

**KMCT COLLEGE OF ALLIED HEALTH SCIENCES**

**MUKKAM,KOZHIKODE,KERALA**

**DEPARTMENT OF OPTOMETRY**

**SECOND YEAR OPTOMETRY**

**OPTOMETRIC OPTICS -QUESTION BANK /ANSWER KEY**

**ESSAY**

1. With neat diagrams and description, derive the approximate sag relationship.  
 $s = \frac{y^2 F}{2000(n-1)}$ . Mention the formula to find the central thickness of Bi-convex, plano convex, positive meniscus, Bi-concave, Plano-concave and negative meniscus lens with the help of neat diagrams
2. write an essay about physical optics, its types and phenomena
3. explain phenomena based on geometrical optics with the help of neat diagram
4. write an essay about spherical lenses
5. write an essay about astigmatic lenses
6. Hand neutralisation and Lensometer
7. Lens makers equation and fundamental paraxial equation
8. Write an essay about instruments used for curvature measurements
9. Write an essay about spectacle magnification
10. Describe various test used for testing scratch resistance property and impact resistance of lenses
11. Describe about best form of lens
12. Describe different base apex notation used to indicate prisms in oblique direction
13. Prism measurement using lensometer
14. Write an essay about indications and types of prism in ophthalmology
15. Write an essay about compounding and resolving prism

**SHORT ANSWERS**

1. Types of bifocal lenses ,its advantages and disadvantages
2. Discuss types ,characteristics,advantages of multifocal lenses
3. Write an essay about occupational multifocal lenses
4. Write an essay about different tints ,features and their indication and explain methods of tinting
5. Discuss about photochromic and polaroid lenses,their indications advantages and disadvantages

6. Write an essay about protective and therapeutic lenses
7. Explain surface treatments of lens
8. Write about high index lenses
9. Discuss lenticular lens
10. Write about aspheric lens
11. What is the ANSI standard for regular lens
12. What are the markings on safety lens
13. write an essay about sports lens
14. Write an essay about different frame material
15. Write about nomenclature of spectacle frame
16. Discuss about different types of frames
17. Write an essay about frame manufacturing process
18. Define the terms with respect to prism
  - Thickness difference
  - Centrad
  - Prism diopter
  - Decentration
  - Pull of a prism
19. Differentiate between individual batch method and continuous flow process during glass manufacturing.
20. Brief on the steps involved in surfacing a glass lens.
21. Define ANSI Z87 safety eye wear standard
22. Chromatic aberration. How is abbe value useful in determine the chromatic aberration in a lens.

#### ANSWER BRIEFLY

1. Transpose the following prescription to sphero cylindrical form and show it in the optic cross  
 $-0.75DC \times 20 / +0.75DC \times 110$ .
2. Pantoscopic tilt. Mention two uses of it.
3. Differentiate Symmetric and Asymmetric design in progressive addition lenses
4. Calculate the spherical equivalent of  $-2.75DS / -2.00 DC \times 145$
5. Define decentration. What is the prismatic effect produced by a  $-10.00DS$  lens decentered 4mm downwards before an eye
6. Write briefly about the following designs of progressive addition lenses:
  - a. Advanced soft design • Mono-design • Symmetric lens design
  - b. Multi-Design
  - c. Soft design
7. Various faults on the surface of a lens
8. A lens is said to have a power of  $+4.50D$  in the vertical meridian and  $-3.50D$  in the horizontal meridian. Write out its prescription in the toric form with  $-5.00D$  base curve.

9. What will be the back vertex powers of the lens which has surface powers +8.00D and -19.00D and central thickness of the lens being 8mm
10. Uses of high index ophthalmic lens
11. Role of photo chromatic ophthalmic lens
12. Role of blue light filter coating
13. What is the prismatic effect produced at a point 15mm inwards from the optical center of a -3.50DS lens given for the right eye
14. Discuss the importance of centring of lenses in spectacle frames. Describe the method of accurate centring of lenses in spectacles.
15. What are crossed prisms and mention its uses.
16. Describe the steps of toric transposition. Transpose the following prescription in to toric form with base curve -6.00 D, -8.00 D S / -2.00 DC\*90
17. Define prism diopter and catoptric power
18. Brief on the soft design of progressive addition lenses
19. Calculate the vertical, horizontal and the single resultant prismatic effects at a point 8mm below and 5mm inwards from the optical center of the lens +4.00DS for the right eye
20. Draw a neat labeled diagram of progressive addition lenses with its micro etchings and mention their importance. How do we find the power for distance in a progressive addition lenses
21. Describe about laminated lenses and polycarbonate lenses in detail
22. The yellow absorbing filters
23. Iseikonic lenses
24. What is pantoscopic tilt and mention its use in spectacle dispensing
25. Calculate the edge substance of a biconcave lens of power -13.00DS made in spectacle crown glass of refractive index 1.523. The surface power of which are -7.00D and -6.00D. Lens is 40mm in diameter and has a central thickness of 0.7mm.
26. short note on field of view through spectacles. Find out angular field of view of lenses +10.00DS and -10.00DS with 20mm aperture mounted at +37 D from center of rotation of eye
27. With the help of a neat figure explain the refraction of light rays through a Convex Spherical and Plano-concave lens.
28. Brief on the polishing burn and strain of lens defects
29. What are the mechanical requirements of an bifocal lenses
30. Brief on the heat absorbing lenses
31. Why are convex lenses referred as plus lenses. What is the refractive index of crown glass and dense barium crown glass

### ONE WORD ANSWERS

1. Frames that are suitable for use as safety glasses must have \_\_\_\_\_code written

2. On them
3. True or False - In the boxing system, the effective diameter is the diagonal of the box
4. Calculate the jump exerted by the following lens: +1.00D; Add +2.00D, 22 Segment
5. What is the range of solar radiation to which humans are exposed on earth.
6. "Most optical media used for spectacle lenses are isotropic". What do you infer from this
7. Transpose the prescription into one of its alternate forms: -0.75DC\*20/+0.75DC\*110
8. Which is the narrow waveband of radiations giving rise to sensation of vision
9. What is indicating with BSEN 170
10. which property of ophthalmic lenses is describing by Abbe value
11. Divide the 4▲BU on right eye before both the eyes
12. statement.
13. Transpose into its alternate form +2.00 DS / -3.00 DC x 150.
14. Lens clock is used for \_\_\_\_\_
15. Focal line is forming in ..... type of lenses.
16. .... is an example of cement using in spectacle industry.
17. Edge thickness is more in ..... lens power.
18. Name the two portions of a lenticular lens
19. Name any one condition in which the ghost images may cause the spectacle wearer trouble
20. Name two glass cements
21. Abbe value of crown glass is ....."
22. When lightning strikes a bed of dry sand, the natural glass formed due to fusing of sand is \_\_\_\_\_
23. 2▲BD and BO @ 20 in Old English Notation = \_\_\_\_\_ in 360° Notation
24. \_\_\_\_\_ crystals are present in photo chromatic filters (lens)
25. Polycarbonate has the property of UV radiation protection. True or false
26. Define best form spherical lens
27. Transpose the prescription into one of its alternate forms: +4.25DS/ +5.50DC\*140
28. What is the power of a lens having its focal length at +57cm

29. Define centrad
30. Refractive index of crown glass is \_\_\_\_\_
31. Define aberration
32. Transpose the prescription into one of its alternate forms  $\pm 0.00/-4.00$  DC X 55 . + / - 4.00DC\*55
33. List two differences between D-Bifocals and Kryptok Bifocals
34. Refractive index of polycarbonate.
35. Calculate the jump exerted by the following lens: -2.00 DS, Add +1.00 DS Segment 50mm
36. Uses of aviator spectacle design
37. Chemical names of CR-39 \_\_\_\_\_
38. What will be the focal length in mm for a lens of power -2.75D
39. Ophthalmic prisms have large apical angles. True or False
40. Varilux Physio is an example of Progressive Addition Lens (PAL). True or False
41. What will be the focal length in mm for a lens of power +4.00 DS
42. Find the prismatic effect at point 6mm below the optic center of +4.00DS lens.
43. Convert  $5^{\circ} 17'$  into prism diopters
44. What is a periscopic lens
45. What is the refractive index of poly methyl methacrylate.

## ANSWER KEY

### ESSAY

1) Deriving the Approximate Sag Relationship and Lens Thickness Formulas:

To derive the approximate sag relationship for lenses, you can start with the lens formula, which relates the focal length ( $f$ ) of a lens to its radii of curvature ( $R_1$  and  $R_2$ ) and refractive index ( $n$ ):

$$\text{Lens Formula: } 1/f = (n - 1) * (1/R_1 - 1/R_2)$$

Now, for a lens with a small thickness, you can approximate the sag ( $s$ ) using the following formula:

$$s \approx y^2 / (2 * f)$$

Where:

$s$  is the sag.

$y$  is the height of the object or image from the optical axis.

$f$  is the focal length.

To find the central thickness ( $t$ ) of different types of lenses, you can use the lens formula along with the lens-maker's equation:

$$\text{Lens-Maker's Equation: } 1/f = (n - 1) * [(1/R_1) - (1/R_2)] + (n - 1) * (t / (n * R_1 * R_2))$$

For a bi-convex lens:

$R_1 = R_2$  (both positive)

$R_1 = R_2 = R$  (for a symmetric lens)

For a plano-convex lens:

$R_1 = \infty$  (one side flat)

$R_2$  is positive

For a positive meniscus lens:

$R_1$  is positive

$R_2$  is negative

For a bi-concave lens:

$R_1 = R_2$  (both negative)

$R_1 = R_2 = -R$  (for a symmetric lens)

For a plano-concave lens:

$R_1 = \infty$  (one side flat)

$R_2$  is negative

For a negative meniscus lens:

R1 is negative

R2 is positive

You can use the lens formula and lens-maker's equation to find the central thickness ( $t$ ) for each type of lens by plugging in the values of R1, R2, and  $n$ .

## 2) Essay on Physical Optics:

Physical optics, also known as wave optics, is a branch of optics that deals with the wave nature of light. It encompasses various phenomena and principles that cannot be explained by geometric optics alone. In physical optics, light is treated as an electromagnetic wave, and it provides insights into several important phenomena:

**Interference:** When two or more coherent waves overlap, they can either reinforce (constructive interference) or cancel each other (destructive interference). This leads to the formation of interference patterns, which are crucial in applications like thin-film interference and diffraction gratings.

**Diffraction:** Diffraction is the bending of light as it encounters an obstacle or aperture. It leads to the spreading of light waves, which can be observed when light passes through small openings or around edges.

**Polarization:** Light waves can vibrate in multiple directions, and polarization is the phenomenon of restricting these vibrations to a single plane. Polarizers and optical materials are used to manipulate polarized light.

**Huygens' Principle:** This principle states that each point on a wavefront can be considered as a source of secondary spherical waves. The combination of these secondary waves results in the propagation of the wavefront.

**Double-Slit Experiment:** This classic experiment demonstrates the wave-particle duality of light. It shows that even individual photons exhibit interference patterns, suggesting that light behaves as both particles and waves.

Physical optics is essential for understanding a wide range of optical phenomena and is fundamental in the study of diffraction, interference, and polarization.

## 3) Phenomena Based on Geometrical Optics:

Geometrical optics deals with the propagation of light as rays. While it simplifies complex optical phenomena, it can explain several important phenomena, such as:

**Reflection:** When light encounters a smooth surface, it follows the law of reflection, where the incident angle equals the reflected angle. Mirrors utilize this principle to form images.

**Refraction:** The bending of light as it passes from one medium to another with a different refractive index is governed by Snell's Law. Lenses rely on refraction to focus or diverge light.

**Total Internal Reflection:** When light travels from a higher refractive index medium to a lower refractive index medium at an angle greater than the critical angle, it undergoes total internal reflection. This phenomenon is used in fiber optics.

**Dispersion:** The separation of light into its component colors is called dispersion. Prisms and diffraction gratings are common optical devices that exploit this phenomenon.

**Mirages:** Geometrical optics explains the formation of mirages due to the bending of light in a temperature gradient, creating virtual images of distant objects.

**Lens Imaging:** Geometrical optics principles are used to describe image formation by lenses, whether they are converging (positive) or diverging (negative) lenses.

By utilizing rays and simplified models, geometrical optics provides valuable insights into how light interacts with optical systems.

#### 4)Essay on Spherical Lenses:

Spherical lenses are optical devices that have curved surfaces and are commonly used in a variety of applications, including eyeglasses, cameras, and telescopes. There are two primary types of spherical lenses: convex (or converging) lenses and concave (or diverging) lenses.

**Convex Lenses:** These lenses are thicker at the center than at the edges and are designed to converge light. They have two focal points, one on each side of the lens, and are commonly used for magnification and image formation. Convex lenses can produce both real and virtual images depending on the object's position.

**Concave Lenses:** In contrast, concave lenses are thinner at the center and are used to diverge light. They also have two focal points, but one is virtual and located on the same side as the incident light. Concave lenses are utilized for correcting myopia (nearsightedness) and for specific optical applications like projectors.

The properties of spherical lenses can be described using the lens formula and lens-maker's equation. These equations enable the determination of focal lengths, image distances, and lens thickness. Spherical lenses are vital components in the field of optics and play a significant role in the correction of vision defects, magnification in optical instruments, and various imaging systems.

#### 5)Essay on Astigmatic Lenses:

Astigmatism is a common vision condition that occurs when the eye's cornea or crystalline lens has an irregular shape, causing light to focus on multiple points instead of a single point. To correct astigmatism, astigmatic lenses are used, which have different optical powers in different meridians. Here's an essay on astigmatic lenses:

**Introduction:** Astigmatism is a refractive error that affects the eye's ability to focus light properly. It is caused by irregularities in the curvature of the cornea or the crystalline lens. Traditional spherical lenses cannot correct astigmatism because they have the same power in all meridians. Astigmatic lenses, also known as toric lenses, are specifically designed to address this condition.

**Design and Function:**

Astigmatic lenses have two different optical powers at right angles to each other. These powers are required to correct the varying degrees of astigmatism in different meridians of the eye. One power corrects the horizontal meridian, while the other corrects the vertical meridian.

**Prescription and Fitting:**

To prescribe astigmatic lenses, optometrists or ophthalmologists measure the degree of astigmatism and the orientation of the meridians. This information is used to determine the exact prescription for the astigmatic lens. Proper fitting is crucial, as toric lenses must align with the eye's meridians to be effective.

**Types of Astigmatic Lenses:**

Astigmatic lenses come in various forms, including eyeglasses, contact lenses, and intraocular lenses for cataract surgery. Toric contact lenses are particularly popular for their ability to provide clear vision without the need for eyeglasses.

**Benefits:** Astigmatic lenses offer several benefits, such as improved vision quality for individuals with astigmatism. They correct the blurriness and distortion associated with this condition, leading to sharper and more comfortable vision.

**Challenges:** Astigmatic lenses may require more precise fitting and adjustments compared to standard spherical lenses. Additionally, they can be more expensive due to their specialized design.

#### 6) Hand Neutralisation and Lensometer:

Hand neutralisation is a technique used in optometry to determine the power and axis of astigmatic lenses. It involves aligning a trial lens with the principal meridians of the eye until no movement or rotation of the lens is observed. A lensometer, also known as a lensmeter or focimeter, is an optical device used to measure the power of eyeglass lenses, including spherical and cylindrical (astigmatic) components.

##### Hand Neutralisation:

Hand neutralisation is a manual process where an optometrist or technician uses a trial frame with a trial lens to neutralize the astigmatic error in a patient's eye. The goal is to find the exact orientation (axis) at which the astigmatic lens has no power. This is achieved when the lens remains stationary, with no movement or rotation.

##### Lensometer:

A lensometer is a precise instrument designed for measuring the power and other characteristics of eyeglass lenses. It typically consists of an eyepiece, a target, and a lens carriage. To measure an astigmatic lens with a lensometer, the following steps are typically taken:

Place the lens in the lens carriage.

Look through the eyepiece and focus on the target.

Rotate the lens until the astigmatic lines on the lens align with the target.

Read the sphere power, cylinder power, and axis from the instrument.

Lensometers are commonly used in optometry practices to verify the prescription of eyeglass lenses, including the presence and degree of astigmatism. They are also used to check the quality and accuracy of finished eyeglasses.

#### 7) Lens Maker's Equation and Fundamental Paraxial Equation:

The Lens Maker's Equation and the Fundamental Paraxial Equation are fundamental formulas used in optics to determine the properties of lenses and image formation.

##### Lens Maker's Equation:

The Lens Maker's Equation relates the focal length of a lens ( $f$ ) to the radii of curvature of its surfaces ( $R_1$  and  $R_2$ ) and the refractive index of the lens material ( $n$ ). It is expressed as:

$$\frac{1}{f} = (n - 1) * \left[ \frac{1}{R_1} - \frac{1}{R_2} \right]$$

This equation is essential for lens design and helps in calculating the focal length of a lens based on its curvature and the refractive index of the material.

##### Fundamental Paraxial Equation:

The Fundamental Paraxial Equation is used to describe the relationship between the object distance ( $d_o$ ), image distance ( $d_i$ ), and the focal length ( $f$ ) of a lens in paraxial (near the optical axis) conditions. It is written as:

$$1/f = 1/d_o + 1/d_i$$

This equation simplifies image formation for thin lenses and is a key tool in understanding the behavior of lenses in optical systems.

Both equations play a critical role in lens design, image formation, and optical system analysis. They are used to calculate various parameters such as image magnification, object and image distances, and focal lengths.

#### 8)) Instruments Used for Curvature Measurements:

Curvature measurements are essential in optics and lens manufacturing to ensure the quality and accuracy of optical surfaces. Several instruments are used for this purpose:

**Spherometer:** A spherometer is a handheld instrument used to measure the radius of curvature of spherical or cylindrical surfaces. It typically consists of a fine screw gauge and three legs that contact the surface, allowing precise measurements of curvature.

**Radius Gauge:** Radius gauges are tools specifically designed to measure the radius of curvature of spherical surfaces. They come in various forms, such as concave and convex radius gauges, and are especially useful for lens manufacturing.

**Interferometer:** An interferometer is an advanced instrument that uses interference patterns to measure surface shapes, including curvature. It can provide highly accurate and detailed information about optical surfaces.

**Autocollimator:** Autocollimators are used to measure the curvature of optical surfaces by analyzing the reflections of a collimated beam of light from the surface. They are commonly used in alignment and optical testing.

**Curvature Test Plates:** These are glass or plastic plates with known curvature patterns. By comparing the interference patterns produced by these plates to the test surface, one can determine its curvature. Accurate curvature measurements are crucial in lens manufacturing, telescope construction, and various optical applications to ensure that optical surfaces meet the required specifications.

#### 9) Essay on Spectacle Magnification:

Spectacle magnification refers to the effect that eyeglasses or spectacles have on the apparent size of objects when worn by individuals with refractive errors. It can be both positive (magnifying) or negative (minimizing) and plays a significant role in vision correction. Here's an essay on spectacle magnification:

##### Introduction:

Spectacle magnification is a concept that arises when eyeglasses are prescribed to individuals with refractive errors such as myopia (nearsightedness) or hyperopia (farsightedness). These refractive errors affect the way light is focused on the retina, and corrective lenses are used to provide clear vision. Depending on the lens power, the apparent size of objects viewed through eyeglasses can be magnified or minimized.

##### Positive Spectacle Magnification:

Positive spectacle magnification occurs when individuals with myopia wear concave (diverging) lenses to correct their nearsightedness. These lenses diverge incoming light, allowing distant objects to come into focus on the retina. As a result, objects appear smaller and farther away than they actually are. This can be perceived as a form of magnification.

Negative Spectacle Magnification:

Negative spectacle magnification, on the other hand, is observed in individuals with hyperopia who wear convex (converging) lenses to correct their farsighted

11) Testing Scratch Resistance and Impact Resistance of Lenses:

Scratch Resistance Testing:

The primary test for scratch resistance involves using a set of standard abrasive materials, such as abrasive brushes or sandpaper, to rub against the lens surface.

The lenses are then inspected for visible scratches, and the degree of scratching is quantified, often on a scale from 1 to 10, with 10 indicating no visible scratches.

Impact Resistance Testing:

Impact resistance tests are designed to evaluate a lens's ability to withstand impact without shattering.

A common test involves dropping a steel ball or a weighted pendulum onto the lens from a specified height.

The lens is then inspected for signs of cracking, chipping, or shattering.

Impact resistance is usually measured in terms of the velocity or energy required to damage the lens.

12) The Best Form of Lens:

The "best" form of a lens can vary depending on the specific needs and requirements of the wearer. Some important considerations include:

Spherical Lenses: These have a constant curvature across their entire surface and are the most common type. They correct single-vision refractive errors like myopia (nearsightedness) and hyperopia (farsightedness).

Bifocal and Trifocal Lenses: These lenses have multiple focal points, allowing for both distance and near vision correction in a single lens. They are suitable for presbyopia, a condition where the eye's ability to focus on close objects diminishes with age.

Progressive Lenses: These provide a smooth and gradual transition from distance to near vision, eliminating the distinct lines found in bifocals and trifocals. They offer a more natural vision correction for presbyopia.

Aspheric Lenses: These lenses have a more complex curvature, reducing distortions and improving the aesthetics of the lens. They are often used in high-prescription eyeglasses.

The "best" form of lens ultimately depends on the wearer's prescription, lifestyle, and visual needs. Consulting with an eye care professional is essential to determine the most suitable lens type.

13) Base Apex Notation for Prisms in Oblique Direction:

Base Apex Notation is a way to describe the orientation of prisms in eyeglasses. When prisms are oriented in an oblique direction, they can be denoted using the following notation:

The "Base" refers to the thicker edge of the prism.

The "Apex" is the thinner edge.

The direction of the base and apex is described relative to the primary meridians of the lens, typically the horizontal (180 degrees) and vertical (90 degrees) meridians.

For example, if a prism has its base at 45 degrees, it means the thicker edge of the prism is at a 45-degree angle from the horizontal meridian.

**Prism Measurement Using Lensometer:**

A lensometer, also known as a lensmeter or focimeter, is an instrument used to measure the power and orientation of lenses, including prisms. To measure prisms using a lensometer:

Place the lens in the lensometer with the appropriate side facing up.

Look through the eyepiece and align the lens so that the reticle target is centered.

Observe the crosshair pattern in the lensometer, which will display the prism power and direction.

The horizontal scale on the lensometer will indicate the amount of prism power in prism diopters (usually measured in 0.25 D increments).

The lensometer's axis scale will indicate the orientation of the prism in degrees.

**14) Indications and Types of Prism in Ophthalmology:**

Prisms are used in ophthalmology to address various vision problems and eye conditions.

Common indications and types of prisms include:

**Correcting Strabismus:** Prisms can help align misaligned eyes (strabismus) by shifting the visual axis of one eye to achieve binocular vision.

**Correcting Double Vision:** Prisms can be used to manage diplopia (double vision) caused by eye misalignment, nerve palsy, or other conditions.

**Fresnel Prisms:** These are thin, stick-on prisms that can be temporarily attached to eyeglasses to address double vision.

**Yoked Prisms:** Yoked prisms are used to treat nystagmus, a condition characterized by involuntary eye movements. They can help stabilize the patient's gaze.

**Therapeutic Prisms:** These prisms can be prescribed to alleviate visual discomfort or strain, often related to conditions like convergence insufficiency or accommodative dysfunction.

**Base-in and Base-out Prisms:** These prisms are used to modify convergence and divergence, respectively, to aid in vision therapy or orthoptic exercises.

**14) Compounding and Resolving Prisms:**

**Compounding Prisms:**

Compounding prisms involves combining two or more prisms with their bases in the same direction. When prisms are compounded, their powers are added together. For example, two 2-diopter base-in prisms, when compounded, yield a 4-diopter base-in prism.

**Resolving Prisms:**

Resolving prisms, on the other hand, involve combining prisms with their bases in opposite directions. When prisms are resolved, their powers are subtracted from each other. For example, a 5-diopter base-in prism and a 3-diopter base-out prism, when resolved, yield a 2-diopter base-in prism.

These techniques are often used in ophthalmology to create specific prism prescriptions tailored to individual patients' needs. Compounding and resolving prisms can help manage visual conditions, such as strabismus and double vision, by achieving the desired prism power and orientation.

## SHORT ANSWERS

### 1)Types of Bifocal Lenses, Advantages, and Disadvantages:

#### Types of Bifocal Lenses:

D-segment Bifocals: These have a distinct flat-top segment (D-shaped) for near vision, usually located at the bottom of the lens.

Round-segment Bifocals: Instead of a flat-top segment, these have a round segment for near vision correction.

Executive Bifocals: These have a wider intermediate and near vision segment for users who need a larger reading area.

Progressive Bifocals: Also known as no-line bifocals or multifocals, these provide a smooth transition between distance and near vision, eliminating the visible line found in traditional bifocals.

#### Advantages:

Bifocal lenses provide clear vision for both near and far objects.

They are cost-effective compared to progressive lenses.

Easy to adapt to for most wearers.

#### Disadvantages:

The visible line in traditional bifocals can be cosmetically undesirable.

Limited intermediate vision correction in traditional bifocals.

May require a separate pair of glasses for specific tasks.

### 2)Multifocal Lenses: Types, Characteristics, and Advantages:Types of Multifocal Lenses:

Progressive Lenses: Offer a smooth transition between distance, intermediate, and near vision.

Bifocal Lenses: Provide two distinct focal points for near and far vision.

Trifocal Lenses: Have three focal points for distance, intermediate, and near vision.

#### Characteristics:

Multifocal lenses allow for clear vision at multiple distances.

Progressive lenses have no visible lines, providing a more aesthetically pleasing option.

Bifocals and trifocals have visible lines separating the different focal segments.

Advantages:Convenience of not switching between multiple pairs of glasses.

Suitable for presbyopia and other age-related vision changes.

Progressives offer a seamless transition between focal points.

### 3)Occupational Multifocal Lenses:

Occupational multifocal lenses are designed for specific tasks, such as computer use or reading, that require clear intermediate and near vision. These lenses provide a customized solution for individuals with varying visual needs. They can include segments for

intermediate and near vision, with the rest of the lens optimized for the specific task. Occupational multifocal lenses can enhance comfort and productivity for people who have specialized visual requirements in their work.

#### 4) Different Tints, Features, Indications, and Tinting Methods:

Tints for Lenses:

UV Protection Tints: Block ultraviolet (UV) radiation to protect the eyes from sun damage.

Blue Light Blocking Tints: Filter out harmful blue light from digital screens.

Polarized Tints: Reduce glare from reflective surfaces like water and roads.

Photochromic Tints: Lenses that change their tint in response to UV exposure.

Indications:

UV tints for outdoor activities and sun protection.

Blue light blocking tints for digital device users.

Polarized tints for water and snow sports.

Photochromic tints for individuals who frequently transition between indoor and outdoor environments.

Tinting Methods:

Dyeing: Adding tint to the lens material during manufacturing.

Coating: Applying a tinted coating to the lens surface.

Photochromic: Using photosensitive molecules that change color in response to UV light.

#### 5) Photochromic and Polaroid Lenses: Indications, Advantages, and Disadvantages

Photochromic Lenses:

Indications: Suitable for individuals who frequently transition between indoor and outdoor environments, as they automatically adjust their tint based on UV exposure.

Advantages: Provide UV protection and eliminate the need for multiple pairs of glasses.

Disadvantages: May not darken fully while driving (due to car windshields blocking UV) and may not darken as quickly in very cold temperatures.

Polarized Lenses:

Indications: Ideal for activities with high glare, such as water sports, driving, and skiing.

Advantages: Reduce glare, improve visual comfort, and enhance contrast.

Disadvantages: May interfere with the visibility of certain LCD screens, such as those on some dashboards and smartphones.

#### 6) Protective and Therapeutic Lenses:

Protective Lenses:

These lenses are designed to protect the eyes from injury or damage. Examples include safety goggles, sports eyewear, and sunglasses with impact-resistant materials.

They are essential for those in high-risk professions or sports.

Therapeutic Lenses:

Therapeutic lenses are prescribed to treat specific eye conditions. Examples include prism lenses for strabismus and amblyopia or orthokeratology lenses for myopia control.

They serve a therapeutic purpose, beyond vision correction.

#### 7) Surface Treatments of Lenses:

Surface treatments are applied to lens surfaces to enhance their properties. Common surface treatments include:

Anti-Reflective Coating: Reduces glare and reflections, improving visual clarity.

Scratch-Resistant Coating: Increases lens durability by making them more resistant to scratches.

UV Coating: Blocks harmful UV radiation to protect the eyes.

Hydrophobic Coating: Repels water, reducing smudging and making the lens easier to clean.

These treatments can improve the performance and longevity of eyeglass lenses.

8)High Index Lenses:High index lenses are designed for individuals with high refractive errors who require strong prescription lenses. They are thinner and lighter than standard lenses, making them more cosmetically appealing and comfortable. High index lenses bend light more efficiently, reducing the lens thickness, but they can be more expensive.

9)Lenticular Lens:

A lenticular lens is a specialized lens used for magnification. It consists of a convex lens placed over a flat or slightly concave lens. This design is often used in magnifying glasses, loupes, and some low-vision aids. Lenticular lenses are effective for enhancing the size and clarity of small objects.

10)Aspheric Lens:

Aspheric lenses have a more complex curvature compared to standard spherical lenses. They are flatter and thinner near the edges while providing sharper vision in the center. Aspheric lenses reduce distortion, especially in high prescription lenses, and can offer a more aesthetic appearance.

11)ANSI Standard for Regular Lenses:

The ANSI Z80.1 standard is a widely recognized standard for ophthalmic lenses. It covers specifications for various aspects of eyeglass lenses, including power, impact resistance, and optical quality. Meeting this standard ensures that lenses are safe, of high quality, and suitable for vision correction.

12)Markings on Safety Lenses:

Safety lenses often have markings to indicate their compliance with safety standards. Common markings may include the manufacturer's logo, the impact resistance standard (e.g., ANSI Z87.1), and the lens material designation. These markings help users identify safety lenses and understand their specifications.

13)Sports Lenses:

Sports lenses are designed to enhance visual performance and protect the eyes during athletic activities. They can include features such as impact resistance, polarized or photochromic technology, and customized tints for specific sports. Sports lenses improve safety and visual comfort, making them essential for athletes.

14)Different Frame Materials:

Frames can be made from various materials, each with its own characteristics:

Different Frame Materials:

Frames can be made from various materials, each with its own characteristics:

Acetate: Lightweight and hypoallergenic, commonly used for fashion frames.

Metal: Durable and lightweight, available in various metals like titanium, stainless steel, and aluminum.

TR-90: A flexible and lightweight thermoplastic material known for its durability and comfort.

Wood: Fashionable and eco-friendly, wooden frames provide a unique look.

Nylon: Lightweight and sporty, often used for athletic eyewear.

#### 15) Nomenclature of Spectacle Frame:

The nomenclature of a spectacle frame refers to the various components and terminology associated with eyeglass frames. It includes terms like temples (arms), bridge, front, endpiece, hinge, and more. Understanding the nomenclature helps opticians and wearers communicate effectively about frame adjustments and preferences.

#### 16) Different Types of Frames:

Frames come in various styles to suit different fashion preferences and functional needs. Common frame types include full-rim, semi-rimless, rimless, cat-eye, aviator, wayfarer, and round frames, among others. Each type has unique aesthetics and features to cater to different tastes and face shapes.

#### 17) Frame Manufacturing Process:

The frame manufacturing process involves several steps, such as design, material selection, cutting, shaping, assembly, and quality control. Frames can be made from a variety of materials, including acetate, metal, and plastic. The manufacturing process ensures that frames meet design specifications, are durable, and meet safety standards. It also involves the addition of hinges, nose pads, and temple tips to create functional eyeglasses. Quality control checks ensure that the final product is of high quality and meets all specifications.

#### 18) Terms Related to Prism:

**Thickness Difference:** The thickness difference refers to the variation in thickness between the thickest and thinnest parts of a prism. It is an important consideration when manufacturing and fitting prismatic lenses, as an even thickness ensures optical quality.

**Centrad:** Centrad is a unit of measurement for prism deviation and is often used in the centesimal system. One centrad equals 1/100 of a radian, making it a useful metric for quantifying prism deviation in ophthalmic lenses.

**Prism Diopter:** Prism diopter (abbreviated as " $\Delta$ " or "PD") is a unit of measurement for the power of a prism. It indicates the amount of deviation that a prism produces at a specified distance. For example, a  $1\Delta$  prism deviates light by 1 centimeter at a distance of 1 meter.

**Decentration:** Decentration in the context of prism refers to the horizontal and vertical displacement of the optical center of a lens relative to the wearer's pupillary center. Decentration is often necessary to ensure that the prism effect aligns with the wearer's visual axis.

Pull of a Prism: The pull of a prism, also known as "prism imbalance," occurs when the center of the lens does not align with the wearer's visual axis, leading to discomfort and distortion in the visual field. It can result from improper lens fitting or decentration.

#### 19) Differentiating Individual Batch Method and Continuous Flow Process in Glass Manufacturing:

**Individual Batch Method:** In the individual batch method, glass is produced in discrete, separate batches or lots. Each batch undergoes a series of steps, such as melting, refining, forming, and annealing, before it is cooled and cut into sheets or other desired shapes. It is suitable for small-scale or specialized production, such as artisanal glassblowing. Each batch may have slight variations in composition, making it more challenging to achieve consistent quality.

**Continuous Flow Process:** In the continuous flow process, glass is manufactured continuously without interruption. Raw materials are fed into a melting furnace, where they are continuously melted and refined. The molten glass is then continuously formed into sheets or other products using methods like the float glass process. This method is highly efficient and suited for large-scale, industrial production. It allows for more consistent glass quality due to the continuous nature of the manufacturing process.

#### 20) Steps in Surfacing a Glass Lens:

Surfacing a glass lens involves creating the prescribed optical power and correcting any aberrations. The process typically includes the following steps: **Blocking:** The lens blank is attached to a blocking system, ensuring it remains stable during surfacing. **Rough Grinding:** Coarse abrasives are used to remove excess material from the lens blank, shaping it close to the desired curvature. **Fine Grinding:** Smoother abrasives refine the lens's shape and curve, approaching the final prescription. **Polishing:** The lens is polished to remove any remaining imperfections and improve optical clarity. **Beveling:** The edges of the lens are beveled to fit the selected frame. **Quality Control:** The finished lens undergoes quality checks to ensure it meets the prescribed power and optical standards.

**21) ANSI Z87 Safety Eyewear Standard:** The ANSI Z87 standard is a set of safety requirements and guidelines established by the American National Standards Institute (ANSI) for protective eyewear. ANSI Z87 safety eyewear standard defines the minimum performance and testing criteria for safety glasses, goggles, and face shields. Key features of this standard include impact resistance, lens thickness, penetration resistance, and coverage area. Eyewear that meets this standard is designed to protect the eyes from various hazards, such as impact, chemical splashes, and UV radiation, in industrial and occupational settings.

**22) Chromatic Aberration and Abbe Value:** Chromatic aberration is an optical phenomenon where different wavelengths of light (colors) are refracted differently, leading to color fringing or blurring in the image. Abbe value, also known as the V-number, is a measure of a lens's dispersion or its ability to minimize chromatic aberration. A high Abbe value indicates low dispersion and better correction of chromatic aberration. Materials with higher Abbe

values, like crown glass, are preferred for eyeglass lenses because they provide better color accuracy and reduced color fringing. A low Abbe value indicates higher dispersion, leading to more noticeable chromatic aberration. Materials with low Abbe values, such as flint glass, are generally unsuitable for ophthalmic lenses. The Abbe value is a critical factor in selecting lens materials to ensure optical clarity and minimize chromatic aberration in eyeglasses.

## ANSWER BRIEFLY

### 1) Transposing a Prescription to Sphero-Cylindrical Form:

Original Prescription: -0.75DC20/+0.75DC110

Sphero-Cylindrical Form:

Sphere (Sph): -0.75 D (This remains the same)

Cylinder (Cyl): -0.75 D in the 20-degree meridian and +0.75 D in the 110-degree meridian

Optic Cross:

In the 20-degree meridian: -0.75 D

In the 110-degree meridian: +0.75 D

2) Pantoscopic Tilt and Its Uses: Pantoscopic Tilt is the angle at which the front of eyeglass lenses tilts downward from the vertical plane. Its uses include: Reducing glare from overhead lighting or the sun. Improving the cosmetic appearance of eyeglasses. Enhancing the visual comfort for users with high prescriptions or multifocal lenses.

### 3) Symmetric vs. Asymmetric Design in Progressive Addition Lenses:

Symmetric Design: In a symmetric progressive lens, the near and intermediate zones are mirror images of each other. There is no specific right or left lens; they are interchangeable. Typically easier to adapt to and are often used for first-time progressive wearers.

Asymmetric Design: In an asymmetric progressive lens, the near and intermediate zones are different in design. The right and left lenses are specific to each eye. Asymmetric designs can provide better customization for individual visual needs but may require more precise fitting.

### 4) Spherical Equivalent Calculation:

Spherical Equivalent (SE) is calculated by adding the sphere and half of the cylinder. For -2.75DS/-2.00DC x 145:

$$SE = -2.75 + (-2.00/2) = -2.75 - 1.00 = -3.75 \text{ D}$$

5) Decentration and Prismatic Effect of a -10.00DS Lens: Decentration is the horizontal or vertical displacement of the optical center of a lens from the wearer's pupillary center. The

prismatic effect produced by a -10.00DS lens decentered 4mm downwards before an eye can be calculated using the formula:

$$\text{Prismatic Effect } (\Delta) = (\text{Decentration (mm)} \times \text{Lens Power (D)}) / 10$$

$$\Delta = (4 \text{ mm} \times -10.00 \text{ D}) / 10 = -4\Delta \text{ Base Down}$$

#### 6) Designs of Progressive Addition Lenses:

##### a. Advanced Soft Design:

A type of progressive lens design with a smooth transition between distance and near zones.

Offers improved peripheral vision and wider intermediate areas for reading. Enhanced comfort and adaptation.

##### b. Mono-Design:

A simple progressive lens design with a single, unified zone for both near and intermediate vision.

Suitable for those who need basic multifocal correction.

##### c. Symmetric Lens Design:

Symmetric progressive lenses have identical right and left lenses.

Easier adaptation for first-time progressive wearers.

#### 7) Various Faults on Lens Surfaces:

Common faults on lens surfaces include scratches, pits, bubbles, inclusions, and optical power deviations. These faults can affect lens quality and optical performance.

8) Toric Prescription in -5.00D Base Curve: The prescription for a lens with +4.50D in the vertical meridian and -3.50D in the horizontal meridian in a -5.00D base curve toric form can be written as:

-5.00D x 90° with +8.00D in the cylindrical component.

9) Back Vertex Power Calculation: The back vertex power of a lens can be calculated using the lens formula:

$$\text{Back Vertex Power (BVP)} = 1 / (\text{Front Vertex Power (FVP)} - (\text{Lens Thickness} \times \text{Lens Material Power}))$$

Given FVP = +8.00D, Lens Thickness = 8mm, and Lens Material Power = -19.00D:

$$\text{BVP} = 1 / (+8.00\text{D} - (8\text{mm} \times -19.00\text{D})) = 1 / (+8.00\text{D} + 152.00\text{D}) = 1 / 160.00\text{D} = +0.00625\text{D}$$

10) Uses of High Index Ophthalmic Lenses: High index lenses are thinner and lighter, improving aesthetics and comfort. They are suitable for strong prescriptions, reducing lens thickness. High index lenses provide UV protection and are more impact-resistant.

11) Role of Photochromatic Ophthalmic Lenses: Photochromatic lenses darken when exposed to UV light and become clear indoors. They provide protection from UV radiation and reduce glare from the sun. Photochromatic lenses offer convenience as they eliminate the need for separate sunglasses.

12) Role of Blue Light Filter Coating: Blue light filter coatings reduce exposure to harmful blue light emitted by digital screens and artificial lighting. They help reduce eye strain and may improve sleep patterns by reducing the disruption caused by blue light exposure before bedtime.

13) Prismatic Effect Calculation: The prismatic effect produced at a point 15mm inwards from the optical center of a -3.50DS lens is calculated using the formula:

$$\text{Prismatic Effect } (\Delta) = (\text{Decentration (mm)} \times \text{Lens Power (D)}) / 10$$

$$\Delta = (15 \text{ mm} \times -3.50 \text{ D}) / 10 = -5.25\Delta \text{ Base In}$$

14) Importance of Centring of Lenses in Spectacle Frames: Centring ensures that the wearer looks through the optical center of the lenses, optimizing visual clarity and minimizing distortion. Accurate centring is essential for comfortable and effective vision correction. It can be achieved by aligning the optical centers with the wearer's pupillary centers.

15) Crossed Prisms and Their Uses: Crossed prisms are two prisms oriented in opposite directions. They are used to cancel out or neutralize the effects of each other, reducing unwanted prismatic effects in eyeglass prescriptions.

16) Toric Transposition and Transposed Prescription: Toric transposition is a process to convert a sphero-cylindrical prescription to toric form. For the prescription -8.00D S / -2.00 DC x 90: Transposed Prescription: -10.00D S / -2.00 DC x 180 (If the cylindrical axis is 90, the transposed axis is 180).

17)Definitions: Prism Diopter and Catoptric Power. Prism Diopter ( $\Delta$ ): A unit of measurement for the power of a prism, indicating the deviation of light in centimeters at a distance of one meter. It is used to quantify the strength of prismatic effects in lenses.Catoptric Power: The optical power of a reflective surface or mirror. It refers to the refractive power of the reflected light and is measured in diopters.

18)Brief on Soft Design of Progressive Addition Lenses:Soft design progressive lenses have a smooth and gradual transition between the distance, intermediate, and near vision zones.They offer a natural and comfortable visual experience.Soft design progressives are preferred for their wide intermediate and reading areas.

19)Calculation of Prismatic Effects:

The vertical prismatic effect = (Decentration x Lens Power) / 10

Horizontal prismatic effect = (Decentration x Lens Power) / 10

Resultant prismatic effect =  $\sqrt{\text{Vertical Prismatic Effect}^2 + \text{Horizontal Prismatic Effect}^2}$

Given: +4.00DS lens, 8mm below and 5mm inwards from the optical center.

Vertical Prismatic Effect = (8mm x +4.00D) / 10 = +3.20 $\Delta$  Base Down

Horizontal Prismatic Effect = (5mm x +4.00D) / 10 = +2.00 $\Delta$  Base In

Resultant Prismatic Effect =  $\sqrt{(3.20^2 + 2.00^2)} = \sqrt{(10.24 + 4.00)} = \sqrt{14.24} \approx 3.77\Delta$  Base Down and In.

20)Diagram of Progressive Addition Lenses and Power for Distance:A labeled diagram of progressive addition lenses includes the corridor, near and intermediate zones, as well as the add power. To find the power for distance, read the power at the top part of the lens, above the corridor.

21)Laminated Lenses and Polycarbonate Lenses:Laminated Lenses: These are made by bonding two or more layers of glass or plastic together, providing added safety and durability. They are often used in safety and bulletproof eyewear.Polycarbonate Lenses: Polycarbonate is a lightweight, impact-resistant material often used in safety glasses and sports eyewear. It provides excellent protection against impact and UV radiation.

22)Yellow Absorbing Filters:Yellow absorbing filters are lenses that absorb or block certain wavelengths of light, particularly blue and violet light. They are used to enhance contrast and reduce glare in certain lighting conditions, such as for shooting glasses or low-light activities.

23)Iseikonic Lenses:Iseikonic lenses have the same power in both meridians and are used for people who have anisometropia (a significant difference in prescription between the two eyes). These lenses ensure that the eyes receive equal retinal images.

24)Pantoscopic Tilt and Its Use in Spectacle Dispensing:Pantoscopic tilt is the angle at which eyeglass lenses are tilted downward from the vertical plane. It is used to:Reduce glare from overhead lighting or the sun.Improve cosmetic appearance by aligning lenses with the wearer's face shape.

25)Edge Substance Calculation:

Edge Substance (ES) can be calculated using the formula:

$$ES = \text{Lens Diameter} - (2 \times \text{Lens Thickness})$$

Given: Lens Diameter = 40mm, Lens Thickness = 0.7mm

$$ES = 40\text{mm} - (2 \times 0.7\text{mm}) = 40\text{mm} - 1.4\text{mm} = 38.6\text{mm}$$

26)Field of View Through Spectacles:The field of view through spectacles is the area that can be seen when looking through the lenses. The angular field of view can be determined using the lens power, lens aperture, and the distance from the center of rotation of the eye.

27)Refraction of Light Through Lenses:Convex Spherical Lens:Light rays passing through a convex spherical lens converge to a focal point on the opposite side of the lens.

Plano-Concave Lens:Light rays passing through a plano-concave lens diverge and do not converge to a focal point.

28)Polishing Burn and Strain of Lens Defects:Polishing burn is a defect caused by excessive heat during the lens polishing process.Strain occurs when the lens material experiences stress, leading to optical distortions.

29) Mechanical Requirements of Bifocal Lenses: Bifocal lenses must have a smooth and clear transition between the distance and near segments. The segment height and width should be appropriate for reading, with no distortion at the segment line.

30) Heat Absorbing Lenses: Heat absorbing lenses have coatings that absorb and dissipate heat, reducing the discomfort caused by exposure to high temperatures, such as in hot climates or while cooking near open flames.

31) Refraction Index and Plus Lenses: Convex lenses are referred to as "plus lenses" because they have positive optical power. The refractive index of crown glass is typically around 1.523, while the refractive index of dense barium crown glass is approximately 1.60.

#### ONE WORD ANSWERS

1. Safety
2. Yes
3. True
4. 2.00D
5. Ultraviolet (UV) to Infrared (IR)
6. Uniformity
7. +0.75DC\*110
8. Visible
9. Eye Protection Standard
10. Dispersion
11. 2 ▲ BU
12. In Progress
13. -2.00 DS / +3.00 DC x 30
14. Measuring Lens Thickness
15. Biconcave
16. Cementing
17. Higher
18. Near and Distant Segments
19. Double Vision or Diplopia
20. Epoxy and Cyanoacrylate
21. Around 50
22. Fulgurite
23. 80° BD and 340° BO
24. Silver Halide
25. True
26. A lens with the least amount of aberrations
27. +5.50DS/ +4.25DC\*50
28. +1.75D
29. A unit of measurement for prism deviation

30. Approximately 1.523
31. Optical imperfections that cause deviations from ideal image formation
32. +4.00DS55 and -4.00DC55
33. D-Bifocals have a straight-line segment for reading, while Kryptok Bifocals have a curved top segment.
34. Approximately 1.586
35. 2.00D
36. Pilot and aviation use
37. Allyl Diglycol Carbonate
38. -363.64 mm
39. False
40. True
41. 250 mm
42. 2.40Δ Base Up
43. 5.283Δ
44. A lens with a curved shape to reduce distortion in the periphery
45. Approximately 1.49

