



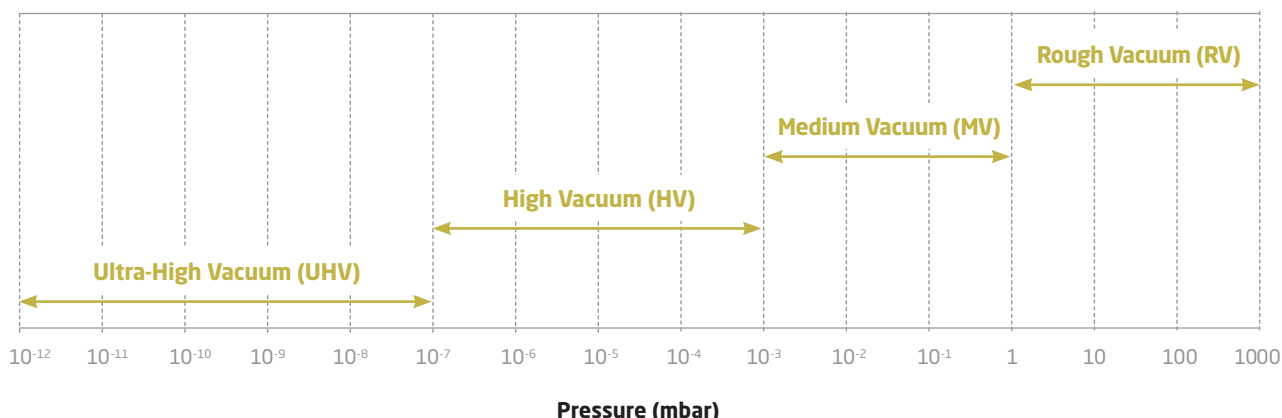
VACUUM VACUUM GUIDE 1

- Vacuum Pressure Ranges..... A 02
- Conversion Table of Pressures A 03
- Some Examples about Vacuum Ranges A 03
- Gas Flow and Leak Rate..... A 04
- Pumping Speed A 04
- Temperature A 04

Vacuum Ranges and Data

It is common in vacuum technology to subdivide its wide overall pressure range - which spans more than 16 powers of ten - into smaller individual regimes.

These ranges do not have universally agreed definitions, but a typical distribution is as the graph below:



	UNIT	UHV ULTRA-HIGH VACUUM	HV HIGH VACUUM	MV MEDIUM VACUUM	RV ROUGH VACUUM
Pressure	mbar	< 10 ⁻⁷	10 ⁻³ - 10 ⁻⁷	1 - 10 ⁻³	1000 - 1
Particle number density	cm ⁻³	< 10 ⁹	10 ¹³ - 10 ⁹	10 ¹⁶ - 10 ¹³	10 ¹⁹ - 10 ¹⁶
Mean free path	cm	> 10 ⁵	10 - 10 ⁵	10 ⁻² - 10	10 ⁻⁵ - 10 ⁻²
Molecular collision rate	cm ⁻² .s ⁻¹	< 10 ⁹	10 ¹⁷ - 10 ⁹	10 ²³ - 10 ¹⁷	10 ²⁹ - 10 ²³
Monolayer time	s	> 100	10 ⁻² - 100	10 ⁻⁵ - 10 ⁻²	< 10 ⁻⁵
Type of gas flow	-	Molecular flow*	Molecular flow*	Knudsen flow**	Viscous flow***

* Molecular flow: gas flow determined by gas-wall collisions

** Knudsen flow: transition flow

*** Viscous flow: gas flow determined by molecule-molecule collisions

CONVERSION TABLE OF PRESSURES

	Pa (N.m ⁻²)	bar	mbar	µbar (dyn.cm ⁻²)	Torr (mm Hg)	atm	psi (lbf.inch ⁻²)
1 Pa (N.m ⁻²)	1	1.10 ⁻⁵	1.10 ⁻²	10	7.5.10 ⁻³	9.87.10 ⁻⁶	1.45.10 ⁻⁴
1 bar	1.10 ⁵	1	1000	1.10 ⁶	750	0.987	14.5
1 mbar	100	1.10 ⁻³	1	1000	0.75	9.87.10 ⁻⁴	1.45.10 ⁻²
1 µbar (dyn.cm ⁻²)	0.1	1.10 ⁻⁶	1.10 ⁻³	1	7.5.10 ⁻⁴	9.87.10 ⁻⁷	1.45.10 ⁻⁵
1 Torr (mm Hg)	133.3	1.333.10 ⁻³	1.333	1333	1	1.32.10 ⁻³	1.93.10 ⁻²
1 atm	1.01.10 ⁵	1.013	1013	1.01.10 ⁶	760	1	14.7
1 psi (lbf.inch ⁻²)	6.89.10 ³	6.89.10 ⁻²	68.9	6.89.10 ⁴	51.71	6.8.10 ⁻²	1

SOME EXAMPLES ABOUT VACUUM RANGES

	PRESSURE (Pa)	PRESSURE Torr (mbar)	MEAN FREE PATH	MOLECULES /cm ³
Standard atmosphere, for comparison	101.325 kPa	760	66 nm	2.5.10 ¹⁹
Vacuum cleaner	approximately 8.10 ⁴	600	70 nm	10 ¹⁹
Liquid ring vacuum pump	approximately 3.2.10 ³	24	1.75 µm	10 ¹⁸
Mars atmosphere	1.155 kPa to 0.03 kPa (mean 0.6 kPa)	8.66 to 0.23		
Freeze drying	100 to 10	1 to 0.1	100 µm to 1 mm	10 ¹⁶ to 10 ¹⁵
Rotary vane pump	100 to 0.1	1 to 10 ⁻³	100 µm to 10 cm	10 ¹⁶ to 10 ¹³
Incandescent light bulb	10 to 1	0.1 to 0.01	1 mm to 1 cm	10 ¹⁵ to 10 ¹⁴
Thermos bottle	1 to 0.01	10 ⁻² to 10 ⁻⁴	1 cm to 1 m	10 ¹⁴ to 10 ¹²
Earth thermosphere	1 Pa to 1.10 ⁻⁷	10 ⁻² to 10 ⁻⁹	1 cm to 100 km	10 ¹⁴ to 10 ⁷
Vacuum tube	1.10 ⁻⁵ to 1.10 ⁻⁸	10 ⁻⁷ to 10 ⁻¹⁰	1 to 1 000 km	10 ⁹ to 10 ⁶
Cryopumped MBE chamber	1.10 ⁻⁷ to 1.10 ⁻⁹	10 ⁻⁹ to 10 ⁻¹¹	100 to 10 000 km	10 ⁷ to 10 ⁵
Pressure on the Moon	approximately 1.10 ⁻⁹	10 ⁻¹¹	10 000 km	4.10 ⁵

GAS FLOW AND LEAK RATE

	Pa.m ³ .s ⁻¹	mbar.l.s ⁻¹	Torr.l.s ⁻¹	atm.cm ³ .s ⁻¹	lusec	sccm	slm	Mol.s ⁻¹
1 Pa.m³.s⁻¹	1	10	7.5	9.87	7.5.10 ³	592	0.592	4.41.10 ⁻⁴
1 mbar.l.s⁻¹	0.1	1	0.75	0.987	750	59.2	5.92.10 ⁻²	4.41.10 ⁻⁵
1 Torr.l.s⁻¹	0.1333	1.333	1	1.32	1000	78.9	7.89.10 ⁻²	5.85.10 ⁻⁵
1 atm.cm³.s⁻¹	0.101	1.01	0.76	1	760	60	6.10 ⁻²	4.45.10 ⁻⁵
1 lusec	1.333.10 ⁻⁴	1.333.10 ⁻³	10 ⁻³	1.32.10 ⁻³	1	7.89.10 ⁻²	7.89.10 ⁻⁵	5.86.10 ⁻⁸
1 sccm	1.69.10 ⁻³	1.69.10 ⁻²	1.27.10 ⁻²	1.67.10 ⁻²	12.7	1	10 ⁻³	7.45.10 ⁻⁷
1 slm	2.69	16.9	12.7	16.7	1.27.10 ⁴	1000	1	7.45.10 ⁻⁴
1 Mol.s⁻¹	2.27.10 ³	2.27.10 ⁴	1.7.10 ⁴	2.24.10 ⁴	1.7.10 ⁷	1.34.10 ⁶	1.34.10 ³	1

PUMPING SPEED

	m ³ .s ⁻¹	l.s ⁻¹	m ³ .h ⁻¹	l.min ⁻¹	cfm
m³.s⁻¹	1	10 ³	3600	6.10 ⁴	2.12.10 ³
l.s⁻¹	10 ⁻³	1	3.6	60	2.12
m³.h⁻¹	2.78.10 ⁻⁴	2.78.10 ⁻¹	1	16.7.10 ⁻⁵	5.89.10 ⁻¹
l.min⁻¹	1.67.10 ⁻⁵	1.67.10 ⁻²	6.10 ⁻²	1	3.536.10 ⁻²
cfm	4.72.10 ⁻⁴	0.47195	1.699	28.32	1

TEMPERATURE

	K	°C	°F
1 K	1	K - 273.15	5/9 x (K - 459.67)
1°C	°C + 273.15	1	5/9 x (°C + 32)
1°F	5/9 x (°F + 459.67)	5/9 x (°F - 32)	1

°C	-50	0	50	100	150	200	250
°F	-58	32	122	212	302	392	482



neyco

30 rue de la Paix
92170 Vanves - France
Tel: +33(0)1 41 90 50 50
Fax: +33(0)1 41 90 50 51

www.neyco.fr



2022 v1

neyco