

※請在答案卷內作答

- 一、 (20%) In Fig 1, the geometry of a nonconducting material is composed of a sphere of radius $2a$ centered at the origin and a spherical cavity of radius a centered at $y = a$ on the y axis. The material has a uniform positive charge density ρ that is not affected by the electric field. Find the magnitude and direction of the electric field \mathbf{E} at (a) (5%) $y = 3a$, (b) (5%) $y = 0$, and (c) (10%) $y = -a$ on the y axis.

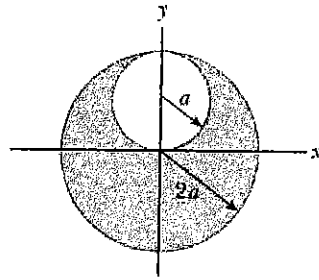


Fig. 1

- 二、 (10%) In Fig. 2, the switch is open for $t < 0$ and then closed at time $t = 0$. (a) (5%) What is the current passing through the switch right after the initial (at $t = 0^+$)? (b) (5%) What is the current passing through the resistor $2R$ in the long time limit?

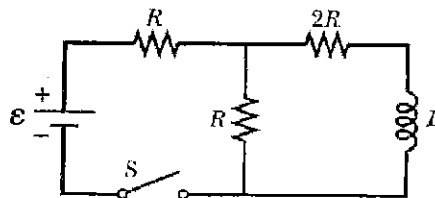


Fig. 2

- 三、 (20%) In Fig. 3, a long, cylindrical conductor of radius R carries a current density

$$J(r) = \frac{3I}{\pi R^2} (1 - (r/R)),$$

where r is the distance from the central axis of the conductor and I is the total current. (a) (5%) Find the magnetic field B at distance $r > R$. (b) (5%) Find B at distance $r < R$. (c) (10%) Where is the maximum of B and what is the maximum?

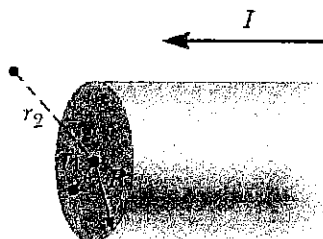


Fig. 3

參考用

注意：背面有試題

※請在答案卷內作答

- 四、 (15%) A car of mass m and speed v runs on a road and negotiates a curve of radius r under the gravitational acceleration g . The roadway is tilted toward the inside of the curve and has a banked angle θ . The coefficient of static friction between the tires and the road is μ_s . To make the turn successfully, (a) (4%) what is the minimum μ_s , if $\theta = 0$? (b) (4%) what is θ , if $\mu_s = 0$? (c) (7%) what is the minimum and maximum θ , if $\mu_s > 0$?

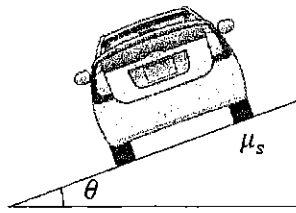


Fig. 4

- 五、 (15%) A disk of mass m is connected by a string passing through a small hole in a table. If the string is pulled by a hand, the disk undergoes a frictionless circular motion of radius R and speed v . (a) (5%) What is the speed of the disk, when the radius is decreased to r ? (b) (5%) How much work is done by the hand in this process? (c) (5%) If the hand is replaced by a cylinder of mass M under the gravitational acceleration g , the circle radius will increase to $2r$. How large is M ?

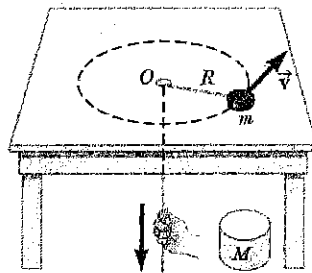


Fig. 5

- 六、 (10%) A tuning fork oscillating at frequency f is put on a car moving at a constant speed of v_c toward a wall. The speed of sound in air is v . (a) (5%) What is the beat frequency between the tuning fork and its echo? (b) (5%) How fast must the car run away from the wall to observe a beat frequency f_b ?
- 七、 (10%) Consider a cylindrical rod of radius r floating upright in a fluid of density ρ under the gravitational acceleration g . When the rod is pushed down a distance x from its equilibrium position and released, it undergoes a frictionless oscillation on the fluid surface. (a) (5%) What is the period of that oscillation? (b) (5%) Should one make x small to obtain a simple harmonic motion for this oscillation and why?

注意：背面有試題

參考用