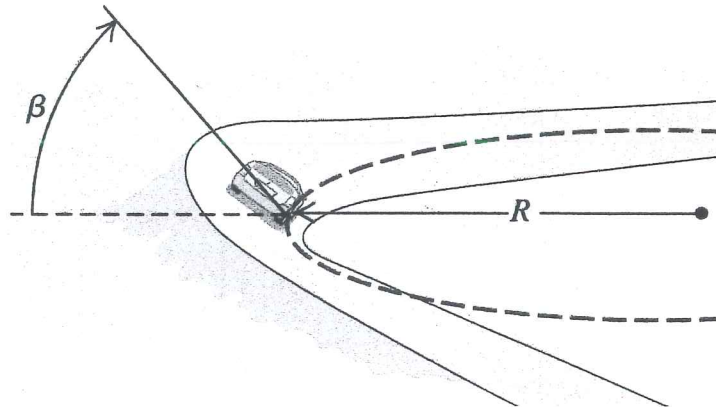# 國立臺灣師範大學 101 學年度碩士班招生考試試題

科目：普通物理　　　　　　　　　　　適用系所：地球科學系

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，否則依規定扣分。

1. A circular racing track of radius R is banked (傾斜) at an angle β so as to provide the centrifugal force (向心力) appropriate for a racing car with velocity v. Find the relation between R, β, v and g. (20 points)

2. Assume that the force between two atoms of mass m can be described by the following potential energy:

$$U = \frac{c}{r^{12}} - \frac{d}{r^6}$$

Here r is the distance between the two atoms and c, d are constants of appropriate units. (20 points)

   A. Write down the force between the atoms as a function of r. Denote a repulsive (排斥) force as positive.

   B. Calculate the equilibrium distance r_0 between the two atoms, ie. when the force is zero.

   C. If we release the two atoms at rest from a large distance, they will attract and move toward each other. How close will the two atoms get?

3. A 0.50 kg block of wood （木塊） is attached to a spring（彈簧）with an elastic constant of k = 400 N/m. (20 points)

   A. Pull the wood 15cm away from the equilibrium point and release it so that it starts to oscillate. Calculate the frequency of the oscillation.

   B. Calculate the velocity of the wood when it passes the equilibrium point during the oscillation.

4. One mole of an ideal gas of diatomic molecules undergoes a thermodynamic cycle that consists of an isothermal, an adiabatic and a constant volume processes as shown in the following P-V diagram. The pressure and temperature at state 1 is p_1=1 atm=1.01×10^5 Pa, T_1 =600K. The volume of the gas at state 2 is three times the volume at state 1. R=8.314 J/mol K. (20 points)

    A. What is the pressure of the gas at state 2? What is the temperature and the pressure of the gas at state 3?
    B. Calculate the heat emitted by the gas during the constant volume process 23. (If you don't have a calculator, just write down the expression.)
    C. Calculate the internal energy difference between the state 1 and 2. What is the internal energy difference between the state 2 and 3?
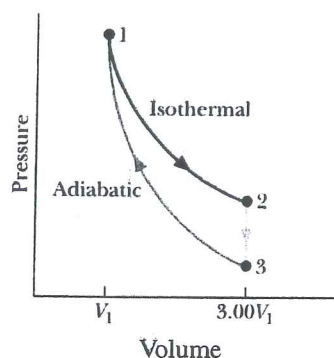
5. Consider a electric dipole, consisting of a point charge q at coordinate $(0,0,d/2)$ and a point charge $-q$ at coordinate $(0,0,-d/2)$. Turn on a uniform electric field in the x direction $\vec{E} = E_0 \cdot \hat{e}_x$ with magnitude E_0. (20 points)

    A. Calculate the total electric force by the field on the electric dipole.
    B. Calculate the torque on the electric dipole around the y axis.
    C. Now turn off the uniform electric field. Calculate the electric field generated by the electric dipole at $(r,0,0)$ when $r \gg d$.