Hard question

I have been reading up on water hardness, and am confused by all the different terms. Can you help sort out the various types of units etc. for me?

I'll try!

Water hardness refers to the 'feel' of water, because the more material dissolved therein, the harder and brittle it 'feels'.

When chemists first wanted to assess the value, they knew that soap would not lather well in hard water, so they measured how much of a standard soap solution needed to be added to give the first lasting bubbles when shaken. This was called Wanklyn's Soap Solution and is still used to this day (in labs where they can't afford electronic gear).

What made soap form a scum, instead of a lather, were calcium and magnesium ions. They were usually present in the carbonate form, or perhaps bicarbonate. Bicarbonates are broken down by heat, so boiling turned the bicarbonate into a smaller amount of bicarbonate (or it 'cracked' out e.g. fur in the kettle). This was therefore called *Temporary Hardness*, whereas the calcium and magnesium remained and were called *Permanent Hardness*.

Hence *Total Hardness* is *calcium Hardness* (the magnesium was just added to the calcium level) plus any *Temporary Hardness*.

The Germans were the first to write aquarist books, so they listed the Calcium Hardness in *German Degrees DH* (Deutsch Harte) and the carbonates as *KH* (Karbonat Harte).

Just a few of the many test kits available to measure hardness and other parameters in aquaria.

Americans translated the German books, but refused to give the values Imperial 'status' (anti-colonialism) and so DH became *GH* for German Hardness, but is now called *General Hardness*. KH remained.

Now we have the European Union and metrication has taken over (but not yet in USA!) so values are listed in *ppm* (parts per million, but can be *mg/l* which is numerically the same) as *Calcium* or *Carbonate Hardness*. That is how your local Waterboard will list it.

By the way, if the Waterboard find only traces, it becomes parts per billion, *ppb*, but note that it is an American billion (1000,000,000) not an English billion (a million million).

Sometimes DH becomes *dH* ... perhaps just a typo!

Note that because of the soap history, things like salt (sodium chloride) do not count as hardness, because the sodium does not react, since soap is sodium paimitate etc. But it is still there, as far as the fish are concerned! That is why things like *Redox* (electrical potential) or *TDS* (Total Dissolved Solids) may be of greater value than just hardness.

Most modern kits measure calcium, magnesium, carbonate and bicarbonate and other anions, such as sulphate, as the Total Hardness GH (General Hardness,

but some claim it means Gesamtharte, which is just German for General Hardness). The kits measure the carbonate and bicarbonate as KH. The difference GH—KH=Sulphate Hardness, called *NKH* (Nonkarbonatharte — German again).

Total Hardness is all most aquarists need, but KH can be useful if you want to change the pH (acidity/alkalinity). The carbonate will react with acids, so you need to know how much is present to calculate how much acid to add to drop the pH. Indeed, it is good to have about 20ppm carbonate/bicarbonate because it slows the pH change down, with less stress on the fish. This is called the *buffering capacity* in the UK, and *reserve alkalinity* (although this is all the alkaline salts and the best value can be 180ppm) in the USA.

What values are assigned to the DH or KH depends on what the makers choose. If metric, it will be ppm, but many stay with German and call the GH value degrees dH based on parts of calcium oxide per 100,00 parts of water. The English (British eventually!) chose grains of calcium carbonate per gallon of water and called this 1° Clark. The French chose calcium carbonate per million parts of water. Hence, there are conversion tables in most books.

However, ppm is the best system, and soft water is 0 to 50 ppm Total Hardness, Hard up to 200 ppm, Very Hard 300 ppm.

Therefore your GH is the total value, and the KH is part of that total, so do not add and divide by two ... Whew!