招生學年度	104	招生類別	碩士班
系所班別	物理學系 應用物理碩士班（一般組）、材料科學與工程學系碩士班		
科目名稱	普通物理		
注意事項	本考科禁止使用掌上型計算機		

1. A solid block of mass m_2, initially at rest on a horizontal frictionless surface, is connected to a massless spring with spring constant k. Another solid block of mass m_1 and speed V_0 collides with m_2.

(10%) (a) What is the maximum compression of the spring?

(10%) (b) If m_1 and m_2 travel in the same direction after the collision, what are the final velocities V_1 and V_2 of m_1 and m_2, respectively?

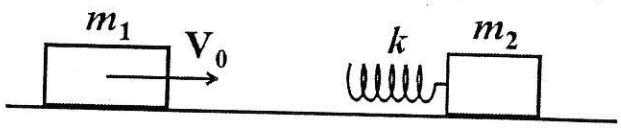

Figure 1

2. (10%) A uniform solid cylinder has a radius R, mass M, and length L. Prove its moment of inertia about its central axis (the z axis in the Figure 2) is $\frac{1}{2}MR^2$.

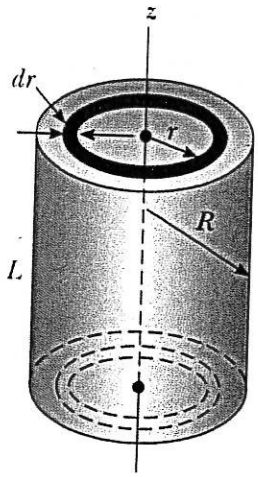

Figure 2

3. One end of a horizontal string is attached to a vibrating blade with vibration frequency f, and the other end passes over a pulley. A sphere of mass m hangs on the end of the string as in the Figure 3. The distance between the vibrating blade and the pulley is L. The linear mass density of the string is μ. The string is vibrating in its fifth harmonic.

(5%) (a) What is the speed of wave on the string?

(5%) (b) If L = 1.0 m, f = 250 Hz, and μ = $9.8\text{x}10^{-5}$ kg/m, what is the mass m of the sphere?

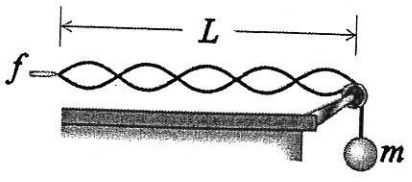

Figure 3

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4. An insulating solid sphere of radius a has a uniform volume charge density ρ and carries a total positive charge Q.

(5%) (a) Calculate the magnitude of the electrical field E at a distance r from the center of the sphere in the region $r > a$.

(5%) (b) Use Gauss's law to prove the magnitude of the electrical field E at a distance r from the center of the sphere in the region $r < a$ is $E = \dfrac{Q r}{4\pi\varepsilon_0 a^3}$.

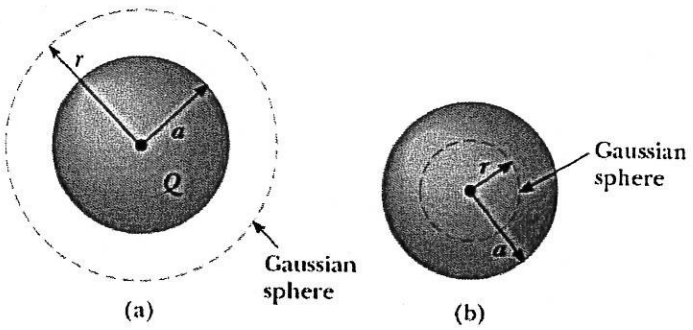

Figure 4

5. A long, straight wire of radius R carries a steady current I that is uniformly distributed through the cross section of the wire.

(5%) (a) Calculate the magnetic field B at a distance r from the center of the wire in the region $r > R$.

(5%) (b) Use Ampère's law to prove the magnetic field B at a distance r from the center of the wire in the region $r < R$ is $B = \dfrac{\mu_0 I r}{2\pi R^2}$.

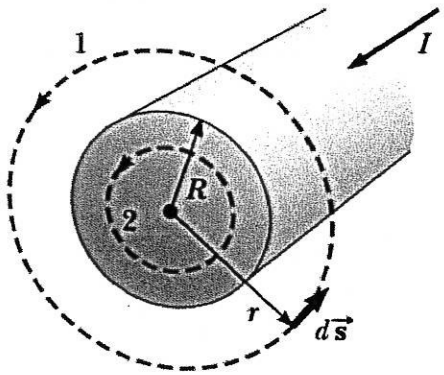

Figure 5

6. An electrical dipole $\vec{P}$ rotates in a uniform electrical field $\vec{E}$. The angle between $\vec{P}$ and $\vec{E}$ is θ.

(5%) (a) What is the change in potential energy as the electrical dipole $\vec{P}$ rotates from $\theta = 0°$ to $\theta = 90°$ in the uniform electrical field $\vec{E}$?

(5%) (b)What is the magnitude of torque τ on electrical dipole $\vec{P}$ when $\theta = 60°$?

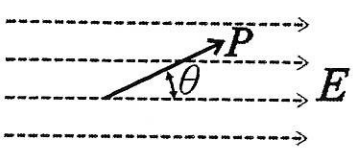

Figure 6

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7. An idea gas ($\gamma = 5/3$) in an engine initially at pressure P_i, volume V_i, and temperature T_A is taken through a cycle as shown in Figure 7. The temperature at condition A is $T_A = 400$ K. The pressure $P_i = 5\times10^5$ Pa. The volume $V_i = 0.01$ m^3.

(5%) (a) Calculate the net work done by the engine per cycle.

(5%) (b) Calculate the heat transferred into the engine from A to B.

(5%) (c) Calculate the heat transferred into the engine from B to C.

(5%) (d) Calculate the efficiency of the engine.

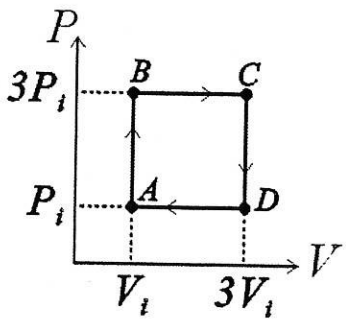

Figure 7

8. (5%) For a light of wavelength $\lambda = 400$ nm, calculate the minimum thickness of a soap-bubble film (index of refraction n = 1.33) that results in constructive interference in the reflected light.

9. (5%) Estimate the minimum separation d between two point sources, emitting 600 nm light, that the eye can distinguish. Assume the point sources are 30 cm away from the observer, the pupil diameter is 2 mm, and its resolution is limited only by diffraction.