考 試 科 目	普通物理 81621	所 別	應用物理研究所 8162	考 試 時 間	3 月 1 日（日）第 1 節

1. (16%) A uniform solid cylinder of mass 10 Kg and radius 0.1 m is pulled by a thin string (the mass of the string is neglectable) under a constant force F of magnitude 15 N. The cylinder rolls smoothly without slip on the horizontal surface. (a) What is the magnitude of the acceleration of the center of mass of the cylinder? (b) What is the friction force acting on the cylinder (denote the magnitude and direction)? (The moment of inertia of the uniform cylinder about its center of mass is $MR^2/2$)
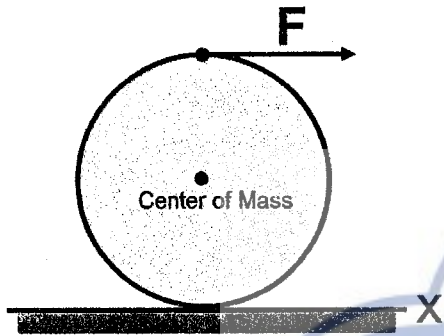
2. (12%) A small ball of mass M is attached to the end of a uniform rod of equal mass M and length L that is pivoted at the top. Determine the tensions in the rod (a) at the pivot and (b) at the point P when the system is stationary. (c) Calculate the period of oscillation for small displacements from equilibrium. (The moment of inertia of the uniform rod about its center of mass is $MR^2/12$)
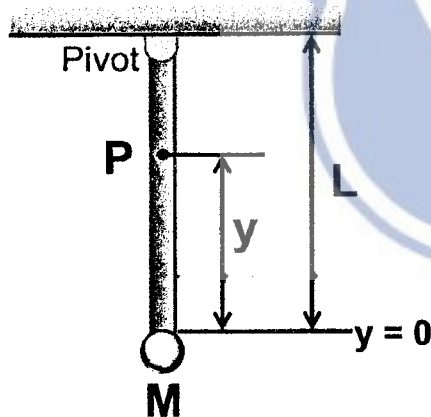
3. (16%) A gun can be viewed as a heat engine that does not operate in cycle but comes apart during its adiabatic expansion. A gun consists of 2 kg silver (specific heat is 234 J/kg°C). It can fire a 2.0 g bullet at 300 m/s with energy efficiency 1%. (a) Find the energy exhaust. (b) Assume the body of gun absorbs all the energy exhaust and increase uniformly in temperature for a short time interval before it loses any energy by heat into environment. Find its temperature increase.

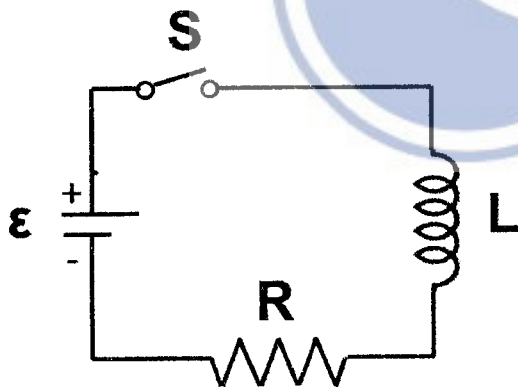| 考　試　科　目	普通物理 8161	所　　別	應用物理研究所 8162	考 試 時 間	3 月 1 日（日）第 1 節

4. (21%) Two circular coils of radius R, each with N turns, each with a steady current I in the same direction are arranged as a set of *Helmholtz coils*. Coils are perpendicular to a common axis and the centers of coils are a distance R apart. (a) Find that the magnetic field on the axis at a distance x from the center of one coil. (b) Find dB/dx and d^2B/dx^2 at the point midway between the coils. (c) What can we conclude about the magnetic field in the region midway between the coils.

5. (14%) Two coherent waves, coming from sources at different locations, move along the x axis. Their wave functions are

$$E_1 = 840 \sin\left[\frac{2\pi x_1}{600} - 1034\pi t + \frac{\pi}{3}\right] \qquad E_2 = 840 \sin\left[\frac{2\pi x_2}{600} - 1034\pi t + \frac{\pi}{5}\right]$$

where E_1 and E_2 are in volts per meter, x_1 and x_2 are in nanometers, and t is in picoseconds. When the two waves are superposed, determine the relationship between x_1 and x_2 that produces constructive interference.

6. (21%) In the circuit diagrammed in Figure, take $\varepsilon = 12.0$ V and $R = 10.0$ Ω. Assume the switch is open for $t < 0$ and is closed at $t = 0$. (a) Gives the equation of current as a function of time for $t \geq 0$. (b) When the switch is closed, the current takes 3.00 ms to reach 98.0% of its final value. What is the inductance? (c) What is the value of the final steady-state current? ($\ln 0.02 = -3.912$, $\ln 0.98 = -0.02$)

備　　　　註	一、作答於試題上者，不予計分。 二、試題請隨卷繳交。