

國立中正大學

112 學年度碩士班招生考試

試題

[第 2 節]

科目名稱	近代物理
系所組別	機械工程學系光機電整合工程

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

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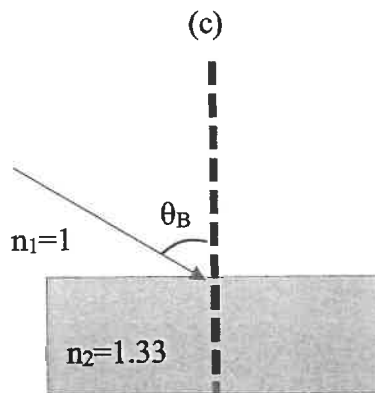
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系所組別：機械工程學系光機電整合工程

1. (10%) The ratio of the focal length of a camera lens to the size of the aperture diameter is called the f-number (also known as f-number or focal ratio). It is known that the light energy passing through the lens per unit of time is directly proportional to the area of the aperture. The focal length of the lens of a digital camera lens is fixed at 50 mm. When the f-number is set to 2, the correct exposure time for the best photo is $\frac{1}{450}$ second. If the f-number is set to 6, how many seconds should the exposure time be?

(a) $\frac{1}{6}$, (b) $\frac{1}{12}$, (c) $\frac{1}{50}$, (d) $\frac{1}{150}$

2. (30%) (a) Explain the meaning of "Brewster's angle θ_B " (10%), (b) following the previous question, solve θ_B of the two substances with refractive indices of 1 and 1.33 (10%), and (c) draw the Brewster's angle light trace diagram to illustrate the polarization state of reflected and refracted light. (10%)



3. (10%) How many photons per second are emitted from a 100 W yellow lightbulb (average wavelength, $\lambda = 550$ nm) if 5.0% of the applied energy is emitted as light?
 (a) $1.38 \cdot 10^{18}$, (b) $13.8 \cdot 10^{18}$, (c) $0.59 \cdot 10^{18}$, (d) $5.9 \cdot 10^{18}$ photons s^{-1} .
4. (30%) Free electron model for a metal:
- (a) What are the assumptions and successes of the electron model? (5%)
- (b) Derive Fermi energy $E_F = \frac{h^2}{2m^*} \left(\frac{3n}{8\pi} \right)^{2/3}$, when n is the electron density. (5%)
- (c) Why is an electron the energy E_F at $T = 0K$? What is the physical meaning? (5%)
- (d) Derive the electron distribution function $f(E)$. (5%)
- (e) Why do electrons follow the Fermi-Dirac distribution? (5%)
- (f) What is the difference in assumption between Fermi-Dirac distribution and Maxwell-Boltzmann distribution? (5%)

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5. (20%) Please briefly explain the content of the following nouns:

(a) Hund's rules (5%), (b) selection rules (5%), (c) de Broglie wavelength (5%), (d) Stark effect (5%)