# Physics 303/573

Homework 5 due Wednesday, October 11.

1. Consider a potential energy in one dimension of the form

$$U(r) = -\frac{A}{r} + \frac{1}{r^n}$$

a) Sketch this potential for the special values $A = 1/2$, $n = 2$.

b) For $r > 0$ and arbitrary $A > 0$, and any $n > 1$, what is the extremum $r_{eq}$ of this potential?

c) For this extremum $r_{eq}$, write the Taylor expansion for $U(r_{eq} + \delta)$ to second order in $\delta$.

d) If the particle has a mass $m$, what is the angular frequency of small oscillations?

2. Problem 5.18 in Taylor.

3. An undamped oscillator has a period $T$. A bit of damping is added, and the period changes to $T\sqrt{1+q^2}$, where $q$ is some constant.

a) What is the damping factor $\beta$? What is the quality factor $Q$?

b) Suppose $q = 1/(2\pi)$. What is the percentage change in the angular frequency? Approximately how many cycles are needed before the amplitude drops by a factor of $e$? Which effect is more noticeable?

4. Consider an overdamped harmonic oscillator with a driving force $F_w \sin(\omega_F t)$.

a) Find the motion without transients.

b) Find the motion if the initial position and velocity vanish.

5. Consider a RLC circuit with a resistor with resistance $R$ in series with a capacitor with capacitance $C$ and an inductor with inductance $L$.

a) What is the natural frequency $\omega$ and what is the damping factor $\beta$?

b) Suppose this is being driven by a voltage $V(t) = A\cos((\omega/2)t) + B\sin(2\omega t)$. What is the steady state current?