選擇題 (30 分)

1. (6 points) A ball is thrown straight down, from an unknown height and hits the floor with a speed that is 5 m/s greater than its release speed. How long does it take to hit the ground? (a) 0.51 sec (b) 0.71 sec (c) 1 sec (d) 1.1 sec (e) 1.21 sec.

2. (6 points) A uniform disc of radius R has a hole of diameter R cut out as shown. The resulting object has a mass M. Calculate its moment of inertia about a perpendicular axis through the disc center C. (a) $(1/8)MR^2$ (b) $(3/16)MR^2$ (c) $(1/4)MR^2$ (d) $(13/24)MR^2$ (e) $(1/2)MR^2$.
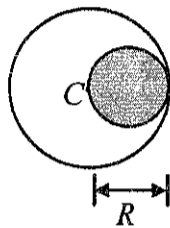
3. (6 points) A long thin uniform rod of length L and mass m is free to **rotate** in a horizontal plane about a **fixed** vertical axis through its center O. Two identical springs with force constant k are connected horizontally between the ends of the rod and a fixed wall (see diagram). What is the period of **small oscillations** when the rod is pushed slightly to one side and released? (a) $T=2\pi(2m/3k)^{1/2}$ (b) $T=2\pi(3k/m)^{1/2}$ (c) $T=2\pi(m/6k)^{1/2}$ (d) $T=2\pi(4k/3m)^{1/2}$ (e) $T=2\pi(m/4k)^{1/2}$.
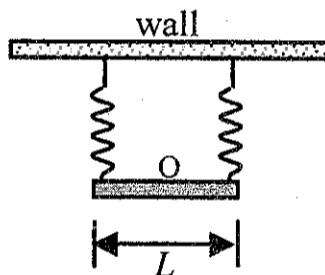

4. (6 points) A nylon rope has the linear mass density 0.25 kg/m. How much **tension** has to apply to produce the observed wave speed of 12.0 m/s? (a) 36.0 N (b) 72.0 N (c) 66.0 N (d) 7.2 N (e) 3.6 N.

5. (6 points) A ballistic pendulum is a system for measuring the speed of bullet (see diagram). The bullet, with mass m, is fired into a block of wood with mass M, suspended like a pendulum, and makes a completely inelastic collision with it. After the impact of the bullet, the block swings up to a maximum height y. Given the values of y, m, M, and gravitational acceleration g, what is the **initial velocity** v_x of the bullet? (a) $(m+M)^2\cdot(2gy)^{1/2}/m^2$ (b) $M\cdot(2gy)^{1/2}/m$ (c) $(m+M)\cdot(2gy)^{1/2}/m$ (d) $m^{1/2}\cdot(2gy)^{1/2}/(m+M)^{1/2}$ (e) $m\cdot(2gy)^{1/2}/M$.
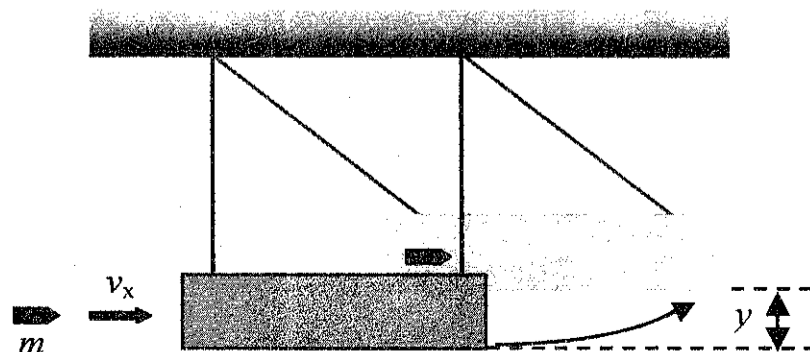
計算與簡答題 (70 分)

1. (10 points) A typical bedroom contains about 2500 moles of air. Find the **change in the internal energy** of this much air when it is cooled from 24°C to 14°C at a constant pressure of 1.0 atm. Treat the air as an ideal gas with $\gamma = C_p/C_v = 1.40$, where C_p and C_v are the molar heat capacities at constant pressure and volume, respectively. Note the gas constant R is 8.314 J/mole·K.

2. (10 points) The top view of a cylindrical gyroscope wheel that has set spinning by an electric motor is shown below. The pivot is at O, and the mass of the axle is negligible. (a) As seen from the above, is the precession **clockwise or counterclockwise**? (b) If the gyro takes 4 s for one revolution of precession, at what **angular speed** ω does the wheel spin?

Top view
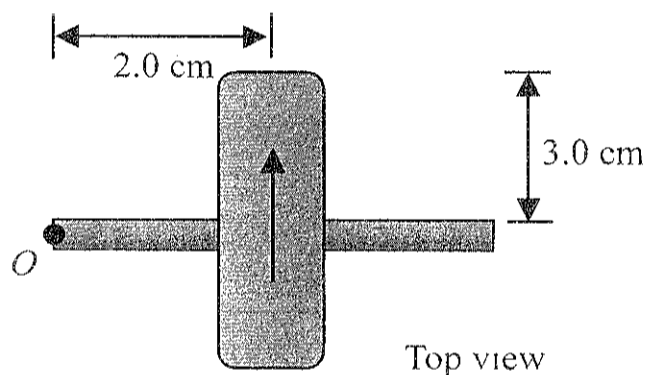
3. A metal rod of mass m and of length ℓ slides on frictionless rails of negligible resistance which terminate in a resistor R, see figure in below. A uniform magnetic field B is directed perpendicular to the plane of the rails. The initial velocity of the rod is v_0 and there is no external agent applying a force to the rod.
   (a) What is the speed of rod $v(t)$ at time t? (14%)
   (b) What is the total traveling distance of the rod before coming to rest? (7%)
   (c) What is the total electrical energy lost in this system? (4%)
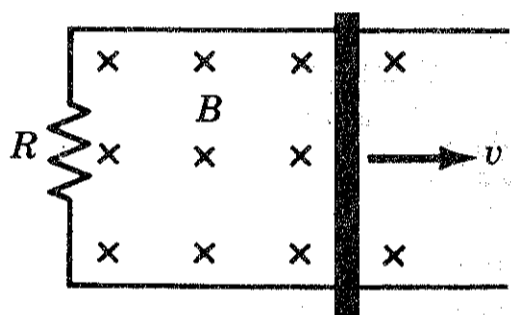
4. In a double-slit experiment a thin plate covers one slit and thereby introduces a 90^0 phase lag. What is the effect on the pattern on the screen? (5%)

5. In principle could one build a microscope to examine the structure of atoms with visible light? Why? (5%)

6. When unpolarized light passes through two crossed polarizing sheets, the transmitted intensity is zero. Is it possible to increase the transmitted intensity by using a third polarizing sheet? If so, how? (5%)

7. How could you make a lens to focus sound wave? Consider wave in air and in water. (5%)

8. Explain what is total internal reflection? (5%)