

LC-16 Classification périodique

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M2 FEADeP

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Commençons par une petite approche historique :

Avant 1700 : 12 éléments connus -> en 1900 : 80 éléments connus

Dénominations des substances chimiques



Première classification



Introduction de la masse atomique



Périodicité des propriétés fondamentales : triade et tétrade



Périodicité des propriétés chimiques : vis tellurique



Première prédiction



Introduction de cases vides

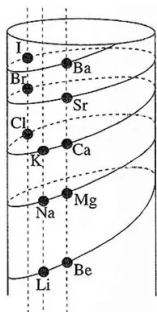


1869, classification de Mendeleïev



Ultérieurement ...

La vis tellurique :



Commençons par une petite approche historique :

Avant 1700 : 12 éléments connus -> en 1900 : 80 éléments connus

Dénominations des substances chimiques



Première classification



Introduction de la masse atomique



Périodicité des propriétés fondamentales : triade et tétrade



Périodicité des propriétés chimiques : vis tellurique



Première prédiction



Introduction de cases vides



1869, classification de Mendeleïev



Ultérieurement ...

The Periodic Table of the Elements, in Pictures and Words

1 H Hydrogen  Sun and Stars	2 He Helium  Balloons																																																																																																																																																																						
3 Li Lithium  Batteries	4 Be Beryllium  Emeralds	5 B Boron  Sports Equipment	6 C Carbon  Birds of Life's Ribbons	7 N Nitrogen  Protein	8 O Oxygen  Air	9 F Fluorine  Toothpaste	10 Ne Neon  Advertising Signs																																																																																																																																																																
11 Na Sodium  Salt	12 Mg Magnesium  Chlorophyll	13 Al Aluminum  Airlanes	14 Si Silicon  Stones, Sand, and Soil	15 P Phosphorus  Bones	16 S Sulfur  Eggs	17 Cl Chlorine  Swimming Pools	18 Ar Argon  Light Bulbs																																																																																																																																																																
19 K Potassium  Fruits and Vegetables	20 Ca Calcium  Shells and Bones	21 Sc Scandium  Bicycles	22 Ti Titanium  Aerospace	23 V Vanadium  Springs	24 Cr Chromium  Stainless Steel	25 Mn Manganese  Earthmovers	26 Fe Iron  Steel Structures	27 Co Cobalt  Magnets	28 Ni Nickel  Coins	29 Cu Copper  Electric Wires	30 Zn Zinc  Brass Instruments	31 Ga Gallium  Light-Emitting Diodes (LEDs)	32 Ge Germanium  Semiconductor Electronics	33 As Arsenic  Poison	34 Se Selenium  Copiers	35 Br Bromine  Photography Film	36 Kr Krypton  Flashlights																																																																																																																																																						
37 Rb Rubidium  Global Navigation	38 Sr Strontium  Fireworks	39 Y Yttrium  Lasers	40 Zr Zirconium  Chemical Pipelines	41 Nb Niobium  Mag Lev Trains	42 Mo Molybdenum  Cutting Tools	43 Tc Technetium  Radioactive Diagnosis	44 Ru Ruthenium  Electric Switches	45 Rh Rhodium  Searchlight Reflectors	46 Pd Palladium  Pollution Control	47 Ag Silver  Jewelry	48 Cd Cadmium  Paint	49 In Indium  Liquid Crystal Displays (LCDs)	50 Sn Tin  Plated Food Cans	51 Sb Antimony  Car Batteries	52 Te Tellurium  Thermoelectric Coolers	53 I Iodine  Disinfectant	54 Xe Xenon  High Intensity Lamps																																																																																																																																																						
55 Cs Cesium  Atomic Clocks	56 Ba Barium  X-Ray Diagnosis	57 - 71 La Lanthanum  Nuclear Submarines	72 Hf Hafnium  Mobile Phones	73 Ta Tantalum  Lamp Filaments	74 W Tungsten  Rocket Engines	75 Re Rhenium  Pen Points	76 Os Osmium  Spark Plugs	77 Ir Iridium  Labware	78 Pt Platinum  Jewelry	79 Au Gold  Thermometers	80 Hg Mercury  Low-Temperature Thermometers	81 Tl Thallium  Weights	82 Pb Lead  Fire Sprinklers	83 Bi Bismuth  Anti-Static Brushes	84 Po Polonium  Radioactive Medicine	85 At Astatine  Surgical Implants	86 Rn Radon  Oxygen																																																																																																																																																						
87 Fr Francium  Laser Atom Traps	88 Ra Radium  Luminous Watches	89 - 103 Pr Praseodymium  Telescope Lenses	90 Nd Neodymium  Lighter Flints	91 Pm Promethium  Torches/Lighters	92 Sm Samarium  Electric Motor Magnets	93 Eu Europium  Luminous Dials	94 Gd Gadolinium  Color Televisions	95 Tb Terbium  MRI Diagnosis	96 Dy Dysprosium  Fluorescent Lamps	97 Ho Holmium  Smart Material Actuators	98 Er Erbium  Laser Surgery	99 Tm Thulium  Optical Fiber Communications	100 Yb Ytterbium  Laser Surgery	101 Lu Lutetium  Scientific Fiber Lasers	102 La Lanthanum  Photodynamic Medicine	103 Ce Cerium  Laser Surgery	104 Pr Praseodymium  Laser Surgery	105 Nd Neodymium  Laser Surgery	106 Pm Promethium  Laser Surgery	107 Sm Samarium  Laser Surgery	108 Eu Europium  Laser Surgery	109 Gd Gadolinium  Laser Surgery	110 Tb Terbium Laser Surgery	111 Dy Dysprosium Laser Surgery	112 Ho Holmium Laser Surgery	113 Er Erbium Laser Surgery	114 Tm Thulium Laser Surgery	115 Yb Ytterbium Laser Surgery	116 Lu Lutetium Laser Surgery	117 La Lanthanum Laser Surgery	118 Ce Cerium Laser Surgery	119 Pr Praseodymium Laser Surgery	120 Nd Neodymium Laser Surgery	121 Pm Promethium Laser Surgery	122 Sm Samarium Laser Surgery	123 Eu Europium Laser Surgery	124 Gd Gadolinium Laser Surgery	125 Tb Terbium Laser Surgery	126 Dy Dysprosium Laser Surgery	127 Ho Holmium Laser Surgery	128 Er Erbium Laser Surgery	129 Tm Thulium Laser Surgery	130 Yb Ytterbium Laser Surgery	131 Lu Lutetium Laser Surgery	132 La Lanthanum Laser Surgery	133 Ce Cerium Laser Surgery	134 Pr Praseodymium Laser Surgery	135 Nd Neodymium Laser Surgery	136 Pm Promethium Laser Surgery	137 Sm Samarium Laser Surgery	138 Eu Europium Laser Surgery	139 Gd Gadolinium Laser Surgery	140 Tb Terbium Laser Surgery	141 Dy Dysprosium Laser Surgery	142 Ho Holmium Laser Surgery	143 Er Erbium Laser Surgery	144 Tm Thulium Laser Surgery	145 Yb Ytterbium Laser Surgery	146 Lu Lutetium Laser Surgery	147 La Lanthanum Laser Surgery	148 Ce Cerium Laser Surgery	149 Pr Praseodymium 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Samarium Laser Surgery	183 Eu Europium Laser Surgery	184 Gd Gadolinium Laser Surgery	185 Tb Terbium Laser Surgery	186 Dy Dysprosium Laser Surgery	187 Ho Holmium Laser Surgery	188 Er Erbium Laser Surgery	189 Tm Thulium Laser Surgery	190 Yb Ytterbium Laser Surgery	191 Lu Lutetium Laser Surgery	192 La Lanthanum Laser Surgery	193 Ce Cerium Laser Surgery	194 Pr Praseodymium Laser Surgery	195 Nd Neodymium Laser Surgery	196 Pm Promethium Laser Surgery	197 Sm Samarium Laser Surgery	198 Eu Europium Laser Surgery	199 Gd Gadolinium Laser Surgery	200 Tb Terbium Laser Surgery	201 Dy Dysprosium Laser Surgery	202 Ho Holmium Laser Surgery	203 Er Erbium Laser Surgery	204 Tm Thulium Laser Surgery	205 Yb Ytterbium Laser Surgery	206 Lu Lutetium Laser Surgery	207 La Lanthanum Laser Surgery	208 Ce Cerium Laser Surgery	209 Pr Praseodymium Laser Surgery	210 Nd Neodymium Laser Surgery	211 Pm Promethium Laser Surgery	212 Sm Samarium Laser Surgery	213 Eu Europium Laser Surgery	214 Gd Gadolinium Laser Surgery	215 Tb Terbium Laser Surgery	216 Dy Dysprosium Laser Surgery	217 Ho Holmium Laser Surgery	218 Er Erbium Laser Surgery	219 Tm Thulium Laser Surgery	220 Yb Ytterbium Laser Surgery	221 Lu Lutetium Laser Surgery	222 La Lanthanum Laser Surgery	223 Ce Cerium Laser Surgery	224 Pr Praseodymium Laser Surgery	225 Nd Neodymium Laser Surgery	226 Pm Promethium Laser Surgery	227 Sm Samarium Laser Surgery	228 Eu Europium Laser Surgery	229 Gd Gadolinium Laser Surgery	230 Tb Terbium Laser Surgery	231 Dy Dysprosium Laser Surgery	232 Ho Holmium Laser Surgery	233 Er Erbium Laser Surgery	234 Tm Thulium Laser Surgery	235 Yb Ytterbium Laser Surgery	236 Lu Lutetium Laser Surgery	237 La Lanthanum Laser Surgery	238 Ce Cerium Laser Surgery	239 Pr Praseodymium Laser Surgery	240 Nd Neodymium Laser Surgery	241 Pm Promethium Laser Surgery	242 Sm Samarium Laser Surgery	243 Eu Europium Laser Surgery	244 Gd Gadolinium Laser Surgery	245 Tb Terbium Laser Surgery	246 Dy Dysprosium Laser Surgery	247 Ho Holmium Laser Surgery	248 Er Erbium Laser Surgery	249 Tm Thulium Laser Surgery	250 Yb Ytterbium Laser Surgery	251 Lu Lutetium Laser Surgery	252 La Lanthanum Laser Surgery	253 Ce Cerium Laser Surgery	254 Pr Praseody

The Periodic Table of the Elements, in Pictures and Words

1 H Hydrogen 	2 He Helium 
3 Li Lithium 	4 Be Beryllium 
5 B Boron 	6 C Carbon 
7 N Nitrogen 	8 O Oxygen 
9 F Fluorine 	10 Ne Neon 
11 Na Sodium 	12 Mg Magnesium 
13 Al Aluminum 	14 Si Silicon 
15 P Phosphorus 	16 S Sulfur 
17 Cl Chlorine 	18 Ar Argon 
19 K Potassium 	20 Ca Calcium 
21 Sc Scandium 	22 Ti Titanium 
23 V Vanadium 	24 Cr Chromium 
25 Mn Manganese 	26 Fe Iron 
27 Co Cobalt 	28 Ni Nickel 
29 Cu Copper 	30 Zn Zinc 
31 Ga Gallium 	32 Ge Germanium 
33 As Arsenic 	34 Se Selenium 
35 Br Bromine 	36 Kr Krypton 
37 Rb Rubidium 	38 Sr Strontium 
39 Y Yttrium 	40 Zr Zirconium 
41 Nb Niobium 	42 Mo Molybdenum 
43 Tc Technetium 	44 Ru Ruthenium 
45 Rh Rhodium 	46 Pd Palladium 
47 Ag Silver 	48 Cd Cadmium 
49 In Indium 	50 Sn Tin 
51 Sb Antimony 	52 Te Tellurium 
53 I Iodine 	54 Xe Xenon 
55 Cs Cesium 	56 Ba Barium 
57 La Lanthanum 	58 Ce Cerium 
59 Pr Praseodymium 	60 Nd Neodymium 
61 Pm Promethium 	62 Sm Samarium 
63 Eu Europium 	64 Gd Gadolinium 
65 Tb Terbium 	66 Dy Dysprosium 
67 Ho Holmium 	68 Er Erbium 
69 Tm Thulium 	70 Yb Ytterbium 
71 Lu Lutetium 	72 Hf Hafnium 
73 Ta Tantalum 	74 W Tungsten 
75 Re Rhenium 	76 Os Osmium 
77 Ir Iridium 	78 Pt Platinum 
79 Au Gold 	80 Hg Mercury 
81 Tl Thallium 	82 Pb Lead 
83 Bi Bismuth 	84 Po Polonium 
85 At Astatine 	86 Rn Radon 
87 Fr Francium 	88 Ra Radium 
89 Ac Actinium 	90 Th Thorium 
91 Pa Protactinium 	92 U Uranium 
93 Np Neptunium 	94 Pu Plutonium 
95 Am Americium 	96 Cm Curium 
97 Bk Berkelium 	98 Cf Californium 
99 Es Einsteinium 	100 Md Mendelevium 
101 Nh Nihonium 	102 Fl Flerovium 
103 Ts Tennessine 	104 Lv Livermorium 
105 Uu Ununpentium 	106 Uub Ununhexium 
107 Uuh Ununheptium 	108 Uuo Ununoctium 
109 Uuq Ununquadium 	110 Uus Ununseptium 
111 Uuh Ununhassium 	112 Uqt Unquettium 
113 Uqb Unbiquadium 	114 Uqo Unquincium 
115 Uqt Unseptium 	116 Uqb Unbiquadium 
117 Uhs Unheptium 	118 Uuo Ununoctium 
119 Uue Ununennium 	120 Uuh Unhassium 
121 Uuo Ununoctium 	122 Uue Ununennium 
123 Uuh Unhassium 	124 Uuo Ununoctium 
125 Uue Ununennium 	126 Uuh Unhassium 
127 Uuo Ununoctium 	128 Uue Ununennium 
129 Uuh Unhassium 	130 Uuo Ununoctium 
131 Uue Ununennium 	132 Uuh Unhassium 
133 Uuo Ununoctium 	134 Uue Ununennium 
135 Uuh Unhassium 	136 Uuo Ununoctium 
137 Uue Ununennium 	138 Uuh Unhassium 
139 Uuo Ununoctium 	140 Uue Ununennium 
141 Uuh Unhassium 	142 Uuo Ununoctium 
143 Uue Ununennium 	144 Uuh Unhassium 
145 Uuo Ununoctium 	146 Uue Ununennium 
147 Uuh Unhassium 	148 Uuo Ununoctium 
149 Uue Ununennium 	150 Uuh Unhassium 
151 Uuo Ununoctium 	152 Uue Ununennium 
153 Uuh Unhassium 	154 Uuo Ununoctium 
155 Uue Ununennium 	156 Uuh Unhassium 
157 Uuo Ununoctium 	158 Uue Ununennium 
159 Uuh Unhassium 	160 Uuo Ununoctium 
161 Uue Ununennium 	162 Uuh Unhassium 
163 Uuo Ununoctium 	164 Uue Ununennium 
165 Uuh Unhassium 	166 Uuo Ununoctium 
167 Uue Ununennium 	168 Uuh Unhassium 
169 Uuo Ununoctium 	170 Uue Ununennium 
171 Uuh Unhassium 	172 Uuo Ununoctium 
173 Uue Ununennium 	174 Uuh Unhassium 
175 Uuo Ununoctium 	176 Uue Ununennium 
177 Uuh Unhassium 	178 Uuo Ununoctium 
179 Uue Ununennium 	180 Uuh Unhassium 
181 Uuo Ununoctium 	182 Uue Ununennium 
183 Uuh Unhassium 	184 Uuo Ununoctium 
185 Uue Ununennium 	186 Uuh Unhassium 
187 Uuo Ununoctium 	188 Uue Ununennium 
189 Uuh Unhassium 	190 Uuo Ununoctium 
191 Uue Ununennium 	192 Uuh Unhassium 
193 Uuo Ununoctium 	194 Uue Ununennium 
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219 Uuh Unhassium 	220 Uuo Ununoctium 
221 Uue Ununennium 	222 Uuh Unhassium 
223 Uuo Ununoctium 	224 Uue Ununennium 
225 Uuh Unhassium 	226 Uuo Ununoctium 
227 Uue Ununennium 	228 Uuh Unhassium 
229 Uuo Ununoctium 	230 Uue Ununennium 
231 Uuh Unhassium 	232 Uuo Ununoctium
233 Uue Ununennium 	234 Uuh Unhassium
235 Uuo Ununoctium 	236 Uue Ununennium
237 Uuh Unhassium 	238 Uuo Ununoctium
239 Uue Ununennium 	240 Uuh Unhassium
241 Uuo Ununoctium 	242 Uue Ununennium
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245 Uue Ununennium 	246 Uuh Unhassium
247 Uuo Ununoctium 	248 Uue Ununennium
249 Uuh Unhassium 	250 Uuo Ununoctium
251 Uue Ununennium 	252 Uuh Unhassium
253 Uuo Ununoctium 	254 Uue Ununennium
255 Uuh Unhassium 	256 Uuo Ununoctium
257 Uue Ununennium 	2

L'élément élémentaire : la case

Numéro atomique	1	1,0	Masse atomique M
	H		Symbole atomique
Nom	hydrogène		

Première classification d'origine macroscopique :

 Nonmetals		 Metals		 Metalloids	
---	--	--	--	--	--

1																	18	
1	IA																	VIIA
1	1	2															2	
	H	He																
2	3	4															10	
	Li	Be															Ne	
3	11	12	13	14	15	16	17											
	Na	Mg	B	C	N	O	F											
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
	Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	87	88	89	104	105	106	107	108	109									
	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt									

*Lanthanides	58	59	60	61	62	63	64	65	66	67	68	69	70	71
	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
	140.12	140.91	144.24	(145)	150.36	151.96	157.25	158.93	162.50	164.93	167.26	168.93	173.04	174.97

**Actinides	90	91	92	93	94	95	96	97	98	99	100	101	102	103
	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
	232.04	231.04	238.03	(237)	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(262)

FIGURE – Les métaux, non-métaux et métalloïdes dans la classification périodique

Périodes et famille dans la classification périodique :

	Famille																		
	I												VIII						
1	1 H	II																	2 He
2	3 Li	4 Be																	10 Ne
3	11 Na	12 Mg																	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr	
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Tb	52 Te	53 I	54 Xe	
6	55 Cs	56 Ba	La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
7	87 Fr	88 Ra	Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo	

57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Les différents blocs dans la classification périodique :

Bloc s

H	
Li	Be
Na	Mg
K	Ca
Rb	Sr
Cs	Ba
Fr	Ra

Bloc d

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Y	Sr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg
Ac									

Bloc p

					He
B	C	N	O	F	Ne
Al	Si	P	S	Cl	Ar
Ga	Ge	As	Se	Br	Kr
In	Sb	Te	Te	I	Xe
Tl	Pb	Bi	Po	At	Rn

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

Pour une période donnée :

$$E_{io}^1(B) = 8,3 \text{ kJ mol}^{-1} < E_{io}^1(C) = 11,3 \text{ kJ mol}^{-1} < E_{io}^1(N) = 14,3 \text{ kJ mol}^{-1}$$

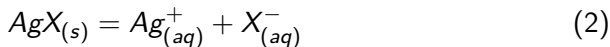
Pour une colonne donnée :

$$E_{io}^1(B) = 8,3 \text{ kJ mol}^{-1} < E_{io}^1(Al) = 5,9 \text{ kJ mol}^{-1} > E_{io}^1(Ga) = 6,0 \text{ kJ mol}^{-1}$$

La constante de solubilité est donnée par :

$$K_S = \frac{[Ag^+]^{eq} \cdot [Cl^-]^{eq}}{c_{O_2}^2} \quad (1)$$

La réaction ayant lieu étant :



La concentration au cours du temps se trouve grâce à un simple bilan de matière :

$$[Cl^-]^{eq}(t) \times (V_0 + v) = [Cl^-]_0 \times V_0 - [ag^+]_0 \times v \quad (3)$$

Cette grandeur peut être mesurée par l'intermédiaire d'une tension. La formule reliant les 2 grandeurs est :

$$K_S = [Cl^-]^{eq}(t) \times \exp\left(\frac{F}{RT}(\Delta E(t) - E^\circ(Ag^+/Ag_{(s)}) + E_{ECS})\right) \quad (4)$$

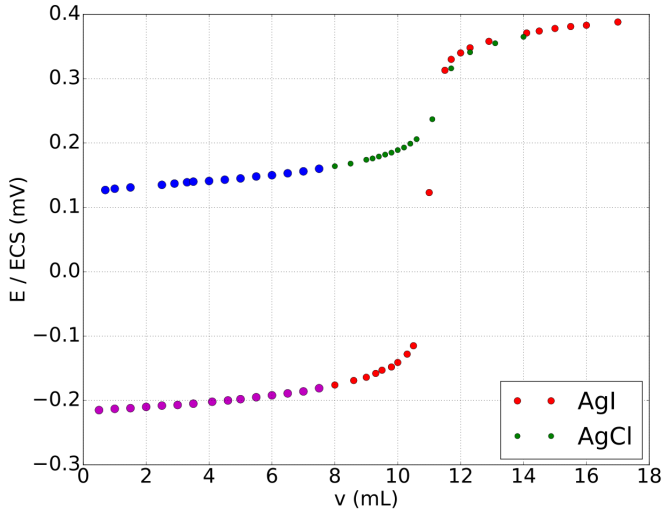


FIGURE – Évolution de la différence de potentiel en fonction du volume de la solution contenant les ions argent

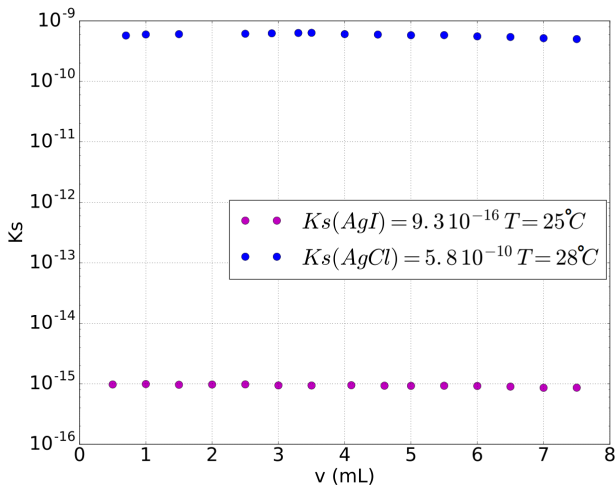


FIGURE – Évolution des constantes de solubilités en fonction du volume de la solution contenant les ions argent

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