Amplitude, Wavelength, Period, and Frequency

Imagine that the dots moving up and down are creating the waves that are travelling to the right (as we'll see later, this is kind of like how radio waves are created). Here are a few things to notice:

1. The Blue wave is twice as “tall” as the green wave.
2. Both waves are travelling to the right at the same speed.
3. The Blue dot is moving up and down three times as fast as the green dot.
4. The Blue wave is three times as compressed as the green wave.

To quantify these observations more precisely, let's look at a snapshot of both waves frozen in time.

- the *amplitude* is the vertical height from the centre of the wave to its highest (or lowest) point. The blue wave has an amplitude of 2 and the green wave has an amplitude of 1.
- the *wavelength* is the horizontal distance of one full cycle. The blue wave has a wavelength of 2m and the green wave has a wavelength of 6m.

Now imagine that the animation is in super slow motion and that the waves are actually travelling at the speed of light, which is roughly 300,000,000 metres per second: How many times does each dot go up and down in one second?

Another way of asking that question is: how many full cycles can you fit in 300,000,000 metres (since radio waves travel 300,000,000 metres each second).

- Since the blue wave has a wavelength of 2m, it'll take 150,000,000 cycles to reach 300,000,000 metres. That means that the blue dot oscillates at 150,000,000 cycles per second, or 150,000,000 Hz, or 150 Mhz
- Similarly, since the green wave has a wavelength of 6m, its frequency is 50 Mhz.

So a quick way to relate the frequency f (in MHz) and the wavelength λ (in metres):

<latex> $$ \lambda = \frac{300}{f} \qquad \text{or} \qquad f = \frac{300}{\lambda}$$ </latex>

Note that the reason we're using just 300, instead of 300,000,000 is that we've cancelled 6 of the zeros so that the frequency is in MHz instead of in Hz.

Now, here's a related question: how long does it take for each wave to complete one cycle?

- For the blue wave, we know that it oscillates 150,000,000 times / second, so only one of those time would take 150,000,000th of a second, or $\frac{1}{150,000,000}$ s or 6.67 x 10^{-9} s or 6.67 ns.[1)]
- Similarly, the green wave oscillates at 50,000,000 cycles per second, so only one of those cycle would take $\frac{1}{50,000,000}$ s or 2 x 10^{-8} s or 20 ns.

The time to complete one full cycle is called the *period (T)* and is the reciprocal of the frequency:

<latex> \qquad $$f = \frac{1}{T} \qquad \text{or} \qquad T = \frac{1}{f}$$</latex>

1)

“ns” means nanosecond. “Nano” means a billionth of ___