The f/NUMBERING SYSTEM

is a geometric sequence whose common ratio is square root of 2 or its inverse, depending on which direction you go, either increasing or decreasing the size of the aperture. The f/numbers are dimensionless, as they are the ratio of focal length, (hence the f), to the diameter of the exit pupil of the lens.

The reason why the f/#'s follow the strange sequence is that no matter what the focal length of a lens is, if its exit pupil's diameter is 1/4th of its focal length, the same amount of light will be delivered to the image plane. Although the exit pupil of a 100 mm f.l. lens is 25 mm when set to f/4, and the pupil of a 50 mm lens is 12.5 mm, with a smaller surface area for light to travel through, the smaller image size projected by the shorter focal length lens concentrates the light, so the same objects in each of these lenses fields of view will be have equal intensity.

This is precisely the reason why this system was adopted in the 1890's; it provided a consistent method of quantifying the light gathering power of lenses, which was especially needed in that era because manufacturers of films and plates needed to give exposure guides for their products.

The surface area of the opening of the lens determines how much light passes through it; the more surface area, the more light can be captured. To have a consistent system of numbering that goes hand in hand with the binary sequences of shutter speed and film speed numbers (which are necessary because of the ratio seeking intensity response of the human eye) the difference from each adjacent number in the series must differ by a factor of 2 in intensity.

When the surface area of a circle is computed, the formula πr^2 is invoked. But halving the radius of a circle <u>quarters</u> its area. To decrease an area by ½, the radius must be decreased by a factor of the **square root of 2**, which equals 1.4142135623730950488016887242097, or rounded off to 1.4 for photographic spec's.

So the basic series is:
1, 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, 22, 32, 45, 64, 90, 128, 180, 256…
Multiplying or dividing by 1.4 and rounding to one decimal point gives the next higher or lower number.

The Canon 20D (and probably similar DSLR's) displays a series:
1.4, 1.6, 1.8, 2, 2.5, 2.8, 3.5, 4.0, 5.0, 5.6, 7.1, 8.0, 10, 11, 14, 16, 20, 22
Which has increments of ½ stops except in the area between 1.4 and 2, which are by 1/3 stops.

Since the f/#'s are ratios, the lower numbers are actually larger openings!