

1. (14%) A road is banked at an angle θ with respect to the horizontal at where there is a curve. The radius of curvature is R . What is the maximum speed of the automobile in order to keep in track and not to slip outward? Assume the friction coefficient between the tire of the automobile and the surface of the road is μ .
2. (14%) A monkey wrench is pivoted at one end and allowed to swing as a physical pendulum. The period is 0.9 s and the pivot is 20 cm from the center of gravity. What is the radius of gyration of the wrench about an axis through the pivot?
3. (14%) A system of ideal gas undergoes an adiabatic expansion from (P_1, V_1) to (P_2, V_2) . If $P_1 = 20 \text{ atm}$; $V_1 = 1000 \text{ cm}^3$; $V_2 = 2000 \text{ cm}^3$; $\gamma = 1.4$, find the work done by the system. [$1 \text{ atm} = 1.013 \times 10^5 \text{ N/m}^2$; $(\frac{1}{2})^{0.4} = 0.758$.]
4. (14%) Several batteries of emf E_i and internal resistance r_i , $i = 1, 2, \dots, N$, are connected in parallel to form an electric source. An external resistor of resistance R is connected to the terminals of the electric source. Find the electric current in the external resistor.
5. (14%) A coaxial cable composed of two cylindrical metallic sheets of radii a and b , $a < b$. Find the self-inductance per unit length of the cable.
6. (15%) A frame of mass 200 gm, when suspended from a coil spring, is found to stretch the spring 10 cm. A lump of putty of mass 200 gm is dropped from rest onto the frame from a height of 30 cm. The putty adhered to the frame and set in oscillation. Neglecting the weight of the spring, find the amplitude of oscillation.
7. (15%) Light of wavelength λ is diffracted from a single slit of width b . Find the angular intensity distribution for the Fraunhofer diffraction pattern. Assume the central intensity being I_0 .