OPTICAL SALES AND DISPENSING

- A PRACTICAL GUIDE

Training in Eye Care Support Services Series

ARAVIND EYE CARE SYSTEM

The Training in Ophthalmic Assisting Series and Training in Eye Care Support Services Series were born from the vision and inspiration of one very special man, Dr. G. Venkataswamy, founder of Aravind Eye Hospitals and guiding light in the world of eye care and community ophthalmology.

We dedicate this effort to him.

Intelligence and capability are not enough. There must also be the joy of doing something beautiful. Being of service to God and humanity means going well beyond the sophistication of the best technology, to the humble demonstration of courtesy and compassion to each patient.

- Dr. G. Venkataswamy

Training in Eye Care Support Services Series (TECSS)

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First Edition

Foreword

The discipline of eye care requires a number of appropriately trained personnel working as a team to deliver comprehensive eye care. The services that are delivered must include the promotion of eye health, the preservation of sight and the prevention of vision loss, restoration of sight when it is lost, the enhancement of vision and functional vision, where feasible and facilitation of rehabilitation through vision substitution. Various cadres of trained personnel, with complementary skills contribute to the work of the team.

In an ideal world, with infinite resources there would be a temptation to use the most highly trained personnel to carry out these tasks. This is neither appropriate nor cost effective, given that human resources for health care comprise the most expensive component of the recurring health budget.

It has been possible to select, train and deploy different cadres of human resources, to carry out tasks in a safe and effective manner to help achieve the goal of eliminating avoidable blindness. One of such cadres is variously referred to as Ophthalmic Assistants, mid level personnel or by their primary functions, such as Nurses, Refractionists etc. Where they exist and function in a stipulated manner, it is acknowledged that they constitute an effective backbone for eye care services. However a critical element to their success lies in the adequacy and appropriateness of the training imparted to them.

There have been several training programmes put in place around the world to train such mid-level personnel depending on the one hand, on the human resource needs for eye care in the country, and the local human resource policies, rules and regulations, on the other.

The Aravind Eye Care System, over the years has developed a cadre of Ophthalmic Assistants who have specific job descriptions. To enable them to perform effectively as part of the eye care team, their training has been task oriented with defined requisite knowledge, skills, competencies and attitudes, to carry out the tasks.

This manual sets out in several sections a step by step method for imparting such task oriented training through didactic, hands on and practical training in real life situations. The sections relate to tasks required of such personnel in different settings in the eye care delivery system such as the out-patient department (general and specialist clinics), wards, operating rooms, optical departments etc. Considerable emphasis has been paid to diagnostic technology, which is increasingly a part of the armamentarium in eye care practice.

Finally the manuals include sections for self assessment as well as for continuing monitoring of the achievements of task oriented objectives. The manual lends itself to translation into local languages where required proficiency in English may not exist. The Human resource Development team at Aravind Eye Care System need to be complimented on their efforts to share there wide and successful experience in this field with others who are already involved in or are planning to venture into such training programmes, particularly in the context of VISION 2020: the Right to Sight.

Dr. Ramachandra Pararajasegaram MB., FRCS., FRCP., FRCOphth. DSc. (Hon)
Past President, IAPB, Co Chair,
Human Resource Programme Committee, IAPB

Preface

In recent years there have been significant advances in eye care, both in technology and in the increasing resolution to address the scourge of needless blindness. Achievements in medical technology have vastly improved diagnosis, treatment and surgery in all aspects of eye care, and efforts like the global initiative "VISION 2020: The Right to Sight" -- which calls for the elimination of avoidable blindness by the year 2020 -- have galvanized support for those working to improve the quality of eye care at the grassroots level around the world.

It has become increasingly evident that trained personnel is one of the most important elements in achieving this goal, and that the effective practice of eye care is a team effort that must combine the talents of ophthalmologists, ophthalmic assistants, ophthalmic technicians, orthoptists, counsellors, medical record technicians, maintenance technicians, and others.

Currently the focus in human resource development continues to be on the training of ophthalmologists. But in many successful eye hospitals it has been shown that four or five trained ophthalmic assistants are engaged to supplement and support the work of an ophthalmologist. When such assistants are used effectively by eye care centres, doctors can treat more patients in less time while still ensuring a high standard of care. It is therefore vital that more attention be paid to the structured training of other ophthalmic personnel.

Over the past three decades, Aravind Eye Hospital has developed and refined a system of structured training programmes for ophthalmic assistants and support services personnel. These series were created to bring together the lessons we have learned over the years, and to share our insights with other eye care programmes and the community at large.

Dr. G. Natchiar
Vice-Chairman, Aravind Eye Care System

Blindness Prevalence

World wide it is estimated that at least 38 million people are blind and that an additional 110 million have severely impaired vision. In all, about 150 million people are visually disabled in the world today, and the number is steadily increasing because of population growth and aging. Overall, the data shows that more than 90% of all blind people live in developing countries and that more than two-thirds of all blindness is avoidable (either preventable or curable). Unfortunately, little information is available on the incidence of blindness around the world; it seems probable, however, that there are some 7 million new cases of blindness each year and that despite every intervention, blindness in the world is still increasing by 1 to 2 million cases a year. Thus, trend assessment points to a doubling of world blindness by the year 2020 unless more aggressive intervention is undertaken.

A major cause of preventable blindness is cataract. Presently, an estimated 7 million cataracts are operated on each year. There is a backlog of 16 million cases that have not yet been operated on. If this backlog is to be eliminated in the next two decades…a staggering 32 million cataract operations must be performed annually by the year 2020.

In addition, there must be an improvement in technology because more than 50% of cataract surgeries in the least developed countries today are still performed without intraocular lens implantation. Thus, most of the developing countries need more surgery facilities, supplies and equipment, and an increased number of trained surgeons. Furthermore, particularly in sub-Saharan Africa, India, China and other parts of Asia, the volume of cataract surgeries must increase greatly. Although considerable progress is being made in some of these countries, the provision of good quality, affordable cataract surgery to all those in need will nevertheless remain the main challenge for ophthalmology world wide for many years to come.

An important aspect of combating cataract blindness is human resource development. To increase the efficiency of ophthalmologists in clinical work, further training of support staff such as paramedical ophthalmic assistants, ophthalmic nurses and refractionists is essential.

Introduction

Eye care in the past three decades has grown with complexity and many divisions. The core product being offered in eye hospital is clinical care; however clinical care by itself is not complete unless it is enhanced by supportive services. This includes services such as housekeeping, medical records, optical dispensing and delivery.

Housekeeping services are of paramount importance in providing a safe, clean, pleasant, orderly and functional environment for both patients and hospital personnel. The medical record department helps in rendering good service to patients, medical staff and hospital administration. Optical delivery and dispensing department helps in timely delivery of glass prescription to patient making an impact in their vision. Training people in these cadres make vital contributions to the achievement of high quality, high volume and financially sustaining eye care in large volume setting.

About Training in Eye Care Support Services Series (TECSSS)

The Training in Eye Care Support Services Series (TECSSS) responds to the desire of many organisations and institutions around the world to train support services personnel to provide high quality and high volume eye care.

The Training in Eye Care Support Series is a set of manuals explaining the principles and techniques for the effective procedures to be followed by the support services personnel.

Each module is based on the practices of Aravind Eye Hospitals in South India.

The intent of this series is to provide a format for Training in Eye Care Support Services based on Aravind Eye Hospital's "best practices", based on over 30 years of growing, changing, and learning from mistakes.

The three modules of TECSSS

1. **Housekeeping in Eye Care Services - A practical guide :** The invisible "bottomline" for patient safety and satisfaction. Cleanliness, appearance, maintenance, attitude are all essential for the entire hospital and OPD. Duties, responsiblities and specific tasks are covered.
2. **Medical Records Management in Eye Care Services - A practical guide** : A complete guide to establishing and running an efficient medical records department: information retrieval, generating statistics, personnel requirements, importance of accuracy.
3. **Optical Sales and Dispensing - A practical guide :** This gives clear guidance about the various spectacle lenses and frames, how to fit the lens into frame, the technical measurement and sales procedure.

About the Ophthalmic Assistant Training Series (OATS)

The Ophthalmic Assistant Training Series responds to the desire of many organisations and institutions around the world to provide high quality and high volume eye care.

The contribution of the ophthalmic assistants to this work is fundamental.

The Ophthalmic Assistant Training Series is a set of manuals explaining the principles and techniques for increasing high quality and high volume eye care through the use of paramedical staff.

Each module is based on the practices of Aravind Eye Hospitals in South India.

The intent of this series is to provide a format for Ophthalmic Assistant Training based on Aravind Eye Hospitals' "best practices", based on over 30 years of growing, changing, and learning from mistakes.

The five modules of OATS

1. **Introduction to Basics of Ophthalmic Assisting** : This is the foundation of the entire Ophthalmic Assistant Training. All the trainees are given general knowledge and training for the fundamentals necessary for their duties, as well as specific information about all activities required in their work.
2. **Handbook for Clinical Ophthalmic Assistants, Principles & Techniques of Clinical Ophthalmic Procedures:** Out-patient Department (OPD): This includes theory and practice of initial patient evaluations. An introduction to refraction is presented as well as steps for assisting the doctor.

   Ward: This contains all the information necessary for the smooth running of a Ward. Pre and post operative procedures and patient instructions, as well as management of emergency and post operative complications are discussed. Ward set-up and management and laboratory functions are covered.
3. **Handbook for Surgical Ophthalmic Assistants (Operation Room Services)**: Contains background and practical steps to the smooth running of a sterile theatre. Personnel requirements, roles and duties of theatre personnel including management of emergencies and medications, and assisting in specific procedures are detailed.
4. **A text book on Optics and Refraction:** All aspects of refractions are covered, including step- by step instruction for subjective and objective refraction, room set up, and equipment required. All types of refractive errors are described as well as the methods of assessing them. The theories and practice of visual fields, ultrasonography, contact lens fitting, low vision aids and optical dispensing are included.
5. **Role of Counselling in Eye Care Services - A practical guide :** Helping patients help themselves. The importance and types of patient interaction are discussed in detail. Basics of communication and specific examples are presented.

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Training in Eye Care Support Services Series

Acknowledgements

We take great pleasure in presenting the Training in Eye Care Support Services Series (TECSSS) which is the consummation of many years of experience and tireless efforts by Aravind's ophthalmic assistant training department.

We acknowledge Seva Foundation's help through a series of volunteers who coached our team, helped in designing the structure, edited the contents, ensured academic rigor and making it relevant for transfer to a larger global audience, under the initiative of Dr.Suzanne Gilbert. In addition Seva Foundation is covering a part of the production costs. Sight Savers provided the initial stimulus and support for understanding the role of ophthalmic assistants in a broader context and in the development of a draft curriculum.

We express our sincere thanks to Dr.Pararajasegaram for contributing foreword to the series.

We take this opportunity to thank Aravind Publications Department particularly Mr.K.V.S.Lakshmanan, Consulting Editor, for his contribution to the final edition and to Ms. Gowri, Ms. N. Deepa, whose team effort has resulted in the fruition of this manual. We are grateful to Ms. Pattammal for co-ordinating the contributions from various sources and also for her contribution in editing the manual.

Finally we sincerely thank the senior leadership team of Aravind Eye Care System particularly our Vice - Chairman Dr. Natchiar for the constant support and encouragement.

The Ophthalmic Assistants team

Aravind Eye Care System

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CONTENTS

CHAPTER 1

INTRODUCTION TO OPTICAL DISPENSING

CHAPTER 1

Introduction to Optical Dispensing

With refractive errors being one of the most common eye disorders, its correction, especially by spectacles, is in great demand. Refractive correction can be brought about by spectacles, contact lenses and refractive surgery. However spectacles are still the preferred choice - largely because they are cheaper and easier to dispense. Hence in this module, 'optical dispensing' will usually refer to the issue of spectacles.

Proper dispensing of a pair of spectacles begins with an accurate prescription. It also includes guiding the patient to choose frames and lenses that are comfortable, affordable as well as aesthetically suitable. The quality of the lens and its fitting also affects the correction provided. In addition to these, proper counselling about use and maintenance can ensure proper uptake of the correction. It is important to design the optical dispensing system itself in order to make it sustainable and efficient. A few guidelines have been included in this module.

This module deals with the different aspects of optical dispensing - such as patient counselling, order processing, fitting of the lenses and stock keeping. Basic information about frames, lenses and their types has also been provided. This module targets the training in the following skills:

- To guide the patients to choose appropriate frames and lenses
- To do lens surfacing and glazing with scientific methods by manual and automatic processes
- To troubleshoot the problematic spectacles
- To do the frame measurements, centering and de-centering techniques
- To inspect lens defects
- To organise optical dispensing services in community outreach programmes

Refraction, with the help of a trial set and Snellen's chart, is a simple and effective method to identify those with errors. And correction, by spectacles, is an easy and affordable solution. Yet, in most developing countries, where people do not readily seek health services especially for non-critical problems, the challenge lies in identifying and reaching out to the patient and providing the refractive correction.

Lack of awareness and inaccessibility of affordable optical services have been indicated in WHO surveys of blindness and visual impairment worldwide. Uncorrected refractive errors could lead to amblyopia in children and may lead to visual loss. Such avoidable blindness can be easily prevented by wearing appropriate spectacles. Aravind Eye Care System, with the help of about 1500 outreach camps a year, reaches out to the people and identifies and treats those with eye problems. Those identified to have refractive errors can buy a pair of glasses and it is fitted and delivered to them on the spot. This module also explains this system of spectacle dispensing at campsites.

It is recommended that dispensing opticians also need to know about the following topics, which are outside the scope of this manual:

- The eye and the way it works
- Refractive Errors
- Corrective methods including surgery
- Contact lenses (only basic information is given in this manual)
- Low vision aids (only basic information is given in this manual)
- Optical accessory products such as cleaning agents for contact lenses, spectacle lenses, frames and sunglasses
- Fashion trends for frames and sunglasses
- The construction of frames, the materials used and the design characteristics
- Business management
- Practical aspects of edging and surfacing of lenses
- Up-to-date information about new optical products available in the market

CHAPTER 2 SETTING UP AN OPTICAL SHOP

CONTENTS

Equipping an optical shop

GOAL

To facilitate the ophthalmic assistant (OA) to appreciate why and how an optical shop is set up

OBJECTIVES

The OA should be able to:

- Understand how an optical shop is set up in proportion to the magnitude of orders expected
- Know the different processes and equipment involved in optical dispensing

CHAPTER 2
Setting up an Optical Shop

Given that the prevalence of Refractive Error is high and largely unaddressed, it makes strategic sense for an eye care provider to expand his services to include spectacle dispensing.

Spectacles are the simplest solution to refractive error because they are cheaper, involve less technology and are easier to dispense than other correction options like contact lenses and refractive surgery.

As an eye care provider by dispensing spectacles you can ensure that your patients do receive the necessary correction and that the spectacles are of good quality (the correct power, appropriate lens and frames etc.,).

It has been found that patients prefer unique spectacle designs and models instead of a standard frame design. As patient, have been found willing to pay for this "Vanity component", the dispensing service can be made sustainable.

At Aravind, we have observed that 10% to 25% of the total outpatients need refractive correction. This large volume justifies a dedicated set up for dispensing spectacles.

Today, setting up a spectacle shop is fairly risk-free as the spectacle market is quite well-established, globally. With many players in the market, both in the corporate as well as unorganized sector, the raw materials are available at fairly cheap cost.

Spectacle dispensing is a fairly simple procedure with minimal training needs. With sufficient demand being created in-house and the low cost of goods, this could easily go beyond being a sustainable venture and can generate a surplus.

Equipping an optical shop

Besides the showroom infrastructure and the necessary shelving arrangement for the stock, certain minimum equipment will have to be invested in for sales as well as for processing the lens to get the right power and to fit them into frames. The range of equipment necessary for spectacle dispensing, again, varies with the variety of products and services provided.

For sales and order taking

One needs only basic instruments for taking the various measurements of the patient's face. This could range from a simple ruler to a sophisticated digital pupillometer.

Processing equipment

- Surfacing is the process by which the power is generated on the lens surface by creating the desired curvature. Lens surface generators or surfacing machines are also available-from basic manual models to fully automated CNC machines.
- Edging of lenses is done to shape them in a way that they can be fitted into the frame. These equipments are available in a wide range in terms of automation and sophistication.

Other essential tools include

- Trial lens set or lensmeter – to determine power of lens.
- Marking, chipping and cutting instruments – to trace and roughly cut the lens to the shape of the frame before fine edging is done on the manual edger.
- Screwdrivers – to fit the lens into metal frames
- Frame warmer – to enable the lens to be fitted into plastic frames.
- Adjustment pliers – for adjusting the frame.

Workflow in a typical optical shop

Receiving the Patient:
- Verifying the prescription
- Counselling

Sales:
- Displaying frames and lenses
- Order Entry

Lens Processing:
- Use readily stocked lenses, if available
- Or else, process or place order for lens

Lens Fitting:
- Edge the lens to fit into frame

Quality Control:
- Check if spectacles matches the prescription
- Check for defects
- Make final adjustments

Delivery:
- Cash collection
- Billing
- Counselling on maintenance
- Delivery or dispatch

Support Activities:
- Staffing
  - Recruiting
  - Training
  - Development
- Inventory management
  - Stock maintenance
  - Quality control
  - Vendor management
- Accounting
- Equipment maintenance
- Overall administration

It must be noted that not all the above processes need to be part of your own dispensing set up. This will vary based on your capacity and circumstance. The following unit will show you which processes can be outsourced and why.

The set up will vary depending upon the number of spectacles you expect to sell. In order to be sustainable, the expected demand should justify the resources employed.

The following table offers recommendations for setting up a dispensing service based on expected demand

No. of orders per Day	Space (sq. ft)	Staffing	Inventory	Process
Fewer than 10	50 to 100	- 1 sales person	Frames only	- Sales only - Outsource all processing activities
10 to 25	200	- 2 sales persons - 1 technician for edging	Ready lenses* & Frames	- Edging and fitting - Outsource surfacing
25 to 100	400	- 4 to 5 sales persons - 3 to 4 technicians for edging - 3 Administrative staff	Ready lenses & Frames	- Edging and fitting - Outsource surfacing
Over 100	600	- 8 to 10 sales persons - 4 to 6 technicians for edging & surfacing - 4 Administrative staff	Frames, Ready & Blank lenses**	- Edging and fitting - Surfacing

* Ready lenses – these are lenses readymade with commonly occurring powers, these are available in the market

** Blank lenses – these are base lenses which have to be surfaced to get the required power

When should you outsource an activity or process?

In order to remain sustainable and to preserve focus, you might want certain processes to be outsourced and some to be done in-house. The following factors might help you weigh which processes to outsource:

- Volume: The volume of any activity must justify the amount of fixed investment that is incurred for setting up the facility and if one can utilise it with near maximum efficiency.
- Delivery time: It is also necessary to look into the time involved in outsourcing an activity. It might be cheaper to get it done by a contractor but it also might take a longer time. If your priority is to save time you might consider doing it yourself.
- Quality and reliability of contractors: To maintain the quality standards of your product, you will have to check if the contractor is able to deliver equal or better service than if you did it yourself. His service would also have to be reliable.
- Cost in outsourcing: Cost of outsourcing the process must ideally be less than or equal to an in-house arrangement.
- Capacity to manage: Sometimes, cost and volume might dictate that a certain process could be done in-house but we might not have the expertise or the capacity to manage it as well as a contractor would.

A trade off on all these factors will help decide which activities to outsource and which to arrange for within our set up.

Era of the plastic lens

Earlier, glass lenses were predominantly used for spectacles. It is still so in most developing countries though plastic has been introduced.

Plastic lenses have lesser shelf life and need more sensitive handling. Thus your decision to dispense plastic lenses can have direct implications on your equipment. World over, the trend is moving towards plastic lenses more so because of the benefits it brings to the user and it is fast becoming more affordable.

Supply Chain

The spectacle goods market has evolved over the years making lenses, frames and equipment accessible and affordable even for developing countries. However, small retailers will have to be aware of huge mark-ups down the supply chain that can escalate the prices. Thus, the closer up the chain you go, cheaper it is. With a large number of players in the unorganised sector, price regulations are absent. However, cost is controlled by a very highly competitive environment. Today, China has become a major source of good and inexpensive frames and lenses.

Human Resource

Spectacle dispensing involves human skills in two major areas:

- counselling and salesmanship
- technical skill for fitting and surfacing

Thus, training will have to be structured for both categories of staff. It must include

- Order taking
- Salesmanship
- Product knowledge
- Vendor management
- Inventory management with an understanding of the latest trends and fashion so that appropriate frames are stocked
- Report preparation

Equally important is that the training must continuously serve to update staff on new developments, in products and techniques.

Spectacles at outreach programmes

Outreach programmes make eye care accessible to rural and remote areas. Thus, it is essential that the service is comprehensive and complete. At Aravind we have observed that 10% of the camp patients need refractive correction and now, dispense spectacles on the spot. This ensures that the patient receives appropriate correction.

In the past Aravind assisted camps were generally focused on cataract services. However, today they provide comprehensive eye care and now, special refraction camps are conducted at schools to address the child population and at industries and offices for the working population.

Finances

The following illustrates the finances involved in setting up an average sized optical shop that handles 25 to 50 orders a day.

- Initial Costs: Major initial investments for setting up infrastructure for the dispensing unit include:
  - Space
  - Furniture
  - Basic Equipment – manual edger
  - Inventory – Lenses & Frames
- Overheads: Other indirect costs that are usually incurred are:
  - Rent
  - Electricity
  - Stationery
  - Salary
  - Freight
  - Machinery maintenance
  - Consumables
  - Miscellaneous
- Recurring Costs: Direct costs incurred in manufacturing spectacles are for:
  - Frames
  - Lenses
  - Accessories
  - Direct labour charges

The following are the average unit selling prices of spectacles at Aravind Eye Hospitals, India. (These prices are neither prescriptive nor indicative of prices in this region).

- In outreach camps: Rs.200 (US$ 5)
- In the free hospital: Rs.250 (US$ 6)
- In the paying hospital: Rs.500 (US$ 12)

Student exercise

Choose the correct answer

1. *Setting up an optical dispensing unit is sustainable because*
   a. *employees need not be trained*
   b. *there is a large number of people with refractive error*
   c. *lenses can be stocked for a long period*
   d. *patients are willing to buy expensive spectacles*
2. *Which of the following will you NOT consider while deciding to outsource a process to a contractor?*
   a. *Price charged by the contractor*
   b. *Time taken by the contractor*
   c. *How frequently the process is used*
   d. *Type of lens needed*
3. *Which of the following is NOT a process involved in optical dispensing?*
   a. *Fitting contact lenses*
   b. *Processing lenses*
   c. *Performing cataract surgery*
   d. *Training opticians*
4. *Which of the following is NOT the job of a dispensing optician?*
   a. *Manufacturing frames*
   b. *Managing suppliers*
   c. *Maintaining inventory*
   d. *Preparing reports*
5. *The demand for plastic lenses is growing because*
   a. *Plastic lenses are cheaper than glass lenses*
   b. *Plastic lenses are clearer than glass lenses*
   c. *Plastic lenses are thinner than glass lenses*
   d. *Plastic lenses are lighter than glass lenses*

CHAPTER 3 BRIEF INTRODUCTION TO SPECTACLES

CONTENTS

Frames
Optics
Common refractive problems and correction
Lenses
Transposition
Measuring lens power
Other corrective methods

GOAL

To create an overall understanding of the basic components of spectacles and other optical devices for correction of refractive error such as contacts and low vision aids.

OBJECTIVES

The OA should be able to

- Know the parts of a frame, frame materials, models and designs
- Know the characteristics of lenses, types, materials and lens forms
- Be able to compare one type of spectacle frame with another
- Receive an introduction to contact lenses
- Receive an introduction to low vision aids

CHAPTER 3
Brief Introduction to Spectacles

Frames

The part of the spectacles that holds the lens in front of the eye is called the frame. This usually rests on the bridge of the nose and the ears. Frames are available in a variety of shapes, structures, materials and colors. The frame that one chooses can affect the comfort, vision and appearance of the spectacles and its wearer. Thus it is important to guide the customer to choose one most apt to his physical features and his habits. This section deals in depth with the parts of a frame and types of frames – based on different designs and materials. It also discusses what features are desirable for a spectacle frame.

Parts of a frame

The basic parts of a spectacle frame are Fig 3.1, Fig. 3.1a:

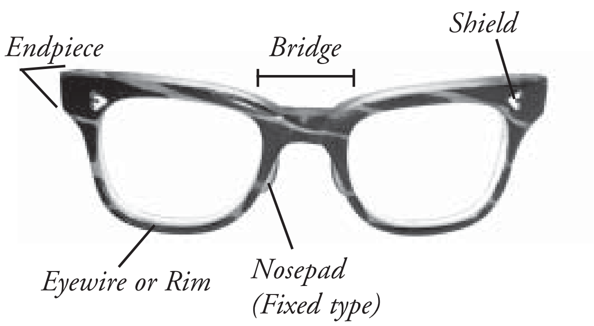


Fig. 3.1a - Frame front of a plastic frame

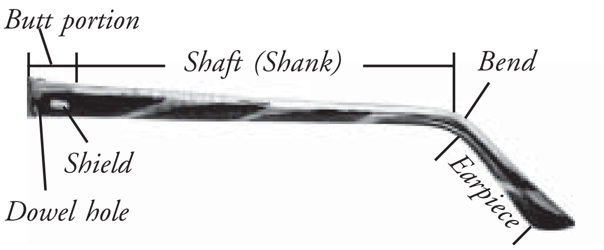


Fig. 3.1b - Frame temple of a plastic frame

- **Eye wire:** Eye wire is the rim that holds the lenses. The eye wire has a groove running along its inner surface wherein the lenses are inserted.
- **End-piece:** The extreme outer extended portion of the frame, on the left and right, near the temple are the end pieces.
- **Front:** The portion of the spectacle housing the lens – including the eye wire, end-pieces and bridge forms the front of the frame
- **Temple:** The temples are the sides of the spectacles, connecting the frame-front and resting over the ears. Usually the front and the temple are made of the same material. The types of temples include:
  - Skull temple: This is the most common type of temple. The skull temple is most comfortable for those people who wear their eyeglasses for long periods of time. It fits easily on the ear, and bends slightly to fit the skull and lightly hug the head Fig 3.2a, Fig. 3.2b.

Fig. 3.2a - Sunglasses with skull temple

Fig. 3.2b - Spectacle frame with skull temple

  - Library temple: The temple is a straight line with rarely a slight bend at the very tip. It is suitable for those who need to remove their spectacles many times a day as in reading glasses Fig 3.3a.

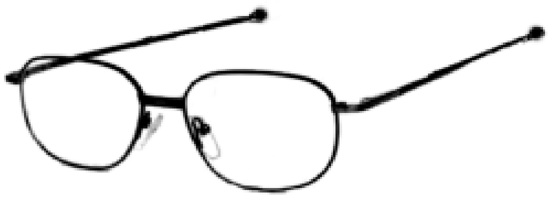


Fig. 3.3a - Library temple

Fig. 3.3b - Cable temple

- Riding bow/Cable temple: This temple has a curved earpiece and fits around the ear. It hugs the ear, and is more difficult to remove. This type of temple would be particularly helpful for those people whose jobs are very active, or for children Fig 3.3b.
- Convertible temple: This looks like a straight line without bend. It can be converted from one shape to another. It can be bent to any shape for comfort Fig. 3.3c.

Fig. 3.3c - Convertible temple

- **Hinge:** The hinge connects the temple to the front. This is usually made of metal. It is made of two leaves, one attached to the front and the other to the temple, which when aligned form a barrel with a hole called the dowel. The two parts are fixed together by a pin running through the dowel hole. Each leaf of the hinge has many loops which are in one of these ratios: 1:2, 3:2, 3:4, and 4:5. Usually, as the number of loops increases, the thickness of each loop is reduced and so the strength of the hinge is also less. These are traditional hinges.

  Today, many fancy and minimalist designs are available. When the temple is made of memory metals which are flexible, there is no hinge at all. Spring hinges use a spring tension to press the temples of the frame closer to the sides of the head. This allows for a closer, snugger fit. As a result, models with spring hinges are usually more expensive.

Traditional flat

Stack hinge

Ball hinge

Aerodynamic hinge

Twisted hinge

Hingeless

Fig. 3.4

- **Shield:** The Shield is the metal piece or rivet supporting the hinge and attaching it to the frame.
- **Earpiece or Curl:** The portion of the temple beyond the temple bend that goes behind the ear is called the curl. This is usually made of softer material. This portion is usually adjusted for tightness of the frame.
- **Bridge:** This is the portion connecting the two lenses which rests above the nose. In the early days the bridge used to rest directly on the nose without nose pads. These are no longer common, except in plastic frames.

- Nose pads: The nose pads are that part of the frame that rests on the nose. In plastic frames the nose pads are usually part of the rim itself. It is designed as: saddle – where it looks like a bridge; modified saddle – this has a bulging surface at both sides, increasing the resting area; keyhole – this is narrower at the upper surface of the nose. In metal frames, these are either fixed or adjustable. The fixed nose pads are fixed saddle type plastic pads fixed by means of a screw or clipped on. These are hard nose pads made of acetone. In other frames small metal arms on the nasal part of the eye wire hold the self-adjustable nose pads; these are called nose pad arms. Adjustable nose pads rest comfortably against the line of the nose and are made of a soft, flexible material like silicon (Fig. 3.5).

Fig. 3.5

Frame measurements

Most frames have the following measurements printed on them (usually on the inner surface of the temple) (Fig. 3.6):

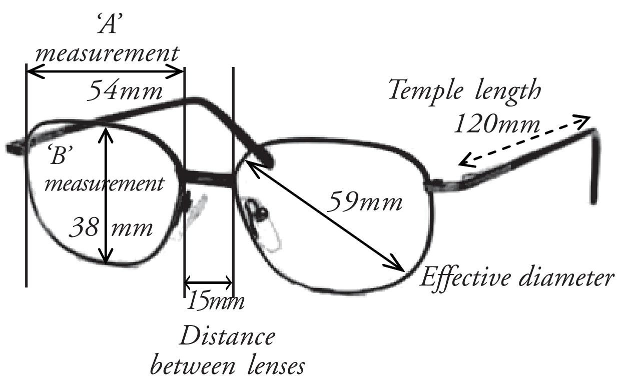


Fig. 3.6 - Frame measureemnts

- Bridge Size: The horizontal length of the bridge piece. This is also called 'distance between the lenses' (DBL).
- Temple Length: The horizontal length of the temple.
- 'A' Measurement: Horizontal length of one rim. A measurement should be same for both left and right eye wires. This is usually referred to as the 'frame size'.
- 'B' Measurement: Vertical length of rim. B measurement should be same for both left and right eye wires.
- Effective Diameter: Diagonal of the rim. This measurement is useful for choosing the optimum diameter of the lens during processing.

Frame designs

Metal and shell frames are usually different in their design especially with respect to the nose pads. Metal frame has plastic or rubber sleeves at the earpiece to avoid skin contact with metal; this is not necessary in plastic frames. Combined frames or combination frames are contemporary frames which have a metal front with plastic sides or plastic fronts with metal sides.

More recently frames are available in very different and fancy shapes to meet the local and current trends as well as specific functionality such as sports eyewear.

Fig. 3.7 - Plastic or shell frame

Fig. 3.8 - Metal frame

Fig. 3.9 - Combined frame (metal front + plastic sides)

Fig. 3.10 - Combined frame (plastic front + metal sides)

Rimless frames are frames without eye wires. The lenses are held in place by screws running through holes drilled into the lenses. Half-rimless or semi-rimless frames have eye wire only along a part of the lens – along the top or along the bottom of the lens or either at the templar or nasal regions. Here, the lens has a groove running along its edge carrying a nylon wire which fixes the lens in position in the frame. Almost all frame models are available in both metal and plastic materials. Half eye frames are designed for reading as it rests lower on the nose. Sports and protection eyewear are made of impact resistant material and are designed for a snug fit.

Fig. 3.11 - Semi-rimless metal frame: Eye wire only along top of lens

Fig. 3.12 - Semi-rimless plastic frame

Fig. 3.13- Rimless metal frame: no eye wire

Fig. 3.14 - Sports eye wear

Frame materials

Desirable qualities of a spectacle frame are:

- Durability – the frame must be able to withstand wear and tear
- Light-weight – if the frame is too heavy it is uncomfortable for prolonged use and can also cause marks on the wearer's face
- Flexible – the frame must be flexible enough to be easily adjusted, to insert the lens and to withstand different conditions and handling
- Maintain the original shape
- Fast Color – The coloring on the frame must not fade, peel or wash off
- Inert to body fluids – frame material must not react to common body secretions like sweat and sebum. It should not cause any skin allergy.
- Inexpensive

Another look at the above features will show that some of these are contradictory. For instance, it insist that a frame must be tough - to maintain its original shape - yet we also require it to be flexible; it requires that the frame material should react well with the coloring agents but not react with body fluids. Thus very few frame materials can satisfy all these qualities. However, many materials today can be used to make a comfortable, affordable, durable, good-looking frame. Basically frame materials can be classified as Plastics and Metals.

Plastic frames

Plastic frames have some drawbacks: They are easier to break than metal frames, they can burn (but are not easily ignited), and aging and exposure to sunlight slightly decrease their strength but do not affect color. These frames are sometimes referred to as "shell" frames because the first frames were made from Tortoise shell. This material was soon banned as it threatened the survival of this species.

Plastic frames are manufactured by the following methods:

- **Injection molding:** The melted plastic is injected into frame-shaped moulds and cooled to get the shape of the frame. Fronts and temples are made in this way and polished. Metal joints are usually fixed prior to cooling.
- **Routing or machining:** Here the frame shape is cut out of a sheet of plastic by means of a die and it is polished. The metal joints are heat-inserted or riveted.

Plastics are classified into two types:

Thermosetting

- This type of plastic is not flexible
- This hardens after final adjustment
- If heated, it burns or melts
- Used for readymade spectacles, sunglasses etc., where adjustment or fitting cannot be done
- Not suitable for spectacle dispensing

Thermoplastic

- This kind of plastic is more flexible and adjustable
- Can be reformed with heat
- Flexible
- Can be reused
- Suitable for spectacle dispensing

The following are the plastic materials used in frame manufacture:

Cellulose acetate

Used since 1894, it is made from cotton linters and acetic acid. These frames are made by machining - joints are heat inserted or riveted and colour is applied by lamination. These frames are lightweight and stable at room temperature. They are non-flammable (softens at 57°C) – making them easy to adjust by warming. But the acetate is not resistant to common solvents and so it is allergenic: the frames whiten at the bridge and temple where there is prolonged contact with skin.

Cellulose nitrate

Made from cotton linters and nitric acid with camphor. This material is stronger than acetate – but it becomes brittle. It is a thermosetting plastic. This softens at 65°C but it gets inflamed at 70°C. So it has been banned in countries like UK. In India it is still used to make cheap frames. This frame cannot be reused.

Cellulose propionate

Some manufacturers also use propionate - a nylon-based plastic that is hypoallergenic. It is lightweight.

Optyl

This material is an epoxy resin which softens at 80°C. It is 30% lighter than acetate. It is produced by moulding and colour is added by dying and varnishing. This material has "thermoplastic memory" – this is the ability of the material to regain its original shape however it is bent.

Polymethylmethacrylate

It is rarely used as frame material as it is hard, rigid and brittle when adjusted. It is a stable and lightweight material which can be coloured by lamination. It is also hypoallergenic (does not cause allergy). It is sometimes used for rigid frame parts as in nose piece and temples for plastic rimless frames.

Nylon

First introduced in the 1940s. As this was brittle, frames are now manufactured with blended nylon which is both strong and lightweight.

Carbon fiber

Carbon frames have 20% carbon fiber and 80% nylon. This material is made by weaving carbon fibers and nylon together. The carbon gives the frame a dark grey colour. This can be coloured by lacquer. This material is thin and very strong but it is not very adjustable. This material is usually used only for the frame front and the sides are usually of another material – usually metal. These sides are attached by a screw fitting to the front. These frames cannot be reused.

Polycarbonate

These frames are used for sports eyewear or safety glasses, nonprescription shields- where the lenses and frame are molded in one unit. Used in combination with polycarbonate lenses, this material offers best impact resistance and eye protection. This material can not be adjusted very well and so cannot be used for spectacle frames.

Metal frames

The following metals are used in frame manufacture:

Nickel silver

It is an alloy of copper, zinc and nickel (12 - 25%).It is a relatively flexible material but it is hyper allergenic and turns green with prolonged contact with body fluids. It needs plating to prevent discolouring.

Monel

It has been used since 1905. It has higher nickel content than nickel silver. Its constituency is 66% nickel; 31.5% copper and traces of iron, manganese & silicon. It is malleable and corrosion-resistant - especially if the right kind of plating, such as palladium or other nickel-free options is used. Otherwise, due to the high nickel content, there is a higher risk of allergic reaction. It is usually used for eye wire with a memory metal bridge so it does not come in contact with the skin. It is the most widely used material in manufacture of frames.

Titanium

Titanium is one of the ideal metals for frames but extraction and manufacture costs make it expensive. It is used as an alloy of titanium, vanadium, aluminum and manganese, called ß (beta) Titanium. It is only half the weight of nickel silver. Its surface hardness is 3 times that of gold plating making it resistant to scratches. Titanium is very flexible - 20% more elastic than nickel silver. Welding of titanium and its alloys can be easily performed, but it is expensive. It is hypo-allergenic, in its pure form, but is usually adulterated with Nickel.

Memory metals

Developed initially for the US military in 1961, these are alloys – usually 40% nickel and 60% titanium or cobalt and titanium. These are very flexible – they are capable of retaining their original shape – so it is called “memory metal”. But this makes it difficult to adjust. The flexibility of this alloy is eight times that of spring steel. It is resistant to corrosion and commonly used for bridges and sides which need not be adjusted.

Aluminum

Aluminum is very light and can be coloured by anodizing and dying. It is hypoallergenic and resistant to stain and tarnish. But it is unsuitable for frames as it cannot be soldered or brazed and joints have to be pinned. However it can be used for sides.

Stainless steel

It is an alloy of iron, chromium and rarely nickel. It is strong, lightweight and when it is nickel-free, hypoallergenic. It is easy to adjust, not easily damaged and rarely causes skin irritation. It discolours when heated.

Beryllium

This is a low-cost alternative to titanium eyewear. It resists corrosion and tarnish, making it hypoallergenic. It is also lightweight, very strong and very flexible - making it easy to adjust.

Metal frames always undergo a special process called electroplating for a final finish. This process coats the base material with a plating material like gold, palladium, rhodium and ruthenium and chromium. This plating is protected from sweat by lacquer which can be applied as a liquid or as a powder, which is then heated until it liquefies. Metallic finish can also be given by 'powder coating' where the surface metal is made into fine powder and sprayed onto the frame; this is then heated till the powder melts and coats the frame evenly.

Frames are also available in other less common materials. These are very expensive.

- Silver: Silver is sometimes used as a trace element in metal alloy frames – and for decoration.
- Gold: Gold is typically used as plating and as decoration. Gold frames are sometimes made with 18K gold. It is seldom used as it is a soft material.
- Wood and Bone: These are stiff and not flexible. They tend to break when adjusted. Thus they are rarely used except as a fancy item making them much more expensive.
- Leather: This is not as durable or practical as other materials but it provides a fashionable look.
- Semi-precious or precious stones: These are sometimes used as decoration in frames, especially in the temples. Popular choices are onyx and turquoise, but even diamonds can be used.

Optics

Optics is the study of light. Light helps one to see.

Some metals and their use in frame manufacture:

Metals	Front	Side	Rim	Bridge	Joint	Pad Arm	Decor	Surface Finish	Core
Chromium								✔	
Copper								✔	
Gold	✔	✔					✔	✔	
Nickel			✔			✔		✔	✔
Palladium								✔	
Ruthenium								✔	
Rhodium							✔	✔	
Aluminum	✔	✔			✔		✔		
Titanium	✔	✔	✔	✔	✔	✔			
Bronze		✔			✔				
Nickel Copper	✔	✔	✔	✔	✔				
Monel			✔	✔	✔				
Beryllium Copper				✔	✔				
Nickel Manganese			✔						
Stainless Steel	✔	✔	✔	✔	✔	✔	✔		

Properties of light

Light travels in a straight line

Light travelling in a straight line represents a ray of light. A set of straight lines represent a beam of light. The beam may be parallel, converging or diverging.

The branch of optics based on this property of light is known as Geometrical Optics.

Light gets reflected

When the light traveling in a medium is incident on another medium, part of the light is sent back into the first medium. This is reflection. The surface separating the two media is the reflecting surface. Sometimes this surface is coated (silvered) to increase reflection. When the surface is smooth and polished it is a regular reflection giving rise to an image. Irregular reflection (scattering) occurs when the surface is not smooth.

Laws of reflection

First Law: The incident ray, the reflected ray and the normal ray at the point of incidence on the reflecting surface are all in the same plane (Fig. 3.15).

Second Law: The angle of incidence is equal to the angle of reflection.

The most important application of reflection is in the plane mirror. The use of such mirrors for cosmetics

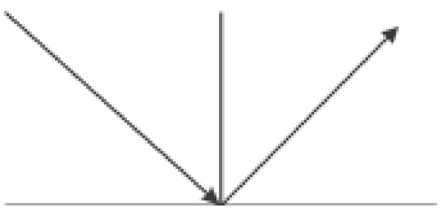


Fig. 3.15

is well known. The image formed on a plane mirror is virtual (not real). It is of the same size as the object and is formed as far behind the mirror as the object is in front of it. The image has left / right inversion.

Plane mirror is used in refraction cubicles to reduce the length of the cubicle to half its length. However the Snellen's chart used with plane mirror will have objects with left right inversion so the patient sees the correct image inside the mirror.

Light gets refracted

When light travelling in one medium enters another there is deviation (bending) in its path. This is known as refraction which arises because of differences in the speed of light in different media.

Laws of refraction

First Law: The incident ray, the reflected ray and the normal ray at the point of incidence on the refracting surface are in the same plane (Fig. 3.16).

Second Law: The ratio of the sine of the angle of incidence to the sine of angle of refraction is a constant which is known as the refractive index of the second medium with respect to the first medium.

(sin i / sin r = constant).

Refractive index (μ)

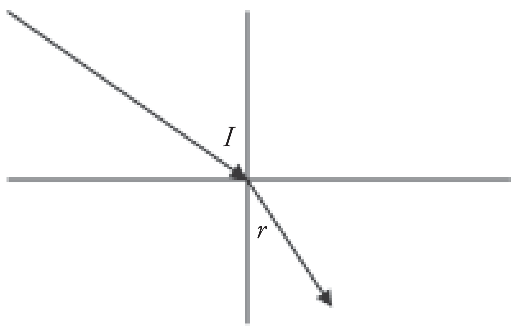


Fig. 3.16

It is the ratio of speed of light in air to the speed of light in the medium. The speed of light in air is maximum (180,000 m/s). Hence the refractive index of a medium is always greater than 1.

For air $\mu = 1$, for water $\mu = 1.33$, for glass $\mu = 1.5$

Prisms and lenses used in ophthalmic practices are refraction devices.

It refers to how much the material is capable of bending the ray of light. A lens with a low refractive index can bend the ray substantially only when it is much thicker than a material of higher refractive index, which can deflect the ray of light even if it is a very thin lens. (Symbol: µ).

Abbé value

Dispersion is the amount different wavelengths of light that the lens spreads out. Abbé number, also called constringence or v value is its reciprocal. Decreasing the Abbé number (or increasing the dispersion) always makes the optical performance poorer – this is experienced as more chromatic aberrations and glares. Usually, an increase in the refractive index decreases the Abbé value – thus it is recommended that hi-index lenses be dispensed with anti-reflective coatings.

Prisms

A prism is a transparent triangular piece of glass or plastic. It has with two plane (flat) refracting sides, an apex (top) and a base (bottom) (Fig. 3.17). A ray of light incident to a prism is always bent towards the base of the prism. The image formed appears displaced towards its apex.

Prisms are used to measure and also to correct muscular imbalance in patient's eyes.

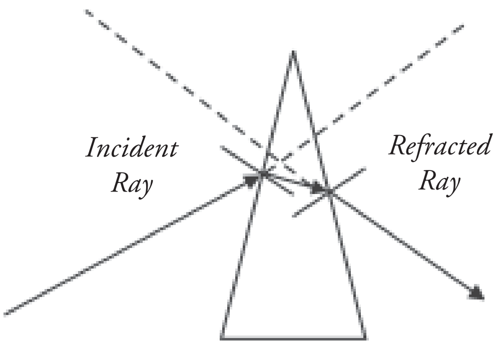


Fig. 3.17

Prism diopter

Prism power is measured by the extent of deviation produced as a light passes through it. If the displacement of the image of an object located 100 cm away from the prism is x cm when seen through the prism its power is x△D (prism diopter) (Fig. 3.18).

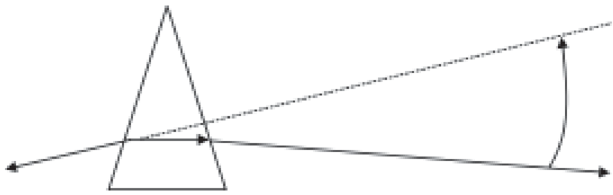


Fig. 3.18

Lens

A lens is a transparent medium bounded by two curved surfaces or one curved surface and a plane surface. Its most common application correction of refractive errors of the eye.

Lenses can be of six different types (Fig. 3.19)

1. Biconvex lens - both sides are convex
2. Plano-convex lens - one side is plane, the other side is convex
3. Meniscus lens - convex meniscus: meniscus shaped with greater convex curvature
4. Biconcave lens - both sides are concave
5. Plano-concave lens - one side is plane and other side is concave
6. Meniscus lens - concave meniscus: meniscus with greater concave curvature

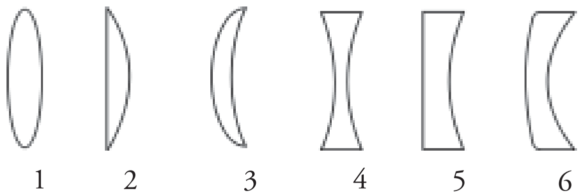


Fig. 3.19

To understand the working of lenses consider two prisms placed base to base. Light rays through them coverage (come together) at some point on the other side of the prism. Similarly if two prisms are placed together apex to apex, the ray will diverge (spread apart) on the other side of the prism (Fig. 3.20).

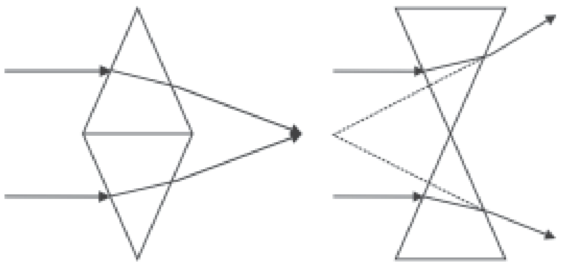


Fig. 3.20

In most applications the curved surface lenses are spherical (part of a sphere) and such lenses are called spherical lenses.

Lenses that converge a beam of light are known as converging, convex or positive lenses while those that diverge a beam of light are known as diverging, concave or negative lenses.

Some important terms relating to lenses

Optic centre: It is a point on a lens where a ray of light passing through it goes straight (there is no deviation).

Principal axis: It is the line joining the centres of curvature of the two curved sides of the lens. In case of plano-convex or plano-concave lenses it is perpendicular to the flat surface from the centre of curvature of the other curved surface.

Focal point (Principal focus): A beam of light parallel to the principal axis of a lens after refraction converges towards a point on the principal axis (convex lens) or appears to diverge from a point on the principal axis (concave lens). This is called the focal point. There are two focal points on either side of a lens at equal distances from the optic centre.

Focal length: The distance of the focal point from the optic centre is the focal length (f).

Power of a lens: The reciprocal of the focal length measured in metre units is the power of the lens in diopter (D = 1 / f). It is taken as positive for convex lenses and negative for concave lenses.

Focal length	Power
1 m	1 D
2 m	(1/2) = 0.5 D
(1/2) = 0.5 m = 50 cm	2 D
3 m	(1/3) = 0.3 D
(1/3) = 0.3 m = 30 cm	3 D

Power of a lens is the sum of powers of its two surfaces.

For a curved surface power P = (n – 1) / r, r being the radius of curvature of the curved surface measured in meter units.

For biconvex lens

P1 = (n – 1) / r1 ; P2 = (n - 1) / r2

Power of the lens: P = P1 +P2 = {(n – 1) /r1} + {(n – 1) /r2}

P = (n - 1) (1/r1 + 1/r2)

For a plano convex lens: The plane surface has no power. For the curved surface P1 = (n - 1) /r1, the total power is P = (n - 1) (1/r1).

These are known as the lens maker's formula.

Formation of images in lenses

Two rays are used to locate the image. A ray of light passing through the optic centre goes undeviated. A second ray of light, parallel to the principal axis, after refraction in case of convex lens converges and proceeds in the direction of the focal point on the other side. In concave lens it diverges and appears to come from the focal point on the same side.

Characteristic of the image formed using a concave lens for all locations of the object

Image is formed on the same side of the lens as the object; virtual, erect and smaller in size (Fig 3.21). Concave lens is used in the correction of short sight (myopia). The eyes of a person wearing such a lens will appear smaller. This is one reason why people requiring high negative powers prefer contact lens instead of spectacle lens.

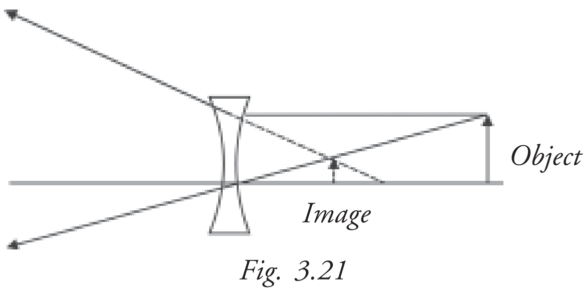


Fig. 3.21

Characteristic of the image in convex lens

Case (i): Object located between the lens and principal focus (Fig. 3.22).

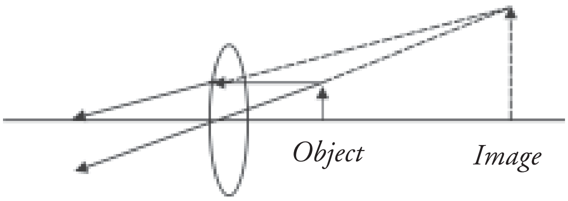


Fig. 3.22

Image if formed on the same side of the lens as the object; virtual, erect and magnified. This is the principle of a magnifier.

Case (ii): Object located between the principal focus (F) and twice the focal length (2F) on one side.

Image is formed beyond 2F on the other side, real, inverted and magnified (Fig. 3.23).

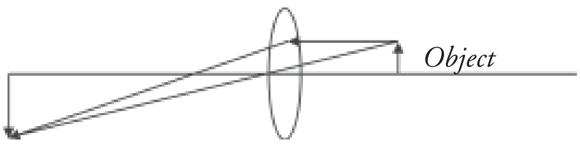


Fig. 3.23

Case (iii): Object beyond 2F on one side

Image is formed between F and 2F on the other side, real, inverted and smaller in size. Convex lens is used in the correction of long sight (hypermetropia / hyperopia). Objects seen through such a lens appear farther than where they actually are (Fig. 3.24).

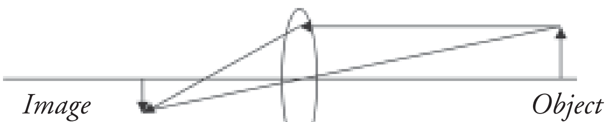


Fig. 3.24

Quick test for lenses

To distinguish between positive and negative lens look at an object at a distance from the lens and move the lens gently. If the image also moves in the same direction (with motion) it is negative lens. If the image moves in the opposite direction (against motion) it is positive lens.

Prism power in lenses: Prentice rule

A spherical lens has prism power for every point in it except for the optic center, at which the prism power is zero. In plus lenses, the prism power bends light rays toward the optic axis, and in minus lenses, it bends away from the optical axis. Prism power increases with the distance of the point from the principal axis.

Using the principle of similar triangles it can be shown that the prism power corresponding to point A at a distance 'y' from the principal axis is the product of the lens power and the distance y. This is Prentice rule (Fig. 3.25).

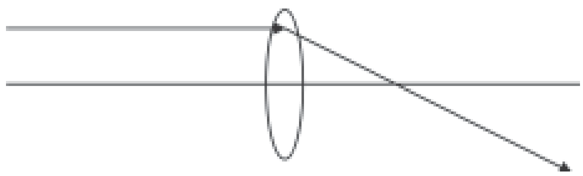


Fig. 3.25

This has application in designing the reading lens part of bifocal spectacle lens for patients with presbyopia. The prism effect helps in bending the rays up to avoid looking down through the reading lens and in reducing the convergence of the eye required for looking at close objects.

Decentration

Prism effect comes into play when the distance between the optic centres of the spectacle lens is not in line with the pupils of the patient. Looking through such spectacle lenses will cause discomfort. This is known as decentration.

Cylindrical lenses

Lenses in which one of the curved surfaces is cylindrical are known as cylindrical lenses. They are used in correcting astigmatism (Fig. 3.26).

A cylinder has no curvature in a direction parallel to its axis. So it has no refractive power in that direction. It is curved in the direction perpendicular to its axis and therefore has a refractive power. The refractive power of a cylindrical surface is also P = (n – 1) / r, as in the case of spherical surface, r being the radius of curvature of the cylinder. With a cylindrical lens one gets a focal line instead of a focal point.

Astigmatism arises when one of the patient's eyes has different powers in different axes. The extra power needs to be added or subtracted in any required axis with the help of positive or negative cylindrical lens.

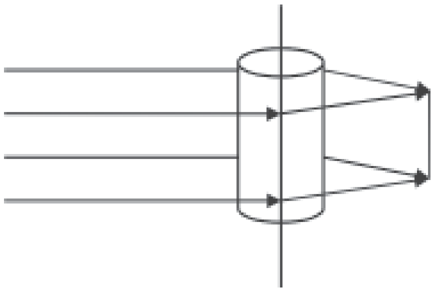


Fig. 3.26

Other properties of light

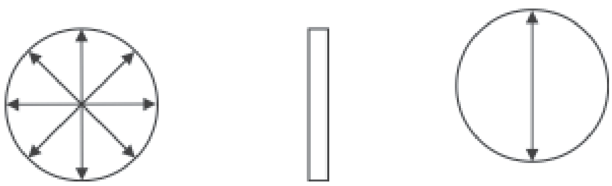
Some of the other properties of light are as follows. They arise because of the wave nature of light.

Scattering

Particles of dust, moisture, scratches on mirror, lens and prism surfaces cause scattering (irregular reflection) of light. Scattering results in loss of brightness and glare.

Polarisation

Light waves are transverse in nature. The vibrations of electric field (or magnetic field) that constitute light are at right angles to the direction of propagation of light. Ordinary light is unpolarised and has vibrations in all directions. Unpolarised light under going polarisation has the vibration confined to one direction. Reflection of light (unpolarised) from some surfaces also gives rise to polarised light (Fig. 3.27).



Unpolarised light *Polaroid* *Polarised light*

Fig. 3.27

When polarised light is viewed through a polaroid there is variation in the brightness of light seen through it depending on its orientation. The light is even cut off in two orientations. This property of Polaroid to cut out strongly polarised reflected light is used in special sun glasses known as Polaroid glasses.

Vergence

This is a useful concept used by optometrists in their calculations (Fig. 3.28).

A parallel beam of light neither converges nor diverges. Its vergence is defined as zero.

A converging beam of light has positive vergence while a diverging beam has negative vergence. The vergence of a beam is measured in dioptre units. The vergence of a beam at a location is the reciprocal of the distance of the location in meter units from the point where the beam converges or appears to diverge.

A positive lens having a power + D introduces a positive vergence of D to a parallel beam of light while a negative lens of power – D introduces a negative vergence of D to a parallel beam of light.

Converging beam (+) *Diverging beam (-)*

Fig. 3.28

Common refractive problems and correction

Fig. 3.29 - Emmetropia with accommodation relaxed. A, Parallel light rays from infinity focus to a point on the retina. B, Similarly, light rays emanating from a point on the retina focus at the far point of the eye at optical infinity

Emmetropia

Emmetropia is a normal refractive condition of the eye that parallel rays of light from a distant object are brought to focus on the retina without any accommodative strain resulting clear vision at all distances (Fig 3.29).

Ametropia

Ametropia is a abnormal refractive condition of the eye in which the light rays from infinity comes to a focus either in front or behind the retina without any accommodative effort. It may be classified as Myopia or short sightedness and Hypermetropia or long sightedness.

Myopia

Definition

Myopia is defined as that optical condition of the non accommodating eye in which parallel rays of light entering the eye are brought to a focus infront of the retina.

The uncorrected non accommodating myopic eye has some point at a finite distance beyond which objects will not be seen clearly. At this far point, an object will be in clear focus, but with increasing distances beyond it, the image becomes progressively more indistinct.

Eetiology of myopia

Myopia is of three types. They are:

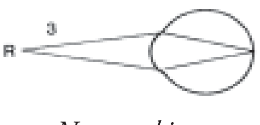
a. Axial Myopia: It occurs due to the excessive axial length of the eye than normal.

b. Curvature myopia: It is mainly due to the steepness of the cornea as well as lens curvature.

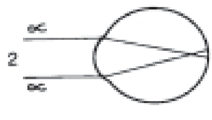
c. Index myopia: It occurs due to the increase of the refractive index of the crystalline lens usually in older age.

Management

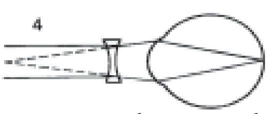
Correction glasses, contact lenses and refractive surgeries are the treatment modalities available (Fig.3.30). Concave lenses are used to correct myopia.



Nearer objects



Father objects



Correction with concave lens

Fig. 3.30

Hypermetropia

Definition

It is a refractive error in which parallel rays of light are brought to focus some distance behind the sentient layer of the retina when the eye is at relaxed.

Etiology

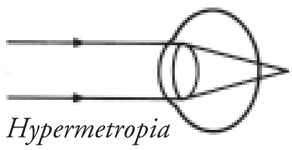
- Axial - Physiological and Pathological
- Curvature
- Index

Optical condition

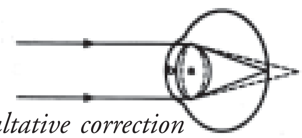
Parallel rays come to a focus behind the retina and the diffusion circles which are formed result in a blurred and indistinct image.

Types of hypermetropia

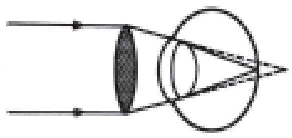
Total hypermetropia may be divided into



Hypermetropia



Facultative correction



Correction with Convex lens

Fig. 3.31 - Optics of hypermetropia

1. Latent hypermetropia - overcome physiologically by the tone of the ciliary muscle.
2. Manifest hypermetropia
   a. Facultative - overcome by accommodation
   b. Absolute - cannot be overcome by accommodation.

Natural course

- At birth - 2-3 dioptre of hypermetropia
- It diminishes until after puberty the refraction tends to become emmetropic.

Clinical features

1. Blurring of vision for close work
2. Symptoms of eye strain
3. Convergent Squint

Management

Hypermetropia is corrected by using convex lenses

1. The general principle is that if the error is small, the visual acuity is normal and there is no eye strain or no squint, treatment is unnecessary.
2. In young children below the age of 6 or 7, some degree of hypermetropia is physiological and a correction need be given only if the error is high or if the strabismus is present. If the error is greater than 3 diopters, it is probably wise to advise that correcting lenses be worn constantly.

In older children it is wise to base the correction on a subjective test carried out after cycloplegia has worn off.

Astigmatism

It is a refractive error where a point focus of light cannot be formed upon the retina.

Aetiology

1. Curvature astigmatism
2. Centering error of lens
3. Index Astigmatism

Symptoms

1. Reduction in visual acuity
2. Aesthenopia and eye strain are more when the error is small
3. Headache
4. Reflex nervous disturbances such as dizziness, neuroasthemia, irritability and fatigue.

Optical condition

Instead of a single focal point there are two focal lines. They are separated from each other by a focal interval.

Regular astigmatism

1. Simple - Simple hypermetropia
   Simple myopic
2. Compound - Compound Hypermetropic
   Compound Myopic
3. Mixed

When the vertical curve is greater than the horizontal - it is called 'with the rule astigmatism' and the opposite condition is called 'against the rule' astigmatism.

Management

Cylindrical lenses are used in the correction of astigmatism

1. Spectacles
   - 0.5D or less with no decrease in vision and no asthenopia, no need to treat it.
   - If there is decrease vision or aesthenopia correct it fully. If we don't fully correct, any difference that is left to the patient to correct by his own efforts and if the patient is forced to do so, the symptoms of eye strain may continue or be exaggerated.
   - In adults with high power who have never worn glass, the unaccustomed effect of cylinders of considerable power makes the object appear distorted and causes distress. So it is best to under correct first, until they become used to it when at a later date a full correction may be comfortable.
2. Contact lenses

3. Surgery: removing the sutures in the axis of more plus cylinder or putting extra sutures in the axis right angles to it.
4. Excimer - keratomileusis

   Treatment of irregular astigmatism is by

   1. Contact lens 2. Keratoplasty

Presbyopia

Definition

As the age advances, it becomes more and more difficult to see near objects distinctly, that is the near point gradually receeds due to the loss of accommodative ability of the crystalline lens. It usually manifests around the age of 40.

Causes

1. As the age advances lens become harder and less easily moulded so that the elastic force of the capsule is no longer greater than the resistance of the lens substance.
2. Progressive increase in the size of the lens together with similar changes in the ciliary body reduces the circumlentral space, so that the zonule become slackened and works at a disadvantage.

Symptoms

- A hypermetropic starts life with his near point considerably further away than that of an emmetropic so that the symptoms of presbyopia will come earlier on.
- In a myope, the opposite condition holds, if he has an error of -4D, presbyopia will probably never occur.
- Small print becomes indistinct and in order to get within the limits of his recording near point, patient tend to hold his head back and his book well away.
- Sooner or later eye strain
- Headache.

Management

It is to provide the patient with convex lenses, so that his accommodation is reinforced and his near point brought within a normal working distance. A good practical hint is to make sure that with the reading correction patient is able to read the near vision chart not only at his reading distance but also some 12-15cm further away.

In some patients the cause of strain may be excessive convergence, in this case it can be relieved by using base in prisms or by decentering the lenses by a corresponding amount.

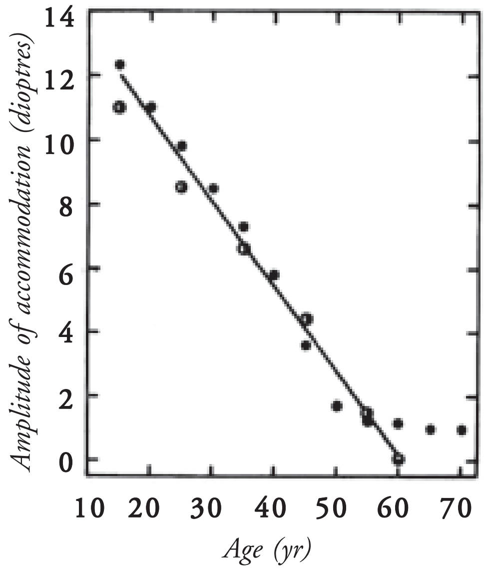


Fig. 3.32

Lenses

This section deals with lenses, their types, their characteristics and designs. Classification has been made according to material and by how they are designed.

Corrective lens

A corrective lens is used to avoid or minimise the distortions through the edges of lens. In theory the Base Curve should have a same curvature, which coincides with the corneal curvature of the rotating eyeball, so as to maintain the proper vertex distance between cornea and the spectacles in all gazes and avoid distortions. Each manufacturer has an individualised series of base curves for toric meniscus lenses. Corrected lenses are in different designs but mainly in meniscus lens form which usually are ground on 6.00D Base curve.

A toric lens is curved like a meniscus lens but also contains a cylinder that formerly has been ground on a convex surface in single vision lenses and on a concave surface in bifocal lens.

Types of corrective lenses

Two principal types of eyeglass lenses are manufactured to correct vision: The corrective lenses are sphere, cylinder and combination of both sphere and cylinder and prisms. These corrective lenses are commonly given in either monofocal (single-vision lens) or multifocal (bifocal, trifocal and varifocal) forms.

Single-vision lenses, have the same power throughout a lens which corrects only one-either distance or near.

Multifocal lenses, combine two or more corrections in a single lens to provide sharp vision at more than one distance.

As part of the process of refraction, the doctor decides which type of lens would most benefit a particular patient.

Lens materials

Glass

Until recently, glass was the most commonly sold lens, mainly because it was cheaper and more resilient to scratches than plastic. All glass lenses do not scratch as easily as plastics lenses (even coated). However, it is much heavier and it also shatters on impact making it dangerous and unsuitable for dispensing to children and persons with an active lifestyle. It is very expensive for plastic lenses to be made photochromatic; hence glass is still in demand as a cheaper photochromatic option.

Common types of glass used are

- Crown glass (μ=1.523): It has a very hard surface – it is the hardest of all the spectacle lens materials and it has the highest Abbé number available in an ophthalmic lens (v=60) making it very clear. It is a soda lime- silica material that contains about 70% silica, 12% calcium oxide and 15% sodium oxide and some other materials in smaller percentages like potassium, borax, arsenic etc. It is extensively used for making single vision ophthalmic lenses and to make the main lens in a fused bifocal lens.
- Flint glass (μ=1.65 to 1.75, v=27 to 33): It is used for the reading area of fused bifocals. It is significantly softer than crown glass. Flint glass, material (1.620) is used in the making of bifocal or achromatic lens. It contains 60% lead oxide, 30% silica, 8% soda and potash and small percentage of arsenic. The lead oxide material increases the refractive index of glass as well as specific gravity and weight. This material is used for making the bifocal segment. It produces high chromatic aberration.
- High index glass (μ=1.8 to 1.83, v= 25 to): The higher the refractive index of the material, the lesser curvature is required to be ground on the back surface of the lens to make the high power lens. Approximately the thickest lens has a refractive index of 1.5 and the thinnest lens has a refractive index of 1.9.When it compares to the conventional lens materials, a 1.60 refractive index lens is approximately 25% thinner than a thick lens and

  a 1.67 index lens is approx. 40% thinner

  a 1.70 index lens is approx. 50% thinner

  a 1.80 index lens is approx. 60% thinner

  a 1.90 index lens is approx. 75% thinner

This is still preferred as the index is higher than the highest plastics index available. As the Abbe value decreases with increase in index it is important to coat hi-index lens with anti - reflection coatings.

Plastic

Plastic lenses have almost the same refractive index as glass, making them only very slightly thicker than glass. And they weigh only half as much as glass lenses and do not shatter easily – which makes them more comfortable and safer. However, plastic lenses are more prone to scratches and they become yellow over time. But this has been overcome today by enhancements in scratch-resistant coatings. Plastic lenses are available in almost all ranges as glass lenses and soare fast replacing glass in the spectacles industry.

Common types of plastic used are

- CR39 (Allyl diglycol carbonate) (μ=1.49 to 1.5, v =54 to 60): It has the lowest refractive index of any plastic material currently used as a spectacle lens. Thus it is suitable for smaller powers. The finished weight of the lenses is about half that of glass and they have a considerable mechanical strength advantage. However, as it is thicker, CR39 has never been popular for high corrections. Even uncoated CR39 can resist scratches to a good extent but it is easily scratched if misused. CR39 can be tinted easily and satisfactorily A.R. coated.
- Note: CR 39 was invented in the research work undertaken during the World War II. This was the 39th formula of the series of Columbia Resins (CR) produced for airplane fuel tanks by the Columbia Chemical Co. Hence, it is called CR 39.
- Polycarbonate (μ=1.586, v=28 to 30): This lens has phenomenal impact resistance that makes it almost "bullet-proof". Hence it is highly suitable for safety eyewear – industrial and sportswear. It is very light and because it is non porous, tinting it is difficult. Today, polycarbonate lenses are dispensed for high myopes, as the lens is relatively thinner. Also, as it has a low Abbé value – it is recommended to dispense with Anti-reflective coating. When dropped from a height of about 1 inch above a countertop, polycarbonate lenses make a distinctive high- pitch sound. The sound is similar to that of dropping a poker chip in the same manner.
- Polymethlmethacrylate (PMMA) (μ=1.49, v=58): This is a tough plastic material used for lens manufacturing. With a center thickness of 3.0mm without special hardening process, the PMMA plastic lenses have a thicker profile than glass lenses, they scratch more easily and do not protect the eye from UV rays unless properly tinted.

Lens forms

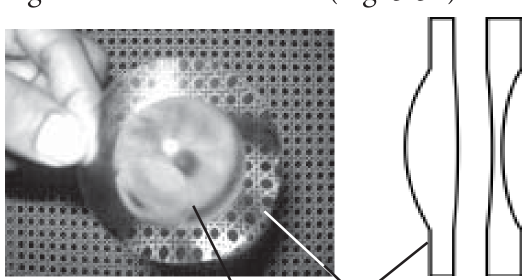
This section discusses the different lens forms or the possible contours of the lens surface. Almost all spectacle lenses are meniscus lenses having - both convex and concave surfaces. Different lens forms have different benefits. For instance, curved lenses are often made flatter to improve the cosmetic appearance.

Single vision lenses

Single vision lenses have the same power or vision correction throughout the lens area. Single vision lens forms can be divided into the following basic categories (Fig. 3.33).

Fig. 3.33

- Flat: If the lens form is flatter, the lens is thinner. Thus the best form of the lens to make it as thin as possible without making the centre too thin (for minus powers) is chosen.
- Lenticular: This lens form is used for high powers – usually more than 10DSph. This form reduces the thickness and weight of high-powered lenses, making them easier to fit. This is done by having only a small circular central area with the actual power. The periphery of the lens is mounted on a longer diameter, thin plano-carrier which is easily edged to fit into the frame (Fig. 3.34).



Power lens *Carrier*

Fig. 3.34 - Lenticular lens

Here the high power lens is cemented onto a base lens. This is the only way that very high-powered lenses can be made. Blended lenticular lenses have the optical power zone blended with the periphery. Lenticular lenses are more conspicuous than blended lenses.

Aspheric: An Aspheric lens is particularly designed to eliminate the peripheral distortions. It has a complex front surface that gradually changes the lens curvature from the center to periphery. In plus lenses, the front curvature of the lens flattens toward the edge of the lens. In minus lenses, the curve becomes steeper toward the lens edge. A conventional pattern lens may be optically correct through its center but causes a increased effect of the lens power as the patients vision moves away from the center to the edges of the lens.

Fig. 3.35

Sometimes aspheric lens can cause reflections off the flatter back surface of the lens because it is positioned slightly closer to the face than conventional lenses. The special coating like AR coating may be a best option to control these reflections and also improves the quality of vision.

Multifocal lenses and design

For Presbyopes there are many lens forms that can cater to different functions and bring different benefits:

Bifocals

The lens has two distinct zones: for distant vision and for near vision. The near vision power is provided by adding or fusing a plus power lens to the distant vision power base lens. This reading segment can be designed in many ways, but it is always found at the bottom of the lens, converging towards the nasal side of the lens. In all bifocals the wearer experiences a "jump effect" when the eye travels from the distant vision zone to the segment – because of the difference in powers. Always warn first time bifocal wearers that they will have to adapt to the lens as there are two zones.

- **Kryptok Bifocal:** Here the reading segment is a small circle. Here the eye of the user has to travel to the centre of the segment to get the maximum reading area (Fig. 3.36).

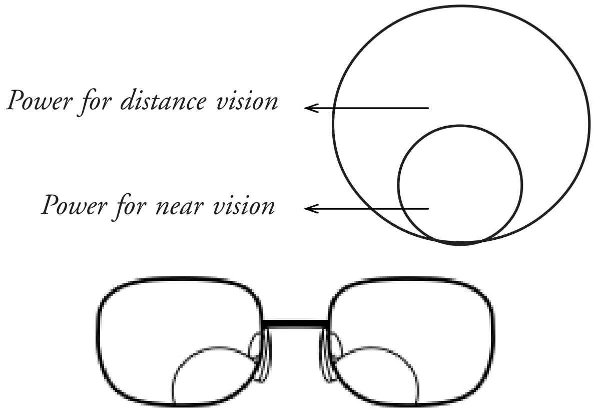


Fig. 3.36

- **D-Bifocal:** The reading segment is shaped like the letter D. This is only available in plastic lenses as it is very expensive to make it with glass. The advantage of a D segment over a kryptok segment is that the maximum reading area is reached at the top of the segment itself, which makes it more comfortable. In this lens, the "jump effect" is also reduced. These are the best form of bifocals that you can recommend (Fig. 3.37).

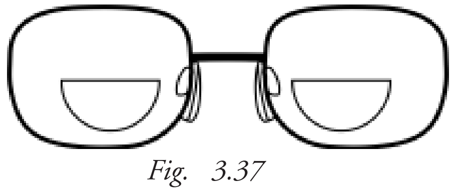
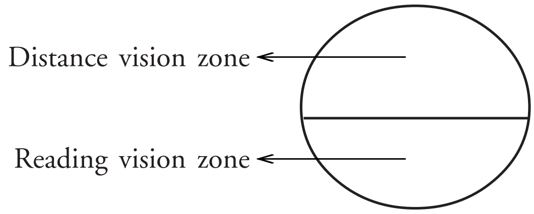


Fig. 3.37

- **Executive Bifocal:** These bifocals have the entire bottom of the lens as the reading zone. This gives a larger reading area but the jump effect is very pronounced. This is usually recommended for those who do a lot of reading and writing. However, if a patient has been using executive lenses it is very difficult for him to adapt to other



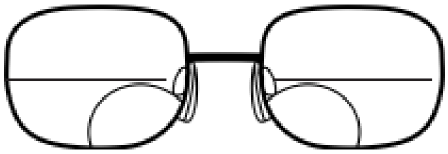


Fig. 3.38

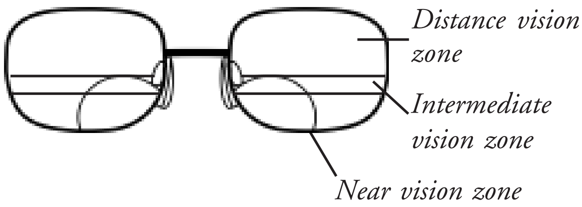


Fig. 3.39

types of bifocals. Thus, these are not highly recommended.

- **Trifocals:** These lenses have three distinct power zones: distant, intermediate and near vision zones.This is not in use nowadays (Fig. 3.39).
- **Varifocal lenses:** Varifocal lenses also called Progressive Addition Lens are designed to give the closest resemblance to vision with a normal eye, as these are not distinctly divided into zones. Instead, they have the power increasing gradually from the distant to the near vision zone. There is absolutely no jump effect. The lens is more comfortable as powers are available for vision at any distance; and not only for fixed distances like > 6m and < 35cm as in bifocals. But the zone of vision is restricted and the peripheral areas by the lower side of the lens are slightly distorted. So, this lens also needs some adaptation time, as the wearer needs to adjust to viewing only along the viewing zone. Advise the patient to learn to tilt his head at different angles, to focus on objects

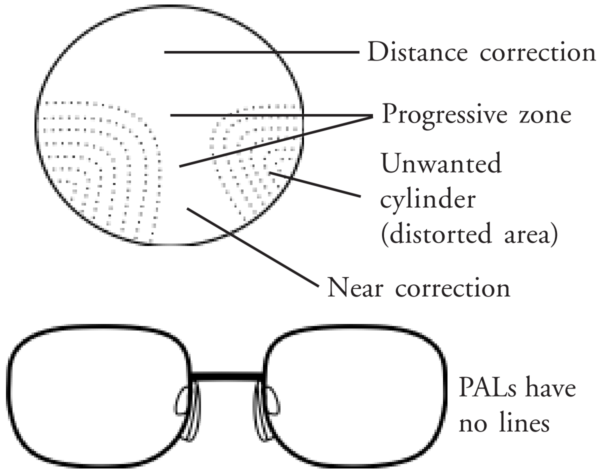


Fig. 3.40

at different distances. This lens is more comfortable and cosmetically more appealing as there is no distinct segment (Fig. 3.40).

Progressive lenses have been developed over the years to increase adaptability, comfort and its flexibility to suit any frame. These lenses are broadly classified into the following types based on their design:

- Hard design PAL: Hard design lenses have a narrow progressive zone i.e., wider distortion areas with a little reading area.
- Soft design PAL: Hard designs have been improved to reduce the distorted area and increase the reading area. In soft design, the progressive zone is much wider that causes very minimal distortion to the wearer and gives an excellent reading area. These designs are very comfortable and easier to adapt to.
- Short corridor PAL: These lenses have a short intermediate corridor enabling the lens to be fitted into smaller frames.

While dispensing PAL lenses demonstrate the clarity of different viewing zones by having the patient focus on objects at different distances. Also, remind the patient that he will take a while to adapt to the lenses; and that he must learn to view only along the progression zone and not the distorted area – in order to view objects on the side he must turn his head instead of moving his eye alone (Fig. 3.41).

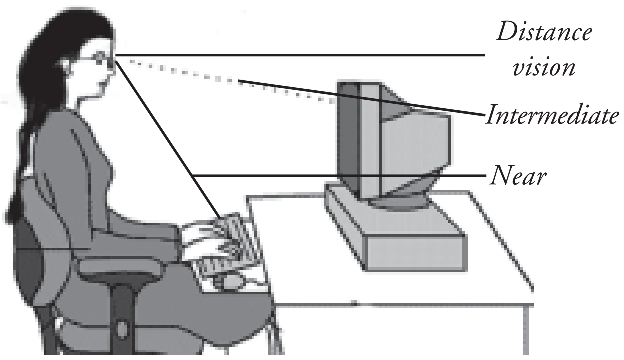


Fig. 3.41

Transposition

Definition

It is a technical formula to change the lens form from one type to another. There are two types of transpositions, Simple and toric transposition.

Simple transpositions are used to convert one form to another, usually "+" to "-". Toric transposition is used to for meniscus and cylindrical lens manufacture.

Rules of simple transposition

1. Algebric sum of sphere and cylinder is a new sphere.
2. Cylindrical power is the same but
3. Sign of the cylinder is reversed and axis of cylinder is changed by 900

Examples

- +2.5 D Sph / +3.0 D cyl x 150°

Answer

- New sphere = + 5.5 D Sph
- New Cylinder = 3.0 D cyl
- Cylinder power & axis = – cyl & (150-90) 60°
- Final Rx : + 5.5D Sph / - 3.0D Cyl x 60°

Another example

- - 5.5 D Sph / + 4.0D Cyl x 150°

Answer

- New sphere = - 1.5 D Sph
- New Cylinder = 4.0 D Cyl
- Cylinder power and axis = - Cyl & (15+90) 105°
- Final Rx: = -1.5D Sph / -4 D Cyl x 105°

Why we do the simple transposition?

Usually we change the lens '+' form into '-'.to reduces the central thickness of lens. It also minimize the peripheral aberration, reduce weight and gives easy adaptation.

Toric transposition

Toric transposition is an application for selecting the proper tool in cylindrical lens surfacing form (e.g., Meniscal) of lens so that it is easy to make a good correcting lenses.

Rules

1. Choose the proper base curve first.
2. Do simple transposition if signs of base curve and cylinder are not same.
3. To find out the spherical surface power, subtract the base curve from sphere.
4. To find out the cylindrical surface power,
   a. Fix the Base curve as a cylinder at right angle to the axis of cylinder.
   b. Add the base curve to the cylinder with axis of the cylinder specified.
5. Both spherical and cylindrical surface determines the lens power. The toric rules are written as a fraction, the numerator value is a spherical tool power and denominator consists of both the base curve and cylindrical require to provide the necessary combination.

Example

+ 1.0 D Sph / + 2.0 D Cyl x 165* (-6.0 Base curve)

Base curve = -6.0

Simple transposition (base curve and cylindrical power are not same)

= + 3.0 D Sph / - 2.0D Cyl x 75*

Spherical surface
power = + 3.0 – (-6.0) = + 9.0 D Sph.

Cylindrical surface
power = - 6.0D Cyl x 165*

-2.0 + (-6.0) = - 8.0D Cyl x 75*

Final Rx = + 9.0D Sph

-6.0D Cyl x 165*/ - 8.0D Cyl x 75*

Another example

+1.0D Sph / +2.0D Cyl x 180* (+6 Base)

Base curve	=	+6.0
Simple transposition	–	not required
Spherical surface power =		+1-(+6) = -5
Cylindrical surface power=		+6 x900
		+2+ (+6) = +8
Final Rx	=	- 5.0D Sph

+ 6.0D Cyl x 90* / + 8.0D Cyl x 180*

Points to remember

Transposition is applied only in optical surfacing lab.

- To choose the correct tool in lens surfacing.
- To bring the lens into proper curvature and thickness.

Measuring lens power

In optics, an ophthalmic lens is constructed so that its refractive power is constant at center of the lens rather than the edge of the lens. Lens power is usually measured by either a conventional method called hand neutralisation or the use of a lensometer.

Hand neutralisation by tial lens method

It is very simple and conventional procedure to neutralise the power of a lens with trial lenses. This method is being qualitatively followed by many practitioners (Fig. 3.42, Fig. 3.43).

Procedure

1. First checking of a lens often involves simply identifying if it is a sphere or cylinder in '+' or '—' form lens.
2. Hand neutralisation is usually done by viewing a distant cross target through the lines whose limbs extend beyond the lens edge.
3. The lens is moved up and down, and left and right to ascertain the presence of a 'with' or and 'against' movement.
4. A 'with' movement is seen with minus powered lenses and an 'against' movement is seen with plus powered lens.
5. Movement is neutralised using an opposite power trial lenses. That is, a 'with' movement occur in concave lens is neutralised by placing the '+' power trial lens in contact with the unknown power lens.
6. The power of the trial lens is increased until no movement of the cross hairs is seen.
7. If the unknown lens is spherical, the movement and speed will be in the same in both principal meridians.

Fig. 3.43

Fig. 3.44

How to find out the cylindrical power

If the lens is cylindrical or sphero-cylindrical then every meridian needs to be neutralised one by one.

1. To find the principal meridians hold the lens against the cross-hairs.
2. Rotate the lens about it optical axis.
3. At some positions, the appearance of cross-hairs through the lens will not be continuous with those outside the lens and will not be at right angles to each other.
4. Rotate the lens so that the lines within the view of the lens are continuous with those outside the lens. This will constitute the principal meridians; these can be marked and individually neutralised. This will constitute the principal meridians; these can be marked and individually neutralised.

Lensometer and procedures

The lensometer is also known as Focimeter or a vertometer (Fig.3.45). The main use of the lensometer is to measure the back or front vertex power of a spectacle lens. The optical centre of the lens is located in order to position the lens correctly, relative to the visual axes and the centre of rotation. When the optical centre is positioned correctly in the lensometer, the sphere, cylinder and its axis and prism power can be measured. The power of the lens is measured by placing on the lens stop.

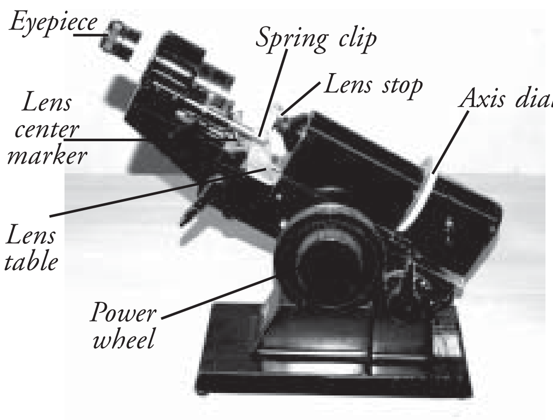


Fig. 3.45

Procedure

Focusing the eyepiece

The eyepiece should be focused at each use as the setting will vary between individuals. Rotate the eyepiece until fully extended from the instrument (usually by rotating the eyepiece as far as possible in an anticlockwise direction). The graticule visible through the eyepiece will now appear blurred. The eyepiece should then be rotated in a clockwise direction until the target crosshairs and the graticule just come into focus. Continued rotation of the eyepiece will force the observer to accommodate in order to keep the graticule in focus. Accommodating whilst viewing the target can cause variability in the power measurement. With the power wheel at the zero position, the cross hairs and the target should be in clear focus. Failure to focus the eyepiece will result in incorrect readings of lens power.

Determining the lens power (Spherical lenses)

If all the lines or dots of the target are in focus at a given setting of the power wheel, the lens is spherical.

Marking the optical centre

1. Check that the centre of the lens coincides with the centre of the target.
2. When this is so, the lens is correctly positioned and the optical centre could be marked.
3. While there is no centre dot, the whole set of dots can be 'framed' within the lines of the graticule to locate the centre.
4. Repeat the same procedure for the other lens.

Determining the lens power (Sphero-cyl lenses)

- Step 1 (finding the sphere power) Rotate the power wheel until one set of lines (stretched dots) becomes clear. Start with the higher positive power (or lower negative power). The axis drum will need to be rotated to ensure that the lines are unbroken. Note the power on the power wheel.

- Step 2 (finding the cyl power) Rotate the power wheel until the second set of lines (stretched dots) becomes clear. The second power reading minus the first reading will give the power of the cyl (and its correct sign).
- Step 3 (finding the axis) Note the direction of the lines (stretched dots) at the second reading. This is the axis. The rotatable line in the graticule is used to line up with the stretched dots to determine the axis.

Examples

- Step 1 (finding the sphere power) Rotate the power wheel until one set of target (lines or dots) becomes clear. Start with the higher plus power (or lower minus power). The axis drum will need to be rotated to ensure that the target is unbroken. Note the power on the power wheel. In this case the power reading is +2.00D.
- Step 2 (finding the cyl power) Rotate the power wheel until the second set of targets becomes clear. The second power reading minus the first reading will give the power of the cyl (and its correct sign). In this case the second reading is – 1.00D. So the cylinder power is: -1.00 and + 2.00 becomes -3.00D.
- Step 3 (finding the axis) Note the direction of the lines at the second reading. This is the axis. The lines are lying at 90 degrees.

So the lens power prescription is +1.00/-2.00 X 90 degrees.

Determination of prism power with lensometer

The lens is correctly positioned with the optical centre on the lens stop. If the target is displaced either vertically or horizontally, then the prism is present in the lens.The direction of the displacement of the focimeter target indicates the base direction of the prism. Thus, if the target is displaced upwards from the centre of the crosshair, base up prism is present in the lens. The value of the prism is measured from the centre of the target to the centre of the eyepiece scale.

Conclusion

Accurate measurement of lens power and the location of the optical centres is an important part of the successful prescribing and dispensing of ophthalmic lenses.

Lens - special features and coatings

Lenses also come with additional features such as being photochromatic, tinted or coatings that bring more advantages such as glare control or scratch resistance. Some of these common features are discussed below (Fig. 3.46).

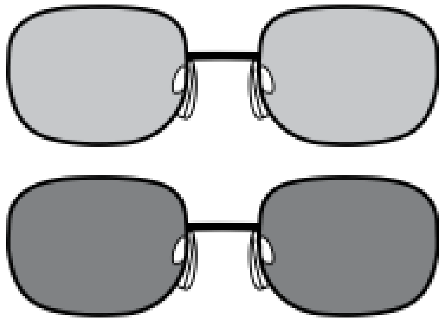


Fig. 3.46

Tinting

This is usually done to reduce the transmission of light when protection from harsh lights is necessary. Thus, while tinted lenses protect from sunlight, they tend to be unsuitable for indoor lighting. Tint colours include: Pink, Blue, Yellow, Grey, Black, Brown, and Green. Tinting methods are of the following types:

- Solid Tints: The tint is distributed (usually) evenly throughout the lens material. Thus even if scratched the transmission is still blocked. This is important especially when viewing harmful sources of light such as welding arcs. The drawbacks of solid tinted lenses are that a different stock lens is needed for each colour and that the depth of tint depends on the lens thickness, hence high prescriptions look odd – darker in the middle for plus lenses, darker at the edge for minus lenses.
- Surface Tints: In glass lenses, this is applied by a vacuum coating process, in which the tint material is evaporated in a vacuum chamber then

recondensed on the cooler lens surface. They are normally on a single surface, so scratches allow transmission. Plastic lenses are tinted by immersing a clear lens into a bath of dye solution. The dye penetrates evenly, but not very deeply, over the whole surface of the lens and a uniform tint is produced. Lenses can also be tinted in a gradient – with one end darker and fading out towards the other end.

- Tinting in high power lenses: Usually the tinting is done either with lens itself or on surface of the lens. In high power lenses tinting gives uneven colouring across the lens. The '+' lens, absorbs more tint at centre and the '-' lens peripheral part absorbs more tint at the periphery. Tinted power lenses are not advisable because it reduces the actual illumination, disturbs the clear vision at near, decrease the functional vision especially in high-powers and ultimately may cause poor cosmetic appearance to the wearers.

Photochromatic lenses

These are used to protect from sunlight and UV rays. These lenses are clear in the shade and indoors and darken when exposed to UV/sunlight. These lenses are ideal for spectacle wearers who need to work outdoors. This effect is brought about by Silver Halide, which is transparent. On exposure to light, this breaks down to silver + halogen. The silver is opaque and hence the lens darkens. Earlier these lenses reacted only to UV light and only at low temperatures, but this problem has been overcome. Photochromatic lenses can be made from glass as well as plastic. Although they totally block UV rays, the darkening performance of plastic is not as good as glass. Also, the life of the current plastic photochromatic materials may also be limited. Photochromatic dyes are solid tinted in glass and surface tinted in plastics. Photochromatic lenses are available in Photo-Grey, Photo-Brown and Photo-Green tints. Some fancy lenses are also available in other colours such as blue and pink (Fig. 3.47).

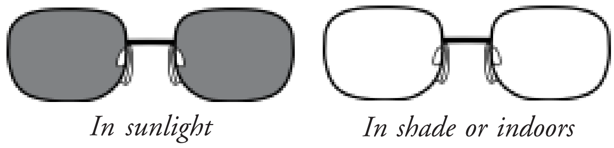


Fig. 3.47

Scratch resistant coating (SRC)

All plastics lenses need to have scratch resistant coatings as they are relatively soft and easily scratched in comparison with glass. As many of the higher index plastics have a softer surface than CR39, a hard coating is a must. Hard coatings can be applied by the following methods: dipping the finished lens, spin-coating, along with the lens as it is being cast, or by vacuum coating. An AR coat increases the surface hardness of a plastic lens to some extent.

Anti-reflection coating (ARC)

At any lens surface, some light is lost by reflection. Artificial powerful lights (i.e.) halogen lights in cars and trucks and computer monitors can cause reflections in uncoated lenses. When light passes through spectacles some light rays are reflected by front and back surface of the lens producing ghost images. From 4% (normal index) to 9% (high index) of the incident light is lost. AR coatings reduce this loss by increasing the transmission, up to 99%. Some lens suppliers only coat one surface, this is not very effective. Both surfaces should always be coated. The colour of an AR coat is seen in reflected light, therefore the coat looks green or blue. AR coating is now given as a multi coat along with hard coat. Multilayer coats increase transmission for different wavelengths of light. Once a lens has been AR coated, it is difficult to apply any other surface coatings. AR coatings enhance the quality of vision by cutting down the glare induced by lens wearing and also improve the looks of the wearer as the reflections on the front surface of the lens are reduced and the wearer's eyes are clearly seen. AR coated lens should be cleaned with proper special cleaning solutions. AR coated lenses are readily available in market and it can be coated separately too.

Water repellent (hydrophobic) coating

This coating is especially useful for those who frequently go between hot and cold environments, as it does not allow moisture to stay on its surface. This also makes cleaning much easier. Most AR coated lenses have hydrophobic coats.

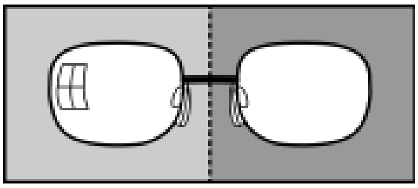


Fig. 3.48

Polarising lenses

Here a polarising film is placed between two layers of CR39 or glass. Polarising lenses are always grey without additional tinting. They eliminate 99.9% of glare from horizontal surfaces: roads, water and snow. They also improve vision and comfort, provide 100% UV protection and are ideal for driving. These are available in single vision, photochromatic, bifocal and progressive type lenses.

Other corrective methods

Contact lenses

These are thin plastic wafers which are designed to rest over the cornea or sclera to correct refractive errors. Leonardo de Vinci is known as the "Father of Contact Lenses". Contact lenses are classified into the following types based on the type of material that they are made of:

- Hard Contact Lens: These are usually made of PMMA (Poly methyl-methacrylate) and so have minimal flexibility. The recommended wearing schedule for these is 8 to 10 hours a day. These are ideal for patients with keratoconus and those with high astigmatism.
- Semi-soft Contact Lens: These are usually made of CAB (Cellulose acetyl butyrate) or Fluorosilicon. The flexibility is moderate. The recommended wearing schedule for these is 8 to 10 hours a day.
- Soft Contact Lens: These are usually made of HEMA (Hydroxyl ethyl metha acrylate) and have good flexibility. The recommended wearing schedule for these is 10 to12 hours a day. But this can provide correction for astigmatism less than 1.25 DCyl only. The types of soft contacts are
  - Cosmetic: Regular and color lenses
  - Prosthetic: for corneal opacity; used by patients with Leucoderma
  - Therapeutic: Used as treatment for conditions like Bullous Keratopathy
  - Toric: For Astigmatic correction in the range up to -6 DSph and -3.25 DCyl

The following are indications for use of contact lenses

- All refractive errors
- Anisometropia
- Anisokonia
- Unilateral aphakia
- Keratoconus
- Corneal opacity
- Aniridia
- Nystagmus with refractive error

Contact lenses SHOULD NOT be used if the following contra indications are noticed

- Any inflammatory conditions in the eye
- Dry eye
- Allergies
- Pregnant women
- Uncontrolled Diabetes

Contact lenses have the following advantages over spectacles

- Field of vision is high
- Cosmetically better
- No Diplopia
- No peripheral aberrations
- No chromatic aberrations
- Sharp vision

However, these disadvantages are noticed with contact lenses:

- Old patients may have a lack of dexterity and thus handling contacts becomes difficult
- Wearers have a foreign body sensation
- Contacts are easy to lose and lens spoilage is high due to breakage, dislodgement etc; this can lead to high recurrent expenditure
- They can cause corneal complications like erosions, ulceration, edema, vascularisation
- Spectacles are anyway required for reading (or distance vision) in presbyopes

Fitting techniques

- For soft contact lens:
    - The diameter of soft contact lens should be 1.5mm more than the limbus
    - The base curve of soft contact lens should be 1.25 mm flatter then the flattest keratometric value
    - It should have equal coverage in all meridians and should have ideal movement of at least 1mm

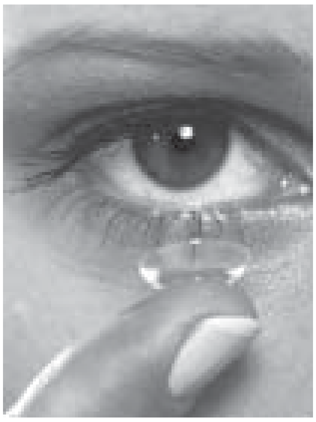


Fig. 3.50

- For Semi-soft & Hard contact lens:
    - Ideally the diameter of semi-soft and hard contact lens should be less than the cornea
    - The fitting of semi-soft and hard contact lens is entirely based on keratomery value
    - But for the selection of first trial lens, the base curve must fall on the mean keratometric value
    - Fluorescein pattern can be studied for fitting evaluation

The following guidelines should be explained to the contact lens wearer:

- Hands should always be washed with soap before handling contact lenses
- Contact lenses should be used for more than 10 hours at a stretch
- Contact lenses should be removed while sleeping
- Store the lens in the given lens case when not in use. Fill the case with the solution till the lenses are submerged. Remember to store the correct lens (right/left) in the correct cup

Fig. 3.51 - Contact lens cases

- Cosmetics should be applied only after insertion of contact lenses
- Lenses should be cleaned regularly with the prescribed solution
- Rinse both sides of the lens by rubbing it well

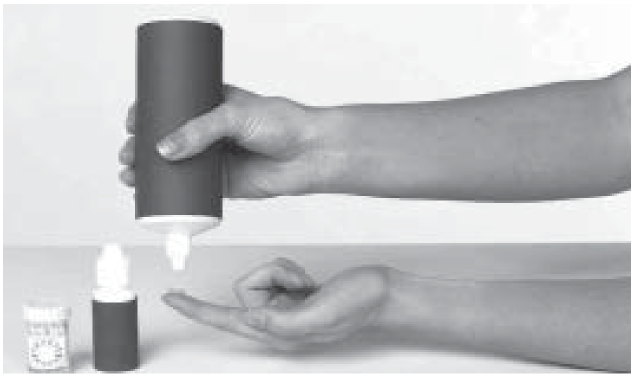


Fig. 3.52

- Soak the lens for a minimum of 6 hours in the solution. This helps in cleaning, disinfecting, protein removal and conditioning of the lens
- Never clean the lens with tap water
- An ophthalmologist should be consulted when any irritation is felt in the eyes

Low vision aids

When visual impairment cannot be corrected by spectacles, medicine or surgery, low vision aids are an alternative. Many people around the world with permanent visual impairment have some residual vision which can be used with the help of low vision aids. Those with low vision often exhibit the following signs:

- Difficulty in recognizing a familiar face
- Difficulty in reading - print appears broken, distorted or incomplete
- Difficulty in seeing objects and potential hazards such as steps, walls, uneven surfaces and furniture

Magnification and types

There are several ways in which an image can be enlarged for viewing by a low vision patient:

- Optical magnification: Magnifying the object by means of a lens or combination of lenses like magnifiers and telescopes
- Relative Size Magnification: Increasing the size of the real object, for example large print books or televisions with larger screen size
- Relative Distance Magnification: Reducing the distance of the object, for example, moving the reading material closer to the eye or going closer to the writing board
- Linear magnification: The linear magnification or transverse magnification means the images projected on a screen in a linear dimension. The image size corresponds to the size of the object creating it.

Traditionally the power of low vision devices is denoted as 'x', which means the relative increase in the image size to the object size. Each 'X' represents four dioptrical powers (4D). For example a 2x (equivalent of that provided by 8D) would mean an increase in the image size by two times. As different manufacturers use different methods to calculate this, there is a growing trend to move away from this labelling and today, the powers of magnifiers is denoted in dioptres or as equivalent viewing distances (EVD).

Magnifiers

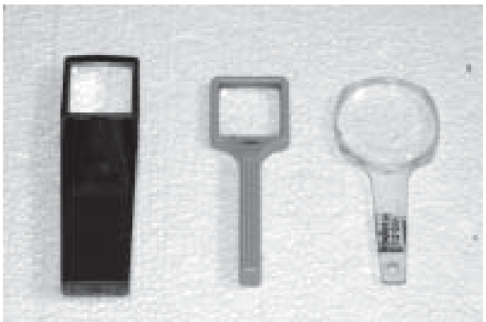
Magnifiers are lenses that enlarge images. These are usually used for desk work. They come in the following models for specific activities:

- hand-held magnifiers
- hanging magnifiers
- stand magnifiers
- illuminated hand-held/stand magnifiers
- spectacles magnifiers
- bar magnifiers
- dome magnifiers

A lower power magnifier, though it has a larger diameter or field of view, will only create a smaller image. A higher power magnifier will have a narrower field of view but the image will be larger.

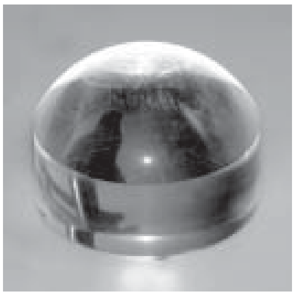
Spectacle magnifiers are the most commonly prescribed magnifiers. They are used for binocular viewing. Hand held magnifiers are used commonly for reading. They come with in-built illumination for increased contrast and clarity.

Fig. 3.53



Hand-held magnifier

Stand magnifier



Dome magnifier

Desk magnifier

Fig. 3.54

Telescopes

A telescope magnifies the image at all distance. Telescopes are basically constructed based on the Galilean and Kaplerian principle. It is available in the ranges of magnification from 2x to 12x. Nowadays, the modern telescopes are available which automatically focus according to the user's distance. The telescopes are practically not comfortable for prolonged use but it may be best in static situations i.e., watching TV, and seeing the blackboard in classrooms. Telescopes may be attached to prescription eyewear to create what is called a bioptic system. Bioptic eyewear design has evolved from large telescopic tubes to smaller, more cosmetic telescopes. These are prescribed for distance and intermediate vision. Types of telescope include:

- Hand-held
- Clip-on
- Spectacle mounted
- Bioptic designs

Fig. 3.55

Glare control devices

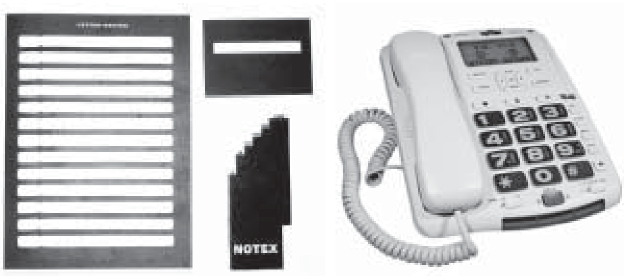
As glare may be a significant disabling factor in many eye conditions, tinted lenses are routinely prescribed. Tinted lenses are absorptive filters, which are used to reduce glare prescribed to improve the functional vision by reducing glare and light sensitivity and increasing the contrast. Different tints are available which offer various levels of absorption and different cut-off points for the visible spectrum of light according to the patient's specific need. As glare and photophobia may be a significant disabling factor in many eye conditions; it is also recommended along with caps and visors.

Closed circuit television (CCTV)

Magnification from telescopes, magnifiers and microscopic lenses is limited by their design, and can rarely be used successfully above magnification of 20X. Closed circuit television systems are capable of higher levels of magnification and can manipulate the brightness and contrast of the image.

In a CCTV system, a video camera is used in real time to capture the image of the reading material and display it on a monitor. For example, the poor

Fig. 3.56



Writing guides *Phone with large size numbers*

Fig. 3.57

contrast of newspaper print can be enlarged 40X, but it can simultaneously be converted to white letters on a black background. The advantage of a CCTV is in its greater amplitude of magnification of 3x to 100x, normal working distance and reversed polarity (e.g. white on black). However CCTV's can also be used for writing, cutting fingernails and other such minute near tasks. CCTV's have a range of magnification and are made in either black and white, or in color. There are three different kinds of CCTV's, each offering its own advantages:

- Free-standing Units: These units consist of a monitor on top of a flat platform. The user places the material to be read on the platform and moves the platform around to read. The magnification can be adjusted.
- Portable CCTV's: Portable CCTV's can be plugged into any television. A device about the size of a computer mouse is rolled across the material to be read and the magnified image appears on the TV.
- Truly Portable CCTV's: These units use the same mouse-like device, but the image appears not on a TV but in a pair of goggles one wears.

The disadvantages are the cost and the bulk of the common free-standing CCTV that makes it quite immovable.

Non-optical low vision devices

Non-optical devices are items designed to promote independent living for the visually impaired individual. These improve environmental perception through enhancing illumination, contrast and spatial relationships. Devices include illumination devices, writing guides, bold-lined paper, needle-threaders, magnifying mirrors, high contrast watches, and large print items.

Other non-optical devices include talking watches, talking calculators, large print books and Speech and Braille conversion systems. With further developments in electronics, more devices are becoming available for people with low vision.

Student exercise

Choose the correct answer

1. *Frames are usually made of the following metal:*
   - *a. Gold* *c. Silver*
   - *b. Nickel* *d. Platinum*
2. *Thermoplastics are*
   - *a. Flexible* *c. Have low melting points*
   - *b. Brittle* *d. Not reusable*
3. *Frame size refers to*
   - *a. Distance between the lenses* *c. Horizontal length of eyewire*
   - *b. Length of the temple* *d. Effective Diameter*
4. *The temple design suitable for those who need to put on and remove their glasses often*
   - *a. Cable bow* *c. Skull*
   - *b. Convertible* *d. Library*

5. *The lightweight metal ideal for spectacles because it is hypoallergenic and tough is*
   a. *Aluminum* c. *Titanium*
   b. *Nickel* d. *Monel*
6. *Half eye frames are designed for*
   a. *Sportswear* c. *Reading glasses*
   b. *Distance only* d. *Children*
7. *Which plastic material is used in the manufacture of safety eye shields*
   a. *Cellulose acetate* c. *Optyl*
   b. *Polycarbonate* d. *Carbon fibre*
8. *In plastic frames the nose pad is usually*
   a. *A part of the frame* c. *Attached with a clip*
   b. *Attached with a screw* d. *Stuck to the frame*
9. *The part of the frame holding the lens is*
   a. *Temple* c. *Eye wire*
   b. *Bridge* d. *Hinge*
10. *Metal frames are given a surface finish by a method called*
   a. *Injection moulding* c. *Electroplating*
   b. *Riveting* d. *Routing*

Lenses

1. *A lens with higher refractive index is*
   a. *Lighter* c. *Thinner*
   b. *Shows less dispersion of light* d. *Cheaper*
2. *Power of a lens is measured in*
   a. *Metres* c. *Dioptres*
   b. *Centimetres* d. *No unit*
3. *Presbyopes who want objects at all distances to be in focus, should wear*
   a. *Trifocals* c. *Plastic lenses*
   b. *Executive Bifocals* d. *Progressive addition lenses*
4. *Glass lens with $\mu = 1.532$ and Plastic lens with $\mu = 1.49$; for the same power, which lens will be thicker?*
   a. *Plastic* c. *Both have same thickness*
   b. *Glass* d. *Both cannot have same power*
5. *Which is a more comfortable lens (less jump effect)?*
   a. *Kryptok bifocals* c. *D Bifocal*
   b. *Trifocals* d. *Progressive lens*
6. *The optic centre of the lens should be in line with the*
   a. *Frame's horizontal axis* c. *Pupil of the patient*
   b. *Geometric centre of the lens* d. *Lower eyelid*
7. *How do you improve the performance of a very high index lens?*
   a. *Use plastic frames* c. *Add photochromatic coating*
   b. *By tinting* d. *Add Anti-reflection coating*
8. *The amount of light dispersed by the lens is measured as*
   a. *Refractive index* c. *Abbe value*
   b. *Focal power* d. *Volts*
9. *Lenses that turn dark when exposed to sunlight are called*
   a. *Tinted lens* c. *Bifocals*
   b. *Photochromatic lens* d. *Polarized lens*
10. *Reading area is maximum in a*
   a. *Progressive lens* c. *Hi index lens*
   b. *D Bifocal* d. *Executive Bifocal*

Other corrective methods

1. *Contact lenses are more preferred to spectacles because they are*
   a. *Cheaper* c. *Easier to handle*
   b. *Offering better field of vision* d. *Easier to maintain*

2. *Contact lens cleaning solution is NOT used for the following action*
   a. *Cleansing*
   b. *Protein removal*
   c. *Lens conditioning*
   d. *Preserving the power*
3. *Magnifiers are used for*
   a. *Viewing distant objects*
   b. *Making a large image appear smaller*
   c. *Making near objects appear larger*
   d. *Increasing field of vision*
4. *Telescopes are used for reading. (True / False)*
5. *To fit Hard contact lenses, Keratometric reading should be taken (True / False)*
6. *Higher the magnification, more the field of vision (True / False)*
7. *One must always rinse the front surface of the contact lens (True / False)*
8. *CCTV is used to view distant objects clearly (True / False)*

CHAPTER 4 ORDER-RELATED ACTIVITIES

CONTENTS

Receiving the customer and counselling
Face measurements
Order entry
Delivery
Outreach activities
Spectacle accessories

GOALS

To explain the processes and skills required to handle an order for spectacles.

OBJECTIVES

The MLOP should

- Understand the role and skills of a dispensing optician
- Know how to take face measurements
- Know how to take an order for spectacles and deliver it
- Know how spectacles are dispensed at outreach camps
- Understand how to provide spectacle maintenance services
- Know about the different spectacle accessories

CHAPTER 4

Order-Related Activities

Receiving the customer and counselling

It is important to receive the patient or customer into the sales area with a smile and a gentle manner. After welcoming the patient double-check the prescription for the following (Fig. 4.1).

- Patient's name
- Medical record No.
- Age
- Date – if the prescription is over 6 months old - insist on a re-examination
- Power – if the power seems probable for that age group (e.g., A child, usually, should not receive a prescription for bifocals)
- Signature of the ophthalmologist

Fig. 4.1

The staff should be sensitive to the needs of the patient. He should be tactful in gathering information about his or her lifestyle, occupation and habits – this will help in choosing an appropriate product. The optician should exude confidence and be knowledgeable in all products and processes of the optical section. Always remember that the patient's welfare is priority.

While taking the order from the patient, the salesperson should:

- Listen attentively to the customer's needs
- Explain to the customer about the prescription
- Enquire about the customer's occupation and other habits which will help to decide the right product for him (e.g. if he actively participates in sports, you can advise lightweight, shatter-proof lenses)
- Speak clearly
- Be patient while explaining the products
- Give entire attention to the customer
- Avoid attending to more than one customer at a time – tell the next customer to wait awhile and give them some product brochures to go through
- Avoid talking to other staff
- Do not push or force the customer to buy a certain product
- Do not hurry the patient to make a choice
- Explain the price and delivery procedure clearly and ensure that the customer is satisfied with the product that he has chosen
- double check the final choice with the patient
- Suggest to the patient that it is handy to have a spare pair of spectacles or in case of bifocal wearers, perhaps an extra reading glass
- Avoid panicking and seek a senior staff for advice, when handling a difficult situation

Guiding the patient to choose an appropriate product

It is important to explain to the patient which frame or lens type best suits his needs – with respect to his prescription as well as his occupation and other activities. While guiding the patient to choose an appropriate pair of spectacles, the following should be kept in mind:

- The pupil should be near the center of the lens space to avoid looking cross eyed
- The top of the frame should not be higher than the line of the eyebrows
- The bottom of the frame should not touch the patient's cheek
- Frames should not be wider than the overall width of the patient's face at the temples
- The design and position of the bridge is important for a comfortable fit. When the bridge leaves pinch marks then the frame is too tight. On adjustable pad frames the pads can be adjusted but plastic frames need to fit as it is
- The next section suggests aesthetically suitable frame shapes for each face shape (Fig. 4.2)

Fig. 4.2

Previous spectacles

Find out from the customer, what kind of spectacles he has already been using. The new spectacles should be compatible to the old one – or else we should warn him about the adaptation time for the new glasses. (e.g. If the customer has been using executive lenses and is now buying D-bifocals – we should tell him that the reading area will be much less and that he must learn to adapt his eye to see only within the reading circle.)

Fig. 4.3

Detailing the price

Once the order has been taken, it is important to repeat the order and show the frame chosen and verify with the patient if the order is correct. Then explain in detail the price of the spectacle along with the break up (if any) into frame price, lens price, fitting charges, delivery charges etc., (Fig. 4.3).

Detailing the delivery

It is also important that the delivery method is explained clearly. Explain how and when the delivery will take place: whether the spectacles will be delivered immediately or if it will be ready for pick up on a mentioned date or if the spectacles will be delivered by mail and on what date (Fig. 4.4).

Fig. 4.4

Taking measurements

While choosing an appropriate frame for the customer, it is necessary to select one that is affordable, aesthetically appealing (looks good), suitable for the lens chosen and comfortable. To ensure that the wearer has comfortable vision, the spectacles should be aligned to the eyes of the wearer for which certain measurements need to be taken. This section talks about how to choose an appropriate frame for each face shape and how to take measurements for a customer.

Here are a few guidelines for choosing an appropriate frame for each face shape:

These guidelines are only suggestive. It is more important for the frame to suit the lens type and fit comfortably.

- Oval face: This face shape is perhaps the easiest to suit. Oval faces have foreheads that are slightly wider than the rest of the face and the sides of the face narrow gently inwards towards the jaw line. Almost any style is suitable: round, oval, angular or upswept, although as with all frames attention should be paid to the fit of the bridge and the size of the frame.
- Round face: A round face is usually short and fairly wide. Cheeks may be full leading to a soft, rounded chin. Try to avoid round frames. Choose frames that are distinctive, angular, almost square, with designs that accentuate the upper part of the face. Look for frames with high temples.
- Heart or Triangular shaped: This face features a small neat chin and mouth leading up to a broader forehead. Choose angular frames with strong vertical lines. Avoid frame shapes which follow the angle of the jaw and in doing so draw attention to it.
- Square face: The square face is angular and well-defined but can be quite short and wide. It is not advisable to use square-shaped frames. Instead soft round frame shapes or large ovals are advisable. Small styles should be avoided as these will only emphasize the squareness of the face.
- Long face: The long face is characterized by high cheek-bones, a deep forehead and a strongly defined sharp chin line. The long shape can benefit from enhancing the width of the face so try wide, large framed glasses in oval or round styles

Back vertex distance and lens effectivity calculations

The Back vertex distance is usually measured between the front surface of the cornea and back surface of the lens. The normal vertex distance of spectacle lens is about 12mm.

When the convex lens moves away from the cornea, its effective power increases and towards the cornea its effective power decreases (Fig.13.17). Similarly a concave lens moved away from the cornea its effective power decreases. When it moves towards the cornea its effective power decreases. When a patient is tested at 12mm vertex distance and found to have 12.0D Sph error and vision is 6/6 by moving the lens the vision is reduced. This is because the effective power is changed. Vertex distance at the time of testing must be equal to the vertex distance after wearing the spectacle. The vertex distance measurement is very essential for all high refractive errors. The distance is measured by means of an instrument called as, 'Distometer'.

Lens optical effect may vary with vertex distance that causes poor visual performances i.e., decrease of vision. If moves away from eye, the effectivity of the '+' lens becomes stronger and becomes weaker in '-' lens.

Example

If the vertex distance is not the same, appropriate correction in the power is required as given below

1. A patient is refracted at 15 mm and prefers to wear a -10.0 D of his glass at 10 mm. What is the effective power in the position?

$$Fe = \frac{f'v}{1 - df'v} = \frac{-10}{1-(-0.05)(-10)} = \frac{-10}{1 - .050} = 10.57D$$

2. A patient found to have a +8.0 D at 15 mm and now the patient wants spectacle at 11 mm what power should be ordered?

$$F = \frac{+8}{1-(.004)(+8)} = +8.25D \qquad \text{(d is +ve)}$$

3. Patient expresses desire for contact lens of -6.5D power tested at 15 mm .What power to be ordered for contact lens?

$$Fe = \frac{-6.50}{1-(.015)(-6.5)} = -5.9D$$

4. Refraction of an aphakic eye is performed at a vertex distance of 13mm and shows need for +12.0DSph. If the lens is now dispensed and worn at 17mm from the cornea. What is the effective power of the lens in this new position?

$$Fe = \frac{+12.0}{1-(.004)(+12)} = +12.605D \qquad (d = +.004)$$

Interpupillary distance (IPD)

Interpupillary distance, the distance between the centre of the pupils, is measured in millimeters. This measurement should be obtained both at distance and near for each patient. Both a binocular measurement (a single recording of the total distance from pupil to pupil) and a monocular measurement (the individual distance from the center of the bridge of the nose to the center of each pupil) should be recorded.

In orthophoric (normal) patients, the eyes look straight ahead when they focus on an object directly in front of them. Eyes that are straight in the primary gaze (straight ahead) will have virtually parallel axes when they fixate on a distant object. However, when the same pair of eyes focus on a near object, the eyes converge (turn in slightly) to allow both foveas to fixate on the object. Because of this convergence, the near IPD will be lesser than the distance IPD.

The distance IPD measurement is required to fit the power spectacles both single-vision and multifocal. The near IPD measurement is required when single-vision or multifocal eyeglasses are prescribed for reading or other specified near tasks. The accurate measurement of both distance and near IPD ensures the appropriate placement of the optical centers of the eyeglass lenses. If the distance between optical centers (DBOC) does not correspond to the patient's IPD, the patient can experience double vision.

Therefore, the OA should verify the correct IPD and DBOC for all eyeglasses, whether they are new prescriptions or eyeglasses brought in by patients with vision complaints (Fig. 4.5).

Several methods exist for measuring distance or near IPD. In addition, either binocular or monocular measurement may be chosen. Monocular measurement of IPD is considered more accurate than binocular measurement because the monocular recording takes into consideration any facial asymmetry that might be present.

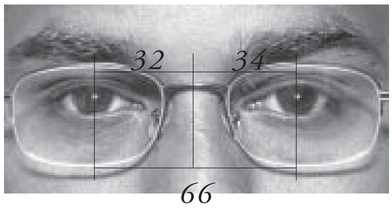


Fig. 4.5 - PD measurements

A binocular distance IPD requires just one pupil-to-pupil measurement made with a millimeter ruler. For a monocular distance IPD measurement, the distances between each pupil and the bridge of the nose are measured separately and the results are added together to yield a single measurement. Simple and accurate monocular IPD measurements may be made with a specially calibrated ruler and a penlight.

Both binocular and monocular near IPD may be measured or calculated. Measuring the binocular or monocular near IPD requires both the millimeter ruler and the penlight.

Measuring monocular distance PD

1. Position yourself 40cm in front of the patient. Make sure your eyes are level with the patient's eyes. Hold the IPD ruler lightly over the bridge of the patient's nose.
2. Hold a penlight under your left eye, aiming the light at the patient's eye. Note the position of the spot light reflection called the corneal reflex on the patient's right eye , and record the number on the ruler just below the reflex. This represents the number of millimeters from the patient's right corneal reflex to the center of the bridge of the nose.
3. Hold the penlight under your right eye, aiming the light at the patient's eye. Observe the corneal reflex on the patient's left eye. Record the number of millimeters from the left corneal reflex to the center of the bridge of the nose (Fig. 4.6).
4. Add the two numbers together and record the sum on the patients chart or form as appropriate.

Fig. 4.6 - PD marking

Face measurements

An Inaccurate size frames greatly affect the overall cosmetic appearance and comfortness of the wearer. In order to fit the spectacles correctly, some technical measurements need to be taken.

Face measurements are taken to choose the appropriate size frame and to hold the spectacle in place. An optician's ruler is a device used for it.

The measurements are

- Bridge size: This is the width of the bridge of the nose
- Intra temporal distance: This is the distance between the temples
- Temple length: This is the distance between the temple and the top of the ear (Fig. 4.7).

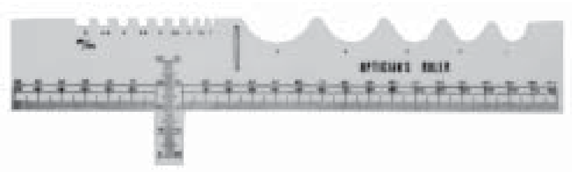


Fig. 4.7 - Optician's ruler

- Pantoscopic tilt: This is the angle between the normal to the temple and the frame front
- Vertex distance: This is the distance between the front of the cornea and the back of the lens
- Segment height: The reading segment should not be placed more than2 mm below the lower eyelid and the frame should be large enough to accommodate at least three-fourths of the segment area to enable comfortable near vision.

Progressive lenses need to be fitted with an additional care as the patient will be sensitive to even slight changes.

Progressive addition lens dispensing

- **Frame selection**: In PAL lenses, the fitting of the lens needs to be accurate; the patient will be sensitive to any small change as it will cause him to see through the distorted area or in the wrong power zone. Thus frames must be chosen appropriately.
  - Type: Metal frames are a better option for PALs because fitting heights can be adjusted, if required, using the nose pads.
  - Height of the frame: Frames must also have sufficient depth (B measurement) to the rim (>22mm below pupil, >14mm above pupil) to ensure adequate area for distance and near optical zones.

- Shape: Another important factor in frame selection is ensuring that the shape of the frame does not reduce the size of the reading area by being too "cut away" in the nasal area of the frame. E.g., an aviator style frame (Ray ban shape) coupled with a narrow PD may not be able to accommodate the reading area.

- Taking the Measurements: Facial fit must be optimized before taking measurements so that fitting heights can be correctly measured. Adjustments like facial wrap and pantoscopic tilt must be performed prior to PD measurements. While taking measurements, let the patient wear the frame as he usually would. The patient's PD is measured by a PD ruler or pupilometer (as described previously) and using the following method the PAL marking are made:
    - The base of both eyewires of the frame are first aligned on same level by verifying with one of the horizontal lines on the layout card (which is usually issued by the PAL manufacturer) (Fig. 4.8).

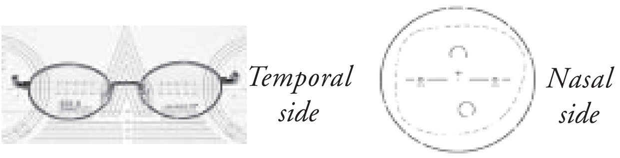


Fig. 4.8

    - The frame is centered on the card by ensuring that the No. of slanting lines below the bridge are equal for both eye wires.
    - The PD measurement is now marked using the mm graduated ruler given.
    - The frame is lowered to align with another horizontal line and the same process is repeated.
    - A straight line is drawn connecting the two points for each eye.
    - The pupillary centre is marked on this line with the help of the corneal reflection.
    - Verify the centre once again. Now, the frame is again held against the layout card positioned to align the vertical line with the one in the card and the fitting cross coinciding with the pupilary centre marked (Fig. 4.8).
    - Now ensure that the reading circle lies well within the eyewire with a fitting height of at least 22mm (fitting height is measured from the fitting cross to the bottom of the eyewire) and that there is at least 14mm between the fitting cross and the top of the eyewire. These specifications may change for other progressive lenses like short corridor PALs (fitting height is only 14mm).

Order entry

Every order has to be recorded carefully. Ensure that the following criteria are taken during order entry:

- Unique order number
- Order date
- Patient's name (along with MR no. if necessary)
- Prescription power
- IPD
- Lens details
    - Material: Glass or plastic; Hi-index etc
    - Design: Kryptok, D Bifocal, Progressive etc.,
    - Coatings: ARC, SRC etc.,
    - Tint: Photochromatic, Black etc.,
    - Price
- Frame details
    - Brand name
    - Model name or number
    - Colour
    - Size
    - Price
- Fitting Charges (and any other extra charges)
- Advance amount received (if applicable)
- Delivery date and time
- Delivery Method: Direct, Mail etc

Some of the above details may not be relevant and there may be others that are. It is important to ensure that all necessary details are recorded in order to ensure that the order can be verified during delivery. If the customer has to collect his spectacles at a later time or date, it is advisable that he is given a slip with his order details, which he can use to claim delivery of his order.

Delivery

At the point of delivery of the orders for spectacles, it is necessary to ensure that the order is ready for delivery before the mentioned delivery time and date. The spectacle must not only have been fitted, but it should also have passed an overall quality test.

Final spectacle quality test

The spectacles should be checked for the following criteria before delivery:

- Check if the lens matches the prescription's specifications - power and axis
- Check if the finished spectacles has the frame and lens mentioned in the order form
- Check for lens defects:
  - Centering
  - Optic centre should coincide with the measurements taken
  - No scratches, waves or bubbles should be present
- The lens should fit well into the frame without gaps or chipping
- Segment height in both lenses should be equal
- Check the pantoscopic angle of the frame - Both rims must be tilted at the same angle
- Final frame adjustments to make it stable:
- Both rims and both temples must rest equally on a flat surface
- Both nose pads should be adjusted to the same angle

The delivery procedure should include the following

- Review pending orders so that orders are readied before their delivery time
- Arrange the spectacles that are ready for delivery in such a way that it is easy to find when the patient arrives: one method is to arrange them according to the order number
- If the delivery is to be made by mail, ensure that they are dispatched on time
- When the patient arrives, greet him and help him try on his spectacles
- If the order is not ready yet, apologize politely, explain the reason for the delay and give a future date or time for delivery
  - If you have the patient's contact information it is advisable to inform him ahead of time about the delay in delivery
- Collect any further payments that are due and prepare the bill

  Any further adjustments of temple and nose pads, to make it comfortable for the patient, should be done with his feedback after he tries the spectacles
- Counsel the patient about how to use and maintain his spectacles
- Encourage him to contact you if he has any problem with the spectacles

Fig 4.9

Checking power of lens with digital lens meter

Final adjustments at delivery

When the patient tries on his spectacles, adjust them so that the following fitting errors are avoided:

- Glasses do not stay in place
- Temples are not on the same level
- Frames sits too high or too low

- Frames touch the eye brows
- Eye wire touches the cheek
- Lens touches the lens
- Lashes unequal distance from lens
- One lens higher than the other
- Both segments not in line
- Segments seem too high
- Pads do not rest evenly on the nose
- Pads cut nose at one surface of pad – the pad pressure is uneven
- Pain is felt at the ears or behind the ears
- Verify the PD once again. In PAL lenses, before removing the temporary painted marking, ensure that the fitting cross coincides with the pupilary centre.

Counselling during delivery of spectacles

- If the patient is wearing a certain type of lens for the first time, explain about the adaptation time in learning to focus with the new type of lenses
- Encourage him to keep the spectacles in a case when not in use and never put lens down on any surface or without a case in a pocket, especially if it is a plastic lens.
- Encourage him to put on and remove the spectacles with both hands
- Teach him to clean the spectacles with a soft cloth and cleaning solution (Fig. 4.10).

Fig. 4.10

Outreach activities

Dispensing spectacles at outreach camp sites is essential to ensure that the patient who needs refractive correction actually procures a pair of glasses. Here, as the patient is sought out to deliver the service instead of him seeking eyecare, it is even more essential to see that he receives a pair of spectacles at the same place. This means that spectacles must be delivered at the camp site it self along with the refractive screening services.

Some institutions dispense readymade spectacles – which offer a range of powers in standard frame designs. Though this offers the patient the required correction it may not fully satisfy his need for a unique-looking frame.

An ideal and workable optical dispensing outreach set up involves

- Screening facilities
- Offering a reasonable range of lenses and frames
- Spectacle fitting facilities

Staffing and inventory

For an average camp seeing 500 outpatients, the expected No. of orders being 50, the following resources are needed:

- 1 sales person
- 1 technician
- Assortment of frames - 150 nos. (3 x no. of orders)
- Inventory of lenses - 500 nos. (10 x no. of orders)
- With the proper set of powers it is possible to deliver up to 85% of the orders on the spot. Thus, the inventory should be fine tuned with experience to achieve maximum on the spot delivery.

Edging & fitting equipment

Manual edging machines and frame warmers are portable and can be handled easily with basic power supply. Trial lens set, chipper, cutter, screwdriver and adjustment pliers complete the kit. Auto edgers are more sensitive and are not very portable. But they can be mounted and fixed to a van or truck to act as a mobile dispensing unit.

Planning

With this modest dispensing kit it is possible to fit and deliver up to 85% of the spectacles on the spot. However, this is possible when we are able to predict the quantity of orders and the powers and types of lenses likely to be prescribed. Orders for special lenses and powers for which lenses are not stocked are booked and delivery of the spectacles can be through mail.

Spectacle maintenance services

The following maintenance services can be offered to the patients at the dispensing showroom. This assures customers that they can rely on you for all their spectacle-related requirements and they will be encouraged to come to you when they need a new pair of spectacles. This range of services should ideally include all products, spares and services relating to spectacles; some of these can be offered free of charge. A few are suggested here.

- Spectacles cleaning service: Spectacles tend to collect dirt at the nose pads and temples and even along the eye wire. First the lens is removed from the frame and using a soft brush or an ultrasonic cleaner, the dirt is removed. Remember to warn the customer that if the frame is very old or of poor quality, it might get damaged while cleaning.
- Spectacle repair service: Frame parts such as the earpiece, nose pads, hinges etc might need to be replaced over time. If an assortment of such spares is stocked, then the repair work can be done on the spot. A few suggested spares:
- Nose pads
- Earpieces
- Hinges, hinge springs
- Tools: screwdrivers, pliers, frame warmer
- Accessories: Spectacle accessories can also be offered at the optical dispensing unit. A few of these have been discussed in the next section.

Spectacle accessories

Ones experience with spectacle wearing can be improved in small ways. These accessories help to make it easier, more comfortable and easy to maintain. Some accessories are meant to be therapeutic.

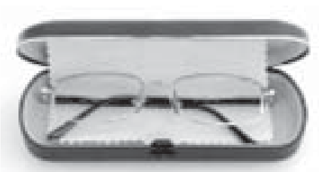
Fig. 4.11 - Protective goggles

- Sunglasses: Most customers expect to find protective eyewear at any spectacle dispensing unit; they also believe that the quality is better here. Thus it is important to stock plano sunglasses and protective eyewear – these come in many fancy shapes and designs.
- Protective Eyewear: These are worn to protect the eyes from harmful rays like UV or welding rays especially in an industrial setup or from harmful objects such as those worn by carpenters etc. For protection against rays the lens material and tint should be chosen to filter the particular ray. Polycarbonates are commonly used for protection against objects as they are impact resistant (Fig: 4.11).
- Rope/Chain: this goes around the wearer's neck and is attached to the temples of the frame. When the spectacles are not in use it can hung from the wearer's neck.

- Belt: This helps to keep the frame in place. It is an adjustable elastic band that goes around the head. It is usually used by young children and the elderly (Fig. 4.12).

Fig. 4.12 - Spectacle rope and chain

- Cleaning cloth: this should be given to all patients. This is a soft cotton cloth that is absorbent and it is used for removing dirt and oil from the lens surface. Nowadays, this cloth is also made of synthetic microfibre.
- Cleaning solutions: This is an alcohol based solvent that helps remove dirt and oil from the lens surface and some solutions can even temporarily make the lens surface anti-static which keeps the dust off. Remember that some solutions are not advisable for anti-reflection coated lenses.
- Case or box: When the spectacles are not in use, they can be stowed away in a box or case. This avoids dust collection and scratching and in the case of a box even protects it from damage from



Hard case

Soft pouch

Fig. 4.13

Patching (a)

Occluder (b)

Metal frame with crutch (c)

Swimmer wearing goggles (d)

Fig. 4.14

impact. Boxes are usually made of plastic or metal. Soft Cases are made of synthetic rexin or leather (Fig. 4.13).

- Occluder: This is prescribed for pediatric patients who have lazy eye. This is a cloth patch or rubber cup that covers or “occludes” one eye so that the child is forced to use the other eye (Fig. 4.14a,b).
- Crutch frame: This is an appendage to a normal frame that helps to hold the upper eyelid more open – for ptosis or ‘drooping eye’ patients. The crutch is a piece of plastic (shell frames) or a wire mounted on to the rim (metal frame) that is usually welded or glued to the top of the frame to hold the eyelid in the correct position. The position of the crutch should be specific for each patient (Fig. 4.14c).
- Swimming goggles: These protect the eyes when underwater. It also enables better vision by locking in air in front of the eyes. They come with a band that fits tightly around the head (Fig. 4.14d).

Student exercise

1. *It is important to know what type of spectacles the patient is already wearing (True /False)*

Answer the following

1. *How should one verify the prescription before taking the order?*
2. *While taking an order what are the details that have to be recorded?*
3. *What kind of inventory should be maintained for offering spectacle repair services?*
4. *What are the different spectacle accessories, relevant to your location, which you must offer to your customers?*
5. *How would you plan to offer spectacles at out reach camps?*
6. *What is the role of the dispensing optician?*
7. *What are the conditions for choosing a frame for PAL lenses?*
8. *What precautions should be taken while measuring pupilary distance?*
9. *Explain the procedure of quality checking prior to delivery?*

CHAPTER 5 SPECTACLE PROCESSING

CONTENTS

Frame and lens checking
Lens fitting
Special fitting procedures
Lens grinding procedures

GOALS

To create an understanding of the different processes involved in making a pair of spectacles

OBJECTIVES

The MLOP should

- Understand how lenses are checked and fitted by manual and automated methods
- Understand special fitting techniques
- Know the different tints and tinting techniques
- Understand how blanks are surfaced by manual and automated methods

CHAPTER 5
Spectacle Processing

Once a frame is chosen by the patient, the selected lenses have to be fitted into the frame. Some lenses are stocked as readymade lenses (ready lenses) and others are processed only when an order is placed (prescription lenses). This section discusses how to fit the lenses into the frame and also how to process prescription lenses.

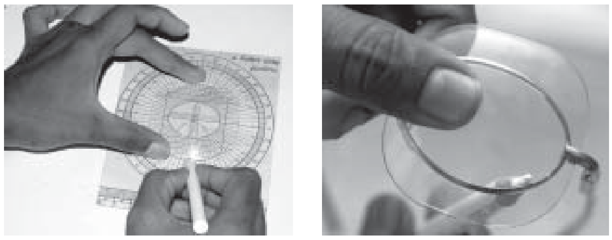


Fig. 5.1

Frame and lens checking

Before processing the spectacles it is recommended that the frame and lens are verified against the order form. The following criteria should be checked before proceeding:

- Condition of the frame
- Center and power of the lens should be checked - this can be done by neutralisation with a trial set or a lensmeter
- Check the lens for defects such as scratches and waves
- In case of bifocals, check if the frame can accommodate the sufficient reading area and if both lenses have matching segment sizes
- In case of progressive lenses, check if the frame can accommodate fitting height, if both lenses are of the same design and brand

Manual Lens fitting

The lens fitting process involves tracing the frame shape onto the lens and edging the lens along the traced shape. In the manual method, almost all processes are done by hand.

Lens marking

The centre of the lens is marked along with the axis meridian. The frame shape is then traced onto the lens by adjusting its position for PD, centering and segment height. The lens is held against the rim of the frame in such a way that the above criteria are satisfied and then the frame shape is traced with a marking pencil. Usually a slightly larger area is marked to allow for adjustments during edging (Fig. 5.1).

Lens cutting and chipping

When the lens has been marked, the excess lens material around the usable area is grossly cut out by marking the area with a diamond tip and snapping it off. Then a chipper is used to chip off the rest of the lens as close to the marked area as possible. This is done only in the manual edging process; in the automatic edger, the full lens is edged to the required shape (Fig. 5.2).

Fig. 5.2

Lens edging

This step involves the finer edging of the lens to the shape of the frame rim and creating a bevel for the lens to be seated in the frame groove. Technological improvements have made this process accurate and easy. The manual edger houses an electrically operated abrasive rotating diamond wheel (Fig 5.4). By holding the lens against the wheel and guiding it, the lens material can be edged into to the desired shape (Fig. 5.3). The edger has multiple wheels, provided for gross edging, finishing and for bevel creation. Water is used to wash away the excess material and to act as coolant during the edging of the lens. The lens is now ready to be fitted into the frame.

Fig. 5.3

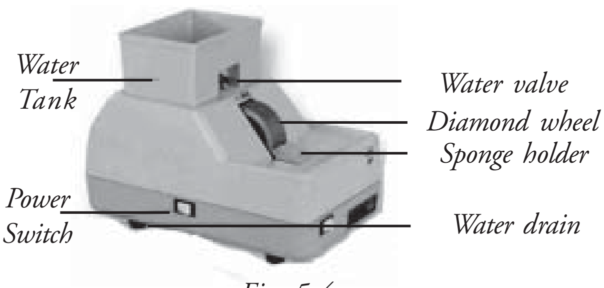


Fig. 5.4

Automated lens fitting

Today, with the advancement in technology fully automated fitting is possible with least human intervention. However, considering cost and for practical reasons, a combination of manual and automated processes can be used.

Lens marking and frame scanning

The power of the lens is checked by means of a lensometer. Then, the shape of the frame is traced by a 'frame tracer', in which a pin traces the shape of the frame and converts it into digital data. Thus the frame shape can be viewed on a screen. An 'axis marker' is a screen displaying the actual frame shape with a graduated top showing the different axes – here the lens is placed and the appropriate lens position is marked (considering centering, PD and segment height) and a block is attached. A block holds the lens in position while the lens is being edged (Fig. 5.5).

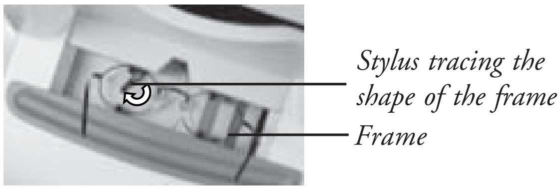


Fig. 5.5

Lens edging

- Pattern Edgers: Information from the frame tracer is used to cut out a plastic pattern in the shape of the lens. This pattern is then run along a sensor, the data from which, is used by the edger to edge the lens
- Patternless Edgers: In patternless edgers, the information from the frame scanner is transferred directly to the edging machine, which edges the lens accordingly

In an automated edger, the frame design has to be given either by information from a frame scanner or in the form of a pattern. The full lens is shaped by a linear lathe (called an 'edger') using either a ceramic or diamond grinding wheel or stainless steel blades. The lens is held in position by a chuck. So, a chuck receiver or block is attached to the lens usually by adhesive pads. The block is placed where the geometrical center of the finished lens will be, and the lens is then oriented on the 180° axis. The lens is chucked in the edger and held in place by a pressure pad that presses on the opposite side of the lens. The automated edger holds the full lens in position. Before each edging, the lens surfaces are measured to define lens edge thicknesses. Then the lens is held against the appropriate wheel for each process such as edging, finishing, beveling, buffing. Now the lens is ready for fitting.

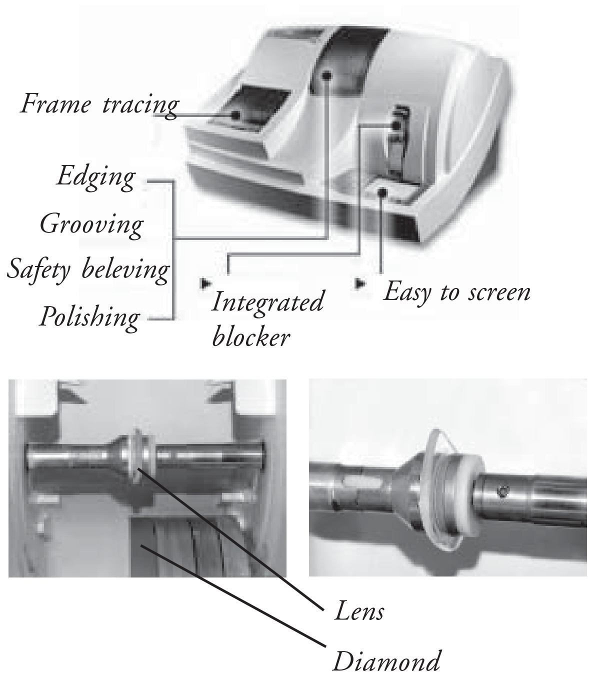


Fig. 5.6

Lens finishing

After edging, the lens might need to be cleaned. If the lens is too thick at the edges, it will show outside the eyewire – this gives the spectacles a dull look. This can be rectified by polishing or 'buffing' the edges of the lens by holding it against a rotary cotton spindle (Fig. 5.7).

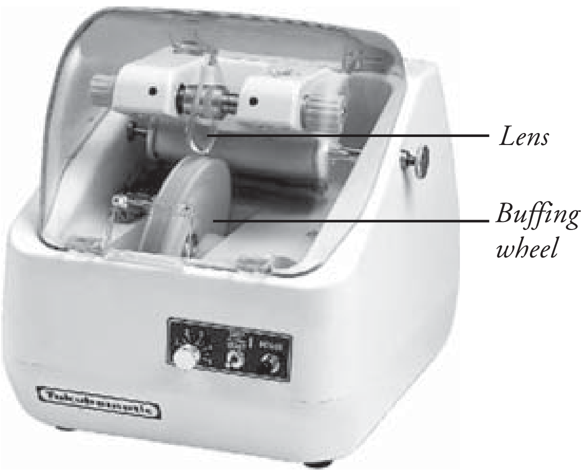


Fig. 5.7

Cleaning

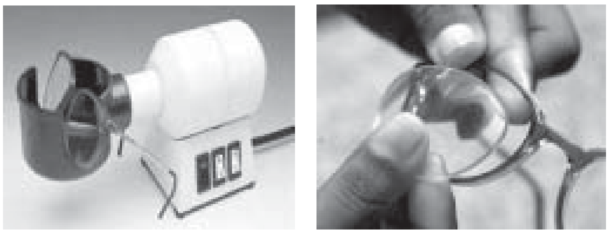
After the lenses have been edged, they are almost ready for tinting, coating, drilling or hardening. Before further processing, they must be cleaned well and inspected for visible flaws.

- **Glass lenses:** If a non-water-soluble paint has been used for marking the lens during blocking then a solvent such as acetone or alcohol must be used to clean the lens surface. The lens is generally dipped in an open container of the solution and wiped with a tissue or lint-free soft cloth. When no sprays have been used, a solution of detergent will be effective.
- **Plastic lenses:** Acetone is used extensively for cleaning CR-39 lenses but should not be allowed to come in contact with plastic frame parts. Detergents also clean plastic lenses well. The most effective cleaning method for glass or plastic is an ultrasonic bath. Inspecting a plastic lens that has been alloy blocked may reveal the presence of an indentation at the location of the block. To eliminate the indentation, place the lens in an oven at 200°F for a minimum of 20 minutes. The same method is also used when plastic lens warpage is detected. When an oven is unavailable, the lens may be placed in water near boiling, for an equal amount of time.
- **Polycarbonate lenses:** Polycarbonate lenses are coated to make them more scratch resistant. Also, polycarbonates are very sensitive to solvents. So, use only a liquid detergent. Acetone should not be used.

Lens fitting

The finished lens is then inserted into the frame. For plastic frames, the frame is slightly warmed with a frame warmer causing it to expand a little and allowing the lens to be snapped in. Lenses can be inserted in metal frame eye wires by a screw (Fig. 5.8).

Once the lens is fitted, the frame has to be adjusted for the pantoscopic tilt, make the temples level, nose pad adjustments etc. This is done with the help of various adjustment pliers, each with a specific function (Fig. 5.9).



Frame warmer *Inserting the lens*

Fig. 5.8

Adjustment pliers

Screwdriver kit

Fig. 5.9

Special fitting procedures

Some frames require special fitting techniques. The lenses can also be enhanced with special methods. This section describes special fitting techniques and lens tinting procedures.

Fitting rimless frames

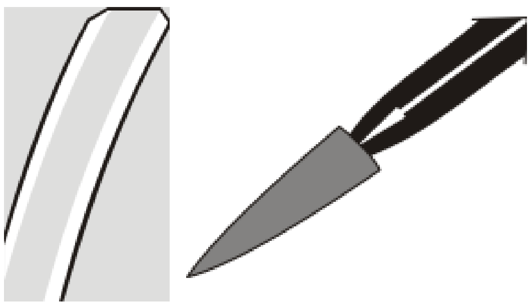
Rimless frames are also called 3-piece frames. As there is no eye wire, the frame comes in three pieces: the two temples with hinge and the bridge with the nose pads. The three pieces are connected by the lenses only. Holes are drilled into the lens and the frame is attached by screws or clips. Thus, these frames require fragile handling (Fig. 5.10).

Bridge is attached to lens by screw *Temple is attached to lens by screw*

Fig. 5.10

Chamfering

The lenses must be prepared for rimless frames. After edging the lenses are flat edged. It is important that their sharp outer rims be slightly beveled in order to prevent flaking or breaking when the frame is attached. This is called "touching off" or "chamfering". This beveling is made at approximately 40 degrees to the flat edge of the lens and around 0.5 mm. in width (Fig. 5.11). The holes created by drilling must also be chamfered. This is done by beveling rims of the holes with a chamfering point - a small, plumb-shaped carborundum drill bit. Rimless spectacles are cosmetically more appealing when their lens edges are polished.



Chamfered lens edges *Drill bit to chamfer the holes*

Fig. 5.11

Drilling holes

Twist drills are used to drill holes in plastic lenses. However, when using any hand drill, be sure to start the hole with a sharp-pointed object otherwise the bit will slip off and scratch the lens.

The following should be ensured while drilling the holes:

- Always ensure that the cylindrical axes are marked and the lens is in proper position before you begin the drilling operation.
- Do not drill too close to the lens edge. You should allow at least 3 mm from the hole to the edge of the lens. The plastic may fracture if the hole is drilled too close to the edge.

Usually the hole should be drilled perpendicular to a flat surface (for example, the surface of a flat table top) rather than being oriented to the lens's surfaces

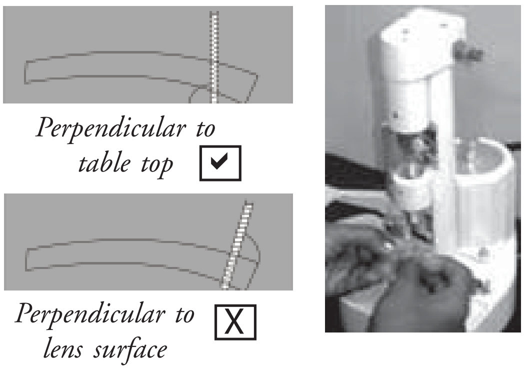


Fig. 5.12

- Do not drill the holes too large. Oversized holes will cause the lenses to wobble.
- Do not drilling non-stop all the way through the lens. Lenses must be drilled half-way and then turned over for completing the drilling. Otherwise, the hole will flake around the edges. Begin drilling with the concave side up. After drilling halfway through the lens, reverse it so that the drill bit goes from the convex side, with the hole from the convex side meeting the unfinished hole from the concave side.

Fitting the screws

Now that the lens holes are drilled, the screws attached to the frame are inserted into the holes and a nut is used to fasten it – a plastic bushing is sometimes used. Usually the manufacturers give a long screw to accommodate high power lenses. Thus it is sometimes necessary to cut off the excess length of the screw.

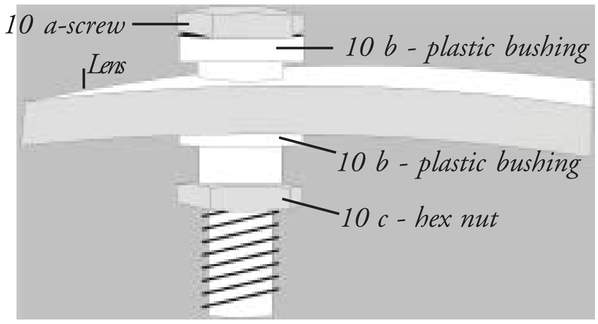


Fig. 5.13

- Avoid cutting the screw flush with the nut. This leaves the screw with a sharp end.
- Do not file down the ridge of the screw. This removes the cutting and leaves a flat, rivetless overhang, and the screw loosens quite easily.
- Cut the screw about 0.5 mm from the nut.
- Dimple the center of the screw end. With a pointed tool, punch a tiny depression in the center of the screw end to achieve a "reverse rivet" effect.
- Apply a sealant (for instance, colorless nail polish, or a commercial liquid adhesive).

Fitting half-rimless frames

To fit lenses into semi- or half-rimless frames, the lens should be ready to receive a nylon wire that runs along its lateral edges and holds it into the frame. Thus, after the lens has been edged a groove is cut into the edge of the lens by means of a grooving machine. Thus even while processing it is important

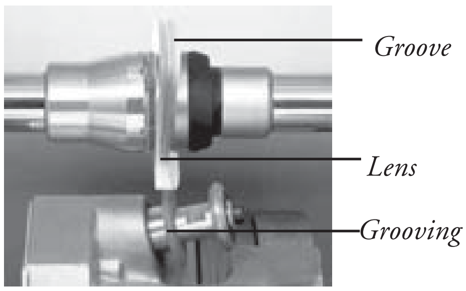


Fig. 5.14

to ensure that the lens is thick enough for the groove. If it is too thin then it is prone to chipping as half the rim is not protected by the eyewire (Fig. 5.14).

Once the grove has been cut the lens is held in place and the nylon wire (which is attached to the frame eyewire) is pulled over the outer edge of the lens and placed into the groove with the help of a strip (Fig. 5.15).

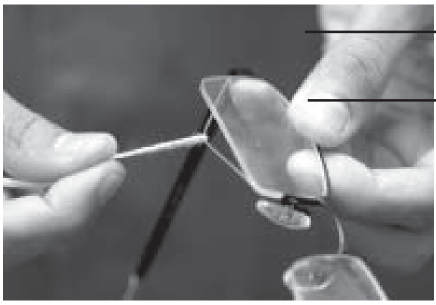
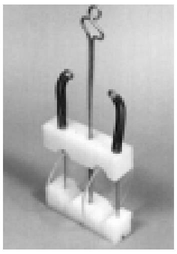


Fig. 5.15

Tinting process

Plastic lenses are absorptive and can be tinted in a multitude of shades. They can be highly tinted for cosmetic purposes or for relief from glare. Light brown or gray tints seem to be more effective in controlling glare problems than cosmetic tints such as pink or blue. However antireflective coated lenses are better in reducing glare. These lenses are normally dipped into a heated dye and the tint is slowly absorbed into the plastic. To make a darker tint, the lenses are simply left in the liquid longer. For the best results replace the dyes frequently to produce accurate tint colors. Using filtered or distilled water further enhances the color and absorption of the tints



Lens holders

This cup, with holes, allows the lens to be immersed into the dye without any clamp

Fig. 5.16

Polycarbonates are not very porous and so generally absorb only light to medium dark tints. Over heating or attempting to tint a polycarbonate lens to a dark tint may damage the lens - the surface will split.

Protection from UV which is important for all lenses meant for sunglasses, is obtained by immersing absorptive lenses into a heated solution of UV filtering chemicals. Polycarbonate and some high index lenses inherently provide UV protection.

Tinting methods

- **Solid tints:** In these the tint is distributed evenly throughout the material. These were the majority of tinted prescription lenses. Nowadays, only photochromatic lenses and some protective filters use solid tints. A significant advantage of solid tinting is that scratches do not affect the performance, making them safer when viewing dangerous sources of light such as welding arcs. The principal drawbacks of solid tinted lenses are that a different stock lens is needed for each color and that the depth of tint depends on the lens thickness, hence high prescriptions look odd darker in the middle for plus lenses, darker at the edge for minus lenses.

Surface tinting

In this method the tint is applied only to the surface of the material. Thus, there is no need to stock a range of lenses for each power with each color and tint depth. Tinting can be done by the dispensing optician once the order is placed.

- **Glass lenses:** The tint is applied by a vacuum coating process, in which the tint material is evaporated in a vacuum chamber then re-condensed on the cooler lens surface. They are normally on a single surface, so scratches can affect transmission.
- **Plastic lenses:** Plastics lenses are usually tinted by immersing a clear lens into a bath of dye solution. The dye penetrates evenly, but not very deeply, over the whole surface of the lens and a uniform tint is produced. If the lens is lowered gradually into, or raised from, the tinting bath, then more dye will be able to penetrate the part of the lens which is in the bath for the longest time and this will become darker. It will therefore have a "graduated" tint. Tinting both surfaces is advisable as surface scratches only damage the tint on one surface. Photochromatic dyes are usually absorbed only into the front surface in a process requiring much more control than ordinary dip-dyeing.

Tinting patterns

- **Equitinting:** Equitinting refers to applying a uniform tint and tint depth through out the lens. Surface tints can achieve this effect easily. But in solid tints, it is seen that the tint is darkest at the thickest portion of the lens. Though done rarely, these lenses can be equitinted by laminating a solid tinted lens along the lens.
- **Gradient pattern:** This usually describes a tint which is dark at the top and light at the bottom, but is also applied to any tint which is deliberately varied over the lens area in either darkness or colour. This allows the wearer to perform near vision tasks like reading which may require more light. The lens is slowly lowered (upside-down) into the dye. Since the top of the lens enters the die first and is withdrawn last, it spends more time in the dye and becomes darker than the lens bottom.
- **Double Gradient Pattern:** This pattern has a darker tint at the top and bottom of the lens, and a medium tint in the center of the lens. Double gradient tints are good for skiers; because glare coming from the sun above and the snow below is heavily blocked but a clearer viewing area is present in the middle of the lens.

Gradient tints are most attractive when the tint gradually lightens to a clear appearance rather than coming to an abrupt stop.

Choosing tint color

As white light is made up of many colors, choosing tints carefully can improve the performance according to specific environments and activities.

- **Pink:** A rose tint/ is cosmetically appealing, soothing to the eyes, and seems to provide a degree of relief when the wearer is working in brightly lit offices. A rose tint is often recommended for computer users to help reduce eyestrain and glare.
- **Yellow:** A yellow tint makes objects appear sharper against a blue or green background. Blue light can create a kind of glare known as "blue haze". Yellow tints are sometimes marketed as "blue blockers" because they are fairly opaque to blue light. Yellow tints are good for foggy conditions. It is used by pilots. Yellow should not be used for any activity that depends on accurate color perception.
- **Brown or Amber:** Brown and amber tints work well in variable light conditions and provide good contrast because they filter some blue light, although not as strongly as a yellow tint. Brown lenses are good general purpose lenses and for sports
- **Green:** Green tints filter some blue light and enhance contrast in low-light conditions. The human eye is most sensitive to green wavelengths of light so green tints offer the highest contrast and greatest visual acuity of any tint.
- **Grey:** A grey tint provides good protection from glare with minimal distortion of colors. Grey is sometimes referred to as a true-color tint. It is a good choice for general use and driving. Grey is the most popular sunglass tint.

- **G-15:** This sunglass tint is sometimes called the "Ray-Ban" tint. It is essentially a combination of a grey and green tint that blocks 85% of the light.
- **Purple:** Purple is a balanced color which provides natural color perception while shading the eye.
- **Blue:** Blue is a good fashion tint in lighter shades. It is not advisable for outdoor use, as it increases glare. Alternatively use a brown or grey lens combined with a blue mirror coating.

Achieving the right tint

Dyes are now readily available for each colour. But they can also be prepared by a combination of tints. A few combinations for standard colours are given here:

- Orange: Dip in Red and then Yellow
- Dark Brown: Dip in Brown and then Gray
- Tru Colour: Dip in Gray and then Green or Blue
- G-15 (Ray Ban Tint): Dip in Gray and then Green

If the resultant tint is wrong, here are ways to correct it:

Desired Lens Tint	Result to be corrected	Method of Correction
Gray	Too green	Dip in Pink
	Too purple	Dip in Yellow
	Too blue	Dip in Brown
	Too brown	Dip in Blue
	Too yellow	Drop in Blue then Red
Green	Too yellow	Dip in Blue
	Too blue	Dip in Brown or Yellow
	Too brown	Dip in Blue
	Too gray	Remove the color
Rose	Too blue	Dip in Red
	Too red	Dip in Violet
	Too brown	Remove the color
Brown	Too red	Dip in Gray or Blue
	Too purple	Dip in Yellow
	Too gray	Dip in Yellow
	Too green	Dip in Red then Blue
	Too blue	Dip in Pink
Other tips	Resultant color is poor	Contaminated or old dye; Replace Tint
	Stress marks seen on thin lens	Clamping pressure in holder too high; Loosen it
	Dark stray marks	Lens needs to be properly cleaned before dyeing
	Uneven Gradient dividing line	Caused by rapid boiling of dye
	Light areas seen in the tinted lens	Lenses may have come in contact with each other or the holder

- Purple: Dip in Blue and then Red
- Autumn Brown: Dip in Gray and then Brown
- Winter Gray: Dip in Gray and then Blue

Dyeing temperatures

The temperature of the dye pots is important when considering the time needed to tint lenses to the desirable shade. Most tints absorb into the lens materials quickly if the dye pots are maintained at a temperature between 175° - 190° F. Usually the temperature is recommend by the dye manufacturers.

Achieving depth of the tint

The depth of the color of a tinted lens depends on the length of time that the lens is immersed into the dye, the lens material and the age of the lens. Dark tints are achieved by immersing the lenses into the dye for longer periods. Dark tints can take up to 20 minutes or longer before reaching the desired depth of color. Sometimes lenses tint unevenly: one lens has darker than another or each lens is a different color, even though they were immersed into the same dye for equal periods of time. This is common while tinting old lenses. Do not tint old lenses especially if they are scratched - the dye disperses more into the scratches, causing abrasions to be darker than the rest of the lens.

Longer a lens is immersed into a heated dye, greater the chance of damaging the material. Heat damaged lenses may appear warped, crazed (the surface is cracked), or waved (the surface appears to have melted). These problems are more frequently seen in high index or polycarbonate lenses. These lenses are more safely tint if dyes are maintained at a lower temperature and if the lenses are continuously cooled during the tinting process – by alternately dipping the lenses between the heated dye and cool water.

Mirror lenses

A mirror coating is applied to the outside of a lens to deflect reflected light. The outside of the lens looks like a mirror but the wearer experiences only the tint.

Fancy photochromatic

Some plastic photochromatic lenses are now available in unusual colors. These lenses are one color in the shade, but change to a completely different color when activated by UV. There are teal-blue lenses that change to green, yellow lenses that change to orange and red lenses that change to purple.

Lens grinding procedures

Today, the manufacture of plastic eyeglass lenses far exceeds the manufacture of glass lenses, but the process has remained much the same for both types. Plastic as well as glass lenses are produced by successive stages of grinding, fine grinding, finishing and polishing. In the past, opticians relied on separate optical laboratories to produce spectacle lenses. Today, there are a number of full-service optical outlets that produce lenses for customers on-site. However, optical outlets do receive lens "blanks" or glass or plastic pieces made almost to the lens size. These have to be “surfaced” to get the right front and back curvatures that will result in the desired power. Today, one-side finished blanks are available: these come in different curvatures and near vision addition powers on the front of the lens and only the back surface needs to be surfaced.

Blank selection

The blank selected should be of the ideal thickness, diameter and correct addition power. For bifocal lenses, the blanks come with a prefixed addition power button which is fused to the base lens. The addition power and the base curvature of the lens are usually printed on the blank by the manufacturer. For the given prescription the blank with the least possible thickness and diameter should be chosen. Thus, the resultant lens will be thin enough to look good but should not be too thin. And if the diameter is less, then less material is wasted during edging. Thus diameter can be chosen according to the frame size – its effective diameter or diagonal of the eyewire.

Manual surfacing

Manual surfacing if at all used is restricted to production of glass lenses. The glass blanks need to be surfaced on both sides. The required curvature is generated by a series of grinding steps where the excess material is removed by abrasion.

Fig. 5.17- Blocking with heated pitch

Blocking

To hold the lens firmly during the grinding process, a metal button is attached to the lens. This is called blocking and pitch is usually used as an adhesive. The blank must be accurately centered considering axis and segment height and the pitch must be spread evenly over the button and the blank must be horizontal when attached. If not, then the lens the lens will have uneven thickness at the edges and this will cause a prism effect. Sometimes, if it is given in the prescription, a ring is used to intentionally tilt the lens so as to induce prism.

Roughing

The laboratory has a range of tools or dies each of which corresponds to a specific prescription power. Also different tools are necessary for each surface. A spindle machine is used for surfacing. The appropriate tool is attached to the spindle and rotated. The blank is moved over the tool which grinds it. Sand emery (grain size = 0.3 mm) or carbora dam is mixed with water and fed to the tool for abrasion. A certain amount of pressure may be exerted while roughing the lens to enable the emery to cut rapidly. But care should be taken to avoid chipping the lens edge. This is done till the required curvature is achieved. This is repeated for the other surface.

Truing

After roughing, the tool and button are washed in water to remove any abrasive. The same process is repeated but sand emery (grain size = 0.075mm; emery grade 302) and fine grade abrasives like corundum or Aluminum Oxide are used for truing. This is continued till the pits caused by sand are removed completely and the surface is smooth. The tool and the blank is again washed with water for the next step.

Smoothing

Two things are accomplished during smoothing. The curve must be made true and the lens surface must be made capable of taking a good polish. Sand emery (grain size = 0.01mm; emery grade 303) or Aluminum oxide is used. Here less abrasive (1 part powder + 3 parts water) is used to prevent pitting. It is better to have both tool and lens rotating. At the end of smoothing, the lens is washed.

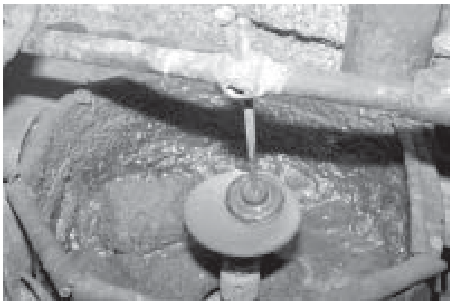


Fig. 5.18

Polishing

Here the tool is covered with adhesive polishing pads made of cellulose fiber, taffeta silk, wool, linen and sometimes paper. The polisher is thus classified as a paper polisher or a cloth polisher. 'Rouge' or red oxide of iron is used for polishing. Cerium oxide may also be used – it gives a perfect polish much faster but is expensive. Other polishing powders are White Tripoli pumice and putty powder. Water is poured during polishing to act as a coolant to prevent the lens from melting or turning brown in the heat.

De-blocking and cleaning

The lens is separated from the block by knocking off - a sharp tap is given to the block with a wooden hammer. The block can also be melted off. It is generally favored that the lens and block are cleaned by dipping in kerosene or mentholated spirit to remove the pad.

Automatic surfacing

Blank and tool selection

When the optical prescription is feeded to a computer, a printout with specifications necessary for producing the required lens is obtained. Based on this information, the technician selects the appropriate plastic lens blanks.

Axis marking

The appropriate blank is placed under a lensmeter, to locate and mark the optical center. If the prescription has cylinder power, a line is marked on the front of the lens to define 180º, and then another line is drawn that matches the desired axis. If there is a segment, the segment edge is used as the 180º line. The optical center of the lens should be made slightly above the segment edge; so, the line is marked the appropriate distance.

(Note: When there is no segment or induced prism, the lens may be left unmarked and the cylinder axis is set during edging.)

Blocking

The lens has to be attached to a metal block which will hold the lens during the grinding process. This is attached by a metal alloy that has a low melting point; so it can be attached and removed by heating it to a relatively low temperature which will not affect the lens.

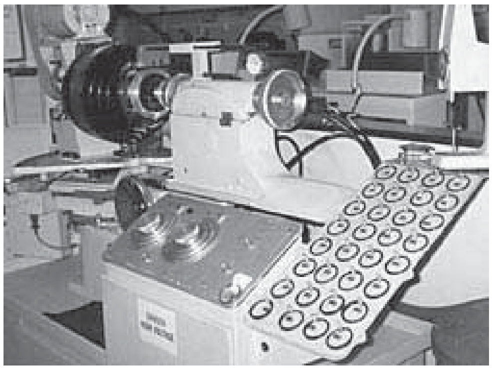


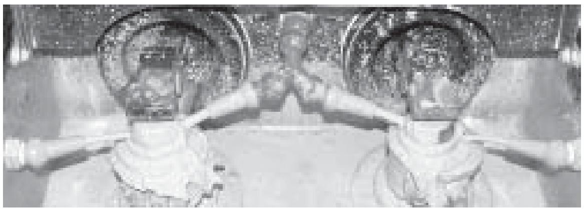
Fig. 5.19

While blocking one-side finished blanks, the finished front surface needs to be protected from the block by an adhesive tape called the "surface saver tape". The block is attached after the tape is stretched over the finished lens surface.

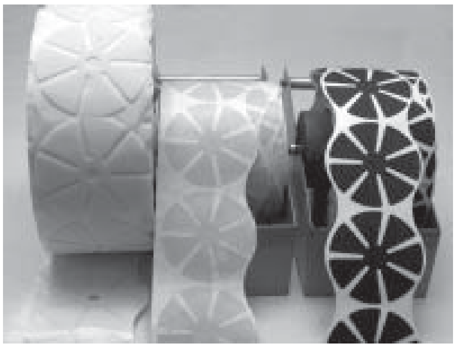
Grinding

The necessary curvature is obtained by a curve generator which cuts the lens surface to the specified extent; these settings are manually set for each lens in a semi-automatic generator; and simply fed by keyboard or by touch-screen to a CNC machine. The curves are set on the machine and the lens is generated or 'ground'. This step can be operated by hand in a curve generator, where the operator manually sweeps the quill or grinding wheel across the lens till the desired lens thickness is achieved. If the lens gets too hot during the operation it may warp or tear, so it is cooled by water, which also washes away the cut material, called scarf. This can also be done

Smoothing



Polishing



Polishing pads

Fig. 5.20

automatically by a CNC machine which performs the dry cutting within a few seconds. In this process, lens thickness is determined by:

- **Curve type:** plus or minus
- **Lens material:** depending upon the strength of the plastic it can be made thinner
- **Other considerations:** e.g., safety glasses are made thicker than lenses for daily use

Smoothing and polishing

After grinding, it is seen that though the appropriate curvature is achieved the surface is still rough and not suitable for spectacles. Hence, this has to be smoothed and polished. A metal die or tool is a mould corresponding to the required optical prescription of the lens – it must have reversed, matching curves (e.g., +2.00 base/+2.50 tool for -2.00/-2.50 lens). Self-adhesive rough sandpaper is attached to the die and this is rubbed against the lens surface in a circular motion by a smoothing machine for one minute, in order to smoothen it. This is once again repeated with a slightly smoother pad. Meanwhile the lenses are kept cool and cleaned with water.

Now, polishing is done by using a very smooth pad on the die for five minutes while a polishing compound consisting of aluminum oxide, water, and polymers flows over the lenses. The lenses are removed from the finishing machine, and the metal block is gently detached by immersing the blocked lens into hot water. The tape can be removed from each lens by hand. The lenses are now ready for edging.

Student exercise

Answer the following

1. *What should be checked before fitting the spectacle?*
2 *What are the equipments needed for fitting by manual and automated methods?*
3. *How is a lens marked before manual fitting?*
4. *What are the different parameters to be considered while surfacing?*
5. *What are the differences and similarities between manual and automated surfacing?*
6. *How are different tints and tint patterns achieved?*

Choose the correct answer

1. *Rimless frames are fitted by*
   a. *Nylon wires*
   b. *Using adhesives*
   c. *Screws and clips*
   d. *Fitting bevel into the groove*
2. *Buffing refers to*
   a. *Edging the lens*
   b. *Polishing the lens edges*
   c. *Cleaning the lens*
   d. *Surfacing the blank*

Answer if True of False

1. *While edging for half rimless frames the lens edges should be beveled (True / False)*
2. *Ray - Ban Tint is achieved by dipping in green then grey (True / False)*

CHAPTER 6 SUPPORT ACTIVITIES

CONTENTS

Trouble shooting
Inventory management
Reporting and reviewing

GOALS

To help the MLOP to understand the support activities that contribute to the smooth functioning of an optical dispensing unit.

OBJECTIVES

The MLOP should

- Understand how patient complaints are handled
- Know how inventory is maintained
- Appreciate reporting systems

CHAPTER 6

Support Activities

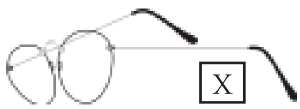
Trouble shooting

When patients come with complaints of discomfort or poor vision with their spectacles, it is important to assure them that you can help them with the problem. If they have a complaint about their spectacles or the service provided, do not deny you made a mistake. Instead listen carefully to the patient's problem as this serve as feedback for you to improve your dispensing practice.

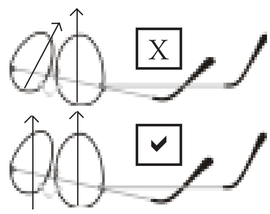
Often, the patient explains his experience with the spectacles and these are usually only symptoms of an underlying problem. One should try to be ready for handling the majority of the problems. A few problems which patients often complain of are discussed here. Possible ways to solve these are also suggested.

Whenever a patient arrives with a complaint, the following steps can help one to arrive at the cause of the problem.

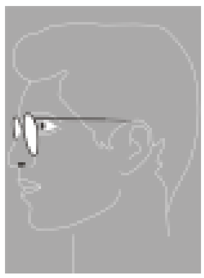
- Refer to the patient's medical records to ensure that the spectacles satisfy the prescription details
- Make sure that the lens power and the lens design are dispensed according to the prescription.
- Observe the frame position and segment height when the patient is wearing the spectacles. Misaligned frames and improper frames size can cause the following problems:
- Vertex distance discrepancy which can affect the effective power of the spectacles
- Ill-fitting frames can slide forward
- Frames may be positioned awkwardly
- Too-tight frame temples cause uncomfortable pressure on the side of the head or at the ears
- Eye lashes touch the lenses
- Frame touches eyebrows
- Complaints of frame discomfort: Adjust the frame and check up the following
- Are both rims in level with each other : A - B level
- Nose pad is positioned evenly and does not press on the nose
- **Facial wrap:** the frame fits properly following the curved line of the face - but not excessively
- **Pantoscopic tilt:** angle between the front and temple should be comfortable – a tilt of 10º to 15º helps to avoid contact with the cheeks
- Inter-pupillary distance (IPD) measurement is correct
- **Temple grip:** the temple is adjusted for a snug fit. Adjust length of temple to minimise sliding - comfortable but not tight



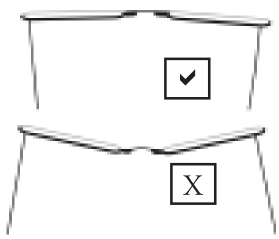
Temples should be level



Rims should be tilted to the same angle



Pantoscopic tilt



Ensure sufficient facial wrap

Fig. 6.1

Complaints in vision: Check for the following:

- Prescription: Verify the spectacles against the prescription – power, axis, prism etc
- Previous spectacles: Investigate what type of spectacles were used previously; it might only need some practice to get used to the new pair
- Centering: the optic centre of the lens should coincide with the eye's pupil – mark the centre of the lenses and check if it coincides with the corneal reflection when the patient is wearing the spectacles
- Segment height: Check if the segment is well below the pupil; otherwise the patient would be viewing distant objects through the near segment. Check that both segments are at level with each other
- The most common defect in dispensing is the wrong centering of lenses – the optic centre of the lenses is not aligned to the patient's pupil. This can cause blurred vision.
- Decentred lenses can induce a prism effect that cause headache and giddiness
- An incorrect form of lens can cause discomfort and heaviness of the spectacle. Check the lens for proper thickness and lens curve. Shadow scope or Polaroid lens can be used to identify the lens defects.
- If all the above seem correct it is worthwhile to confirm the prescription by repeating refraction on the patient.
- If there is no technical problem found, gentle counselling can help to understand the real cause of the dissatisfaction with the spectacles. Other reasons like cost, poor counselling during delivery and miscommunication by staff can make the patient unhappy.

Some common symptoms and possible causes are given below

Symptom (Patient complaints)	Possible causes
Distance vision is blurred	- Incorrect prescription - Incorrect axis - Segment height is too high
Near vision is blurred	- Incorrect prescription - Segment height is too low - Large vertex distance - Incorrect PD - Insufficient pantoscopic tilt
Waves seen in distance vision zone	- Incorrect prescription - Incorrect axis - Large vertex distance - Insufficient facial wrap - Insufficient pantoscopic tilt - Segment height is too high
Difficulty in reading (excessive lateral head movements whenreading)	- Over correction in near vision zone - Incorrect PD - Segment height too low - Large vertex distance - Insufficient facial wrap - Insufficient pantoscopic tilt - Insufficient segment area; frame is too small
Distance vision is clear only when head is tilted back	- Incorrect prescription
Head has to be tilted back for reading	- Incorrect prescription - Fitting height too low
Head tilt forward at distance	- Fitting height too low
Head tilt forward at near & Intermediate	- Incorrect prescription

Inventory management

In an optical dispensing set up it is essential that all goods and consumables are accounted for and stocked in a manner that it is easy to retrieve, use and audit. This section deals with the maintenance of inventory. It discusses how to stock optimum quantities with control on receipts, issues and storage. The inventory items considered for this are frames, lenses and spectacle accessories only. The inventory system discussed here is only one method of handling optical goods there are other possible methods to stock these items. With the help of computers, today, we can manage the stock in a way that is more error-free and the information can be produced faster to enable quicker decision making.

A good inventory manager should:

- Be knowledgeable about all stock items
- Be up-to-date about the new products available in the market
- Be sensitive to the current preferences of the customers
- Be able to deal with the different suppliers – to appraise and select and negotiate with them
- Ensure that all entries are made in the stock register/computer
- Periodically perform an audit of the stock items

Frames and spectacle accessories

Maintaining an inventory of frames or spectacles accessories requires not only a disciplined inventory system but also a sense of fashion and the current trends in the locality. This is important as the models purchased should reflect the preference of the customers.

Lenses

When a customer places an order for the lenses, we usually do not know the combination of the powers and thus we stock only those lenses whose power is of common occurrence. This range of stocked lenses or ready lenses is based upon the frequency of its occurrence in the orders; this range should change according to the changing demand patterns. These lenses can be bought readymade from any optical goods supplier. All other lenses are made-to-order: they are processed or purchased from an external supplier only after the customer places the order.

Purchase planning

While purchasing lenses and frames it is important to plan before placing the order.

- To get a estimate of the quantity to order, we can refer to previous sales figures. (For e.g., An indicator for the frames to order for this month, we can refer to frame sales in the same month, last year).
- The supplier should also be assessed. This can be based on our previous experience with the supplier:
  - Overall performance in delivering the goods on time and in good condition
  - Expertise in the optical field
  - Support offered in replacing rejected goods, repair work and special order processing
- It is important to always check the goods received against the order placed and the bill invoiced. Also perform a quality check of the items

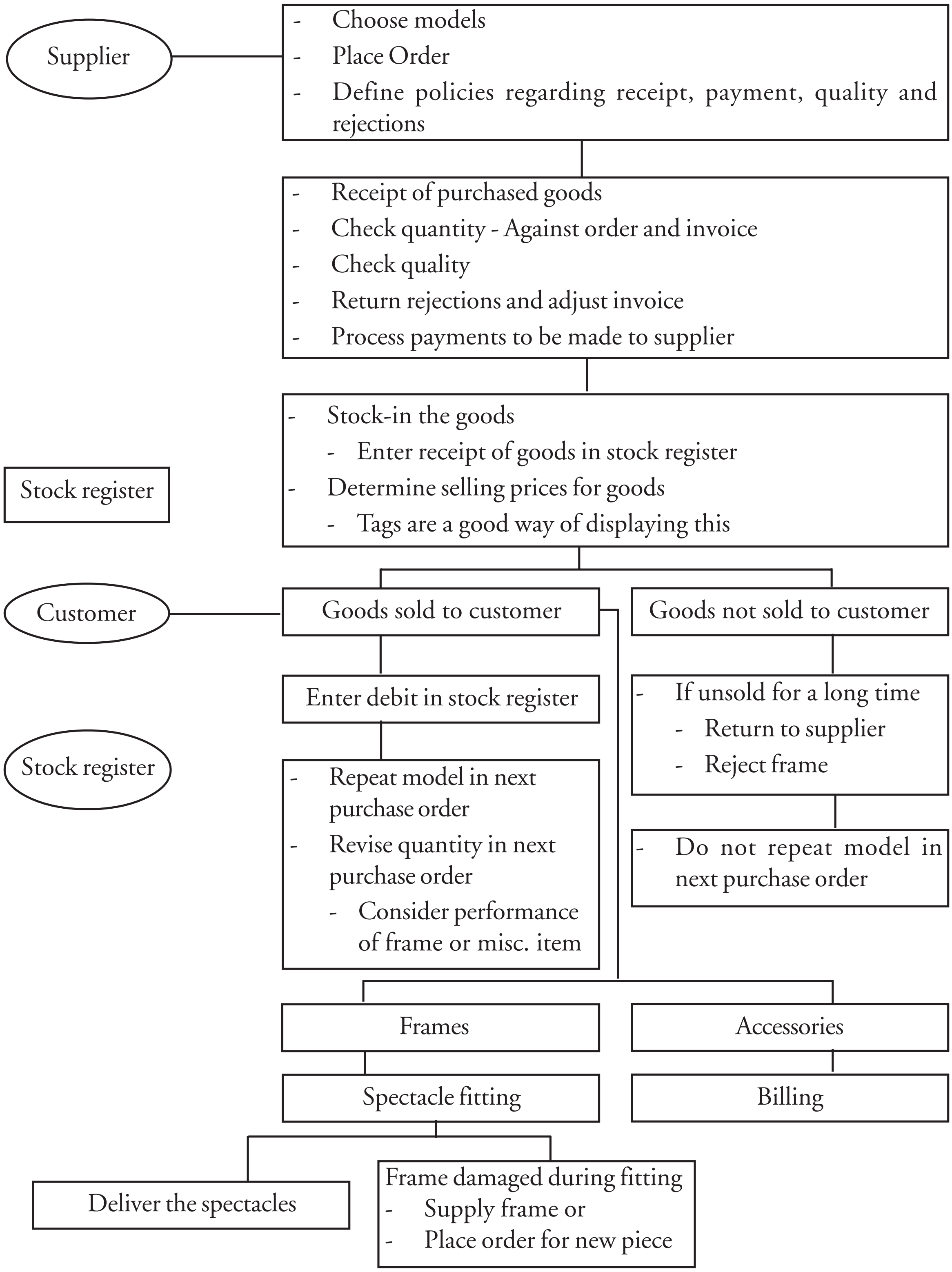
Return goods management

Remember that the longer the stock is held, frames tend to fade and tarnish; glass lenses are more susceptible to breakage and plastic lenses to scratch or turn yellow. When goods remain unsold over a long period of time, they can be disposed off in one of the following ways:

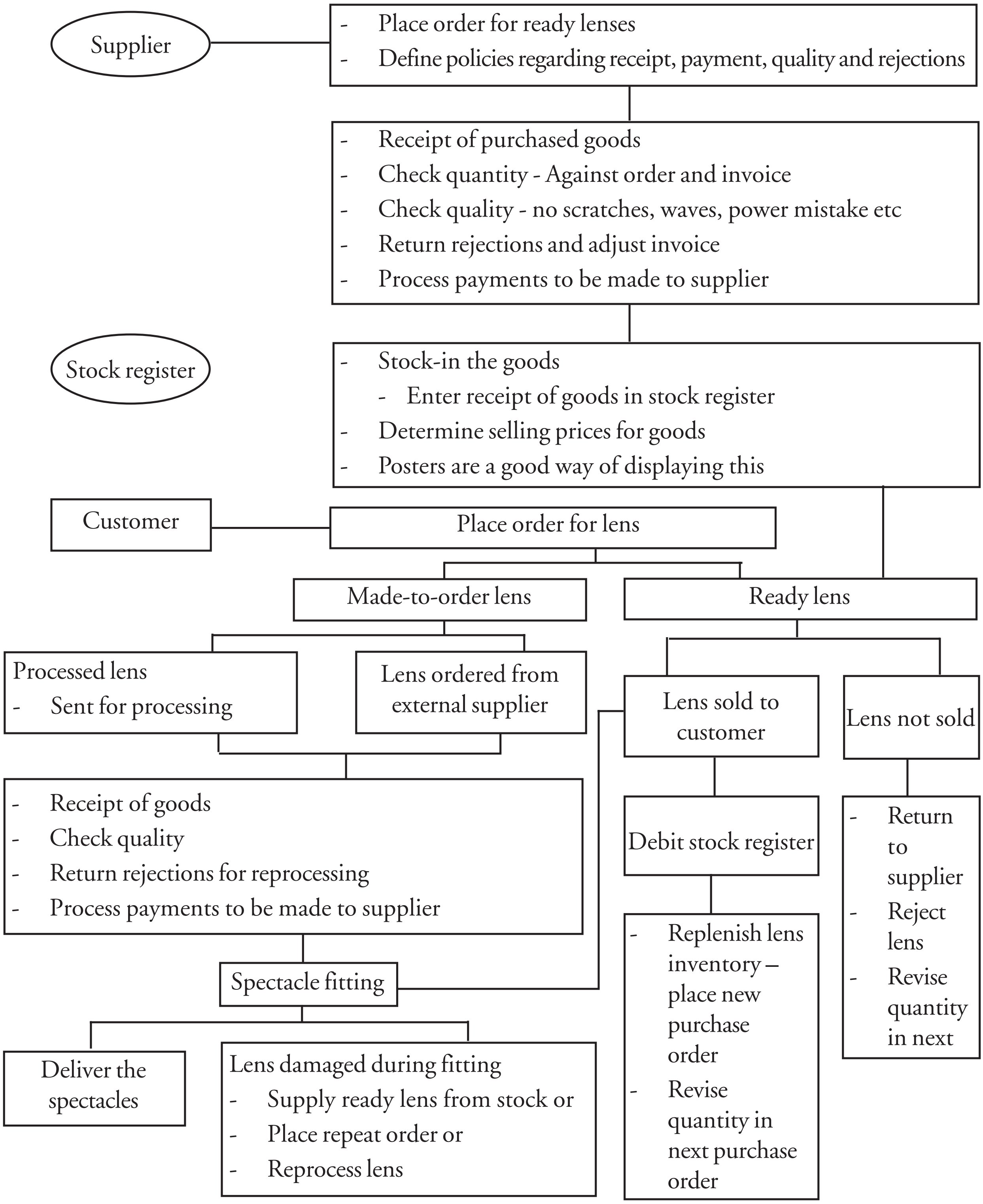
- Offer them on sale at a discounted price
- Suppliers usually accept return of these goods if they are in good condition and if the frame model is still in demand, so that he is still able to resell it to others
- To insure against this it is advisable to enter into an agreement with the supplier that he will accept returns within a certain period – this way both parties are not affected

The following flowcharts show the steps involved in routine inventory maintenance

Flowchart for maintaining inventory of frames and accessories



Flowchart for maintaining inventory of lenses



- The inventory should not be a fixed, static set of items. Instead, it should change constantly to stock the fast moving items – in such a way that any item does not stay shelved for longer than a fixed period. (slow moving stock may be kept in small quantities or purchased or order).

Reporting and reviewing

To effectively run the optical dispensing unit, as in any trade, it is important to record every transaction. More important, is to gather information from all the data collected and present it in a way that it illustrates performance efficiency. It should give feedback in a way that helps us take decisions for the future.

Reports also serve to encourage or discourage a certain aspect among the employees. For instance:

- A report showing the quantity of lenses rejected by each staff will serve to make each employee aware and be more careful; whereas, in the absence of such a report the employee is not aware of his mistakes and may not take any steps to correct it.
- A report showing the quantity of orders taken by each staff will create a competitive spirit and encourage each employee to achieve more. Thus, it is necessary to study what results are desired and design the reports accordingly. Reports also help us monitor the performance of the set up against a set standard (such as the previous year's performance).

The use of computers can make data entry easy and fast. Data collating and reports can also be made quick and accurate. Calculations and extrapolation can be done faster too.

Here are a few report formats that are suggested

Example 1

No. of out - Patients	No. of Prescri-ptions Issued	No. of orders Taken
100	25	22

This report shows the performance of the dispensing unit with respect to the overall patient visits. It also shows how many patients who received spectacle prescriptions actually purchased the spectacles. A modification of this report which compares performance with the previous year is given here.

The use of percentages in reports helps the reader to quickly grasp the effect of the figures in comparison with each other. With such reports, predictions for the future can also be made by extrapolating with a conservative expected growth percentage. *(Table : 1)*

This report shows the break up of the sales into relevant categories. This can help the management take decisions on planning inventory. The following modifications on this show employee-wise details which helps to create competitiveness and serves to

Table : 1

No. of out - patients		No. of prescriptions issued		No. of orders taken		
Yr. 2003	Yr. 2004	Yr. 2003	Yr. 2004	Yr. 2003	Yr. 2004	growth (%)
90	100	20	25	15	22	47%

Table : 2

No. of orders taken	Glass lenses	Plastic lenses	Progressive Lenses	Special lenses	No of Undeli -vered Orders
22	3	19	5	4	2

Table : 3

Staff Name	Orders Taken	Glass Lenses	Plastic Lenses	Progressive Lenses	Special lenses	Undelivered Orders
A	100	30	70	10	16	10
B	80	50	30	3	11	6
C	90	30	60	12	15	9

encourage those performing well. It is necessary however to communicate these reports to the employees in a suitable manner. The communication should explain the management's desired results (e.g., increase sales of plastic and progressive lenses but reduce undelivered orders) *(Table : 2).*

These reports correspond to sales performance. Similar reports can be generated to monitor inventory (non-moving items, rejections, pending purchase orders, payments pending etc), production (quantity produced, rejections, quality reports etc) and delivery (undelivered goods, delayed deliveries, complaints etc). For an effective reporting system it is essential to have a system to collect the data in a reliable manner. *(Table : 3).*

Teaching suggestions

- Have the MLOP observe an optician handling customer complaints
- Let the MLOP observe and assist in the different activities in the inventory section
- Have the MLOP collect data and prepare basic reports which measure different aspects of performance.

Practice questions

1. *How do you handle complaints? How can you change your practices to avoid common complaints?*
2. *What is the role of the inventory manager?*
3. *How do you determine which lens power to stock as readymade and which to process on order?*
4. *How will you determine which supplier to purchase from?*
5. *What factors will you consider when purchasing frames?*
6. *Why should you have a recording and reporting procedure?*
7. *What reports will be relevant to your dispensing set up?*
8. *How would you record data in order to make reporting easier?*

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