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Subatomic Particles

$\left(\begin{array}{l} 0 - \text{protons} - 1 \text{amu} \\ 0 - \text{neutrons} - 1 \text{amu} \end{array} \right) \text{ } \left. \begin{array}{l} \\ \\ \end{array} \right\} \text{ nucleons}$

Nucleus

protons = atomic number (Z)

protons + neutrons = mass number (A)

Protons - electrons = Charge

$$4 - 4 = 0$$

$$4 - 6 = -2$$

Beryllium-9
Beryllium-10

mass number (A)

27N

2

atomiz #

Charge

$$z - z_0$$

$Z = E$
particular element
 $N = \text{neutrons}$

N = neutrons

Z^+ Protons

$E = \text{electrons}$

hydrogen 1 H 1.0079	beryllium 4 Be 9.0122	proton + neutron = mass number (A) protons - electrons = charge 4 - 4 = 0 4 - 6 = -2 Carbon - 12										helium 2 He 4.0026									
lithium 3 Li 6.941		boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180														
sodium 11 Na 22.990	magnesium 12 Mg 24.305	aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948														
potassium 19 K 39.098	calcium 20 Ca 40.078	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80														
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29														
caesium 55 Cs 132.91	barium 56 Ba 137.33	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]														
57-70		57-70																			
		89-102																			
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		Scandium Titanium Van																			

Scientific Notation

$125 = 1.25 \times 100$
 $= 1.25 \times 10 \times 10$
 $125 = 1.25 \times 10^2$

$1700 = 1.7 \times 1000$
 $= 1.7 \times 10 \times 10 \times 10$
 $1700 = 1.7 \times 10^3$

Learn

prefix	symbol	10^n	(scale)
mega	M	10^6	(Million)
kilo	k	10^3	(Thousand)
deci	d	10^{-1}	(Tenth)
centi	c	10^{-2}	(Hundreth)
milli	m	10^{-3}	(Thousandth)
micro	μ	10^{-6}	(Millionth)
nano	n	10^{-9}	(Billionth)
pico	p	10^{-12}	(Trillionth)
femto	f	10^{-15}	(Quadrillionth)

93000000.
7 6 5 4 3 2 1
9.3 $\times 10^7$

67340000.
6.734 $\times 10^7$

00000003.7
3.7 $\times 10^{-7}$

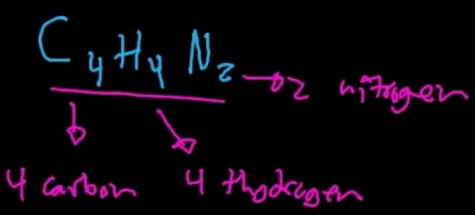
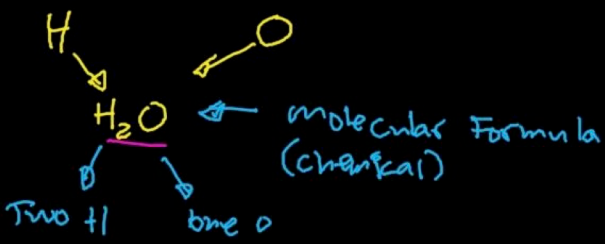
0000064
6.4 $\times 10^{-5}$

LIP
Left is Positive

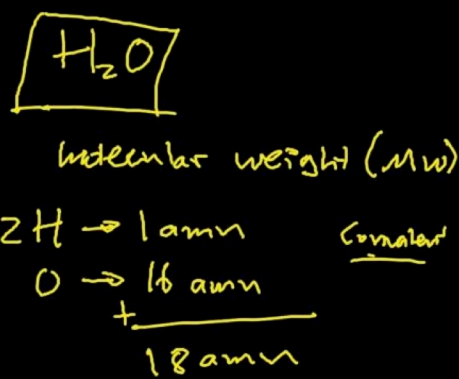
36.9 $\times 10^5$
3.69 $\times 10^6$

1 Km = 1000 m
 1×10^3 m
 $903 \text{ cm} = 9.03 \times 10^{-2} \text{ m}$
 $= 9.03 \text{ m}$

Molecular Formulas and Molecular Weight



Atomic mass (weight) =
Amu (atomic mass unit)
Carbon = 12 → 12 amu



compare compounds

Formula weight
Ionic compounds



hydrogen 1 H 1.0079												helium 2 He 4.0026	
lithium 3 Li 6.941												neon 10 Ne 20.180	
sodium 11 Na 22.990												argon 18 Ar 39.948	
potassium 19 K 39.098												krypton 36 Kr 83.80	
rubidium 37 Rb 85.468												xenon 54 Xe 131.29	
caesium 55 Cs 132.91												radon 86 Rn [222]	
francium 87 Fr [223]													

beryllium 4 Be 9.0122											boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
magnesium 12 Mg 24.305											aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
barium 56 Ba 137.33	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
radium 88 Ra [226]	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	unnilium 110 Uun [271]	ununium 111 Uuu [272]	unubium 112 Uub [277]	ununquadium 114 Uuq [289]					

Atomic mass in amu/s

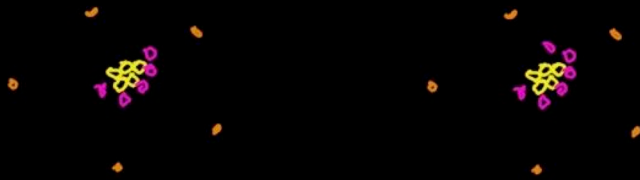
Formula weight

Ionic compounds

NaCl → Na Cl

Atomic Weight

Atomic weight



Boron 10
10.013 amu
20%

Boron 11
11.009 amu
80%

$$(20\%)(10.013 \text{ amu}) + (80\%)(11.009 \text{ amu}) = 10.811 \text{ amu}$$

hydrogen 1 H 1.0079											boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999		
lithium 3 Li 6.941	beryllium 4 Be 9.0122											aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	
sodium 11 Na 22.990	magnesium 12 Mg 24.305											gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	
potassium 19 K 39.098	calcium 20 Ca 40.078	scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39					
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 ★	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]

Ions: Cations and Anions

Group 9

Li^{+} Li^{+} Li^{+} Li^{+}

Li^{+} Li^{+} Li^{+}

Cation Anion

negative charge

C^{+}

1 H																	5 B	6 C	7 N	8 O	
3 Li	4 Be																	11 Al	14 Si	15 P	16 S
11 Na	12 Mg																	21 Ga	22 Ge	23 As	24 Se
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						

Isotopes: The Atoms, Not the Baseball Team from Springfield



hydrogen 1 H 1.0079																		helium 2 He 4.0026							
lithium 3 Li 6.941		beryllium 4 Be 9.0122																		boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990		magnesium 12 Mg 24.305																		aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098		calcium 20 Ca 40.078			scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80					
rubidium 37 Rb 85.468		strontium 38 Sr 87.62			yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29					
caesium 55 Cs 132.91		barium 56 Ba 137.33		57-70 ✱	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]					
francium 87 Fr [223]		radium 88 Ra [226]		89-102 ✱ ✱	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	unnililium 110 Uun [271]	ununilium 111 Uuu [272]	ununbium 112 Uub [277]		ununquadium 114 Uuq [289]									

The Mole: Avogadro's Number

The mole
(n)

Avogadro's Number (N_A or N_0)

1 dozer = 12 units

1 mole = 6020000000000000000000000 units

1 dozen donuts = 12 donuts

1 hole donuts = 602000000000000000000000 donuts

$$60200000000000000000000 = 6.02 \times 10^{23}$$

$$C = 12,4 \text{ Amu}$$

1 mole Catans = 12.01 g C

Ann | Bridge | 9

log A1 $\rightarrow$ n?

26,982 amu
↑ Al atom

$$\boxed{\frac{26.982 \text{ g Al}}{1 \text{ mol Al}}} \quad \begin{matrix} \rightarrow & 1 \text{ mol Al} \\ & 26.982 \text{ g} \end{matrix}$$

$$\frac{10.5 \text{ AT} \times 1 \text{ (circled) Al}}{26.982 \text{ g Al}} = .371 \text{ mol Al}$$

Calcium carbonate (CaCO3)

4.86 mol CaCO₃ $\rightarrow$? g

$$4.86 \text{ mol CaO}_3 \times \frac{1 \text{ mol CaCl}_2}{1 \text{ mol CaO}_3} = 4.86 \text{ mol CaCl}_2$$

hydrogen 1 1.0079	beryllium 4 9.0122																	boron 5 10.811	carbon 6 12.011	nitrogen 7 14.007	oxygen 8 15.999	fluorine 9 18.998	neon 10 20.180																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
lithium 3 6.941	beryllium 4 9.0122																	aluminum 13 26.982	silicon 14 28.086	phosphorus 15 30.974	sulfur 16 32.065	chlorine 17 35.453	argon 18 39.948																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
sodium 11 22.990	magnesium 12 24.305																	gallium 31 69.723	germanium 32 72.61	arsenic 33 74.922	selenium 34 78.96	bromine 35 79.904	krypton 36 83.80																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
potassium 19 39.098	calcium 20 40.078	scandium 21 44.956	titanium 22 47.867	vanadium 23 50.942	chromium 24 51.996	manganese 25 54.938	iron 26 55.845	cobalt 27 58.933	nickel 28 58.693	copper 29 63.546	zinc 30 65.39	gallium 31 69.723	germanium 32 72.61	arsenic 33 74.922	selenium 34 78.96	bromine 35 79.904	krypton 36 83.80																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
rubidium 37 85.468	strontium 38 87.62	yttrium 39 88.906	zirconium 40 91.224	niobium 41 92.906	molybdenum 42 95.94	technetium 43 [98]	ruthenium 44 101.07	rhodium 45 102.91	palladium 46 106.42	silver 47 107.87	cadmium 48 112.41	indium 49 114.82	tin 50 118.71	antimony 51 121.76	tellurium 52 127.60	iodine 53 126.90	xenon 54 131.29																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
caesium 55 132.91	barium 56 137.33	lutetium 71 174.97	hafnium 72 178.49	tantalum 73 180.95	tungsten 74 183.84	rhenium 75 186.21	osmium 76 190.23	iridium 77 192.22	platinum 78 195.08	gold 79 196.97	mercury 80 200.59	thallium 81 204.38	lead 82 207.2	bismuth 83 208.98	polonium 84 [209]	astatine 85 [210]	radon 86 [222]																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
francium 87 [223]	radium 88 [226]	actinium 89 [227]	thorium 90 [232]	protactinium 91 [231]	uranium 92 [238]	neptunium 93 [237]	plutonium 94 [244]	americium 95 [243]	curium 96 [247]	berkelium 97 [247]	californium 98 [251]	einsteinium 99 [252]	fermium 100 [257]	mendelevium 101 [258]	nobelium 102 [259]	lawrencium 103 [260]	rutherfordium 104 [261]	dundubium 105 [262]	seaborgium 106 [266]	bohrium 107 [264]	hassium 108 [269]	meitnerium 109 [268]	unnilium 110 [271]	ununium 111 [272]	unubium 112 [277]	ununquadium 114 [289]	ununhexium 116 [288]	ununseptium 117 [294]	ununoctium 118 [294]	unbihexium 120 [295]	unbihexium 124 [293]	unbihexium 125 [292]	unbihexium 126 [293]	unbihexium 127 [291]	unbihexium 128 [295]	unbihexium 129 [294]	unbihexium 130 [296]	unbihexium 131 [297]	unbihexium 132 [298]	unbihexium 133 [299]	unbihexium 134 [301]	unbihexium 135 [304]	unbihexium 136 [305]	unbihexium 137 [307]	unbihexium 138 [310]	unbihexium 139 [311]	unbihexium 140 [312]	unbihexium 141 [313]	unbihexium 142 [315]	unbihexium 143 [316]	unbihexium 144 [317]	unbihexium 145 [318]	unbihexium 146 [319]	unbihexium 147 [320]	unbihexium 148 [321]	unbihexium 149 [322]	unbihexium 150 [323]	unbihexium 151 [324]	unbihexium 152 [325]	unbihexium 153 [326]	unbihexium 154 [327]	unbihexium 155 [328]	unbihexium 156 [329]	unbihexium 157 [330]	unbihexium 158 [331]	unbihexium 159 [332]	unbihexium 160 [333]	unbihexium 161 [334]	unbihexium 162 [335]	unbihexium 163 [336]	unbihexium 164 [337]	unbihexium 165 [338]	unbihexium 166 [339]	unbihexium 167 [340]	unbihexium 168 [341]	unbihexium 169 [342]	unbihexium 170 [343]	unbihexium 171 [344]	unbihexium 172 [345]	unbihexium 173 [346]	unbihexium 174 [347]	unbihexium 175 [348]	unbihexium 176 [349]	unbihexium 177 [350]	unbihexium 178 [351]	unbihexium 179 [352]	unbihexium 180 [353]	unbihexium 181 [354]	unbihexium 182 [355]	unbihexium 183 [356]	unbihexium 184 [357]	unbihexium 185 [358]	unbihexium 186 [359]	unbihexium 187 [360]	unbihexium 188 [361]	unbihexium 189 [362]	unbihexium 190 [363]	unbihexium 191 [364]	unbihexium 192 [365]	unbihexium 193 [366]	unbihexium 194 [367]	unbihexium 195 [368]	unbihexium 196 [369]	unbihexium 197 [370]	unbihexium 198 [371]	unbihexium 199 [372]	unbihexium 200 [373]	unbihexium 201 [374]	unbihexium 202 [375]	unbihexium 203 [376]	unbihexium 204 [377]	unbihexium 205 [378]	unbihexium 206 [379]	unbihexium 207 [380]	unbihexium 208 [381]	unbihexium 209 [382]	unbihexium 210 [383]	unbihexium 211 [384]	unbihexium 212 [385]	unbihexium 213 [386]	unbihexium 214 [387]	unbihexium 215 [388]	unbihexium 216 [389]	unbihexium 217 [390]	unbihexium 218 [391]	unbihexium 219 [392]	unbihexium 220 [393]	unbihexium 221 [394]	unbihexium 222 [395]	unbihexium 223 [396]	unbihexium 224 [397]	unbihexium 225 [398]	unbihexium 226 [399]	unbihexium 227 [400]	unbihexium 228 [401]	unbihexium 229 [402]	unbihexium 230 [403]	unbihexium 231 [404]	unbihexium 232 [405]	unbihexium 233 [406]	unbihexium 234 [407]	unbihexium 235 [408]	unbihexium 236 [409]	unbihexium 237 [410]	unbihexium 238 [411]	unbihexium 239 [412]	unbihexium 240 [413]	unbihexium 241 [414]	unbihexium 242 [415]	unbihexium 243 [416]	unbihexium 244 [417]	unbihexium 245 [418]	unbihexium 246 [419]	unbihexium 247 [420]	unbihexium 248 [421]	unbihexium 249 [422]	unbihexium 250 [423]	unbihexium 251 [424]	unbihexium 252 [425]	unbihexium 253 [426]	unbihexium 254 [427]	unbihexium 255 [428]	unbihexium 256 [429]	unbihexium 257 [430]	unbihexium 258 [431]	unbihexium 259 [432]	unbihexium 260 [433]	unbihexium 261 [434]	unbihexium 262 [435]	unbihexium 263 [436]	unbihexium 264 [437]	unbihexium 265 [438]	unbihexium 266 [439]	unbihexium 267 [440]	unbihexium 268 [441]	unbihexium 269 [442]	unbihexium 270 [443]	unbihexium 271 [444]	unbihexium 272 [445]	unbihexium 273 [446]	unbihexium 274 [447]	unbihexium 275 [448]	unbihexium 276 [449]	unbihexium 277 [450]	unbihexium 278 [451]	unbihexium 279 [452]	unbihexium 280 [453]	unbihexium 281 [454]	unbihexium 282 [455]	unbihexium 283 [456]	unbihexium 284 [457]	unbihexium 285 [458]	unbihexium 286 [459]	unbihexium 287 [460]	unbihexium 288 [461]	unbihexium 289 [462]	unbihexium 290 [463]	unbihexium 291 [464]	unbihexium 292 [465]	unbihexium 293 [466]	unbihexium 294 [467]	unbihexium 295 [468]	unbihexium 296 [469]	unbihexium 297 [470]	unbihexium 298 [471]	unbihexium 299 [472]	unbihexium 300 [473]	unbihexium 301 [474]	unbihexium 302 [475]	unbihexium 303 [476]	unbihexium 304 [477]	unbihexium 305 [478]	unbihexium 306 [479]	unbihexium 307 [480]	unbihexium 308 [481]	unbihexium 309 [482]	unbihexium 310 [483]	unbihexium 311 [484]	unbihexium 312 [485]	unbihexium 313 [486]	unbihexium 314 [487]	unbihexium 315 [488]	unbihexium 316 [489]	unbihexium 317 [490]	unbihexium 318 [491]	unbihexium 319 [492]	unbihexium 320 [493]	unbihexium 321 [494]	unbihexium 322 [495]	unbihexium 323 [496]	unbihexium 324 [497]	unbihexium 325 [498]	unbihexium 326 [499]	unbihexium 327 [500]	unbihexium 328 [501]	unbihexium 329 [502]	unbihexium 330 [503]	unbihexium 331 [504]	unbihexium 332 [505]	unbihexium 333 [506]	unbihexium 334 [507]	unbihexium 335 [508]	unbihexium 336 [509]	unbihexium 337 [510]	unbihexium 338 [511]	unbihexium 339 [512]	unbihexium 340 [513]	unbihexium 341 [514]	unbihexium 342 [515]	unbihexium 343 [516]	unbihexium 344 [517]	unbihexium 345 [518]	unbihexium 346 [519]	unbihexium 347 [520]	unbihexium 348 [521]	unbihexium 349 [522]	unbihexium 350 [523]	unbihexium 351 [524]	unbihexium 352 [525]	unbihexium 353 [526]	unbihexium 354 [527]	unbihexium 355 [528]	unbihexium 356 [529]	unbihexium 357 [530]	unbihexium 358 [531]	unbihexium 359 [532]	unbihexium 360 [533]	unbihexium 361 [534]	unbihexium 362 [535]	unbihexium 363 [536]	unbihexium 364 [537]	unbihexium 365 [538]	unbihexium 366 [539]	unbihexium 367 [540]	unbihexium 368 [541]	unbihexium 369 [542]	unbihexium 370 [543]	unbihexium 371 [544]	unbihexium 372 [545]	unbihexium 373 [546]	unbihexium 374 [547]	unbihexium 375 [548]	unbihexium 376 [549]	unbihexium 377 [550]	unbihexium 378 [551]	unbihexium 379 [552]	unbihexium 380 [553]	unbihexium 381 [554]	unbihexium 382 [555]	unbihexium 383 [556]	unbihexium 384 [557]	unbihexium 385 [558]	unbihexium 386 [559]	unbihexium 387 [560]	unbihexium 388 [561]	unbihexium 389 [562]	unbihexium 390 [563]	unbihexium 391 [564]	unbihexium 392 [565]	unbihexium 393 [566]	unbihexium 394 [567]	unbihexium 395 [568]	unbihexium 396 [569]	unbihexium 397 [570]	unbihexium 398 [571]	unbihexium 399 [572]	unbihexium 400 [573]	unbihexium 401 [574]	unbihexium 402 [575]	unbihexium 403 [576]	unbihexium 404 [577]	unbihexium 405 [578]	unbihexium 406 [579]	unbihexium 407 [580]	unbihexium 408 [581]	unbihexium 409 [582]	unbihexium 410 [583]	unbihexium 411 [584]	unbihexium 412 [585]	unbihexium 413 [586]	unbihexium 414 [587]	unbihexium 415 [588]	unbihexium 416 [589]	unbihexium 417 [590]	unbihexium 418 [591]	unbihexium 419 [592]	unbihexium 420 [593]	unbihexium 421 [594]	unbihexium 422 [595]	unbihexium 423 [596]	unbihexium 424 [597]	unbihexium 425 [598]	unbihexium 426 [599]	unbihexium 427 [600]	unbihexium 428 [601]	unbihexium 429 [602]	unbihexium 430 [603]	unbihexium 431 [604]	unbihexium 432 [605]	unbihexium 433 [606]	unbihexium 434 [607]	unbihexium 435 [608]	unbihexium 436 [609]	unbihexium 437 [610]	unbihexium 438 [611]	unbihexium 439 [612]	unbihexium 440 [613]	unbihexium 441 [614]	unbihexium 442 [615]	unbihexium 443 [616]	unbihexium 444 [617]	unbihexium 445 [618]	unbihexium 446 [619]	unbihexium 447 [620]	unbihexium 448 [621]	unbihexium 449 [622]	unbihexium 450 [623]	unbihexium 451 [624]	unbihexium 452 [625]	unbihexium 453 [626]	unbihexium 454 [627]	unbihexium 455 [628]	unbihexium 456 [629]	unbihexium 457 [630]	unbihexium 458 [631]	unbihexium 459 [632]	unbihexium 460 [633]	unbihexium 461 [634]	unbihexium 462 [635]	unbihexium 463 [636]	unbihexium 464 [637]	unbihexium 465 [638]	unbihexium 466 [639]	unbihexium 467 [640]	unbihexium 468 [641]	unbihexium 469 [642]	unbihexium 470 [643]	unbihexium 471 [644]	unbihexium 472 [645]	unbihexium 473 [646]	unbihexium 474 [647]	unbihexium 475 [648]	unbihexium 476 [649]	unbihexium 477 [650]	unbihexium 478 [651]	unbihexium 479 [652]	unbihexium 480 [653]	unbihexium 481 [654]	unbihexium 482 [655]	unbihexium 483 [656]	unbihexium 484 [657]	unbihexium 485 [658]	unbihexium 486 [659]	unbihexium 487 [660]	unbihexium 488 [661]	unbihexium 489 [662]	unbihexium 490 [663]	unbihexium 491 [664]	unbihexium 492 [665]	unbihexium 493 [666]	unbihexium 494 [667]	unbihexium 495 [668]	unbihexium 496 [669]	unbihexium 497 [670]	unbihexium 498 [671]	unbihexium 499 [672]	unbihexium 500 [673]	unbihexium 501 [674]	unbihexium 502 [675]	unbihexium 503 [676]	unbihexium 504 [677]	unbihexium 505 [678]	unbihexium 506 [679]	unbihexium 507 [680]	unbihexium 508 [681]	unbihexium 509 [682]	unbihexium 510 [683]	unbihexium 511 [684]	unbihexium 512 [685]	unbihexium 513 [686]	unbihexium 514 [687]	unbihexium 515 [688]	unbihexium 516 [689]	unbihexium 517 [690]	unbihexium 518 [691]	unbihexium 519 [692]	unbihexium 520 [693]	unbihexium 521 [694]	unbihexium 522 [695]	unbihexium 523 [696]	unbihexium 524 [697]	unbihexium 525 [698]	unbihexium 526 [699]	unbihexium 527 [700]	unbihexium 528 [701]	unbihexium 529 [702]	unbihexium 530 [703]	unbihexium 531 [704]	unbihexium 532 [705]	unbihexium 533 [706]	unbihexium 534 [707]	unbihexium 535 [708]	unbihexium 536 [709]	unbihexium 537 [710]	unbihexium 538 [711]	unbihexium 539 [712]	unbihexium 540 [713]	unbihexium 541 [714]	unbihexium 542 [715]	unbihexium 543 [716]	unbihexium 544 [717]	unbihexium 545 [718]	unbihexium 546 [719]	unbihexium 547 [720]	unbihexium 548 [721]	unbihexium 549 [722]	unbihexium 550 [723]	unbihexium 551 [724]	unbihexium 552 [725]	unbihexium 553 [726]	unbihexium 554 [727]	unbihexium 555 [728]	unbihexium 556 [729]	unbihexium 557 [730]	unbihexium 558 [731]	unbihexium 559 [732]	unbihexium 560 [733]	unbihexium 561 [734]	unbihexium 562 [735]	unbihexium 563 [736]	unbihexium 564 [737]	unbihexium 565 [738]	unbihexium 566 [739]	unbihexium 567 [740]	unbihexium 568 [741]	unbihexium 569 [742]	unbihexium 570 [743]	unbihexium 571 [744]	unbihexium 572 [745]	unbihexium 573 [746]	unbihexium 574 [747]	unbihexium 575 [748]	unbihexium 576 [749]	unbihexium 577 [750]	unbihexium 578 [751]	unbihexium 579 [752]	unbihexium 580 [753]	unbihexium 581 [754]	unbihexium 582 [755]	unbihexium 583 [756]	unbihexium 584 [757]	unbihexium 585 [758]	unbihexium 586 [759]	unbihexium 587 [760]	unbihexium 588 [761]	unbihexium 589 [762]	unbihexium 590 [763]	unbihexium 591 [764]	unbihexium 592 [765]	unbihexium 593 [766]	unbihexium 594 [767]	unbihexium 595 [768]	unbihexium 596 [769]	unbihexium 597 [770]	unbihexium 598 [771]	unbihexium 599 [772]	unbihexium 600 [773]	unbihexium 601 [774]	unbihexium 602 [775]	unbihexium 603 [776]	unbihexium 604 [777]	unbihexium 605 [778]	unbihexium 606 [779]	unbihexium 607 [780]	unbihexium 608 [781]	unbihexium 609 [782]	unbihexium 610 [783]	unbihexium 611 [784]	unbihexium 612 [785]	unbihexium 613 [786]	unbihexium 614 [787]	unbihexium 615 [788]	unbihexium 616 [789]	unbihexium 617 [790]	unbihexium 618 [791]	unbihexium 619 [792]	unbihexium 620 [793]	unbihexium 621 [794]	unbihexium 622 [795]	unbihexium 623 [796]	unbihexium 624 [797]	unbihexium 625 [798]	unbihexium 626 [799]	unbihexium 627 [800]	unbihexium 628 [801]	unbihexium 629 [802]	unbihexium 630 [803]	unbihexium 631 [804]	unbihexium 632 [805]	unbihexium 633 [806]	unbihexium 634 [807]	unbihexium 635 [808]	unbihexium 636 [809]	unbihexium 637 [810]	unbihexium 638 [811]	

The International System of Units (SI System)

International System of Units (SI)

Base units

meter (m) → length

Kilogram (kg) → mass

second (s) → time

mole (mol) → amount of substance

Kelvin (K) → temperature

cubic meter (m³) → volume

Chemistry → 1 mL = 1 cm³ = 1 cc
volume

(liquid or gas) 1 L = 1000 cm³ 1000 L = 1 m³

Speed → $\frac{\text{distance}}{\text{time}} \rightarrow \frac{\text{m}}{\text{s}}$

mm
cm

femto → f → 10⁻¹⁵

pico → p → 10⁻¹²

Nano → n → 10⁻⁹

micro → μ → 10⁻⁶

milli → m → 10⁻³

centi → c → 10⁻²

Kilo → k → 10³

Mega → M → 10⁶

1000
10 × 10 × 10
10 × 10²
1000 g = 1 kg

Angstrom → Å → 10⁻¹⁰ m

↳ atomic radii
↳ bond lengths

1-3 Å



Density Mini Video

Density: $\rho = \frac{\text{mass}}{\text{volume}} = \frac{\text{kg}}{\text{m}^3}$

Chem

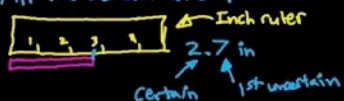
$$\frac{\text{g}}{\text{cm}^3} \xrightarrow{\times 1000} \frac{\text{kg}}{\text{m}^3}$$
$$\frac{\text{kg}}{\text{m}^3} \xrightarrow{\div 1000} \frac{\text{g}}{\text{cm}^3}$$

most
liquids $\rightarrow 1000 \frac{\text{g}}{\text{cm}^3}$
solids

Significant Figures

Significant Figures

- All the certain #s + the 1st uncertain # in a measurement.



Rules for Counting Significant Figures

1. Nonzero integers are always significant.

1 → 9 Significant

2. Zeros

- Leading zeros are zeros that come before all nonzeros.

0.00037 not significant
↑↑↑↑

- Captive zeros are zeros between two nonzeros.

120.00037 Significant
↑↑↑↑

- Trailing zeros are at the end of the #.

500 not significant (no decimal place)
↑↑
500.00 significant (decimal place)
↑↑↑↑

3. Exact numbers

#s that are counted or are defined, have ∞ sig. figs.

2 apples = 2 apples } ∞ significant figures
1 in = 2.54 cm

4. Scientific notation - shorthand for very large or small #s.

Standard notation - #s to the left of 'x10' are significant.
 $136,000,000 = 1.36 \times 10^8$
3 sig. figs.

Rules for Rounding Off

1. 1.33 → 1.3

↑
numbers < 5 are rounded down
numbers ≥ 5 are rounded up
1.37 → 1.4

2. Round at the end of your calculations using only the digit to the right of the last sig. fig.

1.3748

Using Significant Figures in Calculations

Multiplication or division - the final answer is rounded to contain the same number of sig. figs. as the number in the problem with the smallest number of sig. figs.

$1.5 \times 4.56 = 6.84$ Rounded → 6.8
2 sig. 3 sig. < 5
 $7.06 / 301 = 2.34551...$ Rounded → 2.35
4 sig. 3 sig. 2 sig.

Addition and subtraction - the limiting term is the # with the least amount of decimal places

$12.34 + 18.0 + 1.003 = 31.343$ Rounded → 31.3
↑ limiting term, 1 decimal < 5
 $10.6875 - 0.11 = 10.5775$ Rounded → 10.58
↑ 2 decimals 2 sig.

Examples

Solve using the correct # of sig. figs.:

- A) $(10.14 + 17.372 - 18.2) / 1.41 =$
9.312 / 1.41 = 6.604255 → 6.6
2 sig. / 3 sig.
B) $(4.00 \times 10^5 - 2.34 \times 10^6) (3 + 7.5) =$ 1.29556 × 10⁴ → 1.3 × 10⁴
↑ 3 2
C) $1.789 \times (2.54 \text{ cm})^2 =$ 4.54406 cm → 4.544 cm
4 ∞

Dimensional Analysis and Unit Conversion

Dimensional Analysis and Unit Conversion

Example 1:

Convert 2.0 inches to cm. (1 in = 2.54 cm)

$$\frac{2.0 \cancel{\text{in}}}{1} \times \frac{2.54 \text{ cm}}{1 \cancel{\text{in}}} = \frac{5.08 \text{ cm}}{1} = 5.08 \text{ cm}$$

$\left(\frac{1 \text{ in}}{2.54 \text{ cm}} \right) \quad \left(\frac{2.54 \text{ cm}}{1 \text{ in}} \right)$

Example 2:

Convert 3 miles to yards. (1 mi = 5280 ft, 1 yd = 3 ft)

3 miles $\xrightarrow{\text{ft}}$ yards

$$3 \cancel{\text{mi}} \times \frac{5280 \cancel{\text{ft}}}{1 \cancel{\text{mi}}} \times \frac{1 \text{ yd}}{3 \cancel{\text{ft}}} = 5280 \text{ yards}$$

Example 3:

How many milliliters are in one gallon? (1 L = 1000 mL, 1 gallon = 3.79 L)

Gallons $\xrightarrow{\text{L}}$ ~~gallons~~ mL

$$1 \cancel{\text{gallon}} \times \frac{3.79 \cancel{\text{L}}}{1 \cancel{\text{L}}} \times \frac{1000 \text{ mL}}{1 \cancel{\text{L}}} = 3790 \text{ mL}$$

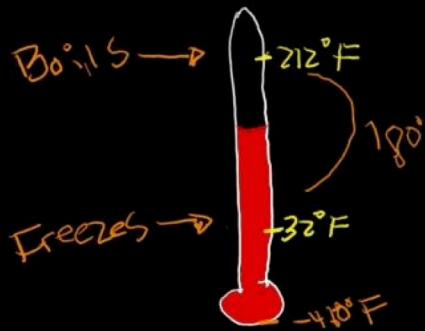
Example 4: How many moles are in a sample of Na containing 3.3×10^{20} atoms? (1 mol = 6.022×10^{23})

Atoms $\xrightarrow{\quad}$ moles

$$3.3 \times 10^{20} \cancel{\text{atoms}} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \cancel{\text{atoms}}} = \frac{3.3 \times 10^{20} \text{ mol}}{6.022 \times 10^{23}} = 5.48 \times 10^{-4} \text{ mol}$$

0.000548 mol

Temperature Conversion



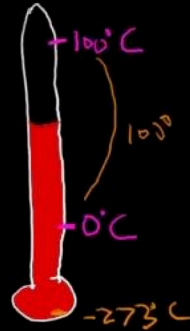
Fahrenheit

$$^{\circ}\text{F} = 1.80(^{\circ}\text{C}) + 32$$

$$^{\circ}\text{C} = \frac{^{\circ}\text{F} - 32}{1.80}$$

$$50^{\circ}\text{F} \rightarrow ^{\circ}\text{C}$$

$$^{\circ}\text{C} = \frac{50 - 32}{1.80} = \boxed{10^{\circ}\text{C}}$$



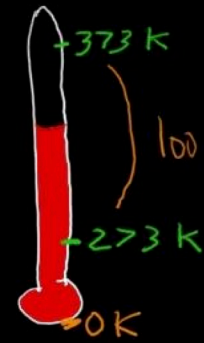
Celsius

$$\text{K} = ^{\circ}\text{C} + 273.15$$

$$^{\circ}\text{C} = \text{K} - 273$$

$$50^{\circ}\text{C} \rightarrow \text{K}$$

$$\begin{aligned} \text{K} &= 50 + 273 \\ &= \boxed{323\text{K}} \end{aligned}$$



Kelvin

Ideal Gas Law: $PV=nRT$

The Ideal Gas Law

$$PV=nRT$$

"Ideal" - Gas molecules bouncing off each other are not a factor.

P = Pressure (atm)

$$1 \text{ atm} = 760.0 \text{ mm-Hg} = 760 \text{ torr} = 101,325 \text{ Pa} = 14.69 \text{ psi}$$

V = Volume (L)

$$1 \text{ L} = 1000 \text{ cm}^3 = 0.001 \text{ m}^3$$

n = moles (mol)

$$1 \text{ mol} = 6.022 \times 10^{23}$$

Avogadro's Number

$$R = 0.08206 \frac{\text{L atm}}{\text{K mol}}$$

Universal Gas Constant

T = Temperature (K)

	Kelvin	Celsius	Fahrenheit
Boil	373 K	100°C	212°F

Freeze	273 K	0°C	32°F
	$373 \text{ K} - 273 \text{ K} = 100$	$100^\circ \text{C} - 0^\circ \text{C}$	$212^\circ \text{F} - 32^\circ \text{F} = 180$

Same Scale

$$^\circ \text{F} = 1.80(^\circ \text{C}) + 32$$
$$\text{K} = ^\circ \text{C} + 273$$

Standard Temperature and Pressure (STP)

$$1 \text{ atm}$$

$$0^\circ \text{C} \text{ or } 273 \text{ K}$$

Example - Changing Conditions

What is the volume of 1 mol of an ideal gas at STP?

$$PV=nRT$$

$$V = \frac{nRT}{P}$$

$$V = \frac{(1 \text{ mol})(0.08206 \frac{\text{L atm}}{\text{K mol}})(273 \text{ K})}{1 \text{ atm}}$$

$$V = 0.08206 \text{ L} \cdot 273 = 22.4 \text{ L}$$

Example - Changing Conditions

A cylinder with a volume of 1 L contains 2 mol of an ideal gas at 20°C and 2 atm. The gas is then heated to 30°C. Given that no change in volume has occurred what is the final pressure of the gas inside the cylinder?

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Change

$$PV=nRT \quad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$20^\circ \text{C} = 20 + 273 = 293 \text{ K}$$
$$30^\circ \text{C} = 30 + 273 = 303 \text{ K}$$

$$\frac{P_1}{T_1} = \frac{nR}{V} = \frac{P_2}{T_2}$$

$$P_2 = \frac{P_1}{T_1} \cdot T_2 = \frac{2 \text{ atm}}{293 \text{ K}} \cdot 303 \text{ K} = 2.07 \text{ atm}$$

Not on video, good to know

$$PV=Nk_B T$$

P = Pressure (Pa)

N = # of atoms

V = Volume (m³)

$$k_B = 1.38 \times 10^{-23} \frac{\text{J}}{\text{K}}$$

T = temperature in Kelvin

Ideal Gas Law: $PV=nRT$, Easier Method

The Ideal Gas Law

$$PV=nRT$$

P = Pressure (atm)

V = Volume (L)

n = moles (mol)

$R = 0.08206 \frac{\text{L atm}}{\text{K mol}}$

T = Temperature (K)

"Ideal" - molecule interaction

volume taken up by gas molecules

any gas you work with

} not factors!

← Universal Gas Constant

Standard temperature and pressure (STP)

(atm 273 K)

Example - Changing Conditions

A cylinder with a volume of 1 L contains 2 mol of an ideal gas at 20°C and 2 atm. The gas is then heated to 30°C. Given that no change in volume has occurred what is the final pressure of the gas inside the cylinder?

change

$$PV=nRT$$

$$\begin{aligned} 20^\circ\text{C} &= 20 + 273 = 293\text{ K} \\ 30^\circ\text{C} &= 30 + 273 = 303\text{ K} \end{aligned}$$

$$\frac{P_i}{T_i} = \frac{nR}{V} = \frac{P_f}{T_f}$$

$$\left(\frac{P_f}{T_f}\right) = \frac{P_i}{T_i} \cdot T_f = \frac{2\text{ atm}}{293\text{ K}} \cdot 303\text{ K}$$

$$= \underline{\underline{2.07\text{ atm}}}$$

$$\frac{P_i V_i = n R T_i}{P_f V_f = n R T_f}$$

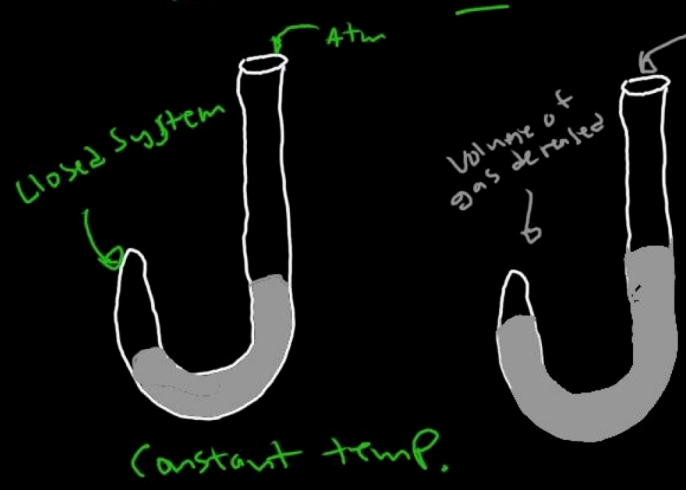
$$\frac{P_i}{P_f} = \frac{T_i}{T_f} \Leftrightarrow P_i T_f = T_i P_f$$
$$\frac{P_i}{T_i} = \frac{P_f}{T_f}$$

$$P_f = \frac{T_f P_i}{T_i} = \frac{303\text{ K} \cdot 2\text{ atm}}{293\text{ K}} = \frac{606\text{ atm}}{293} = \underline{\underline{2.07\text{ atm}}}$$

Boyles Law: PV=PV

Boyle's Law: pressure and volume

Robert Boyle → 1691



Trial	Pressure	Volume
1	29.1	48.0
2	58.2	24.0
3	117.5	12.0

$\uparrow \downarrow$
 $P \downarrow$
 $V \uparrow$

1.40×10^3

$$PV = 1.40 \times 10^3$$

$$PV = nRT$$

$$PV = k$$

$$P_i V_i = k = P_f V_f$$

$$P_i V_i = P_f V_f \quad \text{Boyle's Law}$$

In an automobile engine the gaseous fuel-air mixture enters the cylinder and is compressed by a moving piston before it is ignited by a spark. In a certain engine the initial cylinder volume is 0.725 L. After the piston moves up, the volume is 0.075 L. The initial pressure of the cylinder is 1.00 atm. Find the pressure of the compressed fuel-air mixture, assuming that both the temperature and the amount of gas remain constant.



$$P_i V_i = P_f V_f$$

$$\frac{P_i V_i = nRT}{P_f V_f = nRT}$$

$$\frac{P_i V_i}{P_f V_f} = 1$$

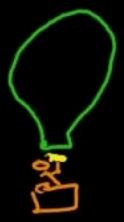
$$P_f = \frac{P_i V_i}{V_f} = \frac{0.725 \text{ L}}{0.075 \text{ L}} = 9.7 \text{ atm}$$

$$P_i V_i = P_f V_f$$

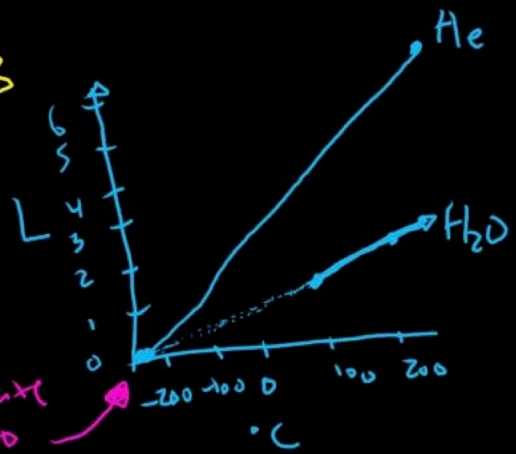
Charles's Law: $V/T = V/T$

Charles's Law: Volume and Temperature

Jacque Charles 1746 - 1823



Temp ↑ Volume ↑
300 K 1 L
600 K 2 L



$$\frac{V}{T} = b$$
$$\frac{V_i}{T_i} = \frac{V_f}{T_f}$$

$$\frac{1}{1} = \frac{2}{2}$$

$$PV = nRT$$

$$\frac{V_i}{T_i} = \frac{nR}{P} = \frac{V_f}{T_f}$$

A 2.0 L sample of air is collected at 298 K and then cooled to 278 K. The pressure is constant at 1.0 atm. Does the volume of the air increase or decrease? Calculate the volume of the air at 278 K.

$T \downarrow$ $V \downarrow$

$$\frac{V_i}{T_i} = \frac{V_f}{T_f}$$

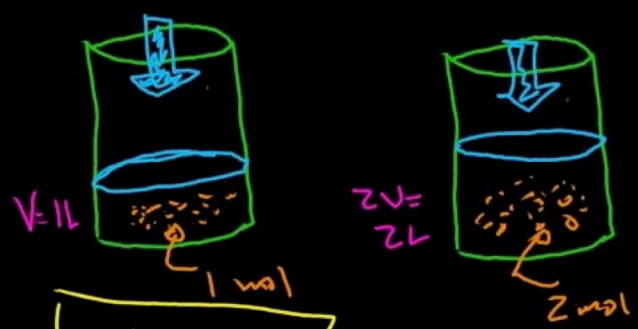
$$\frac{2.0 \text{ L}}{298 \text{ K}} = \frac{V_f}{278 \text{ K}}$$

$$V_f = \frac{2.0 \text{ L}}{298 \text{ K}} \cdot 278 \text{ K} = 1.9 \text{ L}$$

Avogadro's Law: $V/n = V/n$

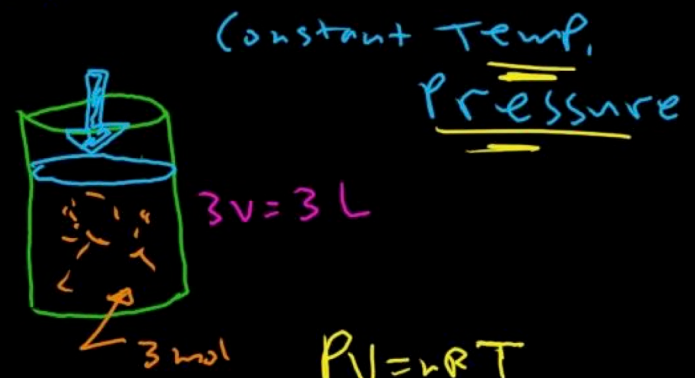
Avogadro's Law: Volume and moles

Amedeo Avogadro → 1811



$$\frac{V_i}{n_i} = \frac{V_f}{n_f}$$

$V = \text{volume}$
 $n = \text{moles}$



Constant Temp,
Pressure

$$PV = nRT$$
$$\frac{V}{n} = \frac{RT}{P}$$

Dalton's Law of Partial Pressures: $P = P_1 + P_2 + P_3$

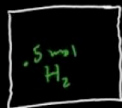
Dalton's Law of Partial Pressure

John Dalton 1803

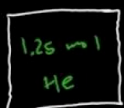
$P_{total} = P_1 + P_2 + P_3$

"For a mixture of gases in a container, the total pressure exerted is the sum of the partial pressures of the gases present. The partial pressure of a gas is the pressure that the gas would exert if it were alone in the container."

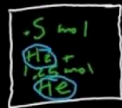
~John Dalton At constant temp. and Volume.



5.0 L tank
 $P_{H_2} = 2.4 \text{ atm}$
 $P = \text{pressure}$



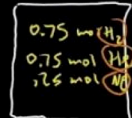
5.0 L tank
 $P_{He} = 6.0 \text{ atm}$



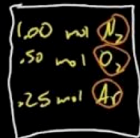
5.0 L tank
 $P_{total} = P_{H_2} + P_{He} = 2.4 + 6 = 8.4 \text{ atm}$



5.0 L tank
 8.4 atm



5.0 L tank
 8.4 atm



5.0 L tank
 8.4 atm

Total # of moles is what is important!
not the identity of the gas!

- 1) Volume the gases take up is not important
- 2) The forces between gases is not important.



$P = \frac{nRT}{V}$
 $P_{O_2} = \frac{0.49 \text{ mol} \cdot 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \cdot 298 \text{ K}}{5.0 \text{ L}} = 2.4 \text{ atm}$

Scuba divers use mixtures of helium and oxygen for deep dives. For one particular dive, 12 L of O_2 at 25°C and 1.0 atm and 46 L of He at 25°C and 1.0 atm were pumped into a 5.0 L Tank. Calculate the partial pressure of each gas and the total pressure in the tank at 25°C.

$PV = nRT$
 $n = \frac{PV}{RT}$
 $n_{O_2} = \frac{1.0 \text{ atm} \cdot 12 \text{ L}}{0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \cdot 298 \text{ K}} = 0.49 \text{ mol } O_2$
 $n_{He} = \frac{1.0 \text{ atm} \cdot 46 \text{ L}}{0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \cdot 298 \text{ K}} = 1.9 \text{ mol He}$
 $25^\circ\text{C} + 273 = 298 \text{ K}$

Answers not in video:

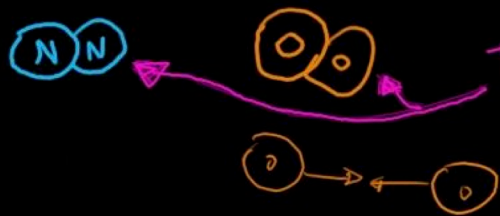
He Partial Pressure:
 $P_{He} = \frac{1.9 \text{ mol} \cdot 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \cdot 298 \text{ K}}{5.0 \text{ L}} = 9.3 \text{ atm}$

Total Tank Pressure:

$P_{total} = P_{O_2} + P_{He} = 2.4 \text{ atm} + 9.3 \text{ atm} = 11.7 \text{ atm}$

Diatomic Molecules

Diatomic Molecules



Two atoms per molecule

25C
or
50

- Bromine (liquid)
- Iodine (solid)
- Nitrogen (gas)
- Chlorine
- Hydrogen
- Oxygen
- Fluorine

Br I N Cl H O F

Molarity vs. Molality

Fundamentals of Solutions

1. Solution - a mixture in which the components are uniformly mixed (salt water)
2. Solvent - the component present in the largest amount (water)
3. Solute - the other component or components present (salt)

$$\text{Molarity (M)} \\ M = \frac{\text{amount (mol) of solute}}{\text{volume (L) of solution}} \\ M = \frac{\text{mol}}{\text{L}}$$

$$\text{vs. Molality (m)} \\ m = \frac{\text{amount (mol) of solute}}{\text{mass (kg) of solvent}} \\ m = \frac{\text{mol}}{\text{kg}}$$

***NOT ON VIDEO, GOOD TO KNOW: Molality is the more precise of the two because molality depends on mass rather than volume. Volume will change with regard to temperature, which can have an impact on measure of molarity when dealing with very precise measures. We also do not always know how two mixed solutions will interact. 0.5 mL + 0.5 mL is not always equal to 1 mL when mixing chemicals. That is why Molality is more precise.

What is the molarity of a solution prepared by dissolving 5 moles of NaCl in 2 liters of water?

- a) 0.4 M
- b) 0.4 m
- c) 2.5 M
- d) 2.5 m

$$M = \frac{5 \text{ mol}}{2 \text{ L}} = 2.5 \text{ M}$$

A .5 molal solution of could be prepared by dissolving

.5 mol of NaOH in

- a) 0.3 liter of water
- b) 1 liter of water
- c) 0.3 kg of water
- d) 1 kg of water

$$.5 \text{ m} = \frac{\text{mol}}{\text{kg}} = \frac{.5 \text{ NaOH}}{\text{kg}} \\ \text{kg} = \frac{.5 \text{ NaOH}}{.5 \text{ m}} = 1 \text{ kg}$$

The Bohr Model of the Atom

The Bohr Model of the Atom

1913 Niels Bohr



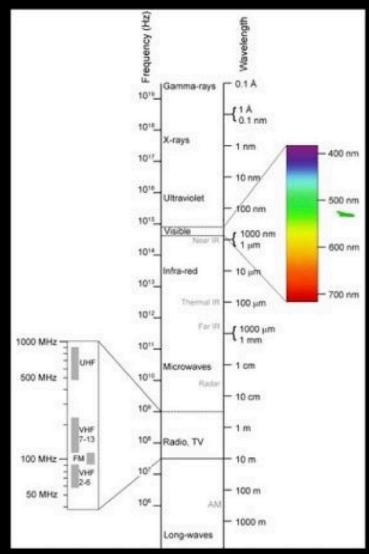
$$\Delta E = h \frac{c}{\lambda}$$

Energy = Joules

h = Planck's constant = 6.63×10^{-34} J·s

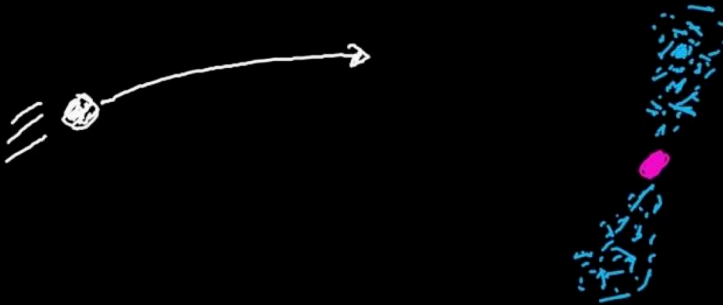
c = speed of light = 3.00×10^8 m/s

λ = wavelength (m)

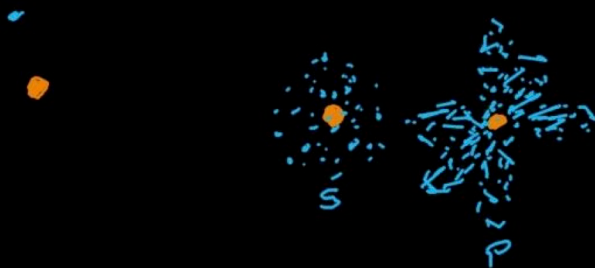


The Heisenberg Uncertainty Principle

Heisenberg uncertainty principle: It is impossible to know an electron's position and momentum (mass $\times$ speed) at the same time.

[illegible]

Electron Quantum Numbers and Modern Atomic Theory



Shell number, $n \rightarrow$ energy, size
Subshell number, $l \rightarrow$ shape

$$\begin{array}{ll} l=0 \rightarrow s & l=2 \rightarrow d \\ l=1 \rightarrow p & l=3 \rightarrow f \end{array}$$

orbital number, $m_l \rightarrow$ orientation

$$m_l = +2 \quad m_l = -2, -1, 0, 1, 2$$

Electron spin, $m_s = +\frac{1}{2}, -\frac{1}{2}$

[illegible]