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ABSTRACT

In response to the need for qualified gemologists and the serious gap in gemological training, a study was directed and designed to develop an instructional program which could be used nationally and to establish a vocational gemology program at Paris Junior College. Following the selection of appropriate instructional materials, stations were equipped with the necessary laboratory instruments for gemology research. Originally designed as a thirteen-week course, the program grew to fifteen weeks. Beginning with an orientation to equipment and textbook assignments, succeeding units included the study of light and the study of species and varieties of gem materials, including a fifty-hour unit on diamonds. Student progress was evaluated several times during the course, and bi-monthly conferences were held with each student. The final examination included an oral presentation, a written exam on general gemology and diamonds, and gem identification and grading. Results indicated the achievement of objectives through the completion of an instructional manual, incorporating objectives into the curriculum, and the use of project results as a guide for developing similar programs. (Appended are excerpts from the instructional manual, an equipment price list and student contract, lesson plans, a training program outline, a gemstone chart, an interview report, and an evaluation form.) (FP)

PILOT PROJECT

IN

VOCATIONAL GEMOLOGY

A Research Study Conducted Under Contract

to the Texas Education Agency

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Paris Junior College
Paris, Texas
August, 1979

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SUMMARY OF THE PROBLEM

When Paris Junior College applied for and received monies to initiate a research project in gemology, a serious gap in gemology training had been identified by the jewelry industry. Estimates were that less than 5,000 of the 47,000 independent jewelers in America possessed skill in gem identification and fewer still had received scientific and theoretical information necessary for a working knowledge of gemology. Although 2,500 gemologists were required each year to meet industry demands, only approximately 340 were available for employment. The only source for certification existing in America was the expensive proprietary Gemological Institute of America in Los Angeles, California, where a two- to three-year wait was necessary before admittance. Additionally, GIA training was directed toward the scientific, rather than retail business, application, and training in polished professional salesmanship was missing.

Another facet of the problem was the increasing burden placed on the modern jeweler to protect his enterprise and his clientele from the consequences of inaccurate evaluation of gem quality with the rise in popularity of the colored gemstone in contemporary jewelry and the improvement of synthetic stones. Eighty to ninety percent of the retail jewelers lacked sufficient knowledge about their products and were faced with the possibility of damaging publicity from lawsuits or very costly mistakes for even apparently small errors. As documented by the prevalent use of such "sale" words as "discount," "wholesale," and "investment" in advertising and promotion of sale of gemstones, most jewelers had little product awareness about precious gems.

Given these parameters, a local advisory committee composed of representatives from the jewelry industry recommended that Paris Junior College consider adding a course in gemology to its already established jewelry technology sequence. After consultation with state and national industry leaders, this institution applied to the Texas Education Agency for assistance in conducting a pilot research project which would not only supply a course model which other vocational training institutions could emulate for upgrading and skill development but also supply a needed service for the jewelry industry.

PROJECT OBJECTIVES

Objectives set were two-fold: the development of an instructional program which proffered a practical, business-oriented curriculum (teaching a highly technical skill which is based on scientific and theoretical knowledge) which could be used nationally for vocational education in gemology; and the establishment of a vocational program in gemology at Paris Junior College to help in meeting the current crisis faced by the independent jewelry industry in the lack of trained gemologists.

Specific objectives in the development of the instructional program were as follows:

1. Development of materials necessary for effective instruction of gemology students.

2. Provision of a program which would prepare students to

   a. identify gemstones properly;

   b. learn techniques of grading for quality and appraising gemstones;

   c. detect imitation and synthetic materials;

   d. use and care for the laboratory instruments necessary to the testing and identification of gemstones;

   e. become skilled in gemstone merchandising through study of the formation, recovery, and cutting of precious gems, with attendant attention to the folklore, traditions, and symbolism of such stones;

   f. trade ethically and accurately in precious stones including also showing merchandise effectively and using proper security measures;

g. and exercise proper care during bench work—through a working knowledge of gemstone reaction to heat, acid, fracture, abrasion, and cleavage. (See attachment in Appendix E.)

3. Compilation of data from the project which would be beneficial to other public institutions who were interested in initiating a similar program.

In establishing a vocational program to provide a service for the jewelry industry, Paris Junior College sought to

1. supply training of a highly technical skill that is inherently necessary in every facet of the independent jewelry industry and which can not now be met through existing certification institutions;
2. furnish gemologists who will require only a minimum amount of on-the-job training before becoming active in the industry;
3. and afford gemology upgrading for those in the jewelry industry.

PROCEDURES

A nationally-recognized authority in gemology, Mr. Orlando Paddock, was employed to direct and design the study. Mr.

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Paddock, a long-time member of the American Gem Society as a Certified Gemologist, and a widely-read author of both textbooks and monographs concerning the precious gem, had served as a visiting lecturer to the program for five years previously as well as having attended the Gemological Institute of America. In the design phase of the research, he worked closely with industry sources to include subject areas and skill development activities in which employer's perceived prospective employees should participate in order to properly grade and appraise gemstones.

When need was identified, Mr. Malcolm Heuser, who is a graduate in residence of the Gemological Institute of America and was previously proprietor of the Central Gemological Laboratory, was added to assist with program instruction and development.

Careful consideration was exercised in selection of instructional material that would stimulate student success. Two texts, Gemformation: A Primer of Precious Gems by Mr. Paddock and Handbook of Gem Identification by Richard Liddicoat, served as basic, primary reference volumes. Mr. Paddock's book served as an introduction to the subject, with each major division treated in simple form to be easily understood. This text introduced an "attitude" toward the subject of precious gems that provided the basis for the course. An advanced text, the Liddicoat book contains descriptions of instruments used, instruction on use and care of each, methods of gem identification, brief descriptions of the major species, complete tables of physical and optical properties of many species, and lists of species in various colors. A need was identified for material that would fill the gap between the highly technical Liddicoat book and the practical Paddock text. Thus, the development of an instructional manual began with hand-out material that was maintained by students in loose-leaf notebooks. It constituted an elaboration of material contained in both textbooks. Physical, optical, and chemical characteristics of each specie, where found, methods of mining, crystal forms and habit, styles of cutting, methods of identification, history and lore, sales presentation, and cautions to the jeweler and customer as to the hardness and toughness of each specie were recorded along with various tables of physical and optical properties for quick reference.

In addition, frequent use of the division library consisting of extensive holdings was required, including assignments in volumes by such authors as Webster, Anderson, Dana, and Frause and Slawson. This combination of hand-outs and textbook provided a solid base for instruction.

The study period was originally composed of one quarter, or 13 weeks, in duration--six hours per day, five days per week. The first class was operationalized in January, 1978, with others offered in September, 1978; January, 1979; and May, 1979. Another class begins in August, 1979, and three classes are planned for 1980.

Each student was assigned a locker in a locked storeroom adjacent to the class in which to store instruments when not in use. Instruments were signed out to students at the beginning of the course. (See list of equipment with price in Appendix B.) All instruments returned in good condition at the end of the course were credited to the student's account which placed responsibility on the student for the equipment's care and proper use.

Twenty stations, equipped with microscope, polariscope, refractomer, and dichroscope, were developed to prepare the student to accept employment as a gemologist. Each student was, thus, provided with everything necessary to identify and evaluate most gem materials. The instrumentation of each station was planned to represent the type of laboratory that would be ideal for a gemologist working in the jewelry field. This configuration was augmented by three weighing devices with hydrostatic specific gravity attachments, two spectroscopes with illuminators, two hand-held spectroscopes, two hot points, two fluorescent lamps with viewing stands, one diamolite for testing diamonds for color grade, and one proportionscope used to make judgment on the "make" or proportion of diamonds.

Sophisticated instrumentation found in the general classroom/laboratory will rarely be available to the beginning of the student's career in the jewelry field, but students were instructed in their use, learning how to obtain the best results from them. Several alternate methods of obtaining information as to physical and optical characteristics which do not require such instrumentation were taught.

The general scope of the course was planned in such a manner that the student was led in progressive steps toward accomplishment of the stated objectives. Strength of the instructional methodology was in the student's realization of the necessity of a thorough knowledge of gemology to succeed in any phase of the jewelry field. The following concepts formed the basis for the teaching sequence:

1. Product knowledge is extremely essential to the jewelry salesman.
2. Knowledge of physical strengths and weaknesses of various species is essential to the bench worker who must know which are subject to fracture or cleavage, which are tolerant to heat and acid.
3. All gemstones must be properly identified correctly by all associated with the trade.
4. The designer will plan gem set jewelry to protect those gems that may be fragile, not only by designing protective settings, but by prescribing the types of jewelry in which each gem should be used.

Specific lessons were designed to incorporate the instructional areas listed below:

1. Each variety of the more commonly encountered species was considered separately and in detail.
2. Synthetic and imitations were studied in depth.
3. A number of less common materials were considered briefly.
4. Considerable laboratory experience was obtained by accurately identifying a number of specimen. More than 500 specimen were identified.
5. Instruction in sales, advertising, display, and promotion of precious gems played an integral part.

Final examinations followed completion of objectives at the conclusion of course with the result of this sequence having been excellent student understanding of one step before another step was added. Of the 80 students who have enrolled in the gemology program, 78 have completed.

No major change in plan of curriculum design has been necessitated other than an increase from thirteen (13) to fifteen (15) weeks in course duration. An initial thirty-hour session was conducted in basic gemology which provided a general orientation to both the field of gemology and to the classroom equipment and study routine. Students were introduced to their work stations, and textbook assignments were made. At the end of this one-week period, students had progressed through projects requiring them to have a working knowledge of the use and care of the precision instruments to be mastered, the ability to differentiate cognitively between precious gems and synthetic stones, and an understanding of the formation and structure of precious stones.

The second week of the program included two units on the behavior of light, with particular emphasis on reflection, refraction, birefringence, and polarization during the first unit and on color, allochromatic and idiochromatic gems, light dispersion, luster, and phenomena, specific gravity determination, and fluorscence and phosphoresence. Additionally, students met for a bi-monthly individual interview with instructors to check progress and to receive student feedback. (See Appendix F for conference form.) Students maintained a project folder in which completed assignments were located which were approved as the course progressed. All units were structured in the classroom with self-paced laboratories.

By the third week students were prepared to advance into study of the species and variety of gem materials. During this segment of the study, students conducted more advanced laboratory work in the chemical, physical, and optical properties of stones, and in the grading and cutting of stones.

Instructional units on corundum, chrysoberyl, beryl, tourmaline, garnet, quartz, quartz chalcedony, and jasper, peridot, jadeite-nephrite, spodumene, feldspar, zoisite, turquoise, opal, and lapis lazuli and on the organic gems—pearl, coral, amber, jet, ivory, and tortoise shell completed the first half of the course. At this point, approximately forty-five days into the study, student progress was again evaluated to determine mid-term proficiences.

Instructional packages contained in the second half of the course begin with those concerning synthetic gemstones, imitations, and assembled stones. Shortly after mid-term, a fifty-hour unit study on diamonds was undertaken.

During the period of study concerning diamonds, students experienced extensive and intensive laboratory opportunities—with eight separate instructional packages to be completed by the student. Topics covered included the geology and properties of diamonds, mining and marketing of rough diamonds, cutting of the diamond, cutting grades and proportion, grading for clarity, grading for color, fancy colors, and the wholesale and retail marketing of diamonds.

The final unit concerning gemstones covered the species and varieties of rare or infrequently encountered gem materials. Included in this group are andalusite, apatite, azurite, benitotite, calcite, cassiterite, iolite, danburite, diopside enstatite, ehmatite, idocrase, knonerupine, malachite, obsidian, phenakite, pyrite, rhodochosite, rhodonite, sphere, scapolite, smithosonite, sodalite, steatite, and varisite.

The final segments of the course were designed to allow the student to apply the knowledge and laboratory skills developed in the course to the business setting. Units were included concerning the promotion and display of precious gems and of record keeping, advertising percious gems, and of the retail, or in-store, merchandising of gemstones.

Evaluation of student performance was conducted on several different levels. Bi-monthly conferences were held, and a mid-term student progress report was developed. To maintain alertness and to prevent student procrastination in learning certain required specifics, a weekly quiz was administered which kept instructors informed as to student progress and acted as a stimulant.

Final examination consisted of the following:

1. Oral Presentation

   Each student gave a 15-minute lecture before the class on a subject important to the gemologist selected by the student and approved by the instructor. The presentation was prepared as if it were actually to be given for a club, school, or other audience. This played an integral part in developing human relations skills.

2. Written Examination--General Gamology.

A test designed to cover the basic prime information received during the duration of the course was administered with three hours allowed for completion.

3. Written Examination--Diamonds

A test concerning general information about mining, marketing, etc. on diamonds was also administered, with one and one-half hours allowed for completion.

4. Gem Identification and Diamond Grading

Fifteen specimen of gem material were required to be correctly identified with three opportunities to pass this section, and five diamonds were to be quality graded.

Determinants in evaluating the student's final grade included

1. weekly tests,
2. grades on two research speeches,
3. final examination,
4. and completion of instructional packages of identifying 100 sets (5 stones per set) of specimen.

Problems Encountered

Although the entire curriculum design has been accepted as a viable model, several aspects of procedure have been identified as problem areas.

Initially, teaching procedures were hampered by the absence of much of the equipment. Microscopes, refractometers, etc., had been ordered, but were not delivered until class had been in session for several weeks. To offset this, 10X loupes were on hand and instruction in the use of this method of magnification was temporarily substituted effectively with satisfactory results. Instruction on the use of refractometers was delayed, and other subjects were covered until the material arrived.

The first several weeks of instruction were accomplished by one instructor. Each class day began at 8 a.m. and continued until 11:30 a.m. and began again at 12:30 p.m. lasting until 3:30 p.m., a total of 6½ hours per day including 4 hours of intensive theoretical lecture daily. Preparation of exhibits, quizes, grading, record keeping etc., had to be accomplished at a time when class was not in session, not an ideal condition. When it became evident that a second instructor was necessary, Mr. Malcolm Heuser, a graduate gemologist, G.I.A., was transferred to the department, and instructional procedures were improved.

While test stones, specimen of various species, and varieties of many species were prepared in advance, it soon became obvious that many more specimen were required. Instruction in gemology is best accomplished by inspecting and testing specimen. Determination of the nature of inclusions, determination if the specimen are singly or doubly refractive, determination of refractive index, specific gravity and other physical and optical characteristics can only be accomplished by study of specimen "in-hand." To learn identification procedures, each student must be supplied with gem materials with which to work. This problem was compounded by the unusual market condition of diamonds at the time diamonds were being ordered. As a result, fewer specimen were available with which to work. Also, pricing of diamonds was complicated by extreme inflation in the diamond market and shortage of material. Subsequently, purchasing of more specimen was accomplished, and donation of materials by cutters, jobbers, brokers, distributors and some retailers solved the existing shortage. Specimen were plac[illegible] in gem papers, each labeled with a lot number and stone number. Papers were numbered 1 through 5. A "lot" consisted of 5 specimen placed in a coin envelope 3 1/8" x 5 1/2". Lots #1 through #20 consisted of

1. synthetic spinel which is man-made, singly refractive and occurrant in a variety of colors,
2. synthetic corundum, which is man-made, doubly refractive and occurrant in a variety of colors,
3. quartz, which is a natural material, doubly refractive, and occurrant in several colors,
4. assembled stones, consisting of an imitation stone, with a protective table of garnet, or a triplet (used to teach

detection by magnification or immersion),

5. and almandine or rhodolite garnets, natural stone, singly refractive, with characteristic inclusions.

Other lots were prepared to disclose a variety of physical and optical characteristics. Some lots were prepared to offer the students experience in gem identification.

Material contained in the textbooks was supplemented by many pages of "hand-out" material to be added to the loose-leaf binders. While much of this material had been prepared in advance, much remained to be done, and information on each specie of gem material was initially lacking. This deficiency was partly corrected by the second instructor who kept abreast of class progress by preparing hand-out material as the quarter progressed. After four classes, this prepared document is now near completion, thus alleviating the pressure on the instructional staff.

The curricular design has been deemed successful, with the major change being a greater emphasis in "Merchandising of Precious Gems" particularly in the subsection "Methods of Display" and in "Advertising and Publicity."

Most of the problems encountered were the result of lack of "lead-time." Preparation of written material and arrangement and listing of specimen required more time than anticipated. Also, ordering of instruments and equipment was too late to ensure delivery in time for class opening. Six months before the beginning of the first class, preparation should be made fo the classroom, instructional material should be developed, and instrumentation for each student and laboratory should be accomplished.

SPECIFIC RESULTS

Program results revealed not only accomplishment of project objectives but also suggested implications for the independent jewelry industry and other educational institutions.

With the completion of a comprehensive curriculum (see program outline in Appendix D) and the graduation of 78 students in four gemology classes, the desired program has been formulated and evaluated. (In the latest graduating class of 19 students, 14 different states were represented with a complement of 10 women and 9 men.) A comment made by Mrs. Julia Lovett, Lapidary Work Shop, Dallas, suggests the program's success, "A salesman who sold diamond imitations said, 'With so many of the graduates of the Gemology Program at Paris Junior College around, it is becoming increasingly difficult for a dishonest traveling man to earn a living.'"

The proposed curriculum, structured on objective-based instructional design, has been implemented, and extensive performance-based assessment has been conducted to ensure that the resulting curriculum design contains the information and activities which maximize the probability of student success in achieving the objectives of the course.

The 35mm camera, which was purchased through project monies, has been adapted for the microscope, permitting microphotography of specimen to differentiate between natural and synthetic materials and showing internal growth markings. These slides and pictures are utilized not only in instructional lectures but also are incorporated in the student manual.

Accomplishment of specific objectives stated in the development of the instructional program has been achieved and is stated below:

1. A comprehensive instructional manual is near completion. This has become an invaluable tool in classroom instruction and for student reference. (Representative samples of various sections can be found in Appendix A.)
2. Each objective of the instructional program has been incorporated into the curriculum and successful completion of each of the following is necessary for graduation:
   a. proper identification of gemstones,
   b. grading for quality and appraisal of gemstones,
   c. detection of imitation and synthetic materials,
   d. learning of the use and care for the laboratory instruments necessary to the testing and identification of gemstones,

e. development of skill in gemstone merchandising through study of the formation, recovery, and cutting of precious gems, with attendant attention to the folklore, traditions and symbolism of such stones,

f. learning to trade ethically and accurately in precious stones,

g. and learning to exercise proper care during bench work--through a working knowledge of gemstone reaction to heat, acid, fracture, abrasion, and clevage.

Confirmation of the program's success will become more evident when a larger number of students have entered the jewelry field, and their progress has been observed. To this point, formal evaluation through employers has not been conducted, but comments from employers who have been contacted have indicated their belief that the Paris Junior College course is a very professional one. They are especially pleased with the students' abilities to deal with customers--a trait which was previously lacking in new employees.

The progress of program graduates will be continually monitored to determine the practicality of the course, whether or not it should be expanded, or if it continues to be adequate in its present form.

3. The research project results will serve as a guide to those who are interested in initiating a similar program.

Additionally, the instructional manual will be available for reference and student use. A slide presentation which has been developed to disseminate knowledge of the Gemology Project provides an overview to interested viewers and gives a fuller perspective of the program.

As was first surmised in the decision to initiate such a program, the need by the jewelry industry has been appallingly evident.

1. Paris Junior College realized the need for a course of study of gemology that was comprehensive, yet economical in terms of time and money for the student. Project results indicate this has been achieved. This is documented by the fact that the demand has been so great for gemology instruction that every class is filled to capacity and the original plan to hold two sessions during each year had to be expanded to three sessions.
2. New employees who are not graduates of a gemology program typically require 6 months training before they are ready to work in the industry. With training from the Paris Junior College program, employees are prepared in 30 days or less to enter the field.
3. The Gemology Project has served as a means of continuing education for those who enroll and complete the sequence. Further, weekend seminars have been presented to members of the Retail Jewelers Association

throughout the United States. These have included laboratory demonstrations, lectures, and talks which have been provided as a service to the industry.

SPECIFIC UTILIZATION OF RESULTS

Results of the research project in gemology suggest implications for the independent jewelry industry and also for other educational institutions developing similar programs. Thus, the following statements can be made from project findings:

1. After piloting the program as a <u>vocational</u> course of study, gemology was found to be a highly technical skill, requiring far more scientific and theoretical knowledge, far greater equipping and operating expense, and more intensive faculty supervision than a vocational course. Gemology should therefore be considered a technical level course. For this reason, states, such as Texas, which fund instruction on a cost-based formula, should consider separate formula for vocational jewelry craft in the computation of state appropriation rates.
2. The program is not designed to attract the average student but to fulfill a need in the occupational market. Those participants are possessive of their knowledge and ability attained

and have worked many tedious hours to complete this sequence. As a result, they are high achievers and expect the same dedication on the part of other students. It is not a course for those with little interest in the field.

3. Originally envisioned as a 13-week, or quarterly, course, the gemology course was ineligible for student financial aid under new Federal regulations for those individuals who were simply returning for job-upgrading. Since the final curriculum design includes fifteen full weeks of instruction, it is recommended that other institutions considering the initiation of such a curriculum plan the addition of one additional week's study to satisfy the semester-length clock hours requirements of Federal financial aid guidelines.

4. In evaluating project success, implications for future programs are that a class could be successfully conducted on the student-teacher ratio of 15:1 with proper equipment and stations only if research were not being conducted simultaneously. If instruction were the only concern, a better student-teacher average would be feasible.

5. Assessment of student performance indicates satisfaction by employers of graduates of the program. As more students complete the sequence and more feedback becomes available from both graduates and employers, the curriculum will be refined to reflect necessary changes.

6. Paris Junior College has already been approached by officials from other states who have exhibited interest in studying the Paris Junior College program for possible application in their own situations.

7. The slide presentation which has been developed will be available for viewings by potential interested individuals in the program including those directly involved in the jewelry industry.

8. The instructional manual, which is in final stages of completion, will serve as an invaluable resource tool for those emulating this program and also for graduates. This manual enhances text material and provides a 350 page description of such aspects of gemology as basic behavior pattern of light, detailed description of colored stones, ultraviolent fluorescent charts describing all species and varieties of gems and their reactions to long- and short-wave ultraviolent fluorescence, individual reference chart showing optical and physical properties (mineralogical and physical properties) of stones, etc.

9. Articles have appeared in professional journals and will continue to be published concerning the program. These will keep interested individuals knowledgeable of the progress of the Gemology Sequence. (Examples are appended to the narrative in Appendix H.)

10. An appropriate model has been developed which can be emulated by other such institutions who are interested in initiating their own program. They will be able to evaluate cost-effectiveness and to decide on the long-term merits of adding the program to their curriculums. (The program personnel cost for the two years was over $73,000; instructional supplies were over $2,000; and equipment rental/purchase amounted to $38,000.)

APPENDICES

APPENDIX A
Excerpts from Instructional Manual

GEMOLOGY FOR
THE
JEWELER

Paris Junior College

January, 1979

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CHAPTER I

Introduction

The purpose of this course is to instill sufficient skill in identification, quality grading, tradition, lore and familarity with precious gems to enable the student to be accurate when buying, selling, advertising and promoting precious gems. Consider the successful completion of this course as a starting point, a foundation upon which practical knowledge may be placed to build a successful career. However, more important than gemological knowledge, is its application in the working world.

When the course is complete the student should be prepared to apply his knowledge in a professional manner. In the competitive professional world the strong will survive and prosper; the weak will falter and fail. Those who best prepare to project the image of a professional jeweler will be among the survivors. It is by the image of professionalism that a jeweler is known. Skeptics may say, "You can't put your image in the bank", but, the amount of money deposited in the bank depends upon what the buying public thinks of you, the jeweler - and that opinion is greatly influenced by the image that is projected.

The professional jeweler is dependable, meeting deadlines and keeping scheduled appointments, honoring verbal agreements and promises as being as inviolate as a signed contract. The phony smile, the enthusiastic handshake, may be the mark of a high pressure salesman but do not contribute to a professional image. Such an image can not be faked and must be genuine. Only by adequate knowledge and a sincere desire to do a job in the best possible manner can a professional image be projected. If you like what you do, all of the elements that contribute to the professional image will fall into place.

To be a professional jeweler you need to learn all you can about the products with which you deal, knowledge of precious gems is a fundamental requirement. Make use of this knowledge to assure yourself and others that you are capable of serving clients accurately and honestly.

Your work area should always be neat and ready for use. An orderly gemological laboratory in an area that is visible to store traffic is an excellent symbol of professionalism. The ideal location for the laboratory is a small room adjacent to the sales area. It should have a glass window so that the instruments are on display but are safe from curious children.

The image projected by a jeweler depends upon personal appearance and behavior. You dress and act according to the way you wish others to think of you. To project the image of a professional jeweler, dress and act as a professional should. THE FACT IS, OR SHOULD BE, SELF-EVIDENT THAT THE JEWELRY BUSINESS IS NOT A "SHIRT-SLEEVE" PROFESSION, Success is dependent upon public reaction to your image, and it is only when prospective clients have been favorably impressed that you are given the opportunity to demonstrate your talents.

As an employee; the jeweler is never tardy or late, as an employer; he sets an equally good example. Good watchmakers and jewelry store workers frequently become store owners, and anyone who has also trained in the field of gemology is even more qualified to operate a business. The owner of a jewelry store is rarely proficient in performance in all of the many areas of expertise required when operating a jewelry store. Many skills must be filled by others: The bookkeeper, keeps the accounts straight, the tax records in order, and the bills paid; the gemologist assists in buying and selling merchandise; the watchmaker, and the jewelers do the work that comes to their benches; but, it is the store owner who has invested his capital, and is taking the risks by assuming the responsibility of meeting all obligations.

The owner, and the people employed to perform various tasks, are all members of a team dedicated to the successful operation of the store. Success or failure is dependent upon how well each member of the store team functions.

The employee, assuming none of the risks, has the advantage of being given the opportunity to perform the tasks for which he is best suited, while the rent, payroll, cost of inventory, taxes, and other obligations are paid for by the owner. As a member of the team, it is to the employee's own interest that a record of promptness, quality performance, and honesty be established. The employee, as well as the store owner, needs to establish a professional image before the public.

CHAPTER II

Gemology

Definition of "Precious Gems"

Gemology is the study of precious gems, synthetic gem materials and imitations of gems.

The word - GEMOLOGY - is formed by the combination of the Latin word "Gemma", meaning gem and the Greek word "Logos", meaning science or study. The word first appeared in the Great Oxford Dictionary in the year 1811, spelled with a double "M" as "gemmology", but in the United States the simpler spelling "gemology" is preferred.

A precious gem may be described as: Any natural substance of great beauty, with hardness and toughness enough to retain that beauty for many years, while being worn as a personal adornment.

Earth sciences may be divided into several main topics which include the mineral kingdom, vegetable kingdom and animal kingdom. While most precious gems are members of the mineral kingdom, some have origins in the animal or vegetable kingdoms. Gemology is not just a study of branches of these sciences, but is also concerned with human relationships and interests in precious gems. Gemology includes tradition, romance, historical and religious significance of precious gems, plus the knowledge and understanding of the contributions made by gems to the many cultures that have populated the earth since the beginning of time. The study of gemology discloses a few scientific tests that will serve to correctly identify precious gems, and aid in consideration of the physical and optical properties of each.

Up to the beginning of this present century most jewelers were content with a dilettante approach to identification of gem stones, relying upon the color, luster and general appearance as a basis for their decisions. Many jewelers, with long experience in gem identification, could detect glass imitations with some degree of accuracy, but were not as dependable when it came to the determination of the identity of a transparent, red gem which might be ruby, garnet, spinel, tourmaline, or any of several natural gem materials.

A transparent yellow gem was often named, topaz, but might have been sapphire, yellow beryl, citrine, grossularite-garnet, or any one of over twenty species that may be yellow in color.

Public interest in precious gems has increased, making it imperative that modern jewelers be knowledgeable and accurate in gem identification. It has long been a common practice to label citrine, topaz; smoky quartz, smoky topaz; golden sapphire, oriental topaz; heat-treated white zircon, matara diamond; and imitation stones as synthetics. These misnomers along with many others are morally, ethically and legally unacceptable; and, their usage can have costly results. With the appearance on the market of several skillfully produced synthetic materials, each of which might easily be mistaken for gems of natural origin, it has become even more important that gem dealers and jewelers know how to protect themselves, and their customers. By being capable and distinguishing one product from the other, and determining the quality grade of each they can achieve this result.

Qualifications of Precious Gems

To qualify as a precious gem, a specimen should excell in one or more of the following: Beauty, durability, rarity, fashion, and portability.

Beauty. To qualify as a precious gem, the prime requirement in any specimen is beauty. Beauty is dependent upon transparency, brilliancy, color, luster, dispersion, and phenomenon. Few gems will excell in all of these areas, many in no more than one or two; but, the result must be pleasing to the eye before being regarded as beautiful-or as a gem. A diamond with splendid transparency, that has been fashioned with skill, will display wonderful brilliancy because of its high refractive power. Beautiful fire will result from its power of dispersion and an extremely high luster is possible because of its great hardness. If it should be pink, golden-yellow, green or of some other hue color may be added to the list of qualifications it has met in being classified as a gem.

On the other hand, turquoise may be beautiful even though it lacks transparency, simply because of its color and luster. Chrysoberyl cat's-eyes, star rubies, and star sapphires depend upon color, luster, and phenomenon for their fascination and classification as gems. Play-of-color in opals and the orient of pearls admit these gems to the select list.

Approximately 80 percent of the diamonds taken from the mines lack the potential for being made beautiful. Even though these flawed, unattractive specimen are diamonds in every sense, they cannot be classified as gems. However, because of their extreme hardness they are almost indispensable as tools in many production processes. If a specimen of any species is beautiful it may be classified as a precious gem, if it lacks beauty it is not a gem regardless of the specie to which it belongs.

Many specimen are beautiful in their natural form, but it usually requires the skillful work of the lapidest to develop their beauty to the fullest. The beauty of precious gems is the result of a combination of the marvels of nature and the expertness of the cutter.

Durability. An important requirement in a precious gem is that the beauty of the gem be preserved for many years, even though the gem is worn as a personal adornment. Hardness is the quality of resistance to abrasion or scratching. Toughness is resistance to fracture or breakage. These two attributes in combination result in durability.

A diamond, the hardest of all materials is not particularly tough because it can be cleaved with comparative ease in any of four directions. Jadeite on the other hand, is not as hard as quartz, but is extremely tough.

Because of their great beauty, several materials are considered as precious gems in spite of the lack of hardness and toughness, or durability. Opal, an example of such a gem, is relatively soft and fragile, yet these physical deficiencies are understood and respected. Many opals may be worn for many years without damaging their beauty.

Rarity. The desirability of many gems is increased because of the human trait of giving value to those objects which are scarce. It is a factor that contributes to the establishment of value or price in many gems. We observe that the extremely rare ruby or emerald of fine quality is very expensive, while the more abundant amethyst or garnet may be priced at only a few dollars per carat.

While rarity is an important factor in the establishment of prices on the market, it certainly adds nothing to the physical or optical properties of a mineral. Many very beautiful gems are fairly abundant, therefore relatively inexpensive.

Fashion. Another factor that helps to determine the acceptability of certain gem stones. The mention of a gem in a fashion magazine, picutres of a prominent person in the newspaper or on television, wearing certain gems has a great effect on the determination of what kind of gem is in fashion. There is a tendency among the populace to follow the "fashion-leader".

A certain "fashion" may be fleeting, and not suitable for all people. It is more important in establishing a suitable style to consider the personality, skin and hair style, coloring and contouring of the face, hands, and body. These factors will help in the selection of the gem stones that will enhance the wearer's good points. Usually gems that have been selected on the basis of individual style are socially significant and serve in a cosmetic sense. An alert jeweler may determine that a fine aquamarine is more suitable than emeralds for certain people. Personal style will remain valid during an entire lifetime.

TERMS AND DEFINITIONS

1. A Precious Gem is any natural material of great beauty with hardness and toughness enough so that beauty will be protected for many years while being worn as a personal adornment.

2. A Mineral is a natural, homogenous, inorganic material having consistant chemical composition and physical properties. A mineral is usually crystalline in structure.

3. An Organic Gem is a gem such as a Pearl, Coral, Amber, or Jet.

4. Hardness is resistance to scratching or abrasion.

5. Toughness is resistance to fracture, cleavage, breakage, or parting.

6. Relfection of Light is the angle of incidence which equals the angle of reflection. The incident ray, the reflected ray and normal are all in the same plane.

7. Refraction of Light is the bending of the path of light rays as they pass obliquely from one medium into another.

8. Refractive Index is the ratio of the speed of light as it passes from a medium of one optical density into another medium with a different degree of optical intensity, and the measure of the critical angle.

9. Dispersion of Light is the division of white light into spectral colors as it passes through transparent material at an oblique angle.

10. Birefringence is the extreme difference of the high refractive index and the low refractive index of a doubly refractive material.

CHAPTER V

Light and Phenomona

The Spectrum Light

The theory is promoted that light and energy travel through space in a series of waves. The wave action caused by a violent storm on the surface of the ocean is severe. On the other extreme is the ripple on the surface of a pond caused by a puff of air. The waves on the pond are quite small and the distance between two successive crests may be a fraction of an inch. This distance between a point on one wave to an identical point on the next wave is known as wave length.

While the waves on the surface of water undulate in one direction, light waves vibrate in all directions perpendicular to the path of travel. (Figure 5, page 4.12).

The range of radiation from the sun known as the spectrum is composed of an extremely wide band of wave lengths ranging from those measured in miles or meters to the very short waves of the cosmic rays which are one-trillionth of a centimeter long.

Only a small portion of the complete spectrum is visible to our eye as light. The longer wave lengths are used for the transmission of radio signals. X-ray, ultra-violet ray, infra-red ray, and many other rays are useful but invisible to the eye.

The visible spectrum is composed of many hues ranging from violet through red. White light is composed of all these hues being transmitted in equal amplitude superimposed upon one another.

The unit of measure used to calculate the wave lengths of the hues of visible light are called Angstrom units. One Angstrom unit equals one ten-millionth of a millimeter. The abbreviation of Angstrom unit is "A." or "A.U." A wave length of violet light is approximately 4,000 A., and a wave length of red is approximately 7,600 A. The wave lengths of all other hues fall between these two extremes, yellow for instance is in the 5,500 A. range.

The colors of most objects are the result of transmission or reflection of a mixture of several wave lengths producing more than one hue, the blending producing the color that we see.

Making use of a slide projector as a source of white light, insert an opaque slide with a narrow slit cut into it, into the projector. Then project the image of the slit upon a screen. Placing a prism of clear glass in the path of light between the screen and the projector will divide the white light into its component parts, a spectrum will appear with violet at one end, red at the opposite end and yellow in the middle. This spectrum indicates that white light is composed of the combination of the various spectral colors.

If a piece of red glass is placed between the light source and the screen, the image of the slit appears to be red. This is because all wave lengths have been filtered out of the beam of light, and only the wave lengths that cause the eye and brain to "see red" are transmitted.

Should the red glass be replaced with one that is blue, the image on the screen would appear to be blue as a result of the absorption of the red end of the spectrum.

The color that is seen results from the subtraction of certain portions of the spectrum and the transmission of the remaining wave lengths.

If the red filter and the blue filter are placed over one another, the filter would absorb all wave lengths except those that produce red and the blue filter would absorb the red end of the spectrum with the result that no light would be transmitted to the screen.

Our best source of white light is the sun. It provides us with a balanced spectrum with all wave lengths being equal in amplitude. Many sources of artificial light such as candle light or light from an incandescent electric light bulb are short on the blue end of the spectrum. As a result, many blue sapphires, particularly those that come from Australia, blue fabrics, and any other blue object will appear very dark or even black. Since the amplitude of the blue wave lengths being transmitted is less than those of the rest of the spectrum and the blue objects are capable of reflecting blue only, the result will be little or no reflection of light.

The color of opaque objects is the result of the absorption of parts of the spectrum and the reflection of the balance. The colors that are seen are those that are reflected. Should the complete spectrum be reflected from a surface, the result is white. If all wave lengths are absorbed and none are refelcted, the result is black.

Color is of great importance to those who are connoisseur's of precious gems. Many gems are desirable primarily because of their color.

When making a judgment of the value of aquamarine, emerald, ruby, sapphire, jadeite, topaz, amethyst and many other colored gems, color is the factor that is considered first.

Colors may differ from one another in several ways. These differences can be described as variations of hue, tone, and intensity.

Hue. Hue can be described as basic color. Pure colors are parts of segments of the visible spectrum. When the eye receives, and the brain registers, wave lengths in the 7,000 A. range, the color "red" is visible while those wave lengths in the 4,000 A. range cause the color "violet". By examining small sections of the spectrum it is possible for the human eye to distinguish over 100 hues.

Tone. These hues, or colors, can be modified by variation of tone, which means lightness or darkness of color. Tone indicates the position a color may occupy on a scale of whiteness to blackness. A can of colored paint can be lightened by addition of white, or darkened by addition of black. Variations of tone can be described as "light", "medium," or "dark".

Intensity. Intensity can be described as the brightness, magnitude or vividness of a color. A hue may be described as being "vivid" or "dull". To illustrate, suppose a piece of jadeite of intense green hue is viewed through a piece of frosted glass. The green hue remains, but intensity will be diminished. The same piece viewed through a pair of dark sunglasses will appear darker. The hue remains unchanged but the tone has been altered.

Considering these variations of hue, tone, and intensity, over a million different color perceptions are possible. To be aware of these slight differences it is necessary for us to observe two specimen side by side in a light that produces a full and balanced spectrum. The best such light source is north-sky-light which is diffused, reflected light. In recent years several artificial light sources have been developed that produce a reasonably accurate spectrum. It is impossible for most of us to "remember" a color or its variations so that we may look at a gem color at one time and match it at another time.

Pastel colors may appear quite attractive on an opaque surface but will have a pale, washed-out appearance if the material is transparent. Most transparent gem stones should be either colorless or nearly so, or else present a hue of darker tone and high intensity.

In the jewelry business it is often necessary to communicate color impressions. Many gem stones do not present a pure hue, but rather a combination of two or more hues. Attempts to describe a color by use of the more common terms such as "apple-green", "honey-yellow", or "sky-blue" fail to convey accurate information. More precise descriptive terms such as "greenish-yellow", "yellow-green", "bluish-green", "greenish-blue", etc., modified by terms describing tone and intensity stand a better chance of conveying color impressions.

However, there still remains the variations on interpretation as people all see colors differently. Color conversation becomes meaningful when all parties involved make use of standard "masters" of hue, tone and intensity. These masters must be consistend and all the same. This concept is carried to a practical ultimate by the "Gemological Institute of America" in their development of sets of "Master-Diamonds" as a tool for color grading diamonds. But these sets do not help to describe or grade color of garnet or aquamarine.

R. Lary Kuehn Productions has developed a "Gem Master Color System" which makes use of numbered transparencies of 26 hues and other slides to assist in the determination of the tone of a gem stone. Since all sets are the same, everyone making use of them will come to a reasonable conclusion when describing the color of a gem.

A "Gem Master Color System" will now be presented and demonstrated by your instructors.

Causes of Color in Gem Stones

Allochromatic and Idiochromatic stones. The majority of gem stones would be colorless if they were chemically pure. Corundum, beryl, topaz, diamond, zircon, quartz and many others, are without color when they are composed of only the elements inherent to their specie.

For instance, corundum is crystallized aluminum oxide. If these are the only elements contained in the crystal, it would be colorless. A trace of chromium oxide included in the structure causes it to be red, and the result is a ruby. Traces of iron oxide and titanium oxide cause corundum to be blue, and sapphire would be the variety of stone.

Species that are colorless when chemically pure, and may occur in a variety of colors as the result of the presence of elements not essential to their formula are known as allochromatic.

Some minerals are colored as the result of elements essential to their formula. These elements are known as Idiochromatic minerals. As an example, turquoise is a phosphate of copper and aluminum. The color blue is caused by copper. In some turquoise, iron partly replaces the copper and the result is greenish-blue turquoise. Peridot, a silicate of magnesium and iron is green as the result of the iron it contains. Malachite, azurite, and turquoise are idiochromatic stones with copper as the coloring agent. Almadine garnet is red, peridot is green, both colors are caused by the presence of iron in their composition.

The colors of allochromatic stones may vary greatly depending upon the intrusion of any one of several elements, while the colors of idiochromatic stones are fairly consistent.

Color Treatment of Gems

The color of many gems can be enhanced or changed by one of several methods. The process used to produce such alteration of color depends upon the nature of the material to be treated. The purpose, of course, is to render specimen more desirable, hence more marketable.

The methods used include:

1. staining or dying
2. heat treatment
3. pressure and heat
4. radiation in a cyclotron or atomic pile

When chalcedony is removed from the ground it is usually pale in color and is not particularly attractive. Since the cryptocrystalline structure is slightly porous, coloring agents can be introduced and the material made quite handsome.

The structure of some chalcedony is layered, some layers being more compact than others. This results in bands of dark color alternating with bands of lighter color or white. The result is onyx or agate.

Black dyed chalcedony is produced by soaking it in a solution of honey or sugar and water for several weeks. It is then immersed in sulfuric acid which is slowly heated to the boiling point and allowed to boil for about twenty minutes. This chars the sugar that has been absorbed. It is then heated gently for several days to remove traces of acid. This process has been used for over a century and a half.

It is safe to assume that all black chalcedony (commonly - but inaccurately - called "black-onyx") and brightly colored specimen have been subjected to color treatment.

Various colors are produced by making use of organic dyes. Chalcedony can be made a bright green by soaking it in a solution of chromium and nickle salts then heating it. The same process will produce shades of red if ferrous nitrate is used. Jasper is sometimes dyed with Prussian blue to resemble lapis-lazuli.

Most of the turquoise on the present day market has been treated to intensify and perpetuate color and to stablize the structure. Most of the turquoise found in the United States is quite porous. Some of it is also friable. It is treated to prevent absorption of oil or other liquids and to make it tough enough to be used in jewelry.

Some turquoise is stained with Prussian blue, other specimen are soaked in oil or wax. Often it is treated by immersion in sodium silicate (water-glass), and heated for several days under pressure. This treatment seals the material and enhances the color.

As long as such treatments produce stable results they are ethically acceptable provided they are presented and named properly. Color enhanced turquoise or chalcedony are legimate products when offered for what they are, while the use of the name "Swiss-Lapis" to describe dyed jasper is improper. This is dealt with further in the section "Change of Color by Heat Treatment".

Dispersion of Light

It has been demonstrated that a beam of white light passed through a prism of glass will be divided into its component colors. It has been noted that each color has its own wave length, and those colors with shorter wave lengths, hence higher frequencies (A.U.), will be refracted more than those colors with longer wave lengths. The component colors of white light range from red, with a wave length of approximately 7,600 A. to violet with a wave length of approximately 4,000 A. Other colors such as orange, yellow, green and blue have wave lengths between these extremes.

Because of these differences in wave lengths and frequencies there will be differences in their speeds as they travel through optically dense, transparent substances; therefore, differences in the angles of their refraction. This results in white light becoming divided into its component colors. This phenomona is called dispersion.

The power of dispersion of a substance is determined by noting the difference in the refractive indices of red and violet. This is accomplished by making use of color filters that screen out all wave lengths other than those being tested.

It is because of dispersion that readings of the refractometer appear as a band or spectrum when white light is used. To obtain a precise reading, monochromatic light should be used. Usually yellow light which is in the middle of the spectrum is used to produce a sharp, definite line on the scale.

The powers of dispersion of gem materials differ greatly. Diamond has a fair[illegible] high power of dispersion which results in the pleasing display of spectral colors which is described as "fire". This contributes greatly to the beauty of diamonds.

The relative powers of dispersion of gem materials is listed here:

Material	Power of Dispersion
Synthetic rutile	.330
Strontium titanate	.109
Andradite garnet	.057
Diamond	.044
Zircon	.038
Grossularite garnet	.028
Pyrope Garnte	.027
Almandine garnet	.024
Spinel	.020
Peridot	.020
Corundum	.018
Spodumene	.017
Tourmaline	.017
Crysoberyl	.015
Topaz	.014
Beryl	.014
Quartz	.013
Orthoclase	.012
Silica glass	.010

Phenomona, Chatoyancy, Asterism

Some varieties of several gem species, when cut in cabachon display a narrow band of light at the apex of the curved surface. The position of the highlight of light changes as the position of the incident light is changed or when the stone is turned. This phenomenon is known as chatoyancy and the gem is called Cat's-Eye.

If the specie of the gem displaying this phenomenon is chrysoberyl it is designated simply as cat's-eye, but the name of any other specie should be included in the description of specimen that have an "eye".

Some varieties of quartz, tourmaline, apatite, scapolite and diopside will display well defined eyes. Some specimen of beryl will display a band of highlight and occasionally specimen of other species will be found that can be made to show chatoyancy.

Such lines or bands of highlights of light are the result of large numbers of parallel needle-like crystals (tubes or canals oriented across the curved surface of the cabachon). The highlight is perpendiuclar to the orientation of the parallel inclusions. The effect is similar to that seen on a spool of high luster thread. Drawing a piece of emery paper across a sheet of curved metal parallel to the direction of the curve will produce a similar effect.

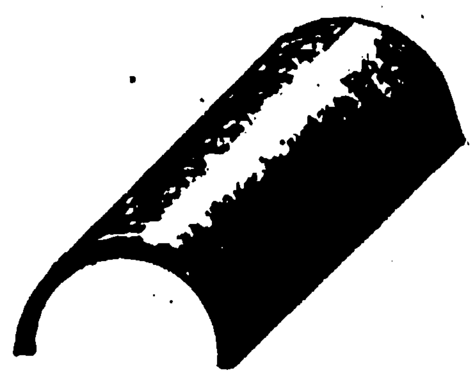


Figure 12

Phenomona of Chatoyancy

While chatoyancy is the result of the reflection of light from a large number of parallel inclusions and a curved surface, asterism is the result of reflection of light from parallel inclusions oriented in two or more directions.

Numerous needle-like inclusions oriented parallel to the crystal faces of a mineral that crystallizes in the cubic system such as almandine garnet will produce two highlights crossing in the center, resulting in a four pointed star. Should the inclusions be oriented parallel to the faces of a dodecahedron, a six pointed star results.

Sapphires and rubies are the most desirable of the asterated gems. Many included, tiny needle-like cyrstals, oriented parallel to the six prism faces of the crystal, produce three highlights of light on the curved surface of the cabachon resulting in a six pointed star. Occasionally a star corundum will display a twelve pointed star.

Specimen of rose quartz may display a six pointed star when cut sperically and a beam of light is transmitted through the stone. This effect is known as diasterism. Some specimen of spinel and chrysoberyl can be fashioned to produce a star. Synthetic star sapphires and synthetic star rubies are well known and many are quite attractive. Imitation star stones are also produced. These stores are dealt with in depth at a later date.

Oiled Stones

A jeweler must be aware of the possibility that some emeralds, rubies, sapphires, star rubies, star sapphires, or other gems may have been treated with oil. Cracks or flaws that come to the surface of the stone can be filled with oil of suitable color which not only obscures the cracks or flaws but improves the color.

There are several dangers in handling such material:

1. If an oiled stone is left in a shop for work, it is only natural that it be cleaned in an ultra sonic machine. This cleaning removes part of the oil, causing some of the flaws to become visible and the color to lighten. The customer is naturally upset because of the changed appearance of the stone.

2. Since oiling obscures cracks it is possible that a jeweler may apply pressure at a point which may appear to be sound but is not, breaking off a fragment of the stone.

3. A jeweler may sell an oiled stone believing that the color and clarity is better than it really is, the fraud being revealed at a later date.

Such oiling can be discovered by rubbing the stone with a piece of cloth that has been soaked with benzine.

Change of Color by Heat Treatment.

The color of many gems can be improved or changed completely by heat treatment. The temperatures used may vary from 150° to 800°C, depending upon the material being treated.

The color of lightly colored chalcedony is frequently improved by heating, producing attractive carnelian. Blue and colorless zircons are produced by heating brownish or red stones. Since blue or colorless zircons do not occur in nature, it is safe to assume that all such stones have been heat treated.

Heat treatment of amethyst or smoky quartz changes the color to yellow, citrine being the resulting color. The color of some amethysts can be improved by heat treatment. A few dark-green tourmaline stones can be lightened by heat treatment. The color of greenish-beryl can be made the fine blue of aquamarine by heating to 450°C.

Zoisite is heat treated at 380°, to produce the blue gem known in the United States as Tanzanite. The color of certain rubies can be imporved by heat treatment. Such heat induced color changes or improvements, are a common practice. The color of most treated gems is stable but the blue of treated zircon is likely to fade. (see "Change of Color by Radiation", and "Color Enhancement by Coating", Liddicoat. pages 234-238).

Change of Color

Sunlight consists of a balanced spectrum, the intensity of all colors being equal. Candlelight or light produced by an electric bulb is unbalanced with a deficiency of violet vibrations while the amplitude of the red end of the spectrum is greater.

Some gem stones, notably the alexandrite variety of chrysoberyl, absorb much of the yellow portion of the spectrum while freely transmitting the shorter and longer wave lengths of blue and red. As a result of the absorption powers of alexandrite it appears green when viewed in daylight and red under artificial light. Its color is purplish-red, similar to the color of amethyst. The color change of the occasional synthetic alexandrite-like spinel more nearly resembles that of alexandrite. Rarely specimen of genuine sapphire, beryl, or tourmaline are found which display change of color. Rare indeed is a chrysoberyl cat's-eye which also displays a change of color. Such specimen known as alexandrite cat's-eye, are usually seen only in museums or extensive private collections.

Play of Color - Interference of Light

The beautiful changing colors seen in opal and the flashes seen in labradorite are caused by interference of light.

The iridescent colors seen in soap bubbles or in a thin film of oil floating on water are caused by this same type of interference of light. The phenomenon can be best explained with the aid of diagrams.

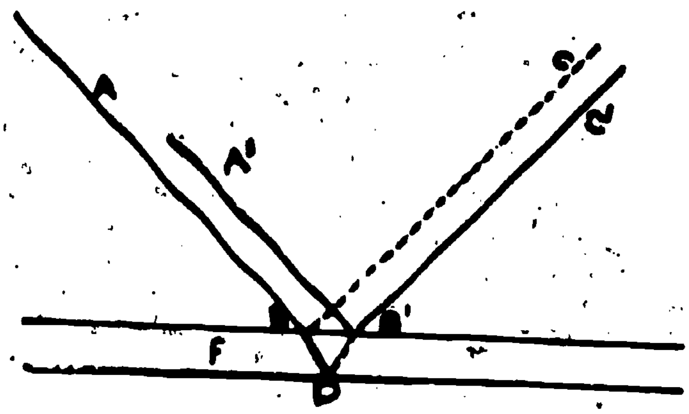


Figure 13

A - B = Ray of incident light impinging upon the upper surface of a microscopically thin, transparent film.

F = Film of material with a different R.I. than the surrounding material. The film has a thickness of one wave length of one color.

Some of the incident ray will be reflected to travel in path B - C, some will be refracted to point "D", where it is reflected to the lower face of the film to follow path D - B^1 - C^1.

Another beam of light A^1 impinges on the surface of "F" at point B^1, and is partly reflected into path B^1 - C^1. The result is two beams of light traveling in identical paths.

Beams A - B and A^1 - B^1 are composed of combinations of wave lengths of all visible colors. The beam of light reflected from the lower face of the film and following path B^1 - C^1, will cause all but one wave length to be out of "phase" and one wave length to be in "phase". The wave length that is in phase will be intensified while all of the wave lengths that are out of phase will cancel.

The solid line = Beam A in sketch 13.

Dashed line = Beam reflected from the bottom face of the film with a wave lengths of beam $B^1 - C^1$. This wave length is determined by the thickness of the film and the angle of the path of travel. These lengths are in phase, so this color is intensified.

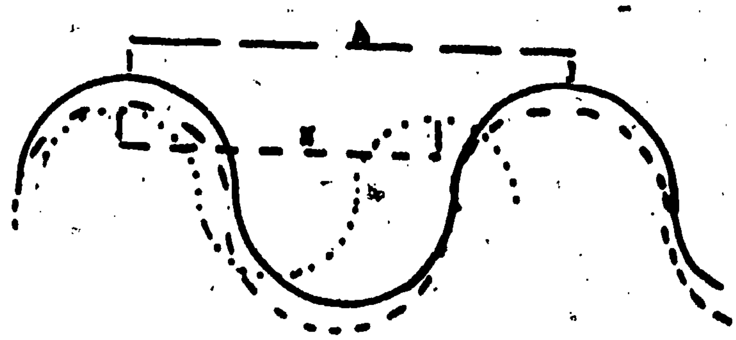


Figure 14

A = The wave length of the harmonious beams.

X = The wave length of a beam out of phase. Being out of phase, it, and all other wave lengths out of phase are cancelled.

It has been determined with the aid of electronic microscopes that an opal consists of great numbers of amorphous silicon dioxide spheres arranged in a more or less orderly manner. This arrangement of spheres and the voids between them, form a three dimensional diffraction grating which results in the transmission of pure colors. The sizes of the spheres and the direction of incident light determine the color that results. Sheets of larger spheres diffract red light while sheets of smaller spheres diffract colors with shorter wave lengths.

In any case, the cause of the play of color as seen in the opal is interference of light.

Adularescence

Moonstone is a variety of orthoclase feldspar that exhibits a floating blue or white sheen called adularescence. This effect is caused by alternate layers of plates of albite and orthoclase. The albite has a slightly different refractive index than orthoclase, and reflection of light from these repeated-twinning planes results in the sheen effect.

Labradorescence

Labradorite is another variety of feldspar. It is subject to repeated twinning which results in a number of thin plates which cause interference of light producing patches of vivid blue color which change as the stone is moved. This effect is known as labradorescence.

Aventurine

Aventurine is a variety of reddish or yellow oligoclase feldspar that contains many included crystals of iron oxide from which light reflects causing a spangled effect. This effect is called aventurescence.

A similar effect is found in aventurine quartz containing many crystals of hematite or mica. Its color may be green, brown, yellow, or red.

Scintillation

A beam of light can be seen only when it strikes directly on the retina of the eye. A beam of light passing through air which contains no pollutants can not be seen from the side no matter how powerful it may be. Light from a powerful search light can be seen from the side only as a result of reflection from droplets of moisture, smoke or specks of dust that might be suspended in the air. This explains why it is impossible to see the beams of light sometimes used to call attention to openings of businesses or to pin point the location of public events in Los Angeles where the air is frequently polluted. The same type of advertisement does not work in areas where the air is not contaminated.

A single-cut diamond that has only 16 facets plus the table and culet can be proportioned so that most of the light entering the stone will be totally reflected from the pavilion factes, and leaked out of the crown resulting in brilliancy. Adding more facets to make a full-cut does not increase the amount of brilliancy but breaks the reflected light up into smaller beams that can be seen from many angles.

If a narrow beam of light is focused on a mirror or in a darkened room, reflection of the light can be seen only from one angle. If the reflecting surface is composed of many small mirrors arranged in various positions, the beam is divided into as many segments as there are mirrors and portions of the reflected light can be seen from many angles. In a practical sense, the facets on the pavilion of a diamond are mirrors. They are arranged at such angles that light passing down through the gem is reflected out through the crown. The single-cut can reflect the light only in eight directions while the twenty-four pavilion facets of the full-cut send reflections into as many directions, greatly enlarging the chances that some of the beams will strike the eye. As the stone is moved or the position of the light source is changed the reflections are also moved causing the eye to register first one beam, then another. The effect is <u>scintalliation.</u>

COLORED STONES

CORUNDUM

Ruby and Sapphire

I. PHYSICAL AND OPTICAL CHARACTERISTICS

A. Chemical composition
Aluminum Oxide (Al_2O_3), Coloring agents: red is caused by chromium oxide, blue by titanium and iron oxide, yellow by iron oxide, orange by chromium and iron oxide, green by iron and titanium oxide; purple by titanium and iron oxide.

B. Crystal System and Habit
Trigonal habit, crystallizes in a six sided prism terminated by flat faces (basal pinacoids).

C. Hardness
9

D. Toughness
Excellent, except in repeated twinning or fractured stones. Many star corundums contain fractures that may be extended by blows received during normal wear.

E. Cleavage
None. Parting or false cleavage often occuring during twinning. Twinning is very common in black star sapphires.

F. Fracture
Conchoidal (shell like)

G. Specific Gravity

Ruby 3.95 to 4.05	Normal 4.0
Sapphires 3.95 to 4.03	Normal 3.99

H. Streak
White

I. Characteristic Inclusions
"Silk" is common in the ruby and sapphire, either as rutile crystals or long negative crystal voids. Both are arranged in three sets of parallel threads that intersect at 60° angles. Other inclusions are zircon with halo, spinel octahedrons, liquid and gas filled in a fingerprint pattern. Prominent hexagonal growth lines and color zoning, curved striae and gas bubbles (donut shaped) in the synthetic variety.

J. **Luster**
Vitreous to subadmantine, the fracture surfaces are vitreous.

K. **Refractive Iedex**
1.762 - 1.770 ± .003
green sapphires about .01 higher

L. **Birefringence**
.008

M. **Optical Character**
Uniaxial negative

N. **Pleochroism**
Ruby: Orange and Red
Blue Sapphire: Strong violetish blue and greenish blue
Green Sapphire: Green and yellow green
Yellow Sapphire: Yellow and light yellow
Orange Sapphire: Strong yellow-brown and colorless
Purple Sapphire: Strong Violet and orange

O. **Dispersion**
.018

P. **Phenomina**
Asterism, rare cat's-eye effect. Alexandrite like change of color from blue to purple. A very rare occurance is change of color from green to reddish-brown.

Q. **Color Filter Reaction**
Ruby: Strong red
Green: Green
Blue: Blackish
Purple: May show reddish

R. **Ultraviolet Fluorescence**
Ruby: Strong red long wave, moderate to inert short wave
Synthetic: strong in both wave lengths
Orange Sapphire: Strong orange to red
Green Sapphire: None (inert)
Ceylon - light blue: Strong orange to red long wave, other blue is inert
Violet and Alexanderite like: Red long wave, weak light red short wave
Colorless: Moderate light orange-red

S. **Heat**
Use with caution. Uneven cooling can damage the stone. May turn green during heating but will resume its red hue when completely cooled. The sapphire may lose its color permanently if heated.

T. **Acids**
Acids attack with difficulty, but in some cases boric acid will attack the ruby's surface and cause an orange-peal effect.

II. SOURCES

Corundum is a fairly common mineral found in the earth's crust in many different kinds of rock and in numerous places on the surface. Only rarely does it occur under ideal conditions and form transparent material. With the exception of the black star sapphire only the transparent to translucent varieties are considered and classed as gem stones.

The right conditions occur for corundum formation in the contact metamorphism of limestones that recrystallize into marble. During the process of change the impurities of the limestone, mainly aluminum oxides, concentrate to permit the crystallization of corundum. The most common occurance of corundum is around pegmitite dikes.

In the region of Mogok, Burma, northeast of the city of Mandaley, is a valley 20 miles long and 2 or 3 miles wide. The valley is located in mountainous terrain and receives 100 to 140 inches of rain annually. Most of the inhabitants are engaged in the mining or cutting of gem stones. Their mining methods are family type operations using crude sluce boxes and water for recovery.

Mining of gems in Burma has been carried on since the early thirteenth century. For many years the British had control of the mining concessions; however, it is now strictly controlled by the Burmese government.

In the southwestern part of the Island of Ceylon (Sri Lanka) is the city of Ratnapura. (Ratnapura is a Singhalese word meaning "City of Gems.") For many generations this area has produced fine gems of great variety. It is our primary source of crysoberyl Cat's Eye.

Today India produces a few stones. The area of Kashmir in the Himalayan Mountians at one period produced blue sapphire. The name Kashmir Blue is still used to describe the finest, most desired color in blue sapphires.

Thailand produces rubies and sapphires of various colors. Siamese sapphires are dark and occasionally reach a high quality. The ruby material is dark purple-red or brownish-red, more like the pyrope garnet.

Australia has increased in importance in gem production. The area near Anakie Queensland, now produces fine quality, deeply intense, blue stones that are sent to Bangkok for cutting.

The United States has three areas of gem production. These areas are not of great importance in the world market. The first area is around and in Macon County, North Carolina. Sapphire and beryl are now being recovered. This area is not worked commercially to any extended basis. The second area is Yogo Gulch in Fergus County, Montana and is mined commercially for sapphire. Of minor importance is a third gem mining operation also located in Montana. Sapphires are found there as a by product of gold mining operations. Most stones found in America are sent to Bangkok, Thailand for cutting.

III. NAMES AND VARIETIES

A. Burma, Burmese or Oriental Ruby

These terms are used to describe only the finest blood-red or "pigeon's blood stones. Though Burma produces some of the finest rubies found it also produces many lower quality stones. The terms should be used to describe the quality of the stone and not the place of origin. Only transparent corundum of medium light to dark tones of red or purple-red hues are properly called ruby. Very light tones of red stones are called pink sapphire.

B. Siam or Siamese Ruby

This term is used despite the fact that the country is now called Thailand. These stones are usually dark red to brownish-red and resemble almadine or pyrope garnet. The stones rarely approach the color and quality of the Burma Ruby.

C. Ceylon Ruby

Usually light to very light red or purplish-red in color.
Those stones that are medium light in tone can be classed as ruby. The light to very light stones are called sapphires. They are used because they are more brilliant than similar Burmese or Siamese stones. The fine stones from Ceylon usually bring higher prices than better quality stones from Thailand.

D. Star Ruby

Rubies cut in cabochon that meet the requirements of color but have an abundance of rutile silk, oriented in the three directional phases to produce the phenomina called "asterism" are called star rubies. The tendency is to allow a wider latitude in color in star rubies than in rubies that are facated. A cat's eye effect is very rare.

E. Cashemere or Kashmir Sapphires

Used to describe the finest intense violet-blue sapphire, called cornflower blue. This color can be found in stones from Burma and Thialand.

F. Burma or Oriental Sapphires

A term used in the jewelry trade for a fine quality, rich royal blue stone. The main variance between the cashmere and Burma stone is that the Burma grade stone will appear slightly inky under artificial light.

G. Siam or Siamese Sapphires

A term used in the United States to describe a very dark blue stone. The stone will appear dark blue even in day light.

H. Ceylon Sapphires

Referring to a pale, grayish-blue to light blue-violet stone that is fairly brilliant. Blue Ceylon sapphires are sometimes subject to uneven coloration.

I. Fancy Sapphires
Most stones other than the blue stone are classed as fancy sapphires and referred to as yellow, green, white, or golden sapphire. Some areas of the world use the terms Oriental Topaz, King Topaz, etc. Federal Trade Commission rules prohibit these terms. It is not good practice to use the name of one gem to describe another.

J. Orange to Orange-Red Sapphires
The fanciest stones of this color are rare and highly prized. They are considered by those who collect and appreciate gem stones to be the most beautiful of all sapphires. The stones are called "Padparadsha" (Pad-par-AHD-shaw) sapphire. Most stones when mined in Ceylon find immediate buyers among the cutters and rarely enter the American market.

K. Green Sapphires
Most green stones sold are a dark to inky color. The lapadarist usually cuts the stone to display the green color rather than the dark blue dichroi color. When lighter green stones are found and cut to a pleasing color they are often called "oriental emerald". The color never matches that of a true emerald.

L. Violet to Purplish-Violet Sapphires
Referred to as amethystine sapphire, or incorrectly as "oriental amethyst". Reddish-purple stones are more frequently called plum sapphires. They may be referred to as rubies, but usually do not contain enough red hue to deserve the n[illegible].

M. Pink or Rose Sapphires
Stones that display a pleasing intense light to pale red or pink color, beautiful in themselves but they cannot uphold the name ruby.

N. Alexandrite-Like Sapphire
Rare in natural sapphires, common in synthetic materials. Stones show a noticeable change of color from reddish or purple color at night to a blue body color in daylight and are referred to as alexandrite-like or alexandrine sapphires. The color change may be weak or distinct.

O. Light Greenish-Blue Sapphires
Sapphires of this color are at times incorrectly referred to as oriental aquamarines. The similarity between the stones usually ends there.

P. Brown Sapphires
Transparent brown sapphires are rather rare, usually more opaque and silky so that if cut in cabochon they may exhibit a star. They are at times called adamantine spar. The major source is Thailand near the Cambodian border.

Q. **Star Sapphires**

Any sapphire that displays a star when cut in cabochon is called a star sapphire. They are rarely transparent and contain an abundance of silky, needle like inclusions. Orange and yellow stars are the most rare, but Ceylon has produced a few. Black stars are the most common and although expensive are still in demand. Highly twinned stones frequently display a twelve-rayed star, alternate legs of which vary in intensity and occasionally in color.

IV. HISTORY

According to the Book of Job in the Bible, "The price of wisdom is above Rubies." Corundum was a valued gem in antiquity. The breast plate worn by Aaron contained twelve stones representing the twelve tribes of Isreal. The fourth stone was called "Nopek" representing the tribe of Judah. The stone was carved and most likely was a garnet rather than a ruby. Many garnets were mistakenly called ruby. Another name for all red stones from carnelian to garnet was Carbunculus. The ruby is always considered a favorite adornment for royal crowns. From Judah sprang the royalty of Isreal. God commanded a ruby be placed on Aaron's neck.

In other writings the ruby is called "the most precious of the twelve stones created by God when He created all things." In Eastern Sanskrit writings the ruby had many names all highly regarded, i.e., "Ratnaraj" (King of Precious Stones). It is referred to as the Lord of Gems by Phillippe DeValois in his book, *The Lapidaire, and Ancient Work*. It is the gem of gems and surpasses all other stones in virtue.

A multitude of legends and superstitutions have always surrounded the Ruby. It was believed one who wore a ruby was blessed with health, wealth, wisdom and outstanding success in affairs of the heart, and the ability to live in peace with his enemies. The ruby had to be worn on the left hand or in a broach on the left side of the body.

Early Hindus believed that a white sapphire was an "unripe" ruby that would in time mature. The Burmese have always held the ruby in high esteem. They believed that a pale-colored stone buried in the earth would in time ripen and change into a fine colored ruby. In Ceylon a flawed stone was considered overripe.

No dispenser of herbs or potions would be without rubies, sapphires, emeralds, and other gems for curing the ailments of his time. In the thirteenth century the ruby was valuable as a remedy for biliousness and flatulency. A famous "ruby elixer" was compounded by a secret process at great expense. Naturally, it was available only to wealthy patients. The stone was used as a strong disinfectant in dread diseases. A Burmese warrior who suffered the pain and inconvenience of inserting the ruby into his flesh through an intentional wound was thought to be immune to sword, spear and shotgun wounds. Sapphire was credited with the power to cure a person who had been poisoned, rid one of demons, and remove all impurities and foreigh matter from the eyes.

Star sapphires are called "the stone of destiny". The three bands of the star represent faith, hope and charity. Oriental tradition believes it wards off evil omens and brings good luck to its owner even after the gem has passed from his hands. Sir Richard Burton the famous explorer of Africa, discoverer of the source of the Nile River, and translator of the *Arabian Nights*, was said to own a large star sapphire that he carried as his tailsman. He believed it brought good horses and good service where ever he went. Reward for good service was a view of the stone. His sapphire disappeared and was never found after his death.

The ruby is a very popular gem stone today. The jewerly trades have adopted it as the July birthstone.

APPENDIX B

Equipment Price List and Student Contract

GEMOLOGY EQUIPMENT

ITEM	NOMENCLATURE	PRICE	SERIAL NUMBER
1	Diamond Grader Binocular Microscope	$420.75	
2	Paired Wide-Field 15X Eye Pieces	40.80	
3	Duplex II Refractometer	115.00	
4	Polarizing Filter	7.50	
5	Illuminator Polariscope	59.00	
6	Immersion Cell	7.50	
7	Gem Dichroscope	12.00	
8	Emerald Filter	9.50	
9	Utility Lamp	103.00	
10	Leveridge Guage	109.50	
11	High Intensity Lamp	5.25	
12	Color Grading Slides	28.50	
13	Specific Gravity Liquid Set #1	8.00	
14	Specific Gravity Liquid Set #2	8.00	
15	Gem Cloth	1.00	
	TOTAL	$935.30	

STUDENT CONTRACT

I certify that the above equipment has been issued to me this date ______________ and that all equipment is in operating condition as verified by both myself and my instructor. I understand that in accepting this issue of equipment I am placing my self in a position of pecuniary responsibility for both the presence and condition of said equipment. I further understand that none of the above equipment may be removed from the Gemology Laboratory without the WRITTEN permission of my instructor.

SIGNED: ______________________________
Gemology Student

APPROVED: ______________________________
Gemology Instructor

APPENDIX C
Lesson Plans

LESSON PLAN

1. The Definition of a Precious Gem

   a. Enumeration of species and varieties
   b. Enumeration of synthetic, imitations and assembled stones
   c. Occurance of gem materials
   d. Hardness - resistance to abrasion
   e. Toughness - resistance to cleavage and fracture

2. Formation of Gems

   a. The atom
   b. Unit cells
   c. Crystalline and amorphous structures
   d. The seven crystal systems - diagrams of crystallin axes
   e. Optic axes
   f. Charts
      single refractive material
      double refractive material
      amorphous
      uniaxial
      biaxial

3. Behavior of light

   a. Color
      wave lengths of light - color perception
      selective absorption - transmission of color
      interference of light
      idiochromatic - allochromatic gems
   b. Reflection
      total internal reflection
      critical angle
   c. Refraction
      speed of light in air and in other materials
      bending of a beam of light
      table of refractive indicies of gems
   d. Polarization of light
   e. Double refraction and birefringence
   f. Dispersion
      division of white light into spectral colors
      table of dispersive powers
   g. Phenomena
      chatoyancy - asterism
      change of color
      play of color
      adularescence - aventurescence

4. Specific Gravity

   a. Definition
   b. Various methods of determination

5. Use and Care of Testing Instruments

   a. Microscope - Hand Loupe
      detection and evaluation of inclusions as an aid to identification
      estimate of hardness, toughness
      observati n of luster and polish
   b. Polariscope
      detectior f single or double refraction
      discovery of birefringence
      determination of optic sign
   c. Refractometer
      determination of refractive indices
      discovery of birefringence
      determination of optic sign
   d. Dichroscope
      detection and evaluation of pleochroism
   e. Ultra violet light
      flourescence and phosphorescence
   f. Spectrascope
      sketches of various absorption patterns
   g. Hot point

6. Series of assignments to cover each of the principle species

   a. Chemical, physical and optical properties
   b. Varieties - grading of each as to quality and market potential
   c. Occurance
      how formed in nature
      where and under what conditions they are found
      mining methods
   d. Identification
      enumeration of materials with which they may be confused
      detection of physical or optical pecularities which will confirm identity
   e. Cutting
      methods used
      styles of cutting - factors that determine style of cutting
      suggestions for use in jewelry
   f. History and lore associated with precious stones
   g. Sales presentation, display, promotion, etc.

7. Series on Diamonds

Because of the economic importance of the diamond to the average jeweler, the factors listed above (6) should be co sidered in detail with special emphasis on grading, evaluation, buying and selling

8. Less Common Gem Materials

   a. Brief description of species and varieties
   b. Instruction on identification

9. Synthetics and Imitations, Assembled Stones

   a. Methods of manufacture
   b. Detection of each
   c. Study of materials that are used to imitate diamonds
   d. Methods of detection and identification

10. Merchandising of Precious Gems

   a. Methods of display
   b. Departmental allocation of precious gems
   c. Record keeping

11. Advertising and Publicity

   a. special exhibits
   b. Lecturing
   c. "*in store*" parties
   d. Advertising in various media

12. In-Store Selling of Precious Gems

   a. Beauty, social significance, etc.
   b. Affordability
   c. Training other sales people

13. Examinations

   a. A quiz at the end of each subject
   b. Examination on physical and optical characteristics
   c. Quiz on each species
   d. Final Examination WILL CONSIST OF:

      Correct identification of species and variety of 15 gem materials, and quality grading of 5 diamonds
      Written examination to cover important information throughout entire course
      Oral examination - Each student will be ask to give a lecture of approximately 15 minutes duration (minimum) before the class on a gem stone, one of the testing instruments or another pertinent subject, as assigned by the instructor

14. Equipment required to be furnished by the student

   a. Two stone tweezers
   b. One each standard stone tweezer - 6 inches
   c. One each locking stone tweezer - 6 inches
   d. One hand loupe - triplex corrected
   e. Pencils and note paper

APPENDIX D

Training Program Outline

PARIS JUNIOR COLLEGE

Division of
Gemology, Horology and Jewelry Technology

TRAINING PROGRAM

Course: GEMOLOGY Course Length: Three months (330 hours)

Name of Student:__________________ Entrance Date:________________

MAJOR DIVISIONS

I. Basic Gemology - Approximately 30 hours

A. General Orientation
1. Units of Instruction
   a. course outline
   b. school policies
   c. working environment
      (1) professional work habits
      (2) personal appearance
      (3) employer-employee relationships
   d. introduction to instruments and text books
   e. introduction to research material

2. Reading Assignments
   a. assignment material *A*
   b. *Gemformation*, foreword, pages 1 through pages 4
   c. Liddicoat, pages 1 through 6

3. Projects
   a. identify instruments, limitations and cautions on maintenance
      date assigned____ date completed____ time rate____ grade____ initial____
   b. confirmation of reference material
      date assigned____ date completed____ time rate____ grade____ initial____

B. Definition of Precious Gems
1. Units of Instruction
   a. enumeration of species and varieties
   b. enumeration of synthetics, imitations and assembled stones
   c. hardness and toughness of gem materials
   d. committ *Mohs Scale* to memory - page 9, Liddicoat

2. Reading Assignments
   a. assignment material *B*
   b. *Gemformation*, pages 2 through 4
   c. Liddicoat, pages 7 through 12, "Imitation" pages 154-159

3. Projects
   a. confirmation of hardness and toughness by testing
      date assigned____ date completed____ time rate____ grade____ initial____
   b. confirmation of reading assignments listed in *A*
      date assigned____ date completed____ time rate____ grade____ initial____

C. Formation of Gems
   1. Units of Instruction
      a. the atom
      b. unit cell
      c. crystalline and amorphous materials
      d. the seven crystal systems and crystal axes
      e. crystalline aggregates and cryptocrystalline materials

   2. Reading Assignments
      a. assignment material "Atom and Unit Cell"
      b. to be assigned
      c. reference library *Dana's Minerology* pages 5 through 7

   3. Projects
      a. confirmation of crystal systems of sample crystals submitted
         date assigned____date completed____time rate____grade____initial____
      b. determination of cryptocrystalline versus amorphous
         date assigned____date completed____time rate____grade____initial____
      c. confirm Mohs scale of hardness
         date assigned____date completed____time rate____grade____initial____

D. Behavior of Light
   1. Units of Instruction
      a. reflection of light
      b. refraction of light
      c. polarization of light
      d. double refraction and birefringence
      e. optic axes
      f. total internal reflection-the critical angle

   2. Reading Assignments
      a. *Gemformation* pages 19 through 32
      b. Liddicoat pages 23 through 25 and 36 through 51
      c. assignment material pages to be assigned

   3. Projects
      a. confirmation of reading assignments
         date assigned____date completed____time rate____grade____initial____
      b. confirmation of reflection, refraction and the critical angle
         date assigned____date completed____time rate____grade____initial____

E. Behavior of Light-II
   1. Units of Instruction
      a. color
      b. cause of color in gem stones
      c. allochromatic and idiochromatic gems
      d. dispersion of light
      e. phenomena--chatoyancy, asterism, change of color, play of color, adularescence, aventurescence
      f. luster

2. Reading Assignments
   a. assignment material "Color"
   b. *Gemformation* pages 19 through 20
   c. reference library - Krause and Slawson, pages 41 through 48

3. Projects
   a. demonstrate dispersion with prism, play of color with drop of oil on water, chatoyancy with parallel asterations on curved survace
   date assigned____date completed____time rate____grade____initial____
   b. confirmation of reading assignments *D*
   date assigned____date completed____time rate____grade____initial____
   c. confirmation of use of Kuehn color system, grade for color specimen submitted
   date assigned____date completed____time rate____grade____initial____

F. Magnification
1. Units of Instruction
   a. proper use of 10X loupe
   b. illumination of stone being observed
   c. detection and evaluation of inclusions
   d. estimation of hardness-toughness
   e. observation of polish-luster
   f. use and care of microscope
   g. use of 10X,30X, higher magnification power
   h. use of types of inclusions in identification of gem materials

2. Reading Assignments
   a. *Gemformation* chapter on "Magnification", pages 33 through 38
   b. assignment "Magnification"
   c. Liddicoat's, *Gem Identification* photographs on pages 84 through 111

3. Projects
   a. examine five specimen under magnification, determine which are genuine, synthetic, imitation, or assembled
   date assigned____date completed____time rate____grade____initial____
   b. confirm reading assignments *E*
   date assigned____date completed____time rate____grade____initial____

G. Polariscope
1. Units of Instruction
   a. description of instrument
   b. determination of single and double refraction
   c. anomalous double refraction in some singly refractive materials
   d. single refraction in doubly refractive materials in directions parallel to optic axes
   e. determination of single refraction or double refraction in cryptocrystalline materials
   f. determination and interpretation of interference figures

2. Reading Assignments
   a. assignment material, "Polariscope"; Section G
   b. *Gemformation* chapter on "Polariscope" page 27 through 29
   c. Liddicoat pages 63 through 65
      (special attention should be paid to diagrams of interference figures)

3. Projects
   a. confirm single refraction, double refraction, anomalous double refraction of five specimen
      date assigned____date completed____time rate____grade____initial____
   b. disclose and interpret interference figure in two fashioned gems
      date assigned____date completed____time rate____grade____initial____

H. Refractometer
1. Units of Instruction
   a. Identification of instrument, description of optical system
   b. demonstration of use to find refractive indices
   c. monochromatic light
   d. determination of birefringence
   e. optic character of minerals-negative or positive
   f. determination of estimated refractive index by immersion

2. Reading Assignments
   a. assignment material "Refractometer" -- "Immersion"
   b. *Gemformation* Chapter on "Refractive Index", pages 20 through 26
   c. Liddicoat pages 23 through 48

3. Projects
   a. determine refractive indices of five specimen-degree of birefringence of double refractive stones
      date assigned____date completed____time rate____grade____initial____
   b. estimation of refractive indices of five stones by immersion method
      date assigned____date completed____time rate____grade____initial____
   c. identification of five gem materials making use of magnification, specific gravity test, polariscope and refractometer, making note of findings of each test
      date assigned____date completed____time rate____grade____initial____

I. Specific Gravity
1. Units of Instruction
   a. definition
   b. determination of specific gravity by hydrostatic method
   c. determination of specific gravity by heavy liquids
   d. chemistry of heavy liquids
   e. maintenance of heavy liquids
   f. tables of specific gravity of gem materials
   g. use of specific gravity in identification of gem materials

2. Reading Assignments
   a. *Gemformation* chapter on "Specific Gravity" pages 39 through 43
   b. Liddicoat pages 13 through 22

3. Projects
   a. determination of specific gravity of five specimen
      date assigned____date completed____time rate____grade____initial____
   b. confirmation of hydrostatic method of determination of specific gravity
      date assigned____date completed____time rate____grade____initial____

J. Dichroscope-Color Filter
1. Units of Instruction
   a. pleochroism-dichroism and trichroism
   b. description of dichroscope
   c. use of dichroscope to discover pleochroic colors
   d. use of tables (Krause and Slawson-page 255) as an aid to identification
   e. emerald-or chelsea filter-demonstration of use

2. Reading Assignments
   a. Liddicoat pages 56 through 58
   b. Liddicoat page 112 through 114
   c. to be assigned

3. Projects
   a. confirm pleochroism of five doubly refractive specimen
      Note colors observed [identify as many as possible on basis of pleochroism]
      make use of chart . Liddicoat's book page 414 through 415
      date assigned____date completed____time rate____grade____initial____
   b. confirm identity of same five stones by application of any or all preceding test
      date assigned____date completed____time rate____grade____initial____

K. Fluorescence and Phosphorescence
1. Units of Instruction
   a. demonstrate ultraviolet lamp
   b. define flourescence and phosphorescence
   c. use of ultraviolet light in detection of some synthetic materials, doublets, etc.

2. Reading Assignments
   a. Liddicoat page 114 through page 117
   b. to be assigned

3. Projects
   a. test five specimen under long wave and short wave ultraviolet light, confirm results
      date assigned____date completed____time rate____grade____initial____
   b. confirm identities of same five stones by suitable test
      date assigned____date completed____time rate____grade____initial____

L. Spectrascope
1. Units of Instruction
   a. description of instrument, types and optical systems
   b. proper illumination
   c. use of instrument
      (1) identification of certain materials

(2) detection of treated diamonds
(3) detection of dyed jadeite
d. illustration of typical spectra

2. Reading Assignments
a. refrence library, "Webster" and "Anderson" pages to be assigned
b. Liddicoat pagec 176 through 207
c. to be assigned

3. Projects
a. confirm spectra of ruby (synthetic or genuine) and almadite garr
date assigned____date completed____time rate____grade____ini ___
b. confirm spectra of treated jade, untreated
date assigned____date completed____time rate____grade____initial_____
c. identify one specimen with spectrascope, make sketch of spectrum found and reasons for conclusion
date assigned____date completed____time rate____grade____initial_____

M. Supplementary Tests
1. Units of Instruction
a. identification and use of "hot-points"
b. use of acids to identify some materials, "streak" test
c. lectrical proper ies of some gem stones, frictional electricity, pyro-electricity, piezoelectricity
d. compare heat conduction of crystal-glass

2. Reading Assignments
a. Liddicoat pages 212 through 214
d. reference library "Krause and Slawson" pages 46 through 51

3. Projects
a. compare frictional electricity of amber and topaz or tourmaline, confirm results
date assigned____date completed____time rate____grade____initials_____
b. onfirm use of all testing instruments and methods of gem identification
date assigned____date completed____time rate____grade____initials_____

T E N D A Y P R O J E C T E D G U I D E L I N E

II. Advanced Gemology

Species and Varieties of Gem Materials. Approximately 70 hours

A. Outline of elements of each presentation
1. Units of Instruction
a. specie and varieties
(1) chemical composition
(2) physical properties
(3) optical properties

b. occurance
   (1) crystal habit
   (2) how formed-in what environment
   (3) principle sources
   (4) mining methods
c. cutting
   (1) suitable styles of fashioning
   (2) lapidary techniques
d. identification- enumeration of materials with which each variety may be confused, methods of identification
e. graduation of qualities
   (1) appraisal
f. history, lore and superstitions
g. sales presentation
   (1) recommended uses in jewelry
   (2) methods of display
   (3) promotion
   (4) social significance
h. cautions to setter, jeweler, customer, on hardness-fragility

2. Reading Assignments
   a. *Gemformation* pages 87 to 90
   b. Krause and Slawson pages 143 through 145
   c. to be assigned

3. Projects
   a. confirmation of assignment *B*, Division *1*
      date assigned____date completed____time rate____grade____initial____
   b. confirmation of assignment *E*, Division *1*
      date assigned____date completed____time rate____grade____initial____

B. Corundum
1. Units of Instruction
   a. presentation of elements outlined in *A*
   b. laboratory
      (1) methods of identification
      (2) identification of possible substitutes

2. Reading Assignments
   a. Liddicoat pages 232 through 233
   b. to be assigned
   c. *Gemformation* - Corundum, pages 97 through 100

3. Projects
   a. confirmation of specifics of corundum
      date assigned____date completed____time rate____grade____initial____
   b. identification of five specimen to include genuine and substitute materials
      date assigned____date completed____time rate____grade____initial____
   c. grade and appraise one specimen
      date assigned____date completed____time rate____grade____initial____

C. Chrysoberyl
1. Units of Instruction
   a. presentation of elements outlined in *A*

b. Laboratory
   (1) methods of identification
   (2) identification of possible substitutes

2. Reading Assignments
   a. Liddicoat, bottom page 229 through 230
   b. to be assigned

3. Projects
   a. identification of five specimen to include genuine and substitute materials
      date assigned____date completed____time rate____grade____initial____
   b. confirmation of specifics of crysoberyl
      date assigned____date completed____time rate____grade____initial____
   c. grade and appraise one specimen
      date assigned____date completed____time rate____grade____initial____

D. Beryl
1. Units of Instruction
   a. presentation of elements outlined in *A*
   b. laboratory
      (1) methods of identification
      (2) identification of possible substitutes

2. Reading Assignments
   a. Liddicoat pages 226 to top of page 228
   b. *Gemformation*, "Chrysoberyl" pages 96 through 97
   c. to be assigned

3. Projects
   a. confirmation of specifics of beryl
      date assigned____date completed____time rate____grade____initial____
   b. identification of five specime
      date assigned____date completed____time rate____grade____initial____
   c. grade and appraise one specimen
      date assigned ____date completed____time rate____grade____initial____

E. Tourmaline
1. Units of Instruction
   a. presentation of el [illegible] outlined in *A*
   b. laboratory
      (1) methods of identification
      (2) identification of substitutes

2. Reading Assignments
   a. Liddicoat pages 270 and 271
   b. *Gemformation*, "Tourmaline" pages 118 and 119
   c. To be assigned

3. Projects
   a. confirm specifics of tourmaline
      date assigned____date completed____time rate____grade____initial____
   b. identification of five specimen
      date assigned____date completed____time rate____grade____initial____

c. grade and appraise one specimen
date assigned____date completed____time rate____grade____initial____

F. The Garnet Group; Almandite, Rhodolite, Pyrope, Andridite, and Grossularite

1. Units of Instruction
   a. chemistry of group
   b. chemistry of each specie
   c. presentation of elements outlined in *A* for each specie
   d. laboratory
      (1) methods of identificaiton
      (2) identification of substitutes

2. Reading Assignments
   a. Liddicoat pages 242 through 245
   b. to be assigned
   c. *Gemformation* pages 103 and 104

3. Projects
   a. confirmation of specifics of each specie of garnet
      date assigned____date completed____time rate____grade____initial____
   b. identification of eight specimen
      date assigned____date completed____time rate____grade____initial____
   c. grade and appraise one specimen
      date assigned____date completed____time rate____grade____initial____

G. Quartz

1. Units of Instruction
   a. presentation of elements outlined in *A*
   b. laboratory
      (1) methods of identification
      (2) identification of substitutes

2. Reading Assignments
   a. Liddicoat pages 258 to 259
   b. to be assigned
   c. *Gemformation* pages 111 to 113

3. Projects
   a. confirmation of specifics of quartz
      date assigned____date completed____time rate____grade____initial____
   b. identification of five species
      date assigned____date completed____time rate____grade____initial____
   c. grade and appraise one amethyst and one citrine
      date assigned____date completed____time rate____grade____initial____

H. Quartz (Cryptocrystalline) Chalcedony, Jasper

1. Units of Instruction
   a. presentation of elements outlined in *A*
   b. laboratory
      (1) methods of identification
      (2) identification of substitutes

2. Reading Assignments
   a. Liddicoat, bottom page 259 through 261
   b. to be assigned
   c. *Gemformation* pages 114 and 115

3. Projects
   a. confirmation of specifics of chalcedony
      date assigned____ date completed____ time rate____ grade____ initial____
   b. identification of five specimen
      date assigned____ date completed____ time rate____ grade____ initial____
   c. grade and appraise three specimen
      date assigned____ date completed____ time rate____ grade____ initial____

I. Peridot
1. Units of Instruction
   a. presentation of elements outlined in *A*
   b. laboratory
      (1) methods of identification
      (2) identification of substitutes

2. Reading Assignments
   a. Liddicoat page 256
   b. to be assigned
   c. *Gemformation* page 111

3. Projects
   a. confirmation of specifics of peridot
      date assigned____ date completed____ time rate____ grade____ initial____
   b. identification of three specimen
      date assigned____ date completed____ time rate____ grade____ initial____
   c. grade and appraise one specimen
      date assigned____ date completed____ time rate____ grade____ initial____

J. Jadeite-Nephrite
1. Units of Instruction
   a. presentation of elements for each specie as in *A*
   b. laboratory
      (1) methods of identification
      (2) identification of substitutes

2. Reading Assignments
   a. Liddicoat pages 247 through 249
   b. to be assigned
   c. *Gemformation* pages 105 through 106

3. Projects
   a. confirmation of specifics of both species
      date assigned____ date completed____ time rate____ grade____ initial____
   b. identify five specimen
      date assigned____ date completed____ time rate____ grade____ initial____
   c. grade and appraise two specimen
      date assigned____ date completed____ time rate____ grade____ initial____

K. Spodumene
1. Units of Instruction
   a. presentation of elements listed in *A*
   b. laboratory
      (1) methods of identification
      (2) identification of substitutes

2. Reading Assignments
   a. Liddicoat page 267
   b. to be assigned
   c. *Gemformation* page 116

3. Projects
   a. confirm specifics of spodumene
      date assigned____date completed____time rate____grade____initial____
   b. identification of two specimen
      date assigned____date completed____time rate____grade____initial____
   c. grade and appraise one specimen
      date assigned____date completed____time rate____grade____initial____

L. Feldspar Group
1. Units of Instruction
   a. presentation of elements listed in *A* for each specie
   b. laboratory
      (1) methods of identification
      (2) identification of substitutes

2. Reading Assignments
   a. Liddicoat pages 240 through 242
   b. to be assigned
   c. *Gemformation* page 102

3. Projects
   a. confirmation of specifics of feldspar species
      date assigned____date completed____time rate____grade____initial____
   b. identification of two specimen
      date assigned____date completed____time rate____grade____initial____
   c. grade and appraise one specimen
      date assigned____date completed____time rate____grade____initial____

M. Zoisite (Tanzanite)
1. Units of Instruction
   a. presentation of elements as listed in *A*
   b. laboratory
      (1) methods of identification
      (2) identification of substitutes

2. Reading Assignments
   a. Liddicoat pages 275 through 276
   b. to be assigned

3. Projects
   a. confirmation of specifics of Zoisite
      date assigned____date completed____time rate____grade____initial____
   b. identification of two specimen
      date assigned____date completed____time rate____grade____initial____

N. Turquoise
   1. Units of Instruction
      a. presentation of elements listed in *A*
      b. laboratory
         (1) methods of identification
         (2) identification of substitutes

   2. Reading Assignments
      a. Krause and Slawson pages 201 through 202
      b. reference library - to be assigned
      c. *Gemformation* pages 119 and 120

   3. Projects
      a. confirmation of specifics of turquoise
         date assigned____date completed____time rate____grade____initial____
      b. identify five specimen
         date assigned____date completed____time rate____grade____initial____
      c. grade and appraise two specimen
         date assigned____date completed____time rate____grade____initial____

O. Opal
   1. Units of Instruction
      a. presentation of elements listed in *A*
      b. laboratory
         (1) methods of identification
         (2) detection of treated opal, synthetic opal

   2. Reading Assignments
      a. *Gemformation* pages 106 through 110
      b. Liddicoat pages 254 through 255
      c. to be assigned

   3. Projects
      a. confirmation of specifics of opal
         date assigned____date completed____time rate____grade____initial____
      b. confirmation of varieties of five specimen of opal
         date assigned____date completed____time rate____grade____initial____
      c. grade and appraise two specimen of opal
         date assigned____date completed____time rate____grade____initial____

P. Lapis Lazuli
   1. Units of Instruction
      a. confirmation of elements listed in *A*
      b. laboratory
         (1) methods of identification
         (2) detection and identification of substitutes

   2. Reading Assignments
      a. Liddicoat page 251
      b. to be assigned
      c. reference library, Krause and Slawson page 243

   3. Projects
      a. confirmation of specifics of lapis lazuli
         date assigned____date completed____time rate____grade____initial____
      b. identification of three specimen
         date assigned____date completed____time rate____grade____initial____

ORGANIC GEMS
PEARL, CORAL, AMBER, JET, IVORY, AND TORTOISE SHELL

Q. Pearl-Natural, Cultured, Imitation
   1. Units of Instruction
      a. occurence of natural pearl
         (1) salt water
         (2) fresh water
      b. production of cultured pearl
         (1) salt water
         (2) fresh water
      c. imitation pearl
      d. methods of determination
      e. graduation of qualities
      f. sales presentation
         (1) use in jewelry
         (2) methods of display
         (3) promotion
         (4) social significance

   2. Reading Assignments
      a. Liddicoat pages 160 through 175
      b. to be assigned

   3. Projects
      a. confirmation of specifics of pearl, cultured pearl-salt and fresh water [diagrams of cross-section of each]
         date assigned____date completed____time rate____grade____initial_____
      b. determination of five specimen
         date assigned____date completed____time rate____grade____initial_____
      c. examine a piece of pearl jewelry, determine nature of pearls set therein [appraise]
         date assigned____date completed____time rate____grade____initial_____

R. Coral, Amber, Jet
   1. Units of Instruction
      a. specifics of coral
      b. origin-substance
      c. specifics of amber
      d. origin-substitutes
      e. specifics of jet, ivory, and tortoise shell
      f. origin of each-substitutes

   2. Reading Assignments
      a. reference library, Krause and Slawson, pages 276 through 281, 275 through 283
      b. to be assigned
      c. Liddicoat pages 223, 231, and bottom of page 249

   3. Projects
      a. confirmation of specifics and origin of coral, amber, and jet [substitutes and their detection]
         date assigned____date completed____time rate____grade____initial_____
      b. identify five specimen
         date assigned____date completed____time rate____grade____initial_____

ONE AND ONE-HALF MONTH GUIDE LINE

S. Synthetic Gem Stones
1. Units of Instruction
   a. methods of synthesis
      (1) flame fusion
      (2) flux melt
      (3) hydrothermal
   b. sythetics used in jewelry
      (1) corundum
      (2) spinel
      (3) emerald
      (4) Y.A.G., G.G.G.
      (5) rutile
      (6) strontium titanate
      (7) opal, turquoise, quartz
   c. methods of identification

2. Reading Assignments
   a. Liddicoat pages 118 through 148
   b. to be assigned

3. Projects
   a. identify three specimen of synthetic materials and indicate the method of creation
      date assigned____ date completed____ time rate ____grade____ initial____
   b. confirm meanings of "*synthetic*" and "*imitation*"
      date assigned____ date completed____ time rate____ grade____ initial____

T. Imitation and Assembled Stones
1. Units of Instruction
   a. types of assembled stones
   b. methods of detection and identification
   c. imitation stones
      (1) glass
      (2) plastic
      (3) synthetic materials or treated genuine stones
   d. identification of imitations

2. Reading Assignments
   a. Liddicoat pages 149 through 175
   b. to be assigned
   c. *Gemformation* pages 14, 74, and 80 through 83

3. Projects
   a. identify materials and types of five specimen of imitation stones
      date assigned____ date completed____ time rate____ grade____ initial____
   b. report on ethics, advantages, and disadvantages of stocking and selling; (1) synthetics, and (2) imitation gem stones
      date assigned____ date completed____ time rate____ grade____ initial____

III. Diamond-Approximately 50 hours

A. Occurence of Diamond
   1. Units of Instruction
      a. varieties
      b. chemical, physical and optical properties
      c. crystalline habits
      d. geology of the diamond

   2. Reading Assignments
      a. Liddicoat pages 234 through 238
      b. assignment material
      c. *Gemformation* page 61

   3. Projects
      a. confirm specifics of the diamond
         date assigned____date completed____time rate____grade____initial____
      b. estimate refractive indices by immersion of diamond and two substitutes
         date assigned____date completed____time rate____grade____initial____
      c. determine comparative specific gravities of diamond, Y.A.G., synthetic spinel, strontium titinate
         date assigned____date completed____time rate____grade____initial____

B. Mining and Marketing Rough Diamonds
   1. Units of Instruction
      a. recovery and mining methods
      b. sources
      c. marketing of rough diamonds

   2. Reading Assignments
      a. reference library, Krause and Slawson, pages 181 through 199
      b. assignment material
      c. to be assigned

   3. Projects
      a. confirmation of mining methods and sources
         date assigned____date completed____time rate____grade____initial____
      b. confirmation of marketing methods
         date assigned____date completed____time rate____grade____initial____

C. Cutting of Diamonds
   1. Units of Instruction
      a. planning
      b. cleaving-sawing
      c. bruting-shaping
      d. blocking
      e. brillianteering-polishing
      f. styles of cutting

   2. Reading Assignments
      a. reference library, Krause and Slawson, pages 109 through 127
      b. to be assigned
      c. *Gemformation* pages 62 through 70

3. Projects
   a. draw crown and pavillion of brilliant [name facets]
      draw emerald-cut, marquise, single-cut, oval pear-shape
      date assigned____date completed____time rate____grade____initial____
   b. confirm steps of cutting diamond
      date assigned____date completed____time rate____grade____initial____

D. Cutting Grades-Proportions
1. Units of Instruction
   a. grading chart
   b. grading for make
      (1) proportions
      (2) finish
   c. degree of beauty as a result of make
   d. effect of make grade on beauty-value

2. Reading Assignments
   a. *Gemformation* pages 64 and 65
   b. reference library Krause and Slawson pages 108 through 115, and 124
   c. to be assigned

3. Projects
   a. measure and evaluate proportions of two diamonds
      date assigned____date completed____time rate____grade____initial____
   b. confirm importance of make on beauty-value of diamond
      date assigned____date completed____time rate____grade____initial____

E. Grading for Clarity-Flaws, Internal and External
1. Units of Instruction
   a. nomenclature of clarity grades
   b. types of inclusions
   c. types of external flaws
      (1) plotting of flaws
      (2) internal and external
   d. effect of clarity-imperfection grade on beauty-value

2. Reading Assignments
   a. reference library, Krause and Slawson, pages 125 and 126
   b. to be assigned
   c. *Gemformation* pages 71 through 73

3. Projects
   a. grade two diamonds for clarity grade [plot imperfections]
      date assigned____date completed____time rate____grade____initial____
   b. confirm symbols used to indicate imperfections, internal and external
      [comment on effect on beauty and value]
      date assigned____date completed____time rate____grade____initial____

F. Grading for Color
1. Units of Instruction
   a. nomenclature of color grades
   b. process of color grading diamonds
   c. florescence of some diamonds-effect on color grade
   d. effect of color grade on beauty of diamond
   e. effect of color grade on vlaue of diamond

2. Reading Assignments
   a. *Gemformation* pages 72 and 73
   b. reference library, Kráuse and Slawson, page 124
   c. to be assigned

3. Projects
   a. grade for color two diamonds [demonstrate flurrescence in some diamonds]
      grade one fluorescent diamond for color
      date assigned____date completed____time rate____grade____initial____
   b. confirm relative importance of grade of cut, grade of clarity and grade
      color on beauty, value
      date assigned____date completed____time rate____grade____initial____
   c. confirm methods of presentation of each of these gradations to the
      prospective buyer
      date assigned____date completed____time rate____grade____initial____

G. Fancy Colors of Diamonds
   1. Units of Instruction
      a. natural colors of diamonds
      b. treated diamonds
      c. fraudulent enhancement of color
      d. appraisal of fancy colored diamond-natural-treated

   2. Reading assignments
      a. *Gemformation* pages 77 through 79
      b. Liddicoat pages 234 through 238

   3. Projects
      a. confirm ability to distinguish natural color from color as a result of
         treatment
         date assigned____date completed____time rate____grade____initial____

H. Marketing of Diamonds
   1. Units of Instruction-Selection and Buying of Diamonds
      a. sources
         (1) cutter
         (2) broker-importer
         (3) wholesaler
         (4) estates-distress merchandise
      b. merchandising
         (1) pricing policy
         (2) display
         (3) advertising
         (4) presentation to prospective buyer
      c. diamonds as an investment

   2. Reading Assignment
      a. assignment material
      b. *Gemformation* pages 100 and 101
      c. to be assigned

3. Projects
   a. confirm advantages-disadvantages of buying from each of the sources discussed
      date assigned____date completed____time rate____grade____initial____
   b. grade for quality one diamond [state price that should be paid-price at retail and state factors to be used in sales presentation
      date assigned____date completed____time rate____grade____initial____

** TWO MONTH GUIDE LINE**

IV. Species and Varieties of Infrequently Encountered Gem Materials-Approximately 25 hours

A. Andalusite, Apatite, Azurite, Benitotite
   1. Units of Instruction
      a. specifics of each specie-varieties
      b. occurrence and crystal habits
      c. phenomenon [if present]-cutting styles
      d. identification methods

   2. Reading Assignments
      a. Liddicoat pages 225 through 226
      b. to be assigned

   3. Projects
      a. confirm specifics of each specie
         date assigned____date completed____time rate____grade____initial____
      b. identify three specimen assigned
         date assigned____date completed____time rate____grade____initial____

B. Calcite, Cassiterite, Iolite, Danburite, Diopside
   1. Units of Instruction
      a. specifics of each specie
      b. occurrence and crystal habits
      c. phenomenon-cutting styles
      d. identification methods

   2. Reading Assignments
      a. Liddicoat pages 228,229,233 and 238
      b. to be assigned

   3. Projects
      a. confirm specifics of each specie
         date assigned____date completed____time rate____grade____initial____
      b. identify three specimen as assigned
         date assigned____date completed____time rate____grade____initial____

C. Enstatite, Hematite, Idocrase, Kornerupine, Malachite
   1. Units of Instruction

a. specifics of each specie
b. occurrence and crystal habits
c. phenomenon-cutting styles
d. identification methods

2. Reading Assignments
a. Liddicoat pages 239,246,247,250 and 251
b. to be assigned

3. Projects
a. confirm specifics of each specie
date assigned____date completed____time rate____grade____initial____
b. identify three specimen to be assigned
date assigned____date completed____time rate____grade____initial____

D. Obsidian, Phenakite, Pyrite, Rhodochosite, Rhodonite, Sphene
1. Units of Instruction
a. specifics of each specie
b. occurrence and crystal havits
c. phenomenon-cutting styles
d. identification methods

2. Reading Assignments
a. Liddicoat pages 253,257,262 and 266
b. to be assigned

3. Projects
a. confirmation of specifics of each specie
date assigned____date completed____time rate____grade____initial____
b identify three specimen to be assigned
date assigned____date completed____time rate____grade____initial____

E. Scapolite, Smithsonite, Sodalite, Steatite, Varisite
1. Units of Instruction
a. specifics of each specie
b. occurrence and crystal habits
c. pehnomenon-cutting styles
d. methods of identification

2. Reading Assignments
a. Liddicoat pages 263,265, and 272
b. to be assigned

3. Projects
a. confirm specifics of each specie
date assigned____date completed____time rate____grade____initial____
b. identify three specimen to be assigned
date assigned____date completed____time rate____grade____initial____

V. Identification-Evaluation of Gem Materials-Approximately 120 hours

A. Identify Groups of Stones as Assigned

1. Units of Instruction
   a. review process of identification
   b. review process of establishment of value

2. Reading Assignments
   a. Liddicoat pages 277 through 405
   b. property tables
      (1) those presented in assignment material
      (2) *Gemformation* - Simplified Tables
      (3) Liddicoat pages 408 through 421

3. Projects
   a. identify stones in group #1 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   b. identify stones in group #2 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   c. identify stones in group #3 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   d. identify stones in group #4 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   e. identify stones in group #5 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   f. identify stones in group #6 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   g. identify stones in group #7 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   h. identify stones in group #8 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   i. identify stones in group #9 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   j. identify stones in group #10 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   k. identify stones in group #11 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   l. identify stones in group #12 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   m. identify stones in group #13 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   n. identify stones in group #14 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   o. identify stones in group #15 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   p. identify stones in group #16 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   q. identify stones in group #17 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   r. identify stones in group #18 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   s. identify stones in group #19 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____
   t. identify stones in group #20 [determine approximate value]
      date assigned____ date completed____ time rate____ grade____ initial____

VI. Merchandising of Precious Gems

A. Promotion, Display of Precious Gems; Record Keeping

1. Units of Instruction
    a. methods of display of unmounted precious gems
    b. methods of display of mounted gems
    c. departmental allocation of colored gems
    d. record keeping
        (1) gems in inventory
        (2) gems available on memorandum
        (3) records of customers former purchases, lists of "gift-giving" dates, special interests

2. Reading Assignments
    a. *Gemformation* to be assigned
    b. to be assigned

3. Projects
    a. confirmation of attitude concerning allocation of colored gems to #1 gem department
       date assigned____date completed____time rate____grade____initial____
    b. arrange a display of five gems [receive comment from other members of class]
       date assigned____date completed____time rate____grade____initial____

B. Advertising Precious Gems

1. Units of Instruction
    a. value of "Special Exhibits"-events
    b. lecturing-where and when-value of lectures
    c. "In Store" parties
    d. publicity in press, radio and television (How to inspire such coverage)
    e. advertising
        (1) newspapers
        (2) programs and other one-time publications
        (3) radio-television
        (4) magazines
        (5) telephone book yellow pages

2. Reading Assignments
    a. to be assigned

3. Projects
    a. write copy for an advertisement for gems (to be assigned) for newspaper, for yellow pages
       date assigned____date completed____time rate____grade____initial____

C. In-Store Selling of Gem Stones

1. Units of Instruction
    a. avoid "technical lecture"
        (1) stress beauty
        (2) social significance of gem being offered
        (3) suitability for occasion
        (4) cosmetic value of colored gems, pearls, etc.

b. affordability
c. best of its kind [a beautiful specimen of a less expensive specie rather than a poorer grade of a more expensive specie]
d. training other sales people
   (1) employees
   (2) co-workers
   (3) regularly scheduled training meetings

2. Reading Assignments
   a. to be assigned
   b. review specifics of each specie--assignment materi... (Prepare for exam)

3. Projects
   a. prepare a presentation on assigned related subject [to be performed before class] Disertation to be 15 minutes in length, suitable for presentation before Women's Club, Service Club, etc. [Grade will be part of final exam.]
   date assigned____date completed____time rate____grade____initial____
   b. Post Test
      (1) WRITTEN EXAMINATION COVERING MATERIAL CONTAINED IN COURSE
      time assigned____time completed____time rate____grade____initial____
      (2) LABORATORY WORK-CORRECT IDENTIFICATION OF 20 GEM STONES
      time assigned____time completed____time rate____grade____initial____

APPENDIX E

Gemstone Chart

STONE	HARDNESS AND TOUGHNESS	REACTION TO SETTING	REACTION TO POLISHING	REACTION TO SIZING AND REPAIRS WHICH REQUIRE TORCH	REACTION TO BOILING	REACTION TO STEAMING	REACTION TO ULTRASONIC	REACTION TO ACIDS PICKLING AND PLATING	COMMENTS.
DIAMOND	H. 10 T. good	very good	excellent	good	excellent	excellent	excellent	excellent	
RUBY AND SAPPHIRE (Corundum)	H. 9 T. very good	very good	excellent	Ruby good; Sapphires may lose color when heated	good	good	good	good	Watch for oiled stones. Do not heat
CATSEYE AND ALEXANDRITE (Chrysoberyl)	H. 8½ T. very good	very good	excellent	good-fair; remove if repairs are made near stone	good	good	good	good	
SPINEL	H. 8 T. good-fair	Very good-fair	very good	good-fair; remove if repairs are made near stone	good-fair	good	good	good	
PRECIOUS TOPAZ	H. 8 T. poor	fair-poor; take care stone cleaves easily	good	poor; stone may crack or lose color	poor	poor	fair	good	Any heating may discolor or crack stone
EMERALD (beryl)	H. 7½-8 T. poor	poor; stones usually flawed and under strain	fair; do not apply heavy pressure	poor; stones should never be heated	poor; should be cleaned in lukewarm water only	poor	fair	poor; stones may crack or lose oil if solutions are too hot	Avoid all heat; Chatham and Gibson synthetics react the same as natural stones
AQUAMARINE (beryl)	H. 7½-8 T. good-fair	good-fair	good	poor; stone may change color with heat	fair-poor; avoid fast temperature changes	fair	fair	good	
TOURMALINE	H. 7-7½ T. good-fair	good-fair;	good	fair-poor	fair	fair	good	good-fair	May change color with heat during repairs
GARNET incl. RHODOLITE AND TSAVORITE	H. 6½-7½ T. good-fair	good-fair; flawed stones are under strain	good	fair-poor; play safe, remove expensive stones before repair	fair-poor	fair	good	fair-poor; acids may affect polish on stone	Sudden change of temperature will crack stone
RUTILE AND FABULITE (Synthetic)	H. 6½-7 T. poor-very poor	very poor; will take very little pressure	very poor; use very light pressure or set after polishing	very-poor; stones will crack with heat	poor; stone may crack	poor	fair-poor	fair	Reacts poorly under heat and pressure

STONE	HARDNESS AND TOUGHNESS	REACTION TO SETTING	REACTION TO POLISHING	REACTION TO SIZING AND REPAIRS WHICH REQUIRE TORCH	REACTION TO BOILING	REACTION TO STEAMING	REACTION TO ULTRASONIC	REACTION TO ACIDS PICKLING AND PLATING	COMMENTS
AMETHYST AND CITRINE (quartz)	H. 6½-7 T. good	good	good	fair; color may change with heat	fair	fair	good	good-fair	
PERIDOT	H. 6½-7 T. poor-very poor	poor; facet edges chip easily	poor	very poor; remove stone before repairs or sizing are made	poor; avoid extreme temperatures	fair-poor	fair	poor	Should not get much heat or pressure
TANZANITE (zoisite)	H. 6½ T. poor	poor	fair (avoid heavy pressure)	very poor; remove before repairs are made	poor	poor	poor	fair	Will not take much heat or pressure
JADEITE AND NEPHRITE (jade)	H. 6-7 T. Excel.	excellent	fair; tripoli may damage polish on stone. Use only rouge	poor, no repairs near stone	good; heat may dis-color dyed material	good	good	poor; acid will affect polish on stone	
KUNZITE AND HIDDENITE (spodumene)	H. 6-7 T. very poor	poor	fair	poor; stones will lose color	poor; may crack if boiled	poor	fair	fair	Heat may fade color
ZIRCON	H. 6-6½ T. poor	poor	fair	poor	poor	poor	fair	fair	Does not take heat well
MOONSTONE (feldspar)	H. 6-6½ T. fair-poor	good-fair	good-fair	poor	poor	fair	fair	fair-poor	
OPAL - Also doublets and triplets	H. 5½ - 6½ T. very poor	poor	poor (avoid heavy pressure	very poor; remove before repairs are made	poor; boiling will crack stone, triplets separate	poor	fair-poor triplets will separate	poor	Opals should be examined by shining a light through the stone to see if there are cracks. Do not process cracked stones.
HEMATITE	H. 5-6½ T. good-fair	good-fair	good-fair	poor	good	good	good	poor; acids attack stones	
TOURQUOISE	H. 5-6 T. good-poor	fair	fair	very poor; stone will explode with heat	poor; may lose color	fair	fair-poor	very poor; will dissolve in acids	Takes heat and pressure poorly, Color may fade in untreated stones.

STONE	HARDNESS AND TOUGHNESS	REACTION TO SETTING	REACTION TO POLISHING	REACTION TO SIZING AND REPAIRS WHICH REQUIRE TORCH	REACTION TO BOILING	REACTION TO STEAMING	REACTION TO ULTRASONIC	REACTION TO ACIDS PICKLING AND PLATING	COMMENTS
LAPIS LAZULI (lazurite)	H. 5-6 T. fair-poor	fair	fair-poor; tripoli will harm polish on stone	poor	fair-poor; some dyed stones will lose color	good	good-fair	poor; will change color. Acid will attack Pyrite and Calcite inclusions	Many lapis are dyed. Colors may change with heat or acids.
SHELL CAMEO	H. 3½ T. poor	poor; will crack with excess pressure	poor; polish jewelry lightly with very little pressure	cannot take heat of repair. Will show burn marks	Color will fade if boiled	fair-poor	poor will dissolve	very poor; will dissolve in acids	Cameos made of shell are very delicate and will not take much heat or pressure.
CORAL	H. 3-4 T. good-poor	good	poor; use rouge only	very poor; remove stone before repair	poor; may lose color	fair	poor	very poor; will dissolve in acids	Much coral is dyed and will be affected by heat.
PEARLS AND MOBES	H. 2½-4½ T. fair-poor	fair; mobes take pressure poorly	poor; will affect luster badly	poor; pearls will burn	poor; will lose color tint. Mobes separate	fair	poor	very poor; will dissolve in acids	Watch for spot in nacre which may be hollow underneath.
IVORY	H. 2½-3 T. fair	fair	fair-poor; use light pressure	poor; heat will cause stone to shrink	fair-poor; dyed pieces may lose color	good	fair	fair	Many imitations available, all react differently.
AMBER	H. 2-2½ T. poor	very poor; will scratch easily	poor	very poor; stone will melt or burn	very poor; do not boil	poor-fair	poor	very poor; will dissolve in acids	Many imitations will react the same

APPENDIX F

Training Progress Interview Report

PARIS JUNIOR COLLEGE
HOROLOGY, JEWELRY TECHNOLOGY AND GEMOLOGY DEPARTMENT

Training Progress Interview Report

Student ______________________________ Course ______________

Date Entered ______________________ Course Close out Date ______________

DATE	INITIAL	ATTITUDE	CRAFTSMANSHIP	PRODUCTION	MOTIVATION	ATTENDANCE		REMARKS
						TOTAL	EXCUSED	
						A	A	
						T	T	
						TOTAL	EXCUSED	
						A	A	
						T	T	
						TOTAL	EXCUSED	
						A	A	
						T	T	
						TOTAL	EXCUSED	
						A	A	
						T	T	
						TOTAL	EXCUSED	
						A	A	
						T	T	
						TOTAL	EXCUSED	
						A	A	
						T	T	
						TOTAL	EXCUSED	
						A	A	
						T	T	

* Instructor's Initials
** Rate--Good (G) - Fair (F) - Poor (P) From last interview date

APPENDIX G

Instructional Evaluation Forms

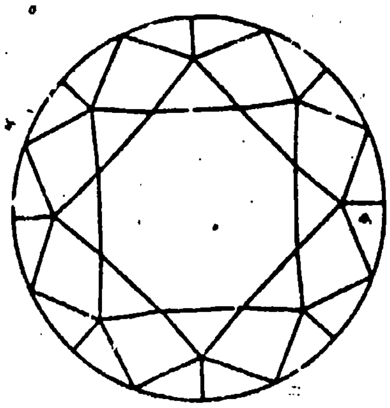
PARIS JUNIOR COLLEGE

Name ____________________

Stone Ident No. ____________

Depth ______ Diameter __________

Weight ____________________



Proportioning: % Deduction

Depth % (Dep ÷ Dia) ________ ______

Table Diameter % ________ ______

Girdle Thickness ________ ______

Finish:

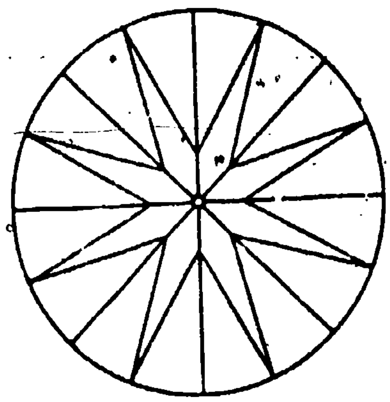
Girdle Surface ___

Symmetry ___

Culet ___

Polish ___ ______

Total % Deduction ______



Corrected Weight: Wt.x (100%-Deductions)

______

BASE PRICE (at Corrected weight)

______

Clarity ______ Color ________

% of value based on color and clarity grades ______

The per carat value (% value x base price) ______

STONE VALUE (Per carat value x corrected wt. ______

COMMENTS: __________

____

____

____

PARIS JUNIOR COLLEGE

STONE SET NUMBER ______

GEMOLOGY

NAME ______________________

STONE TESTING RESULTS

DATE ______________________

STONE NUMBER	DESCRIPTION	INCLUSIONS	POLAR-ISCOPE	R.I.	BIRE-FRINGENCE	S.G.	OTHER TESTS	SPECIE AND VARIETY

APPENDIX H

Newspaper and Magazine Clippings

Gemology Training Course Added To Paris College Program

MARCH, 1978

For a pilot research project in professional gemology, the Texas Education Agency has awarded a grant of $132,335 to Paris Texas College, announced Louis B. Williams, president of the college.

"We are extremely excited over this new program and over the fact that the Texas Education Agency and the State Board of Education have recognized the importance of this training for the national jewelry industry," Williams stated. "The program for training gemologists will give added dimension to the jewelry technology and horology program at the college."

Under the direction of Orlando Paddock, the first class started Jan. 9 with the maximum of 20 students enrolled. Assisting Paddock as an instructor is Malcolm D. Heuser, a 1973 graduate of the GIA.

The next class, to begin in September, is filled to capacity, and the third class, set for January of 1979, is filling fast. Classes will be scheduled on a continual basis, and inquiries may be made to Paul Clayton, chairman of the Division of Horology, Jewelry Technology and Gemology, Paris Texas College, Paris, Texas 75460.

The pilot project in vocational gemology will prepare graduates for accurate identification, grading, appraisal of gemstones, for use and care of laboratory instruments, for successful merchandising and ethical trade practices, and for craftsmanship in the execution of benchwork.

Jewelry industry representatives have estimated that fewer than one of 10 independent jewelers have sufficient gemological skills for the proper evaluation of gemstone quality, Paddock explained. Only one proprietary, scientifically oriented gemology certification program exists, and the national jewelry industry needs other sources for gemological training and development of a business-oriented curriculum in gem evaluation to facilitate intelligent buying and selling.

Dissemination of the results of the project will be conducted, and other institutions and organizations in the nation will have the benefit of this piloting research on which to base similar programs.

Paris Texas College gemology instructors, Orlando Paddock, (right), and Malcolm Heuser point out gem characteristics to Debbie and Scott Kinard, one of two married couples enrolled in the new pilot program at the college.

Modern Jeweler

APRIL, 1978
American Independent Jeweler

Swest Official Visits PTC

J.R. Newman of Dallas, right, general manager of Swest Inc., jewelry suppliers, recently visited the Paris Texas College campus to learn about the new gemology program.

Paul Clayton, left, chairman of the college's Division of Horology, Jewelry Technology and Gemology, shows Newman some of the stones used in the program.

Swest has donated sample stones to the college for the new program.

PJC gem class first in the nation

The Paris (Texas) News, Sunday, Jan. 29, 1978

$132,335 grant sets up pilot jewelry training project

Photographs
By ROB ROBERTSON
Paris News Staffer

A grant of $132,335 has enabled the Paris Junior College jewelry technology and horology program to expand into new training which, PJC President Louis B. Williams says, is a first in the nation.

The Texas Education Agency awarded the grant to the college for a pilot research project in professional gemology aimed at helping to fill demand for qualified jewelers.

JEWELRY industry representatives have estimated that fewer than one in 10 independent jewelers have enough gemological skills for proper evaluation of gemstone quality, Orlando S. Paddock, course directoı and nationally recognized authority in gemology, said.

"We are extremely excited over this new program and over the fact that the Texas Education Agency and the State Board of Education have recognized the importance of this training for the national jewelry industry," Williams said. "The program for training gemologists will give added dimension to the jewelry technology and horology program at the college."

THE PILOT project in vocational gemology will prepare graduates for accurate identification, grading and appraisal of gemstones, for use and care of laboratory instruments, for successful merchandising and ethical trade pratices and for craftsmanship in the execution of benchwork.

The first class started on Jan. 9 with the maximum of 20 students enrolled. Students in the program are from all over the United States. They include two married couples.

Assisting Paddock as an instructor is Malcom D. Heuser, a 1973 graduate of the Gemological Institute of America.

The next class, to begin in September, is filled to capacity. The third class, in January 1979, is filling fast. Classes will be scheduled on a continual basis. Inquiries may be made to Paul Clayton, chairman of the Division of Horology, Jewelry Technology and Gemology at PJC.

ONLY ONE scientifically oriented gemology certification program exists, PJC officials say, and the national jewelry industry needs other sources for gemological training and development of a business-oriented curriculum in gem evaluation. The program is aimed at producing intelligent buying and selling.

Results of the project will be available to other institutions and organizations so they will have the research on which to base similar programs.

IN THE course, each student has his own station, equipped with microscope, polariscope, refractometer and dichroscope. Students use the texts, "Gemformation," a primer of precious gems written by Paddock, and "Gem Identification" by Richard Liddicoat. Classes will be held for 13 weeks, six hours per day, five days per week, in the Applied Sciences Center on campus.

Paddock, director and instructor of the project, is a longtime member of the American Gem Society and a 1941 graduate of the Gemological Institute of America. He has more than 35 years experience in independent jewelry management with more than 20 years of that experience related to the precious gem departments of Tilden-Thurber Corp., Providence, R. I.; Mermod, Jaccard and King, St. Louis, Mo.; and Everts Jewelers, Dallas.

A monthly columnist for Independent Jeweler magazine, Paddock has taught gemology for the Dallas Health and Science Museum and for the Gemologist Institute of America tutorial groups. He has served as consultant to PJC in the development of the gemology short courses from which the pilot project evolved.

HEUSER, who will assist Paddock as instructor, attended PJC, the Colorado School of Mines, the University of California at Santa Barbara and Eastern New Mexico University, in addition to being a graduate in residence of the Gemological Institute of America.

A graduate of the Jewelry Technology Program at PJC, he returned to join the faculty in 1974.

Prior to that, he was co-owner of the Central Gemological Laboratory in Oklahoma City, Okla.

The Paris (Texas) News, Sunday, Jan. 29, 1978

Paris college trains craftsmen for retail jewelry industry

Paris, Texas, Junior College's programs of horology, jewelry technology and gemology, which have experienced continued growth since the instruction was established at the college in 1942, have attracted national attention in recent years. The college is cooperating with jewelry industry leaders in attempting to establish a national center for the training of retail jewelers.

"Because of a national shortage of qualified jewelers for the retail industry, Paris,Texas Junior College is committed to work with the retail jewelry industry in developing practical training concepts and providing trained personnel to meet the needs of the industry," Louis B. Williams, president of the college, explained in discussing the proposed center.

THE COMMITTEE for establishment of the National Professional Jewelers' Educational Center, Inc., composed of retail jewelers across America, expects to establish this center at the college in three to five years, Williams noted.

In the college's Division of Horology, Jewelry Technology and Gemology, certificate courses include watch repair, jewelry repair, stone setting and gemology. Students attend class for six hours daily from 8 a.m. to 2:45 p.m., and enrollment is on a quarterly basis in January, March, June and September.

Since the department began in 1942, directions of emphasis have changed, many instructional areas have been added, and much new equipment has been purchased to accommodate 160 full-time students. The program is the most diverse of any jewelry school in existence, and the most modern equipment is used for instruction. Because the college is a state-supported public institution, the cost of instruction is less than most other horology, jewelry, and gemology schools.

Although similar departments exist at other colleges in the United States, the division at Paris,Texas, Junior College has several objectives and services which make it unique. Because of these services for the retail jeweler, the lower cost and greater diversity, the program has established a reputation throughout the United States and many foreign countries.

In addition to career certificate programs, the college initiated an associate degree program in 1976 for horology and jewelry technology students who complete related business courses along with the required technical work. Students also are able to work toward a bachelor's degree in industrial technology by later completing two additional years in advanced management and marketing courses at the university level.

CERTIFICATE PROGRAMS

Jewelry Technology — This twelve-month program includes repair and fabrication of jewelry, stone setting, engraving, design and basic gem identification, small business management (jewelry store operation), and merchandising and salesmanship of jewelry.

Horology— Horology technology provides twelve months of training including the use of bench lathe, cleaning of watches, stafing, truing and poising of balance wheels, calculating strengths of hairsprings and mainsprings, adjusting escapement, using standard automatic and calendar movements, electric, electronic, tuning fork, and quartz analog movement repair, small business management, and merchandising and salesmanship of jewelry.

Gemology —Specialized training is provided on a semester basis in precious stone formation, recovery and cutting, identification by crystal system, species (special series on diamonds), operation care and use of laboratory instruments, grading, appraisal, and merchandising of precious gems.

THE ASSOCIATE degree program, which requires 12 months in addition to certificate programs, is encouraged for students but is optional. Enrollment for this program is held each September and January. The bachelor's degree includes junior and senior level work in management and marketing courses at colleges and universities offering the bachelor of technology degree.

COURSE COST

Monthly Tuition Charge (Same for out-of-state)	$50
Gemology	$75
Tools:	
Jewelry Repair, Stone Setting	$300.15
Watch Repair	$409.89

Tool payment may be made monthly without interest. The prices are approximate and subject to change.

SINCE THE institution maintains a six-to-nine-month waiting list for enrollment due to the popularity of the programs, prospective students are encouraged to complete pre-enrollment applications as far in advance of enrollment as possible.

For further information, prospective students should write to Paul Clayton, Chairman, Division of Horology, Jewelry Technology and Gemology, Paris, Texas, Junior College, Paris, Texas, 75460.