<FranQ> ok then lets run through the foundation notes up to and including the transmission elements

<FranQ> then we can see what the diploma notes add to that part of the subject

<FranQ> we'll get into the other causes next week

<PhyllisQ> yes..

<PhyllisQ> we can go over the foundatin thing quickly..

<PhyllisQ> just as a reminder..

<PhyllisQ> then we can see what we do and don't understand

<FranQ> so what is colour? what does colour in gemstones depend on?

<PhyllisQ> i don't rememmber

<FranQ> an object appears to be coloured when some parts of the spectrum are removed from white light

<FranQ> this can happen when light is transmitted through or reflected from an object

<FranQ> so if we pass light through a ruby then the yellow and green get absorbed

<FranQ> along with a little of the violet

<FranQ> and what is left reaches the eye and is interpreted as being red

<PhyllisQ> yes..

<PhyllisQ> i have no problem with that..

<FranQ> so then the human eye has a very narrow slice of the electro magnetic spectrum which it can "see"

<FranQ> do you know what the upper and lower limits are?

<PhyllisQ> 400 to 700

<PhyllisQ> red to violet

<FranQ> yes ok you have it

<PhyllisQ> what do u call them??

<PhyllisQ> the colour we see in the spectroscope

<FranQ> I'd call them the same

<FranQ> 400nm to 700nm

<FranQ> or red through violet

<FranQ> they are generally classed as the 'visible spectrum'

<PhyllisQ> yes.. that name

<FranQ> some people can see further into the red than others same for the blue / violet ends

<FranQ> so what is the name for violet which is smaller than 400nm?

<FranQ> and for red which is longer than 700nm

<PhyllisQ> infra red??

<FranQ> yes and for the blue end?

<FranQ> it comes in short and long wave

<PhyllisQ> UV

<FranQ> yes :)

<FranQ> do you understand dispesion?

<FranQ> dispersion...breaking up of white light into it's component colours?

<FranQ> I'm just trying to work up to a starting point phyllis

<PhyllisQ> dispersion is ok

<FranQ> when we get to where your not sure then we'll start from there

<FranQ> okwhat about diffraction

<PhyllisQ> tell me again..pls

<PhyllisQ> just look into GP..

<PhyllisQ> it's fine..

<FranQ> diffraction is when light waves pass the edges of any object and the waves become spread out.

<FranQ> this happens in a diffraction grating spectroscope and

<FranQ> when reflecting of a cd

<FranQ> though the colours on the cd disc can be enhanced or removed due to interference

<PhyllisQ> yes..

<PhyllisQ> the difference between the two is the spread out..

<FranQ> diffraction causes the play of colour in opal

<PhyllisQ> diffraction is more evenly lay out..

<FranQ> and also thin film effect like seen in an oil slick

<PhyllisQ> dispersion - red has long wavelength and so it spreads out more

<FranQ> yes thats right :0

<FranQ> these are all causes of colour though they have little to do with the body colour of a gemstone.

<FranQ> Most gemstone body colour is caused by the transition elements

<FranQ> there are eight of these in total

<FranQ> can you name them?

<PhyllisQ> transition element as??

<FranQ> there are eight of them

<FranQ> they are the major cause of colour in many / most gemstones

<FranQ> they are Titanium, Vanadium, Chromium, Manganese

<FranQ> Iron, Cobalt, Nickel and copper

<FranQ> Sometimes these elements make up an integral part of the gemstones chemical formula

<PhyllisQ> so transition element = element cause colour in most gemstones?

<FranQ> Yes but not only in gemstones

<FranQ> the same elements are used to produce colour in ceramic glases

<FranQ> glazes

<PhyllisQ> http://www.chemicalelements.com/groups/transition.html

<PhyllisQ> according to there, there is 38 of them..

<FranQ> well only eight of them are usefull in gemmology

<PhyllisQ> yeah..

<PhyllisQ> i am going too far ..

<PhyllisQ> let's come back to the 8 elements...

<FranQ> you are reading deeper than you need and maybe that is contributing to the confusion

<FranQ> ok as I said sometimes the transition element is an integral part of the gem

<PhyllisQ> yes, i get side tracked very easily..

<FranQ> for example peridot has the formula (Mg,Fe)2SiO4

<FranQ> so although the ratio of iron in the stone may change

<FranQ> the iron is always there

<FranQ> stones in which the transition element is part of it's chemical structure are termed idiochromatic

<FranQ> that is "self coloured"

<FranQ> can you name any other idiochromatic gems?

<PhyllisQ> malachite

<FranQ> yes

<FranQ> turqoise too...what causes their colour?

<FranQ> which element

<PhyllisQ> copper

<PhyllisQ> for malachite

<FranQ> yes :)

<FranQ> and for turquoise

<PhyllisQ> one being green and one being blue

<PhyllisQ> ummmmm..

<FranQ> there aren't that many idiochromatic gems...others include almandine and spessartite garnets

<FranQ> colour is not always the same for any given element

<PhyllisQ> yes.. i know..

<PhyllisQ> trying to see how i can connect one to one..

<FranQ> it also depends on the crystal structure and the valency of the element

<FranQ> for example iron is the cause of red in almandine, blue in aquamarine and green in peridot

<FranQ> chrome is responsible for ruby red and emerald green

<PhyllisQ> i can remember the chromium part

<PhyllisQ> is chrome the same as chromium??

<PhyllisQ> google's product name.. - it's confusing me..ahhaha

<FranQ> chromium is the academic name for the element

<FranQ> chrome is a trade name I think

<FranQ> though it's possible it's some kind of oxide or something

<FranQ> so then most gems do NOT have the transision element as part of their essential chemical make up

<FranQ> the transition element exists as an impurity within the crystal structure

<FranQ> so for corundum Al2O3

<FranQ> some of the aluminium atoms are replaced by chromium atoms

<FranQ> and the chromium is responsible for making the corundum red

<FranQ> if the corundum has iron and Titanium instead of chromium as an impurity then we will have a blue sapphire

<FranQ> gems which are coloured by transition elements as impurities in the crystal lattice are termed allochromatic

<FranQ> All clear so far?

<PhyllisQ> yes. very clear

<FranQ> Ok I'said that the valency state of the transition element is also important

<FranQ> do you understand that statement?

<PhyllisQ> yes..

<AfriQanuck> yes

<FranQ> So iron can exsist in several ionic states

<FranQ> it can be Fe2+ or Fe3+ for example

<AfriQanuck> ok

<AfriQanuck> how many electrons are usually in the outer shell of iron?

<FranQ> Fe2+ has two electrons missing from it's outer shell and Fe3+ is three electrons short of a stable state

<FranQ> all atoms try for eight in the outer shell

<AfriQanuck> I know that

<FranQ> except hydrogen and helium

<PhyllisQ> how many are they then?

<AfriQanuck> I'm asking if iron is in it's usual state, how many electrons does it usually have in the outer shell

<AfriQanuck> less than 8

<FranQ> ok let me find a periodic table and I'll tell yo

<AfriQanuck> if it's giving some away

<FranQ> ok it's atomic number is 26 so 2 in the first shell then three shells of eight each

<FranQ> unfortunately the metals do not follow either ionic or covalent bonding rules

<AfriQanuck> any idea how it gives away three electrons then?

<AfriQanuck> oh

<AfriQanuck> lol

<AfriQanuck> i hate exceptions

<AfriQanuck> :)

<FranQ> there are seperate rules for metals which allow their electrons to flow from atom to atom

<AfriQanuck> ok

<FranQ> which is why metals are classed as conductors

<FranQ> due to the free movement of electrons

<AfriQanuck> ok, got that...

<FranQ> well if we take the examle of aquamarine

<PhyllisQ> icic

<FranQ> in it's usual state it is coloured by Fe3+ which gives it a yellow hue

<FranQ> and by Fe2+ which gives it a blue hue

<FranQ> the result is a mix between the blue and the yellow

<AfriQanuck> why would it be both?

<FranQ> green

<AfriQanuck> electron levels, i mean

<FranQ> however by heating the green aquamarine we can turn some or all of the Fe3+ into Fe2+ by

<FranQ> it just usually (but not always) comes out of the ground like that

<AfriQanuck> ok.

<FranQ> so if we heat it then electrons start to move around and the Fe3+ grabs one and becomes Fe2+

<AfriQanuck> and it grabs one from which other atom?

<FranQ> so the yellow hue is removed from the aquamarine and replaced with a (more salable / desirable blue stone)

<FranQ> it's a bit like pass the parcel Julie

<AfriQanuck> lol

<AfriQanuck> i'll put that in my exam

<AfriQanuck> hehehe

<FranQ> when the music (heat) stops then those with the greediest need grab what they can

<PhyllisQ> hahaa...

<FranQ> If you want a really scientific explanation for it then go and read Brians physics chats. He explains it in one of them

<PhyllisQ> easier for me to remember..

<AfriQanuck> but it grabs it from either the beryllium, aluminium or the silica, right?

<AfriQanuck> obviously

<AfriQanuck> ?

<FranQ> If we then irradiate the blue aqua then the electrons are kicked out again and the stone assumes it's original green colour

<FranQ> yes I'd think that was right

<AfriQanuck> ok

<FranQ> I guess we've strayed a bit of course...we were doing transition elements and we seem to have crossed over into charge transfer

<AfriQanuck> ah, I was going to ask what topic this one was

<FranQ> lets go back to the transition elements again to get some more idea of what is happenning

<PhyllisQ> yeah yeah

<AfriQanuck> ok

<FranQ> We've now covered all the foundation stuff and are moving into the diploma notes now

<AfriQanuck> ok

<AfriQanuck> first in our notes is dispersed metal ions

<FranQ> ok dispersed metal ions is a posh way of saying the transition elements are causing colour

<AfriQanuck> darned brits, lol

<PhyllisQ> haha

<FranQ> so imagine that you have a beam of white light

<FranQ> up till now we have thought of light as a ray

<FranQ> a wavelength

<FranQ> but light can also be viewed as a particle in some instances

<FranQ> light is and has energy

<AfriQanuck> yes

<FranQ> we spoke last week about the orbits around atoms which contain electrons

<PhyllisQ> yeah..

<FranQ> each of these orbits is called an electron energy level

<FranQ> now imagine our beam of white light entering the gemstone

<AfriQanuck> the further from the nucleus, the more energy they need, right?

<FranQ> suddenly some of the light hits one of the electrons orbiting around an atom

<FranQ> yes Julie

<FranQ> so if the electron belongs to one of the transition elements then it's electrons have the ability to absorb some of the energy from the light

<FranQ> if the energy absorbed is high enough then that electron can jump from it's usual orbit to a higher one

<AfriQanuck> why only the transition element electrons?

<FranQ> dunno...ask a chemist

<AfriQanuck> ok

<FranQ> :)

<AfriQanuck> lol

<FranQ> gem-a don't get in that deep

<PhyllisQ> we just have to remmber them

<FranQ> so the electron is whizzing round and round and minding it's own business when the white light arrives like a shot of energy drink

<FranQ> the electron begins to absorb energy ie it absorbs particular wavelengths from the light

<FranQ> when it has absorbed enough of this energy then it jumps up to the next electron shell

<FranQ> but life up there is hard and once the energy has passed then the electron drops back to it's original orbit (called the ground state)

<FranQ> when this happens then energy is released

<AfriQanuck> that just like me before and after coffee

<FranQ> this energy usually transmits itself as atomic vibrations through the crystal lattice

<FranQ> basically causing heat

<FranQ> the other thing that might happen as the electron goes back to it's ground state is that instead of heat the energy is given of as light (ie fluorescence in ruby)

<FranQ> the rest of the white light which hasn't been absorbed is free to pass out of the gemstone

<FranQ> but because of the absorbtion it's colour is no longer white

<FranQ> when you look through a spectroscope you are looking at what is left of the white light and any absorbtion seen is where energy has been taken from that wavelenght by hungry elecrons

<AfriQanuck> and so the various transition elements are more partial to certain wavelenghts of light then, right?

<FranQ> yes

<FranQ> you can see which parts they are fond of by observing say a cobalt spectrum from an iron or chromium one

<AfriQanuck> yes, exactly

<FranQ> this is the reason people with spectrometers can tell you which trace elements are within any stone...the trace elements alsways leave tell tale absorbtion peaks

<FranQ> even when they are too small to be seen with the eye

<AfriQanuck> and i guess that's how we know that the sun is made of too

<FranQ> is all this clear?...questions???

<AfriQanuck> very clear

<FranQ> yes the faunhofer whachamacallhim lines

<AfriQanuck> yes, those things

<AfriQanuck> lol

<FranQ> Phyllis?

<PhyllisQ> yes..

<PhyllisQ> very clear..

<FranQ> :)

<FranQ> questions?

<PhyllisQ> now things are connected..

<AfriQanuck> no questions on that

<FranQ> so we touched briefly on charge transfer we can continue that next week and maybe get into colour centres too

<AfriQanuck> ok, that would be great

<PhyllisQ> yes..

<FranQ> If you look at the index of chats on the forum Tim did a series of these chats

<AfriQanuck> ok, will look them up

<PhyllisQ> ok. will try to look them up

<FranQ> so did doos and annie but I think they were kept on Alains computer / server so they may be lost

<PhyllisQ> thanks frank

<AfriQanuck> darn, the alain/annie one's were probably really good

<FranQ> Brian also covered colour in detail but not sure which chat it's in

<AfriQanuck> maybe he'll remember

<FranQ> ask him...or just read them all...a few are mostly quantum maths but the others are fantastic

<AfriQanuck> i will ask him. maybe he'd like to sit in on the colour chats too

<AfriQanuck> if he feels like it