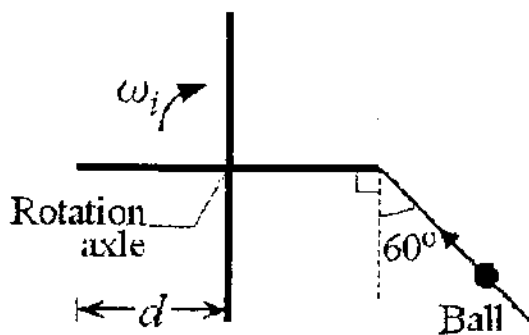


1. (20 分)

In the overhead view of Fig.1, four thin, uniform rods, each of mass M and length $d = 1.00\text{ m}$, are rigidly connected to a vertical axle to form a turnstile. The turnstile rotates clockwise about the axle, which is attached to a floor, with initial angular velocity $\omega_i = -4.0\text{ rad/s}$. A mud ball of mass $m = M/6$ and initial speed $v_i = 24\text{ m/s}$ is thrown along the path shown and sticks to the end of one rod. What is the final angular velocity ω_f of the ball-turnstile system?



(Fig. 1)

2. (20 分)

Compute the temperatures at which the *rms*(root-mean-square) speed for (a) molecular hydrogen and (b) molecular oxygen is equal to the speed of escape from earth. (c) Do the same for the speed of escape from the Moon, assuming the gravitational acceleration on its surface to be 0.16 g . (d) The temperature high in Earth's upper atmosphere is about 1000 K , Would you expect to find much hydrogen there? Much oxygen? Explain. (*Hint*: hydrogen's molar mass $m = 2.02 \times 10^{-3}\text{ kg/mol}$, oxygen's $m = 32.0 \times 10^{-3}\text{ kg/mol}$. Earth's radius is $6.37 \times 10^6\text{ m}$, moon's radius $1.74 \times 10^6\text{ m}$, gas constant $R = 8.31\text{ J/mol}\cdot\text{K}$).

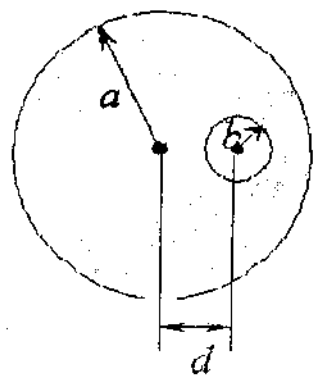
3. (20 分)

Fig. 2 shows a cross section of a long cylindrical conductor of radius a containing a long cylindrical hole of radius b . The axes of the cylinder and hole are parallel and are a distance d apart; a current i is uniformly distributed over the tinted area. (a) Use superposition to show that the magnetic field at the center of the hole is

$$B = \frac{\mu_0 i d}{2\pi(a^2 - b^2)}$$

(b) Discuss the two special cases $b=0$ and $d=0$. (c) Use Ampere's law to show that the magnetic field in the hole is uniform.

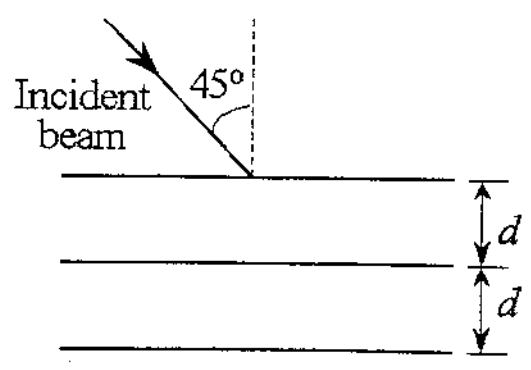
(背面仍有題目,請繼續作答)



(Fig. 2)

4. (20 分)

(a) In Fig. 3, an x-ray beam of wavelengths from 85.0 pm to 125.0 pm is incident at 45° to a family of reflecting planes with spacing $d=250.0 \text{ pm}$. At which wavelengths will these planes produce intensity maxima in their reflections? (b) Let a beam of x-rays of wavelength 0.115 nm be incident on an NaCl crystal at an angle of 45° to the top face of the crystal and a family of reflection planes. Let the reflecting planes have separation $d=0.232 \text{ nm}$. Through what angles must the crystal be turned about an axis that is perpendicular to the plane of the page for these reflecting planes to give intensity maxima in their reflections?



(Fig. 3)

5. (20 分)

An observer S sees a big flash of light 1200 m from his position and a small flash of light 480 m closer to him directly in line with the big flash. He determines that the time interval between the flashes is $5.00 \mu\text{s}$ and the big flash occurs first. (a) What is the relative velocity v (give both the magnitude and direction) of the second observer S' from whom these flash occurs at the same places in S' reference frame? (b) From the point of view of S' , which flash occurs first? (c) What time interval between them does S' measure?