1. Explain why the gravitational force is one example of a conservative force. (5 points)

2. Three objects of uniform density and the same mass - a solid sphere, a solid cylinder and a hoop – are placed at the top of an incline. They are all released from rest at the same elevation and roll without slipping. Which object reaches the bottom first? Which reaches it last? Explain. (10 points)

3. Does a particle moving at constant speed in a straight line have angular momentum about a point on the line? (1 point) About a point not on the line? (1 points) In either case, is its angular momentum constant? (3 points)

4. Describe explicitly the Zeroth, First and Second laws of thermodynamics. (10 points)

5. (a) Explain the theorem of the equipartition of energy. (3 points) (b) Figure shows the C_v/R for H_2 gas as a function of temperature. Explain which of the measured effects were non-classical and why, and explain how they can be understood by using the theorem of the equipartition of energy. (7 points)
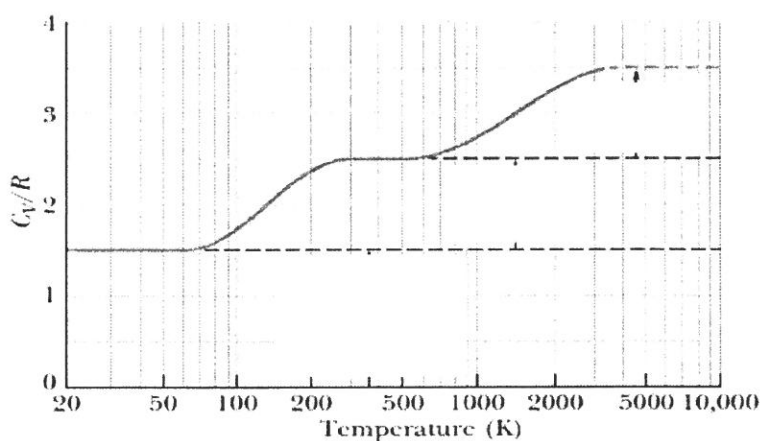
6. A solid sphere of radius R has a uniform charge density ρ and total charge Q. Derive an expression for its total electric potential energy. (10 points)

7. (a) What is the definition of magnetic dipole moment? (2 points) (b) What factors

contribute to the total magnetic dipole moment of an atom? (3 points)

8. (a) Write down the four Maxwell's equations in a vacuum. Explain what it says in these four laws of electromagnetism. (12 points) (b) Give a brief description of Maxwell's displacement current. (3 points)

9. Describe the photoelectric effect, including the experimental setup and results. Compare the predictions made by a classical approach and the Einstein's explanation. (15 points)

10. (a) What is the ground-state energy of an electron in an infinite square well whose width L is the approximate diameter of a hydrogen atom, about 10^{-10} m? (5 points) (b)What is the probability that it will be found in the leftmost quarter of the well ($0 < x < L/4$)? (10 points) ($m_e = 9.11 \times 10^{-31}$ kg , $h = 6.63 \times 10^{-34}$ J·s)