COMPLETE GEMOLOGICAL REFERENCE MANUAL

A Technical Encyclopedia of Gemstones

Comprehensive Guide to Classification, Properties, and Identification

Table of Contents

PART 1: GEMSTONE CLASSIFICATION & FUNDAMENTAL SCIENCE

1.1 Crystal Systems

Gemstones are crystalline materials that form according to seven fundamental crystal systems. Understanding crystal structure is essential for gemstone identification and explains many optical and physical properties.

Crystal System	Axes	Examples	Key Features
Cubic (Isometric)	3 equal axes at 90°	Diamond, Garnet, Spinel	Isotropic; single RI
Tetragonal	2 equal + 1 unequal at 90°	Zircon, Rutile	Uniaxial; moderate birefringence
Hexagonal	3 equal at 120° + 1 perpendicular	Beryl, Corundum, Apatite	Uniaxial; dichroic
Trigonal	3 equal at 120° (rhombohedral)	Quartz, Tourmaline, Calcite	Uniaxial; strong birefringence
Orthorhombic	3 unequal axes at 90°	Topaz, Peridot, Tanzanite	Biaxial; trichroic
Monoclinic	3 unequal; 2 at 90°, 1 oblique	Jadeite, Kunzite, Orthoclase	Biaxial; complex optics
Triclinic	3 unequal axes, all oblique	Labradorite, Microcline	Biaxial; lowest symmetry

1.2 Optical Properties

1.2.1 Refractive Index (RI)

The refractive index measures how much light bends when entering a gemstone. It is the most fundamental optical property for identification.

Property	Description	Typical Range
Single Refraction (SR)	Cubic system stones; one RI value	Diamond: 2.417, Spinel: 1.718
Double Refraction (DR)	Non-cubic stones; two RI values	Difference = birefringence
Birefringence	Difference between max and min RI	Low: <0.01, High: >0.04
Uniaxial	Hexagonal/Trigonal/Tetragonal systems	Corundum, Beryl, Quartz
Biaxial	Orthorhombic/Monoclinic/Triclinic	Topaz, Peridot, Tanzanite

1.2.2 Dispersion and Fire

Dispersion is the separation of white light into spectral colors. High dispersion creates 'fire' in gemstones. Measured as the difference between RI for red and blue light.

Gemstone	Dispersion Value	Fire Quality
Diamond	0.044	Exceptional
Sphene	0.051	Very High
Demantoid Garnet	0.057	Very High

Zircon	0.039	High
Sapphire	0.018	Moderate
Emerald	0.014	Low
Quartz	0.013	Low

1.3 Physical Properties

1.3.1 Hardness (Mohs Scale)

The Mohs scale measures scratch resistance from 1 (softest) to 10 (hardest). Critical for durability assessment and identification.

Mohs	Mineral	Common Gemstones	Scratch Test
10	Diamond	Diamond	Scratches everything else
9	Corundum	Ruby, Sapphire	Scratches all except diamond
8.5	Chrysoberyl	Alexandrite, Cat's Eye	Very durable
8	Topaz	Topaz	Excellent durability
7.5	Beryl	Emerald, Aquamarine	Good durability
7	Quartz	Amethyst, Citrine, Agate	Scratches glass
6.5	Garnet	Pyrope, Almandine	Near glass hardness
6	Feldspar	Moonstone, Labradorite	Scratched by quartz
5.5	Apatite	Apatite	Delicate
5	Apatite	Turquoise	Very delicate

1.3.2 Specific Gravity (SG)

Specific gravity is the ratio of a gemstone's density to water. Measured using hydrostatic weighing or heavy liquids. Essential for identification of similar-looking stones.

SG Range	Density Class	Examples
1.0-2.0	Very Light	Amber (1.08), Opal (2.15)
2.0-3.0	Light	Quartz (2.65), Feldspar (2.56-2.76)
3.0-4.0	Medium	Tourmaline (3.06), Topaz (3.53)
4.0-5.0	Heavy	Zircon (4.69), Corundum (4.00)
5.0+	Very Heavy	Hematite (5.26), Cassiterite (6.99)

1.4 Inclusions - Nature's Fingerprints

Inclusions are internal features within gemstones that serve as diagnostic tools for identification, origin determination, and treatment detection. They form during crystal growth or subsequent geological processes.

Inclusion Type	Description	Common In	Significance
Needle Inclusions	Fine linear crystals (often rutile)	Ruby, Sapphire	Can create asterism (star effect)
Silk	Networks of fine needles	Corundum, Chrysoberyl	Kashmir sapphire signature
Three-Phase	Liquid + gas + crystal in cavity	Emerald (Colombian)	Geographic origin indicator
Fingerprint	Partially healed fractures	Most gemstones	Natural vs synthetic
Crystal Inclusions	Other minerals trapped inside	All types	Species identification
Negative Crystals	Cavities shaped like host crystal	Quartz, Topaz	Growth environment clue
Color Zoning	Uneven color distribution	Sapphire, Amethyst	Natural vs synthetic
Feathers	Internal fractures	Most gemstones	Durability concern

PART 2: DEEP DIVES ON PRECIOUS STONES

2.1 Diamond - The Ultimate Gemstone

Diamond is the hardest natural substance, composed of pure carbon crystallized in the cubic system. Its exceptional brilliance, fire, and durability make it the most prized gemstone.

Property	Value	Notes
Chemical Formula	C (pure carbon)	Allotrope of graphite
Crystal System	Cubic (Isometric)	Highly symmetrical
Refractive Index	2.417	Single refraction
Dispersion	0.044	Exceptional fire
Hardness	10 (Mohs)	Hardest natural material
Specific Gravity	3.52	Relatively light for RI
Cleavage	Perfect octahedral (4 directions)	Can chip if hit precisely
Luster	Adamantine	Brilliant reflection
Thermal Conductivity	Highest of any gemstone	Diamond tester principle
UV Fluorescence	Variable (none to strong)	Blue, yellow, or orange glow

2.1.1 Diamond Color Grading (GIA Scale)

Colorless diamonds are graded from D (colorless) to Z (light yellow/brown). Grades D-F are colorless, G-J near-colorless, K-M faint, N-R very light, S-Z light.

Grade	Category	Description	Value Impact
D-E-F	Colorless	No color visible, even to experts	Premium pricing (+30-50%)
G-H-I-J	Near Colorless	Slight color only visible to experts	Excellent value
K-L-M	Faint	Noticeable warmth in larger stones	Moderate discount
N-O-P-Q-R	Very Light	Obvious yellow/brown tint	Significant discount
S-T-U-V-W-X-Y-Z	Light	Strong color presence	Lower tier pricing

2.1.2 Diamond Clarity Grading

Clarity grades range from Flawless (FL) to Included (I3), based on visibility of inclusions under 10x magnification.

Grade	Full Name	Description	Visibility
FL	Flawless	No inclusions or blemishes at 10x	Extremely rare (<1%)
IF	Internally Flawless	No inclusions, only surface blemishes	Very rare
VVS1-VVS2	Very Very Slightly Included	Minute inclusions, difficult for expert to see	Excellent quality

VS1-VS2	Very Slightly Included	Minor inclusions, difficult to see at 10x	High quality
SI1-SI2	Slightly Included	Noticeable at 10x, may be visible to naked eye	Good value
I1-I2-I3	Included	Obvious at 10x, visible to naked eye	Budget tier

2.1.3 Diamond Cut Quality

Cut quality determines how well a diamond reflects light. GIA grades cut as Excellent, Very Good, Good, Fair, or Poor based on proportions, symmetry, and polish.

Critical Cut Parameters for Round Brilliant:

• Table: 53-58% of diameter (optimal)

• Depth: 59-62.5% of diameter (optimal)

• Crown Angle: 34-35 degrees

• Pavilion Angle: 40.6-41 degrees

• Girdle: Thin to Slightly Thick

2.2 Corundum - Ruby and Sapphire

Corundum (Al_2O_3) is second only to diamond in hardness. Red corundum is ruby; all other colors are sapphire. Chromium causes ruby's red; iron and titanium create sapphire's blue.

Property	Value	Notes
Chemical Formula	Al₂O₃ (aluminum oxide)	Pure is colorless
Crystal System	Hexagonal (Trigonal)	Uniaxial
Refractive Index	1.762-1.770	Birefringence: 0.008-0.009
Dispersion	0.018	Moderate fire
Hardness	9 (Mohs)	Extremely durable
Specific Gravity	4.00-4.05	Heavy for size
Pleochroism	Strong in ruby, moderate in sapphire	Color changes with viewing angle
Fluorescence	Red corundum: strong red	UV diagnostic feature

2.2.1 Ruby Color and Value

Ruby color ranges from orangish-red to purplish-red. The most valuable is 'pigeon's blood' - a vivid, pure red with slight blue undertone. Burmese and Mozambique rubies command premium prices.

Color Grade	Hue Range	Saturation	Value Multiplier
Pigeon's Blood	Pure red, slight blue undertone	Vivid	3.0-5.0x
Fine Ruby	Medium to medium-dark red	Strong to vivid	2.0-3.0x
Commercial Ruby	Light to medium red	Moderate to strong	1.0-2.0x
Pink Sapphire Border	Pinkish-red to red-pink	Moderate	0.3-1.0x

2.2.2 Sapphire Color Varieties

Sapphires occur in virtually every color except red. Blue is most popular, but padparadscha (pink-orange), yellow, green, and color-change varieties are highly valued.

Variety	Color	Cause	Key Sources
Blue Sapphire	Cornflower to royal blue	Fe + Ti	Kashmir, Burma, Sri Lanka
Padparadscha	Pink-orange (lotus flower)	Cr + Fe	Sri Lanka, Madagascar
Yellow Sapphire	Canary to golden	Fe<super>3+</super>	Sri Lanka, Thailand
Pink Sapphire	Baby pink to hot pink	Cr (less than ruby)	Madagascar, Sri Lanka
Green Sapphire	Yellow-green to blue-green	Fe	Montana, Australia
Color-Change	Blue to purple/red	Cr + V	Tanzania, Madagascar
Star Sapphire	Any color with asterism	Rutile needle inclusions	Burma, Sri Lanka

2.3 Beryl Family - Emerald, Aquamarine, and More

Beryl ($Be_3Al_2Si_6O_{18}$) creates some of nature's most beautiful gemstones. Emerald (green) and aquamarine (blue) are the most famous, but the family includes morganite, heliodor, and goshenite.

Property	Value	Notes
Chemical Formula	Be₃Al₂Si₆O₁₈	Cyclosilicate
Crystal System	Hexagonal	Uniaxial
Refractive Index	1.577-1.583	Birefringence: 0.006
Dispersion	0.014	Low fire
Hardness	7.5-8 (Mohs)	Good durability but brittle
Specific Gravity	2.67-2.90	Varies with variety
Cleavage	Poor basal cleavage	Can chip
Characteristic Inclusion	Three-phase (emerald), tubes	Diagnostic features

2.3.1 Emerald - The Green Gem

Emerald is colored green by chromium and/or vanadium. Unlike other gems, emeralds are evaluated with the 'jardin' (garden) concept - inclusions are expected and accepted. Colombian emeralds are considered finest.

Quality Grade	Color	Clarity	Typical Enhancement	Value
Fine	Vivid green, medium-dark	Eye-clean to minor jardin	Cedar oil only	Premium
Commercial	Medium green	Visible inclusions	Resin/oil filling	Standard
Garden Grade	Light to medium green	Heavy inclusions	Heavy treatment	Budget

2.3.2 Beryl Color Varieties

Variety	Color	Coloring Agent	Notable Sources
Emerald	Green	Cr, V	Colombia, Zambia, Brazil
Aquamarine	Blue to blue-green	Fe<super>2+</super>	Brazil, Nigeria, Madagascar
Morganite	Pink to peach	Mn	Brazil, Madagascar, USA
Heliodor	Yellow to golden	Fe<super>3+</super>	Brazil, Ukraine
Goshenite	Colorless	None (pure)	Brazil, USA
Red Beryl	Red (very rare)	Mn	Utah (Wah Wah Mountains)
Green Beryl	Pale green (non-emerald)	Fe	Various

PART 3: MAJOR SEMI-PRECIOUS GROUPS

3.1 Quartz Family - Most Abundant Gemstone

Quartz (SiO_2) is the most abundant gemstone material. It occurs in two main forms: macrocrystalline (visible crystals) and cryptocrystalline (microscopic crystals, called chalcedony).

Property	Value
Chemical Formula	SiO₂ (silicon dioxide)
Crystal System	Hexagonal (Trigonal)
Refractive Index	1.544-1.553
Birefringence	0.009
Hardness	7 (Mohs)
Specific Gravity	2.65
Luster	Vitreous
Cleavage	None (conchoidal fracture)

3.1.1 Macrocrystalline Quartz Varieties

Variety	Color	Cause	Notes
Rock Crystal	Colorless	Pure	Most common
Amethyst	Purple	Fe + irradiation	Most valuable quartz
Citrine	Yellow to orange	Heat-treated amethyst or Fe	Natural is rare
Smoky Quartz	Brown to black	Natural irradiation	Scotland is famous
Rose Quartz	Pink	Ti, Fe, Mn	Rarely transparent
Prasiolite	Green	Heat-treated amethyst	Rare naturally
Rutilated Quartz	Clear with needles	Rutile inclusions	Decorative
Aventurine	Green with sparkle	Fuchsite inclusions	Ornamental

3.1.2 Cryptocrystalline Quartz (Chalcedony)

Variety	Description	Pattern/Color
Agate	Banded chalcedony	Concentric or parallel bands
Carnelian	Red-orange chalcedony	Solid color, Fe oxide
Chrysoprase	Apple-green chalcedony	Nickel-colored, most valuable
Onyx	Black or black/white banded	Used for cameos
Jasper	Opaque, multicolored	Often spotted or striped
Bloodstone	Green with red spots	Iron oxide spots
Sardonyx	Brown and white banded	Historical significance
Moss Agate	Translucent with dendrites	Appears to have moss inside

3.2 Garnet Group - Complex Silicate Family

Garnets are a group of silicate minerals with similar crystal structure but varying chemistry. The general formula is $X_3Y_2(SiO_4)_3$, where X and Y are different metal ions.

Species	Formula	Color	RI	SG	Use
Almandine	Fe₃Al₂(SiO₄)₃	Deep red to brown-red	1.78-1.83	4.05	Most common
Pyrope	Mg₃Al₂(SiO₄)₃	Red to purple-red	1.73-1.76	3.70	Fine jewelry
Spessartine	Mn₃Al₂(SiO₄)₃	Orange to red-orange	1.79-1.81	4.16	Mandarin garnet
Grossular	Ca₃Al₂(SiO₄)₃	Green, yellow, orange	1.73-1.75	3.60	Tsavorite variety
Andradite	Ca₃Fe₂(SiO₄)₃	Various colors	1.88-1.94	3.85	Demantoid variety
Uvarovite	Ca₃Cr₂(SiO₄)₃	Emerald green	1.86	3.77	Rare, small

Note: Most garnets are solid solutions (mixtures) of two or more species. Rhodolite is pyrope-almandine; Mali garnet is grossular-andradite.

3.3 Tourmaline - The Rainbow Gem

Tourmaline is a complex borosilicate with one of the most complex chemical formulas in gemology. It occurs in virtually every color and often displays multiple colors in a single crystal.

Property	Value
Chemical Formula	(Na,Ca)(Li,Mg,Fe,Al)₉B₃Si₆O₂₇(O
Crystal System	Hexagonal (Trigonal)
Refractive Index	1.624-1.644
Birefringence	0.018-0.020
Hardness	7-7.5 (Mohs)
Specific Gravity	3.06 average (2.82-3.32)

Pleochroism	Strong (darker along c-axis)
Special Property	Pyroelectric and piezoelectric

Trade Name	Color	Composition	Value
Paraíba	Neon blue-green	Cu-bearing elbaite	Extremely high
Chrome Tourmaline	Vivid green	Cr-bearing dravite	High
Rubellite	Red to pink	Mn-rich elbaite	High
Indicolite	Blue	Fe-bearing elbaite	Moderate-High
Watermelon	Pink center, green rim	Color zoning	Novelty value
Bi-color/Parti-color	Two or more colors	Variable chemistry	Depends on colors
Schorl	Black	Fe-rich	Low (industrial)

3.4 Topaz - The Imperial Gem

Topaz is an aluminum fluoro-hydroxy-silicate valued for its hardness, clarity, and range of colors. Imperial topaz (orange-pink) is most valuable, but blue topaz is most popular commercially.

Property	Value	Notes
Chemical Formula	Al₂SiO₄(F,OH)₂	Fluoro-hydroxy
Crystal System	Orthorhombic	Biaxial positive
Refractive Index	1.609-1.643	Birefringence: 0.010
Hardness	8 (Mohs)	Third hardest common gem
Specific Gravity	3.49-3.57	Dense for composition
Cleavage	Perfect basal	Handle with care
Pleochroism	Weak to moderate	Depends on color

Color	Cause	Treatment	Value
Imperial (orange-pink)	Chromium	Natural, sometimes heated	Highest
Pink	Chromium	Often heat-treated yellow	High
Yellow/Golden	Color centers	Natural or irradiated	Moderate
Blue (Sky)	Color centers	Irradiation + heat	Low-Moderate
Blue (Swiss)	Color centers	Irradiation + heat	Moderate
Blue (London)	Color centers	Irradiation + heat	Moderate
Colorless	Pure	Natural	Low
Mystic/Rainbow	Coating	Thin film coating	Novelty

3.5 Opal - The Play-of-Color Phenomenon

Opal is a hydrated amorphous silica ($SiO_2 \cdot nH_2O$) that displays play-of-color caused by diffraction from ordered silica spheres. It is one of few non-crystalline gemstones.

Property	Value
Chemical Formula	SiO₂·nH₂O (5-10% water)
Crystal System	Amorphous (no crystal structure)
Refractive Index	1.37-1.47 (varies with water content)
Hardness	5.5-6.5 (Mohs)
Specific Gravity	1.98-2.25
Special Phenomenon	Play-of-color (precious opal)
Stability	Sensitive to heat, dehydration, chemicals

Type	Description	Source	Value

Black Opal	Dark body tone with play-of-color	Lightning Ridge, Australia	Highest
White Opal	Light body tone with play-of-color	Coober Pedy, Australia	Moderate
Boulder Opal	Thin layer on ironstone matrix	Queensland, Australia	High
Crystal Opal	Transparent to semi-transparent	Various Australian fields	Variable
Fire Opal	Orange-red, may lack play-of-color	Mexico	Moderate
Common Opal	No play-of-color	Worldwide	Low
Doublet/Triplet	Thin opal layer, backed/capped	Manufactured	Low

PART 4: ENHANCEMENTS, SYNTHETICS & APPRAISAL

4.1 Common Enhancement Treatments

Most gemstones undergo some form of enhancement to improve appearance. Disclosure is required, and treatment stability varies significantly.

Treatment	Gemstones	Purpose	Stability	Disclosure
Heat Treatment	Corundum, Topaz, Zircon, Tanzanite	Improve color, clarity	Permanent	Required
Oiling/Resining	Emerald, Ruby	Fill fissures, improve clarity	Temporary	Always disclose
Fracture Filling	Diamond, Ruby	Mask fractures with glass	Moderate	Always disclose
Irradiation	Topaz, Diamond, Quartz	Induce color change	Usually permanent	Required
Diffusion	Corundum	Add color to surface	Surface only	Always disclose
Coating	Topaz, Quartz	Add color/effects	Temporary	Always disclose
Dyeing	Jade, Quartz, Pearl	Enhance color	Variable	Always disclose
Bleaching	Pearl, Jade	Lighten color	Permanent	Usually disclosed
HPHT	Diamond	Improve color/clarity	Permanent	Always disclose
Laser Drilling	Diamond	Remove dark inclusions	Permanent	Always disclose

4.2 Synthetic Gemstone Production Methods

Synthetics are lab-created gems with identical chemical and physical properties to natural stones. They must be disclosed but have legitimate markets.

Method	Process	Gemstones Produced	Identifying Features
Verneuil (Flame Fusion)	Powdered feed melts in oxy-hydrogen flame	Corundum, Spinel	Curved growth lines, gas bubbles
Czochralski (Pulled)	Crystal pulled from melt	Corundum, Alexandrite, YAG	Curved color zoning
Flux Growth	Slow crystallization from molten flux	Emerald, Ruby, Spinel	Flux inclusions, fingerprints
Hydrothermal	Growth in superheated water solution	Quartz, Emerald	Seed plate, chevron patterns
Skull Melt	High-temp melt in water-cooled crucible	Cubic Zirconia	Layered growth structure
HPHT	High pressure, high temperature	Diamond	Metallic flux inclusions
CVD	Chemical vapor deposition	Diamond	Layered growth, strain patterns

4.3 Gemstone Value Factors - Beyond the 4Cs

While the 4Cs (Color, Clarity, Cut, Carat) form the foundation of gem valuation, additional factors significantly impact value.

4.3.1 The Extended Valuation Formula: 4Cs + O + T

Factor	Description	Impact on Value
Color	Hue, tone, saturation	30-50% of value for colored stones
Clarity	Presence/visibility of inclusions	20-40% of value
Cut	Proportions, symmetry, polish, style	15-25% of value
Carat Weight	Size (non-linear pricing above certain weights)	Exponential increase
Origin (O)	Geographic source (e.g., Burma ruby, Kashmir sapphire)	10-300% premium for top sources
Treatment (T)	Type and extent of enhancement	-10% to -90% for heavy treatments

4.3.2 Origin Premiums for Top Gemstones

Gemstone	Premium Origin	Standard Origin	Premium Multiplier
Ruby	Burma (Myanmar), Mozambique	Thailand, Madagascar	2-5x
Blue Sapphire	Kashmir, Burma	Sri Lanka, Madagascar	2-10x
Emerald	Colombia	Zambia, Brazil	1.5-3x
Paraíba Tourmaline	Brazil (original)	Mozambique, Nigeria	2-4x
Alexandrite	Russia (Ural)	Brazil, Sri Lanka	2-3x
Tsavorite Garnet	Kenya, Tanzania	Other sources rare	N/A

PART 5: PRACTICAL APPENDIX

5.1 Quick Identification Reference Chart

Use these tables for rapid gemstone identification based on key physical and optical properties.

Gemstone	RI	SG	Hardness	DR/SR	Key Features
Diamond	2.417	3.52	10	SR	Adamantine luster, thermal conductivity
Corundum	1.762-1.770	4.00	9	DR	Strong fluorescence (ruby)
Emerald	1.577-1.583	2.72	7.5	DR	Three-phase inclusions
Aquamarine	1.577-1.583	2.68	7.5	DR	Blue, dichroic
Spinel	1.718	3.60	8	SR	Often confused with ruby
Topaz	1.619-1.627	3.53	8	DR	Perfect basal cleavage
Garnet	1.73-1.89	3.5-4.3	7-7.5	SR	Varies by species
Tourmaline	1.624-1.644	3.06	7-7.5	DR	Strong pleochroism
Quartz	1.544-1.553	2.65	7	DR	Conchoidal fracture
Peridot	1.654-1.690	3.34	6.5-7	DR	High birefringence, oily luster
Zircon	1.925-1.984	4.69	7.5	DR	Very high RI and dispersion

5.2 Common Simulants and How to Identify Them

Simulants are materials that look like gemstones but have different chemical/physical properties. They are not synthetics.

Simulant	Simulates	RI	SG	Hardness	Detection
Glass	Various	1.50-1.70	2.4-2.8	5-6	Bubbles, swirl marks, lower hardness
Cubic Zirconia (CZ)	Diamond	2.15-2.18	5.6-6.0	8.25	High SG, doubling of back facets
Moissanite	Diamond	2.65-2.69	3.22	9.25	Extreme doubling, greenish tint
YAG	Diamond	1.833	4.55	8.25	Lower RI than diamond
Synthetic Spinel	Aquamarine, etc.	1.728	3.64	8	Curved growth lines
Glass Doublets	Various	Variable	Variable	5-6	Separation plane visible
Plastic	Amber, etc.	1.50-1.55	1.05-1.55	2-3	Very low hardness, hot point test
Synthetic Rutile	Diamond	2.62-2.90	4.25	6-6.5	Extreme fire, lower hardness

5.3 Essential Gemological Testing Equipment

Tool	Purpose	Price Range	Skill Level
10x Loupe	Inclusion examination, clarity grading	$20-$200	Essential
Refractometer	Measure refractive index	$300-$2000	Intermediate
Polariscope	Determine SR vs DR, examine pleochroism	$200-$800	Intermediate
Dichroscope	View pleochroism in colored stones	$50-$300	Basic
Chelsea Filter	Ruby/emerald screening	$30-$100	Basic
UV Lamp (LW/SW)	Fluorescence examination	$100-$500	Basic
Spectroscope	Absorption spectrum analysis	$200-$1500	Advanced
Thermal Tester	Diamond vs simulant	$20-$200	Basic
Specific Gravity Set	Hydrostatic weighing	$100-$500	Intermediate
Microscope	Detailed inclusion study	$1000-$10000	Advanced

Conclusion

This reference manual provides the fundamental knowledge required for gemstone identification, classification, and evaluation. Gemology combines scientific analysis with aesthetic appreciation, requiring both technical skill and experience. Continued study, hands-on examination, and familiarity with market trends are essential for professional competence.

For advanced topics including spectroscopy, X-ray analysis, geographic origin determination, and laboratory techniques, consult specialized gemological literature and consider formal certification programs from institutions such as GIA, AIGS, or Gübelin.