<http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html>

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| Circular Membrane Modes http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/mem.gif   |  |  |  | | --- | --- | --- | | [Details of four lowest modes](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c2) | [Preferred modes for timpani](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c3) | [Discussion](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c4) |  |  | | --- | | [Calculation for circular membrane](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c4) | | [Index](http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html)  [Percussion instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/percus.html#c1)  [Musical instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/musinscon.html#c1)  Reference [Berg & Stork](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/souref.html) |
| |  |  | | --- | --- | | [HyperPhysics](http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html)\*\*\*\*\* [Sound](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/soucon.html) | *R Nave* | | [Go Back](Javascript:history.go(-1)) |

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| Circular Membrane Modes The four lowest [vibrational modes](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c1) for a circular membrane.  http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/mem2.gif  Mode 11 is the lowest of the [preferred modes](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c1) for the [timpani](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/timpani.html#c1). | [Index](http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html)  [Percussion instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/percus.html#c1)  [Musical instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/musinscon.html#c1)  References [Rossing](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/souref.html) Science of Sound  Ch 2 [Morse & Ingard](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/souref.html) |
| |  |  | | --- | --- | | [HyperPhysics](http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html)\*\*\*\*\* [Sound](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/soucon.html) | *R Nave* | | [Go Back](Javascript:history.go(-1)) |

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| Preferred Timpani Modes Assuming that these selected modes are excited, the relative frequencies and intervals in cents are given compared to the 11-mode. The preferred vibrational modes for a [timpani](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/timpani.html#c1) are a subset of the [modes](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c1) of a [circular membrane](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c4).  http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/mem3.gif  The interval values in [cents](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cents.html#c1) here are calculated from the mode frequencies given by Berg & Stork. They can be compared to [equal tempered intervals](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cents.html#c1). The actual [sounding frequencies](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/timpani.html#c3) are affected by air damping. | [Index](http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html)  [Percussion instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/percus.html#c1)  [Musical instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/musinscon.html#c1)  References [Backus](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/souref.html) pg 300  [Berg & Stork](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/souref.html) |
| |  |  | | --- | --- | | [HyperPhysics](http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html)\*\*\*\*\* [Sound](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/soucon.html) | *R Nave* | | [Go Back](Javascript:history.go(-1)) |

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| Circular Membrane The [vibrational modes](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c1) of a circular membrane are very important musically because of drums, and in particular the [timpani](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/timpani.html#c1). The expression for the fundamental frequency of a circular membrane has some similarity to that for a stretched string, in that it depends on tension and density. The fundamental or 01 mode of an ideal circular membrane is given by:  http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/mem4.gif  A timpani head, made of mylar of thickness about 0.2 mm might have the following values for those parameters:   |  |  | | --- | --- | | http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/mem5.gif | Starting with the values at left as the default values, parameters can be changed below to explore the effects on the membrane resonance.  Top of Form  T = N/m  σ = kg/m2  f01= Hz  D = m  Bottom of Form |   The nature of vibrational modes in membranes is calculated from the [wave equation](http://hyperphysics.phy-astr.gsu.edu/hbase/waves/waveq.html#c1) in two dimensions. | [Index](http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html)  [Percussion instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/percus.html#c1)  [Musical instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/musinscon.html#c1)  References [Hall](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/souref.html) Ch 9  [Berg & Stork](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/souref.html) |
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| |  |  | | --- | --- | | http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/snaredrum.jpg | Snare Drum Drums make use of circular membranes which have many [modes of vibration](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c1). The excitation of the various modes depends upon where the drum is struck. The [timpani](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/timpani.html#c1) is struck near the side to excite certain [preferred modes](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c3). By contrast, the snare drum is struck in the center and excites the 01, 02, 03, modes. The fundamental frequency for an ideal [circular membrane](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c4) with no air damping effects is given by  http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/snare.gif |   The snare drum is a two-headed drum, as is the [bass drum](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/bdrum.html#c1) and other orchestral and band drums used in Western music. On the snare drum, eight to ten wire-bound gut strings, or snares, usually are stretched across the lower of the two heads; they vibrate against the heads as the membranes are struck.  The two membranes of the snare drum are acoustically coupled to each other, particularly at the low frequencies. This coupling via the enclosed air acts to double the modes. The lower frequency member of the mode pair involves both heads moving in the same direction and for the higher mode they move oppositely.  Note that the value of the constant in the above equation for the frequency assumes that [MKS units](http://hyperphysics.phy-astr.gsu.edu/hbase/units.html#uni4) are used, as in the calculation for the [circular membrane](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c4). | [Index](http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html)  [Percussion instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/percus.html#c1)  [Musical instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/musinscon.html#c1) |
| |  |  | | --- | --- | | [HyperPhysics](http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html)\*\*\*\*\* [Sound](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/soucon.html) | *R Nave* | | [Go Back](Javascript:history.go(-1)) |

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| |  |  | | --- | --- | | http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/bdrum.jpg | Bass Drum Drums make use of circular membranes which have many [modes of vibration](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c1). The excitation of the various modes depends upon where the drum is struck. The [timpani](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/timpani.html#c1) is struck near the side to excite certain [preferred modes](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c3). By contrast, the bass drum is struck in the center and excites the 01, 02, 03, modes. The fundamental frequency for an ideal [circular membrane](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c4) with no air damping effects is given by  http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/snare.gif |   The bass drum usually has a diameter of 50-100 cm and membranes on both ends of the cylindrical body. Although the drum does not have a well-defined pitch center, it is common practice to tune the [lowest modes](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c1) of the two heads about a musical fourth apart. The coupling between the two heads of the drum produces a splitting of the two lowest modes, the 0,1 and 1,1 modes.  Note that the value of the constant in the above equation for the frequency assumes that [MKS units](http://hyperphysics.phy-astr.gsu.edu/hbase/units.html#uni4) are used, as in the calculation for the [circular membrane](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/cirmem.html#c4). | | [Index](http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html)  [Percussion instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/percus.html#c1)  [Musical instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/musinscon.html#c1) |
| |  |  | | --- | --- | | [HyperPhysics](http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html)\*\*\*\*\* [Sound](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/soucon.html) | *R Nave* | | | [Go Back](Javascript:history.go(-1)) |
| |  |  | | --- | --- | | http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/tbell.jpg | Tubular Bells A bell-like sound can be obtained by tuned metal tubes. They are commonly referred to as bells or chimes. A similar instrument is constructed of metal bars.  The set of hollow vertical pipes is suspended at the top of the pipes by thin wire. Each pipe is struck with hammers on the top part of the chime. The three lowest modes of vibration of a chime tube have frequencies with ratios 2:3:4. The ear perceives this as the pitch one octave below the fundamental by the [missing fundamental effect](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/subton.html#c2). Other overtones depart from this approximate linear set of harmonics and help give the chime its unique sound. There are end plugs which are said to add to the sustain of the tone and to damp out high harmonics. The end plug helps to lower the frequencies of the first few modes, but has little effect on higher modes. | | [Index](http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html)  [Percussion instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/percus.html#c1)  [Musical instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/musinscon.html#c1)  Reference [Rossing](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/souref.html#c1) Acous of Percussion, Pt I | |
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| |  |  | | --- | --- | | http://hyperphysics.phy-astr.gsu.edu/hbase/Music/imgmus/hbell.jpg | Bells Some of the commonly used bells are church bells, carillion bells, and handbells (See Rossing 2nd Ed p280). Carillion bells have eight modes of vibration which contribute to the tone. Handbells, struck with a soft internal clapper, have a 2,0 mode which is the strike tone. The 3,0 mode is tuned to three times the frequency of the 2,0 mode and the 2,0 mode produces some second harmonic, so you have sound at the first three harmonics. Rossing (p283) shows hologram interferograms of 17 modes of a C5 (523 Hz) handbell. | | [Index](http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html)  [Percussion instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/percus.html#c1)  [Musical instruments](http://hyperphysics.phy-astr.gsu.edu/hbase/Music/musinscon.html#c1)  Reference [Rossing](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/souref.html) Science of Sound |
| |  |  | | --- | --- | | [HyperPhysics](http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html)\*\*\*\*\* [Sound](http://hyperphysics.phy-astr.gsu.edu/hbase/sound/soucon.html) | *R Nave* | | [Go Back](Javascript:history.go(-1)) |