

## CERAMIC BALLS - PROPERTIES OF MATERIALS

PHYSICAL PROPERTIES	SAPPHIRE AND RUBY	ALUMINA OXIDE	SILICON NITRIDE	ZIRCONIUM OXIDE
STRUCTURE	single crystal	multi-crystal	multi-crystal	multi-crystal
CHEMICAL FORMULA	$\text{Al}_2\text{O}_3$	$\text{Al}_2\text{O}_3$	$\text{Si}_3\text{N}_4$	$\text{ZrO}_2$
PURITY %	99.99	99.8	95.00	97.00
DENSITY g/cm <sub>3</sub>	3.99	3.90	3.20	5.50
OPERATING TEMPERATURE °C		1800	1100	1000
MELTING POINT	2050 °C	2050 °C	1900 °Ñ	
SOFTENING POINT	1800 °C	1725 °Ñ	1400 °Ñ	
SPECIFIC HEAT AT 25 °C (CAL/g/°C)	0.18	0.25	0.17	9
THERMAL CONDUCTIVITY	36 W/m <sup>°k</sup>	29 W/m <sup>°k</sup>	29 W/m <sup>°k</sup>	9 W/m <sup>°k</sup>
MECHANICAL PROPERTIES	SAPPHIRE AND RUBY	ALUMINA OXIDE	SILICON NITRIDE	ZIRCONIUM OXIDE
VICKERS Hv10 HARDNESS (N/mm2)	17000	16500	24000	20000
MODULUS OF ELASTICITY (N/mm2)	4,3610 <sup>5</sup>	3,5610 <sup>5</sup>	3,1610 <sup>5</sup>	2610 <sup>5</sup>
BREAKING MODULUS AT 25 °C (N/mm2)	392	470	700	600
COMPRESSIVE STRENGTH AT 25 °C (N/mm2)	2060	2354	2500	2100

## CHEMICAL RESISTANCE

### SAPPHIRE / RUBY:

inert to most acids at very high temperatures.

### ALUMINA (OXIDE):

inert to most acids, but not recommended in environments with hydrochloric or hydrofluoric acids or strong alkaline solutions

### SILICON NITRIDE:

inert to most acids.

### ZIRCONIUM OXIDE:

inert except to hydrofluoric acid and strong concentrations of sulphuric acid.

## Dimensional Conversion Chart

Inch Fractions	Inch Decimals	Metric mm	Weight per 1000 balls kg	Inch Fractions	Inch Decimals	Metric mm	Weight per 1000 balls kg
1/64	.0156	0.397	.00026	-	.7480	19.000	27.98
-	.0197	0.500	.00051	3/4	.7500	19.050	28.20
1/32	.0312	0.794	.00210	25/32	.7812	19.844	31.87
-	.0394	1.000	.00407	-	.7874	20.000	32.63
3/64	.0469	1.190	.00688	13/16	.8125	20.637	35.85
-	.0472	1.200	.00704	-	.8268	21.000	37.77
-	.0590	1.500	.01377	27/32	.8437	21.431	40.15
1/16	.0625	1.588	.01632	-	.8661	22.000	43.43
5/64	.0781	1.984	.03187	7/8	.8750	22.225	44.78
-	.0787	2.000	.0326	-	.9055	23.000	49.63
3/32	.0937	2.381	.0550	29/32	.9062	23.019	49.75
-	.0984	2.500	.0638	15/16	.9375	23.812	55.07
7/64	.1094	2.778	.0875	-	.9449	24.000	56.39
-	.1181	3.000	.1101	31/32	.9687	24.606	60.77
1/8	.1250	3.175	.1305	-	.9842	25.000	63.73
-	.1378	3.500	.1749	1	1.0000	25.400	66.84
9/64	.1406	3.572	.1859	-	1.0236	26.000	71.69
5/32	.1562	3.969	.2550	1 1/16	1.0625	26.987	80.17
-	.1575	4.000	.2610	-	1.1024	28.000	89.54
11/64	.1719	4.366	.3394	1 1/8	1.1250	28.575	95.17
-	.1772	4.500	.3716	-	1.1811	30.000	110.10
3/16	.1875	4.762	.4406	1 3/16	1.1875	30.162	111.90
-	.1968	5.000	.5099	1 1/4	1.2500	31.750	130.50
-	.2165	5.500	.6786	-	1.2598	32.000	133.70
7/32	.2187	5.556	.6996	1 5/16	1.3125	33.337	151.10
15/64	.2344	5.953	.8605	-	1.3386	34.000	160.30
-	.2362	6.000	.8810	1 3/8	1.3750	34.925	173.80
1/4	.2500	6.350	1.044	-	1.3780	35.000	174.90
-	.2559	6.500	1.120	-	1.4173	36.000	190.30
17/64	.2656	6.747	1.253	1 7/16	1.4375	36.512	198.50
-	.2756	7.000	1.399	-	1.4960	38.000	223.80
9/32	.2812	7.144	1.487	1 1/2	1.5000	38.100	225.60
-	.2953	7.500	1.721	1 9/16	1.5625	39.687	255.00
19/64	.2969	7.541	1.749	-	1.5748	40.000	261.00
5/16	.3125	7.938	2.040	1 5/8	1.6250	41.275	286.00
-	.3150	8.000	2.088	1 11/16	1.6875	42.862	321.20
-	.3346	8.500	2.505	1 3/4	1.7500	44.450	358.20
11/32	.3437	8.731	2.715	-	1.7716	45.000	371.70
-	.3543	9.000	2.973	1 13/16	1.8125	46.037	398.00
23/64	.3594	9.128	3.102	1 7/8	1.8750	47.625	440.60
-	.3740	9.500	3.497	1 15/16	1.9375	49.212	486.10
3/8	.3750	9.525	3.525	-	1.9685	50.000	509.90
25/64	.3906	9.922	3.983	2	2.0000	50.800	534.70
-	.3937	10.000	4.079	2 1/8	2.1250	53.975	641.40
13/32	.4062	10.319	4.481	-	2.1653	55.000	678.60
-	.4331	11.000	5.429	2 1/4	2.2500	57.150	761.30
7/16	.4375	11.112	5.597	-	2.3622	60.000	881.00
-	.4528	11.500	6.203	2 3/8	2.3750	60.325	895.40
29/64	.4531	11.509	6.219	2 1/2	2.5000	63.500	1044.40
15/32	.4687	11.906	6.884	-	2.5590	65.000	1120.10
-	.4724	12.000	7.048	2 5/8	2.6250	66.675	1209.00
31/64	.4844	12.303	7.596	2 3/4	2.7500	69.850	1390.10
1/2	.5000	12.700	8.355	-	2.7559	70.000	1484.70
-	.5118	13.000	8.961	2 7/8	2.8750	73.025	1588.40
17/32	.5312	13.494	10.02	-	2.9528	75.000	1720.70
-	.5512	14.000	11.19	3	3.0000	76.200	1804.70
9/16	.5625	14.288	11.90	3 1/8	3.1250	79.375	2039.80
-	.5905	15.000	13.77	-	3.1500	80.000	2088.30
19/32	.5937	15.081	13.99	3 1/4	3.2500	82.550	2294.40
5/8	.6250	15.875	16.32	-	3.3464	85.000	2530.90
-	.6299	16.000	16.70	3 1/2	3.5000	88.900	2865.70
21/32	.6562	16.669	18.89	-	3.5433	90.000	2993.40
-	.6693	17.000	20.04	-	3.7401	95.000	3521.10
11/16	.6875	17.462	21.72	3 3/4	3.7500	95.250	3524.70
-	.7087	18.000	23.79	-	3.9370	100.000	4078.80
23/32	.7187	18.256	24.82	4	4.0000	101.600	4277.70

## Technical Data

### Tolerances by Grade for Individual Balls

	Ball Grade	Allowable Ball Diameter Variation	Allowable Deviation From Spherical Form	Maximum Surface Roughness Arithmetic Average
Inch	Grade			
	3	.000003	.000003	0.5
	5	.000005	.000005	0.8
	10	.000010	.000010	1
	16	.000016	.000016	1
	24	.000024	.000024	2
	48	.000048	.000048	3
	100	.0001	.0001	5
	200	.0002	.0002	8
	500	.0005	.0005	*
1000	.001	.001	*	
Metric $\mu\text{m}$	3	0.08	0.08	0.012
	5	0.13	0.13	0.02
	10	0.25	0.25	0.025
	16	0.4	0.4	0.025
	24	0.6	0.6	0.05
	48	1.2	1.2	0.08
	100	2.5	2.5	0.125
	200	5	5	0.2
	500	13	13	*
	1000	25	25	*