

## Syringe Pump Pressure and Flow Rate

### How to Calculate the Pressure of Various Syringe Sizes

The pressure that a syringe pump can generate is a function of both the force of the pump (measured at the pusher block in pounds) as well as the physical characteristics of the syringe and setup used. The following table compares various syringe pumps and the pressures in PSI (pounds per square inch). Each data point was calculated by dividing the average pump force by the surface area (in square inches) of syringes with diameters from 0.1 to 50 mm. Diameters and surface areas for a variety of syringes can be found in the table on page 120. This table is intended to be a guide of total pressures generated.

Actual values may be higher or lower than the listed pressures due to the influence of other factors such as tubing diameter and length. When using more than one syringe sharing the same pusher block, the pressure is calculated by dividing the force (lbs) by the total surface area (square inches) of all syringes on the pump. For example, nominal pressure obtained using two 25 ml Hamilton Gastight® syringes on a PHD 22/2000 standard pressure syringe pump would be: 50 lbs / (0.644 in<sup>2</sup> X 2) = 38.81 PSI (2.68 bars).

Pump Average Pressure <sup>A</sup> (PSI) <sup>B</sup>							
Syringe Size	Syringe Diameter (mm)	Pump 11 Plus	Pump 22	Pump 33	PHD 22/2000	PHD 22/2000 Hpsi	PHD 4400 Hpsi
0.5 µl	0.1	>1000	>1000	>1000	>1000	–	>1000
10 µl	0.5	>1000	>1000	>1000	>1000	–	>1000
50 µl	1	>1000	>1000	>1000	>1000	–	>1000
1 ml	5	526	>1000	>1000	>1000	–	>1000
5 ml	10	131	386	468	394	–	1438
10 ml	15	58	172	208	175	–	639
50 ml	25	21	62	75	63	569	230
Force (lbs)		16	47	57	48	433	200
See page		29	30	31	32	35	35

A. Calculated pressure based on pump force at average speed

- Higher pressures may be achieved at minimum speed and lower pressures at maximum speed.
- Pump speed and force are inversely proportional.
- Most syringes are pressure rated and may not be able to tolerate pressure generated by the syringe pump. Consult Harvard Apparatus or your syringe manufacturer for syringe details and specifications.

B. To convert pressure from PSI to bars use the following equation: bar pressure = PSI x 0.0690.

C. Actual force is higher. Use of pump with greater back pressure may result in premature wear of syringe pump halfnut.

### Minimum/Maximum Flow Rates by Pump and Syringe Size

Flow rates were calculated based on the pusher block travel rate for each pump (rate at which the syringe pump moves the syringe plunger) and the diameter of the syringe.

PHD 22/2000 HPSI Flow Rates			
Syringe Size	Diameter **	Minimum	Maximum
20 ml	19.13 mm	1.5 µl/hr	20 ml/min
50 ml	28.60 mm	3.4 µl/hr	46 ml/min
100 ml	34.90 mm	5.0 µl/hr	68 ml/min
200 ml	44.75 mm	8.2 µl/hr	112 ml/min

\* The Rates listed are for single stainless steel syringe

\*\*Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

PHD ULTRA™ HPSI & XF Flow Rates			
Syringe Size	Syringe ID **	Minimum Rate	Maximum Rate
20 ml	19.130 mm	50.7884 nl/min	26.3709 ml/min
30 ml	21.590 mm	64.6904 nl/min	33.5893 ml/min
50 ml	28.600 mm	113.519 nl/min	58.9423 ml/min
100 ml	34.900 mm	169.038 nl/min	87.7700 ml/min
130 ml	37.948 mm	199.854 nl/min	103.770 ml/min
200 ml	44.755 mm	277.983 nl/min	144.337 ml/min

\* The Rates listed are for single stainless steel syringe

\*\*Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

## Syringe Pump Pressure and Flow Rate

### Minimum/Maximum Flow Rates By Pump and Syringe Size

#### Pump 11 Elite Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.  
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	1.26 pl/min	1.326 µl/min
1 µl	0.146 mm	2.52 pl/min	2.654 µl/min
2 µl	0.206 mm	5.10 pl/min	5.304 µl/min
5 µl	0.343 mm	14.160 pl/min	14.710 µl/min
10 µl	0.485 mm	28.260 pl/min	29.400 µl/min
25 µl	0.729 mm	63.960 pl/min	66.430 µl/min
50 µl	1.030 mm	127.700 pl/min	132.600 µl/min
100 µl	1.457 mm	255.500 pl/min	265.400 µl/min
250 µl	2.304 mm	638.900 pl/min	663.500 µl/min
500 µl	3.256 mm	1.276 nl/min	1.325 ml/min
1000 µl	4.608 mm	2.556 nl/min	2.654 ml/min
1 ml	4.699 mm	2.658 nl/min	2.760 ml/min
3 ml	8.585 mm	8.871 nl/min	9.213 ml/min
5 ml	11.99 mm	17.300 nl/min	17.970 ml/min
10 ml	14.43 mm	25.050 nl/min	26.020 ml/min
20 ml	19.05 mm	43.680 nl/min	45.360 ml/min
30 ml	21.59 mm	56.110 nl/min	58.270 ml/min
50 ml	26.59 mm	85.130 nl/min	88.400 ml/min
60 ml	26.59 mm	85.130 nl/min	88.400 ml/min

\* Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

#### NanoCool Injector Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.  
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	3.66 pl/min	1.909 µl/min
1 µl	0.146 mm	7.32 pl/min	3.819 µl/min
2 µl	0.206 mm	14.70 pl/min	7.635 µl/min
5 µl	0.343 mm	40.74 pl/min	21.17 µl/min
10 µl	0.485 mm	81.48 pl/min	42.32 µl/min
25 µl	0.729 mm	184.1 pl/min	95.62 µl/min
50 µl	1.030 mm	367.6 pl/min	190.9 µl/min
100 µl	1.457 mm	735.6 pl/min	381.9 µl/min
250 µl	2.304 mm	1.839 nl/min	955.1 µl/min
500 µl	3.256 mm	3.677 nl/min	1.907 ml/min

\* Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

#### Pump 11 Plus Flow Rates

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.10 mm	0.0001 µl/min	0.0003 ml/min
1 µl	0.15 mm	0.0001 µl/min	0.0008 ml/min
2 µl	0.21 mm	0.0002 µl/min	0.0016 ml/min
5 µl	0.33 mm	0.0003 µl/min	0.0040 ml/min
10 µl	0.46 mm	0.0005 µl/min	0.0078 ml/min
25 µl	0.73 mm	0.0013 µl/min	0.0198 ml/min
50 µl	1.03 mm	0.0025 µl/min	0.0395 ml/min
100 µl	1.46 mm	0.0049 µl/min	0.0794 ml/min
250 µl	2.30 mm	0.0121 µl/min	0.1970 ml/min
500 µl	3.26 mm	0.0242 µl/min	0.3959 ml/min
1 ml	5.00 mm	0.0484 µl/min	0.7918 ml/min
2.5 ml	7.28 to 9.6 mm	0.1206 µl/min	1.974 ml/min
3 ml	8.66 to 9.0 mm	0.1706 µl/min	2.794 ml/min
5 ml	10.3 to 13.0 mm	0.2413 µl/min	3.952 ml/min
10 ml	14.57 to 15.9 mm	0.4828 µl/min	7.909 ml/min
20 ml	19.13 to 20.05 mm	0.9142 µl/min	14.97 ml/min
30 ml	21.7 to 23.2 mm	1.214 µl/min	19.88 ml/min
50 ml	26.7 to 32.6 mm	1.622 µl/min	26.56 ml/min

\* Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

#### Pump 11 Elite Nanomite & PHD ULTRA™ Nanomite Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.  
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	3.66 pl/min	1.909 µl/min
1 µl	0.146 mm	7.32 pl/min	3.819 µl/min
2 µl	0.206 mm	14.70 pl/min	7.635 µl/min
5 µl	0.343 mm	40.74 pl/min	21.17 µl/min
10 µl	0.485 mm	81.48 pl/min	42.32 µl/min
25 µl	0.729 mm	184.1 pl/min	95.62 µl/min
50 µl	1.030 mm	367.6 pl/min	190.9 µl/min
100 µl	1.457 mm	735.6 pl/min	381.9 µl/min
250 µl	2.304 mm	1.839 nl/min	955.1 µl/min
500 µl	3.256 mm	3.677 nl/min	1.907 ml/min
1000 µl	4.608 mm	7.358 nl/min	3.820 ml/min

\* Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

## Syringe Pump Pressure and Flow Rate (continued)

### Minimum/Maximum Flow Rates By Pump and Syringe Size

#### Pico Plus Elite Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.  
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	0.54 pl/min	596.5 nl/min
1 µl	0.1457 mm	1.14 pl/min	1.194 µl/min
2 µl	0.206 mm	2.28 pl/min	2.386 µl/min
5 µl	0.343 mm	6.36 pl/min	6.615 µl/min
10 µl	0.485 mm	12.72 pl/min	13.230 µl/min
25 µl	0.729 mm	28.74 pl/min	29.880 µl/min
50 µl	1.030 mm	57.42 pl/min	59.650 µl/min
100 µl	1.457 mm	114.9 pl/min	119.4 µl/min
250 µl	2.304 mm	287.4 pl/min	298.5 µl/min
500 µl	3.256 mm	574.0 pl/min	596.1 µl/min
1000 µl	4.608 mm	1.150 nl/min	1.194 ml/min
1 ml	4.699 mm	1.196 nl/min	1.241 ml/min
3 ml	8.585 mm	3.990 nl/min	4.144 ml/min
5 ml	11.989 mm	7.782 nl/min	8.082 ml/min
10 ml	14.430 mm	11.270 nl/min	11.700 ml/min

\* Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

#### Pump 22 and Physio 22 Flow Rates

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.10 mm	0.002 µl/hr	23.8 µl/hr
1 µl	0.15 mm	0.003 µl/hr	47.8 µl/hr
2 µl	0.21 mm	0.006 µl/hr	95.2 µl/hr
5 µl	0.33 mm	0.015 µl/hr	238.0 µl/hr
10 µl	0.46 mm	0.029 µl/hr	474.0 µl/hr
25 µl	0.73 mm	0.073 µl/hr	1193.0 µl/hr
50 µl	1.03 mm	0.002 µl/min	39.7 µl/min
100 µl	1.46 mm	0.005 µl/min	79.7 µl/min
250 µl	2.30 mm	0.012 µl/min	197.8 µl/min
500 µl	3.26 mm	0.024 µl/min	397.0 µl/min
1000 µl	4.61 mm	0.048 µl/min	795.0 µl/min
1 ml	5.00 mm	0.049 µl/min	805.0 µl/min
2 ml	9.00 mm	0.011 ml/hr	186.6 ml/hr
2.5 ml	7.28 to 9.6 mm	0.010 ml/hr	168.2 ml/hr
3 ml	8.66 to 9.0 mm	0.011 ml/hr	181.4 ml/hr
5 ml	10.3 to 13.0 mm	0.019 ml/hr	317.0 ml/hr
10 ml	14.57 to 15.9 mm	0.028 ml/hr	461.0 ml/hr
20 ml	19.13 to 20.05 mm	0.050 ml/hr	821.0 ml/hr
30 ml	21.7 to 23.2 mm	0.074 ml/hr	1208.8 ml/hr
50 ml	26.7 to 32.6 mm	0.002 ml/min	28.4 ml/min
100 ml	34.9 to 35.7 mm	0.003 ml/min	47.6 ml/min
140 ml	38.40 mm	0.004 ml/min	55.1 ml/min

\* Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

## Syringe Pump Pressure and Flow Rate (continued)

### Minimum/Maximum Flow Rates By Pump and Syringe Size

Pump 33 Flow Rates			
Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	0.0004 µl/hr	0.79 µl/min
1 µl	0.1457 mm	0.0008 µl/hr	1.58 µl/min
2 µl	0.206 mm	0.0015 µl/hr	3.1 µl/min
5 µl	0.3257 mm	0.0037 µl/hr	7.93 µl/min
10 µl	0.46 mm	0.0073 µl/hr	15.829 µl/min
25 µl	0.73 mm	0.0183 µl/hr	39.756 µl/min
50 µl	1.03 mm	0.0365 µl/hr	79.519 µl/min
100 µl	1.46 mm	0.0731 µl/hr	159.46 µl/min
250 µl	2.30 mm	0.1813 µl/hr	23.751 ml/hr
500 µl	3.26 mm	0.2184 µl/hr	28.62 ml/hr
1000 µl	4.61 mm	0.7281 µl/hr	95.418 ml/hr
1 ml	5.00 mm	0.7828 µl/hr	102.580 ml/hr
2 ml	9.00 mm	2.8493 µl/hr	373.430 ml/hr
2.5 ml	7.28 to 9.6 mm	1.8156 µl/hr	237.950 ml/hr
3 ml	8.66 to 9.0 mm	2.5691 µl/hr	336.710 ml/hr
5 ml	10.3 to 13.0 mm	4.9824 µl/hr	653.010 ml/hr
10 ml	14.57 to 15.9 mm	7.2024 µl/hr	15.733 ml/min
20 ml	19.13 to 20.05 mm	12.536 µl/hr	27.384 ml/min
30 ml	21.7 to 23.2 mm	16.131 µl/hr	35.236 ml/min
50 ml	26.7 to 32.6 mm	24.4201 µl/hr	53.346 ml/min
100 ml	34.9 to 35.7 mm	0.087 µl/min	91.20 ml/min
140 ml	38.40 mm	0.1053 µl/min	106.60 ml/min

\* Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

PHD 22/2000 and PHD 4400 Hpsi Flow Rates			
Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.10 mm	0.0001 µl/hr	95.330 µl/hr
1 µl	0.15 mm	0.0002 µl/hr	190.70 µl/hr
2 µl	0.21 mm	0.0004 µl/hr	381.30 µl/hr
5 µl	0.33 mm	0.0010 µl/hr	953.17 µl/hr
10 µl	0.46 mm	0.0019 µl/hr	1.901 ml/hr
25 µl	0.73 mm	0.0046 µl/hr	4.775 ml/hr
50 µl	1.03 mm	0.0092 µl/hr	9.551 ml/hr
100 µl	1.46 mm	0.0183 µl/hr	19.153 ml/hr
250 µl	2.30 mm	0.0454 µl/hr	47.532 ml/hr
500 µl	3.26 mm	0.0911 µl/hr	95.492 ml/hr
1000 µl	4.61 mm	0.0031 µl/min	190.950 ml/hr
1 ml	5.00 mm	0.0033 µl/min	205.30 ml/hr
2 ml	9.00 mm	0.0119 µl/min	747.35 ml/hr
2.5 ml	7.28 to 9.6 mm	0.0076 µl/min	476.21 ml/hr
3 ml	8.66 to 9.0 mm	0.0100 µl/min	11.231 ml/min
5 ml	10.3 to 13.0 mm	0.0208 µl/min	21.781 ml/min
10 ml	14.57 to 15.9 mm	0.0301 µl/min	31.486 ml/min
20 ml	19.13 to 20.05 mm	0.0523 µl/min	54.804 ml/min
30 ml	21.7 to 23.2 mm	0.0673 µl/min	70.518 ml/min
50 ml	26.7 to 32.6 mm	0.1019 µl/min	106.76 ml/min
100 ml	34.9 to 35.7 mm	0.1740 µl/min	182.40 ml/min
140 ml	38.40 mm	0.2106 µl/min	220.82 ml/min

\* Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

## Syringe Pump Pressure and Flow Rate (continued)

### Minimum/Maximum Flow Rates By Pump and Syringe Size

#### PHD ULTRA™ 4400 Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.  
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	3.0600 pl/min	1.59133 µl/min
1 µl	0.1457 mm	6.1200 pl/min	3.18423 µl/min
2 µl	0.206 mm	12.240 pl/min	6.36532 µl/min
5 µl	0.343 mm	33.960 pl/min	17.6471 µl/min
10 µl	0.485 mm	67.920 pl/min	35.2833 µl/min
25 µl	0.729 mm	153.480 pl/min	79.7151 µl/min
50 µl	1.030 mm	306.420 pl/min	159.133 µl/min
100 µl	1.457 mm	613.200 pl/min	318.423 µl/min
250 µl	2.304 mm	1.53348 nl/min	796.252 µl/min
500 µl	3.256 mm	3.06258 nl/min	1.59021 ml/min
1 ml	4.699 mm	6.37872 nl/min	3.31205 ml/min
2.5 ml	4.851 mm	6.79806 nl/min	3.52979 ml/min
3 ml	8.585 mm	21.915 nl/min	11.0552 ml/min
5 ml	11.989 mm	41.5232 nl/min	21.5601 ml/min
8 ml	9.525 mm	26.2093 nl/min	13.6087 ml/min
10 ml	14.427 mm	60.1280 nl/min	31.2204 ml/min
20 ml	19.050 mm	104.837 nl/min	54.4347 ml/min
30 ml	21.590 mm	134.658 nl/min	69.9183 ml/min
50 ml	26.594 mm	204.311 nl/min	106.085 ml/min
100 ml	34.900 mm	351.865 nl/min	182.699 ml/min
140 ml	37.950 mm	416.009 nl/min	216.005 ml/min

\* Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

#### PHD ULTRA™ Flow Rates

Nominal Minimum/Maximum Flow Rates for Various Syringes.  
(Actual Limits will vary depending on syringe manufacturer)

Syringe Size	Diameter *	Minimum	Maximum
0.5 µl	0.103 mm	1.500 pl/min	1.59133 µl/min
1 µl	0.1457 mm	3.060 pl/min	3.18423 µl/min
2 µl	0.206 mm	6.120 pl/min	6.36532 µl/min
5 µl	0.343 mm	16.980 pl/min	17.6471 µl/min
10 µl	0.485 mm	33.960 pl/min	35.2833 µl/min
25 µl	0.729 mm	76.740 pl/min	79.7151 µl/min
50 µl	1.030 mm	153.180 pl/min	159.133 µl/min
100 µl	1.457 mm	306.600 pl/min	318.423 µl/min
250 µl	2.304 mm	766.740 pl/min	796.252 µl/min
500 µl	3.256 mm	1.53126 nl/min	1.59021 ml/min
1 ml	4.699 mm	3.18936 nl/min	3.31205 ml/min
2.5 ml	4.851 mm	3.3990 nl/min	3.52979 ml/min
3 ml	8.585 mm	10.645 nl/min	11.0552 ml/min
5 ml	11.989 mm	20.7616 nl/min	21.5601 ml/min
8 ml	9.525 mm	13.1046 nl/min	13.6087 ml/min
10 ml	14.427 mm	30.0640 nl/min	31.2204 ml/min
20 ml	19.050 mm	52.4186 nl/min	54.4347 ml/min
30 ml	21.590 mm	67.3288 nl/min	69.9183 ml/min
50 ml	26.594 mm	102.156 nl/min	106.085 ml/min
100 ml	35.700 mm	184.091 nl/min	191.171 ml/min
140 ml	37.948 mm	208.005 nl/min	216.005 ml/min

\* Note: These figures have been rounded and therefore may not exactly match the Syringe Diameter Chart on page 120.

## Common Syringe Data

### Diameter and Plunger Surface Area

The following list is a guide to common syringes and their associated diameters and surface area. Syringe diameter data, in mm, is listed below for each syringe. All Harvard Apparatus microprocessor syringe pumps require the user to input syringe diameter information. The pump uses this diameter data to set flow rates. The PHD 22/2000 series of syringe pumps also has this information built into the pump memory in a handy Syringe Look Up Table. Surface area information

was used to calculate PSI (pounds per square inch) data for the pressure table on page 115. Average pressures for any syringe pump and syringe combination can be calculated by dividing the average (nominal) syringe pump force by the syringe diameter (in square inches) to obtain PSI. Example, nominal pressure obtained using a 25 ml Hamilton Gastight® Syringe on a PHD 22/2000 standard pressure syringe pump would be: 50 lbs / 0.644 in<sup>2</sup> = 77.6 PSI (5.35 bars).

#### Common Syringe Diameters

Volume	Diameter (mm)	Surface Area (in <sup>2</sup> )
<b>BD Plastic</b>		
1 ml	4.699	0.026880
3 ml	8.585	0.089722
5 ml	11.989	0.174980
10 ml	14.427	0.253381
20 ml	19.05	0.441786
30 ml	21.59	0.567450
50/60 ml	26.594	0.860974
<b>BD Glass</b>		
0.5 ml	4.64	0.026209
1 ml	4.64	0.026209
2.5 ml	8.66	0.091297
5 ml	11.86	0.171235
10 ml	14.34	0.250335
20 ml	19.13	0.445505
30 ml	22.7	0.627298
50 ml	28.6	0.995760
100 ml	34.9	1.482768
<b>SGE Glass</b>		
25 µl	0.73	0.000649
50 µl	1.03	0.001292
100 µl	1.46	0.002595
250 µl	2.3	0.006440
500 µl	3.26	0.012938
1 ml	4.61	0.025872
2.5 ml	7.28	0.064519
5 ml	10.3	0.129151
10 ml	14.57	0.258429

#### Common Syringe Diameters

Volume	Diameter (mm)	Surface Area (in <sup>2</sup> )
<b>Harvard Apparatus Stainless Steel</b>		
2.5 ml	4.851	0.027937
8 ml	9.525	0.110447
20 ml	19.13	0.445505
50 ml	28.6	0.995760
100 ml	34.9	1.482768
200 ml	44.75	2.438382
<b>Terumo Plastic</b>		
3 ml	8.95	0.097514
5 ml	13	0.205735
10 ml	15.8	0.303904
20 ml	20.15	0.494279
30 ml	23.1	0.649601
60 ml	29.1	1.030881
<b>Air-Tite All Plastic</b>		
2.5 ml	9.6	0.112193
5 ml	12.45	0.188695
10 ml	15.9	0.307763
20 ml	20.05	0.489386
30 ml	22.9	0.638401
50 ml	29.2	1.037979
<b>Cadence Science (formerly Popper &amp; Sons) Perfectum Glass</b>		
0.5 ml	3.45	0.014490
1 ml	4.5	0.024652
2 ml	8.92	0.096862
3 ml	8.99	0.098388
5 ml	11.7	0.166646
10 ml	14.7	0.263061
20 ml	19.58	0.466711
30 ml	22.7	0.627298
50 ml	29	1.023808
100 ml	35.7	1.551525

#### Common Syringe Diameters

Volume	Diameter (mm)	Surface Area (in <sup>2</sup> )
<b>Hamilton Gastight Glass</b>		
0.5 µl	0.103	0.000013
1 µl	0.146	0.000026
2 µl	0.206	0.000052
5 µl	0.343	0.000129
10 µl	0.485	0.000258
25 µl	0.729	0.000647
50 µl	1.03	0.001294
100 µl	1.457	0.002595
250 µl	2.304	0.006440
500 µl	3.256	0.012938
1 ml	4.608	0.025872
2.5 ml	7.285	0.064519
5 ml	10.3	0.129151
10 ml	14.567	0.258429
25 ml	23.033	0.643989
50 ml	32.573	1.293772
100 ml	32.573	1.293772
<b>Covidien Monoject Plastic (formerly Kendall)</b>		
1 ml	4.674	0.026323
3 ml	8.865	0.097297
6 ml	12.600	0.196350
12 ml	15.621	0.307763
20 ml	20.142	0.506621
35 ml	23.571	0.689567
60 ml	26.568	0.861362
140 ml	37.948	1.795084

## How to Select the Correct Syringe for Your Application

### Syringe Selection Guide

Syringe Type/Size	Swage Lock	Luer Lock	RN	Threaded 1/4-28	Luer Slip Fit	Pressure Maximum p.s.i.	Compatibility with Substance in Syringe	Accuracy 1%	Accuracy 5%	Materials
<b>Stainless Steel Syringes, see pages 50 to 51</b>										
2.5 ml	•					7,500	Maximum	•		316 / St. Steel
8 ml	•					1,500	Maximum	•		316 / Perfluoroelastomer
20 ml	•	•				750	Maximum	•		316 / Viton or Perfluoroelastomer
50 ml	•	•				750	Maximum	•		316 / Viton or Perfluoroelastomer
100 ml	•	•				750	Maximum	•		316 / Viton or Perfluoroelastomer
200 ml	•	•				750	Maximum	•		316 / Viton or Perfluoroelastomer
<b>Glass GasTight Syringes, see pages 55 to 56</b>										
1 to 100 µl		•	•	•	•	1,000	Maximum	•		Glass and PTFE
250 to 500 µl		•	•	•	•	500	Maximum	•		Glass and PTFE
1 to 10 ml		•	•	•		200	Maximum	•		Glass and PTFE
25 to 100 ml		•	•	•		100	Maximum	•		Glass and PTFE
<b>Glass Multifit Syringes, see page 57</b>										
2 to 50 ml		•				100	Maximum	•		Glass Only
<b>Plastic Syringes, see pages 58 to 59</b>										
1 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
5 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
10 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
20 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
30 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
50/60 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber
140 ml		•			•	125	Minimum		•	Polypropylene and Natural Rubber

# PUMP REFERENCES

## French Scale and Needle Gauge Cross Reference Chart

PUMP REFERENCES French Scale and Needle Gauge Cross Reference Chart

French Scale and Needle Gauge Cross Reference Chart								
French Scale	Exact French OD		Needle Gauge	Exact Gauge OD		Exact Gauge ID		Volume
	inches	mm		inches	mm	inches	mm	µl/in
-	0.0083	0.21	33	0.0083	0.21	0.0040	0.11	0.20
-	0.0093	0.24	32	0.0093	0.24	0.0043	0.11	0.20
-	0.0103	0.26	31	0.0103	0.26	0.0053	0.13	0.34
-	0.0123	0.31	30	0.0123	0.31	0.0063	0.16	0.45
1	0.013	0.33	29	0.013	0.33	-	-	-
-	0.014	0.36	28	0.014	0.36	0.0073	0.18	0.63
-	0.016	0.41	27	0.016	0.41	0.0083	0.21	0.80
-	0.018	0.46	26	0.018	0.46	0.0103	0.26	1.25
1.8	0.024	0.61	25	0.023	0.51	0.0103	0.26	1.25
-	0.022	0.57	24	0.022	0.57	0.0123	0.31	1.80
2	0.026	0.66	23	0.025	0.64	0.0133	0.34	2.17
-	0.028	0.72	22	0.028	0.72	0.0163	0.41	3.35
2.4	0.031	0.79	21	0.032	0.82	0.0203	0.51	5.19
2.9	0.038	0.97	20	0.036	0.91	0.0238	0.60	6.71
3	0.039	0.99	-	0.039	0.99	-	-	-
3.3	0.043	1.09	19	0.042	1.07	0.0270	0.69	-
3.7	0.048	1.22	-	0.048	1.22	-	-	-
3.8	0.050	1.27	18	0.050	1.27	0.0330	0.84	14.08
4	0.052	1.32	-	0.052	1.32	-	-	-
4.6	0.060	1.52	17	0.058	1.47	0.0420	1.07	22.84
4.7	0.062	1.57	-	0.062	1.57	-	-	-
5	0.066	1.68	16	0.065	1.65	0.0470	1.19	28.25
5.1	0.067	1.70	-	0.067	1.70	-	-	-
5.7	0.075	1.91	15	0.072	1.83	0.0540	1.37	-
5.9	0.078	1.98	-	0.078	1.98	-	-	-
6	0.079	2.01	-	0.079	2.01	-	-	-
6.2	0.082	2.08	14	0.083	2.11	0.0630	1.60	51.07
7	0.092	2.34	-	0.092	2.34	-	-	-
7.2	0.095	2.41	13	0.095	2.41	0.0710	1.80	64.63
8	0.105	2.67	-	0.105	2.67	-	-	-
8.1	0.106	2.69	-	0.106	2.69	-	-	-
-	0.109	2.77	12	0.109	2.77	0.0850	2.16	93.07
8.4	0.118	3.00	11	0.120	3.05	0.0940	2.39	113.00
9.8	0.128	3.25	-	0.128	3.25	-	-	-
10	0.131	3.33	10	0.134	3.40	0.1060	2.69	143.28
11	0.145	3.68	-	0.145	3.68	-	-	-
11.7	0.153	3.89	-	0.153	3.89	-	-	-
12.3	0.161	4.09	-	0.161	4.09	-	-	-
13	0.171	4.34	-	0.171	4.34	-	-	-
14	0.184	4.67	-	0.184	4.67	-	-	-
15	0.197	5.00	-	0.197	5.00	-	-	-
16	0.210	5.33	-	0.210	5.33	-	-	-
17	0.223	5.66	-	0.223	5.66	-	-	-
18	0.236	5.99	-	0.236	5.99	-	-	-

\* French Scale = OD (in) x 76.211 - 0.0014



## Pressure Unit Conversion Chart

### Pressure Unit Cross Reference Chart

	atm	psi	cm H <sub>2</sub> O	mm Hg	kPa	inch H <sub>2</sub> O	inch Hg	mbar
1 atm =	1	14.696	1033.228	760	101.325	406.783	29.921	1013.25
1 psi =	0.068	1	70.307	51.715	6.895	27.68	2.036	68.948
1 cm H <sub>2</sub> O =	0.001	0.0142	1	0.7356	0.0981	0.3937	0.0291	0.9807
1 mm Hg =	0.0013	0.0193	1.36	1	0.133	0.5352	0.039	1.333
1 kPa =	0.0099	0.145	10.197	7500.616	1	4.015	0.295	10
1 inch H <sub>2</sub> O =	0.0025	0.036	2.54	1.868	0.2491	1	0.0736	2.491
1 inch Hg =	0.0334	0.4912	34.532	25399	3.386	13.595	1	33.864
1 mbar =	0.001	0.015	1.02	0.7501	0.1	0.4015	0.0295	1

### Force Units Conversion Table

mN	mg-force	mp
0.1	10	10.2
0.2	20	20.39
0.3	30	30.59
0.4	40	40.79
0.5	50	50.99
0.6	60	61.18
0.7	70	71.38
0.8	80	81.58
0.9	90	91.77
1	100	101.97
2	200	203.94
3	300	305.91
4	400	407.89
5	500	509.86
6	600	611.83
7	700	713.8
8	800	815.77
9	900	917.74

1N = 1 Newton = 1 kg m/s<sup>2</sup>

1p = 1 Pond



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