國立中山大學 108 學年度
碩士暨碩士專班招生考試試題

科目名稱：電磁學【物理系碩士班】

—作答注意事項—

考試時間：100 分鐘

- **考試開始響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，不得另攜帶紙張，請衡酌作答。
- 答案卡請以 2B 鉛筆劃記，不可使用修正液（帶）塗改，未使用 2B 鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，其後果由考生自行負擔。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶具有通訊、記憶或收發等功能或其他有礙試場安寧、考試公平之各類器材、物品（如鬧鈴、行動電話、電子字典等）入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學108學年度碩士暨碩士專班招生考試試題

科目名稱：電磁學【物理系碩士班】　　題號：423002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　共1頁第1頁

計算題和式子推導過程請盡量寫詳細。

1. Write down the curl theorem and divergence theorem in the integration form. (10 points)

2. Write down the Maxwell equations in vacuum in the differential form. (10 points)

3. Derive the speed of an electromagnetic wave from the Maxwell equations. (20 points)

4. Calculate the electric field induced by a dipole, P, in a spherical coordinate. (20 points)

5. The total charge q is uniformly distributed on the surface a spherical shell with a radius of R. Please calculate the potential at the point of $2R$ away from the spherical shell center. The reference potential is at the infinite. (10 points)

6. Please use the Biot-Savart law to calculate the magnetic field at a distance s from a long straight wire which carries a steady current I. (20 points)

7. Find the magnetic field at a distance z above the center of a circular loop of radius R, which carries a steady current I. (10 points)

國立中山大學108學年度
碩士暨碩士專班招生考試試題

科目名稱：近代物理【物理系碩士班】

—作答注意事項—

考試時間：100分鐘

- **考試開始響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，不得另攜帶紙張，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，其後果由考生自行負擔。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶具有通訊、記憶或收發等功能或其他有礙試場安寧、考試公平之各類器材、物品（如鬧鈴、行動電話、電子字典等）入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

國立中山大學 108 學年度碩士暨碩士專班招生考試試題

科目名稱：近代物理【物理系碩士班】 題號：423001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題） 共 2 頁第 1 頁

問答題與計算題 [共六題] 試題共兩頁

＊1 至 4 題每題 15 分，5 至 6 題每題 20 分，答錯不倒扣。

1.(a) Does a blackbody always appear black ? Explain the term blackbody ?
(b) Explain the general characteristics of the spectrum of a blackbody. That is, what does the blackbody spectrum depend on ?

2. A stick with length of 100 cm moving in a direction parallel to its length appears to be only 75 cm long to an observer. What is the speed of the meter stick relative to the observer ?

3. In a photoelectric experiment in which monochromatic light and a sodium photocathode are used, we find a stopping potential of 1.85 V for λ = 3000 Å and 0.82 V for λ = 4000 Å.
From these data determine
(a) a value for Planck's constant h in unit of Joule•sec
(b) the work function of sodium in electron volts
Hint (1) : 1 Joule = 6.242×10^{18} eV
(2) : The kinetic energy of the photoelection can be expressed as $K = hc/\lambda - w_0$, where c is the speed of light ($c = 3\times10^{8}$ m/s) and w_0 is the work function of sodium.

4. The wave function of a free particle in the first excited state moving in the region −a/2 < x < +a/2 is

$$\Psi(x,t) = \begin{cases} A\,\sin\frac{2\pi x}{a} e^{-iEt/\hbar}, & -a/2 \le x \le a/2, \\ 0, & x < -a/2 \quad \text{or} \quad x > a/2. \end{cases}$$

Determine the value of the total energy E of the particle in the first excited state by using the time-independent Schrodinger equation.

5. A particle moving with kinetic energy equal to its rest energy has a de Broglie wavelength of 1.7898×10^{-6} Å. If the kinetic energy doubles, what is the new de Broglie wavelength ?
Hint : For a relativistic particle, the energy E of the particle can be expressed as $E^2 = p^2c^2 + m^2c^4 = (mc^2 + K)^2$, where p and K are the momentum and the kinetic energy of the particle, respectively. The de Broglie wavelength is defined as $\lambda = h/p$, where h is the Planck constant h = 6.626×10-34 m^2 kg / s

試題請隨卷繳回

科目名稱：近代物理【物理系碩士班】 題號：423001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）

6. Suppose that a particle is initially moving in the region $x < 0$ where the potential energy $V(x) = 0$, and traveling in the direction of increasing x towards the point $x = 0$ where the potential steps up to the value $V(x) = V_0$ in the region $x > 0$. The total energy of the particle E is greater than V_0.

(a) Solve the time-independent Schrodinger equation and give the general solution of the wave function (including the time dependent component)

(b) Show that the reflection coefficient R can be expressed in the following form

$$R = \left(\frac{1-\sqrt{1-V_0/E}}{1+\sqrt{1-V_0/E}}\right)^2$$

Note that the definition of R is $R = B^*B/A^*A$, where A and B are the amplitudes of the forward propagating and reversely propagating wave functions at the region $x < 0$.