科目：普通物理　　　　　　　　　　　　　適用系所：地球科學系、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，否則依規定扣分。

1. You are working in the NTNU library, reshelving books. You lift a book from the floor to the top shelf. The kinetic energy of the book on the floor was zero, and the kinetic energy of the book on the top shelf is zero, so there is no change in kinetic energy. Yet you did some work in lifting the book. Is the work-kinetic energy theorem violated? (10 points)

2. In Figure, a cockroach with mass m rides on a circular disk of mass 10.0 m and radius R. The circular disk rotates freely in a horizontal plane about a frictionless vertical axle at the angular speed $\omega_i = 1.50$ rad/s. The cockroach is initially at radius $r = 0.80R$, but then it crawls out to the rim of the disk. Treat the cockroach as a particle. What then is the angular speed? (10 Points)
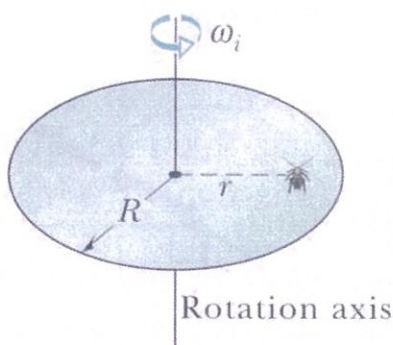
3. A gas undergoes the cyclic process depicted in below Figure. In the process abc, the system absorbs 4200 J of heat. The internal energy at a is $U_a = 500$ J. (a) Determine U_c. (8 points) The net heat absorbed during the complete cycle is 800 J. For the process c to a find (b) the heat transfer (6 points) and (c) the work done on the gas (6 points).
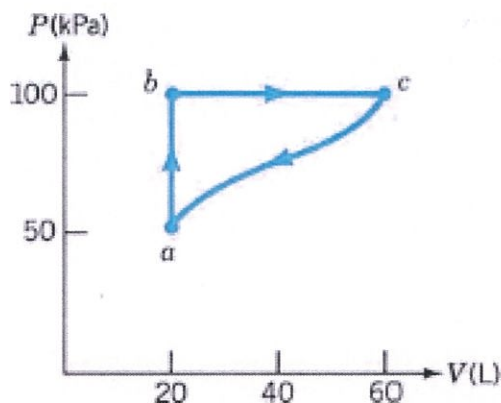
4. (a) What is the definition of electric dipole moment? (6 points) (b) An electric dipole is fixed at the origin of a coordinate system, and an electric field detector can be moved anywhere along the surface of an imaginary sphere of radius R that is centered on the origin. The radius of this sphere greatly exceeds the dipole separation, $R \gg d$. As the detector is moved over the spherical surface, what is the ratio of the largest and smallest magnitudes of the electric field it detects, E_{max} / E_{min}? (14 points)

5. (a) What exactly did Thomas Young demonstrate in his interference experiment with light? (5 points) (b) What conditions must be met for two waves to interfere? (5 points)

6. Explain what was learned from **two** of the following experiments:
    (a) Black body radiation spectrum.
    (b) Photoelectric effect.
    (c) Compton scattering.
    (d) Franck-Hertz experiment.
    (e) Davisson-Germer experiment.
    Describe the experiments selected in detail, indicate which of the measured effects were non-classical and why, and explain how they can be understood as quantum phenomena. Give equation if appropriate. (30 points)