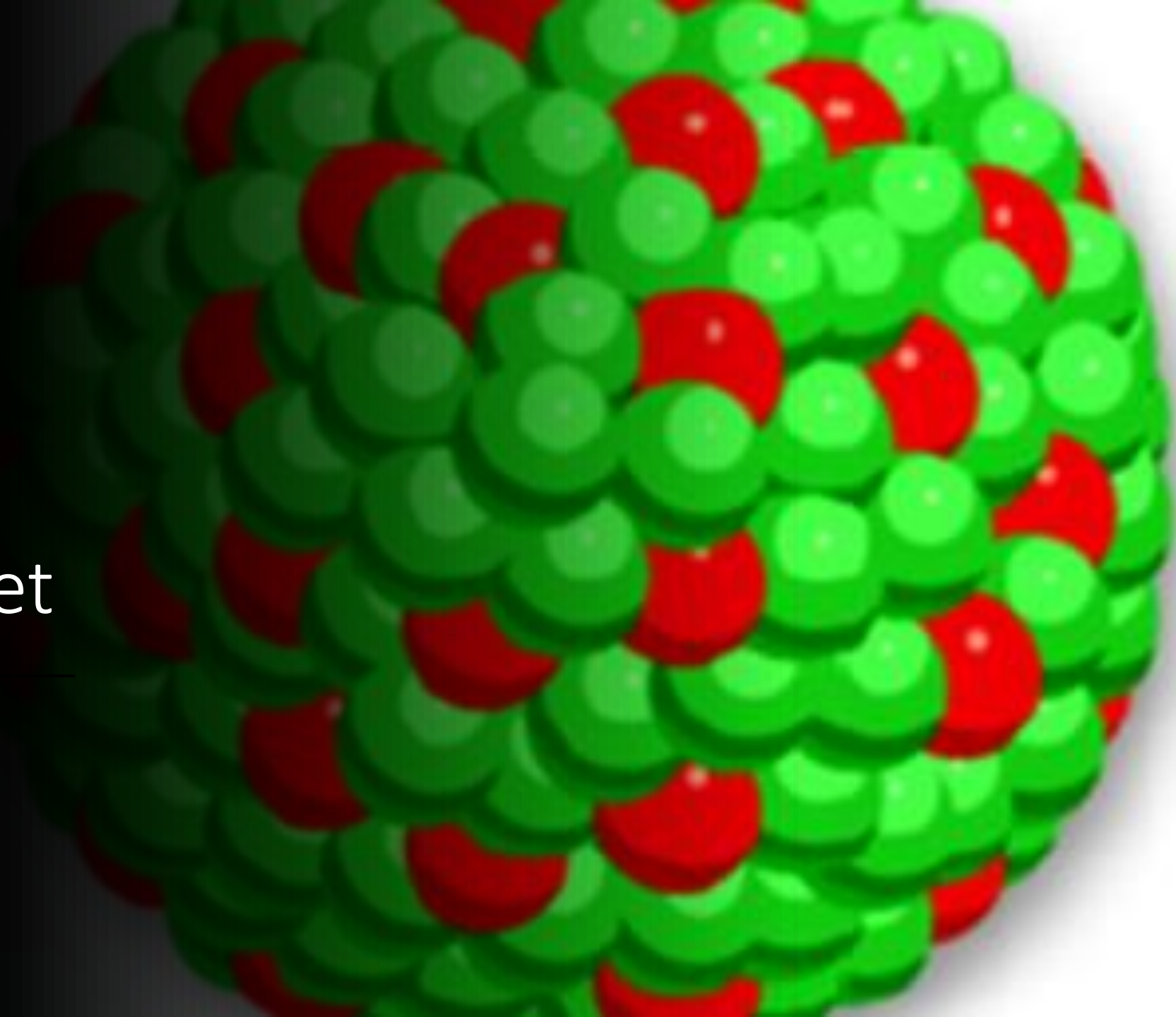




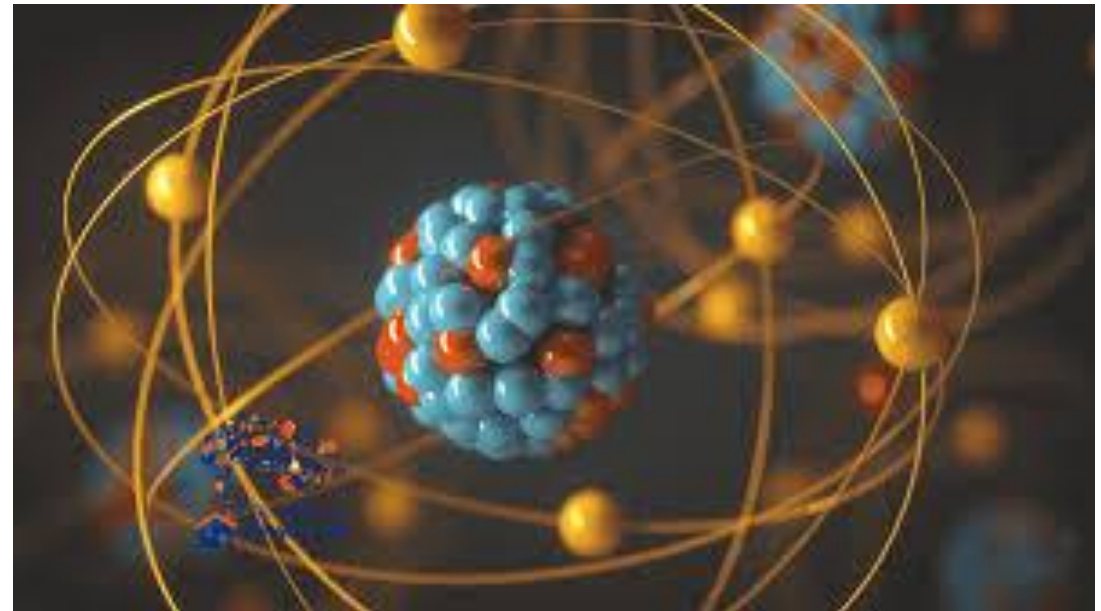
# Atomet og periodesystemet

Kapittel 1



# Innhold

- Hva er et atom?
- Hva er mindre enn atomet?
- Grunnstoffer
- Periodesystemet
- Atommodeller
- Ioner







JOHN DALTON, F.R.S.

# En kort historie om atomet

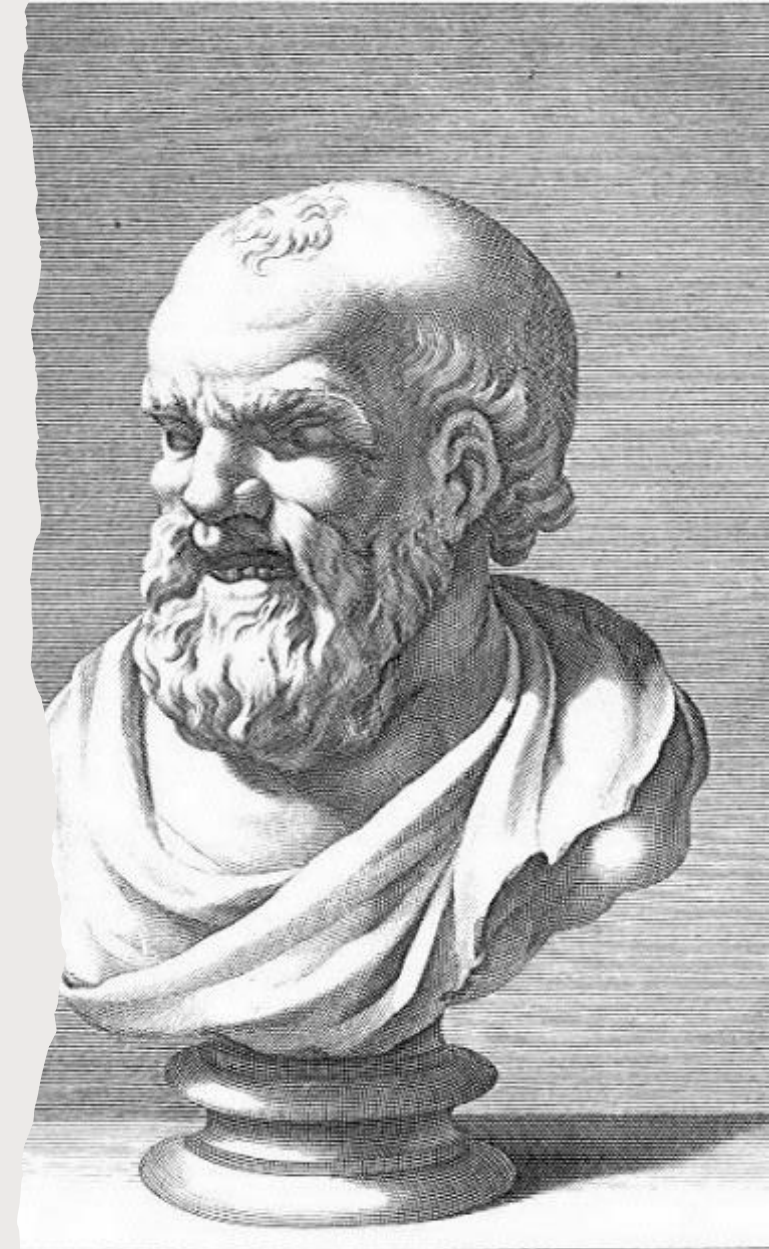
- 500 fvt: Demokrit.  
All materie består av små,  
udelelige partikler – atomer

- 1808: John Dalton.

Vi har ulike grunnstoffer.

Atomene i ett grunnstoff er  
forskjellige fra alle andre  
grunnstoffers atomer.

Alle atomer av ett grunnstoff er  
like.



D E M O C R I T U S

*Ex marmore antiquo apud T. G.*



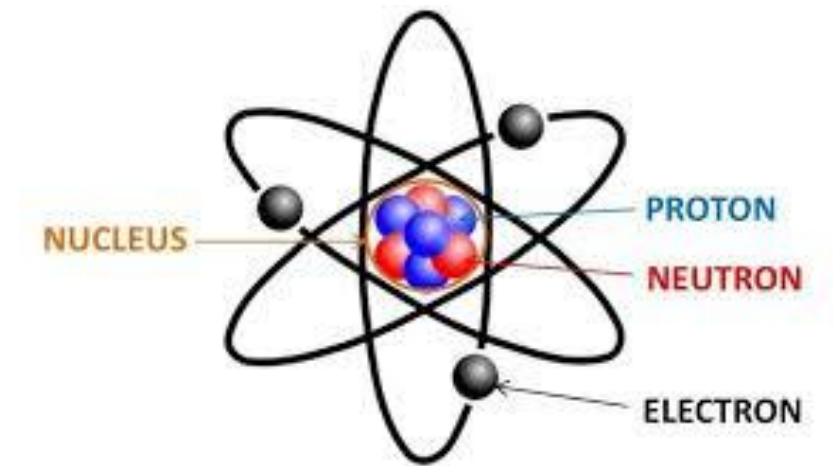


# Dekadiske forstavelser

• Tera	T	$10^{12}$	billion
• Giga G		$10^9$	milliard
• Mega M		$10^6$	million
• Kilo	k	$10^3$	tusen
• Milli	m	$10^{-3}$	tusendel
• Mikro $\mu$		$10^{-6}$	milliondel
• Nano n		$10^{-9}$	milliarddel
• Piko	p	$10^{-12}$	billiondel

# Subatomiske partikler

- 1897: Elektroner – negativ ladning.  $e^-$
- 1917: Protoner – positiv ladning.  $p^+$
- 1932: Nøytroner – nøytrale.  $n^0$
- Protoner og elektroner har like stor, men motsatt ladning
- Protoner og nøytroner er (nesten) like store
- Elektroner er veldig mye mindre enn protoner og nøytroner



# Atommasse

- Antallet protoner og nøytroner gir *atommassen*
- Et proton veier 1840 ganger så mye som et elektron
- Enhet for atommasse: u
- 1 u er 1/12 av massen til et karbonatom med seks protoner og seks nøytroner
- Massen til et proton og et nøytron er 1 u
- Massen til et elektron er 0.0005 u

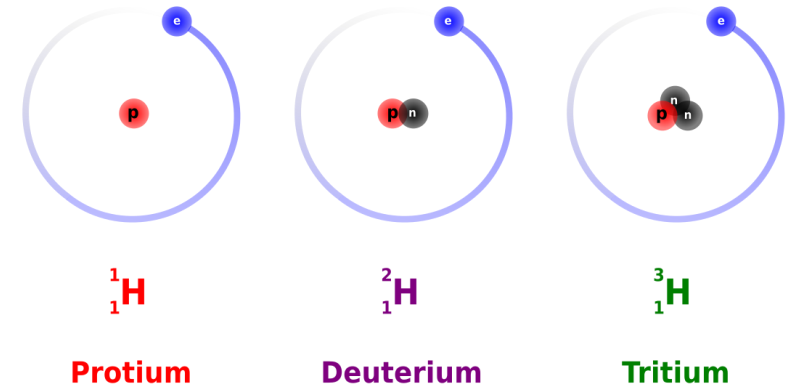


# Grunnstoffer

- Dalton: Atomene i ett grunnstoff er forskjellige fra alle andre grunnstoffers atomer.
- Alle karbonatomer har seks protoner. Bare karbonatomer har akkurat seks atomer.
- Dysprosium: 66 protoner.
- Thorium: 90 protoner
- Vi kjenner 118 grunnstoffer. Ingen grunnstoffer med mer enn 94 protoner er noensinne funnet i naturen.
- Noen grunnstoffer er radioaktive – de desintegrerer av seg selv, sender ut stråling og blir til andre grunnstoffer.
- I atomene er det like mange elektroner som protoner. De er *nøytrale*.

# Isotoper

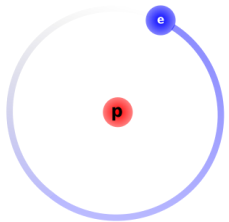
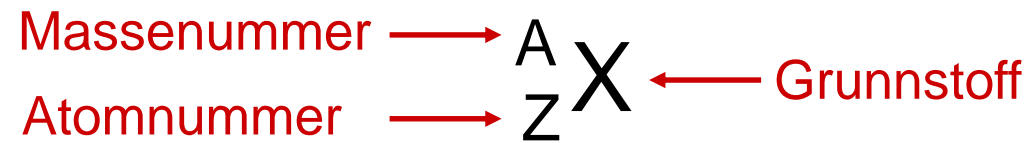
- Dalton: Alle atomer av ett grunnstoff er like.
- Feil. Vi har tre typer hydrogenatomer. I naturen finnes tre typer karbonatomer.
- Et grunnstoff kan ha ulike *isotoper* – forskjellig antall nøytroner i kjernen.



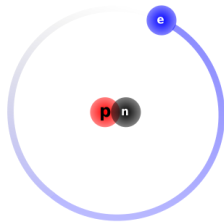


# Atomnummer og massenummer

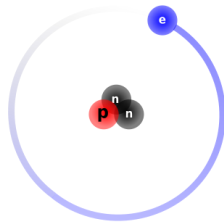
- Atomnummer (Z) – antall protoner i kjernen
- Massenummer (A) – antall protoner og nøytroner i kjernen



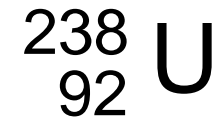
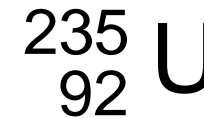
${}^1_1\text{H}$   
Protium



${}^2_1\text{H}$   
Deuterium



${}^3_1\text{H}$   
Tritium





Dimitri Michalev

18691871

# PERIODIC TABLE OF ELEMENTS

## Chemical Group Block

PubChem																		18																	
1 1.0080 <b>H</b> Hydrogen Nonmetal												2 4.00260 <b>He</b> Helium Noble Gas																							
3 7.0 <b>Li</b> Lithium Alkali Metal		4 9.012183 <b>Be</b> Beryllium Alkaline Earth Metal												5 10.81 <b>B</b> Boron Metalloid		6 12.011 <b>C</b> Carbon Nonmetal		7 14.007 <b>N</b> Nitrogen Nonmetal		8 15.999 <b>O</b> Oxygen Nonmetal		9 18.9984... <b>F</b> Fluorine Halogen		10 20.180 <b>Ne</b> Neon Noble Gas											
11 22.989... <b>Na</b> Sodium Alkali Metal		12 24.305 <b>Mg</b> Magnesium Alkaline Earth Metal												13 26.981... <b>Al</b> Aluminum Post-Transition Metal		14 28.085 <b>Si</b> Silicon Metalloid		15 30.973... <b>P</b> Phosphorus Nonmetal		16 32.07 <b>S</b> Sulfur Nonmetal		17 35.45 <b>Cl</b> Chlorine Halogen		18 39.9 <b>Ar</b> Argon Noble Gas											
19 39.0983 <b>K</b> Potassium Alkali Metal		20 40.08 <b>Ca</b> Calcium Alkaline Earth Metal		21 44.95591 <b>Sc</b> Scandium Transition Metal		22 47.867 <b>Ti</b> Titanium Transition Metal		23 50.9415 <b>V</b> Vanadium Transition Metal		24 51.996 <b>Cr</b> Chromium Transition Metal		25 54.93804 <b>Mn</b> Manganese Transition Metal		26 55.84 <b>Fe</b> Iron Transition Metal		27 58.93319 <b>Co</b> Cobalt Transition Metal		28 58.693 <b>Ni</b> Nickel Transition Metal		29 63.55 <b>Cu</b> Copper Transition Metal		30 65.4 <b>Zn</b> Zinc Transition Metal		31 69.723 <b>Ga</b> Gallium Post-Transition Metal		32 72.63 <b>Ge</b> Germanium Metalloid		33 74.92159 <b>As</b> Arsenic Metalloid		34 78.97 <b>Se</b> Selenium Nonmetal		35 79.90 <b>Br</b> Bromine Halogen		36 83.80 <b>Kr</b> Krypton Noble Gas	
37 85.468 <b>Rb</b> Rubidium Alkali Metal		38 87.62 <b>Sr</b> Strontium Alkaline Earth Metal		39 88.90584 <b>Y</b> Yttrium Transition Metal		40 91.22 <b>Zr</b> Zirconium Transition Metal		41 92.90637 <b>Nb</b> Niobium Transition Metal		42 95.95 <b>Mo</b> Molybdenum Transition Metal		43 96.90636 <b>Tc</b> Technetium Transition Metal		44 101.1 <b>Ru</b> Ruthenium Transition Metal		45 102.9055 <b>Rh</b> Rhodium Transition Metal		46 106.42 <b>Pd</b> Palladium Transition Metal		47 107.868 <b>Ag</b> Silver Transition Metal		48 112.41 <b>Cd</b> Cadmium Transition Metal		49 114.818 <b>In</b> Indium Post-Transition Metal		50 118.71 <b>Sn</b> Tin Post-Transition Metal		51 121.760 <b>Sb</b> Antimony Metalloid		52 127.6 <b>Te</b> Tellurium Metalloid		53 126.9045 <b>I</b> Iodine Halogen		54 131.29 <b>Xe</b> Xenon Noble Gas	
55 132.90... <b>Cs</b> Cesium Alkali Metal		56 137.33 <b>Ba</b> Barium Alkaline Earth Metal				72 178.49 <b>Hf</b> Hafnium Transition Metal		73 180.9479 <b>Ta</b> Tantalum Transition Metal		74 183.84 <b>W</b> Tungsten Transition Metal		75 186.207 <b>Re</b> Rhenium Transition Metal		76 190.2 <b>Os</b> Osmium Transition Metal		77 192.22 <b>Ir</b> Iridium Transition Metal		78 195.08 <b>Pt</b> Platinum Transition Metal		79 196.96... <b>Au</b> Gold Transition Metal		80 200.59 <b>Hg</b> Mercury Transition Metal		81 204.383 <b>Tl</b> Thallium Post-Transition Metal		82 207 <b>Pb</b> Lead Post-Transition Metal		83 208.98... <b>Bi</b> Bismuth Post-Transition Metal		84 208.98... <b>Po</b> Polonium Metalloid		85 209.98... <b>At</b> Astatine Halogen		86 222.01... <b>Rn</b> Radon Noble Gas	
87 223.01... <b>Fr</b> Francium Alkali Metal		88 226.02... <b>Ra</b> Radium Alkaline Earth Metal				104 267.1... <b>Rf</b> Rutherfordium Transition Metal		105 268.1... <b>Db</b> Dubnium Transition Metal		106 269.1... <b>Sg</b> Seaborgium Transition Metal		107 270.1... <b>Bh</b> Bohrium Transition Metal		108 269.1... <b>Hs</b> Hassium Transition Metal		109 277.1... <b>Mt</b> Meitnerium Transition Metal		110 282.1... <b>Ds</b> Darmstadtium Transition Metal		111 282.1... <b>Rg</b> Roentgenium Transition Metal		112 286.1... <b>Cn</b> Copernicium Transition Metal		113 286.1... <b>Nh</b> Nihonium Post-Transition Metal		114 290.1... <b>Fl</b> Flerovium Post-Transition Metal		115 290.1... <b>Mc</b> Moscovium Post-Transition Metal		116 293.2... <b>Lv</b> Livermorium Post-Transition Metal		117 294.2... <b>Ts</b> Tennessine Halogen		118 295.2... <b>Og</b> Oganesson Noble Gas	
						57 138.9055 <b>La</b> Lanthanum Lanthanide		58 140.116 <b>Ce</b> Cerium Lanthanide		59 140.90... <b>Pr</b> Praseodymium Lanthanide		60 144.24 <b>Nd</b> Neodymium Lanthanide		61 144.91... <b>Pm</b> Promethium Lanthanide		62 150.4 <b>Sm</b> Samarium Lanthanide		63 151.964 <b>Eu</b> Europium Lanthanide		64 157.2 <b>Gd</b> Gadolinium Lanthanide		65 158.92... <b>Tb</b> Terbium Lanthanide		66 162.500 <b>Dy</b> Dysprosium Lanthanide		67 164.93... <b>Ho</b> Holmium Lanthanide		68 167.26 <b>Er</b> Erbium Lanthanide		69 168.93... <b>Tm</b> Thulium Lanthanide		70 173.05 <b>Yb</b> Ytterbium Lanthanide		71 174.9668 <b>Lu</b> Lutetium Lanthanide	
						89 227.02... <b>Ac</b> Actinium Actinide		90 232.038 <b>Th</b> Thorium Actinide		91 231.03... <b>Pa</b> Protactinium Actinide		92 238.0289 <b>U</b> Uranium Actinide		93 237.04... <b>Np</b> Neptunium Actinide		94 244.06... <b>Pu</b> Plutonium Actinide		95 243.06... <b>Am</b> Americium Actinide		96 247.07... <b>Cm</b> Curium Actinide		97 247.07... <b>Bk</b> Berkelium Actinide		98 251.07... <b>Cf</b> Californium Actinide		99 252.0830 <b>Es</b> Einsteinium Actinide		100 257.0... <b>Fm</b> Fermium Actinide		101 258.0... <b>Md</b> Mendelevium Actinide		102 259.1... <b>No</b> Nobelium Actinide		103 266.1... <b>Lr</b> Lawrencium Actinide	



# Grupper og perioder

Grupper →

Perioder ↓

Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Period	↓																	
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	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 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	* 71 Lu	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	* 103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
			* 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		
			* 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		

# Grupper og perioder

- 18 grupper (1-18)
  - Gammelt system: 8 hovedgrupper (1A – 8A) og sidegrupper (B)
  - Gruppe 1: Alkalimetallene
  - Gruppe 2: Jordalkalimetallene
  - Gruppe 17: Halogenene
  - Gruppe 18: Edelgassene
- 
- Atomene blir større nå vi går nedover i periodene
  - Innad i en periode endrer også mange egenskaper seg systematisk
  - Periodenummer: Skall

# Metaller, halvmetaller og ikke-metaller

Metal			Metalloid			Nonmetal											
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La-Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac-Lr															
			La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
			Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr



A close-up photograph of numerous dark, jagged, and irregularly shaped fragments of metal, likely iron or steel, piled together. The fragments have a rough, crystalline texture with some lighter, silvery-grey areas visible. The lighting creates highlights and shadows, emphasizing the sharp edges and uneven surfaces.

# Metaller

- Glinser.
- Harde.
- Leder strøm og varme godt.
- Er formbare og duktile, og brukes derfor i konstruksjoner og til pyntegjenstander.
- Høye smelte- og kokepunkt.
- Høy tetthet.
- Kan danne legeringer.
- De vanligste metallene i industrien er jern, stål og kobber.
- Gir positive ioner. Inngår i salter.



# Ikke-metaller

- Lave smelte- og kokepunkt
- Leder strøm og varme dårlig
- Sprø, brekker lett
- Reflekterer lys dårlig
- Lavere tetthet
- Finnes som gasser, væsker og faste stoff
- Gir negative ioner
  
- Karbon, klor, fluor, hydrogen, nitrogen, oksygen, fosfor, svovel, ++





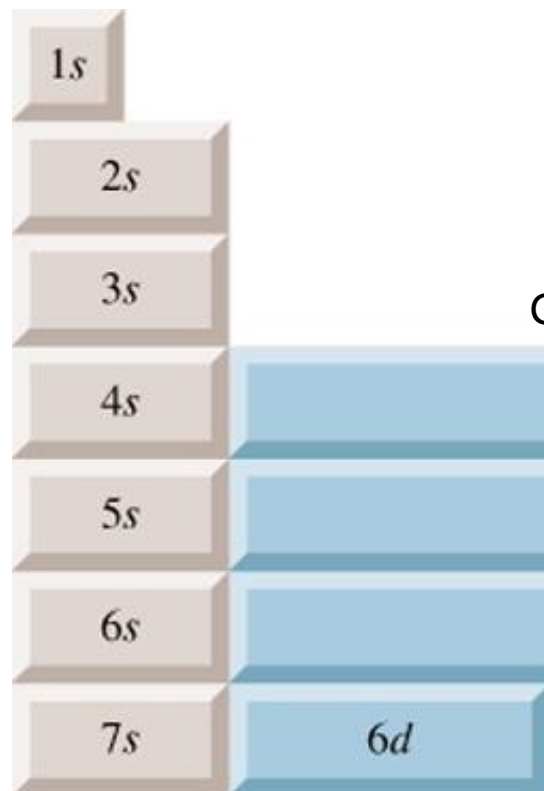
# Halvmetaller

- I en mellomstilling
- Har noen egenskaper fra metallene, noen fra ikke-metallene
- Bor – nest hardeste grunnstoff
- Silisium – viktigste halvleder (Silicon Valley)
- Germanium – brukt i den første transistoren
- Arsen – brukes i batterier og i legeringer. Fargestoff. Rottegift.
- Antimon – fargestoff. Sminke. Skyld i Mozarts død?
- Tellur – legeringer. Gir hvitløksånde.



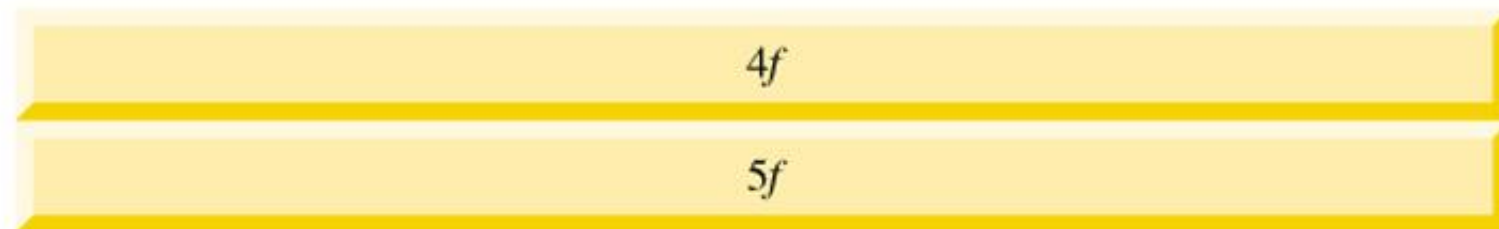
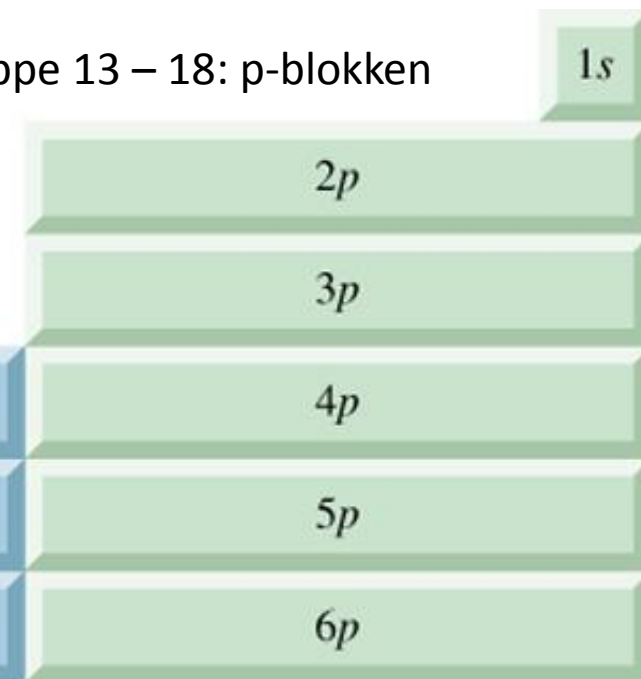
# Blokker

Gruppe 1 og 2: s-blokken



Gruppe 3 – 12: d-blokken

Gruppe 13 – 18: p-blokken



Periode 6 og 7 (noen av dem): f-blokken

# Blokker

- s- og p-blokkene: Hovedgrupper
- d-blokken: Overgangsmetaller eller innskuddsmetaller
- f-blokken: lantanoider og actinoider

1

1.0080

H

Hydrogen

Nonmetal

3

7.0

Li

Lithium

Alkali Metal

11

22.989...

Na

Sodium

Alkali Metal

19

39.0983

K

Potassium

Alkali Metal

37

85.468

Rb

Rubidium

Alkali Metal

55

132.90...

Cs

Cesium

Alkali Metal

87

223.01...

Fr

Francium

Alkali Metal

2

4.002602

He

Helium

Noble Gas

4

9.012183

Be

Beryllium

Alkaline Earth Metal

12

24.305

Mg

Magnesium

Alkaline Earth Metal

20

40.08

Ca

Calcium

Alkaline Earth Metal

38

87.62

Sr

Strontium

Alkaline Earth Metal

56

137.33

Ba

Barium

Alkaline Earth Metal

88

226.02...

Ra

Radium

Alkaline Earth Metal

17

35.45

Cl

Chlorine

Halogen

13

10.81

B

Boron

Metalloid

6

12.011

C

Carbon

Nonmetal

7

14.007

N

Nitrogen

Nonmetal

15

30.973...

P

Phosphorus

Nonmetal

16

32.07

S

Sulfur

Nonmetal

17

35.45

Cl

Chlorine

Halogen

18

39.948

Ar

Argon

Noble Gas

5

26.981...

Al

Aluminum

Post-Transition Metal

14

28.085

Si

Silicon

Metalloid

32

72.63

Ge

Germanium

Metalloid

50

118.71

In

Indium

Post-Transition Metal

82

207

Pb

Lead

Post-Transition Metal

112

277.1

Cn

Copernicium

Post-Transition Metal

113

286.1

Nh

Nihonium

Post-Transition Metal

114

290.1

Fl

Flerovium

Post-Transition Metal

115

290.1

Mc

Moscovium

Post-Transition Metal

116

293.2

Lv

Livermorium

Post-Transition Metal

117

294.2

Ts

Tennessine

Halogen

118

295.2

Og

Oganesson

Noble Gas

23

50.9415

V

Vanadium

Transition Metal

24

51.996

Cr

Chromium

Transition Metal

25

54.93804

Mn

Manganese

Transition Metal

26

55.84

Fe

Iron

Transition Metal

27

58.93319

Co

Cobalt

Transition Metal

28

58.693

Ni

Nickel

Transition Metal

29

63.55

Cu

Copper

Transition Metal

30

65.4

Zn

Zinc

Transition Metal

31

69.723

Ga

Gallium

Post-Transition Metal

33

72.63

As

Arsenic

Metalloid

34

74.92159

Se

Selenium

Nonmetal

35

78.97

Br

Bromine

Halogen

36

83.8

Kr

Krypton

Noble Gas

41

92.90637

Nb

Niobium

Transition Metal

42

95.95

Mo

Molybdenum

Transition Metal

43

96.90636

Tc

Technetium

Transition Metal

44

101.1

Ru

Ruthenium

Transition Metal

45

102.9055

Rh

Rhodium

Transition Metal

46

106.42

Pd

Palladium

Transition Metal

47

107.868

Ag

Silver

Transition Metal

48

112.41

Cd

Cadmium

Transition Metal

49

114.818

In

Indium

Post-Transition Metal

51

121.760

Sb

Antimony

Metalloid

52

127.6

Te

Tellurium

Metalloid

53

126.9045

I

Iodine

Halogen

54

131.2

Xe

Xenon

Noble Gas

72

178.49

Hf

Hafnium

Transition Metal

73

180.9479

Ta

Tantalum

Transition Metal

74

183.84

W

Tungsten

Transition Metal

75

186.207

Re

Rhenium

Transition Metal

76

190.2

Os

Osmium

Transition Metal

77

192.22

Ir

Iridium

Transition Metal

78

195.08

Pt

Platinum

Transition Metal

79

196.96...

Au

Gold

Transition Metal

80

200.59

Hg

Mercury

Transition Metal

81

204.383

Tl

Thallium

Post-Transition Metal

82

207

Pb

Lead

Post-Transition Metal

83

208.98...

Bi

Bismuth

Post-Transition Metal

84

208.98...

Po

Polonium

Metalloid

85

209.98...

At

Astatine

Halogen

86

222.01...

Rn

Radon

Noble Gas

104

267.1...

Rf

Rutherfordium

Transition Metal

105

268.1...

Db

Dubnium

Transition Metal

106

269.1...

Sg

Seaborgium

Transition Metal

107

270.1...

Bh

Bohrium

Transition Metal

108

269.1...

Hs

Hassium

Transition Metal

109

277.1...

Mt

Meitnerium

Transition Metal

110

282.1...

Ds

Darmstadtium

Transition Metal

111

282.1...

Rg

Roentgenium

Transition Metal

112

286.1...

Cn

Copernicium

Transition Metal

113

286.1...

Nh

Nihonium

Post-Transition Metal

114

290.1...

Fl

Flerovium

Post-Transition Metal

115

290.1...

Mc

Moscovium

Post-Transition Metal

116

293.2...

Lv

Livermorium

Post-Transition Metal

117

294.2...

Ts

Tennessine

Halogen

118

295.2...

Og

Oganesson

Noble Gas

57

138.9055

La

Lanthanum

Lanthanide

58

140.116

Ce

Cerium

Lanthanide

59

140.90...

Pr

Praseodymium

Lanthanide

60

144.24

Nd

Neodymium

Lanthanide

61

144.91...

Pm

Promethium

Lanthanide

62

150.4

Sm

Samarium

Lanthanide

63

151.964

Eu

Europium

Lanthanide

64

157.2

Gd

Gadolinium

Lanthanide

65

158.92...

Tb

Terbium

Lanthanide

66

162.500

Dy

Dysprosium

Lanthanide

67

164.93...

Ho

Holmium

Lanthanide

68

167.26

Er

Erbium

Lanthanide

69

168.93...

Tm

Thulium

Lanthanide

70

173.05

Yb

Ytterbium

Lanthanide

71

174.966

Lu

Lutetium

Lanthanide

89

227.02...

Ac

Actinium

Actinide

90

232.038

Th

Thorium

Actinide

91

231.03...

Pa

Protactinium

Actinide

92

238.0289

U

Uranium

Actinide

93

237.04...

Np

Neptunium

Actinide

94

244.06...

Pu

Plutonium

Actinide

95

243.06...

Am

Americium

Actinide

96

247.07...

Cm

Curium

Actinide

97

247.07...

Bk

Berkelium

Actinide

98

251.07...

Cf

Californium

Actinide

99

252.0830

Es

Einsteinium

Actinide

100

257.0...

Fm

Fermium

Actinide

101

258.0...

Md

Mendelevium

Actinide

102

259.1...

No

Nobelium

Actinide

103

266.1...

Lr

Lawrencium

Actinide

1

1.0080

H

Hydrogen

Nonmetal

3

7.0

Li

Lithium

Alkali Metal

11

22.989...

Na

Sodium

Alkali Metal

19

39.0983

K

Potassium

Alkali Metal

37

85.468

Rb

Rubidium

Alkali Metal

55

132.90...

Cs

Cesium

Alkali Metal

87

223.01...

Fr

Francium

Alkali Metal

2

4.002602

He

Helium

Noble Gas

4

9.012183

Be

Beryllium

Alkaline Earth Metal

12

24.305

Mg

Magnesium

Alkaline Earth Metal

20

40.08

Ca

Calcium

Alkaline Earth Metal

38

87.62

Sr

Strontium

Alkaline Earth Metal

56

137.33

Ba

Barium

Alkaline Earth Metal

88

226.02...

Ra

Radium

Alkaline Earth Metal

17

35.45

Cl

Chlorine

Halogen

13

10.81

B

Boron

Metalloid

6

12.011

C

Carbon

Nonmetal

7

14.007

N

Nitrogen

Nonmetal

15

30.973...

P

Phosphorus

Nonmetal

16

32.07

S

Sulfur

Nonmetal

18

39.948

Ar

Argon

Noble Gas

5

26.981...

Al

Aluminum

Post-Transition Metal

14

28.085

Si

Silicon

Metalloid

32

72.63

Ge

Germanium

Metalloid

50

118.71

In

Indium

Post-Transition Metal

82

207

Pb

Lead

Post-Transition Metal

112

277.1

Cn

Copernicium

Post-Transition Metal

113

286.1

Nh

Nihonium

Post-Transition Metal

114

290.1

Fl

Flerovium

Post-Transition Metal

115

290.1

Mc

Moscovium

Post-Transition Metal

116

293.2

Lv

Livermorium

Post-Transition Metal

117

294.2

Ts

Tennessine

Halogen

118

295.2

Og

Oganesson

Noble Gas

23

50.9415

V

Vanadium

Transition Metal

24

51.996

Cr

Chromium

Transition Metal

25

54.93804

Mn

Manganese

Transition Metal

26

55.84

Fe

Iron

Transition Metal

27

58.93319

Co

Cobalt

Transition Metal

28

58.693

Ni

Nickel

Transition Metal

29

63.55

Cu

Copper

Transition Metal

30

65.4

Zn

Zinc

Transition Metal

31

69.723

Ga

Gallium

Post-Transition Metal

33

72.63

As

Arsenic

Metalloid

34

74.92159

Se

Selenium

Nonmetal

35

78.97

Br

Bromine

Halogen

36

83.8

Kr

Krypton

Noble Gas

41

92.90637

Nb

Niobium

Transition Metal

42

95.95

Mo

Molybdenum

Transition Metal

43

96.90636

Tc

Technetium

Transition Metal

44

101.1

Ru

Ruthenium

Transition Metal

45

102.9055

Rh

Rhodium

Transition Metal

46

106.42

Pd

Palladium

Transition Metal

47

107.868

Ag

Silver

Transition Metal

48

112.41

Cd

Cadmium

Transition Metal

49

114.818

In

Indium

Post-Transition Metal

51

121.760

Sb

Antimony

Metalloid

52

127.6

Te

Tellurium

Metalloid

53

126.9045

I

Iodine

Halogen

54

131.2

Xe

Xenon

Noble Gas

72

178.49

Hf

Hafnium

Transition Metal

73

180.9479

Ta

Tantalum

Transition Metal

74

183.84

W

Tungsten

Transition Metal

75

186.207

Re

Rhenium

Transition Metal

76

190.2

Os

Osmium

Transition Metal

77

192.22

Ir

Iridium

Transition Metal

78

195.08

Pt

Platinum

Transition Metal

79

196.96...

Au

Gold

Transition Metal

80

200.59

Hg

Mercury

Transition Metal

81

204.383

Tl

Thallium

Post-Transition Metal

82

207

Pb

Lead

Post-Transition Metal

83

208.98...

Bi

Bismuth

Post-Transition Metal

84

208.98...

Po

Polonium

Metalloid

85

209.98...

At

Astatine

Halogen

86

222.01...

Rn

Radon

Noble Gas

104

267.1...

Rf

Rutherfordium

Transition Metal

105

268.1...

Db

Dubnium

Transition Metal

106

269.1...

Sg

Seaborgium

Transition Metal

107

270.1...

Bh

Bohrium

Transition Metal

108

269.1...

Hs

Hassium

Transition Metal

109

277.1...

Mt

Meitnerium

Transition Metal

110

282.1...

Ds

Darmstadtium

Transition Metal

111

282.1...

Rg

Roentgenium

Transition Metal

112

286.1...

Cn

Copernicium

Transition Metal

113

286.1...

Nh

Nihonium

Post-Transition Metal

114

290.1...

Fl

Flerovium

Post-Transition Metal

115

290.1...

Mc

Moscovium

Post-Transition Metal

116

293.2...

Lv

Livermorium

Post-Transition Metal

117

294.2...

Ts

Tennessine

Halogen

118

295.2...

Og

Oganesson

Noble Gas

57

138.9055

La

Lanthanum

Lanthanide

58

140.116

Ce

Cerium

Lanthanide

59

140.90...

Pr

Praseodymium

Lanthanide

60

144.24

Nd

Neodymium

Lanthanide

61

144.91...

Pm

Promethium

Lanthanide

62

150.4

Sm

Samarium

Lanthanide

63

151.964

Eu

Europium

Lanthanide

64

157.2

Gd

Gadolinium

Lanthanide

65

158.92...

Tb

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Lanthanide

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Np

Neptunium

Actinide

94

244.06...

Pu

Plutonium

Actinide

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243.06...

Am

Americium

Actinide

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247.07...

Cm

Curium

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Berkelium

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258.0...

Md

Mendelevium

Actinide

102

259.1...

No

Nobelium

Actinide

103

266.1...

Lr

Lawrencium

Actinide

Pub

C

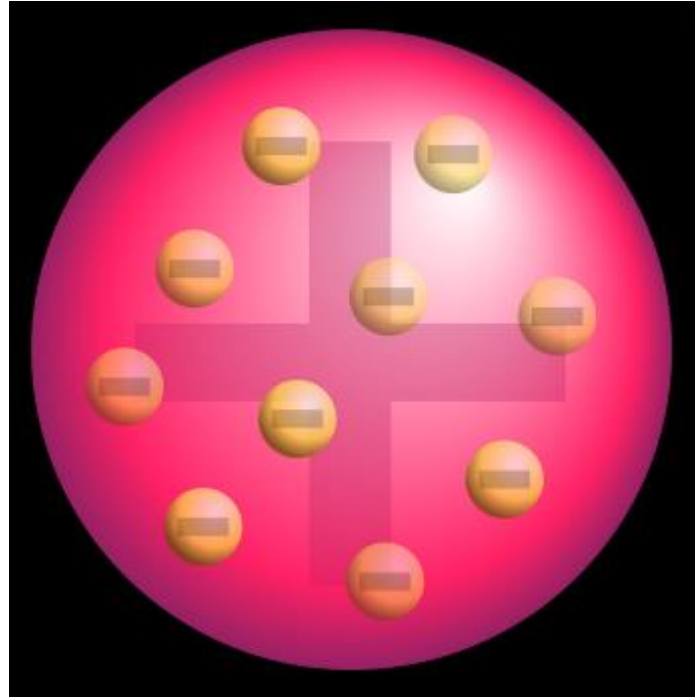
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# Atommodeller

- Thomsons rosinbollemodell
- Rutherford: Atomet er stort sett tomrom med en kjerne og elektroner
- **Bohr: Elektronene går i baner med bestemt radius rundt kjernen**
- Kvantemekanikk: Ikke baner, men orbitaler

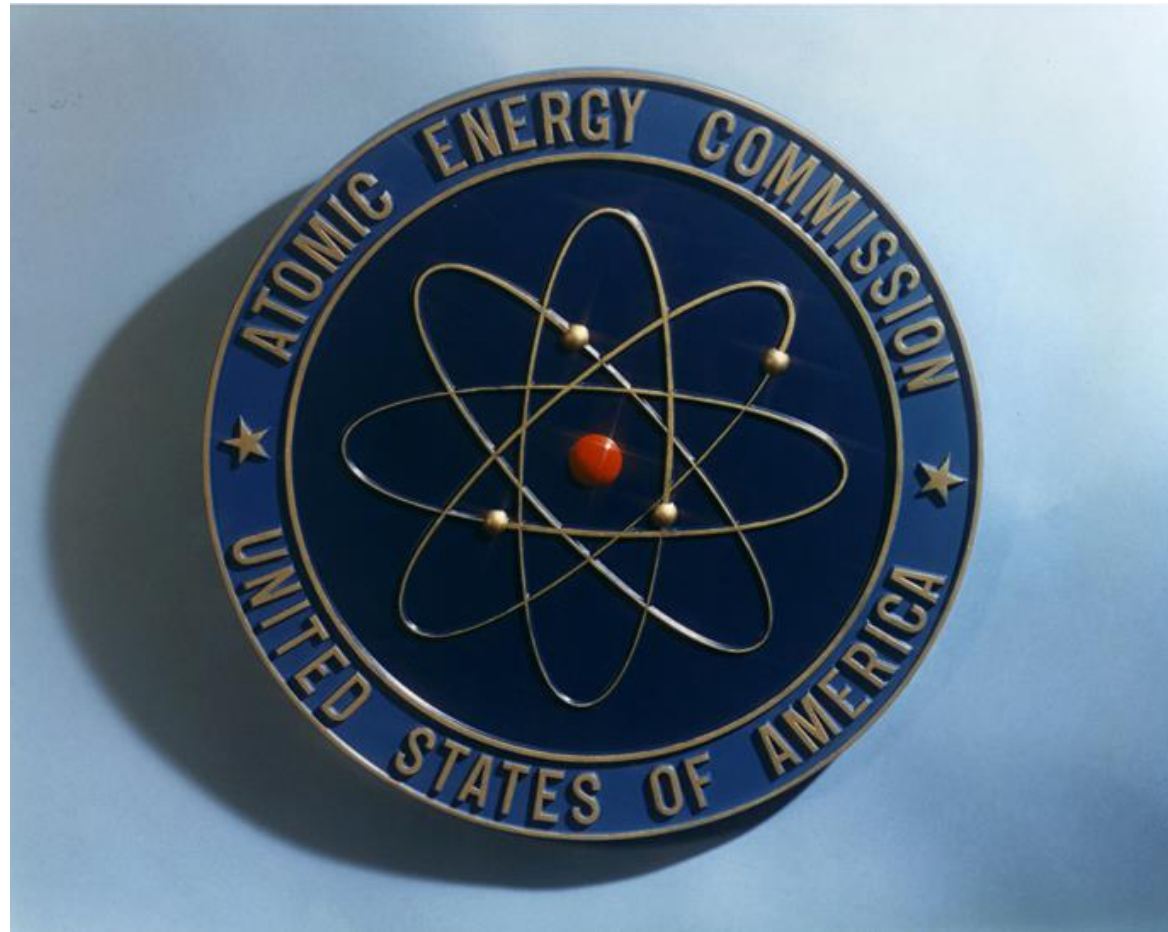


# 1900: Thomsons atommodell



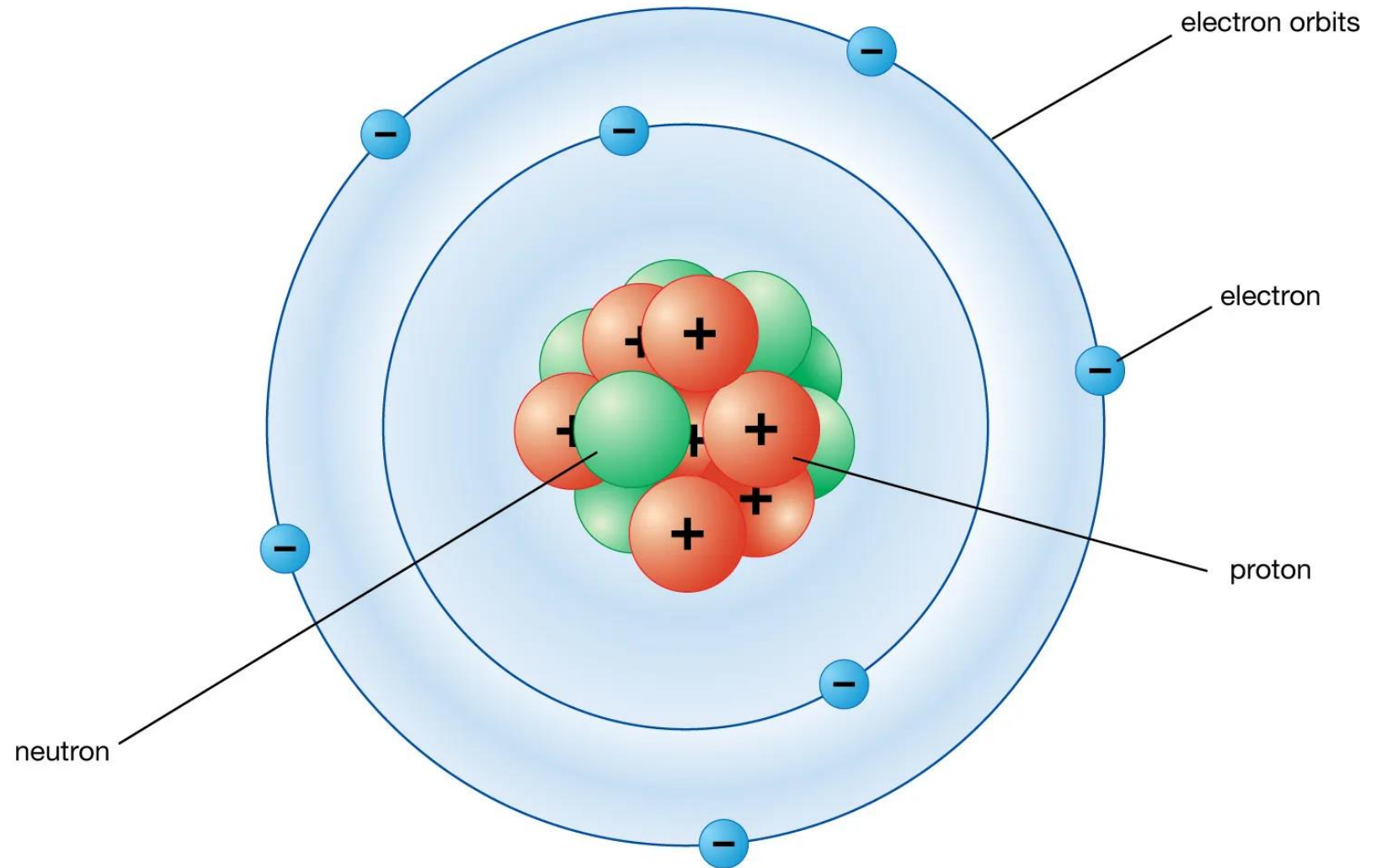
Rosinbollemodellen



# 1911: Rutherfords atommodell



# 1913: Bohrs modell

Bohr atomic model of a nitrogen atom



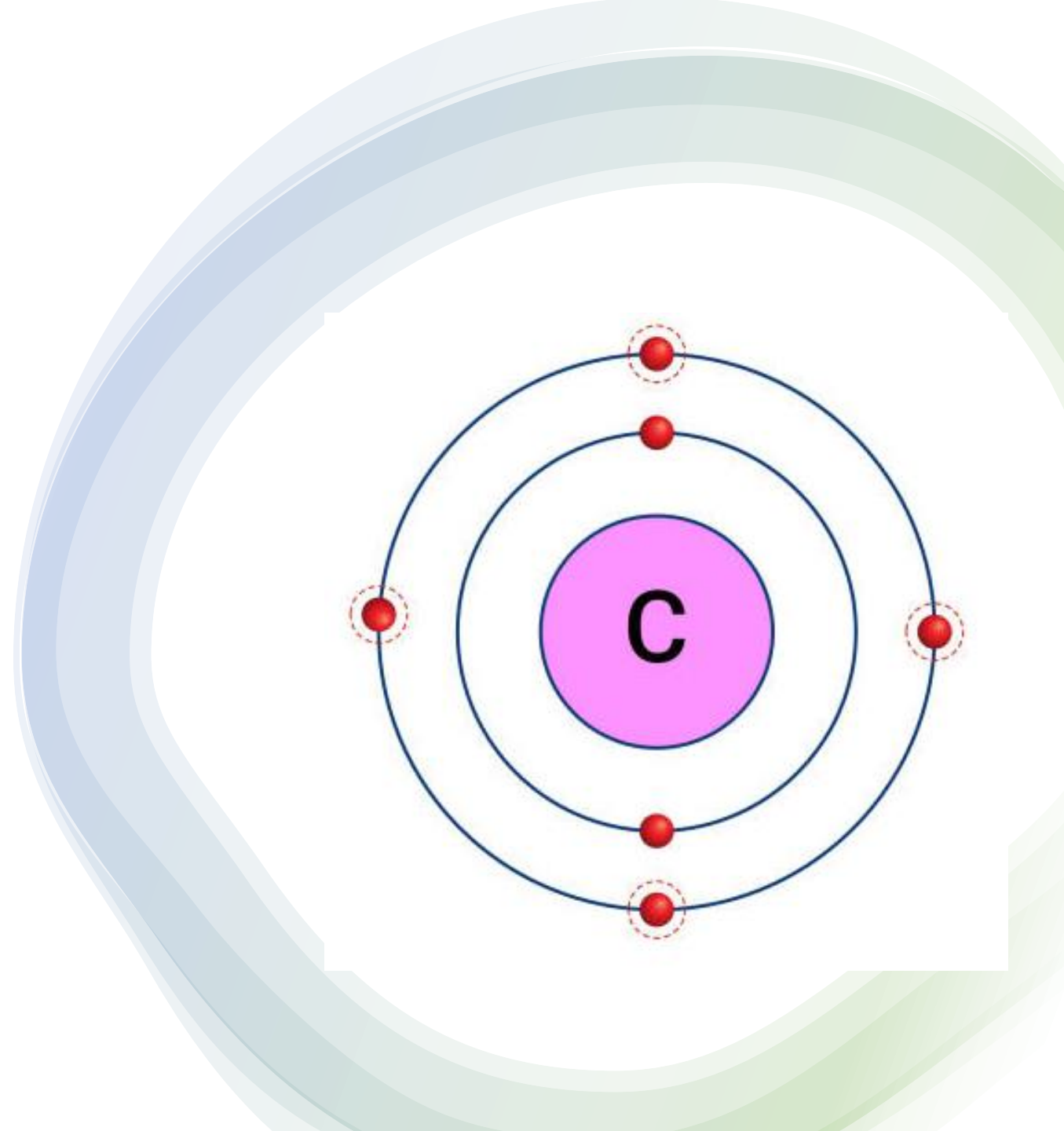

$$E_n = -R_H \left( \frac{1}{n^2} \right)$$

# Bohrs modell

- Elektronene går i baner rundt kjernen
- Bare bestemte baner (radius) er tillatt
- Banens radius bestemmer energien til elektronet
- Energiene er *kvantisert*
- Banene kalles for *skall*
- $n = 1$ : K-skallet
- $n = 2$ : L-skallet
- $n = 3$ : M-skallet

# Valenselektroner

- Skallene har plass til et ulikt antall elektroner
- K – 2. L – 8. M – 18.
- Når vi skal forstå kjemisk binding, ser vi på elektronene i det ytterste skallet
- Disse kalles *valenselektronene*
- Edelgassene (gruppe 18) har fulle valensskall
- Dette er en spesielt stabil tilstand
- Naturen går spontant mot den mest stabile tilstanden
- Atomer søker å oppnå edelgasskonfigurasjon





# Ioner

---

- I atomer er det like mange elektroner som protoner
  - De er elektrisk nøytrale
  - Atomer kan gi fra seg eller ta imot elektroner
  - Vi får en ladet partikkel – et *ion*
- 
- Underskudd elektroner: Positiv ladning. Kation. Typisk fra metaller
  - Overskudd elektroner: Negativ ladning. Anion. Typisk fra ikke-metaller.
- 
- |                 |                  |                                |
|-----------------|------------------|--------------------------------|
| • $\text{Na}^+$ | $\text{Mg}^{2+}$ | Natriumionet og magnesiumionet |
| • $\text{Cl}^-$ | $\text{S}^{2-}$  | Kloridionet og sulfidionet     |
- 
- Hvorfor ikke  $\text{Na}^{2+}$  eller  $\text{S}^-$ ?
  - Antall valenselektroner



# Navnsetting

---

Kationer:

Navn på grunnstoffet + ion: Natriumionet.

Aluminiumionet.

---

Anioner:

Navn på grunnstoffet + endingen *-id*.

Klorid (eller kloridionet)

---

Unntak:  $S^{2-}$  er sulfid.  $O^{2-}$  er oksid.

# Overgangsmetallene

---

- Det er enkelt å forstå hva slags ion man får i s- og p-blokkene
- Dette med valenselektroner blir mer komplekst i d-blokken
- Noen overgangsmetaller kan ha flere typer ioner
- Jernioner kan være +2 eller +3
- Kobberioner kan være +1 eller +2
- Vanadium kan være +2, +3, +4 eller +5
- Dette har å gjøre med elektronstrukturen



# Fleratomige ioner

## Anioner

- $\text{SO}_4^{2-}$  – sulfat
- $\text{CO}_3^{2-}$  – karbonat
- $\text{PO}_4^{3-}$  – fosfat
- $\text{ClO}_3^-$  – klorat
- $\text{CN}^-$  – cyanid
- $\text{OH}^-$  – hydroksid
- $\text{NO}_3^-$  – nitrat
- $\text{SO}_3^{2-}$  – *sulfitt*
- $\text{PO}_3^{3-}$  – *fosfitt*
- $\text{ClO}_2^-$  – *kloritt*
- $\text{NO}_2^-$  – *nitritt*

## Kationer

- $\text{NH}_4^+$  - ammonium
- $\text{H}_3\text{O}^+$  - hydronium (en type oksoniumion)