<FranQ> ok so last week we did metal transition ions

<FranQ> any questions on that first?

<DragonStek> none here

<FranQ> So then charge transfer

<AfriQanuck> yes pls

<FranQ> and colour caused thereby

<FranQ> in some gemstones electrons are able to move from one type of ion to another and then back again

<FranQ> instead of just jumbing from one orbit to another it actually changes the atom it is attached to and joins another

<FranQ> this happens back and forth between the two atoms as long as energy (light in this case)

<FranQ> is passing through the material

<FranQ> The electron get the energy to do this by absorbing light of a particular energy level / wavelength (Colour)

<FranQ> this transfer of an electron from one ion to another is known as charge transfer

<FranQ> selective absorbtion of visible light may take place during this cycle

<FranQ> So as long as light shines through the gem then the excited electrons will jump between atoms and back using up some of the lights energy and giving of an altered light

<FranQ> any questions?

<AfriQanuck> this is the gem version of "if a tree falls in the forest", isn't it?

<@Keirkof> no Qs here

<AfriQanuck> if a blue sapphire is in the dark, is it blue?

<AfriQanuck> lol

<FranQ> there are two schools of thought on that :)

<FranQ> But glad you brought up blue sapphire

<FranQ> as usual corundum gets to be the example

<FranQ> Charge transfer can take place between two different metals

<FranQ> So in blue sapphire there is a charge transfer brteen titanium and iron

<FranQ> Now remember that in corundum each metal ion is surrounded by oxygen

<FranQ> so the electron has to also navigate that in it's path so everythibg is quite a bit more comlicated than this simple explanation

<FranQ> but the end result is that an electron jumps back and forward between an iron ion and a titanium ion.

<FranQ> so we have Fe^{2+} + Ti^{4+} changing places with Fe^{3+} + TI^{3+}

<FranQ> this all happens at the speed of light back and forth back and forth

<FranQ> and produces a blue colour in sapphire

<FranQ> any questions?

<AfriQanuck> nope. it's kind of neat, like the stones are alive in some way

<FranQ> This needed mix of Titanium and Iron can in some instances be induced by heat treatment

<FranQ> you should read Brians quantum theoris chats...everything is alive

<FranQ> This is done for example on gueda sapphires

<FranQ> they are greyish white colour and not at all gemmy looking

<FranQ> then by heating up to a high temperature the rutile can be dissolved into the crystall lattice

<FranQ> if the stone is then cooled too rapidly for the rutile to recrystallise then we now have fee titanium atoms dissolved into the crystal lattice

<FranQ> these free atoms are then able to join in charge transfer with the FE2+ ions and produce that blue we all love so much

<FranQ> So we have seen how charge transfer can occur between 2 metals

<FranQ> but it can also occur between two ions of the same metal

<FranQ> Here iron is a good example. It is a common element yet plays an important part in the colour of many gems

<FranQ> here again the crystal lattice has each metal ion surrounded by oxygen molecules

<FranQ> some how the electron crosses these oxygen ions and joins to it's brother so we get Fe2+ e- Fe3+ e+ Fe2+ cycles

<FranQ> so the charge changes each Fe ion from Fe2+ to Fe3+ and back again

<FranQ> again very quickly and over and over as long as light shines on the stone

<FranQ> (So no Canuck...if we remove the light then the stone isn't blue as no selective absorbtion would be possible

<FranQ> good question though :)

<AfriQanuck> i knew that... no light, no colour

<AfriQanuck> it just reminded me of the tree thing

<FranQ> lol

<FranQ> In reality the energy needed for each type of charge transfer is different

<FranQ> in the Fe2+ to Fe3+ to Fe2+ cycle the energy absorbed is from the lower energy of the visible spectrum

<FranQ> so it's mostly reddish light thats absorbed

<FranQ> this makes the stone appear blue to our eye

<FranQ> aquamarine and iolite are both coloured as a result of the Fe metal ion

<@Keirkof> yes!

<@Keirkof> you just gave me an excuse to post a link frank :)

<FranQ> the ration of Fe2+ to Fe3+ will decide if the aqua is greenish or bluish

<@Keirkof> http://picasaweb.google.co.uk/lh/photo/1KQy2t3LkvKOEiTeFwQAVw?feat=directlink :)

<@Keirkof> (lets let frank continue tho)

<PhyllisQ> show off...hehee

<FranQ> but heat treatment can alter the ratio by turning some of the Fe3+ which produces yellow colour to Fe2+ which causes the blue colour

<FranQ> sorry Bart I cant type and read it at the same time so I'm not aware if some one types until I look up

<AfriQanuck> and the extra electron goes where?

<@Keirkof> i know, dont worry - just wanted to show off before nodding off ^^

<FranQ> like I said last week it's a bit like musical chairs

<FranQ> as long as there is light there is movement

<AfriQanuck> that's rather poetic

<FranQ> when the light goes out then all the atoms return to there ground state and resume their chairs

<DragonStek> so its just waits to find a seat

<FranQ> any stray electrons caught napping will settle into whichever niche they can find (perhaps even causing a atomic sized colour centre

<FranQ> when the light comes back on then the electrons start to dance again

<FranQ> I don't mean to suggest that electron movement stops when the light goes out

<FranQ> they just spin around there own orbits until some energy comes along which can boost them from their own state to their excited states

<FranQ> whether it be jumping to a higher orbit or jumping from one ion to another

<FranQ> both effects give the result as colour

<FranQ> so we have looked at charge transfer between two different metal ions

<FranQ> and charge transfer between two ions of the same metals

<FranQ> but there is also an important charge transfer possible between Oxygen and metal ions

<FranQ> This quite common charge transfer often occurs between oxygen and iron

<FranQ> absorbtion from this type of transfer usually absorbs light from the blue to the UV part of the spectrum and the colour caused is usually yellow / orange / brown

<FranQ> Yellow beryl is coloured by the iron ion Fe3+ and although the electrons from an Fe3+ ion are possible to some degree of excitation the main cause of colour in yellow beryl

<FranQ> is a charge transfer between O2- and Fe3+

<FranQ> this metal oxygen charge transfer is also responsible for the colour in yellow quartz and yellow sapphire

<FranQ> The charge transfer between Fe2+ and oxygen causes absorbtion in the UV region only and doesn't have much or any effect on colour

<FranQ> question?

<AfriQanuck> nope

<FranQ> sorry any questions?

<PhyllisQ> nope

<AfriQanuck> very clear

<FranQ> the only other type of charge transfer which may be of account is that which can take place in organic molecules

<FranQ> this causes some electrons to be shared through all the atoms of the organic molecule

<FranQ> these shared orbits are called molecular orbitals and are capable of charge transfer with other molecular orbitals

<FranQ> this type of molecular charge transfer is thought to cause the yellows of amber and the reds of coral.

<FranQ> many of the organic dyes used to dye for example jadeite have their colour because of similar charge transfer between molecular orbitals

<FranQ> any questions?

<PhyllisQ> noooooooooooooooo

<@Keirkof> nops