(1) A charged particle with mass m and charge +q is released from rest in an uniform eletromagnetic field with $\vec{E} = E_0 \hat{e}_y$, $\vec{B} = B_0 \hat{e}_z$ 12%

(a) Express the forces exerted on the particle while the particle is in motion.

(b) What are the equations of motion of the particle?

(c) Verify that the motion of the particle will be limited on the x-y plane?

(2) Using the results of Kepler's laws of planetary motion, show that 12%

(a) the gravitational force must be central.

(b) its radial dependence must be $\frac{1}{r^2}$.

(3) Consider a symmetrical top with radius R, height H, and mass m as shown in Fig. 1 14%

(a) Find the position of the center of mass.

(b) Find the moment of inertia of the top about X_3-axis.

(c) If the top spins about the X_3-axis and makes a steady precession about verticle line with a constant angle θ, suppose the precession angular velocity is Ω, find the angular velocity of spinning ω.

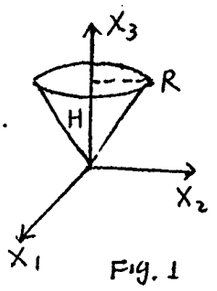

Fig. 1

(4) A sphere of radius ρ is constrained to roll without slipping on the lower half of the inner surface of a hollow cylinder of inside radius R. Determine the Lagrangian function, the equation of constrain, and the Lagrange's equations of motion. Find the frequency of small oscillation 12%

(5) Prove that (a) the change in enthalpy during an isobaric process is equal to the heat that is transferred (b) in the case of a reversibly isothermal and isobaric process, the Gibbs free energy remains constant 15%

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(6) (a) What is called the Carnot cycle ?

15% (b) Show that the maximum efficiency of any engine operating between two reservoirs is that of a Carnot engine operating between the same two reservoirs.

(7) A system consists of N_A distinguishable, independent particles, each of which is capable of existing in only two nondegenerate energy states

20% 0 and E.

(a) What is the partition function ?

(b) Calculate the energy.

(c) Calculate C_v.

, where N_A is the Avogadro's number and C_v is the heat capacity per mole.