國立中山大學109學年度
碩士暨碩士專班招生考試試題

科目名稱：普通物理【材光丙組聯合招生碩士班、材光系碩士班丙組、材料前瞻應材碩士班丙組】

－作答注意事項－

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，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109學年度碩士暨碩士專班招生考試試題

科目名稱：普通物理【材光丙組聯合招生碩士班、材光系碩士班丙組、材料前瞻應材碩士班丙組】
題號：489001
※本科目依簡章規定「不可以」使用計算機(問答申論題)

Problem 1. [10 points] Three masses are placed on the x-axis: 200 g at $x = 0$, 500 g at $x = 30$ cm, and, 400 g at $x = 70$ cm. Find their center of mass.

Problem 2. [10 points] A 1.2 μF capacitor is charged to 3.0 kV. Compute the energy stored in the capacitor.

Problem 3. [5 points] (a) Determine the shortest length of pipe closed at one end that will resonate in air to a sound source of frequency 160 Hz. Take the speed of sound in air to be 340 m/s. [5 points] (b) Repeat for a pipe open at both ends.

Problem 4. [10 points] Positive electric charge Q is distributed uniformly along a line of length $2a$ lying along the y-axis between $y = -a$ and $y = +a$ (Figure 1). Find the electric potential at a point P on the x-axis at a distance x from the origin.

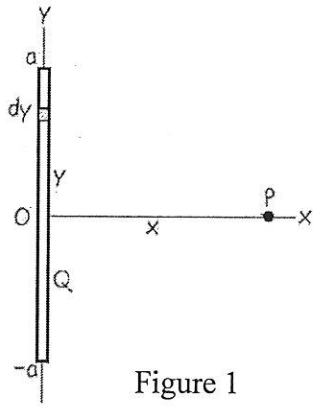

Figure 1

Problem 5. [10 points] A metal rod is 2 m long and 8 mm in diameter. Compute its resistance if the resistivity of the metal is 4×10^{-8} $\Omega \cdot m$.

Problem 6. An electric heater of resistance 8.0 Ω draws 15 A from the service mains. [5 points] (a) At what rate is thermal energy develop, in W? [5 points] (b) What is the cost of operating the heater for a period of 4.0 h at 100 NTD/$kW \cdot h$?

Problem 7. [10 points] A proton enters a magnetic field of flux density 1.5 Wb/m^2 with a velocity 2.0 $\times 10^7$ m/s at an angle 30^0 with the field. Compute the force on the proton.

Problem 8. [10 points] How much work is required to carry an electron from the positive terminal of a 12-V battery to the negative terminal?

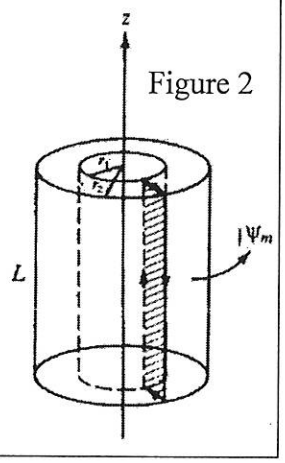

Figure 2

Problem 9. [10 points] In the annular cylindrical space shown in the Figure 2, the magnetic potential is $\boldsymbol{A} = -k \ln r \, \mathbf{a}_z$, where k is a constant. Determine the total magnetic flux in the annular space. (Here, r_1 and r_2 are inner and outer radius, respectively. Ψ_m stands for magnetic flux. L: annular cylinder length. $\mathbf{a}_z$: unit vector in the **z** direction)

試題請隨卷繳回，請留意背面是否有題

Problem 10. [10 points] As shown in the figure below (Figure 3), a uniform solid sphere rolls on a horizontal surface at 20 *m/s* and then rolls up the incline. If friction losses are negligible, what will be the value of *h* where the ball stops?

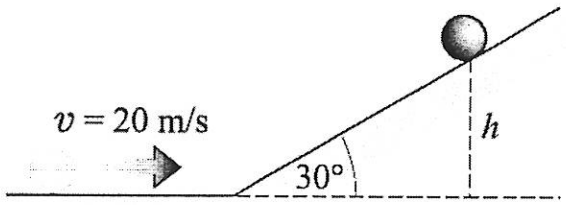

Figure 3

(1) Note that electron charge $q = -1.6 \times 10^{-19}$ C, $g = 9.8\ m/s^2$, NTD: 新台幣

(2) You might need the following integration table.

$$\int \sqrt{a^2+u^2}\,du = \frac{u}{2}\sqrt{a^2+u^2} + \frac{a^2}{2}\ln\left(u+\sqrt{a^2+u^2}\right) + C$$

$$\int u^2\sqrt{a^2+u^2}\,du = \frac{u}{8}(a^2+2u^2)\sqrt{a^2+u^2} - \frac{a^4}{8}\ln\left(u+\sqrt{a^2+u^2}\right) + C$$

$$\int \frac{\sqrt{a^2+u^2}}{u}\,du = \sqrt{a^2+u^2} - a\ln\left|\frac{a+\sqrt{a^2+u^2}}{u}\right| + C$$

$$\int \frac{\sqrt{a^2+u^2}}{u^2}\,du = -\frac{\sqrt{a^2+u^2}}{u} + \ln\left(u+\sqrt{a^2+u^2}\right) + C$$

$$\int \frac{du}{\sqrt{a^2+u^2}} = \ln\left(u+\sqrt{a^2+u^2}\right) + C$$

$$\int \frac{u^2\,du}{\sqrt{a^2+u^2}} = \frac{u}{2}\sqrt{a^2+u^2} - \frac{a^2}{2}\ln\left(u+\sqrt{a^2+u^2}\right) + C$$

$$\int \frac{du}{u\sqrt{a^2+u^2}} = -\frac{1}{a}\ln\left|\frac{\sqrt{a^2+u^2}+a}{u}\right| + C$$