(1) A playground merry-go-round of radius R=2.0 m has a moment of inertia I=250 kg-m^2 and is rotating at 10.0 rev/min about a frictionless vertical axle. Facing the axle, a 25.0-kg child hops onto the merry-go-round and manages to sit down on the edge. What is the new angular speed of the merry-go-round? (10%)

(2) A ball of mass m is connected to two rubber bands of length L, each under tension T as in Fig. 1. The ball is displaced by a small distance y perpendicular to the length of rubber bands. Assume that the tension does not change. (a) Prove that the motion of the ball is a simple harmonic motion. (b) Find the frequency of the simple harmonic motion.

Fig. 1.
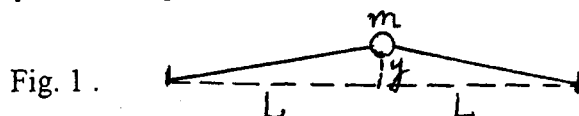
(18%)

(3) A parallel-plate capacitor has a plate separation of 1.50 cm and a plate area of 25.0cm^2. The plates are charged to a potential difference of 250 V. Determine (a) the charge on the plates and (b) the energy stored in the capacitor. (the permittivity of the free space $\varepsilon_0 = 8.85 \times 10^{-12} C^2 / N \cdot m^2$) (18%)

(4) A long, straight wire of radius R carries a steady current density J(r) = kr through the cross section of the wire. Find the magnetic field a distance r from the center of wire in the region r>R and r<R. (18%)

(5) An ideal gas is taken through a Carnot cycle. The isothermal expansion occurs at 250^{0}C, and the isothermal compression takes place at 50^{0}C. Assuming that the gas absorbs 1200J of energy from the hot reservoir during the isothermal expansion, find (a) the energy expelled to the cold reservoir in each cycle and (b) the net work done by the gas in each cycle. (18%)

(6) A sodium surface is illuminated with light having a wavelength of 300 nm. The work function for the sodium metal is 2.46 eV. Find (a) the maximum kinetic energy of the ejected photoelectrons and (b) the cutoff wavelength for sodium. (Planck's constant h=6.63x10^{-34}J-s, e=1.60x10^{-19} C) (18%)