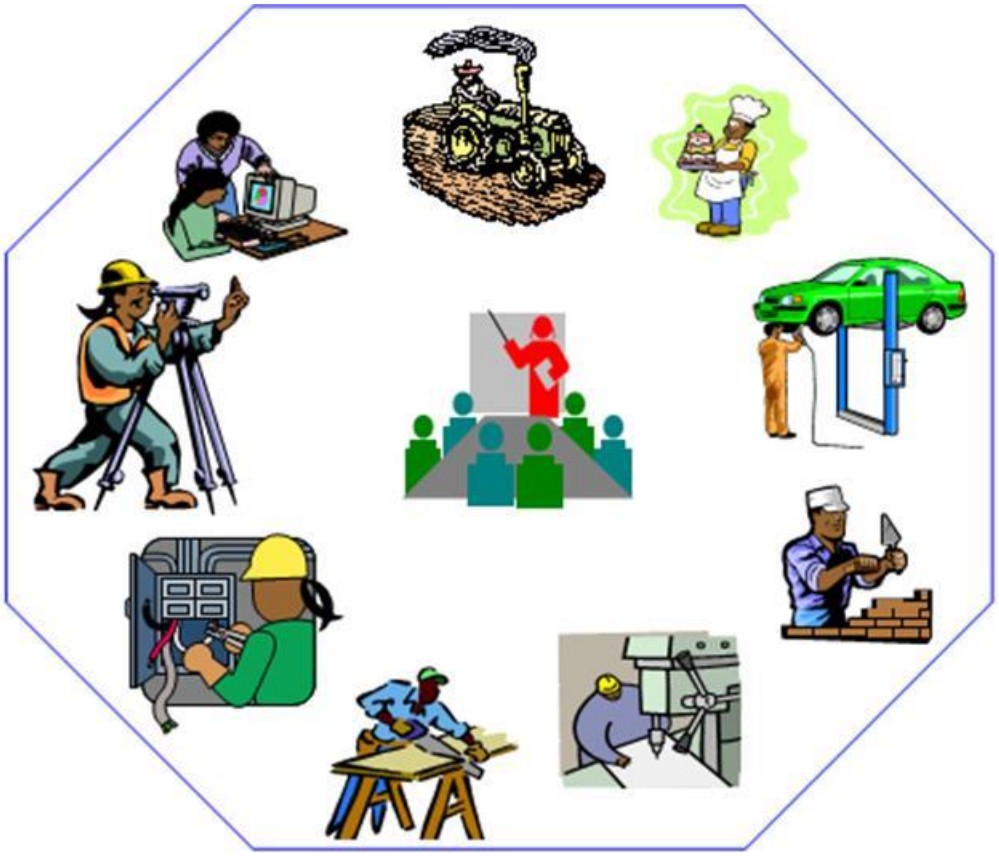
Lapidary
Level-II

Based on January 2014, Version 1 OS and April. 2021, V1 Curriculum



Module Title: - Identifying and asessing gemstone material

LG Code: MIN LAP2 M01 LO (1-4) LG (1-4)

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Adama,Ethiopia
April, 2021

Table of Contents

LG #1	LO #1- Develop knowledge of gemstone

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- identifying the formation of gemstone
- determining sources of gemstone

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- identify the formation of gemstone
- determine sources of gemstone

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
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Information Sheet 1-identifying the formation of gemstone

1. Introduction

1.1.1. A Gemstone:- is a piece of mineral crystal which, in cut and polished form, is used to make jewelry or other adornments. However, certain rocks and occasionally organic materials that are not minerals are also used for jewelry and are therefore often considered to be gemstones as well. The most common of organic gemstones are pearl, bone, amber, coral, jet, and ivory. These are materials, produced by organisms, that have been cut into gems and other ornamental objects.

Some example of inorganic gemstone:- Emeral, Sapphire, Rubby, Aquamarine, Amazonite, Tanzanite, etc.

A. Rough emerald

B. Unpolished emerald

C.Polished emerald

Figure 1. Emerald

A. Unpolished sapphire **B. Polished sapphire**

Figure 2. Sapphire

A. Unpolished Rubby B. Polished Rubby

Figure 3. Rubby

Organic gemstone

A. Rough Amber B. Polished Amber

Figure 4. Amber Amber- A Magical Time Capsule Of a Gemstone.[via torchbrowser.com].mp4

A. Rough Pearl **B. Polished pearl**

Figure 5. Pearl

1.1.2. An Opal:- Opal is a hydrated amorphous form of silica; its water content may range from 3 to 21% by weight, but is usually between 6 and 10%. Because of its amorphous character, it is classed as a mineraloid, unlike crystalline forms of silica, which are classed as minerals.

Figure 6. Rough Opal

Gem Adventures In Ethiopia- On The Hunt For Opal[via torchbrowser.com].mp4

A. Rough black Opal B. Polished Black Opal

Figure 7. Ethiopian black opal

What is Ethiopian Opal - Value & Meaning[via torchbrowser.com].mp4

1.2. Formation of Gemstone and Opal

1.2.1 Formation of gemstone

There are five requirements for crystals to form: ingredients and temperature, pressure, time, and space.

Gemstone Formation Process

Generally speaking there are 4 ways gemstones can form. They are

1. Igneous- These minerals are created deep within the earth (Diamonds, Ruby, Sapphire, Peridot)
2. Hydrothermal- Similar to the rock candy example, gemstones are formed when bodies of mineral rich water cool
3. Metamorphic- As the name suggests, these are gems that are ‘morphed’ due to intense heat and pressure. (Sapphire, Ruby, Spinel, Garnet)
4. Sedimentary- Gems that form due to water depositing sediments (Malachite, Azurite, Opal)

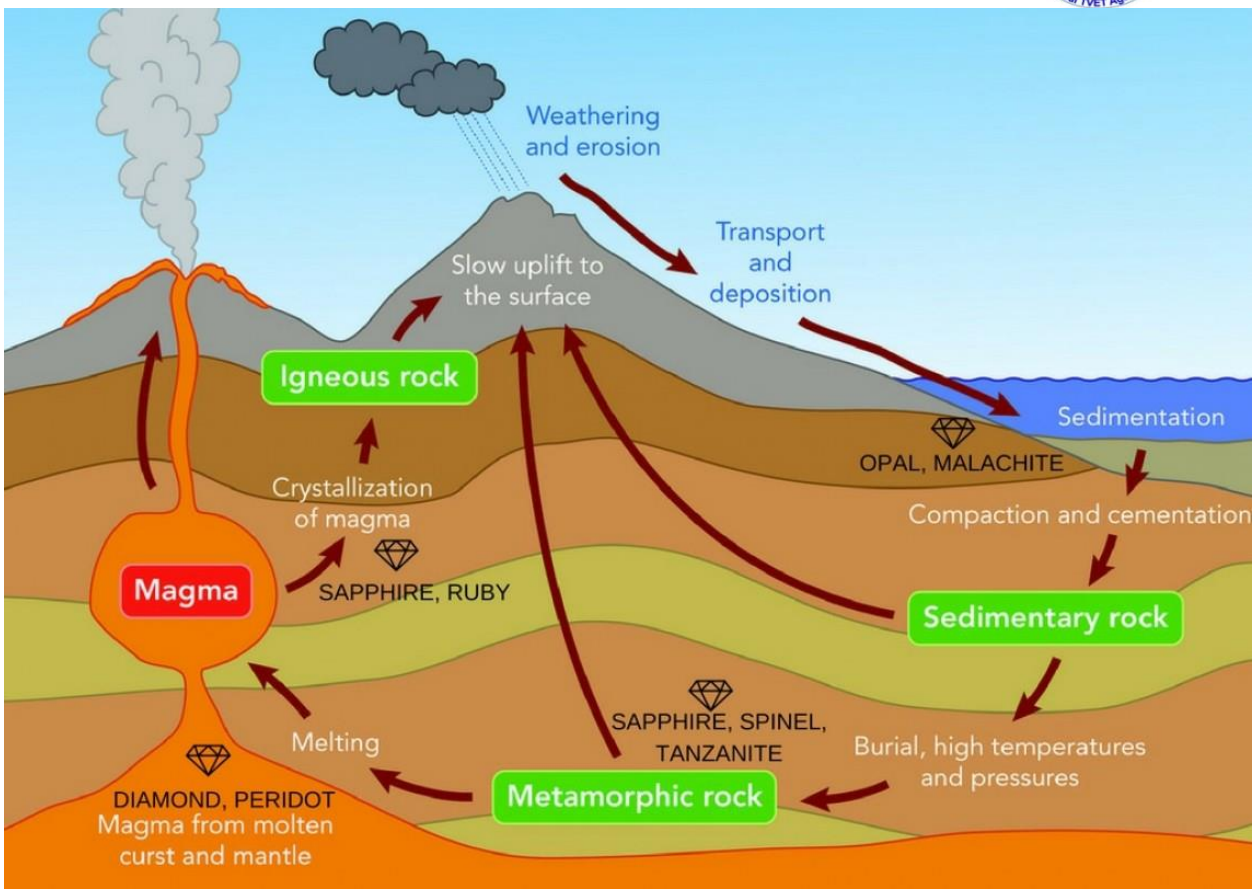


Figure 8. Gemstone formation process

1. **Igneous Gemstones Formed in the Earth's Mantle**

While our knowledge of the earth's mantle is limited, there is evidence that some gemstones form in the mantle. This requires extremely high temperatures.

Perhaps the most notable examples of gemstones forming in the earth's mantle are peridot and diamond. Geologists studied Arizonan peridot deposits and believe that they were created on rocks that were floating in the earth's mantle, up to 55 miles beneath the surface. They were brought closer to the surface by an explosive eruption, with erosion and weathering pushing them close enough to the surface to be discovered.

However, there is a better understanding of diamonds. Diamonds crystallise in the magma just below the crust. However, these formations have a different chemical composition. Geologists believe it comes from 110 miles to 150 miles beneath the earth's surface. The magma is incredibly fluid at this depth, and the temperatures very high.

Figure 9. Open pit Mining

This magma can force its way through the crust far faster and much more violently than other volcanic eruptions. During the process of eruption, the magma breaks up and dissolves rocks and then carries them to the surface.

If the magma was to rise slowly the diamonds likely would not survive. The pressure and changing temperatures would result in the diamonds vaporising, or possibly re-crystallising as graphite. However, because of the speed with which the magma rises the diamonds don't have time to transform or vaporise, thus remaining as diamonds.

When there are dramatic and rough changes in the crust crystals are often broken. When growth conditions are present material seeps into the fractures and crystallises. This heals the fractures by sealing them together. They don't heal completely, though, the fine cavities remain and they are seen as fingerprints.

How do they rise to the surface once gemstones form? Because they form so far under the surface, it's a wonder they can be mined. They're brought to the surface during volcanic eruptions, but most of them reach the surface through erosion and mountain building.

2. Hydrothermal Gemstone Creation

This process is the most similar to the rock candy. Super saturated water with many different minerals is pushed up into cavities and cracks in the earth. as this solution begins to cool the different minerals begin to crystallise.

The most important hydrothermal finds are in Columbia. Specifically the Muzo Emerald mine. These hydrothermal deposits are rich with Chromium with gives the Emeralds from region their incredible color.

The image below shows a hydrothermal mineral vein. This vein is created when the water solution cools inside the crack of the surrounding rock.

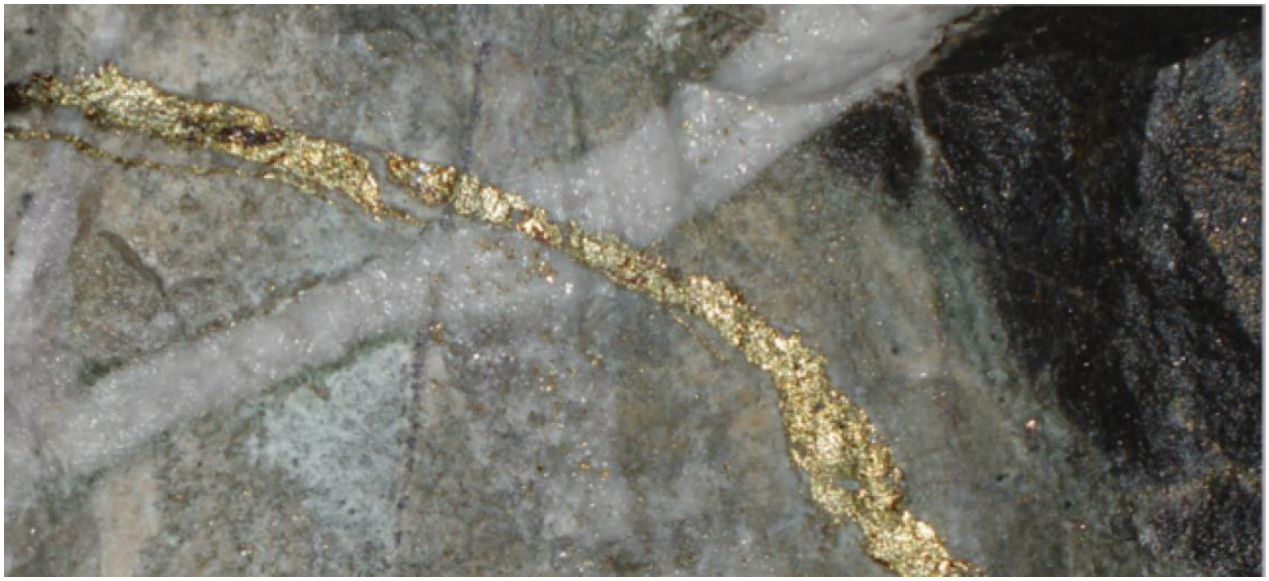


Figure 10. Hydrothermal Gemstone creation

3. Metamorphic Gemstone Creation

The majority of gemstones are formed by metamorphism. This is when minerals are forced together under great pressure and heat usually by tectonic plates moving underneath each other. The minerals are forced together and they metamorphose into different minerals, sometimes without melting.

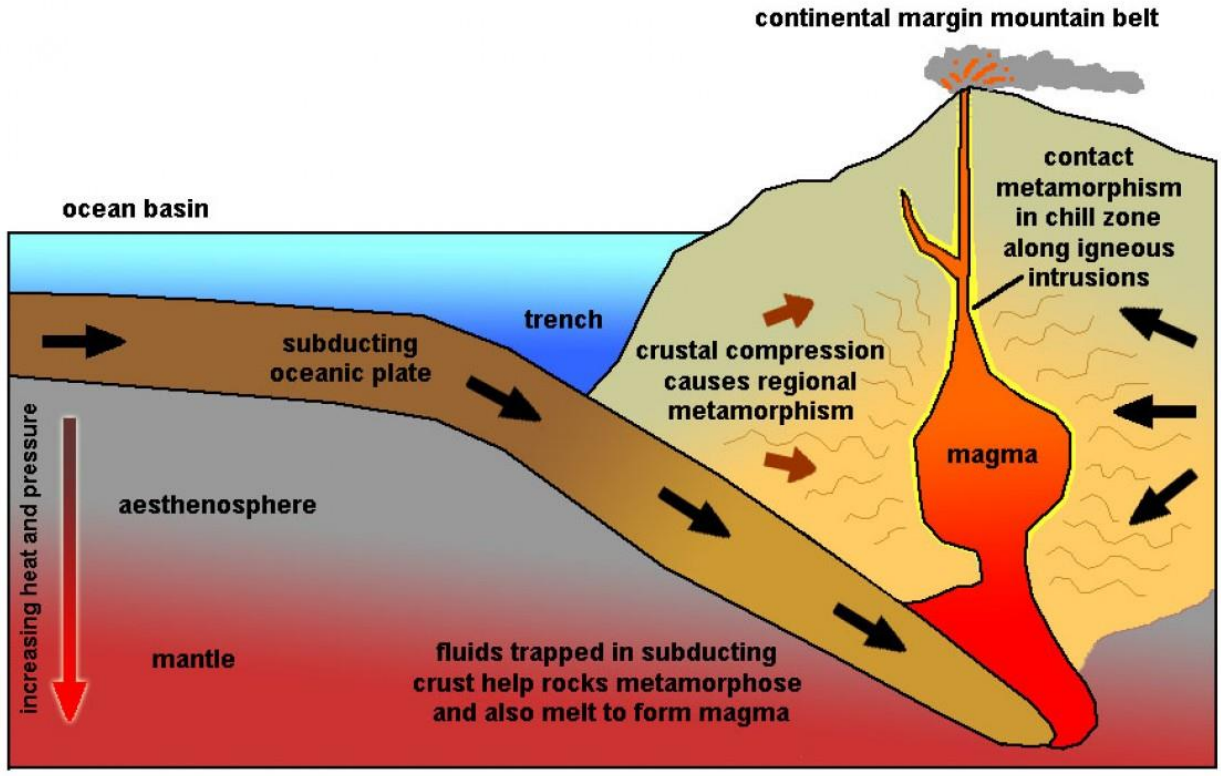


Figure 11. Hydrothermal Gemstone creation

4. Sedimentary Gemstone Creation

Sedimentary gemstone creation occurs when water mixes with mineral on the earth surface. The mineral rich water the seeps down between the cracks and cavities in the earth and deposits layers of minerals. This is how minerals like Opal, Malachite and Azurite are formed. Opal is formed when the water mixes with silica. As the silica solution settles, microscopic spheres of silica stack on top of each other forming Opal.

1.3. Opal formation

Opal is formed from a solution of silicon dioxide and water. As water runs down through the earth, it picks up silica from sandstone, and carries this silica-rich solution into cracks and voids , caused by natural faults or decomposing fossils. As the water evaporates, it leaves behind a silica deposit.

Occasionally, when conditions are ideal, spheres of silica, contained in silica-rich solutions in the earth form and settle under gravity in a void to form layers of silica spheres. The solution is believed to have a rate of deposition of approximately one centimetre thickness in five million years at a depth of forty metres. If the process allows spheres to reach uniform size,

then precious opal commences to form. For precious opal the sphere size ranges from approximately 150 to 400 nanometres producing a play of colour by diffraction in the visible light range of 400 to 700 nanometres.

Each local opal field or occurrence must have contained voids or porosity of some sort to provide a site for opal deposition. In volcanic rocks and adjacent environments the opal appears to fill only vughs and cracks whereas in sedimentary rocks there are a variety of voids created by the weathering process. Leaching of carbonate from boulders, nodules, many different fossils, along with the existing cracks, open centres of ironstone nodules and horizontal seams provide a myriad of moulds ready for the deposition of secondary minerals such as opal.

Much of the opal deposition is not precious. It is called “potch” by the miners, or common opal by the mineralogist, as it does not show a play of colour. Opaline silica not only fills the larger voids mentioned but also may fill the pore space in silt and sand size sediments cementing the grains together forming unique deposits, known as matrix, opalised sandstone or “concrete” which is a more conglomeratic unit near the base of early Cretaceous sediments.

The many variations in the types of opal depends on a number of factors. In particular, the climate provides alternating wet and dry periods, creating a rising or more importantly a falling water table which concentrates any silica in solution. The silica itself is formed either by volcanic origin or by deep weathering of Cretaceous clay sediments producing both silica and white kaolin often seen associated with the Australian opal fields. Special conditions must also prevail to slow down a falling water table in order to provide the unique situation for the production of its own variety of opal.

The chemical conditions responsible for producing opal are still being researched, however some maintain that there must be acidic conditions at some stage during the process to form silica spheres, possibly created by microbes.

While volcanic-hosted and other types of precious opal are found in Australia, virtually all economic production comes from sediment-hosted deposits associated with the Great Australian Basin. Australia has three major varieties of natural sediment-hosted precious opal – black opals from Lightning Ridge in New South Wales, white opals from South Australia, and Queensland boulder and matrix opal.

Self-check 1	Written test

Directions: Answer all the questions listed below. Examples may be necessary to aid some explanations/answers.

Instruction 1: choose the correct answer and write the letter on the space provided?

----------1. The process of forming gemstones due to high pressure and temperature is called_____? (2 points)

A. Sedimentary rocks B. Metamorphic rock C. Igneous rocks D. All

----------2. Gem formations can be occurred by?

A. Molten rock and associated fluids

B. Environmental changes

C. Surface water

D. All

3. If you want to see an inclusion of a gemstone what hand tools are you use?

A. spectroscope B. goggle C. hammer D. slab saw

Directions 2: short answer Items

1. List two type of gemstone formed by metamorphic rock.
2. What opal makes is not mineral?
3. What is five requirements for crystals form?

Instruction 2 Fill the correct word or phrase in the space provided?

1. As magma goes through various stages of changing temperature, pressure, and chemistry, ----------.
2. _____is a solution of silicondioxide and water
3. _____is a gem that is formed by intense heat and pressure

Note: **Satisfactory rating - 8 points** **Unsatisfactory - below 8 points**

Score = _____

Rating: _____

Information Sheet 2- Determining the source of gemstone

2.1. Source of gemstone world wide and in Ethiopia

Australia has been the dominant force in the opal market for over 100 years. During that time as much as 95% of the worldwide opal production has been mined in Australia.
Australia and visit the amazing opal and sapphire pearl pink and red diamonds.
Zimbabwe would reward a keen rock hound with emerald, garnet, aquamarine, malachite, tourmaline, tiger's eye and every variety of quartz.
Burma (Myanmar), where we could see some amazing and legendary areas with jade, ruby, sapphire and spinel, plus numerous rare and peculiar oddities that would win some serious show-and-tell points.
Ampara Sri Lanka Gem A Gemstone Producing Countries Gem an important source of gemstones, especially sapphires.
Brazil is A gemstone producing country of haively Topaz, Emerald, Aquamarine,

2.2. Ethiopian Gemstone

Today, Ethiopia is on its way to becoming the second heavy weight in the opal market.

A small discovery in 1994 put Ethiopia on the worldwide opal map. This was followed by important discoveries in 2008 and 2013. These are now producing beautiful precious opal, fire opal, and black opal with spectacular play-of-color in a variety of patterns and body colors.

Ethiopian opals are not only beautiful, but they generally cost less than similar-quality opal from Australia. People now go to the store looking for "Welo opals" or "Ethiopian opals." They also use the internet and search for these opals by name. This surge of public awareness has developed in just a few years without a major mining company or jewelry brand spending millions of dollars to promote them. This popularity is being driven by the beauty of Ethiopian opal and their current attractive prices.

Short History of Ethiopian Opal

Precious opal mined in Ethiopia began entering the gem and jewelry market in 1994. This opal originated from a discovery made in the Menz Gishe District in the northern part of the Shewa Province. Opal from this area occurs in a wide range of body colors. Much of the opal has a brown, red, or orange body color; however, yellow, white, and clear body colors are also found.

Shewa Province opal is found in stratified igneous rocks such as rhyolite, tuff, and ignimbrite. Although much of this opal has crazing problems, stable material enters the gem and jewelry market. These opals are often called “Shewa opals” or “Mezezo opals” after their locality of origin.

The most important opal discovery in Ethiopia to date was made in 2008 near the town of Wegel Tena in the Wollo Province in the northern part of the country. This opal can have vivid play-of-color flashing from a body color of clear, white, yellow, orange, or brown. It is more stable than the North Shewa opal. This material quickly became known in the trade as “welo opal,” but the names “wollo” and “wello” are also encountered.

Much of the welo opal is produced from a single area of stratified volcanic rocks. The main vein is an opalized rhyolitic ignimbrite up to one meter thick that overlies a base of clay. The opal likely formed as silica-bearing waters accumulated on top of the impermeable clay. Silica gel precipitated in the pore spaces of the ignimbrite and was later transformed into opal.

The seam outcrops along steep valley walls, where short horizontal tunnels are excavated to mine the opal. Underground mining here is very dangerous work, as the ignimbrite is often fractured, friable and poorly lithified. The seam can be traced along the valley walls where it is being mined, but its full geographic extent is unknown because the opal-bearing stratum is covered by up to 350 meters of stratified volcanic deposits. However, the deposit may extend over several kilometers and could become a major source of gem-quality opal.

A third deposit was found in 2013, again in the Wollo Province, but about 100 kilometers north of the Wegel Tena area. Much of the opal in this deposit has a translucent gray to black body color.It occurs in a seam of mineralized ignimbrite. The seam is in an extensive

sequence of stratified volcanic rocks. It is up to 60 centimeters thick and rests atop of an impermeable clay. This deposit is also poorly defined but the seam can be traced along the steep valley walls. Current mining is by horizontal tunnels dug into the seam's outcrop on steep hillsides.

Notable Ethiopian Gemstone:- Four types of Opal

1. Semen Showa (Brown Opal) 2. Fire Opal
2. Wello Opal 4. Black Opal

Ethiopia has sourced, more than 20 types of gemstones including:-

- Emerald Amber
- Aquamarine Tourmaline
- Amethyst Corundum
- Citrine- Fluorite
- Obsidian Peridot
- Quartz Jasper
- Chrysoprase Chrysocolla
- Malachite Garnet
- Putrefied wood Agate
- Amazonite Iolite, etc.

A. Chrysopras

B. Chrysocolla

c. Fire Opal

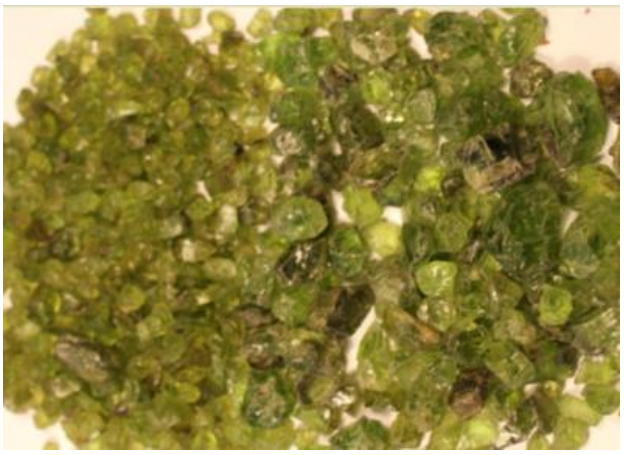
D. Amethyst

E. Rubby

F. Aquamarine

G. Tormaline

H. Quartiz



I. Routine quartz

J. Peridot

K. Citrine

L. Amazonite

M. Emerald

N. Green Amber

O. Wello Opal

P. Semen shewa brawn opal

Figure 12. Gemstone found in ethiopia

Self-Check – 2	Written test

Part 1:True or False

Instruction1- Say true if the statement is correct and false if the statement is in correct)

1. Ethiopia is the first country of opal production(1 pt)
2. Ethiopian Opal is less in value than same quality of Australian opal(1 pt)
3. Sapphire, Emerald and Rubby are some the big three gems in the market. (1 pt)

Part 2: Short Answer

1. List at least four type of Opal found in Ethiopia.(2Pt)

2. What is the difference Preciscous and Semi precisous gemstone? .(2Pt)

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5 points**

Score = _____

Rating:

LG #2	LO #2- Applying the principles of grading and quality assessment to gemstone

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identifying the value of gemstone based on their characteristics
- Applying the principle of valuing gemstone

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify the value of gemstone based on their characteristics
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Information Sheet 2-Identifying the value of gem based on their characteristics

Introduction

The grading of colored stone is somewhat similar to how it is achieved in Diamonds

It is a set of gem parameter (which may slightly differ between gem varieties.

The colored stone grading factors are

1. Color
2. Clarity
3. Cut
4. Carat

4C's

5. Country/Source
6. Confidence
7. Transparency
8. Enhancement
9. Optical Phenomena

1. Color

Gemologists usually describe gem color by referring to three properties: hue, tone, and saturation.

Hue:-is the first impression of an object's basic color. When most people describe colors, they probably mean hue. The basic hues are red, orange, yellow, green, blue, violet, and purple.

Tone refers to a gem's relative lightness or darkness. Black and white are tones, from darkest to lightest.

Saturation refers to the intensity of its hue. Colors can be strong or soft. Pink is desaturated red. Warm colors, like red and orange, become shades of brown as their saturation decreases.

Figure 13. Color hue

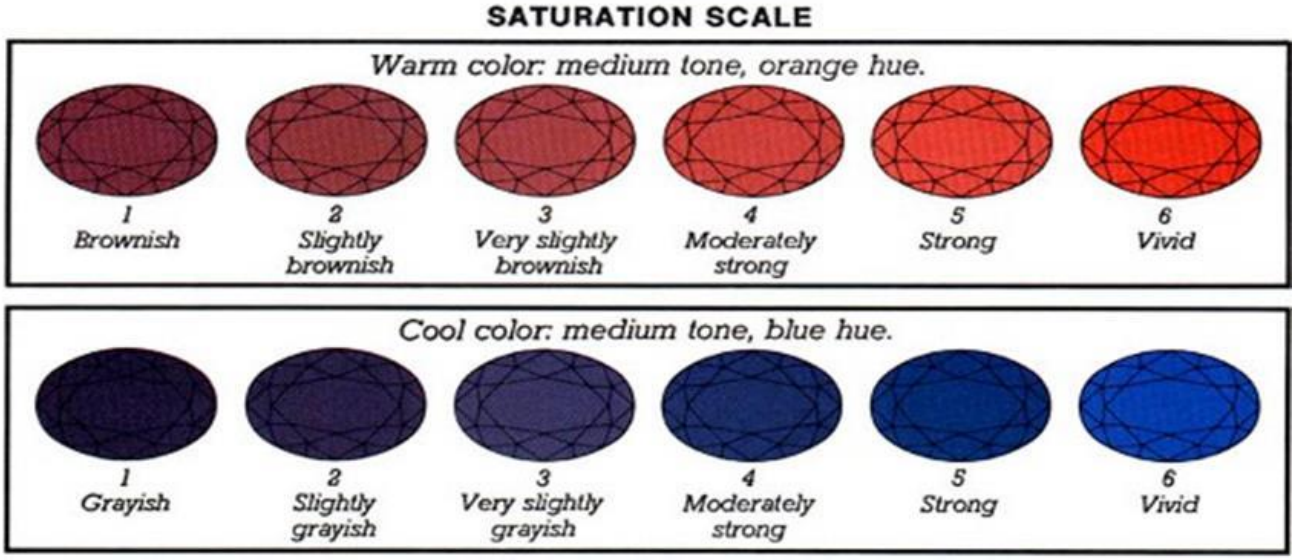


Figure 14. Color Saturation

Table 1. Color tone scale

GIA Ton Scale	
0c	Colorless or white
1exl	Extremely light
2vl	Very light
3l	Light
4ml	Medium light
5m	Medium
6md	Medium dark
7d	Dark
8vd	Very dark
9exd	Extremely dark
10bl	Black

Note:-GIA refer to Gemological Institute of America

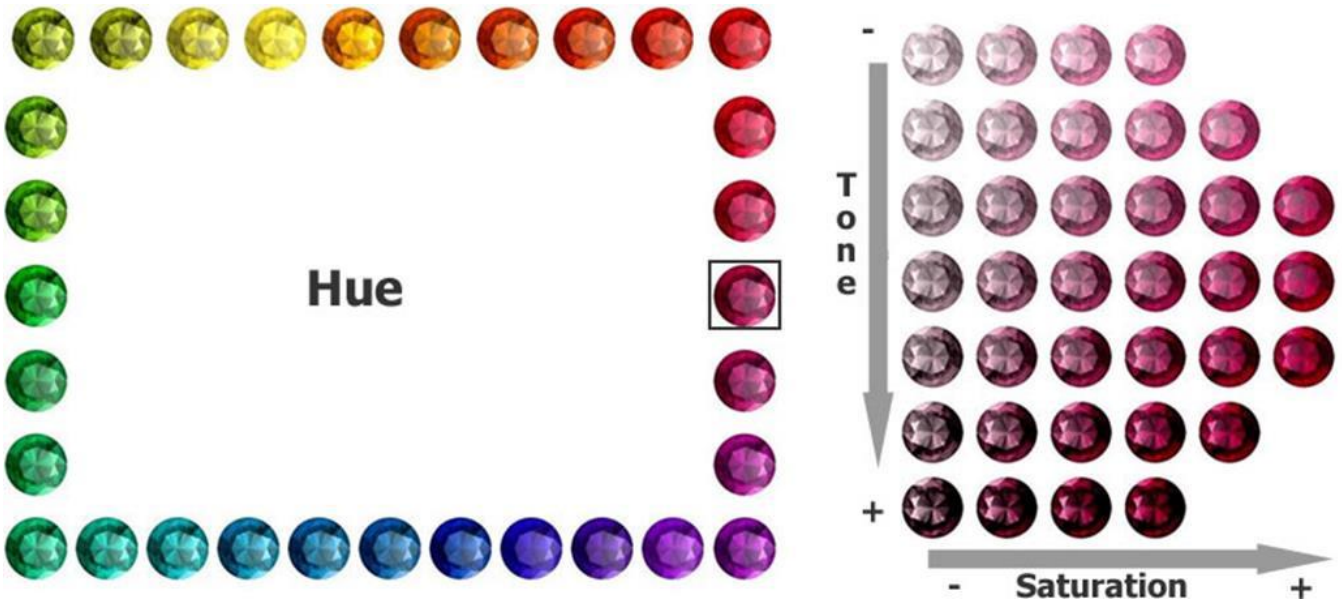
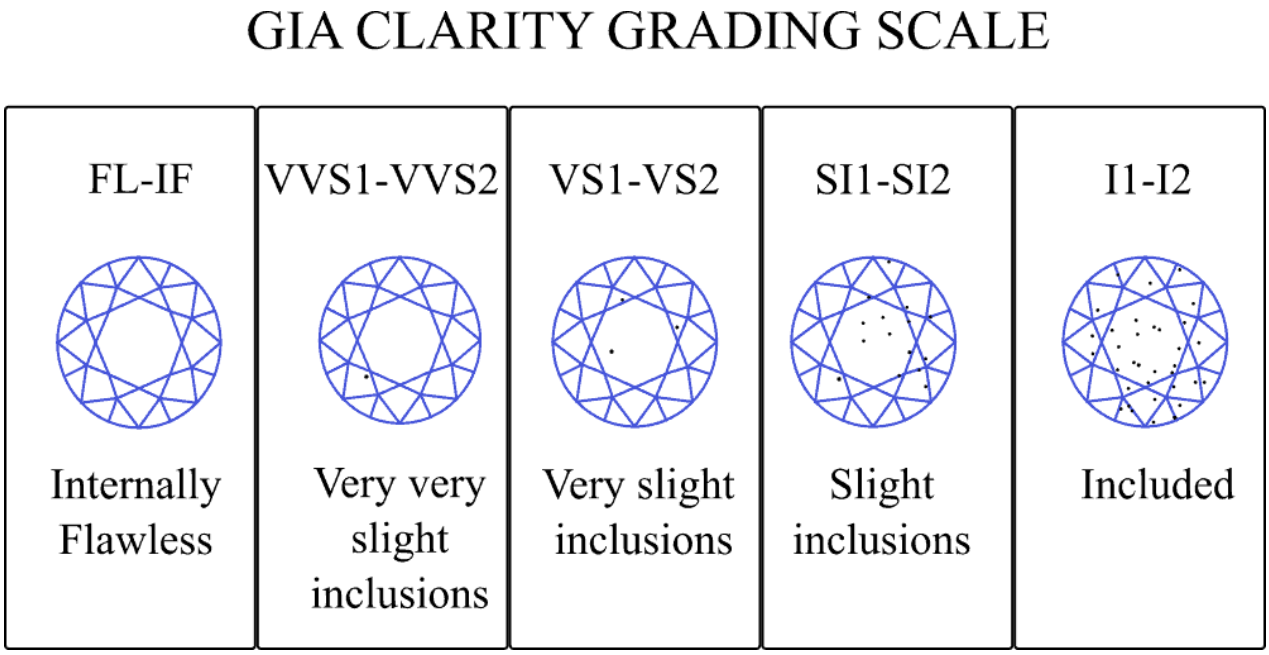


Figure 16. Color tone, hue and saturation

2. Carity

Gemstones contain a wide variety of inclusions. In faceted gems, inclusions are defined as anything that will interfere with the free passage of light. These can include little bits of minerals, hollow areas, and fractures. Clarity grading addresses the visual and structural impact of these things.

A. Emerald clarity



B. Gem clarity grading scale

Figure 17. Gemstone clarity

3. Cut

Gemstones come out of the earth in a rough crystal formation. Each mineral will have its own unique arrangement and structure. It is up to the gem cutter, or lapidary, to bring out the inherent beauty. Some of the most well-known gemstone cuts are:

- Cabochon: a cabochon or “cab” can be cut to a variety of shapes and has smooth surfaces without facets.

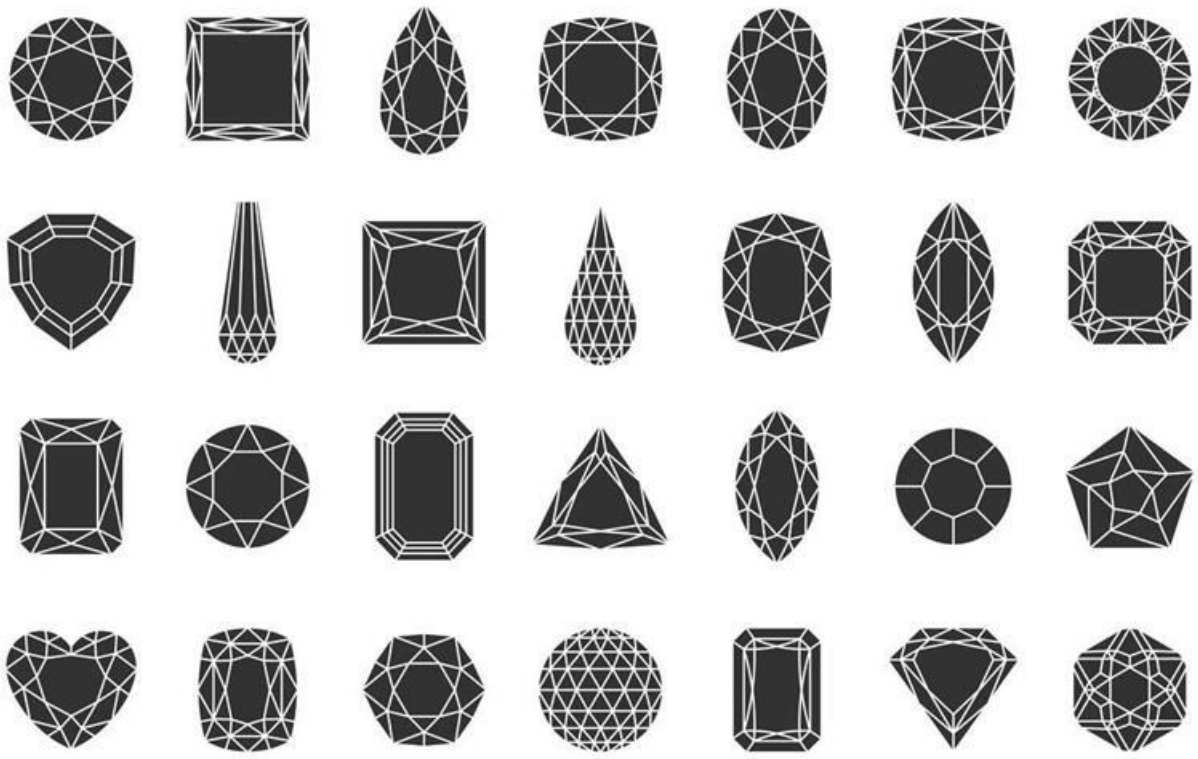
- Round and round brilliant; this typically has 58 facets, or polished surfaces.
- Princess cut: square shaped with angular facets.
- Cushion: this has a square or rectangular shape but with slightly curved sides and soft edges.
- Radiant: this is rectangular with cut corners and angular facets.
- Emerald cut: this differs from the radiant in that it is rectangular with cut corners and parallel facets.
- Asscher cut: a modified emerald cut, in that it is square with cut corners and parallel facets.
- Trillion, which is triangle shaped.

Some gemstone cuts are fairly self-explanatory, as the name gives the indication of the general shape.

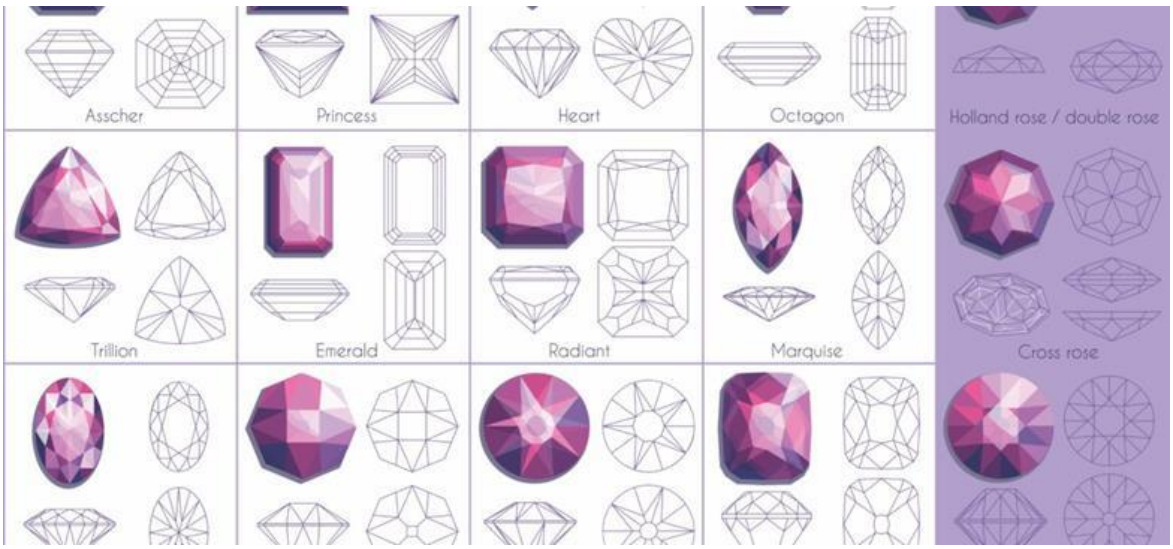
- Heart
- Oval
- Pear
- Marquise

While cabochons do not have faceted surfaces, most other gemstone cuts will. The largest facet is called the table. Surrounding the table are star facets, then bezel facets, and upper girdle facets. The girdle or outer diameter of the stone may or may not be faceted. The area below the girdle is called the pavilion and may have parallel or kite shaped facets. The very bottom of the stone is called the culet, which may or may not be polished. Sometimes there is no culet. When the gemstone does not terminate to a single point, it may have a keel.

When questioning why a lapidary might or might not facet a girdle or make any other curious cutting decisions, the answer is almost always the same: to maximize the weight and/or color of the gemstone. A well cut gemstone will have a pleasing symmetry and a good length to width ratio (if the stone is not round).



A. cut template



B. Cut gem with template

Figure 18. Types of cut

What are the Different Cuts of GEMSTONES Jill Maurer_.mp4

4. Carat

A carat is a unit for measuring gem weight. One carat equals 1/5 of a gram, or 200 milligrams. One kilogram (approximately 2.2 pounds) equals 5,000 carats.

Simply put, larger stones are less common than smaller ones. Hence, they often demand a higher price per carat. For example, a quarter-carat topaz may cost $60 per carat, or $15 total. A half-carat topaz, with the same color, clarity, and cutting grades, might cost $100 per carat, or $50 total. For a topaz one-carat and over in size, the price could reach $200 per carat. So, a one-carat stone will cost $200 total, not $60 or $100.

Figure 19. Carat of gemstone

5. Country of orgion

Source(country of origin):-gems from a specific desired country of origin could fetch a higher value than similar quality gems from other sources.

6. Confidence

If you have feelings of worthlessness, lack self-belief, or suffer from low self-esteem, these nine healing crystals for confidence can help.

True confidence comes from within. It’s knowing the value you bring to others, without arrogance, conceit or self-delusion.

Most importantly, confidence is the magical ingredient for reaching your goals and fulfilling your truest potential.

In contrast, low confidence holds you back from your potential. It stops you being assertive, makes you vulnerable, and causes self-doubt.

The nine healing crystals below can restore inner confidence. They bring balance to the Solar Plexus and Sacral Chakra, helping you feel valued and develop a strong sense of self.

1. Sunstone

2. Spirit Quartz

3. Citrine (The Lucky Merchant's Stone)

4. Carnelian (Stone of Creativity, Motivation, Endurance, Leadership and Courage)

5.Orange Calcite

6. Red Jasper (The Supreme Nurturer, Stone of Endurance)

7. Rose Quartz (Stone of Unconditional Love)

8. Amazonite (Stone of Hope, Success, Abundance and Courage)

9. Tiger's Eye (Stone of the Mind)

Figure 20. Some of cofidence gemstone

6. Enhancement

Many gems have undergone treatment processes, also called enhancements, to change their color and/or clarity a more desirable one, to improve their luster, or even to change its appearance to a more precious gems.

According to the ethical rules of most countries and gemological institution, the seller is obligated to disclose any treatment which the gem has undergone.

- Traditional enhancement
  - ✓ Example oiling in emeralds
- Non traditional acceptable enhancement
  - ✓ Example heating in rubby which leaves flex residue in fractures.
- Unacceptable enhancement process that change original identification.

- ✓ Example:-green dyed colorless beryl look like emerald.

7. **Optical Phenomena**

Optical Phenomena results from the way light interact with the crystalline structure of a gemstone. This interaction or interference can be in the form of light scattering, reflection, refraction, diffraction, absorption or transmission.

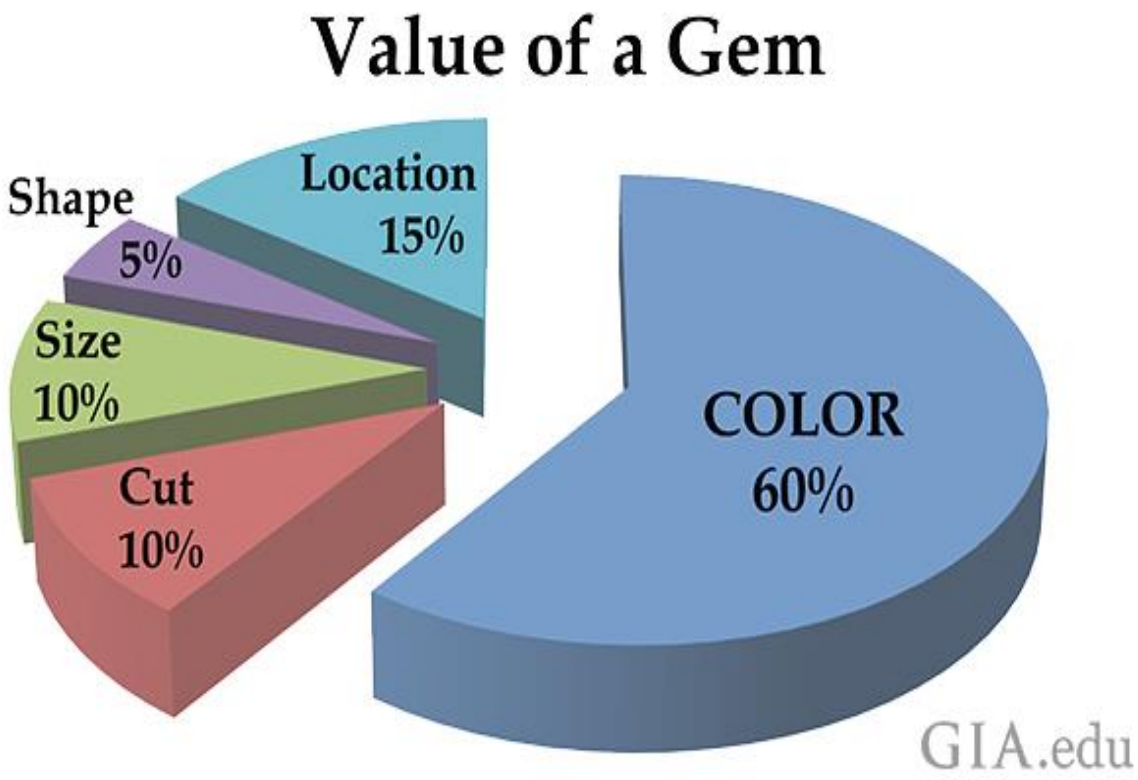


Figure 21. Value of gem

Introduction to colored stones grading (online webinar by Gem Color Academy experts)[via torchbrowser.com].mp4

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions 1: Multiple Choice Items

Instruction 1: choose the correct answer and write the letter on the space provided?

The ability of the gemstone to resist scratching is known as. (1 points)

Toughness B. Hardness C. stability All

2. Which of the following has the ability to resist breaking or chipping? (1 points)

A. stability B. Hardness C. toughness D. rarity

3. The availability of resources in bulky quantity but a few in quality is called…… (1 points)

A. relative rarity B. Inherent rarity C. Saturation D. Stability

4. Which one is the softest gem? (1 points)

A. Diamond B. Topaz C. Feldspar D. Fluorite

5. Which one is the hardest gem? (1 points)

A. Diamond B. Topaz C. Feldspar D. Fluorite

Directions 2: short answer Items

Instruction 2 Fill the correct word or phrase in the space provided?

6. What does it mean Mohs" Scale? (2 points)

7. Explain rarity of gemstone (3 points)

Note: Satisfactory rating 8 points and above Unsatisfactory - below 8 points

Score = _____

Rating: _____

Answer sheet

Information Sheet 2- Applying the principle of valuing gem

2.1. Opal Quality Factors

Individual opals can vary widely in appearance and quality. As diverse as snowflakes or fingerprints, each gem can differ noticeably.

There are three main aspects of an opal's quality:

- Color—Background color and play-of-color
- Pattern—Arrangement of play-of-color
- Clarity—Transparency and quantity of inclusions

Opal evaluation should be done under controlled lighting on a dark background. Rotating the opal against a background helps when you're determining its type and evaluating its play-of-color and cut.

The Five Steps of Evaluating an Opal

1. Determine the type of opal:
   - Is it a black opal, white opal, crystal opal, etc.?
2. Determine the ratio and quality of its play-of-color:
   - Consider the percentage of play-of-color compared to background color, its intensity, dominant hues, range of color and pattern.
3. Determine the opal's transparency:
   - Is it transparent, semi-transparent, translucent, semi-translucent or opaque?
4. Determine the opal's clarity:
   - Look for the presence of matrix, crazing, pits, etc.
5. Evaluate the opal's cut:
   - Consider the opal's symmetry, thickness, polish, sizing and calibration.

OPAL COLORS

Opal hues can range across the spectrum. An opal might display a single color, two or three colors, or all the colors of the rainbow. Opal displays background color in addition to play-of-color. Background color—also called bodycolor—is caused by the suspension of tiny impurities within opal's silica spheres.

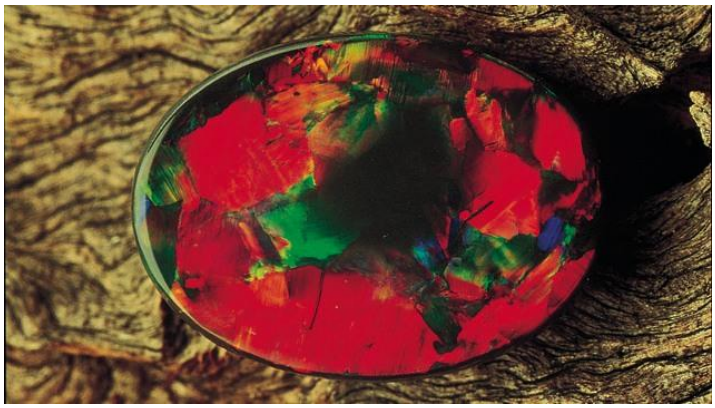


Figure 22 Red-play off color

Opals are often divided into types based on background color. Even though there are many different categories for opals, here are the main five types:

- **Black Opal**

All other quality factors being equal, many buyers favor the dark background color of black opal. This is partly because play-of-color tends to stand out attractively against a dark background. The contrast of play-of-color to bodycolor makes black opals very popular. Additionally, black opals are considered to be the rarest (white opals are more common).

- **White Opal**

An opal with a translucent to opaque white and other light color backgrounds (bodycolor) with play-of-color is called white opal.

- **Fire Opal**

Fire opal is transparent to translucent with a bodycolor that is usually yellow, orange or red. This material, which might show play-of-color, is also known in the trade as "Mexican opal" or "Mexican fire opal".

Figure 23. Fire Opal

Boulder Opal

Boulder opal is translucent to opaque opal with play-of-color within a host rock. Thin layers of opal exist within the host rock (called matrix). The opal is cut with the matrix attached and is part of the finished gem.

Figure 24. Bondular Opal

Crystal and Water Opal

Crystal opal is transparent to semitransparent with a clear background. This type of opal can show excellent play-of-color. Water opal might or might not display play-of-color. If it does show play-of-color, it is faint and covers only small portions of the gem.

Play-of-color might be the most spectacular aspect of an opal's appearance. No matter the color or combination of colors, play-of-color must be vivid to command a high rating. In other words, opal lovers prize bright play-of-color over faint play-of-color.

Secondary in importance to play-of-color's strength is its range. If an opal's play-of-color is not just bright, but also ranges across the entire spectrum, it's very rare and valuable. Not every precious opal, however, sparkles with every color of the rainbow. In some, the play-of-color consists of just one main color and two or more secondary colors.

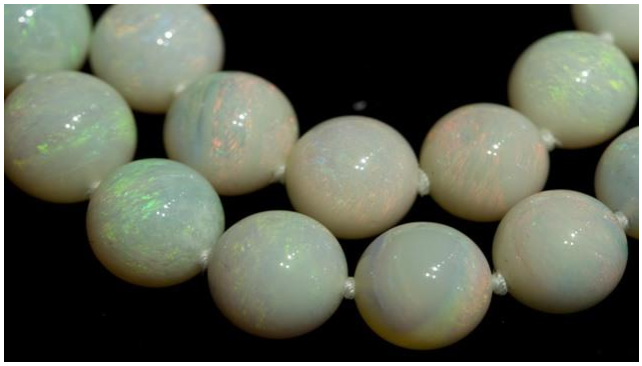


Figure 25. Light color

Desirable play-of-color is further broken down by the colors themselves. Traditionally, red is considered the best prominent color, orange the next most desirable, followed by green. However, favored colors can vary with fashion or personal preference.

In addition, an opal's play-of-color can change along with the viewing angle or type of light. For example, red might dominate in the same portion of an opal cabochon where blue dominates when it's viewed from a different angle.

The most valuable opals display play-of-color from all angles.

How does opal get its play of color.mp4

OPAL PATTERNS

Pattern describes the arrangement of an opal's play-of-color. Like the shapes you see in the figure 26. below

- clouds, play-of-color takes many forms.
- Common terms for play-of-color patterns include:
- Pinfire or pinpoint: Small, closely set patches of color
- Harlequin or mosaic: Broad, angular, closely set patches of color
- Flame: Sweeping reddish bands or streaks that shoot across the stone
- Peacock: Mainly blue and green

In general, connoisseurs prefer large, closely arranged patches of color over tiny, scattered dots. As with any play-of-color, no matter what the pattern, colors must be bright for the stone to be valuable.

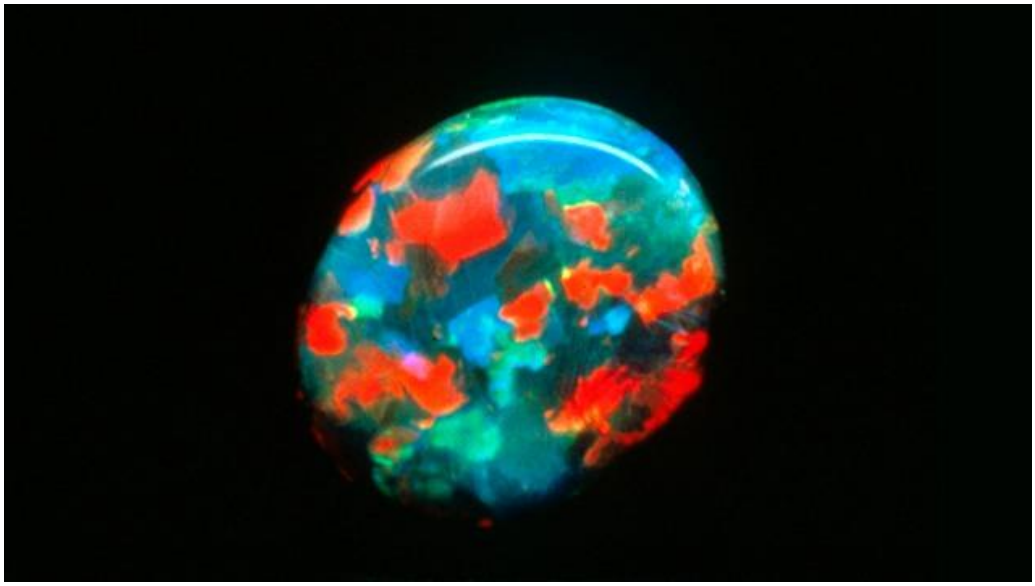


Figure 26. Opal Pattern

Let me teach you patterns in opal.mp4

OPAL CLARITY AND TRANSPARENCY

With an opal, clarity is its degree of transparency and freedom from inclusions. An opal's clarity can range all the way from completely transparent to opaque. Experts prize different levels of clarity for different opal types. For example, in crystal opal, experts admire transparency, while in black opal they prefer an opaque background. Each provides the best background for displaying play-of-color in its individual opal type. A cloudy or milky background color lowers the value of any opal. It makes the gem less attractive, and it can sometimes signal a lack of stability.

Figure 27. Opal clarity

There are various types of opal clarity characteristics that affect value. Opals, like other gems, can have fractures, or pits and other surface blemishes. An opal might also contain fragments of its host rock, called matrix. Matrix in a polished opal is usually—but not always—detrimental to its appearance and value. It depends on the type of opal.

17_83 cts - Holiday Special! Amazing Water Clear Transparent Welo Opal!.mp4

OPAL CUTTING

The cutter considers an opal's color, pattern, and clarity when planning the finished gem. As with many top-quality colored stones, exceptional opals might not be cut to standard sizes and shapes.

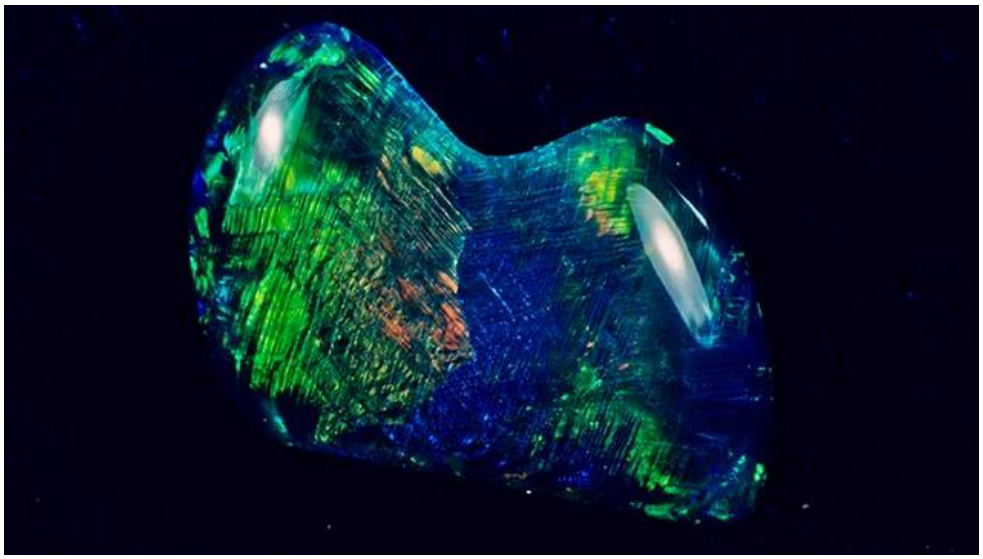


Figure 28. Opal Cut

How to Cut & Polish Gemstones 1 Introduction & Identifying Inclusions.mp4

Carat Weight

Opals come in a wide range of sizes and carat weights. Opal has relatively low density compared to many other gemstones so even larger sizes can be comfortable to wear.

Common sizes for many of the opal cabochons set in jewelry are 6×4, 7×5, and 8×6 mm.

The Fire of Australia, a large uncut opal, weighs 998 grams or just under 5,000 carats. South Australia is one of the few places on Earth where opals of this size can be found. Approximately 90% of the world's opals are from Australia.

Figure 29.Opal carat weight

ASSEMBLED OPALS

Opal can be fragile. In solid opal cabochons, the gem material is usually thick enough to withstand everyday wear and jewelry repair without breaking. But with thinner material, manufacturers often have to add a rigid backing for durability.

Assembled opals are fashioned opals with backings. They might include materials like glass that aren't usually part of gem-quality jewelry, but because they are partly precious opal, they still have value as gems. They sell for only a fraction of the price of boulder opals, but they allow manufacturers to make attractive finished gems from thin opal pieces.

The two common types of assembled opal are the opal doublet and triplet. The doublet is a thin layer of opal cemented to a backing. The backing is often composed of obsidian, dyed black chalcedony, black glass, natural common opal, or plastic. The triplet is a thin layer of opal cemented between a domed top of colorless quartz or clear glass and a backing of obsidian, chalcedony, or black glass.

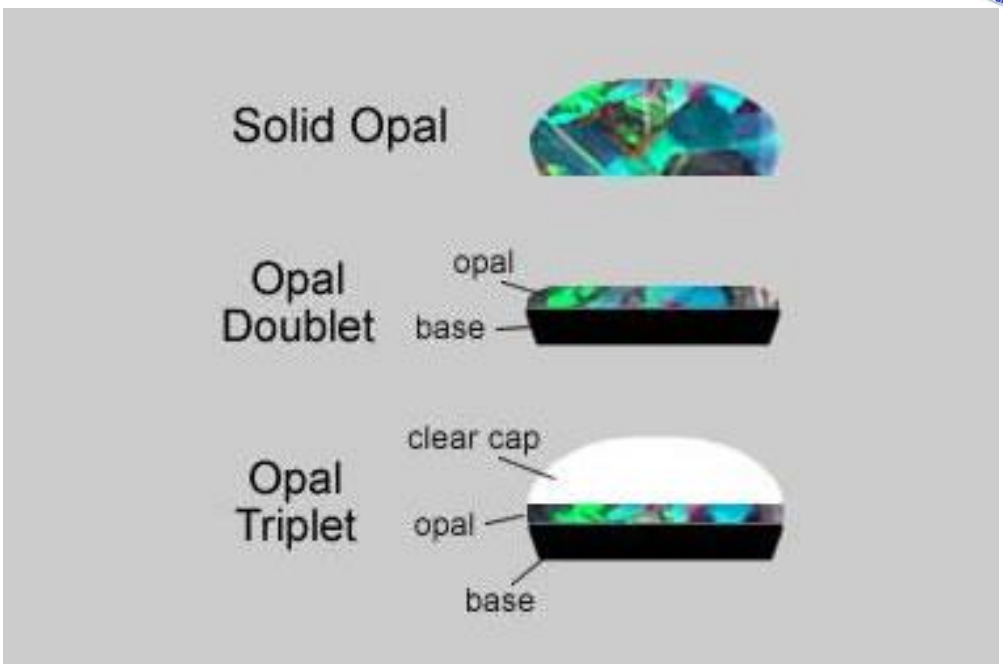


Figure 30. Opal Doublet and Triplet

Refer Lo.2. information sheet 1 for further study

Self-Check – 2	Written test

Name…… ID…… Date…….

Directions 1: True / false Items

Instruction 2 write true if the statement is correct and write false if the statement is incorrect

1. The highest values of gem stones associated with pure hues and strong rich colors (1 point)

2. The strength or weakness of a gem color is expressed by hue (1 point)

Directions 3: short answer Items

Instruction 3: Write short answer for the following questions

1. Is inclusion always lowers the value of the gems? Justify your reason(2 point)

2. If you have two opals with the same colour and clarity but different sizes which one will you more value per carat? Explain it? (2 point)

Note: Satisfactory rating 3 points and above Unsatisfactory - below 3 points

Score = _____

Rating: _____

Answer sheet

Test I

1._____

2. _____

3._____

LG #3	LO #3- Distinguish natural opal from man-made varieties

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Identifying gemological characteristics of gemstone
- Selecting gemological tool and equipment of gemstone identification
- Using equipment's and tools safley
- Comparing the characteristics of natural opal to synthetic opal

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Identify gemological characteristics of gemstone
- Select gemological tool and equipment of gemstone identification
- Use equipment's and tools safley
- Compare the characteristics of natural opal to synthetic opal

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information Sheet 1	Identifying gemological characteristics of gemstone

1.1. Opal - Mineral and Healing Properties

- Chemistry: SiO2 - nH2O; Hydrated Silicon Dioxide.
- Class: Mineraloids
- Group: Some minerologists place Opal in the Quartz Group.
- Uses: As a gemstone and ornamental stone.

Opal's internal structure makes it diffract light; depending on the conditions in which it formed it can take on many colors. Opal ranges from clear through white, gray, red, orange, yellow, green, blue, magenta, rose, pink, slate, olive, brown, and black. Of these hues, the reds against black are the most rare, whereas white and greens are the most common. It varies in optical density from opaque to semi-transparent. For gemstone use, its natural color is often enhanced by placing thin layers of opal on a darker underlying stone, like basalt.

Green Opals are deposited at a relatively low temperature and may occur in the fissures of almost any kind of rock, being most commonly found with limonite, sandstone, Rhyolite, marl and basalt.

In late 2008, NASA announced that it had discovered opal deposits on Mars.

The world's largest and most valuable gem opal "Olympic Australis" was found in August 1956 at the "Eight Mile" opal field in Coober Pedy. It weighs 17,000 carats and is 11 inches long, with a height of 43 inches and a width of 41 inches . It is valued at $2,500,000

We use semi-precious and precious stones in our jewelry. Some stones are more fragile than others and need to be handled with care.

Physical Characteristics

- Color: Colorless, white, yellow, red, orange, green, brown, black, blue.
- Luster: Subvitreous to uneven.
- Transparency: Opaque, translucent, transparent.
- Crystal System: Amorphous
- Crystal Habits: Irregluar veins, in masses, in nodules.

- Cleavage: None
- Fracture: Concoidal to uneven
- Hardness: 5.5 - 6
- Specific Gravity: 2.15
- Streak: White
- Associated Minerals: Chert, volcanic rock and many others.
- Best Field Indicators: Color play & opalescence, low density, fluorescence, fracture filling tendency and lack of cleavage or crystal faces.

Refer LO.2 Information sheet 1 and 2

Self-Check – 1	Written test

Directions 1: Multiple Choice Items

Instruction 1: choose the correct answer and write the letter on the space provided.

----------1. Green garnet called---------can be far more valuable than a mid-quality emerald

(2 points)

A. opal B. ruby C. emerald D. tsavorite

----------2.Which of the following is the characteristics of gemstone? (2 points)

A. clarity

B. rarity

C. beauty

D. All

----------3. Which one of the following gemstone is not precious? (2 points)

A. diamond B. ruby C. obsidian D. emerald

Directions 2: True False

Instruction 2: choose the correct answer and write the letter on the space provided.

4. Colour is not the dominant factor in Opal identification
5. Opal is classified as a mineraloide group and its chemical formula $Sio_2 .n\ H_2O$

Note: Satisfactory rating 3 points and above Unsatisfactory - below 3 points

Answer Sheet

Score = _____

Rating: _____

Information sheet 2:- selecting gemological tools and equpments to identify natural opal

2.1. Tools and equipment's used by Gemologists

While some gemstones are readily identified on sight, even by novices, many of them are quite similar in appearance and cannot reliably be identified on visual appearance alone. The tools used by gemologists for the identification and grading of different gemstones range from simple and familiar to the high-tech and exotic. Most gemstones can be identified by a few basic tools that every gemologist should have at hand. Often, a single test is not conclusive, and a gemologist often needs to perform several different tests to achieve a positive identification.

Binocular microscope. Simple models such as the one shown here may be obtained for a few hundred dollars, but better scopes with enhanced accessories typically cost several thousand dollars. These scopes provide both light field (lighting from below) and dark field (lighting from the side) views and usually have a magnification range from 10X to perhaps 100-200X. Magnifications of 10X to 40X are most often used, but the higher range is sometimes needed for careful inspection of inclusions.

Refractometer. small drop of liquid with a high refractive index (RI) is placed on a glass cylinder in the top of the refractometer and illuminated from a separate light source (sometimes white light, but a monochromatic light source provides better accuracy). The RI is then read from a magnified gauge on the front of the refractometer.

Figure 32. Refracto meter

Polariscope has two polarizing filters and a light source below. As the upper filter is rotated, it allows a varying amount of light to pass through the system. A transparent gemstone held and turned between the crossed filters shows different patterns of light, depending on its optic character, and this can often be used to distinguish between different gemstones with similar appearance.

Figure 33. Polarioscope

Chelsea filter, aka emerald filter, is sometimes useful in distinguishing between natural and synthetic emeralds or between aquamarine and blue topaz, but its usefulness and reliability are quite limited, so it has declined considerably in importance over recent decades.

Figure 34. Spectroscope

Spectroscope is sometimes used to separate natural from synthetic gem materials, as variations in chemical composition can be revealed in the absorption spectrum of light transmitted through the stone. These instruments can be quite simple, as shown here, or

much more elaborate. The average gemologist is unlikely to use this very often, but the more specialized gem trade labs use spectroscopes frequently to identify difficult materials.

Figure 35.Spectroscope

An ultraviolet (UV) light source, or black light, will reveal fluorescent activity in many gem materials, and this can help to identify many stones.

Figure 36. Uv light

Hardness points: - intended to test the scratch resistance or hardness of a material, are very rarely used by gemologists, because they are by nature destructive. Occasionally, a gemologist will attempt a very small scratch in an inconspicuous area of an object, such as a sculpture, but such tests should never be used until other tests are exhausted, and a faceted stone should never be subjected to a hardness test.

Figure 37. Hardness kit

Specific gravity (SG) are sometimes used to distinguish between various materials that closely match in other characteristics. As the substrate of s.g liquids evaporates, the s.g

changes, so such test sets must be recalibrated periodically. Specific gravity can also be tested on weight scales by comparing the weight of an object immersed in water with the weight of the object in air. Another test often used to distinguish amber from its substitutes is simple immersion in a saturated salt solution; amber floats in salt water, but most of its imitations sink.

Figure 38 Specific gravity

X-ray photographs are sometimes used, as in the separation of natural pearls from cultured pearls, and x-ray diffraction techniques are used in advanced laboratories.

A heated point can be used to separate some organic materials from their substitutes. For example, a hot point will elicit a sweet resinous smell from amber but an acrid odor from plastic.

Figure 39. EDXRF

Visor light:-is magnifying instruments used to observe the detailed conditions of gem (facet designs, degree of polish, etc.) It helps to use two hands during observation.

Figure 40 Gem visor light

I use These Gemstone Tools for Identification of Gemstones and Handling Gemstones.mp4

Self-Check -2	Written Test

Directions 1: Multiple Choice Items

Instruction 1: choose the correct answer and write the letter on the space provided?

----------1. Which one of the following not a part of gem microscope?
(2 points)

A. Light field B. dark field C. refractive index D. A and C

----------2.Which of the following is different in use? (2 points)

A. Gem microscope B. Polaris cope C. Chelsea filter D. Chelsea filter

Directions 2: short answer Items

Instruction 2: Write the correct answers for the following questions on the space provided

3. what is the difference between Polaris cope and gem microscope?(4points)

Note: Satisfactory rating - 3 points Unsatisfactory - below 3 points

Answer sheet:-

1. _____
2. _____
3. _____

Score = _____

Rating: _____

Information sheet 3:- Using tools and equipments saflely

3.1. Safe handling of tools and equipment

Workers should be trained on safe procedures for working with tools. However, safe practices when carrying or storing those tools may not be thoroughly covered. Tools can pose a safety risk when they are misplaced or improperly handled by workers.

The National Safety Council offers the following tips for safe handling of tools when they are not in use:

- Workers should never carry tools up or down a ladder in a way that inhibits grip. Ideally, tools should be hoisted up and down using a bucket or strong bag, rather than being carried by the worker.
- Tools should always be carefully handed from one employee to another – never tossed. Pointed tools should be passed either in their carrier or with the handles toward the receiver.
- Workers carrying large tools or equipment on their shoulders should pay close attention to clearances when turning and maneuvering around the workplace.
- Pointed tools such as chisels and screwdrivers should never be carried in a worker's pocket. Accept-able ways to carry them include in a toolbox, pointed down in a tool belt or pocket tool pouch, or in the hand with the tip always held away from the body.
- Tools should always be put away when not in use. Leaving tools lying around on an elevated structure such as a scaffold poses a significant risk to workers below. This risk increases in areas with heavy vibration.

Keep these tips in mind to avoid accidents when operating equipment and machinery on lab.

- Read and comply with the manual.
- Follow and keep up with federal and state laws.
- Always keep your slow-moving-emblem (SMV) clean, visible and properly mounted.
- Dress appropriately.
- Ensure you're well rested.
- Avoid alcohol.

Self-Check – 3	Written test

Directions 1: Short answer

Instraction:- Write the correct answers for the following questions on the space provided

1. List some tips to avoid risk to operate equipment (3 Point)
2. Can equipment safty procedure separetlly view with operating procedure?(2Point)

Note: Satisfactory rating - 3 points Unsatisfactory - below 3 points

Score = _____

Rating: _____

Information sheet 4:- Comparing the characteristics of natural opal to synthetic opal

4.1. Synthetic Opal

Synthetic opals are man-made opals that have the same chemical composition, internal structure, physical properties, and appearance as natural opals. They are often called lab-created opals, lab-grown opals, or cultured opals to indicate their man-made origin.

ynthetic opals can exhibit a spectacular play-of-color appearance that often exceeds the beauty of many natural precious opals. They are produced in a wide range of colors and patterns that many people enjoy.

Many synthetic opals look so much like natural opal that trained gemologists can have difficulty separating them from natural opals. This is why whenever synthetic opals are advertised or presented for sale, sellers are required by law to clearly communicate that they are manufactured by people and they are not natural opals.

The first synthetic opals were made by precipitating tiny silica spheres of uniform size, and allowing them to settle into a close packing arrangement. The spaces between the spheres were then filled with a binding medium that would harden, hold the structure together, and allow the diffraction of light.

Creating synthetic opal was different from the creation process for most other synthetic gem materials. Other gem materials are single crystals, and growing the crystals is the key to producing the gem material. Synthetic opal creation presented multiple challenges: creating millions of spheres of identical size; settling them into perfect arrays (which requires as much as a year or more of time); and, binding the spheres together into a material with a durability that is suitable for a gem. Binding the spheres often requires impregnation of the opal by a polymer resin, an ingredient that is not in natural opal. In addition to improving durability, the polymer resin can improve translucence, luster, and color. Synthetic gem materials are often treated for the same reasons as natural gem materials.

Identifying Synthetic Opal

Synthetic opal has been in the marketplace since the 1970s. Many of the early synthetic opals could easily be separated from natural opal with a quick examination unaided by

magnification; however, the manufacturers of synthetic opals have been improving the appearance of their products, and today many of them are more difficult to detect. Features that a synthetic opal might exhibit to reveal a laboratory-grown origin include:

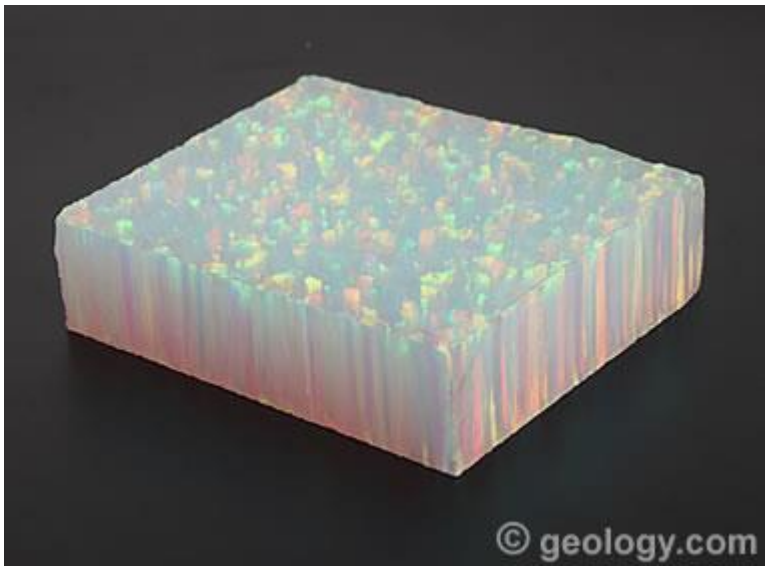


Figure 41. Synthetic opal grawing

Columnar Growth Pattern: The photo above shows a block of rough synthetic opal revealing its columnar growth pattern. The columns are the vertical features visible on the sides of the block. This block is approximately 1 1/2 inch x 1 1/2 inch in size.

1) the play-of-color patches might display a columnar growth pattern when viewed perpendicular to the growth direction (see accompanying photo);

2) under magnification, a synthetic opal's play-of-color areas might exhibit a "chicken wire" or "snake skin" pattern (see accompanying photo);

3) resin-impregnated synthetic opal often has a lower specific gravity than natural opal;

4) play-of-color patches are often more uniform in size and distribution across the face of a synthetic opal;

5) synthetic opals are sometimes stained an outrageous color, or the stain produces absorption bands when viewed through a spectroscope.

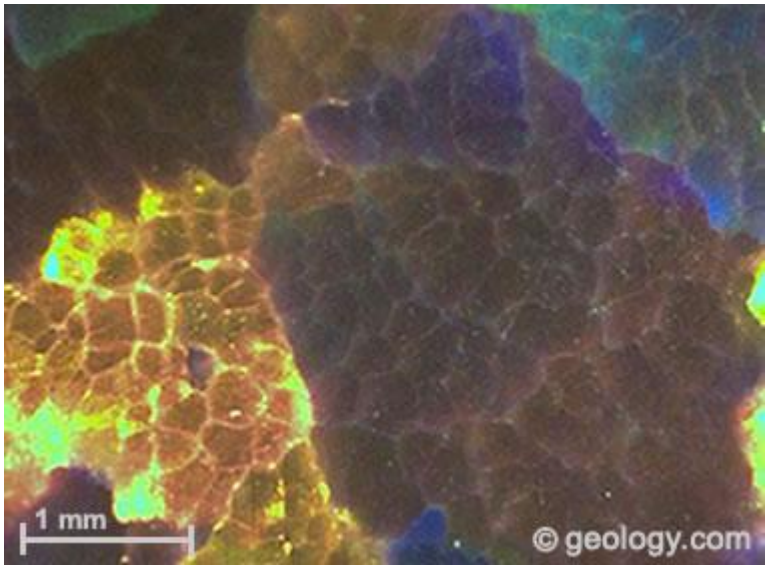


Figure 42.Microscopic View of synthetic Opal

Chicken Wire or Lizard Skin: Many types of synthetic opal display a chicken wire or lizard skin pattern when a polished surface is viewed under magnification in reflected light. Each "cell" or "scale" in this pattern represents the outline of a growth column of the synthetic opal.

Table 2. Property of synthetic opal to natural opal

Property	Mexifire Synthetic fire opal	Natural fire opal
Color	Brownish yellow to orange Yellow	Brownish yellow to orange Yellow
Color distribution	Typically even	Often color zoned, flow like or wavy pattern
Diaphaneity	Transparent under normal viewing condition Translucent/turbid with fiber optic light	Transparent to translucent
Quality of polish	Good	Dull to good
Refractive index	1.380-1.405	1.92-2.06
Specific gravity	1.63-1.77	2.00
Polariscope	Strong strain pattern	Weak strain pattern , no snake like bands

reaction	with snake like band	seen
Long and short wave	Inert	Inert
Desk model spectroscope	No feature	No feature
Internal feature	Turbidity following zone with fiber optic light	Turbidity following zone with one sample
EDXRF	Si, Fe and Ca	Si, Fe and Ca

How to spot a synthetic opal 3 tips_.mp4

Self-Check – 4	Written test

Directions 1: short answer Items

Instruction 1: Write the correct answers for the following questions on the space provided

1. Describe the color of gemstone in terms of hue ,tone and saturation?(4points)
2. Explain luster and cleavage of gemstone(4points)
3. What does it mean amorphous gem?(2points)
4. Describe synthetic opal identification from natural opal identification.

Note: Satisfactory rating 4 points and above Unsatisfactory - below 4 points

Score = _____

Rating: _____

LG #12	LO #4- Identifying and describing the different types of gemstone

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Identifying various types of gemstone
- Identifying types of gemstone treatments

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- Identify various types of gemstone
- Identify types of gemstone treatments

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

Information sheet 1:- Identifing different types of gemstone

Opal

Opal is a hydrated amorphous form of silica (SiO2•nH2O), Because of its amorphous character, it is classed as a mineraloid, unlike crystalline forms of silica, which are classed as minerals.

It is deposited at a relatively low temperature and may occur in the fissures of almost any kind of rock, being most commonly found with limonite, sandstone, rhyolite, marl, and basalt.

Precious Opal - is opal which exhibits the phenomenon known as play of colour, which is produced by the diffraction of white light through a micro-structure of orderly arrayed spheres of silica.The internal structure of precious opal makes it diffract light; depending on the conditions in which it formed, it can take on many colors.

The variety of natural opal is determined by the two characteristics of body tone and transparency.

Body Tone - The base tones of light, dark and black opal range from colourless, white, through the various shades of grey, to black.

Transparency - Opal of any body colour will be opaque, translucent or transparent. When it is transparent or very translucent, and the colour clarity is sharp, it is often referred to as crystal opal.

Types of Natural Opals

- **Black/Dark Opal.**

Black Opal is the most valued of Opals and comes mainly from Lightning Ridge. High quality stones are very rare. The term 'black opal' does not mean that the stone is completely black (a common mistake), it simply means the stone has a dark body tone in comparison to a white opal. Easily distinguished by the blackness of the background "body tone" or body colour.

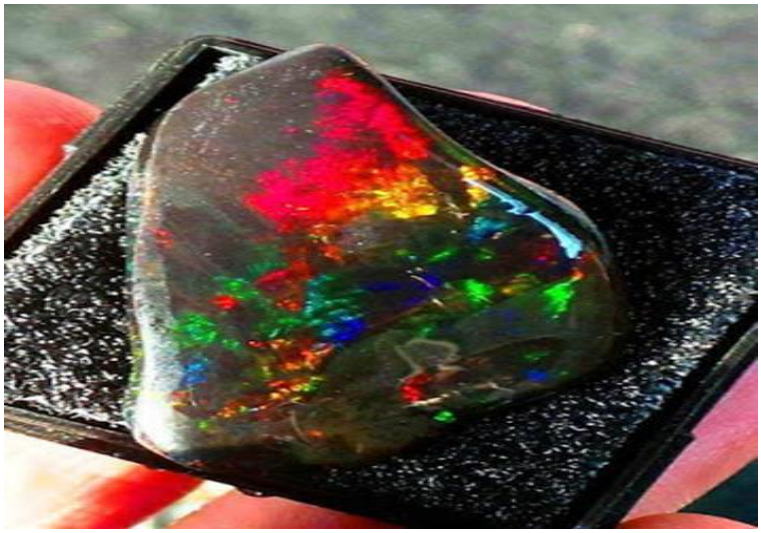


Figure 33.Black Opal

Light/White Opal

White opals with a base tone ranging from colourless to medium grey are called light opal. Some people refer to these as "white" although this expression should only be used where the body colour is very milky. White opal is more common and because of its body tone, generally does not show the colour as well as black opal. Nevertheless, white opals can still be absolutely magnificent in colour if a good quality stone is found.

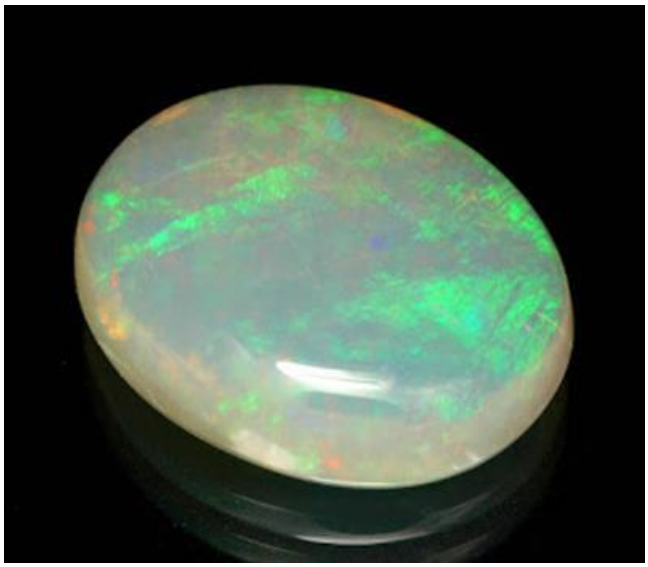


Figure34. White opal.

Boulder Opal.

Boulder is a variety of precious opal that has the host rock forming naturally as part of the gem. Often just a thin vein of precious opal is present. It mainly occurs in specific locations

over a wide area of Western Queensland. Boulder opal occurs as in-fillings of cracks or voids usually in ironstone boulders. Boulder opal can be black or light depending on the appearance of the stone when viewed from the surface. Boulder Opal has a tendency to cleave; when cleaved the "split" leaves two faces of opal, with a naturally polished face.

Figure 35. Boundular Opal

Fire opal

Fire opal is a transparent to translucent opal, with warm body colors of yellow to orange to red. Although it does not usually show any play of color, occasionally a stone will exhibit bright green flashes. The Fire opal is a term not commonly used within Australia but most famous source of fire opals is the state of Querétaro in Mexico; these opals are commonly called Mexican fire opals. Fire opals that do not show play of color are sometimes referred to as jelly opals. Mexican opals are sometimes cut in their ryholitic host material if it is hard enough to allow cutting and polishing. This type of Mexican opal is referred to as a Cantera opal. Also, a type of opal from Mexico, referred to as Mexican water opal, is a colorless opal which exhibits either a bluish or golden internal sheen.

Figure 36. Fire opal

Matrix Opal.

The term matrix opal is commonly used where the opal is intimately diffused as infillings of pores or holes between grains of the host rock in which it was formed. Boulder matrix opal is found in Queensland and can be distinguished by the ironstone host rock. Andamooka matrix opal is a porous material from Andamooka,South Australia, Which may be enhanced by soaking the specimen in a sugar solution and then boiling in acid to deposit carbon in the available pore spaces, resulting in a dark background.

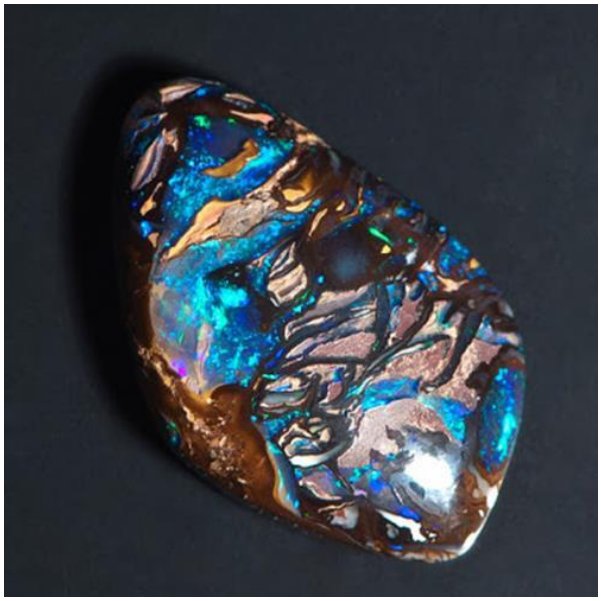


Figure 37. Matrix opal

Peruvian opal

Peruvian opal (also called blue opal) is a semiopaque to opaque blue-green stone found in Peru, which is often cut to include the matrix in the more opaque stones. It does not display pleochroism. Blue opal also comes from Oregon in the Owyhee region, as well as from Nevada around Virgin Valley.

Figure 38. Honey opal

Refer LO 3. Information sheet 1-3

Types of gemstone

These are beryl, chrysoberyl, corundum, diamond, feldspar, garnet, jade, lazurite, olivine, opal, quartz, spinel, topaz, tourmaline, turquoise, and zircon. Some of these minerals provide more than one type of gem; beryl, for example, provides emeralds and aquamarines, while corundum provides rubies and sapphires

1. **Varity of Quartz**

Quartz, one of the most abundant minerals of the earth's crust, provides us with a greater number of gem varieties than any other stone. It has been valued since pre-history for the range of colours, degrees of transparency and patterns which it displays. Treatments, some of which have been practised for hundreds or thousands of years, and more recently, the growth of synthetic stones have widened the range of available colours in quartz stones.

Quartz varieties include a number of transparent or translucent stones which are fashioned from simple crystals. Rock crystal is white, citrine yellow, amethyst purple and rose quartz is pink. Brown or green transparent varieties are also available. One variety, ametrine, is part purple and part yellow.

1.1. Amethyst

Amethyst is the world's most popular purple gemstone. It is the purple color variety of quartz and has been used in personal adornment for over 2000 years. It is the birthstone of February and an important New Age gem. Amethyst is used to produce faceted stones, cabochons, beads, tumbled stones, and many other items for jewelry and ornamental use.

Amethyst has a Mohs hardness of 7 and does not break by cleavage. It is a gem that is durable enough for use in rings, earrings, pendants, bracelets and other types of jewelry. Enormous deposits of amethyst in South America and Africa provide enough material to keep amethyst's price low enough that most people can easily afford it.

Figure 39. Amethyst

Figure 40. Amethyst cabochons

Color in Amethyst

Amethyst is an extremely popular gem because of its attractive purple color. Like the word "turquoise," the word "amethyst" is now the name of a color as well as the name of a gem material.

Figure 41. Color saturation of amethyst

Figure 42. Faceted Amethyst

1.2. Ametrine

A. Rough Ametrine B. Faceted Ametrine

Figure 43. Ametrine

Ametrine is a rare gemstone with a finite supply that is produced in commercial quantities at only one mine in the world. It is a relative newcomer to the gemstone trade, being available in small quantities for just a few decades.

Ametrine is a variety of bicolor quartz that has zones of amethyst (purple) and citrine (golden yellow) in contact with one another in a single crystal. The words **AMEthyst** and **ciTRINE** were combined to yield the name "ametrine," which is widely used in the gemstone trade. This material is known by other less-frequently used names including: "amethyst-citrine," "trystine," "bicolor amethyst," "bicolor quartz," and "bolivianite." The bolivianite name is a response to the material being designated as the national gemstone of Bolivia.

1.3. Citrine

Citrine is a transparent variety of quartz with a yellow to orange color. Its attractive color, high clarity, low price, and durability make it the most frequently purchased yellow to orange gem.

Citrine is also a modern birthstone for the month of November. Its designation as a birthstone contributes to its popularity and drives a large number of sales.

A. Faceted Citrine B. Rough Citrine

Figure 44. Citrine

Citrine's color ranges from yellow, to orangey yellow, to yellowish orange, to brownish orange. The name citrine is used for any transparent quartz in that color range - regardless of its saturation. Stones with a faint color and stones with a rich color are all called "citrine".

The quality of a stone's color has an enormous impact on its price. Stones with a faint color are abundant and inexpensive. Stones with a rich, uniform color are rare, valuable, and preferred by buyers.

2. Amazonite

Amazonite is a trade name used for a green to bluish green to greenish blue gem material that is made into cabochons, beads, and tumbled stones. It is a color variety of microcline, a potassium-rich member of the feldspar mineral group. Amazonite has a chemical composition of KAlSi3O8 and its green color is thought to be caused by trace amounts of lead.

A. Amazonite Mineral Specimen

B. Amazonite Cabochons

Figure 45. Amazonite

The gem was first named “Amazon stone”, after the Amazon River - although there are no known occurrences near that river. That name evolved into Amazonite, which sounds more appropriate for a gem or a mineral

3. Apatite

Apatite is the name of a group of phosphate minerals with similar chemical compositions and physical properties. They are an important constituent of phosphorite, a rock mined for its phosphorus content and used to make fertilizers, acids, and chemicals. Apatite has a relatively consistent hardness and serves as the index mineral for a hardness of five in the Mohs Hardness Scale. Specimens with excellent clarity and color are sometimes cut as faceted gemstones. Those with good color and translucence are cut as cabochons.

Figure 46. Apatite

4. Beryl

Beryl is a relatively rare silicate mineral with a chemical composition of Be3Al2Si6O18. It is found in igneous and metamorphic rocks in many parts of the world.

Beryl has served as a minor ore of beryllium, and color varieties of the mineral are among the world’s most popular gemstones. Emerald, aquamarine, heliodor, and morganite are the most popular varieties of beryl.

5. Aquamarine

Aquamarine is the name used for gem-quality specimens of the mineral beryl within a color range of greenish blue to blue. The name is used regardless of a stone's tone or saturation. So, aquamarines can range from a very light, almost imperceptible color to stones with a rich vibrant color.

Most aquamarine has a very light color, which can be almost unnoticeable in very small stones. Stones with a rich blue color are the most popular. They are also the rarest and most valuable.

The name aquamarine is derived from a combination of two Latin words: aqua, meaning water, and marina, meaning the sea - the color of the sea.

A. Tumbled Aquamarine

C. Rough aquamarine

B. Faceted Aquamarine

Figure 47. Aquamarine

6. Emerald

Emeralds are gem-quality specimens of the beryl mineral family with a rich, distinctly green color. They are found in igneous, metamorphic, and sedimentary rocks in a small number of locations worldwide.

For over 5000 years, emeralds have been one of the most desirable and valuable colored stones. Ancient civilizations in Africa, Asia, and South America independently discovered emeralds and made them a gemstone of highest esteem. In the United States and many other countries, emerald serves as the birthstone for people who were born in the month of May.

Today emerald, together with ruby and sapphire, form the "big three" of colored stones. The "big three" generate more economic activity than all other colored stones combined. In 2015 the value of emeralds imported into the United States exceeded the value of all colored stones outside of the "big three" combined.

A. Rough Emerald

B. Faceted Emerald

Figure 48. EmeraldEthiopia, Land of origins Part I Emeralds from Southern Ethiopia.mp4

7. Sapphire

Sapphire is a precious gemstone, a variety of the mineral corundum, consisting of aluminium oxide (α-Al2O3) with trace amounts of elements such as iron, titanium, chromium, vanadium, or magnesium.

Figure 49 Sapphire

Ethiopian Sapphire - A New Discovery_.mp4

Self-Check -1	Written Test

Name_____**Section**_____**Id No**_____

Direction 1: Short answer items

Instruction1- Read the following questions and give answers for each.(2pts each)

1. What is the difference between opal doublet and Opal triplet?

2. What is the gem emerald group?

3. List some type of amorphous gem?

Direction 2. True or False

1. Sapphire is the gem mineral group of Al2O3
2. All gemstone is a mineral but all mineral is not a gemstone.
3. Sapphire, Emeral and Rubby is the big three gems available in the world.

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Information Sheet-2	Identifying different type of gemstone treatment

Gemstone treatment

Treatment refers to any process other than cutting and polishing that improves the appearance of the color or clarity, or that are used to alter the appearance (color, clarity or phenomena), durability, value, or supply of a gemstone.

Types of Gem treatment

1. BLEACHING

A chemical used to alter / reduce a component of, or the entire color, of a porous gem. Some gemstones are bleached and then dyed, a form of “combination treatment.”

The most commonly encountered bleached gems include:

1.1. Jadeite jade – Jadeite is often bleached with acid to remove an unwanted brown component from the material. Bleaching in jade is typically part of a two-step process: because acid bleaching causes the material to become slightly porous or susceptible to breakage along fractures, it is then subsequently treated with polymer impregnation to fill these open spaces to produce a better overall appearance.

Figure 50 Jade bleaching before and after bleaching

1.2. **Pearls** – All types of pearls are routinely bleached with hydrogen peroxide to lighten and improve their uniformity of color.

Figure 51Cultured pearls are routinely bleached to achieve uniformity of color.

Other materials – Some coral, chalcedony and tiger's eye quartz may be bleached to lighten their color.

2. **Detectability** – Bleaching as a one-step process is virtually impossible to detect in most cases. The second step, impregnation with polymer compounds, is easier to detect by a qualified gemological laboratory using magnification and more advanced analytical techniques.
3. **Encountered in the trade** – Frequently in pearls and jadeite.
4. **Durability factors** – Acid bleaching causes a breakdown in the structure of most materials, so as a stand-alone treatment, leaves materials vulnerable to breakage. Most bleaching is followed by impregnation to improve durability and strengthen perceived color
5. **Special care requirements** – Bleached gems tend to be more brittle, and they may be much more porous and thereby more absorbent of human oils and other liquids. It is suggested that pearls be kept in a soft, dry environment to avoid surface damage.

1. SURFACE COATING

Altering a gem's appearance by applying a coloring agent like paint to the back surfaces of gems (a treatment known as "backing"), or paint applied as a coating to all or a portion of a gemstone's surface with the effect of altering the color.

The most commonly encountered coated gems include:

1.1. **Diamonds** – Thin-film coatings are sometimes used on diamonds to change their color. Crude, yet effective coatings can also include the use of permanent ink markers along the girdle surface of a diamond, causing its face–up appearance to be affected by the color of the ink used. More modern coating methods use metal oxide thin films.

Figure 52. The intense pink color of these three diamonds is the result of a surface coating.

1.2. Tanzanite – Though rarely used, tanzanites have been coated to improve the intensity of their blue-violet color.

Figure 53. Classic tanzanite exhibits a deep, purplish blue color (left). Pale tanzanite, and other pale stone species are sometimes coated with an ink-like substance to try to deepen and improve their color (right).

1.3. **Topaz** – Some colorless topaz is coated with metal oxides to create the appearance of a variety of different colors. In the past, such treatments were often

described as a form of “diffusion” of a chemical into the surface of the gemstone, but this was a misnomer since in most cases the added color was confined to the surface of the gemstone.

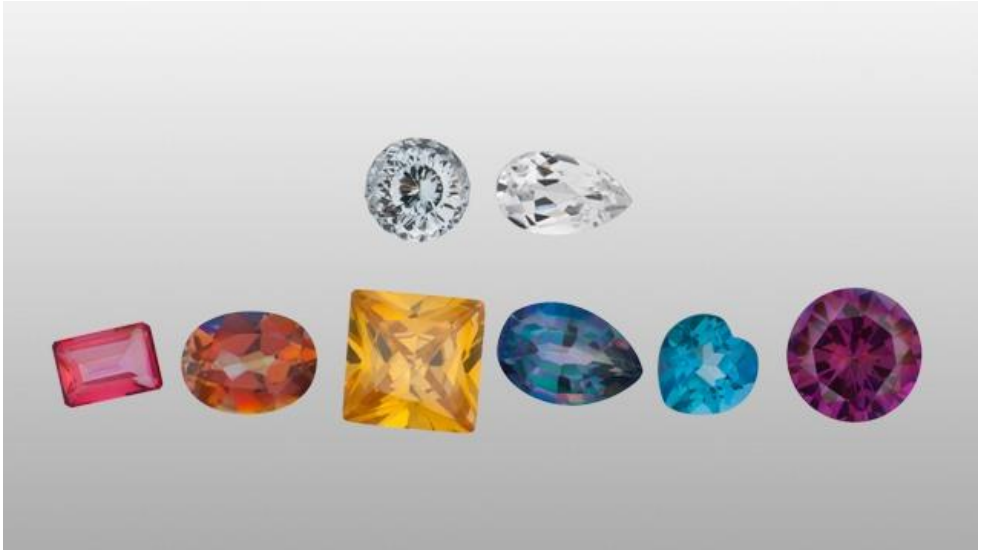


Figure 54. Some natural topazes are colorless (top two), but they can be coated with metal oxides to produce a variety of metallic colors (bottom).

1.4. **Coral** – Some black coral (also known as Horn coral) has been reported as bleached and then coated with relatively thick layers of artificial resin with the goal of protecting the coral and intensifying its color.

Figure55. This golden coral is the result of a two-step process: one to bleach away the dark color (the coral branch has been partially dipped in bleach to result in the golden color). The coral is then coated with a resin to deepen the tone and protect the coral.

1.5. **Quartz** – Occasionally, quartz is coated with metal oxides to create colors rarely seen in natural quartz.

Figure 57. Quartz coating steps

Vapor deposition can coat many types of gems with metal oxides. This thin layer can alter the color of whatever it coats, such as the quartz crystals, or already faceted quartzes such as those shown in figure 57.

2. **Durability factors** – Because they tend to be softer than or may not adhere well to the underlying gem, thin-film surface coatings of any kind are susceptible to scratching, particularly along facet edges and junctions. Care should be taken to not allow any hard or abrasive objects to come in contact with coated gems.
3. **Detectability** - Once suspected, the treatment is easy to identify by a skilled gemologist except in the situation where the coating substance is colorless, and it has been added to improve durability.
4. **Encountered i**n the trade – Occasionally for some gems.
5. **Special care requirements** – When they are not being worn, coated gem materials should be wrapped in soft packaging and kept in a dry environment.

3.DYEING

Introducing colored dyes into porous or fractured gems to change their color. Such fractures are sometimes purposely induced by heating the gem so that an otherwise non-porous material can more readily accept the dye.

The most commonly encountered dyed gems include:

1.1. **Pearls** – Dye often improves the appearance of lower–quality natural and cultured pearls by enhancing their color.

Figure 58. Many pearls seen in the market are dyed, as the bottle of dye-soaked pearls (left) shows, and the single pearl demonstrates (right).

Other gem materials – The process has been used since ancient times for materials such as coral, turquoise, lapis lazuli, howlite, nephrite jade, chalcedony, quartz, emerald, and ruby.

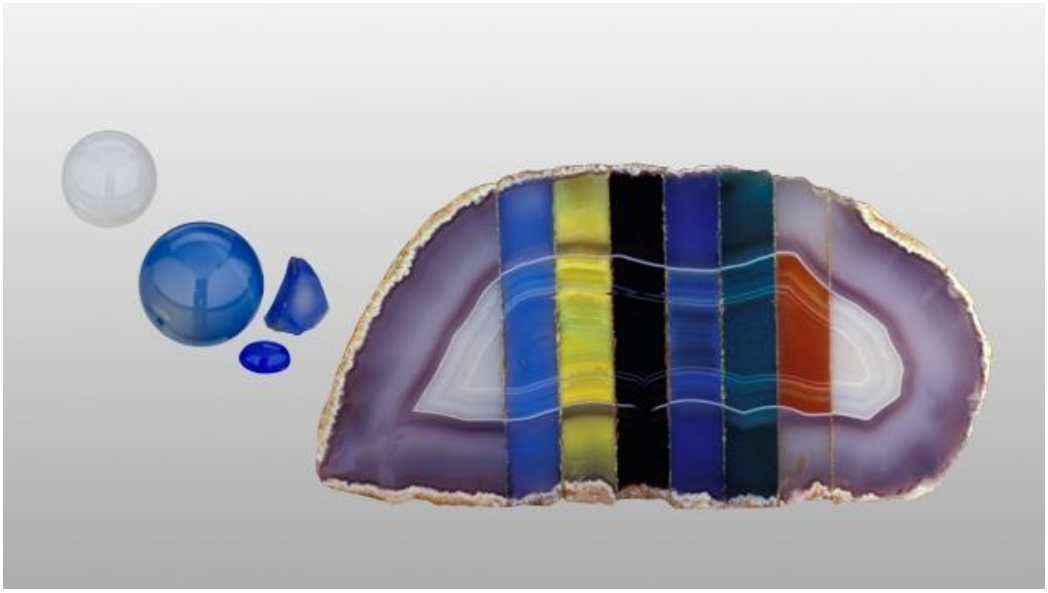


Figure 59. Natural chalcedony (colorless sphere to left), may be dyed with a variety of colors to achieve deeply colored materials.

1. Durability factors – When dye is applied to porous materials, their durability may be long-lived but is ultimately dependent on the stability of the dye itself. In gems with larger fractures, the dye can sometimes leak out under a variety of conditions. Many dyes can be removed if the gem comes into contact with a solvent such as alcohol or acetone. Some dyes are unstable with exposure to the ultraviolet in sunlight and can fade over time.

3. Detectability –A qualified gemologist can detect dyed gems in most cases.

4. Encountered in the trade – Occasionally for most gems, and frequently for colored pearls.

5. Special care requirements – When it is known that gem materials have been dyed, care must be taken to not bring them in contact with chemicals such as acetone or alcohol, which could dissolve the dyes, or have them exposed to prolonged periods of sunlight (such as leaving it on a sunny window ledge) which could cause the dyed colors to fade.

2. FRACTURE OR CAVITY FILLING

filling surface-reaching fractures or cavities with a glass, resin, wax or oil to conceal their visibility and to improve the apparent clarity of gem materials, appearance, stability, or in extreme cases—to add to a slight amount of weight to a gem. The filling materials vary from being solids (a glass) to liquids (oils), and in most cases, they are colorless (colored filler materials could be classified as dyes).

1. The most commonly encountered fracture-filled gems include:

Diamond – Surface-reaching fractures are sometimes filled with high-lead-content glass. This reduces the visibility of the fracture, with the goal of enhancing the appearance of the diamond. The filled fracture is still present – it is just less apparent.

Figure 60. Surface reaching fractures in diamonds can be filled with molten lead glass, lessening the appearance of the fractures.

Ruby – Numerous surface-reaching fractures are filled with a glass to lessen their visibility and make the gem more transparent than it really is. In some cases, the amount of filler glass can be significant in a treated ruby.

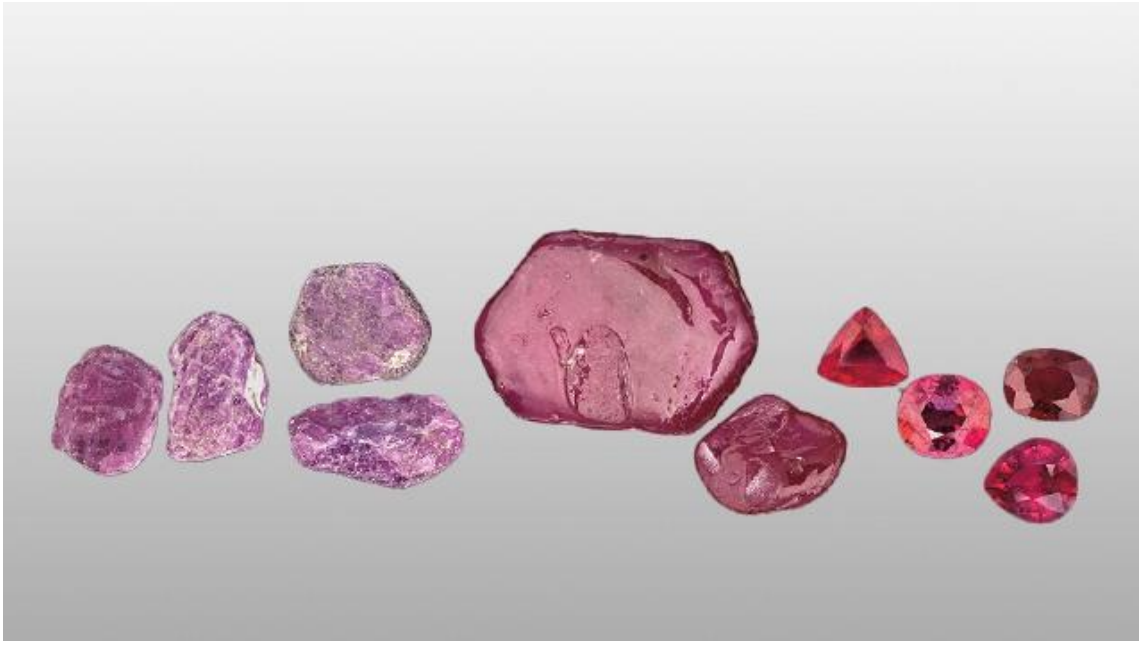


Figure 61. Surface reaching fractures in rubies, such as these, can be filled with molten lead glass, lessening the appearance of the fractures.

Emerald – Surface-reaching fractures in emerald are sometimes filled with essential oils, other oils, waxes, and “artificial resins” —epoxy prepolymers, other prepolymers (including UV-setting adhesives), and polymers to reduce the visibility of the fractures and improve the apparent clarity. These substances have varying degrees of stability in treated emeralds, and the volume of filler material present can range from insignificant to major amounts.

Figure 62. Surface reaching fractures in emeralds, such as this one can be filled with artificial resins, wax, and epoxy polymers. This lessens the appearance of the fractures, as the treated emerald on the right shows.

Other materials – Resins and glasses can potentially be used on any durable gem with surface-reaching fractures, including quartz, aquamarine, topaz, tourmaline and other transparent gems. This kind of treatment is, however, less prevalent than the other treatment processes mentioned above.

2. **Durability factors** – Much depends on the durability of the filler. Glasses tend to be harder and therefore more durable than resins, oils or waxes. Changes in air pressure, proximity to heat, or by exposure to chemicals can all affect the appearance of filled gems by potentially altering or removing the filler substance.

3. **Detectability** – In most cases, filled gems can be recognized by a qualified gemologist using magnification.

4. **Encountered** in the trade – Often encountered for diamonds, ruby and sapphires, and emerald.

5. **Special care requirements** –Avoid exposure to heat, and changes in air pressure (such as in an airline cabin), or chemicals. Filled emeralds can also be damaged by exposure to hot water used for washing dishes.

5. **HEAT TREATMENT**

1. The most commonly encountered heat-treated gems include.

Amber – When amber is submerged in hot oil—linseed oil for example—it's inherent body color can darken, and the material can take on a clearer appearance. The hot oil can also cause the material to develop a series of spangled, glittery inclusions.

Figure 63. The rounded inclusions in amber are caused by immersing it in heated oil, which results in a “spangled” effect

Amethyst – Heating can remove unwanted brownish inclusions in some amethysts or lighten the color of overly dark stones.

Aquamarine – Without treatment, much of the aquamarine is blue–green in coloration. Heating in a controlled environment can remove the greenish color component from the material to produce a more blue appearance.

Citrine – Some forms of amethyst can be heated and turned into citrine.

Ruby – Heating can remove purplish coloration rendering a more pure red color. The process can also remove “silk” (minute needle–like inclusions) that can cause a gem to appear lighter in tone and be more opaque. Heating can also cause recrystallization of the silk inclusions to make them more prominent which allows the gemstone to have stronger asterism (a reflecting star effect).

Sapphire – Heating can intensify, or even induce, a blue coloration in sapphires. The heating can also remove “silk” inclusions, which also helps to make the material appear more transparent. It can also cause recrystallization of the silk inclusions to make them more prominent, which allows the gemstone to have stronger asterism (a reflecting star effect).

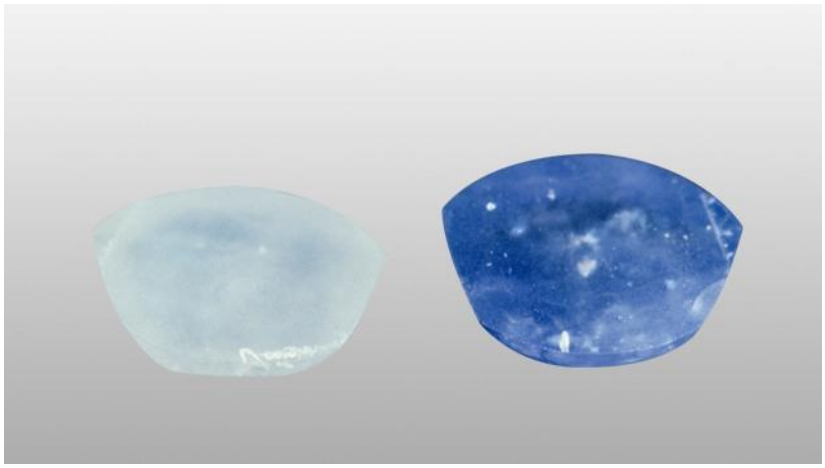


Figure 64. Pale sapphires that were once discarded in the mining process were treated to a desirable color of blue when heated in a controlled environment.

Tanzanite – The mineral zoisite, which includes the gem variety known as tanzanite, it is often heated at low temperatures to remove a brownish color component to produce a stronger purplish-blue color.

Figure 65.Tanzanite often is mined as a brownish material (as the rough and cut stone on the left show). Once heated, the gem changes to a blue or purplish blue color (as the rough and cut gem on the right show).

Opal Treatment

A. Sugar treatment of opal

The process is fairly simple. The matrix opal is cut and polished to shape and then “cooked” in a saturated sugar solution. After a period of time the opal is removed and immersed into a concentrated sulphuric acid solution.

Watch how I smoke treat an opal (This is NOT Australian opal).mp4

B. Heat Teatment Opal

The new method involves taking near finished stones and placing them in a saucepan with canola oil. There should be enough oil to cover the stones. Simmer the stones in the oil (DO NOT BOIL) for about 4 hours. Check the stones regularly, unlike meat they do not soften but they do turn to black.

HOW TO TREAT Matrix Opal STEP BY STEP_ (Create Your Own Black Opal Gemstones!).mp4

Self-Check -2	Written Test

Name_____**Section**_____**Id No**_____

Direction 1: Short answer items

Instruction1- Read the following questions and give answers for each.(2pts each)

1. What is the purpose of treated gemstone? Explain some characteristic
2. List atleast three type of gem treatment technique
3. What chemical is Used in sugar Smoke Opal?

Answer Sheet

1. _____

2. _____

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Reference Book:

1. Gem& Gemology :THE QUARTERLY JOURNAL OF THE GEMOLOGICAL INSTITUTE OF AMERICA
2. JOEL E AREM, PHD, FG.A.Color encyclopidiya of gemstone. Second edition
3. Smith sonian; Nature guide of rocks and minerals
4. W.Dan Housen and Wayne M.Shulterd Gemstone and other unique minerals and rocks of WYOMING; A field guid to collector

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1. **https://www.gemsociety.org/article/cleavage-gemology/**
2. https://www.gemsociety.org/article/handling-gems-securely/
3. https://www.gwlab.com/laboratory/identification/
4. https://gem-a.com/gem-hub/gem-knowledge/laboratory-reports-and-geographic-origin-of-gemstones
5. www.geology.com

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The trainers who developed this learning guide

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