3 tied

(單選題)____ 7 可嘗試次數= 2 分數= 2 A slowly moving proton has its velocity doubled. How does this affect its de Broglie wavelength[一個運動速度較慢的質子速度加倍。這會對其德布羅意波長產生什麼影響？]? (A)it is divided by 4 (B)it is divided by 2 (C)it is doubled (D) it is quadrupled

(單選題)____ 8 可嘗試次數= 2 分數= 2 A slowly moving proton has its kinetic energy doubled. How does this affect its deBroglie wavelength[一個運動緩慢的質子的動能增加了一倍。這會對其德布羅意波長產生什麼影響？]? (A)it is divided by $\sqrt{4}$ (B)it is divided by $\sqrt{2}$ (C)it is multiplied by $\sqrt{2}$ (D)it is multiplied by $\sqrt{4}$

(單選題)____ 9 可嘗試次數= 2 分數= 2 An electron and a proton have the same kinetic energy. Which has the greater de Broglie wavelength[電子和質子具有相同的動能，哪一個的德布羅意波長較長？]? (A)electron (B)proton (C)same

(單選題)____ 10 可嘗試次數= 2 分數= 2 A free electron and a free proton have the same momentum. This means that, compared to the matter wave associated with the proton, the matter wave associated with the electron has[自由電子和自由質子具有相同的動量。這意味著，與質子相關的物質波相比，電子相關的物質波具有]: (A) a shorter wavelength and a greater frequency (B) a longer wavelength and a greater frequency (C) the same wavelength and the same frequency (D) the same wavelength and a greater frequency (E) the same wavelength and a smaller frequency

(單選題)____ 11 可嘗試次數= 2 分數= 2 A free electron and a free proton have the same kinetic energy. This means that, compared to the matter wave associated with the proton, the matter wave associated with the electron has[自由電子和自由質子具有相同的動能。這意味著，與質子相關的物質波相比，電子相關的物質波具有較小的動能。]: (A) a shorter wavelength and a greater frequency (B) a longer wavelength and a greater frequency (C) a shorter wavelength and the same frequency (D) a longer wavelength and the same frequency (E) a shorter wavelength and a smaller frequency

(單選題)____ 12 可嘗試次數= 2 分數= 2 A non-relativistic free electron has kinetic energy K. If its wavelength

doubles, its kinetic energy is[非相對論性自由電子的動能為K。如果它的波長加倍，則其動能變成]: (A) 4 K (B) 2 K (C) still K (D) K/2 (E) K/4

(單選題)____ 13 可嘗試次數= 2 分數= 2 An electron is in a one-dimensional trap with zero potential energy in the interior and infinite potential energy at the walls. The ratio E_3/E_1 of the energy for n = 3 to that for n = 1 is[一個電子處於一維勢阱中，勢阱內部位能為零，勢阱壁面位能為無限大。 n = 3 時的能量與 n = 1 時的能量之比 E_3/E_1 為]: (A) 1/3 (B) 1/9 (C) 3/1 (D) 9/1 (E) 1/1

(單選題)____ 14 可嘗試次數= 2 分數= 2 A particle is trapped in a one-dimensional well with infinite potential energy at the walls. Three possible pairs of energy levels are: 1. n = 3 and n = 1 2. n = 3 and n = 2 3. n = 4 and n = 3 Order these pairs according to the difference in energy. least to greatest.[一個粒子被束縛在一個一維位勢阱中，勢阱壁面的位能為無窮大。可能存在三對能階： 1. n = 3 和 n = 1 2. n = 3 和 n = 2 3. n = 4 和 n = 3 請依能量差從小到大的順序排列這三對能階。] (A) 1, 2, 3 (B) 3, 2, 1 (C) 2, 3, 1 (D) 1, 3, 2 (E) 3, 1, 2

(單選題)____ 15 可嘗試次數= 2 分數= 2 Identical particles are trapped in one-dimensional wells with infinite potential energy at the walls. The widths L of the traps and the quantum numbers n of the particles are (1). $L = 2L_0, n = 2$, (2). $L = 2L_0, n = 4$, (3). $L = 3L_0, n = 3,$ (4). $L = 4L_0, n = 2.$ Rank them according to the kinetic energies of the particles, least to greatest.[相同的粒子被束縛在一維勢阱中，勢阱壁具有無限大的位能。勢阱的寬度 L 和粒子的量子數 n 分別為：(1). $L = 2L_0, n = 2$, (2). $L = 2L_0, n = 4$, (3). $L = 3L_0, n = 3,$ (4). $L = 4L_0, n = 2.$ 。請根據粒子的動能從小到大對它們進行排序。] (A) 1, 2, 3, 4 (B) 4, 3, 2, 1 (C) 1 and 3 tied, then 2, 4 (D) 4, 2, then 1 and 3 tied (E) 1, 3, then 2 and 4 tied

Problem 2

PART.1 Use the theory of special relativity to derive the following formula for the momentum of a particle in terms of its kinetic energy (K), mass (m) and speed of light c: p^2c^2=_____ .

利用狹義相對論推導出粒子動量與其動能 (K)、質量 (m) 和光速 c 之間的以下公式：p^2c^2=_____ (01小題)

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16 p^2c^2=_____ [K,m,c] 分數= 4

Problem 2

PART.2 Following previous problem, derive a relativistically correct formula that gives the de Broglie wavelength of a charged particle in terms of the charge q, mass m and the potential difference V through which it has been accelerated. λ =_____ [承接上題，推導出一個相對論意義上的公式，該公式以電荷 q、質量 m 和粒子加速所經過的電位差 V 表示帶電粒子的德布羅意波長 λ。 λ = _____] (01小題)

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17 λ=_____ [h,q,V,m,c] 分數= 4

Problem 3

投手將一顆150克的棒球以時速144公里/小時丟出，物質波的波長約為__公尺? (01小題) 18 λ =_____ m 分數= 4

Problem 4

如果一個電子和一個光子的波長都是2.0?，請計算(a)電子的動量, (b)光子的動量, (c)電子的能量, (d)光子的能量

(04小題) 19 (a)_____ kg.m/s 分數= 3 20 (b)_____ kg.m/s 分數= 3 21 (c)_____ eV 分數= 3 22 (d)_____ eV 分數= 4

Problem 5

Find the de Broglie wavelength of (a) an electron whose speed is 1.0×10^8 m/s, and (b) an electron whose speed is 2.0×10^8 m/s.

求 (a) 速度為 1.0×10^8 m/s 的電子的德布羅意波長，以及 (b) 速度為 2.0×10^8 m/s 的電子的德布羅意波長。 (02 小題) 23 (a) λ =_____ pm 分數= 4 24 (b) λ =_____ pm 分數= 4

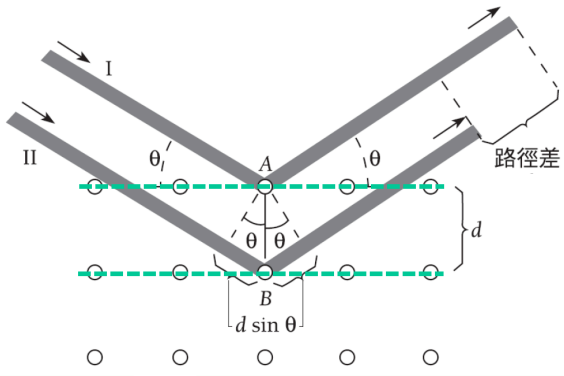
Problem 6

Find the kinetic energy of an electron whose de Broglie wavelength is the same as that of a 200-keV x-ray in (a)non-relativistic and (b)relativistic calculations.

求德布羅意波長與 200 keV X 射線相同的電子的動能，分別採用（a）非相對論計算和（b）相對論計算。 (02小題) 25 (a)non-relativistic KE=____ keV 分數= 4 26 (a)relativistic KE=____ keV 分數= 4

Problem 7

A beam of neutrons emerging from a nuclear reactor contains neutrons with a variety of energies. To select neutrons with a kinetic energy of 0.050 eV, the beam is directed onto a crystal whose atomic planes are separated by 0.20 nm. Using Bragg's law, calculate the smallest and largest possible Bragg angles between 0° and 90°. The Bragg angle is defined as the angle between the incident neutron beam and the crystal planes.



立方晶體的 x 射線散射。

從核反應器射出的中子束包含各種不同能量的中子。為了選出動能為 0.050 eV 的中子，讓中子束入射至原子晶面間距為 0.20 nm 的晶體。 根據布拉格定律，計算 0° 至 90° 之間可能產生繞射的最小及最大布拉格角。布拉格角定義為入射中子束與晶體原子晶面之間的夾角。 (02小題) 27 (a)smallest angle, θ =_____ degree 分數= 4 28 (b)largest angle, θ =_____ degree 分數= 4

Problem 8

Obtain an expression for the energy levels (in MeV) of a neutron confined to a one-dimensional box 1.00×10^{-14} m wide. What is the neutron's minimum energy? (The diameter of an atomic nucleus is of this order of magnitude.)

求出限制在邊長為 1.00 × 10?1? 公尺的一維盒子中的中子的能階表達式（單位：MeV）。中子的最小能量是多少？（原子核的直徑與此數量級相同。） (01小題) 29 KE_{min}=_____ Mev 分數= 4

Problem 9

A proton in a one-dimensional box has an energy of 400 keV in its first excited state. How wide is the box? Use non-relativistic consideration.

一維盒子中的質子在第一激發態的能量為 400 keV。這個盒子有多寬？請使用非相對論方法考慮。 (04小題) 30 (a)Obtain the width by the exact formula for the energy. The width of the box[利用能量的精確公式求得寬度。盒子的寬度]=_____ m 分數= 4 31 (b)the ground state energyE_1=_____ eV 分數= 4 32 (c)the momentum of the proton in the ground state, p_1=_____ kg.m/s 分數= 4 33 (d)Use uncertainty principle and make the approximation that $\Delta p \simeq p_1$ to estimate the minmum width[利用不確定原理，並近似假設 $\Delta p \simeq p_1$ 來估計最小寬度。]=_____ m 分數= 1

Problem 10

A proton has a kinetic energy of 1.0 MeV. If its momentum is measured with an uncertainty of 5.0%, what is the minimum uncertainty in its position?

一個質子的動能為 1.0 MeV。如果它的動量測量不確定度為 5.0%，那麼它的位置的最小不確定度是多少？ (01 小題) 34 Δx=_____ 分數= 4