科目：普通物理　　　　　　　　　　　適用系所：物理學系、科學教育研究所

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) Write down the definition of "**rotational inertia**" and explain why it is defined in this way. (6 points)

   (b) What is "Parallel-Axis Theorem" in the calculation of rotational inertia? Describe this theorem and try to prove it. (7 points)

   (c) and (d) Derive the rotational inertia for the following two objects (mass=M). (7 points)
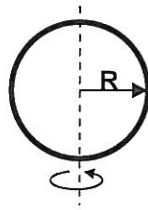
   **(c) Solid sphere**　　　　**(d) Solid Cylinder**
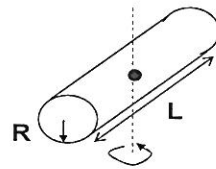
   $I=(MR^2)/4+(ML^2)/12$

2. (a) Plot the "Carnot's Cycle" in a Pressure-Volume phase diagram and describe the thermodynamic processes involved in the "Carnot's Cycle". (10 points)

   (b) Prove that in the adiabatic processes, $PV^\gamma = const.$ ($\gamma = \dfrac{C_v}{C_p}$ is given). (5 points)

   (c) If the "Carnot's Cycle" is operated between the low temperature T_c and the high temperature T_h. Derive that the efficiency of the Carnot's Engine equals $[1-(T_c/T_h)]$. (5 points)

3. (a) Write down the four **Maxwell's equations** in a vacuum and explain their physical meaning. (10 points)

   (b) Derive the **wave equation** and **light velocity** from the above Maxwell's equations. (10 points)

4. In the following cases, derive the **frequency f** of simple harmonic motion when the displacement x or angle θ is small. (5 points × 4)

   (a) A pendulum of mass = M, length = L. (Gravitative acceleration = g is known.)

   (b) Two objects of mass = M are separated and fixed. Their inter-distance is 2L. When another small object of mass = m is put in the center region between the two M. (Gravitational constant G is given.)

(c) Two charge points of charge +Q are separated and fixed. Their inter-distance is 2L. When another point of charge = +q is put in the center region between the two Q. (Electrostatic constant K is given.)

(d) Explain what is a "**damped harmonic oscillation**" and give an example.

(a)

(b)

(c)
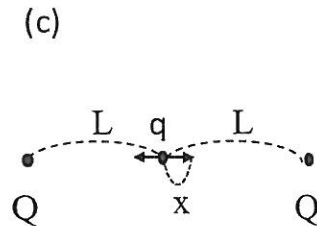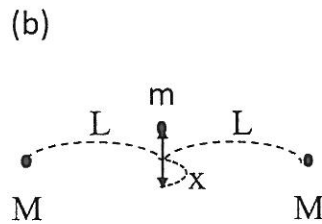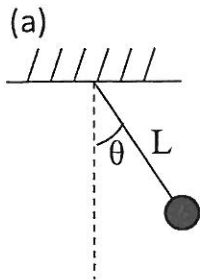
5. (a) Explain the phenomenon of "**time dilation**" in relativity and give an example.   (10 points)

   (b) Explain the phenomenon of "**length contraction**" in relativity and give an example.   (10 points)