

# 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【物理系碩士班】

## —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。

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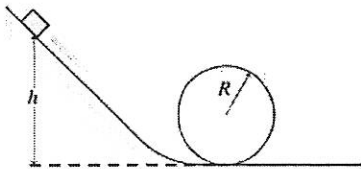
題號：423002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（選擇題）

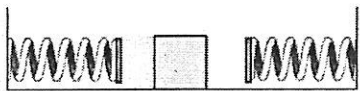
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單選題（一題 6 分共 10 題，共 60 分）

1. When an object is hooked on a spring vertically, the system forms a vertical simple harmonic oscillator due to the influence of both spring force and gravity. Which of the following is true: (a) gravity will change the position of balance point but won't change the oscillation frequency (b) gravity will change the oscillation frequency but won't change the position of balance point (c) gravity will change **both** the position of balance point and the oscillation frequency (d) gravity **won't** change the position of balance point and the oscillation frequency
2. An object with a mass of 1 kg is vertically hanged on a spring. If it is doing a simple harmonic oscillation with a frequency of 1 Hz, what is the spring constant  $k$  (unit: N/m): (a)  $4\pi^2$  (b)  $\frac{1}{4\pi^2}$  (c)  $2\pi$  (d)  $\frac{1}{2\pi^2}$
3. An object with mass  $m$  is attached to a spring with spring constant  $k$ . The friction in the system is described by the coefficient of damping (阻尼係數)  $b$ . By how much time, the oscillation amplitude will roughly reduce to 1/3 of its initial value: (a)  $m/3b$  (b)  $3b/m$  (c)  $2m/b$  (d)  $b/2m$
4. A block slides on a frictionless loop-the-loop track shown in the figure. Find the minimum height  $h$  at which it can start from rest and still make it around the loop. (a)  $3R/2$  (b)  $2R$  (c)  $5R/2$  (d)  $3R$



A 100-g block slides back and forth on a frictionless surface between two springs as shown in the figure. The left-hand spring has  $k = 110$  N/m and its maximum compression is 20 cm. The right-hand spring has  $k = 240$  N/m.



5. Find the maximum compression of the right-hand spring: (a) -7.0 cm (b) -10.5 cm (c) -13.5 cm (d) -16.0 cm;
6. Find the speed of the block as it moves between the springs: (a)  $\pm 6.63$  m/s (b)  $\pm 8.63$  m/s (c)  $\pm 10.63$  m/s (d)  $\pm 12.63$  m/s
7. Which of the following descriptions is correct?
  - (a) If two forces act on the same object but the net force is  $\vec{0}$ , the net torque must be  $\vec{0}$
  - (b) Even if two forces act on the same object but the net force is  $\vec{0}$ , the net torque may be NOT  $\vec{0}$
  - (c) We can apply a counterclockwise torque to an object that's rotating clockwise, and the object will rotate faster in the beginning
  - (d) We can NEVER apply any counterclockwise torque to an object that's rotating clockwise.
8. In an RC circuit with  $R = 400$  k $\Omega$  and  $C = 200$   $\mu$ F, the time constant is ? (a) 8 s (b) 80 s (c) 700 s (d) 6000 s
9. If a coaxial cable consists of an inner conductor and an outer conductor, and has a geometry as shown below. The inner and outer conductor carries uniform current  $I$  with the same magnitude but opposite

試題請隨卷繳回，請留意背面是否有題

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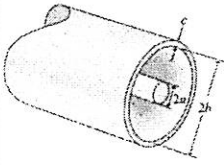
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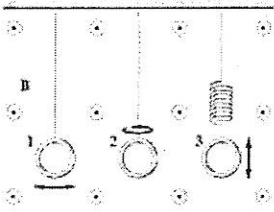
※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（選擇題）

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direction. What is the strength of magnetic field lies between the inner and outer conductor (representing it with the radius  $r$  from the center of the inner conductor,  $a < r < b$ ): (a)  $\frac{\mu_0 I}{2\pi r}$  (b)  $\frac{\mu_0 I}{2\pi a}$  (c)  $\frac{a\mu_0 I}{2\pi r}$  (d) 0



10. Three coils move differently in an uniform magnetic field  $B$  as shown below. The first one moves horizontally, the second one rotates counterclockwise, and the third one oscillates vertically. Which one will have the induced electromotive force: (a) coil 1 (b) coil 2 (c) coil 3 (d) all of them



是非題 (是選 A，否選 B，共 40 分)

(一)(16%) Figure 1 shows a pattern of resonant oscillation of a string of mass  $m = 2.500 \text{ g}$  and length  $L = 0.800 \text{ m}$  and that is under tension  $\tau = 325.0 \text{ N}$ . Which of the following is true:

11. The wavelength  $\lambda$  of the transverse waves producing the standing-wave pattern is 0.4 m (4 pt.)
12. The harmonic number  $n$  is 2 (4 pt.)
13. The frequency  $f$  of the transverse waves is 300 Hz (4 pt.)
14. The maximum magnitude of the transverse velocity of the element oscillation at coordinate  $x = 0.180 \text{ m}$  is 6.26 m/s (4 pt.)

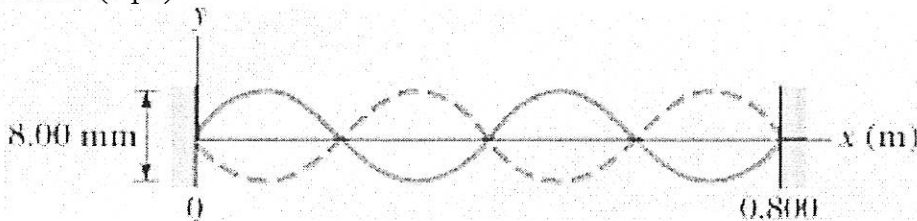


Fig. 1

(二)(12%) An oscillating  $LC$  circuit consists of a  $75.0 \text{ mH}$  inductor and a  $3.60 \mu\text{F}$  capacitor. If the maximum charge on the capacitor is  $2.90 \mu\text{C}$ , which of the following is true:

15. The angular frequency of the oscillation is  $0.19 \times 10^4 \text{ rad/s}$ . (4 pt.)
16. The total energy stored in the circuit is  $1.17 \times 10^{-6} \text{ joules}$  (4 pt.)
17. The maximum current in the circuit is  $4.58 \times 10^{-3} \text{ amp}$ . (4 pt.)

(三)(12%) In the double-slit experiment (Fig.2), the viewing screen is at distance  $D = 4.00 \text{ m}$ , point P lies at distance  $y = 20.5 \text{ cm}$  from the center of the pattern, the slit separation  $d$  is  $4.50 \mu\text{m}$ , and the wavelength  $\lambda$  is  $650 \text{ nm}$ . Which of the following is true:

18. The phase difference in radians between the two wave fronts arriving at P is  $0.354 \times 2\pi \text{ (rad)}$ . (4 pt.)
19. Based on (a), the position of point P lies in between the central bright fringe (at  $y=0$ ) and first dark fringe in the interference pattern. (4 pt.)

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20. Using  $I = 4I_0 \cos^2\left(\frac{\phi}{2}\right)$ , where  $\phi$  is the phase difference between the two wave fronts, the ratio of the intensity  $I_P$  at point P to the intensity  $I_{cen}$  at the center of the pattern, i.e.  $I_P/I_{cen}$ , is 0.18 (4 pt.)

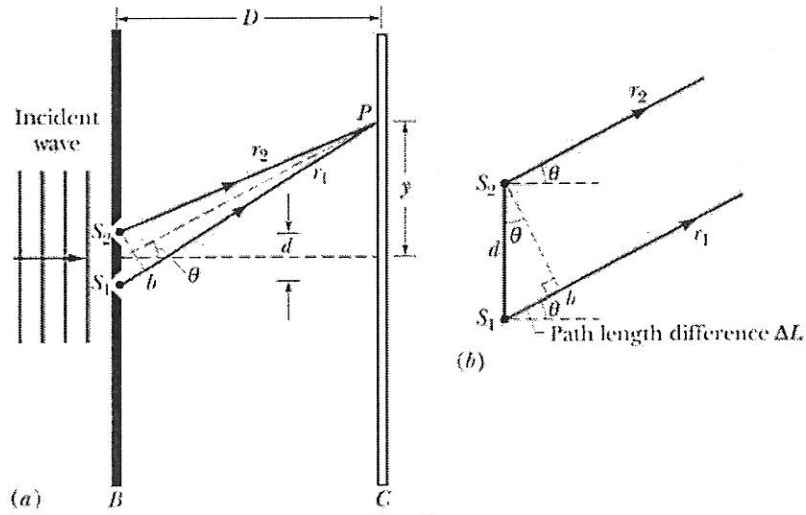


Fig. 2

# 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：近代物理【物理系碩士班】

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科目名稱：近代物理【物理系碩士班】

題號：423001

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共 2 頁第 1 頁

單選題 [共四題]

\*1~4 題每題 10 分，答錯不倒扣。

1. [10%] An electron and a proton are accelerated from rest through the same potential difference. Which particle has the longer wavelength?
- A. The electron
  - B. The proton
  - C. Equal for both
  - D. Ill-conditioned

2. [10%] Which line in Figure 1 should be the Bose-Einstein distribution?
- A. A
  - B. B
  - C. C

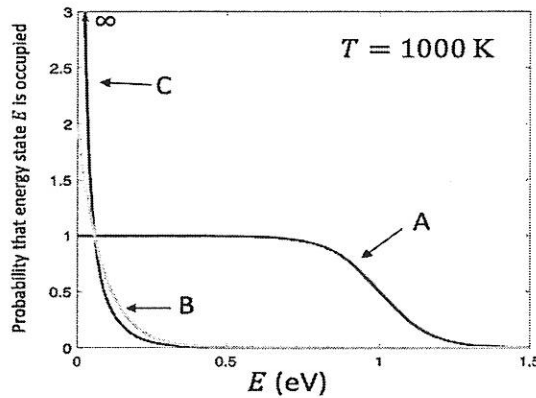


Figure 1

3. [10%] A particle of energy  $E$  is hitting a square barrier of potential height  $V$  and width  $W$  ( $W > 0$ ). Which one has a large tunneling probability?
- A.  $V = 2E$  and  $W = d$
  - B.  $V = 4E$  and  $W = d$
  - C.  $V = 2E$  and  $W = 2d$
  - D.  $V = 4E$  and  $W = 2d$
4. [10%] How many magnetic quantum numbers are allowed in the  $4p$  state of a hydrogen atom.
- A. 1
  - B. 2
  - C. 3
  - D. 4

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計算題 [共三題]

\*5 至 7 題每題 20 分，答錯不倒扣。

5. [20%] A plasmon has a dispersion relation  $\omega(k) = \sqrt{\omega_{pl}^2 + c^2 k^2}$ , which relates the angular frequency  $\omega$  and the wave number  $k$ .  $\omega_{pl}$  and  $c$  are constants.
- (a) [7%] What is the phase velocity as a function of  $\omega$ ,  $v_p(\omega)$ ?
  - (b) [7%] What is the group velocity as a function of  $\omega$ ,  $v_g(\omega)$ ?
  - (c) [6%] In what frequency range there is no propagating wave?
6. [20%] A photon of initial wave length  $\lambda$  experiences a Compton  $180^\circ$ -backward scattering by a rest electron, and then the photon's wave length changes to  $\lambda'$ . Let the rest mass of the electron be  $m$  and the speed of light be  $c$ .
- (a) [6%] What is the momentum of the electron after the scattering (in terms of  $\lambda$  and  $\lambda'$ )?
  - (b) [7%] Show the equation expressing conservation of energy.
  - (c) [7%] Solve the relation between  $\lambda'$  and  $\lambda$  from above conditions.
7. [20%] A particle of energy  $E (> 0)$  is incident from the left to a potential  $V(x) = 0$  for  $x \leq 0$  and  $V(x) = U (> 0)$  for  $x > 0$ .
- (a) [10%] Show your wavefunction for the particle when  $E < U$ .
  - (b) [10%] Show your wavefunction for the particle when  $E > U$ .