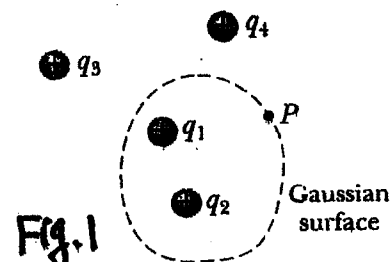


考試科目	普通物理(二)	所別	應用物理所 <sup>8162</sup> / <sub>8163</sub>	考試時間	3月14日 星期六	第四節
------	---------	----	---	------	--------------	-----

[Answers in both Chinese and English are acceptable.]

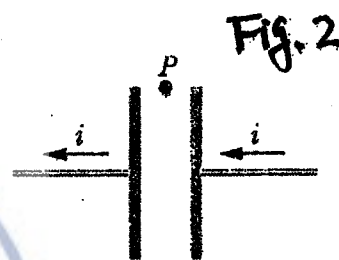
1 (32%) (simple answers are sufficient).

(1) In Fig. 1, a full Gaussian surface encloses two of the four positively charged particles. (a) Which of the particles contribute to the electric field at point  $P$  on the surface? (b) Which net flux of electric field through the surface is greater (if either): that due to  $q_1$  and  $q_2$  or that due to all four charges?

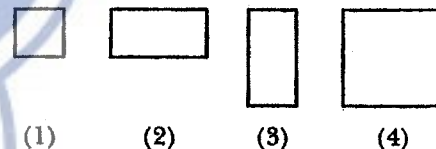


(2) Three wires, of the same diameter, are connected in turn between two points maintained at a constant potential difference. Their resistivities and lengths are  $\rho$  and  $L$  (wire A),  $1.2\rho$  and  $1.2L$  (wire B), and  $0.9\rho$  and  $L$  (wire C). Rank the wires according to the rate at which energy is transferred to thermal energy within them, greatest first.

(3) An electron in an external magnetic field  $\vec{B}_{ext}$  has its spin angular momentum  $S_z$  antiparallel to  $\vec{B}_{ext}$ . If the electron undergoes a *spin flip* so that  $S_z$  is then parallel with  $\vec{B}_{ext}$ , must energy be supplied to or lost by the electron?



(4) Figure 2 shows a parallel-plate capacitor and the current in the connecting wires that is discharging the capacitor. Are the directions of (a) electric field  $\vec{E}$  and (b) displacement current  $i_d$  leftward or rightward between the plates? (c) Is the magnetic field at point  $P$  into the page or out of the page?



(5) Figure 3 shows four choices for the rectangular opening of a source of light waves. The sides have lengths of either  $L$  or  $2L$ , with  $L$  being 3.0 times the wavelength of the waves. Rank the openings according to the extent of (a) left-right spreading and (b) up-down spreading of the waves due to diffraction, greatest first.

Fig. 3

(6) According to the theory of relativity, which of the following statements is true?

(a) moving clocks run fast; (b) energy is not conserved in high speed collisions; (c) the speed of light must be measured relative to the ether; (d) momentum is not conserved in high speed collisions; (e) none of the (a), (b), (c) and (d) are true.

(7) While standing outdoors one evening, you are exposed to: (a) yellow light from a sodium street lamp, (b) radio waves from an AM radio station, (c) radio waves from an FM radio station, and (d) microwaves from an antenna of a communications system. Rank these four types of waves in terms of increasing photon energy, lowest first.

(8) Consider the element chlorine ( $Z = 17$ ). In its part of the periodic table, the subshells of the electronic states are filled in the sequence  $1s 2s 2p 3s 3p 3d 4s 4p \dots$ . Identify the highest occupied subshell and state how many electrons are in it.

備 考 試 題 隨 卷 繳 交

命 題 委 員 :

( 簽 章 )

命題紙使用說明：1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。  
2. 書寫時請勿超出格外，以免印製不清。  
3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。

考試科目	普通物理(二)	所別	應用物理所	考試時間	3月14日 星期六 第四節
------	---------	----	-------	------	---------------

2. (10%) In Fig. 4, a sphere, of radius  $a$  and charge  $+q$  uniformly distributed throughout its volume, is concentric with a spherical conducting shell of inner radius  $b$  and outer radius  $c$ . This shell has a net charge of  $-q$ . Find expressions for the electric field, as a function of the radius  $r$ , (a) within the sphere, (b) between the sphere and the shell, (c) inside the shell. (e) What are the charges on the inner and outer surfaces of the shell?

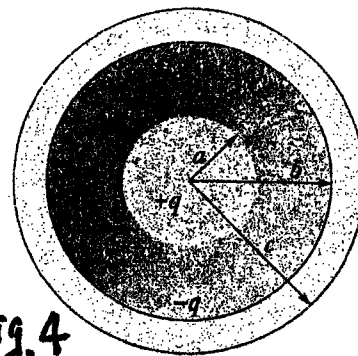


Fig. 4

3. (9%) A parallel-plate capacitor with capacitance  $C$  is charged by a battery to a potential difference  $V$  between its plates. The charging battery is now disconnected and a porcelain slab with dielectric constant  $\kappa$  is slipped between its plates. What is the potential energy of the capacitor-slab device, both before and after the slab is put into place?

4. (9%) A proton (charge  $+e$ , mass  $m_p$ ), a deuteron (charge  $+e$ , mass  $2m_p$ ), and an  $\alpha$  particle (charge  $+2e$ , mass  $4m_p$ ) are accelerated through a common potential difference  $\Delta V$ . Each of the particles enters a uniform magnetic field  $\vec{B}$ , with its velocity in a direction perpendicular to  $\vec{B}$ . The proton moves in a circular path of radius  $r_p$ . Determine the radii of the circular orbits for the deuteron,  $r_d$ , and the alpha particle,  $r_\alpha$ , in terms of  $r_p$ .

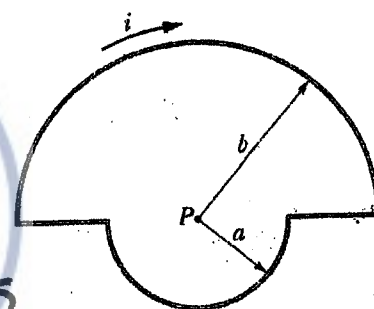


Fig. 5

5. (9%) A length of wire is formed into a closed circuit with radii  $a$  and  $b$ , as shown in Fig. 5, and carries a current  $i$ . (a) What are the magnitude and direction of  $\vec{B}$  at point  $P$ ? (b) Find the magnetic dipole moment of the circuit.

6. (10%) Figure 6 shows a lens with radius of curvature  $R$  lying on a flat glass plate and illuminated from above by light with wavelength  $\lambda$ . Find the radii  $r$  of the interference maxima (called Newton's rings) assuming  $r/R \ll 1$ .

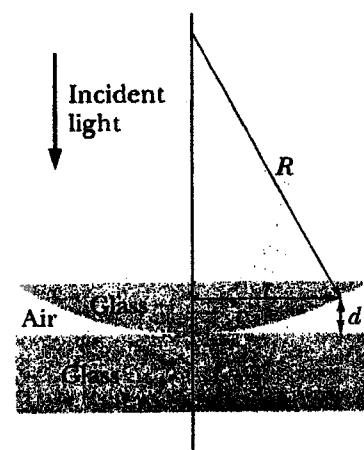


Fig. 6

7. (9%) A particle of charge  $q$  and mass  $m$  has been accelerated from rest to a nonrelativistic speed through a potential difference  $\Delta V$ . Find an expression for its de Broglie wavelength.

8. (12%) Seven electrons are confined to a square corral that is a two-dimensional infinite potential well with widths  $L_x = L_y = L$ . Assume that the electrons do not electrically interact with one another.

- What is the electron configuration for the ground state of the system of seven electrons?
- What is the total energy of the seven-electron system in its ground state, as a multiple of  $h^2/8mL^2$ ?
- How much energy must be transferred to the system for it to jump to its first excited state, and what is the energy of that state?

備考	試題隨卷繳交
命題委員：	(簽章)

命題紙使用說明：  
 1. 試題將用原件印製，敬請使用黑色墨水正楷書寫或打字（紅色不能製版請勿使用）。  
 2. 書寫時請勿超出格外，以免印製不清。  
 3. 試題由郵寄遞者請以掛號寄出，以免遺失而示慎重。