1. (15%) See Fig. 1. An uniform sphere of mass m and radius R is placed on a smooth and Frictionless table. It is given a horizontal impulse I at height $R/2$ below the center.
   (a) What is its angular momentum with respect to its center?
   (b) What is its velocity? What is its angular velocity around its center if it rolls?
   (c) Describe the motion of the sphere.

2. (15%) A massive string is attached to a light string. A wave pulse on the massive string propagates toward the junction. Part of it will be transmitted and part of it will be reflected. Draw on the answer sheet a graph to show this process. Will the reflected pulse be inverted? Give your reasoning.

3. (15%) A particle of charge q and mass m is moving on xy-plane. There is uniform magnetic field B along z-direction. Now the magnetic field increases steadily, i.e. $dB/dt=constant$. How will this affect the motion of the particle initially? Will the cyclotron radius increase or decrease? Why?

4. (15%) A circular circuit loop carries current I. See Fig. 2. If the radius of the loop is R, what is the magnetic field at the center? Consider the magnetic field at point A which is off the center. Will it be larger than that at the center? Why?

Fig. 1

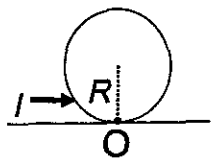
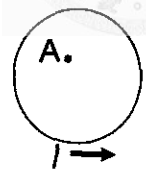


Fig.2



5. (a) 4% A p-V (pressure-volume) diagram is usually used to describe a "thermodynamic process" for the change from the initial state to the final state of a system. Please describe what is thermodynamic process? (b) 4% If a process is not a thermodynamic process, can we still calculate the work done by the gas? Why? (c) 4% Is a free expansion a thermodynamic process? Why? (d)8% Please calculate the entropy change in a free expansion if the volume V of the system expands to 4V. (Please derive the equation you use and give a reason why you can use it.)

6. "Duality" is one of the important concepts in quantum physics. (a)5% Dose it means that in quantum physics the "matter" can have the properties of wave and particle in the same time? (b)5% Please try to describe this concept and point out its major difference from the "wave" or "particle" concept in classical physics.(c)10% Please also give two examples in details for the "wave" behaving as "particle" and the "particle" as "wave", respectively.

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