

國立臺灣師範大學 100 學年度碩士班招生考試試題

科目：普通物理

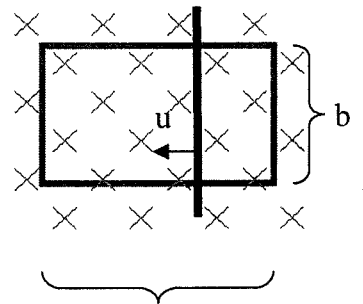
適用系所：物理學系

注意：1.本試題共 2 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則不予計分。

1. A bowling player throws out a bowling ball (mass M , diameter D) smoothly on the wooden runway with purely sliding (with velocity v) without rolling. The kinetic friction coefficient between the ball and the wooden surface is μ_k , and the friction will exert a torque on the ball and make it start to roll during its sliding. The motion of the ball becomes rolling without sliding after its velocity is reduced to a specific value.
 - (a) What is the specific velocity? (5 points)
 - (b) How far does the bowling ball glide before its motion becomes rolling without sliding? (5 points)
 - (c) How much kinetic energy is dissipated? (10 points)

2. A fresh water lake is exposed to atmosphere and a slab of ice 5.0 cm thick is formed on its surface. The air above the ice is at rest and has a constant temperature of -10°C .
 - (a) What is the rate of ice formation (in centimeter per hour) of the ice slab? (10 points)
 - (b) What is the change of the total entropy per square meter of the lake surface? Use this result to judge if this process is reversible or not. (10 points)(The thermal conductivity of the ice is $0.004 \text{ cal/s}\cdot\text{cm}\cdot\text{K}$, and its density is 0.92 g/cm^3 . The heat of fusion for water is 333 kJ/kg .)

3. A rectangular metal frame is located horizontally in a uniform magnetic field with the field directing vertically downward. Another copper rod lies on the frame (as shown in the graph) and moves to the left with a constant speed of u . What is the current flowing in the copper rod? (10 points)



4. An engineer wants to design a directional speaker set (speakers that emit sound wave in specific direction) by placing two speakers 20 cm apart side by side and both facing west. The speakers generate a coherent 33 kHz sound. Assuming the relative phase between the speakers is zero. What is the angle between the central maximum and first minimum? (10 points)
5. An atom is confined in a cubic box of edge length of L . The energy of the atom is described by three quantum numbers: n_x, n_y, n_z .
 - (a) Find the energies of the four lowest energy levels. (10 points)
 - (b) Find the density distribution of the fourth level. (10 points)

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6. A dipole is composed of $+Q$ at $(0,0,D/2)$ and $-Q$ at $(0,0,-D/2)$.
- (a) What is the electric field at the position $(L,0,0)$ on the $+x$ axis with $L/D \gg 1$? (10 points)
- (b) Another small dipole with magnitude of moment p is placed at the position $(L,0,0)$ What is the torque and force acting on the small dipole if its direction is pointing to $+y$? (10 points)
- (hint: The small dipole moment can be treated as $p = q \cdot d$.)