Watching electrons "drop"

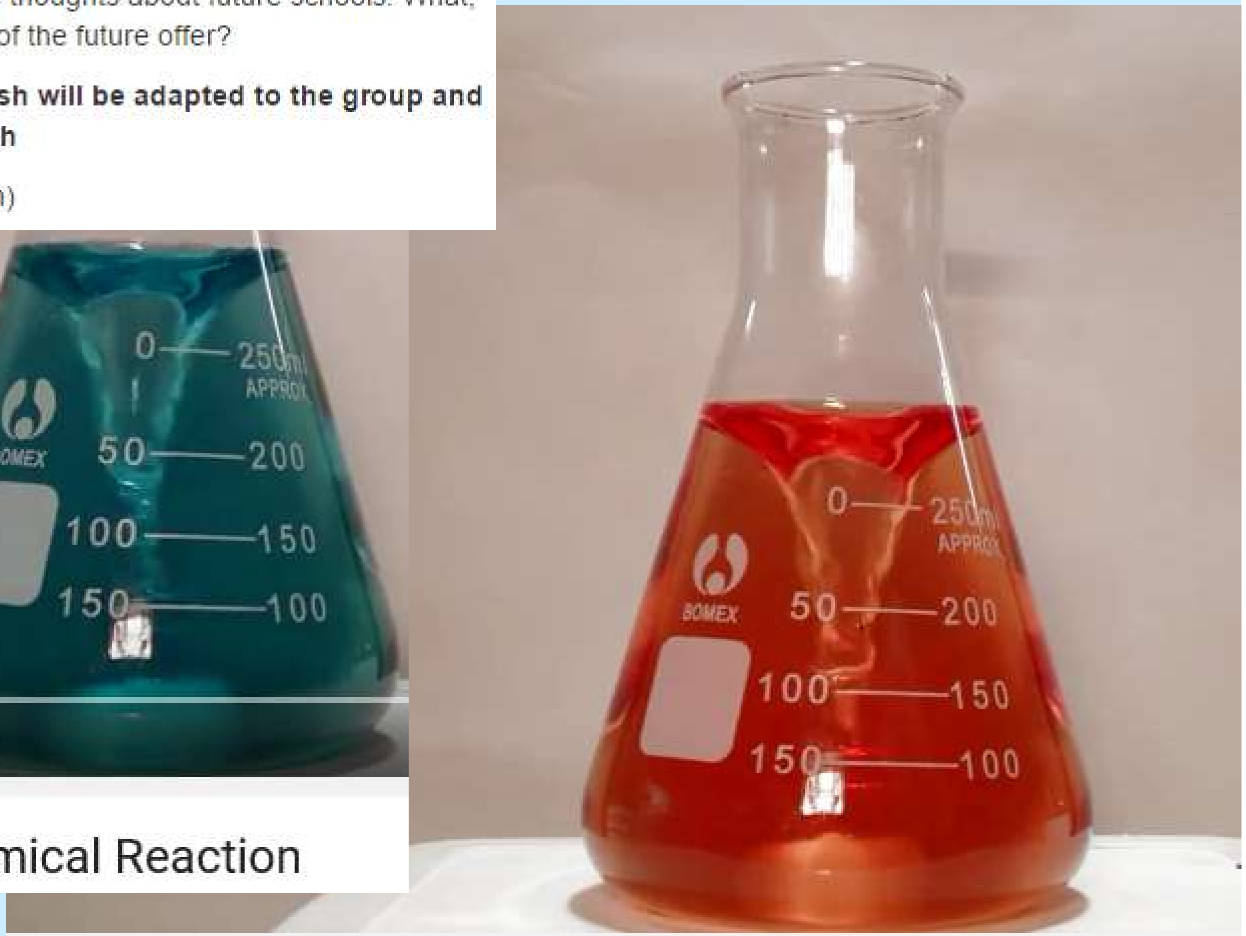
Colourful Chemistry/Färgsprakande Kemi

This workshop invites students to explore a reversible oxidation/reduction reaction that generates a range of bright colours, and provides practice in using English in a scientific context. A discussion about what could be happening chemically to produce the colours observed is followed by an opportunity to contribute thoughts about future schools. What, apart from lots of inspiring science, should schools of the future offer?

The workshop is held in English. **the level of English will be adapted to the group and can be complemented by information in Swedish**

(För mellanstadiet anpassas språket till målgruppen)

Colour change Chameleon Chemical Reaction



Colour change Chameleon Chemical Reaction

https://www.youtube.com/watch?v=kKlXe2mrnHQ

Uppsala International School
– Kvarngärdesskolan, Uppsala, SWEDEN

The Science behind the Colour Chameleon Chemistry experiment

The Science:
Even though this experiment is easy to perform, there's actually some really complicated and interesting chemistry going on! It involves something called a redox reaction. This basically means that new compounds are formed when one chemical takes electrons from another chemical. Here, the potassium permanganate is reduced, meaning it gains electrons, and the sugar is oxidized, meaning it loses some.

This happens in two steps. In the first step, the permanganate ion (the part of the potassium permanganate that changes) is reduced to the manganate ion:

$MnO_4^- + e^- \rightarrow MnO_4^{-2}$



The compound on the left is **purple**, and the one on the right is green. As this reaction is going, there is some purple and some green in the solution and these combine to make it look **blue** at the beginning.

Next, the **green** manganate ion is reduced again into manganese dioxide:

$MnO_4^{-2} + 2H_2O + 2e^- \rightarrow MnO_2 + 4OH^-$

The manganese dioxide is a brown solid, but it's in such tiny particles that it appears to make the liquid turn yellow. As this reaction continues, there is some yellow and some red in the solution and these combine to make it look **orange** at the beginning. The final **red** comes from impurities left in the water.

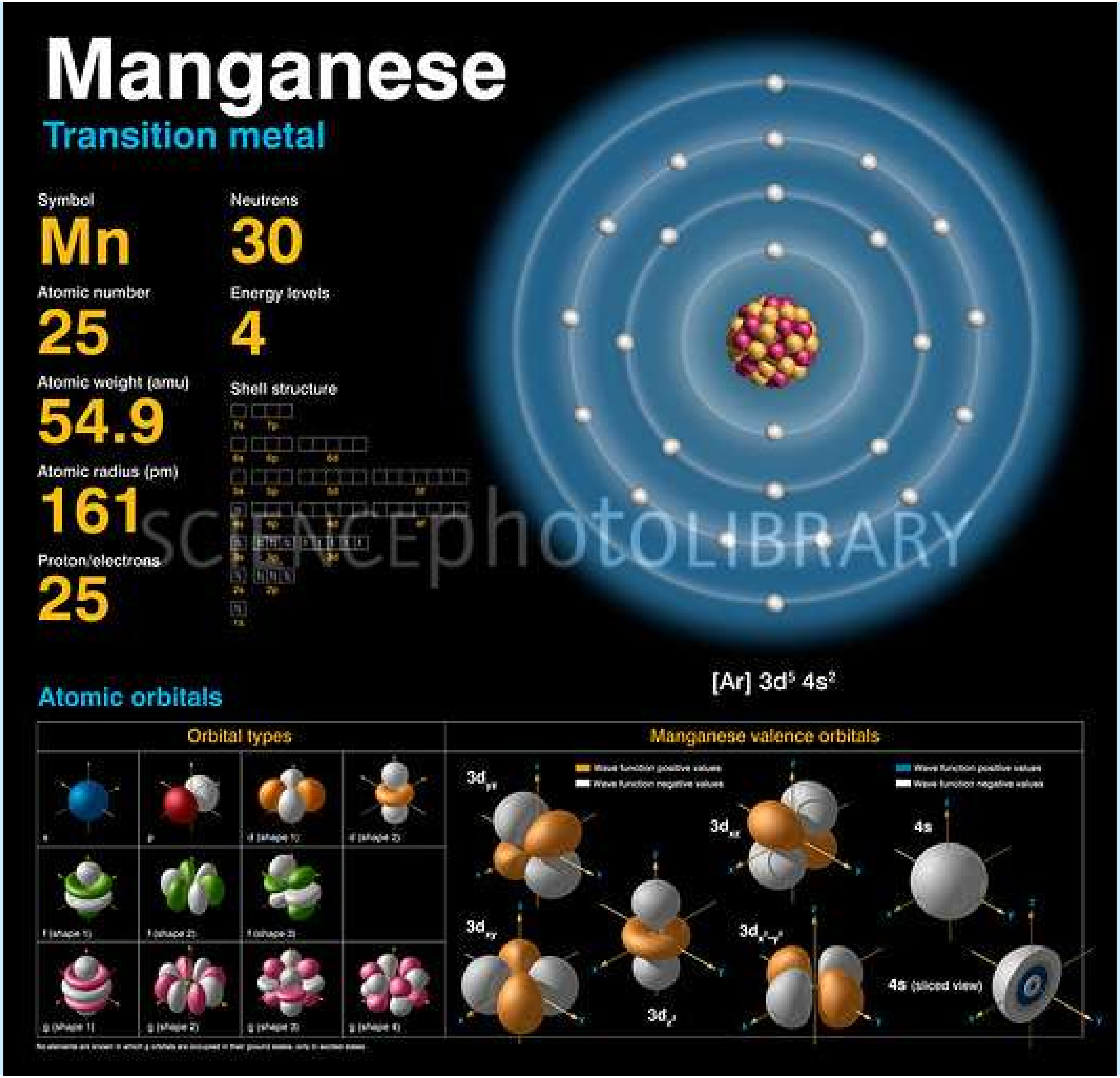


Brady Caldwell
Science Teacher

Manganese Science

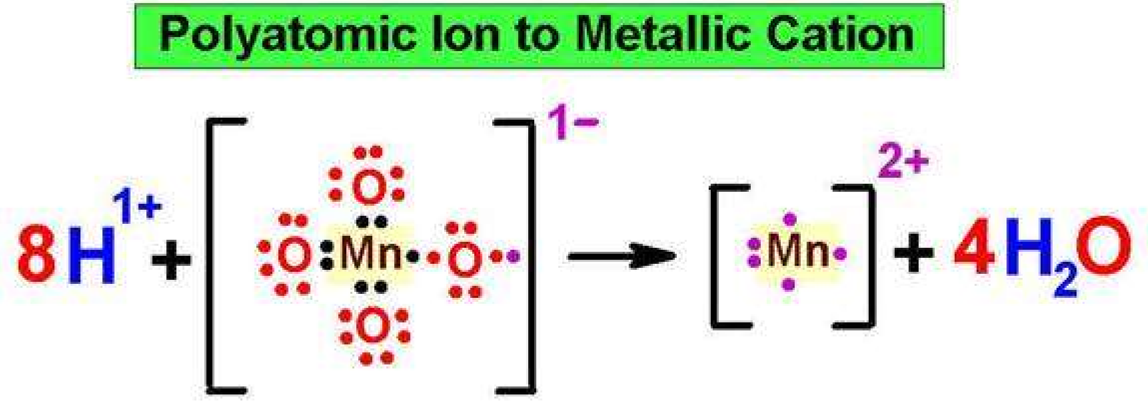
Pyrolusite – manganese dioxide – MnO_2

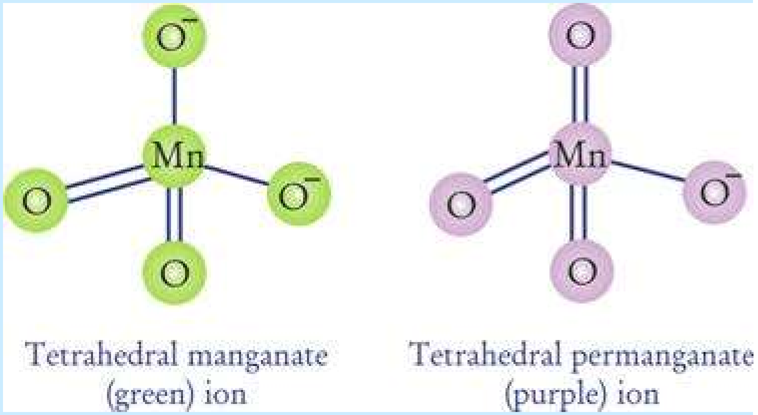
http://www.rsc.org/periodic-table/element/25/manganese

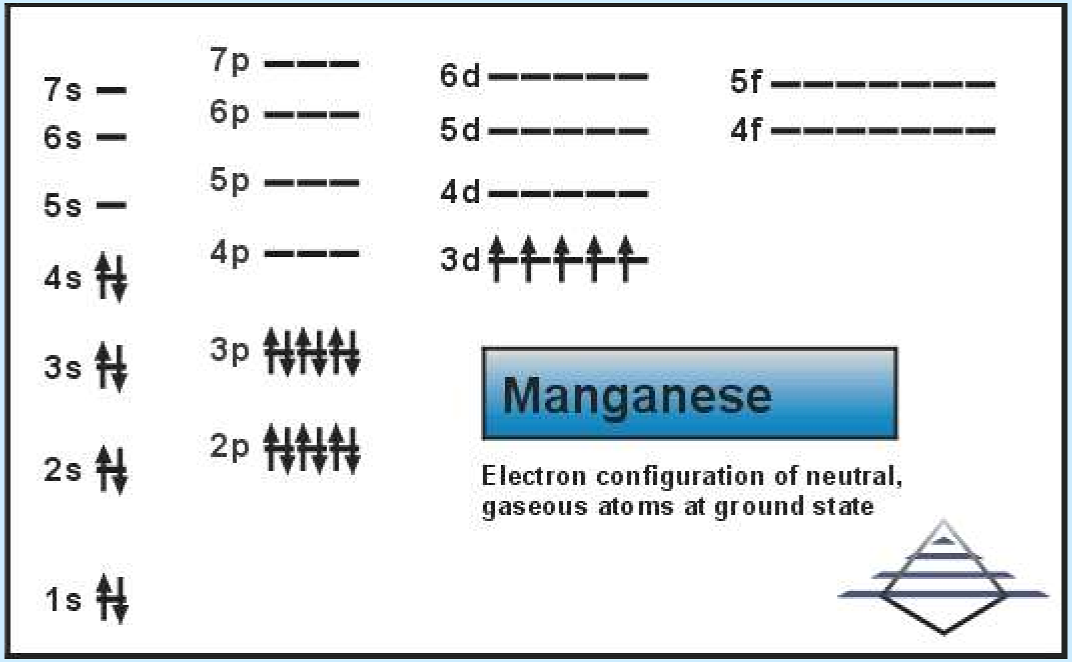


Manganese
Transition metal
Symbol
Mn
Neutrons
30
Atomic number
25
Energy levels
4
Atomic weight (amu)
54.9
Shell structure
Atomic radius (pm)
161
Proton/electrons
25
[Ar] 3d5 4s2
Atomic orbitals
Orbital types
Manganese valence orbitals
4s
4s (sliced view)
SCIENCEphotoLIBRARY

Manganese – Electron Theory







https://pilgaard.info/Elements/Manganese/AtomProperties.htm

Manganese: A Case Study

Manganese is widely studied because it is an important reducing agent in chemical analysis. it is also studied in biochemistry for catalysis, as well as in fortifying alloys. In plants, manganese is required in trace amounts; stronger doses begin to react with enzymes and inhibit some cellular function. Due to manganese's flexibility in accepting many oxidation states, it becomes a good example to describe general trends and concepts behind electron configurations.

Electron configurations of unpaired electrons are said to be **paramagnetic** and respond to the proximity of magnets. Fully paired electrons are **diamagnetic** and do not feel this influence. Manganese, in particular, has paramagnetic and diamagnetic orientations depending on what its oxidation state is.

Mn_2O_3 is manganese(III) oxide with manganese in the +3 state. 4 unpaired electrons means this complex is **paramagnetic**.

$4s^0$

$3d^4$ x^2-y^2 z^2 xy yz xz

MnO_2 is manganese(IV) oxide, where manganese is in the +4 state. 3 unpaired electrons means this complex is **less paramagnetic** than Mn^{3+}.

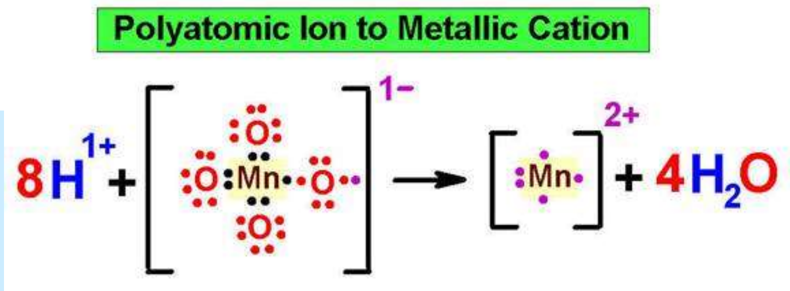
$4s^0$

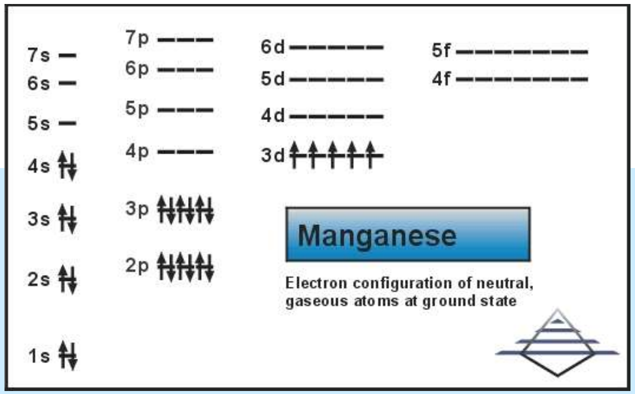
$3d^3$ x^2-y^2 z^2 xy yz xz

$KMnO_4$ is potassium permanganate, where manganese is in the +7 state. No electrons exist in the 4s and 3d orbitals. The 3p orbitals have no unpaired electrons, so this complex is **diamagnetic**.

$4s^0$

$3d^0$ x^2-y^2 z^2 xy yz xz





http://chemwiki.ucdavis.edu/Core/Inorganic_Chemistry/Descriptive_Chemistry/Elements_Organized_by_Block/3_d-Block_Elements/1b_Properties_of_Transition_Metals/Oxidation_States_of_Transition_Metals