

國立成功大學  
110學年度碩士班招生考試試題

編 號： 38

系 所： 物理學系

科 目： 普通物理學

日 期： 0203

節 次： 第 2 節

備 註： 不可使用計算機

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

**Useful information:**

※ Ideal gas constant  $R = 8.314 \text{ J/mol-K}$ ; Gravitational acceleration  $g = 9.8 \text{ m/s}^2$

※ Electric permittivity in free space  $\epsilon_0 = 1/(4\pi \times 9 \times 10^9) = 8.85 \times 10^{-12} \text{ C}^2/\text{N-m}^2$  or  $\text{F/m}$

※ Magnetic permeability in free space  $\mu_0 = 4\pi \times 10^{-7} \text{ T-m/A}$

※ Bernoulli's equation:  $p + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$

※ Momentum of inertia about the center of mass for a circular object of mass  $M$  and of radius  $R$ :

A ring  $I_{\text{com}} = MR^2$ ; A disk  $I_{\text{com}} = MR^2/2$ ; A spherical shell  $I_{\text{com}} = 2MR^2/3$ ; A solid sphere  $I_{\text{com}} = 2MR^2/5$

※ Magnetic field at the center of a circular arc of angle  $\phi$  and of radius  $R$  with carrying current  $i$ :

$$B(0) = \frac{\mu_0 i}{2R} \left( \frac{\phi}{2\pi} \right)$$

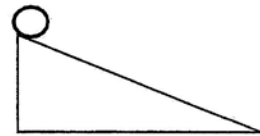
※  $e^{+1} \sim 2.72$ ;  $e^{-1} \sim 0.37$ ;  $\ln 2 \sim 0.69$ ;  $\ln 3 \sim 1.1$ ;  $\ln 5 \sim 1.6$ ;  $\ln 10 \sim 2.3$

1-4 題為單選題 (每題 5 分，答錯不倒扣。)

1) Assuming that a star and its final state, a neutron star, are solid spheres with uniform densities. The radius of the star is  $8 \times 10^8 \text{ m}$  and its period of the spin is  $8 \times 10^8 \text{ s}$ . If the star collapses to be a neutron star with a radius of  $4 \times 10^4 \text{ m}$ , what is the period of the spin for the corresponding neutron star?

(A)  $8 \times 10^4 \text{ s}$  (B)  $4 \times 10^4 \text{ s}$  (C)  $2 \times 10^4 \text{ s}$  (D)  $2 \text{ s}$  (E)  $0.5 \text{ s}$

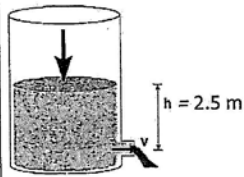
2) A circular object of mass  $M$  and of radius  $R$  rolls smoothly (without sliding) along a frictional incline, as shown below. In the following, which type of the object will be the first one rolling down to the bottom of the incline? (A) A disk (B) A spherical shell (C) A solid sphere (D) A ring (E) The same



3) For a photoelectric effect experiment, the kinetic energy of the electron emitted from the surface of a metal is measured to be  $1.5 \text{ eV}$ . If the work function of the metal is  $0.4 \text{ eV}$ , which kind of the light was used in this experiment? (A) Infrared (B) Ultraviolet (C) X-ray (D) Blue light (E) Red light

4) A tank is filled with water of mass density  $\rho_w$ , as shown below. What is the speed  $v$  of the water emerging from the small hole? Assume that the height of  $h$  remains unchanged all the time.

- (A) 4.95 m/s (B) 7 m/s (C) 9.9 m/s (D) 14 m/s (E) 49 m/s



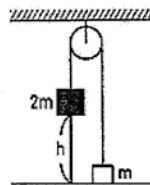
5-17 題為簡答題 (每題 5 分。請直接寫下答案，無需列計算過程。數值答案需附上單位。)

5) A 2 Kg block that rests on a frictionless surface is attached to a horizontal spring with the force constant  $k = 202 \text{ N/m}$ , as shown below. When a 20 g bullet with speed of 404 m/s is shot into the block and embedded, find the amplitude of the resulting simple harmonic motion (SHM) of the block with the embedded bullet.



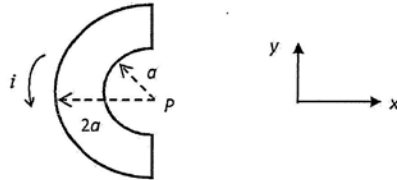
6) What is the magnitude of the angular frequency of the above SHM?

7) A heavier block of mass  $2m$  releases at rest from the height of  $h$  as shown below. Calculate the center of mass acceleration of the system before the  $2m$  block hits the ground. The pulley is massless in this case.

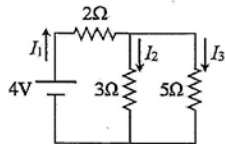


8) A particle of mass  $m = 100 \text{ g}$  moves straight forward with an acceleration given by  $a(t) = 2 + t^2 \text{ m/s}^2$ . If this particle starts at rest, what is the momentum of the particle at  $t = 3 \text{ sec}$ ?

- 9) What is the ideal efficiency of a Carnot engine operating between 300 and 900 K?
- 10) An ideal gas of one mole at 350 K experiences a free expansion from volume  $V_1$  to  $V_2 = 2V_1$ . Calculate the change of the entropy under this process.
- 11) In a certain region of space with volume  $0.2 \text{ m}^3$ , the electric potential is found to be 5 V everywhere. What is the magnitude of electric field in this region?
- 12) An electric dipole has a dipole moment of  $1.6 \times 10^{-9} \text{ C}\cdot\text{m}$ . Find the ratio of the electric potential due to the dipole at the distances of 0.6 m and 0.9 m from the center of the dipole,  $V(r = 0.6 \text{ m})/V(r = 0.9 \text{ m})$ , situated on a line making an angle of  $60^\circ$  with the dipole axis.
- 13) Determine the magnetic field (magnitude and direction) at  $P$  due to the current  $i$  in the wire shown below.

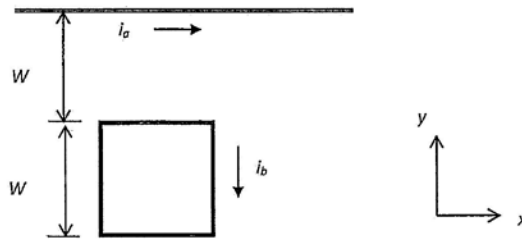


- 14) What is the magnitude of the magnetic dipole moment  $\mu$  of the corresponding loop shown above?
- 15) Three resistors are connected to a battery with an output voltage of 4 V as shown below. Calculate the value of the current  $I_2$  in Ampere.



- 16) A glass has an index of refraction  $n = 2$ . Determine the critical angle  $\theta_c$  for the incident light from the glass to the air.

17) A dc current  $i_a$  flows through an infinitely long, straight wire, as shown below. What is the direction of the net magnetic force exerted on the square loop which carries a clockwise current  $i_b$ ?



18 題為計算題 (共 15 分。計算題要寫計算過程，僅列式對給部份分數。)

18) (a) Determine the electric field (magnitude and direction) at the center of the square with four point charges on the corners as shown below. (b) Find the electric potential at the center of the square with the same charge configuration. (c) Calculate the total potential energy of this four-charge system.

