

國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：普通物理【物理系碩士班選考】

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

Useful physical constant: permittivity constant ($\epsilon_0: 8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2$); electron charge ($e: 1.6 \times 10^{-19} \text{ C}$)

1 [15%]. A hot-air balloon of diameter 10 m rises vertically at a constant speed of 12 m/s. A passenger accidentally drops his camera from the railing of the basket when it is 18 m above the ground. If the balloon continues to rise at the same speed, how high is the railing when the camera hits the ground?

2 [20%]. Please calculate the rotational inertia for the following uniform objects of inertia M and radius R about axes through their center of mass

- (a) [10%] thin-walled sphere
- (b) [10%] solid sphere.

3 [15%]. A uniform disk of mass m and radius R lies in a vertical plane and is pivoted about a point a distance l_{cm} from its center of mass. When given a small rotational displacement about the pivot, the disk undergoes simple harmonic motion. Determine the period of this motion.

4 [15%]. An infinitely long nonconducting solid cylinder of radius R has a nonuniform but cylindrically symmetrical charge distribution. The volume charge density is given by $\rho(r) = c/r$, where c is a positive constant having units C/m^2 and r is the radial distance from the long central axis of the cylinder.

- (a) [5%] What is the charge in a section of the cylinder of length l ?
- (b) [5%] Write an expression for the electric field magnitude for $r < R$.
- (c) [5%] Write an expression for the electric field magnitude for $r > R$.

5 [20%]. A certain wire has a circular cross section of radius R and carries a current I . Suppose that the charge carriers all move along the cylindrical surface of the wire, not through its cross-sectional area.

- (a) [10%] Derive an expression for the magnetic field magnitude $B(r)$ as a function of distance r from the center of the wire; check that your expression makes sense for $r < R$ and for $r > R$.
- (b) [10%] Make a graph showing the magnitude of the magnetic field in and around the wire as a function of the radial distance r from the center. Mark the wire radius R on your graph.

6 [15%]. Two parallel-plate capacitors are identical except that capacitor 1 has vacuum between the plates and capacitor 2 has a dielectric slab of dielectric constant κ filling the space between the plates. Each capacitor is isolated (that is, not connected to a battery), and they store equal quantities of charge.

Compare the two based on

- (a) [3%] capacitance,
- (b) [3%] potential difference between the plates,
- (c) [3%] energy stored,
- (d) [3%] electric field magnitude between the plates, and
- (e) [3%] energy density.

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