

# The Harmonic Series

## for Brass Instruments

Brass musicians can change pitches in two ways: by moving the valves (or trombone slide) to change the length of the instrument; or by blowing the air faster (or slower) to play different pitches with the same fingering (or slide position). The set of pitches that can be played with a single fingering is known as the *harmonic series* (sometimes called the *overtone series*). The interval pattern is the same for every fingering, and for every brass instrument, although the actual starting pitch will be different depending on which fingering and which key the instrument is pitched in. The example below shows the first 8 *partials* of a harmonic series beginning on the note 'C'. The first partial is called the *fundamental pitch* (or *pedal tone*), and all the subsequent pitches are called the *overtones*.

Partials:    1                    2                    3                    4                    5                    6                    7                    8

Fundamental | Overtones

The interval pattern follows a simple mathematical relationship of the overtones to the fundamental pitch, which corresponds with *just intonation* (or *pure intonation*). The frequency of each pitch is measured in *hertz* (Hz), or cycles per second, where a cycle is one complete vibration of a sound wave. The partials vibrate at frequencies that are multiples of the fundamental frequency (f), in the sequence 1f, 2f, 3f, 4f, etc. The example below shows this relationship, based on the fundamental pitch 'A' with a frequency of 110 Hz.

Hertz:    110                    220                    330                    440                    550                    660                    770                    880

1f                    2f                    3f                    4f                    5f                    6f                    7f                    8f

In theory this pattern continues upwards indefinitely (9f, 10f, etc.), but in reality the brass player is limited by their own particular ability to play higher.

Notice that the frequency of the notes in any pitch class (e.g., all octaves of the note 'A') doubles with each higher octave (e.g., A-110, A-220, A-440, A-880, etc.).

Because modern instruments such as the piano use the twelve-tone *equal temperament* system of tuning, brass players must learn how to adjust those partials in our harmonic series which are out of tune by comparison. In the example above, the 3rd and 6th partials are sharp, the 5th partial is flat, and the 7th partial is significantly flat.

- = normal
- = sharp - player must slightly lower pitch
- = flat - player must slightly raise pitch
- ▲ = very flat - usually too out of tune to use