3.3.3.1: Quality

So far we have been talking about systems that have a single resonance frequency. The peak in the graph in section 4.2.1 is very sharp which means that driving the system at any frequency other than 2.5 Hz will not produce a very large amplitude vibration. Many systems, including musical instruments, have a wide range of frequencies at which the system will resonate. Several different resonance curves appear in the graph below. Notice that, although there is always a single resonance frequency for any one curve (the frequency of the peak), there are many frequencies near resonance that will cause almost the same amplitude of vibration. The width of the resonance curve is called the ***Quality*** or *Q-factor*. The higher the Q-factor, the narrower the curve and the more selective the system is about what frequencies will excite it into resonance.

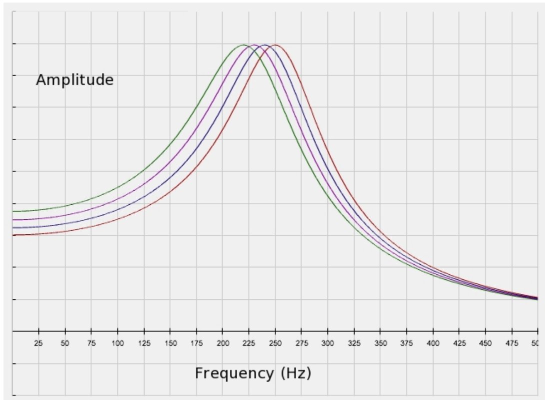

Figure $3.3.3.1.1$

The mathematical calculation (not given here) of the Q-factor depends on the amount of friction or damping in the system. Less damping means a narrower and higher resonance curve and it also means the frequencies will die away more slowly. An instrument designed with a high Q-factor would resonate loudly and for a long time but only at one frequency. Decreasing the Q-factor by having more damping means the resonance is not as sharp or as loud but it allows the instrument to play many different notes with nearly equal loudness. As we will see, the body of stringed musical instruments demonstrates a trade-off between sharp resonances (high Q) and broad range (low Q).