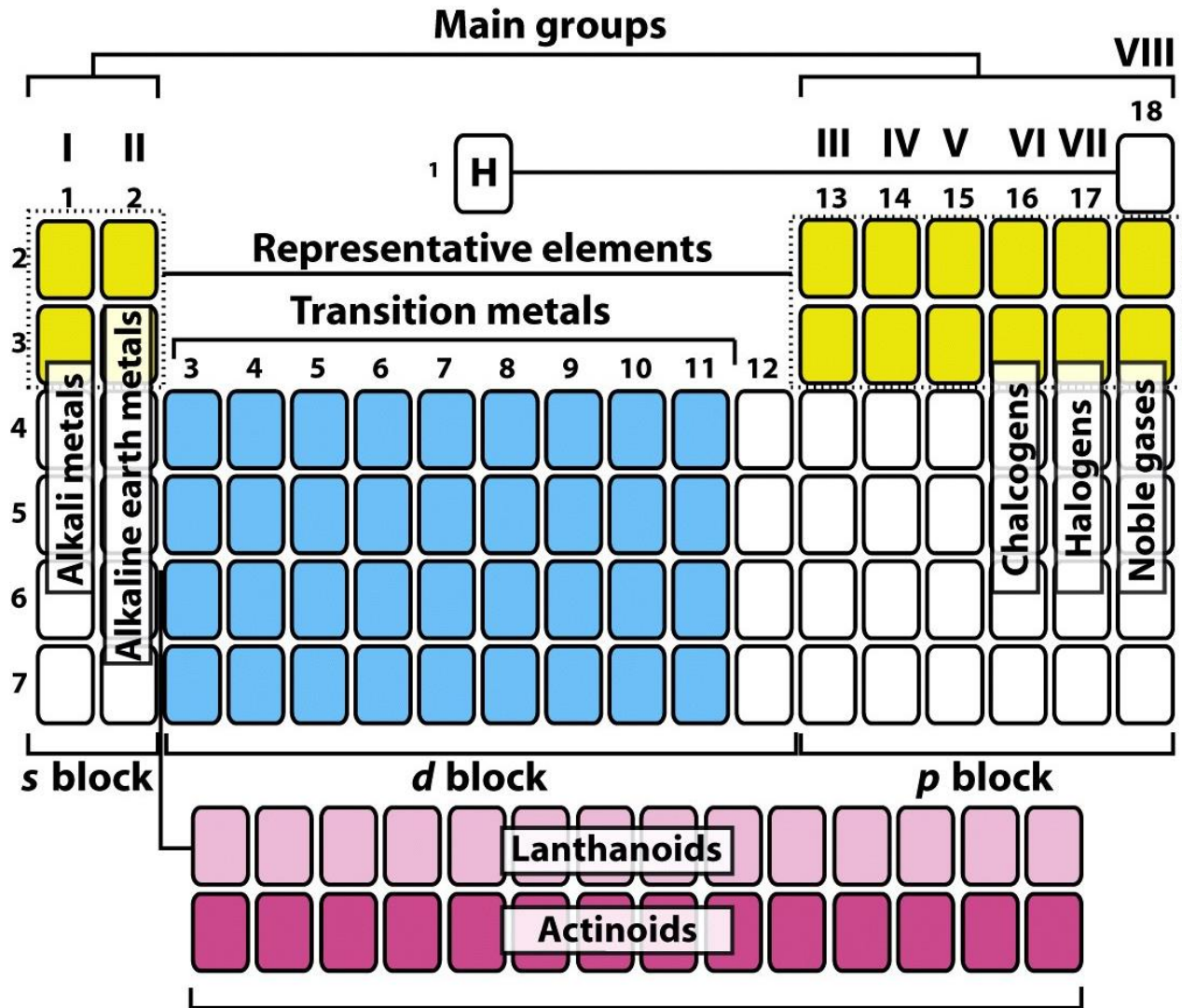


<http://www.rsc.org/periodic-table>



Metalli di inizio serie

Metalli di fine serie

IUPAC Periodic Table of the Elements

1 H hydrogen 1.008 [1.0078, 1.0082]																	18 He helium 4.0026						
3 Li lithium 6.94 [6.938, 6.997]	4 Be beryllium 9.0122																	5 B boron 10.81 [10.806, 10.821]	6 C carbon 12.011 [12.009, 12.012]	7 N nitrogen 14.007 [14.006, 14.008]	8 O oxygen 15.999 [15.999, 16.000]	9 F fluorine 18.998	10 Ne neon 20.180
11 Na sodium 22.990	12 Mg magnesium 24.305 [24.304, 24.307]																	13 Al aluminium 26.982	14 Si silicon 28.085 [28.084, 28.086]	15 P phosphorus 30.974	16 S sulfur 32.06 [32.059, 32.076]	17 Cl chlorine 35.45 [35.446, 35.457]	18 Ar argon 39.948
19 K potassium 39.098	20 Ca calcium 40.078(4)	21 Sc scandium 44.956	22 Ti titanium 47.867	23 V vanadium 50.942	24 Cr chromium 51.996	25 Mn manganese 54.938	26 Fe iron 55.845(2)	27 Co cobalt 58.933	28 Ni nickel 58.693	29 Cu copper 63.546(3)	30 Zn zinc 65.38(2)	31 Ga gallium 69.723	32 Ge germanium 72.630(8)	33 As arsenic 74.922	34 Se selenium 78.971(8)	35 Br bromine 79.904 [79.901, 79.907]	36 Kr krypton 83.798(2)						
37 Rb rubidium 85.468	38 Sr strontium 87.62	39 Y yttrium 88.906	40 Zr zirconium 91.224(2)	41 Nb niobium 92.906	42 Mo molybdenum 95.95	43 Tc technetium 101.07(2)	44 Ru ruthenium 102.91	45 Rh rhodium 106.42	46 Pd palladium 107.87	47 Ag silver 112.41	48 Cd cadmium 114.82	49 In indium 114.82	50 Sn tin 118.71	51 Sb antimony 121.76	52 Te tellurium 127.60(3)	53 I iodine 126.90	54 Xe xenon 131.29						
55 Cs caesium 132.91	56 Ba barium 137.33	57-71 lanthanoids	72 Hf hafnium 178.49(2)	73 Ta tantalum 180.95	74 W tungsten 183.84	75 Re rhenium 186.21	76 Os osmium 190.23(3)	77 Ir iridium 192.22	78 Pt platinum 195.08	79 Au gold 196.97	80 Hg mercury 200.59	81 Tl thallium 204.38 [204.38, 204.39]	82 Pb lead 207.2	83 Bi bismuth 208.98	84 Po polonium	85 At astatine	86 Rn radon						
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganesson						

Key:
atomic number
Symbol
name
conventional atomic weight
standard atomic weight



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57 La lanthanum 138.91	58 Ce cerium 140.12	59 Pr praseodymium 140.91	60 Nd neodymium 144.24	61 Pm promethium	62 Sm samarium 150.36(2)	63 Eu europium 151.96	64 Gd gadolinium 157.25(3)	65 Tb terbium 158.93	66 Dy dysprosium 162.50	67 Ho holmium 164.93	68 Er erbium 167.26	69 Tm thulium 168.93	70 Yb ytterbium 173.05	71 Lu lutetium 174.97
89 Ac actinium	90 Th thorium 232.04	91 Pa protactinium 231.04	92 U uranium 238.03	93 Np neptunium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

For notes and updates to this table, see www.iupac.org. This version is dated 28 November 2016.
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7	8	9	10	11	12	
Mn	Fe	Co	Ni	Cu	Zn	Al
Tc	Ru	Rh	Pd	Ag	Cd	Ga
Re	Os	Ir	Pt	Au	Hg	In
						Tl

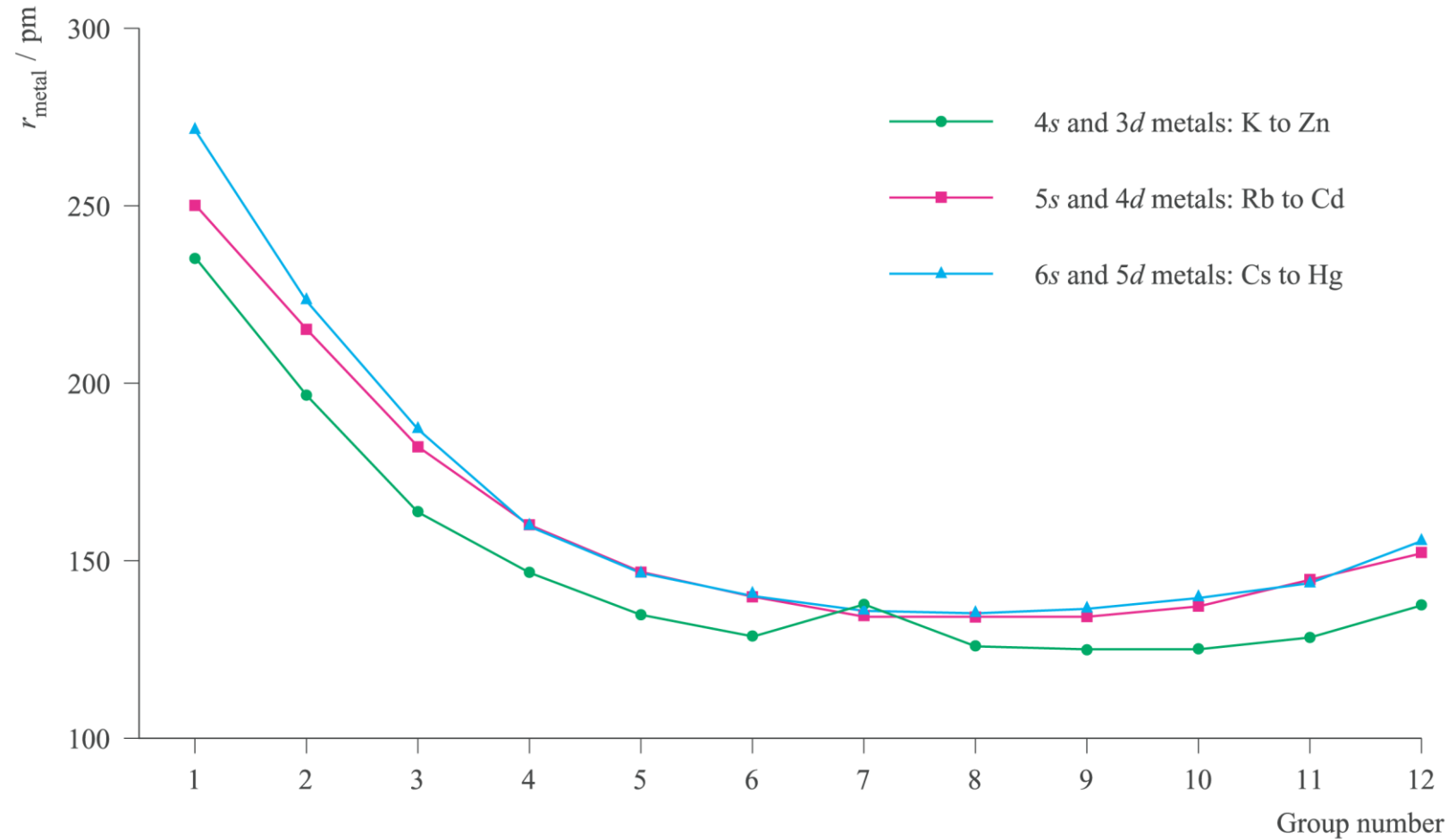
**Platinum
metals**

**Coinage
metals**

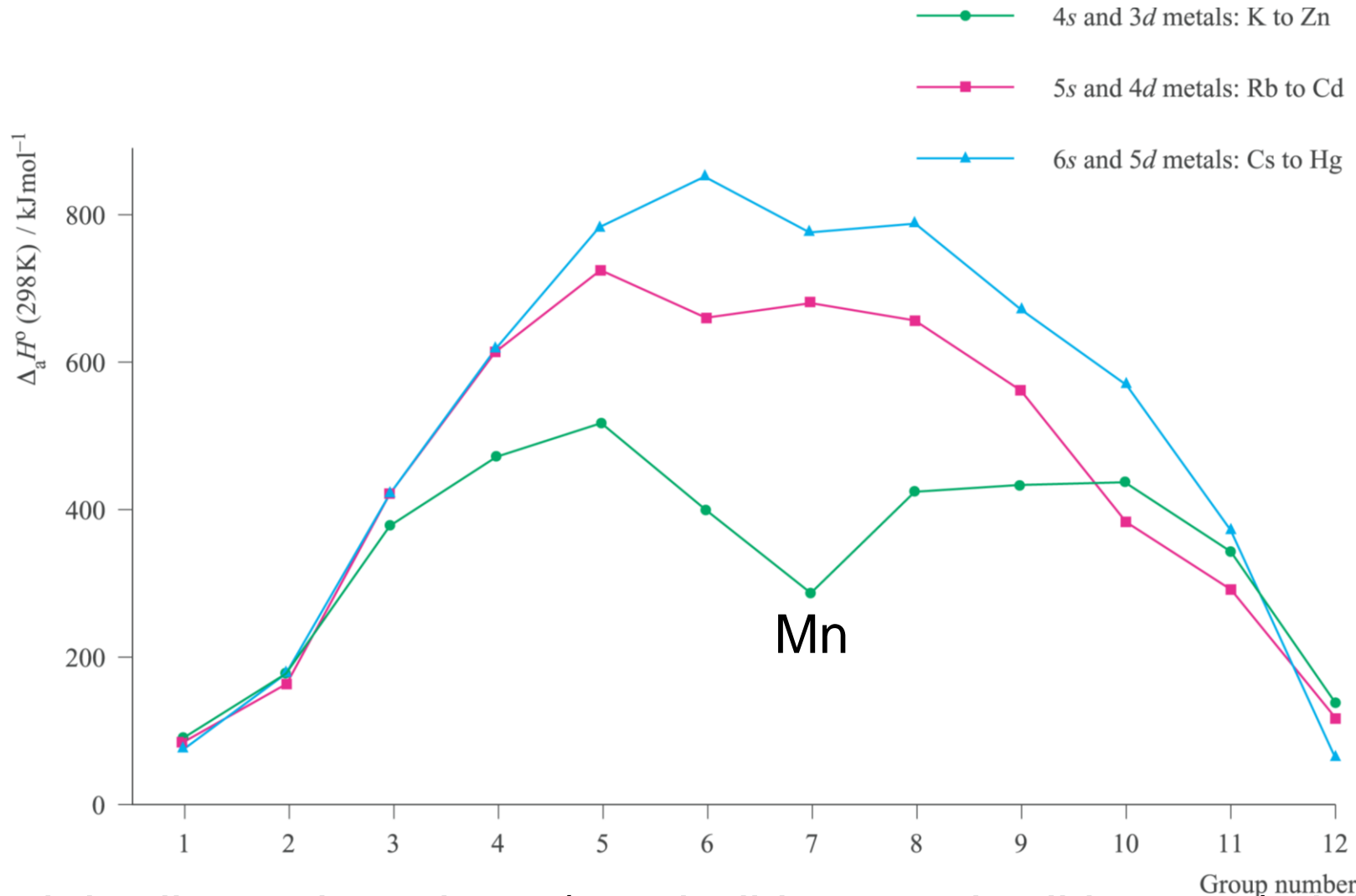
Platinum group metals

<https://www.youtube.com/watch?v=Fg2WzCzKpYU>

Raggio metallico



Entalpia di atomizzazione

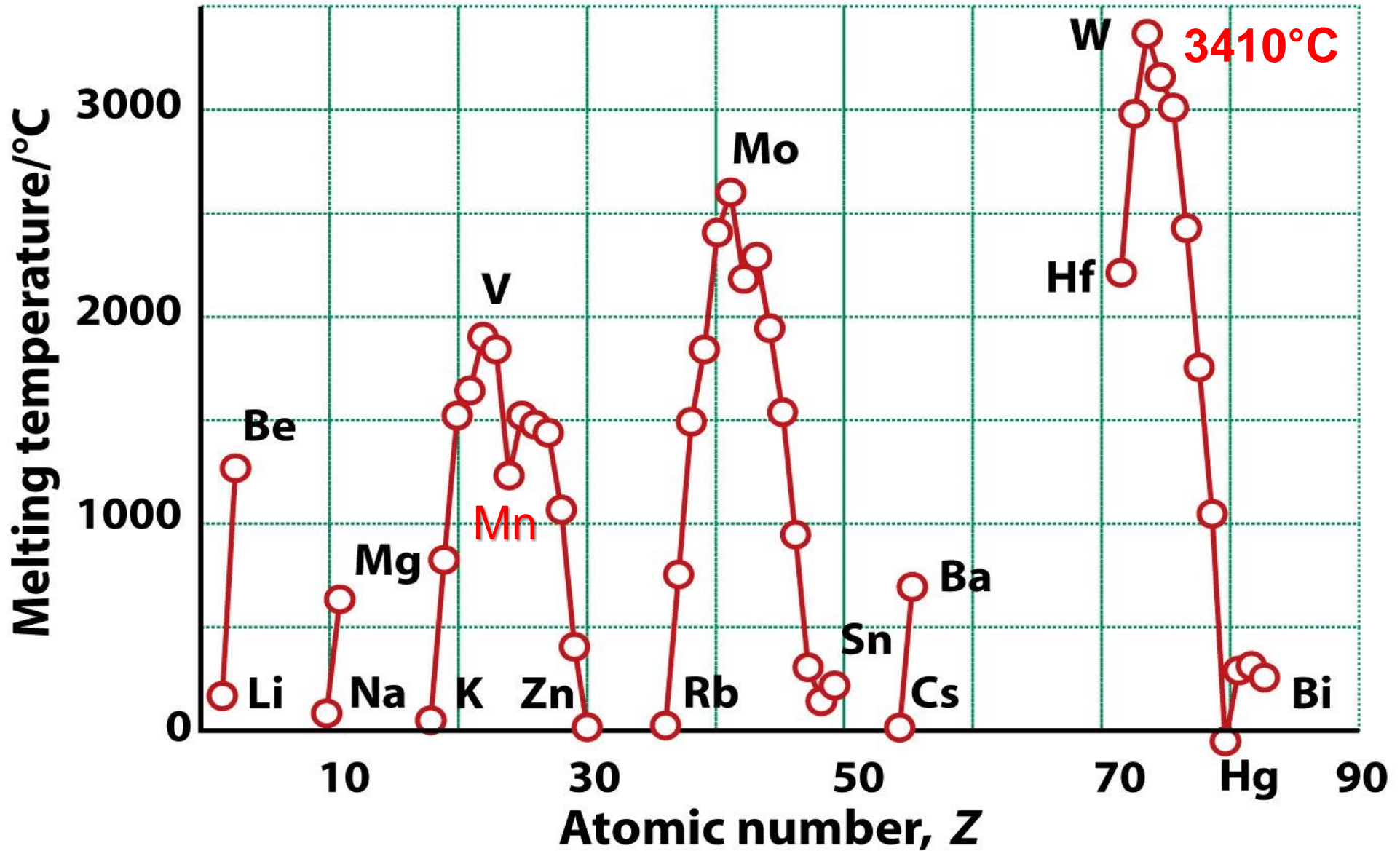


Mn

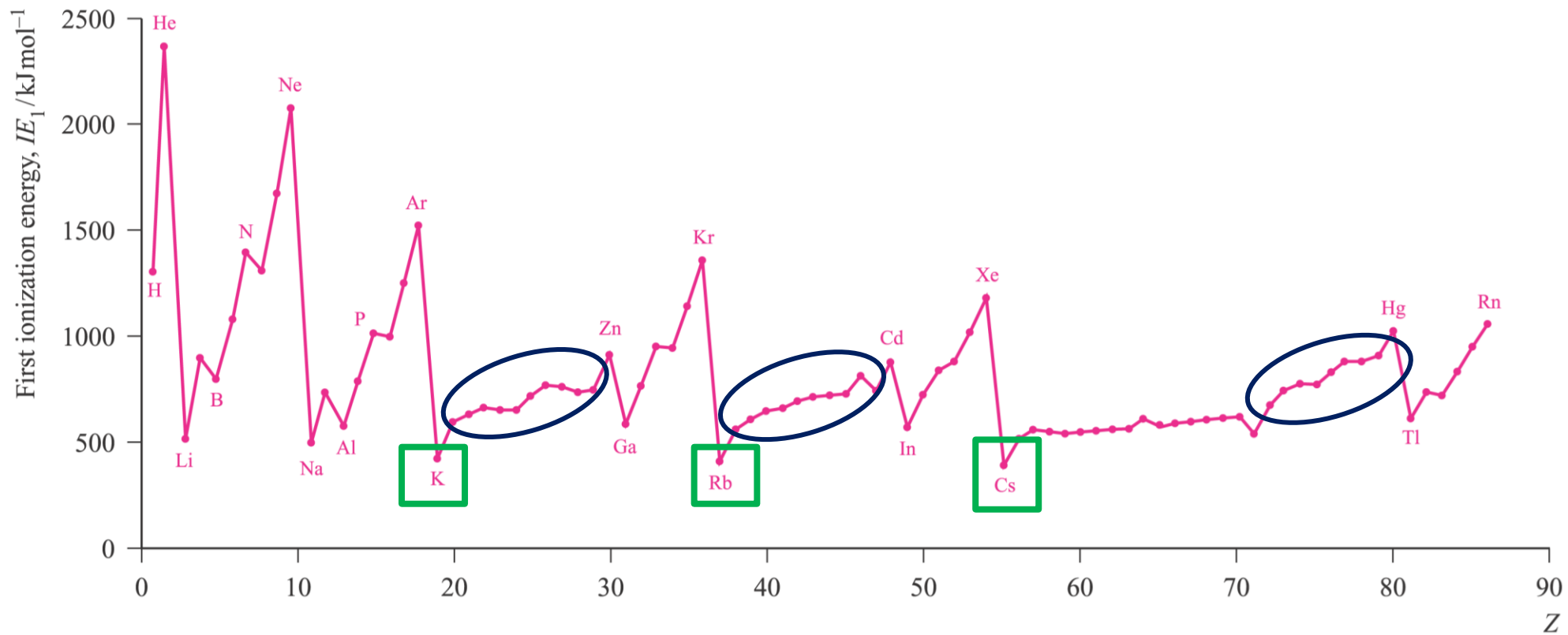
Group number

Le entalpie di atomizzazione (e quindi le energie di legame) dei metalli più pesanti sono più elevate di quelli leggeri a causa della maggiore espansione radiale degli orbitali d e quindi migliore sovrapposizione⁶

Punti di fusione



Energia di ionizzazione



Potenziali standard di semireazione

Reduction half-equation	E^0 / V
$\text{Ca}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Ca}(\text{s})$	-2.87
$\text{Ti}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Ti}(\text{s})$	-1.63
$\text{V}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{V}(\text{s})$	-1.18
$\text{Cr}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cr}(\text{s})$	-0.91
$\text{Mn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Mn}(\text{s})$	-1.19
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Fe}(\text{s})$	-0.44
$\text{Co}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Co}(\text{s})$	-0.28
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Ni}(\text{s})$	-0.25
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cu}(\text{s})$	+0.34
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Zn}(\text{s})$	-0.76

Quando il potenziale standard per la riduzione di uno ione metallico a metallo è negativo, il metallo dovrebbe subire ossidazione in acido 1 M con sviluppo di H_2 .

Andamento dei potenziali di riduzione dell'acqua con il pH

$$E^\circ(\text{Co}^{3+}/\text{Co}^{2+}) = + 1.92 \text{ V}$$

$$E^\circ(\text{Ce}^{4+}/\text{Ce}^{3+}) = + 1.76 \text{ V}$$

$$E^\circ(\text{MnO}_4^-/\text{Mn}^{2+}) = + 1.51 \text{ V}$$

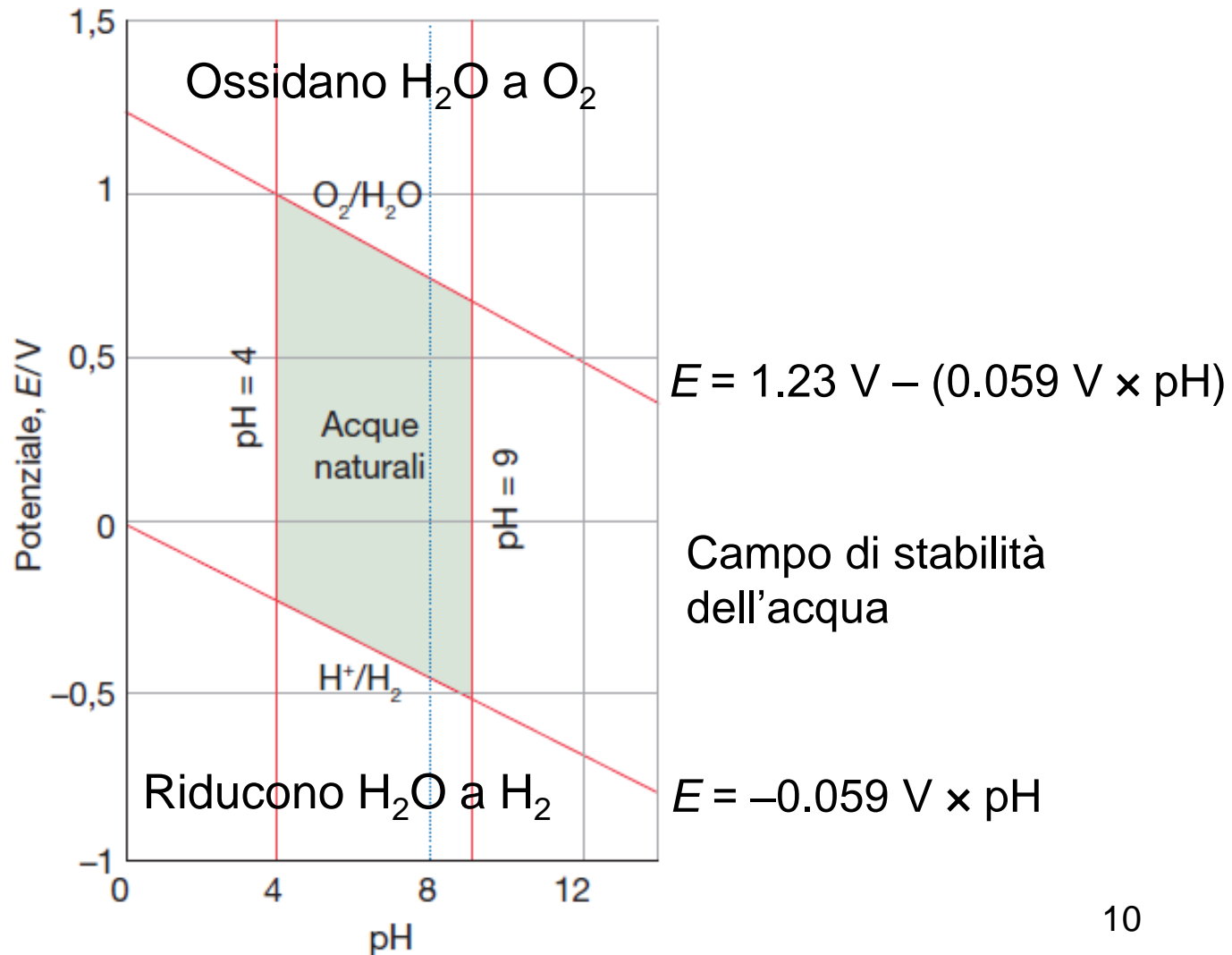
$$E^\circ(\text{Cr}_2\text{O}_7^{2-}/\text{Cr}^{3+}) = + 1.38 \text{ V}$$

Perché Co^{3+} ossida l'acqua mentre gli altri ossidanti vengono usati in acqua seppure abbiano potenziali $> 1.23 \text{ V}$?

$$E^\circ(\text{Fe}^{3+}/\text{Fe}^{2+}) = + 0.77 \text{ V}$$

Perché le soluzioni di Fe^{2+} in acqua non sono stabili?

Diagramma di Pourbaix



Colour of light <i>absorbed</i>	Approximate wavelength ranges / nm	Corresponding wavenumbers (approximate values) / cm^{-1}	Colour of light <i>transmitted</i> , i.e. complementary colour of the absorbed light
Red	700–620	14 300–16 100	Green
Orange	620–580	16 100–17 200	Blue
Yellow	580–560	17 200–17 900	Violet
Green	560–490	17 900–20 400	Red
Blue	490–430	20 400–23 250	Orange
Violet	430–380	23 250–26 300	Yellow

† When an electronic spectrum exhibits more than one absorption in the visible region, the simplicity of the colour wheel does not hold.

$$40 \text{ kcal (167 kJ)} \div 72 \text{ kcal (300 kJ)}$$

Colour
of light
absorbed

In a 'colour wheel'[†]
representation,
complementary colours
are in opposite sectors

Red
Orange
Yellow
Green
Blue
Violet



[†] When an electronic spectrum exhibits more than one absorption in the visible region, the simplicity of the colour wheel does not hold.

Stati di ossidazione dei metalli del blocco d, prima serie

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
	0	0	0	0	0	0	0	[0]	
		1	1	1	1	1	1	1	[1]
	2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3	
	4	4	4	4	4	4	4	[4]	
		5	5	5					
			6	6	6				
				7					

Stati di ossidazione dei metalli del blocco d, seconda serie

Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
			0	0	0	0	0		
				1		1		1	[1]
3	2	2	2	[2]	2	2	2	2	2
	3	3	3	3	3	3		3	
	4	4	4	4	4	4	4		
		5	5	5	5	5			
			6	6	6	6			
				7	7				
					8				

Stati di ossidazione dei metalli del blocco d, terza serie

La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg
			0	0	0	0	0	[0]	
				1		1		1	1
	2	2	2	2	2	2	2	[2]	2
3	3	3	3	3	3	3		3	
	4	4	4	4	4	4	4		
		5	5	5	5	5	5	5	
			6	6	6	6	6		
				7	7				
					8				

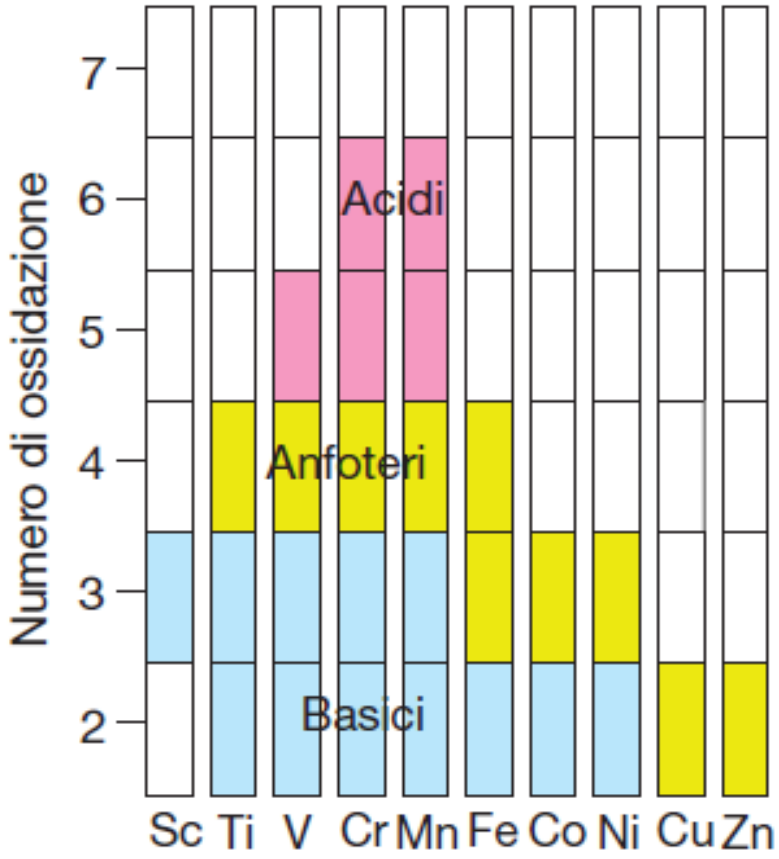


Identification of an iridium-containing compound with a formal oxidation state of IX

Guanjun Wang, Mingfei Zhou , James T. Goettel, Gary J. Schrobilgen , Jing Su, Jun Li, Tobias Schlöder & Sebastian Riedel 

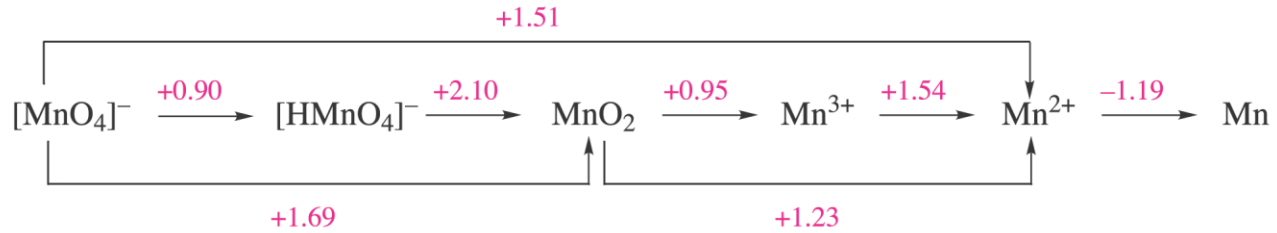
Nature **514**, 475–477 (23 October 2014) | [Download Citation](#) 

La chimica di un elemento dipende anche dal suo stato di ossidazione. Per esempio, al crescere del numero di ossidazione aumenta il carattere acido degli ossidi, che passano da prevalentemente ionici a covalenti.

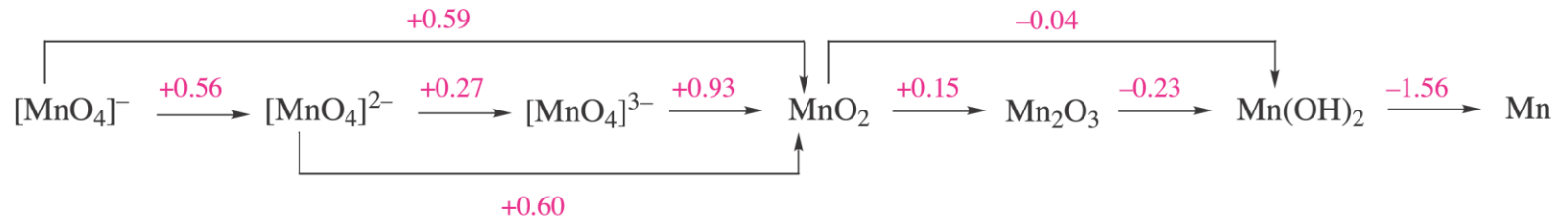


Diagrammi di Latimer

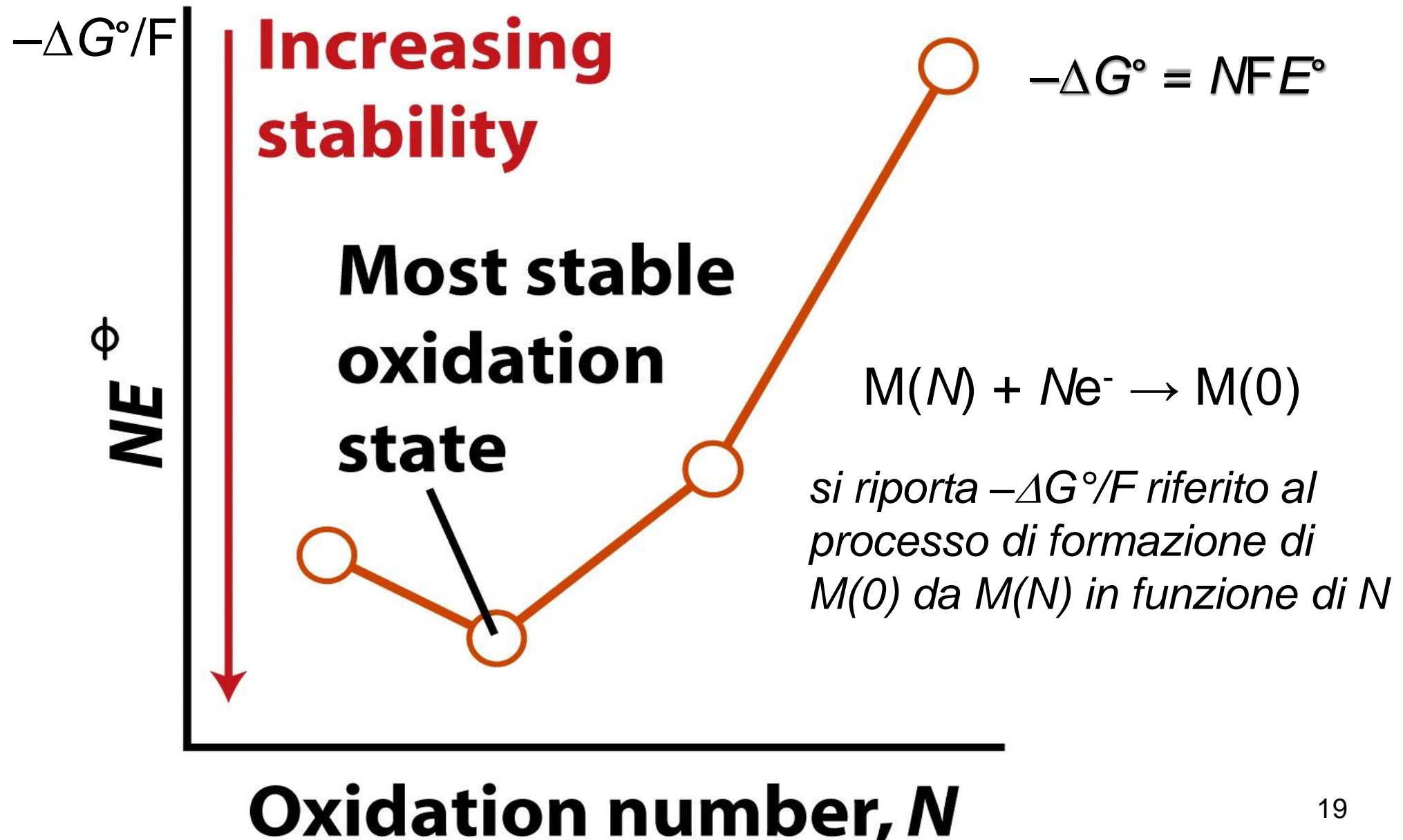
Acidic solution (pH 0)



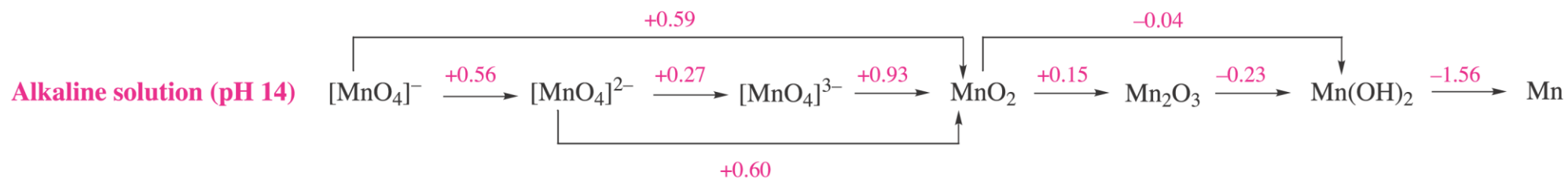
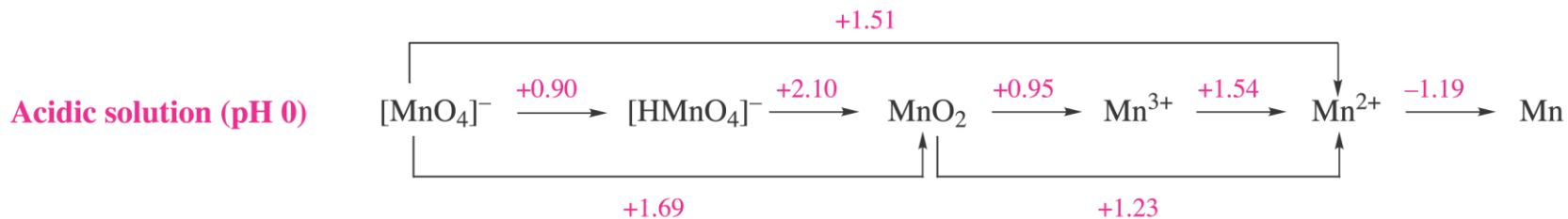
Alkaline solution (pH 14)



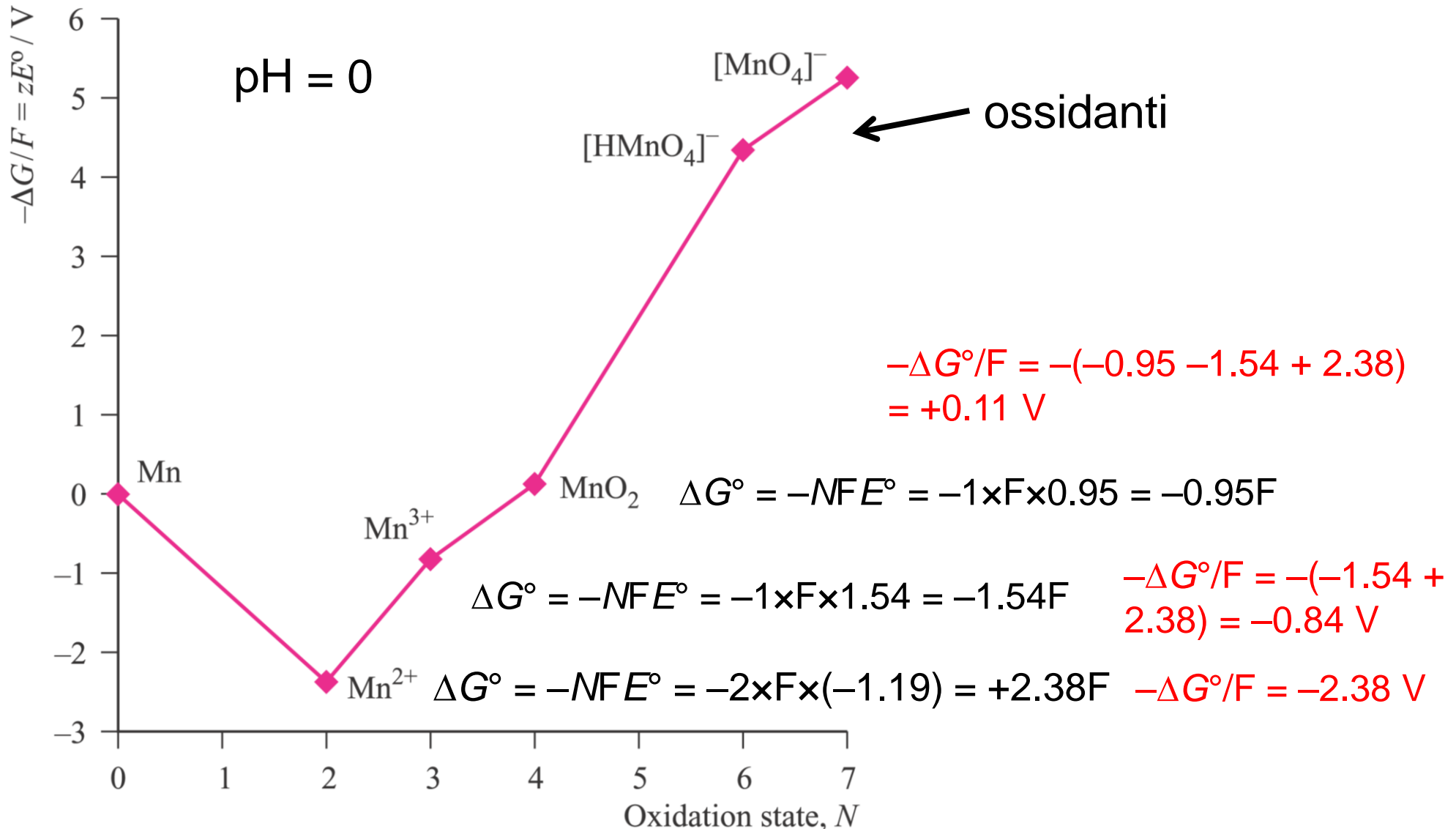
Diagrammi di Frost - Ebsworth

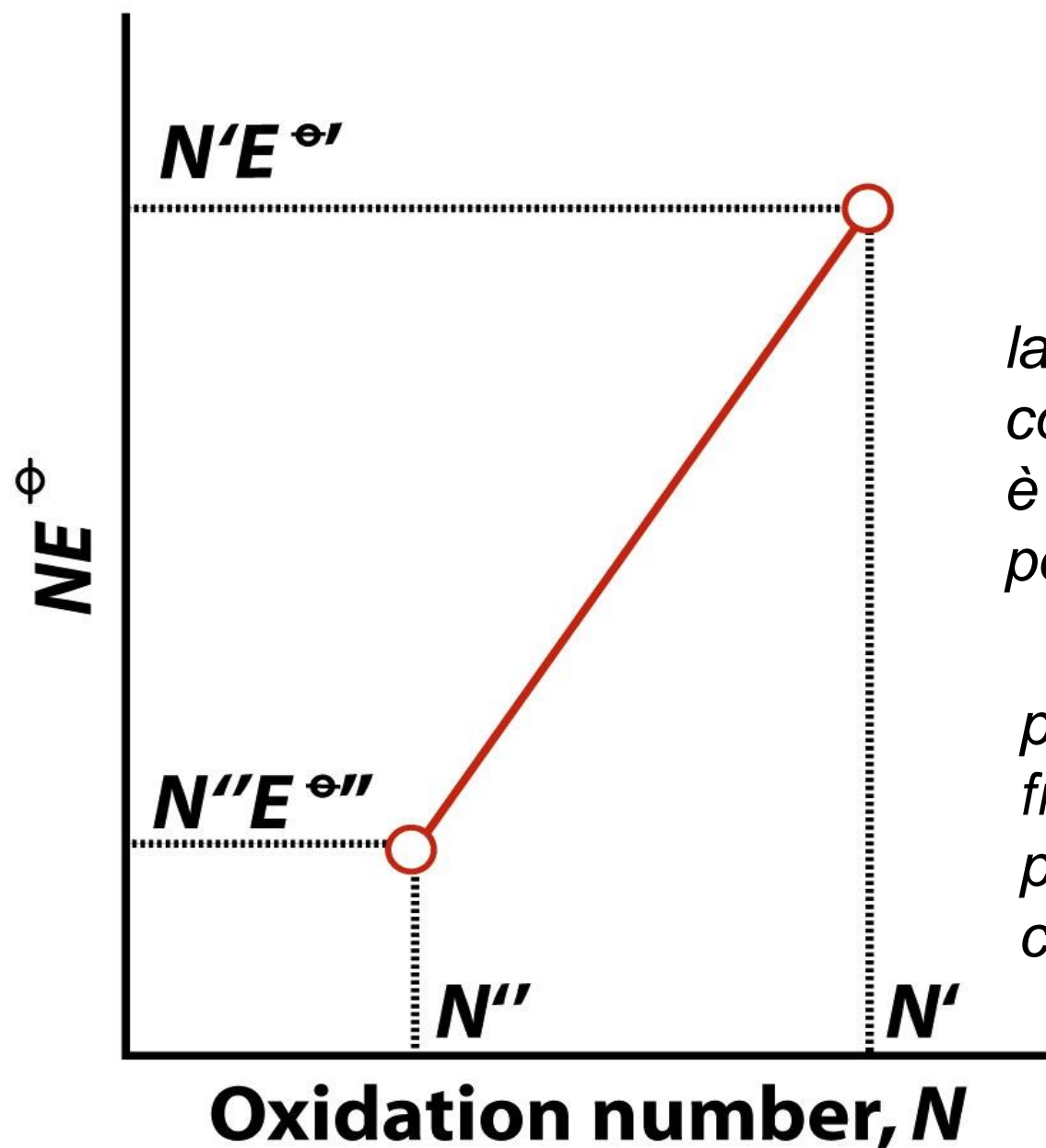


Diagrammi di Latimer



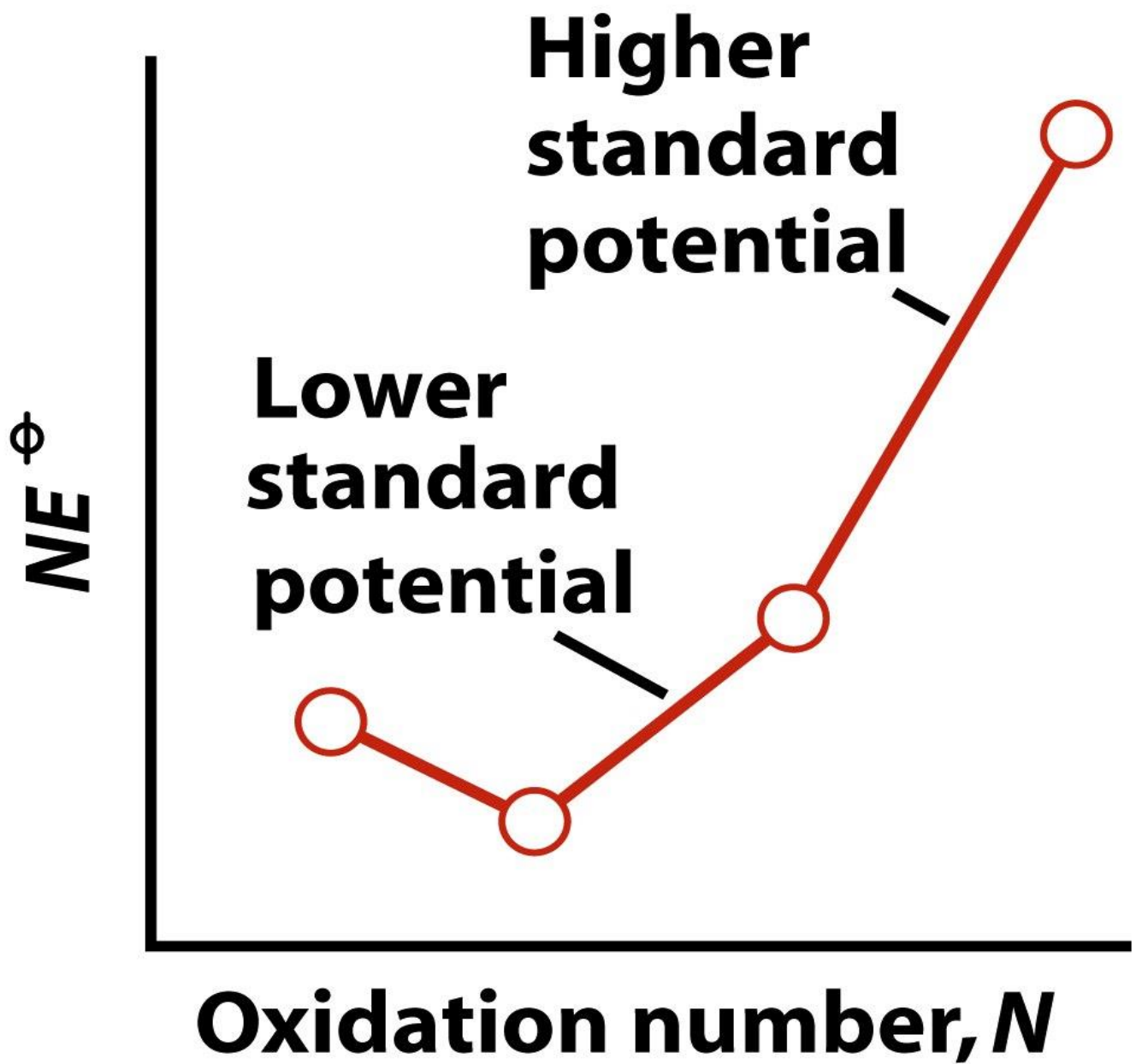
uno spostamento verso il basso nel diagramma corrisponde a un processo termodinamicamente favorito

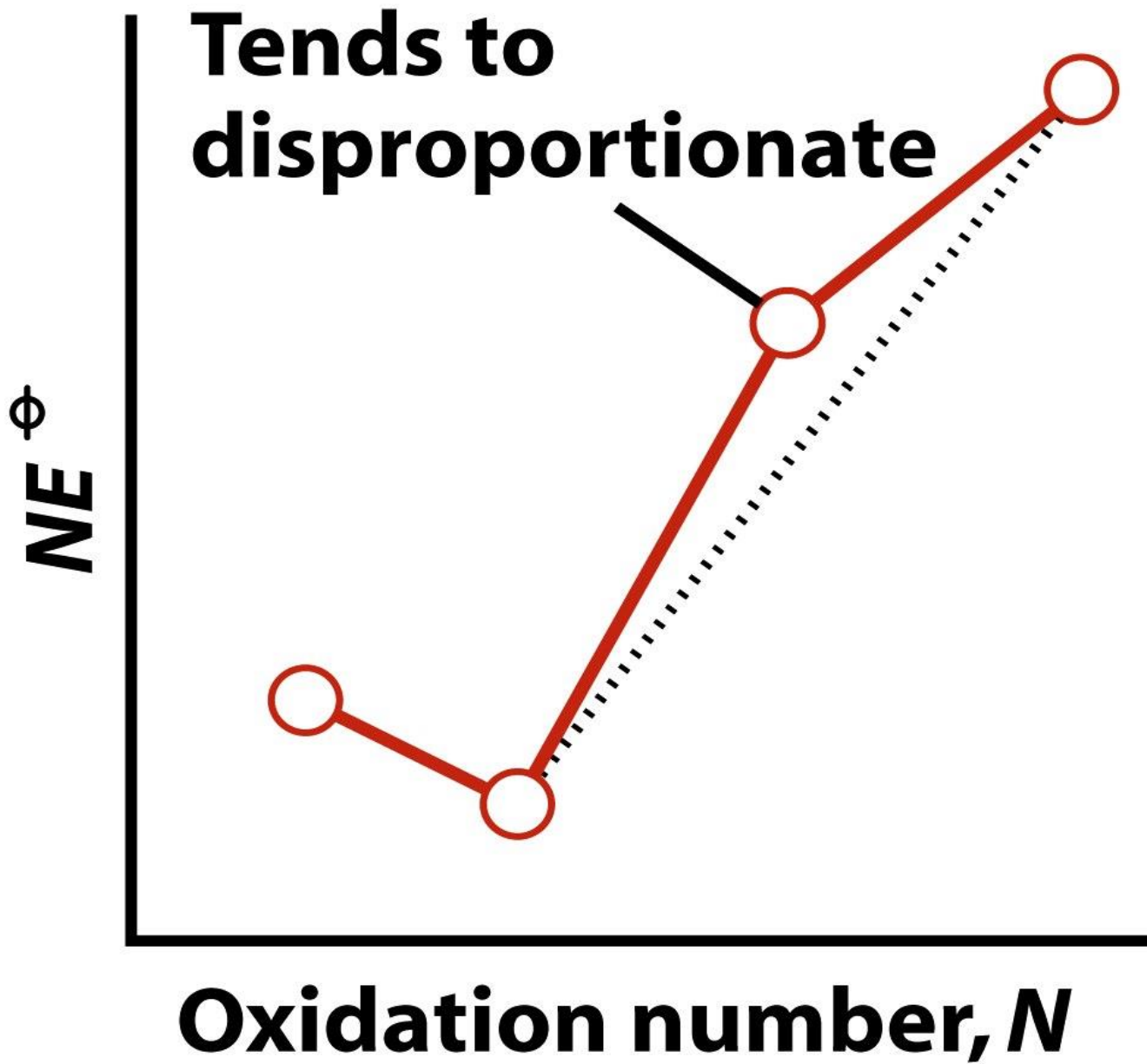


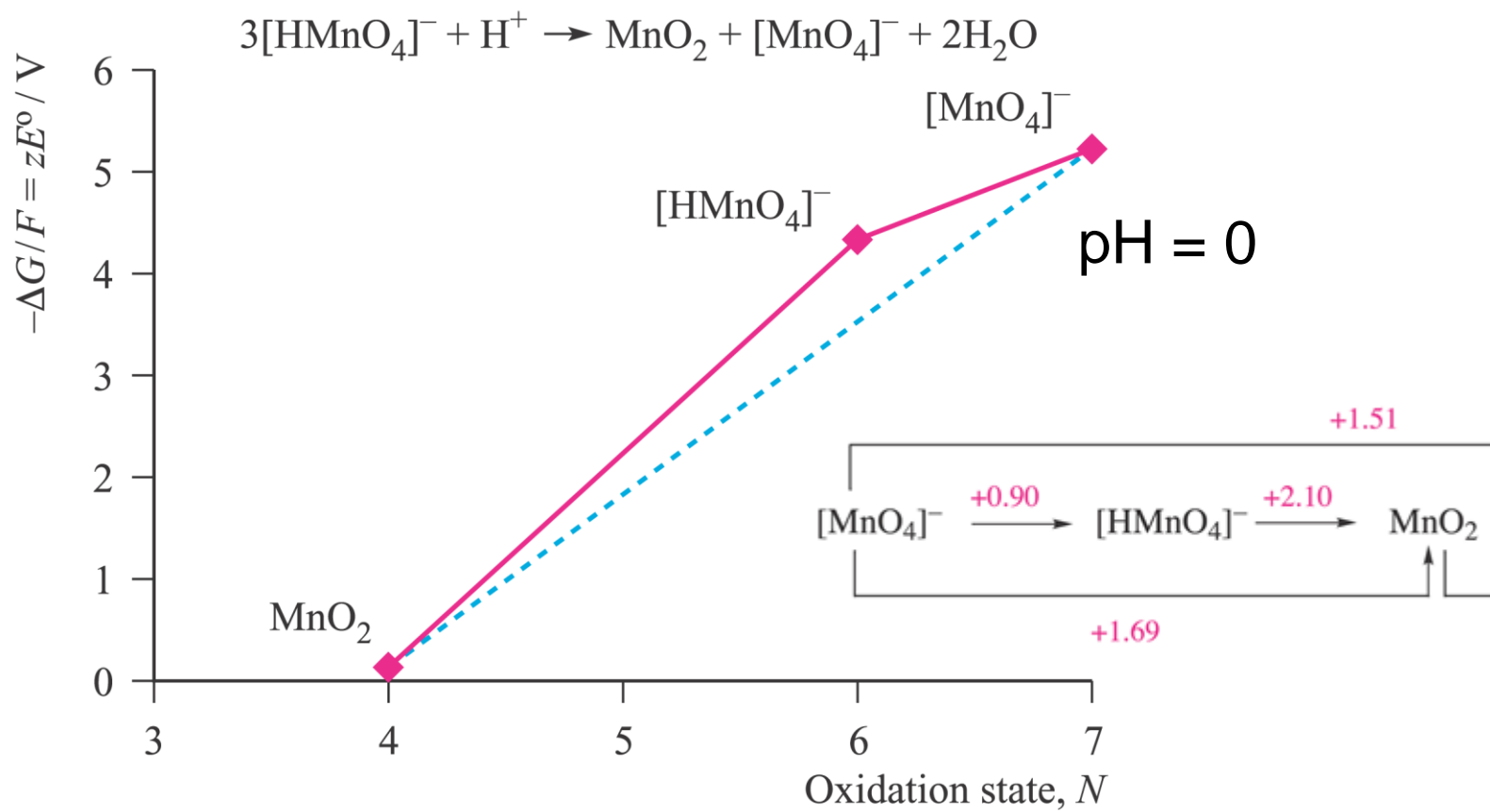


la pendenza della linea che congiunge due punti qualsiasi è uguale al potenziale standard per quella coppia

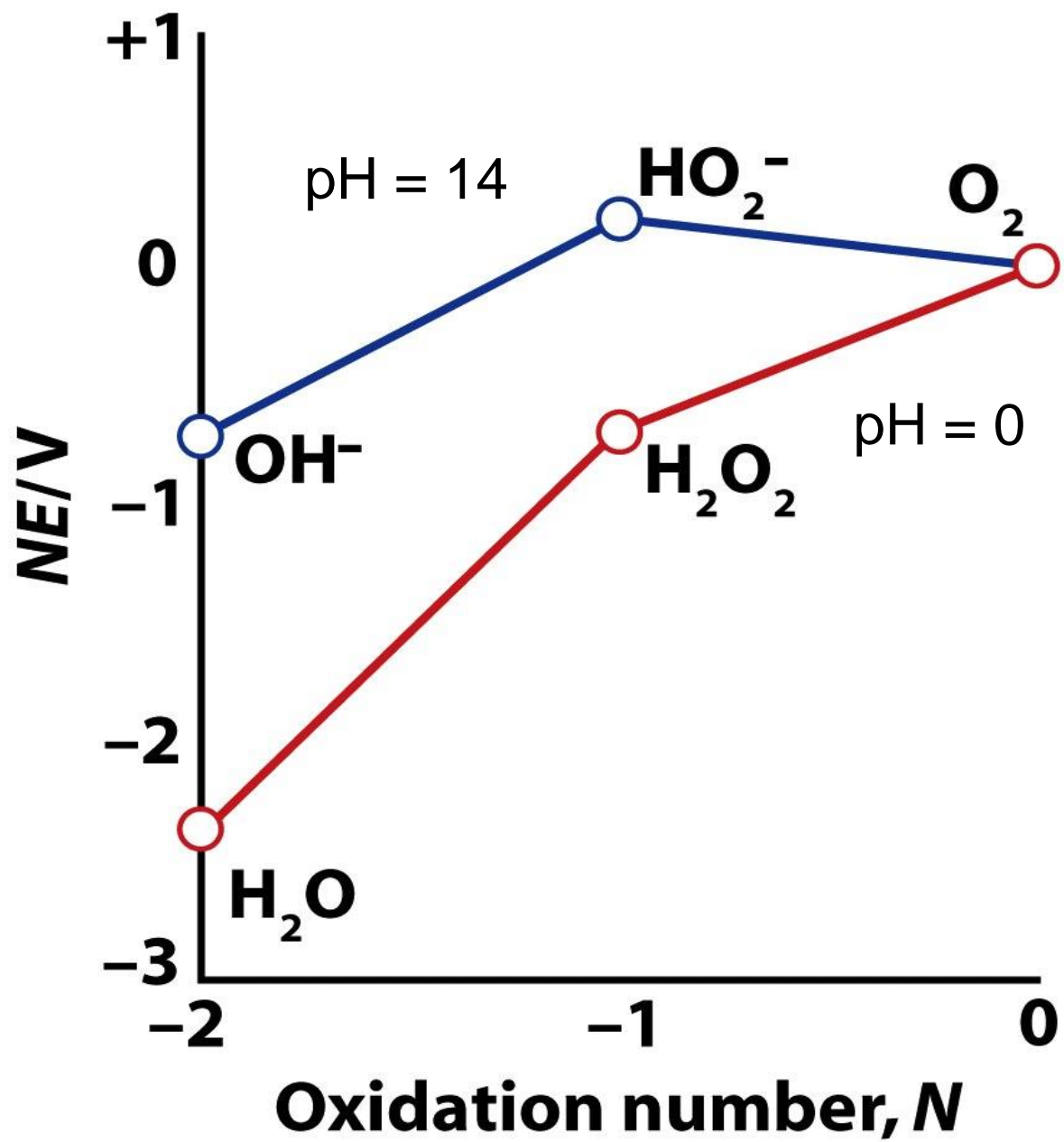
più ripida è la congiungente fra due punti nel diagramma e più alto è il potenziale della coppia corrispondente

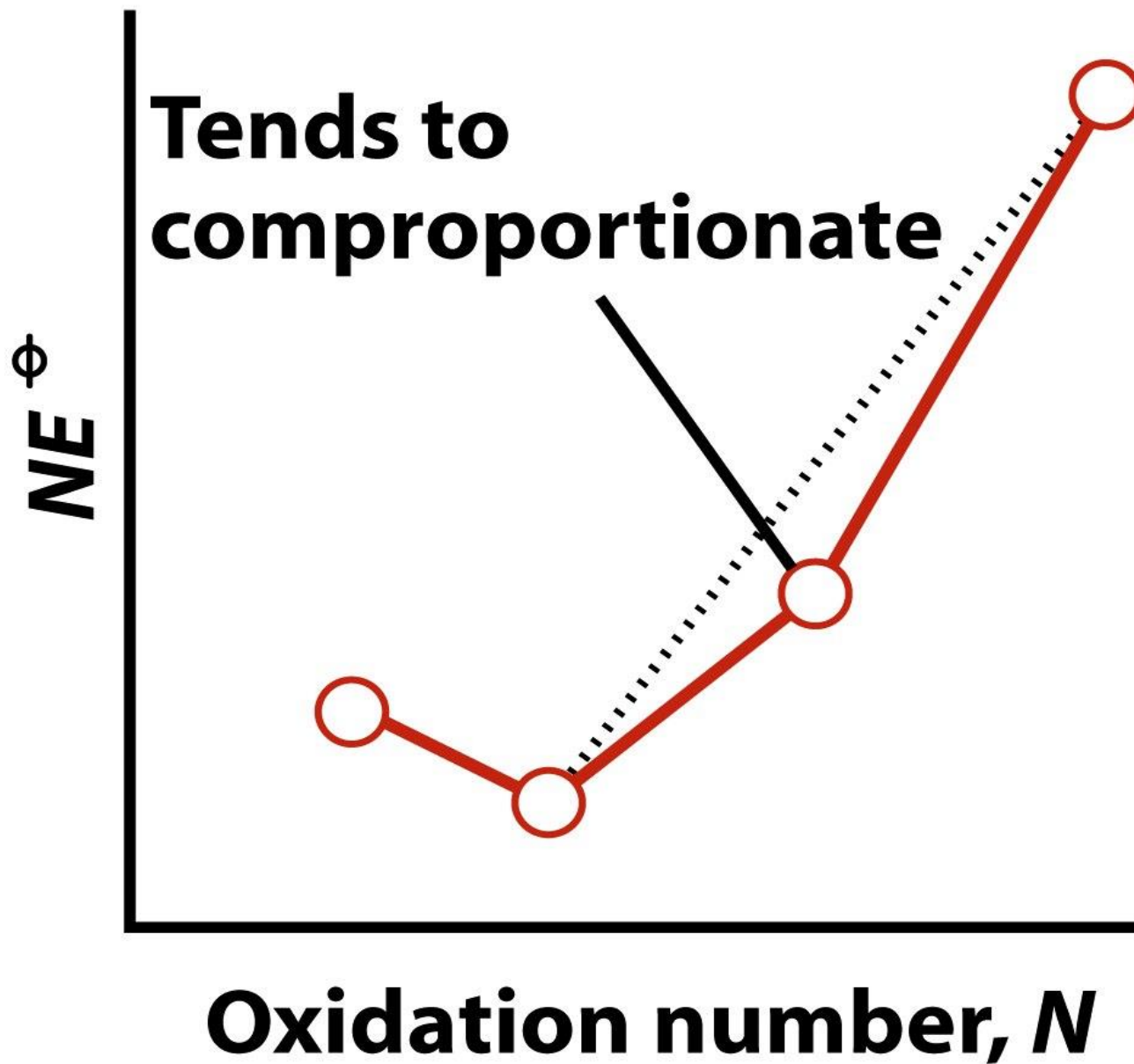


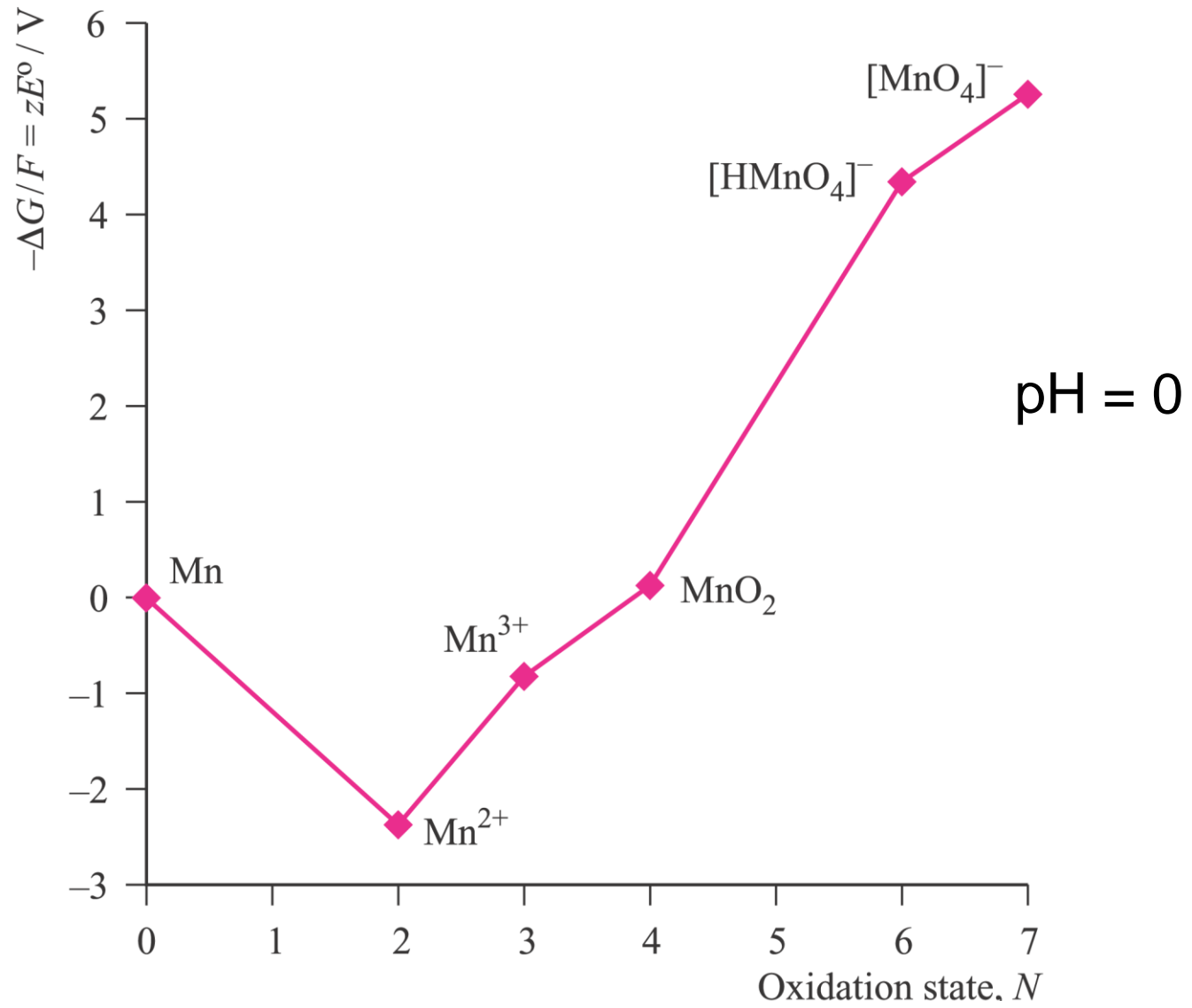


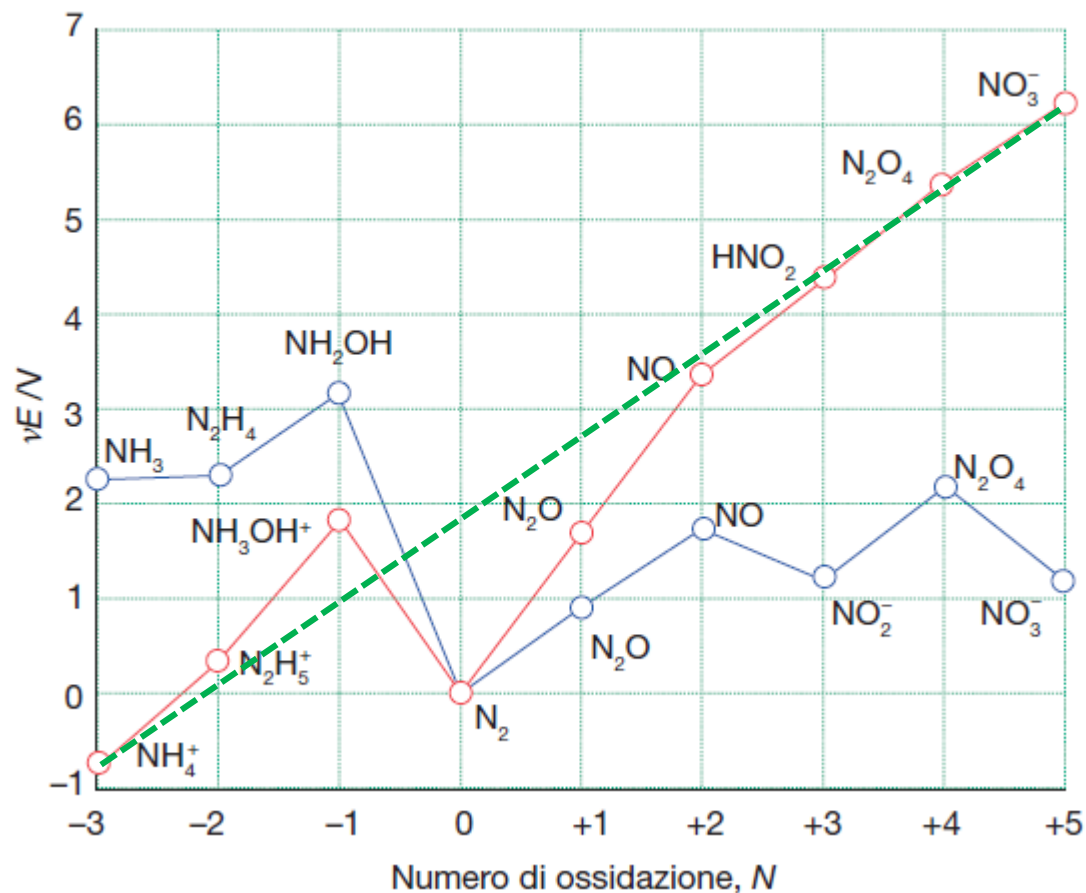


(b)



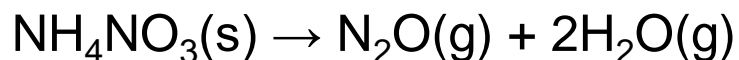






L'azoto in NH_4NO_3 ha due ioni con numeri di ossidazione -3 (NH_4^+) e $+5$ (NO_3^-). Poiché N_2O sta sotto alla retta che congiunge NH_4^+ a NO_3^- , la loro comproporzione è un processo spontaneo.

In soluzione è inibita dal punto di vista cinetico e normalmente non avviene. La corrispondente reazione allo stato solido:



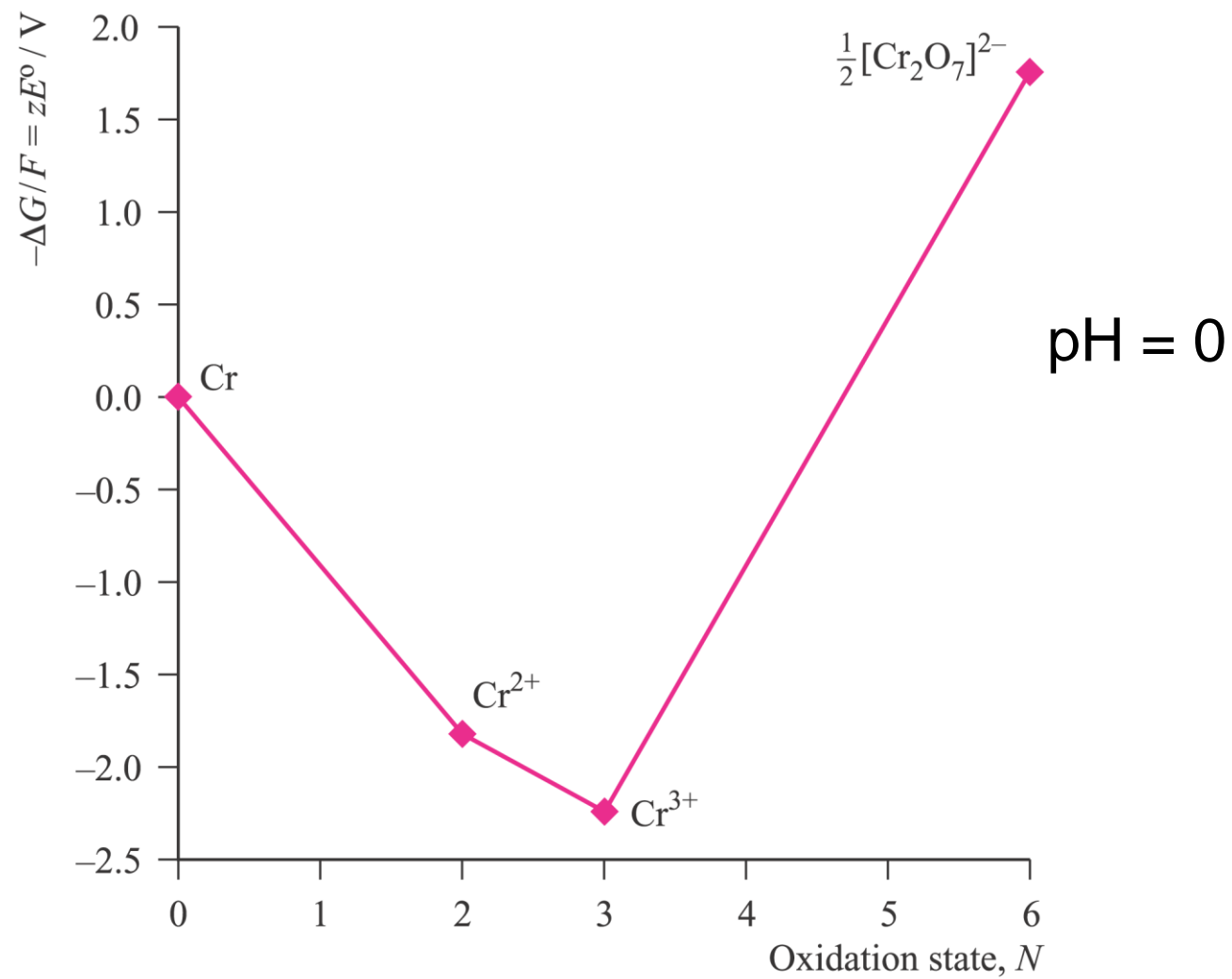
una volta innescata tramite una detonazione è tanto veloce da essere esplosiva

Beirut, 4 agosto 2020
Esplodono ca. 3000 t di NH_4NO_3



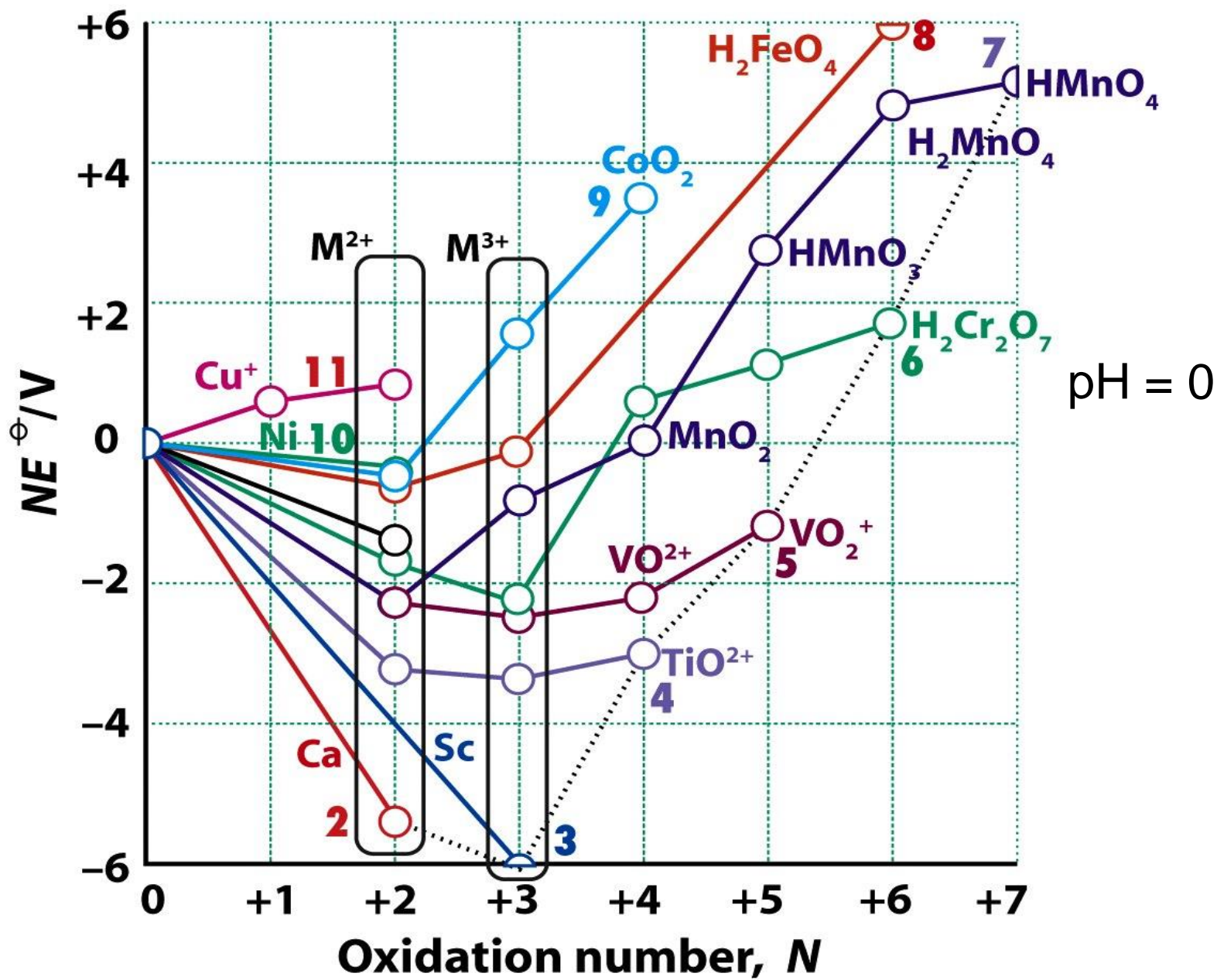
Beirut, 4 agosto 2020
Esplodono ca. 3000 t di NH_4NO_3



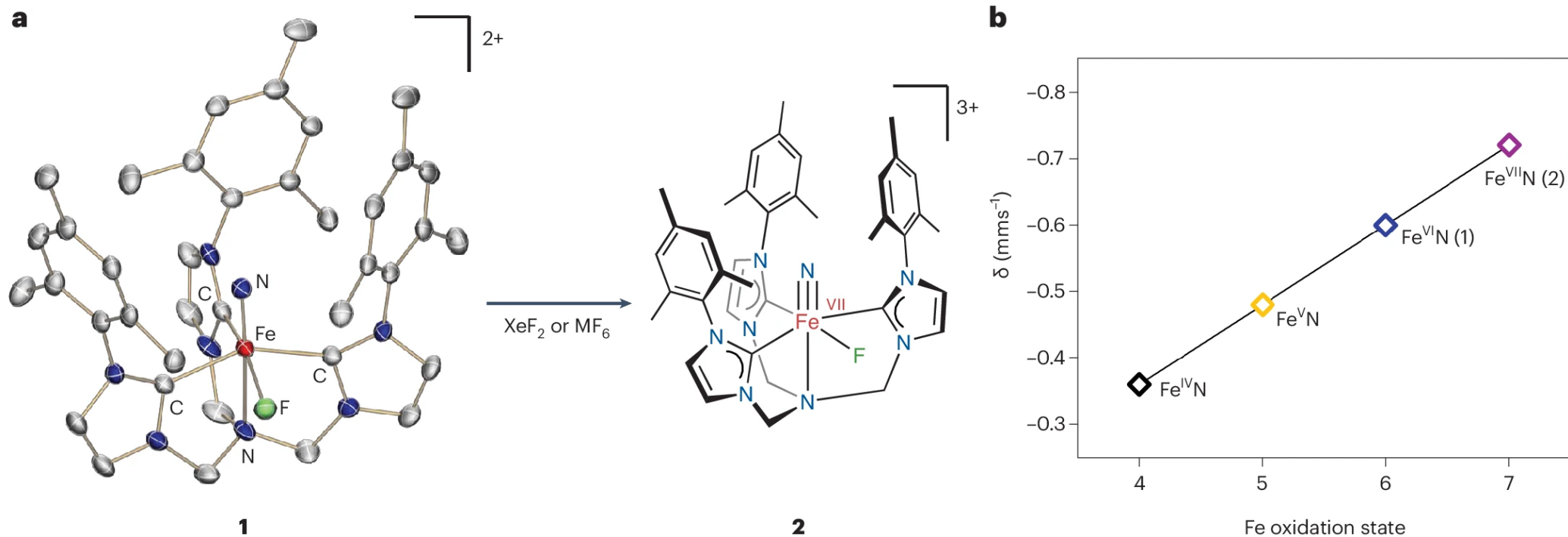


(a)

http://www.periodicvideos.com/videos/mv_chromium_trioxide.htm



Primo esempio di un complesso di Fe(VII)



Nature Chemistry 2024

