

1. The external force needed to produce an extension x in a string is given by $F(x) = 8x + x^3$ N. What is the work needed to extend it from $x = 1$ m to $x = 2$ m ? (10 %)
2. A uniform rod of mass m and length L is freely pivoted at one end. What is the period of its oscillation ? (10 %)
3. An ideal gas expands adiabatically to twice its original volume and in the process it does 400 J of work. (8 %) (a) What is the change in its internal energy ? (7 %) (b) What is the heat transfer ?
4. A wave on a string is given by $y = 3 \sin(2x + 10t)$, where x and y are in meters and t is in seconds. Find (8 %) (a) the wavelength and period, (7 %) (b) the particle velocity at $x = 2$ m and $t = 0.2$ s.
5. An insulating solid sphere of radius R has a uniform positive volume charge density and total charge Q .
 - (a) Find the electric potential at a point outside the sphere, that is, for $r > R$. Take the potential to be zero at $r = \infty$. (5%)
 - (b) Find the potential at a point inside the sphere, that is, for $r < R$. (5%)
6. A long solenoid of radius R has n turns of wire per unit length and carries a time-varying current that varies sinusoidally as $I = I_{\max} \cos(\omega t)$, where I_{\max} is the maximum current and ω is the angular frequency of the alternating current source.
 - (a) Determine the magnitude of the induced electric field outside the solenoid at a distance $r > R$ from its long central axis. (5%)
 - (b) What is the magnitude of the induced electric field inside the solenoid, a distance r from its axis ? (5%)
7. Monochromatic light from a helium-neon laser ($\lambda = 632.8$ nm) is incident normally on a diffraction grating containing 6000 grooves per centimeter. Find the angles at which the first- and second-order maxima are observed. (10%)
8. Briefly describe (a) The Hall effect, (b) Displacement current, (c) Meissner effect, (d) Coherent waves, and (e) Polarization of light waves by reflection. (20%)