

<@Spauwe> we can revise the previous bits (will be good for Crystal and Dragon as the mother of all learning is repeating)

<@Spauwe> repetitio est mare lexionis

<Crystal> okey dokey

<strmrdr> color is caused by trace elements in the material cause different adsorption curves hence different colors, colors can also be caused by inclusions such as silk

<@Spauwe> and many other phenomena

<@Spauwe> ok

<@Spauwe> so the dispersed metal ions bit is familiar to you

<strmrdr> in general yes

<@Spauwe> some atoms, when present as ions, will have some of their electrons excited by ,light

<@Spauwe> resulting in absorption of those wavelengths that excite those electrons

<@Spauwe> so the residual light will no longer be perceived as white

<@Spauwe> by our (stupid) eyes and brain

<@Spauwe> now there's more to that

<strmrdr> ok

<@Spauwe> in the case of let's say peridot iron ions are present that will absorb certain wavelengths

<@Spauwe> this will happen 'within' those iron atoms

<@Spauwe> electrons will go to a higher energy state

<@Spauwe> ie. will orbit in a higher orbit

<@Spauwe> another phenomenon is called charge transfer

<strmrdr> what is the most common type of metal ions that cause colors in gemstones?

<@Spauwe> ehm....

<@Spauwe> iron?

<DragonStek> sapphires iron

<@Spauwe> dunno

<@Spauwe> I think iron

<strmrdr> thanks

<DragonStek> iron can do three colors red green and yellow

<@Spauwe> yes

<@Spauwe> I was going a bit fast

<@Spauwe> with the dispersed metal ions many things influence the absorption

<@Spauwe> 1. crystal structure

<@Spauwe> 2. valency

<@Spauwe> 3. incident light

<@Spauwe> in peridot it causes us to see green

<@Spauwe> in almandine garnet red

<@Spauwe> in both cases the iron isn't an impurity

<@Spauwe> it's part of the essential chemical make up

<DragonStek> idiochromatics

<@Spauwe> question for the ladies: name one gem material in which iron is the colouring element and it's not part of the chemical make-up

<Crystal> heliodore?

<@Spauwe> yep, that'll gain you points

<Crystal> hah!

<@Spauwe> so would aquamarine

<@Spauwe> some blue spinel

<@Spauwe> and probably many others

<@Spauwe> that I can't think of at the moment

<strmrdr> some ruby?

<@Spauwe> but it's the heliodor that we'll end up discussing today

<strmrdr> ok

<@Spauwe> ruby is always coloured by chromium

<@Spauwe> but still may contain iron

<@Spauwe> the red colour is caused by the chromium though

<strmrdr> right but brown red is because it was modified by iron?

<@Spauwe> the almandine-peridot example describes the difference in crystal structure

<@Spauwe> the aquamarine is best use to illustrate the valency dependency

<@Spauwe> you know about valencies storm?

<@Spauwe> it's the electrical charge an ion has

<strmrdr> sounds familiar refresh my memory please

<@Spauwe> the amount of electrons in an atoms outer shell available for bonding with other atoms

<strmrdr> ok

<@Spauwe> in other words: the amount of electrons missing or the amount of electrons that are extra

<@Spauwe> the build up of an atom is clear?

<strmrdr> yes

<@Spauwe> cool

<@Spauwe> now in aqua  $Fe^{2+}$  causes a blue colour to be seen

<@Spauwe>  $Fe^{3+}$  a yellow colour to be seen

<@Spauwe> resulting in the blue green aquamarine colour

<strmrdr> ah ok makes sence

<@Spauwe> this is where the heating of aquamarine comes in:

<@Spauwe> during the heating we allow the  $Fe^{3+}$  to gain an electron

<@Spauwe> so it becomes  $2+$

<@Spauwe> more blue less yellow

<@Spauwe> more money

<strmrdr> kewl

<@Spauwe> now there's the third dependency

<@Spauwe> the incident light

<@Spauwe> best example: alexandrite

<@Spauwe> red in incandescent light

<@Spauwe> green in sunlight

<@Spauwe> since it's still all coloured by the same element: chromium

<@Spauwe> our messed up perception of things and the make up of the two light sources

<@Spauwe> we are very good in seeing minor differences in different shades of green

<@Spauwe> my explanation for this is that we are trained to see the sabertooth hiding in the bush

<@Spauwe> those who couldn't didn't get to reproduce

<@Spauwe> the light part: candle light or light bulbs have way more red and infra red in 'm then sunlight which contains more green and blue

<@Spauwe> so the same absorption by one rock can be perceived by our brain as two different colours, the balance is tipped over

<@Spauwe> questions?

<strmrdr> not so far

<DragonStek> no sorry had to answer the door

<@Spauwe> ok

<Crystal> ok here

<@Spauwe> ok

<@Spauwe> so all this was about colour caused by transition elements

<@Spauwe> electrons get excited by certain wavelengths

<@Spauwe> and 'take'that energy from the full spectrum (white light)

<@Spauwe> we call it to be absorbed

<@Spauwe> the next colour cause would be charge transfers

<@Spauwe> two electrons that are close to eachother may be able to share an electron when that electron is hit by the right wavelenght(s)

<@Spauwe> can you picture that?

<DragonStek> yes

<strmrdr> two atoms?

<@Spauwe> instead of just reaching a higher orbit it will actually leave orbit and enter another one

<@Spauwe> and back again

<@Spauwe> the easiest way of thinking about is would be thinking of figure '8'ts

<@Spauwe> with nuclei in both voids in the 8

<DragonStek> ok

<strmrdr> ok

<@Spauwe> My course teaches me there's 3 possibilities

<@Spauwe> Brian will probably laugh at that

<@Spauwe> but I can't teach what I don't know

<@Spauwe> so here we go:

<@Spauwe> charge transfers between 2 metal ions

<@Spauwe> charge transfers between a metal and a oxygen atom

<@Spauwe> and charge transfers without metal ions

<@Spauwe> btw

<@Spauwe> everywhere where I typed atom you should read ion

<@Spauwe> they're always missing electrons or having a few to spare

<@Spauwe> first up:

<@Spauwe> metal to metal

<@Spauwe> a good example: blue sapphire

<@Spauwe> Fe<sup>2+</sup> and Ti<sup>4+</sup>

<@Spauwe> sitting close to each other minding their own bizniz

<@Spauwe> but here comes Timmay

<@Spauwe> puts his jackhammer in the ground and pulls the two friends with all their gazillion mates from the ground

<DragonStek> hehe

<@Spauwe> and the sun hit's 'm

<@Spauwe> what happens?

<DragonStek> color

<@Spauwe> that sleepy electron sitting in that Fe<sup>2+</sup> (missing 2 electrons already) gets such a boost that it jumps to the Ti<sup>4+</sup>

<@Spauwe> and is returned immediately

<@Spauwe> sunlight still shining so off it goes again

<@Spauwe> and again

<@Spauwe> and again

<@Spauwe> you get my drift

<DragonStek> they take from each other

<@Spauwe> I woke up the electron

<@Spauwe> love waking them up too

<@Spauwe> I mean

<DragonStek> sorry wrong page again in my notes

<@Spauwe> no you're right

<DragonStek> ok

<@Spauwe> colour is caused because the electron takes the energy to start moving

<@Spauwe> energy taken from the white light ----> absorption -----> colour is seen

<DragonStek> the light that makes the electron jump to give color

<DragonStek> oh ok

<strmrdr> so the  $Fe^{2+}$  tries to fill what it is missing by borrowing electrons from the  $Ti^{4+}$  and since it doesn't have the energy to split it gets rejected?

<@Spauwe> it's not the missing part

<@Spauwe> merely the fact that it's excited that much that it is drawn in by the even bigger positive charge of the Ti

<@Spauwe> for these kind of things we're better off at the Sunday chat with a physics professor handy

<strmrdr> ok

<@Spauwe> HIGHLY recommended btw

<DragonStek> but it's just to know the basics right

<@Spauwe> the electron will be returned to the Fe nucleus straight away

<@Spauwe> so before the light hits we have a  $Fe^{2+}$  and a  $Ti^{4+}$  combination and one electron jumps from that Fe to that Ti

<@Spauwe> so what do we end up with?

<strmrdr> it's not computing for me as they would repel one another unless it had the energy to steal the electrons and make itself whole. as matter seeks a balanced state of no charge

<@Spauwe> A) Fe<sup>3+</sup> and Ti<sup>5+</sup>

<@Spauwe> B) Fe<sup>1+</sup> and Ti<sup>2+</sup>

<@Spauwe> c) Fe<sup>3+</sup> and Ti<sup>3+</sup>

<@Spauwe> D) none of the above

<@Spauwe> ?

<DragonStek> c

<@Spauwe> 10 points

<DragonStek> oh no its 2

<@Spauwe> why?

<DragonStek> my first is right

<@Spauwe> yesh

<@Spauwe> you had it right

<DragonStek> sorry started to confuse myself

<@Spauwe> storm you see it as well?

<strmrdr> D because it doesnt have the energy to actually take the electron otherwise you would have fision

<@Spauwe> they don't fuse

<@Spauwe> merely share a electron for a very brief moment

<DragonStek> they share

<@Spauwe> figure 8'ts

<@Spauwe> if not clear please ask

<DragonStek> im ok on this

<@Spauwe> Crystal and Storm as well?

<Crystal> ok here

<@Spauwe> I'll take that as a yesh

<strmrdr> so they try and pair up and the like charges push them back apart? -- im trying to make this fit with what I know of atomic structure...

<@Spauwe> 2 nuclei with insufficient electrons to be neutral are sitting close to each other

<@Spauwe> they have some 'free' electrons that are hanging around

<strmrdr> right an would repel one another holding each other apart

<@Spauwe> those electrons are excited by light

<@Spauwe> they take that energy to start spinning harder and further away from their nuclei then they normally do

<@Spauwe> one of 'm actually leaves it's own orbit and spins around the other

<@Spauwe> the nuclei (protons and neutrons) are not moving

<@Spauwe> the electrons are

<strmrdr> ok

<@Spauwe> kewl

<DragonStek> so in the dark they are close together

<@Spauwe> so the blue in blue sapphire is caused by a charge transfer between FE and Ti

<DragonStek> light they get further apart

<strmrdr> ok

<@Spauwe> further apart?

<@Spauwe> not that I'm aware off

<DragonStek> higher orbital away from the center

<@Spauwe> the electron and their nuclei

<@Spauwe> yes

<DragonStek> ok

<@Spauwe> thought you meant the two ions

<@Spauwe> they stay where they are

<DragonStek> no just trying to get it in my head

<DragonStek> sorry

<@Spauwe> kewl

<@Spauwe> no sorrys required

<@Spauwe> now...

<@Spauwe> there's other gems that have metal to metal transfers

<@Spauwe> sometimes it involves the same element

<@Spauwe> like in iolite

<@Spauwe> Fe<sup>2+</sup> and Fe<sup>3+</sup>

<@Spauwe> same thing happens

<strmrdr> so in simple words the fe<sup>2+</sup> tries to steal a ball(electron) from the ti<sup>4+</sup> and the ti<sup>4+</sup> snags it back. like 2 kids on the playground and light gives it the energy to do so

<@Spauwe> yes but then with the ti being the thief

<Crystal> good explanation Storm

<DragonStek> yehehe thats what im trying to do

<@Spauwe> and the light being the rest of the class shouting at 'm providing motivation

<Crystal> GO, GO GO GO

<@Spauwe> ghehe

<strmrdr> ok

<@Spauwe> so metal to metal transfers can occur between the same type of element

<strmrdr> gotcha... im clear on what its doing the mechanics of it arent important and thats where im not clear.. so go on.

<@Spauwe> but they have to have different valencies

<@Spauwe> the charge transfer between fe<sup>2+</sup> to Fe<sup>3+</sup> is caused by some red light

<@Spauwe> causing us to see blue

<@Spauwe> the red is taken from the spectrum

<@Spauwe> kewl?

<DragonStek> Fe<sup>2+</sup> + Fe<sup>3+</sup> ---->Fe<sup>3+</sup> + Fe<sup>2+</sup> repeats the proces

<DragonStek> right

<@Spauwe> exactly

<DragonStek> ok im getting it

<@Spauwe> 2+ means it's missing 2 electrons

<@Spauwe> (every electron is 1-)

<@Spauwe> so if it loses another it becomes 3+

<strmrdr> kewl

<DragonStek> ok cool

<@Spauwe> let's go on to crystals answer: heliodor

<Crystal> very kewl

<@Spauwe> to keep it in the iron part

<@Spauwe> some of the yellow we see is caused by colour cause 1: transition elements

<@Spauwe>  $Fe^{3+}$  to be exact

<@Spauwe> their electrons are excited by light and absorb wavelengths whose absence will cause us to see yellow

<@Spauwe> but there's more going on inside heliodor

<@Spauwe> a charge transfer between  $Fe^{3+}$  and  $O^{2-}$

<@Spauwe> this is where the second sort of charge transfer occurs

<@Spauwe> the ones between metal ions and oxygen

<@Spauwe> now here we go again:

<@Spauwe> if the  $O^{2-}$  loses an atom to a  $Fe^{3+}$  what do we end up with? (for a very brief moment?)

<@Spauwe> a cookie for the first answer...

<DragonStek> it jumps to a higher orbital

<@Spauwe> wrong or right

<@Spauwe> you get a cookie

<@Spauwe> but that wasn't what I was going at

<@Spauwe> a)  $O^{3-}$  and  $Fe^{2+}$

<@Spauwe> b)  $O^-$  and  $Fe^{2+}$

]<@Spauwe> c)  $O^-$  and  $Fe^{4+}$

<@Spauwe> d) all of the above and stop doing this

<strmrdr> B

<DragonStek> c hehe d

<@Spauwe> storm you're getting it

<DragonStek> ok so it goes down by one

<Crystal> c

<Crystal> oh, then d

<Crystal> :)

<@Spauwe> what does the O<sup>2-</sup> mean?

<Crystal> 2 negative oxygen atoms

<DragonStek> its missing one

<@Spauwe> it means that the Oxygen atom has two electrons to spare

<@Spauwe> 2 extra

<@Spauwe> 2 to many

<DragonStek> oh its negative ok

<@Spauwe> so if it loses one it becomes 1 negative

<@Spauwe> it's tricky with that positive negative stuff but once you see it isn't that hard

<DragonStek> yes im getting now

<strmrdr> thru me for a loop for a second too then recalled we are talking charges and both become less charged under those conditions... now that I can equate this to electricity it is making sense...

<@Spauwe> So Heliodor can be called yellow by a oxygen-Iron charge transfer

<@Spauwe> well, it is electro magnetic energies

<DragonStek> hehe brian would be proud

<@Spauwe> that's what light is: electro magnetic energy

<@Spauwe> so is radio

<strmrdr> positive to negative makes sense to me positive to positive don't at the electrical level.

<@Spauwe> and your microwave

<@Spauwe> and x rays

<@Spauwe> and gamma rays

<@Spauwe> and cosmic rays

<strmrdr> i have a degree in electronic engineering but its been a while since school...

<@Spauwe> I think Brian will laugh his ass off when he reads all this

<@Spauwe> I'm taught a simplification of things

<DragonStek> no he would be proud of you

<@Spauwe> Brian doesn't do simplifications

<DragonStek> we only need the foundation of it , to know this is how it works ? right

<@Spauwe> good to round this up let me mention the last charge transfer possibility briefly

<strmrdr> ok

<@Spauwe> charge transfers without metal ions

<@Spauwe> organic materials are mostly made up of larger molecules

<@Spauwe> those molecules may have shared electronically orbits

<@Spauwe> ie

<@Spauwe> they do charge transfers constantly

<strmrdr> right

<@Spauwe> but it takes place at a much larger scale

<strmrdr> ok

<@Spauwe> we call these ones molecular orbits

<@Spauwe> the yellow in amber and the red in coral is caused by these types of charge transfer

<@Spauwe> so is the colour of many organic dyes

<@Spauwe> end