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# Formula Review

One Meter (m) is equal to: **39.37 inches**

One Inch is equal to: **25.4 Millimeters (mm)**

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Addition of two plus numbers: **The answers are always plus.**
Example: **+2.25**
**+1.50**
**+3.75**

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Addition of two minus numbers **The answers are always minus.**
Example: **−2.00**
**−1.50**
**−3.50**

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Addition of a plus and minus number: **The sign of the answer will always be the same As the sign of the higher of the two numbers you are adding.**
Example: **+10.25**
**−8.50**
**+1.75**

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Multiplication and Division
Like Signs: **When multiplying or dividing two numbers with the same sign the answer will always result in a number with a plus sign**,
That is, when two numbers with plus
signs are multiplied or divided the answer well be plus. When two numbers with minus
signs are multiplied or divided the answer will also be plus.

Examples: **−3 x -3 = +9** **+18 / +3 = +6**

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Unlike Signs: **When multiplying or dividing unlike signs, That is, when one number is Preceded by a plus sign and the other number by a minus sign, the resulting answer will Always be minus**

.Examples: **− 4 x + 3 = -12** **+ 15 / − 3 = -5**

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Focal Length and Prism ***There is a definite relationship between the power of a lens in diopters and the resulting focal length in meters. The stronger the power, the shorter the focal length, the weaker the power, the longer the focal length. This relationship may be expressed in the following formula:*** **D = 1/f or f = 1/D**
Where D = power of the lens in diopters and f = focal length in meters.

| **Calculate Focal Lengths** | **Calculate Powers** |
|---|---|
| **D = +2.00** | **f = + 7.7 cm** |
| **f = 1/D** | **D= 1/f** |
| **f = 1/ +2.00** | **D= 1/ +.077m** |
| **f = +0.5 m** | **D= +13.00 D** |

**Prentice's Rule** *The power of the prism is equal to the power of the lens in diopters times the amount of decentration in millimeters divided by ten.*

Stated algebraically: $\Delta = \frac{f \text{ x dec (mm)}}{10}$

Where Δ= prism diopters
f = power of the lens in diopters
dec= decentration or distance in mm away from the optical center of the lens.

Example: How much prism is induced 4 mm away from the optical center of a +3.00 D sph.
Applying Prentice's rule, **f = +3.00 and dec. = 4.0 mm**
So:
**Δ = f x dec/10 or $\frac{+3.00 \text{ x } 4}{10}$ = 1.2Δ**
**= +3.00 x 4/10**
**= 1.2Δ**

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**Determining Power from Surface Curves**
To determine the total power of a thin lens in air simply add the front surface power to the back surface power algebraically by applying the formula: **$F_1 + F_2 = F_T$**
Where **$F_1$** = the power of the front surface, **$F_2$** = the power of the back surface, and **$F_T$** = the total power of the lens.

Example: (*Note this is a spherical lens*)
**Front +6.00 ($F_1$) + Back −5.00 ($F_2$) = Power +1.00 ($F_T$)**

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**Transposition**
How to transpose a Prescription
1. Change the sign of the cylinder (***from + to – or – to +***)
2. Add the first two numbers together algebraically
3. Change the cylinder axis by 90˚ so the new number falls between 1-180 degrees.

| Example: | **Original RX** | **Transposed** |
|---|---|---|
| | **+2.50 −0.75 x 180** | **+1.75 +0.75 x 090** |
| | **−3.75 +1.25 x 060** | **−2.50 −1.25 x 150** |

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**Vertex Distance**
*Rule of Thumb: The effective power of a 10.00 diopter lens moved a distance of 5 mm will change by* ***approximately*** *0.50 diopters.*

Example: Patient has a **+ 10.00** lens fit at a Vertex distance of **13mm** light focuses on the Retina. This is the correct power for this patient.
If the same patients frame is fit at a Vertex distance of **18 mm** the effective power would be **+10.50** The **Compensated** power would be **+9.50**
If the same patients frame is fit at a Vertex distance of **8 mm** the effective power would be **+9.50** The **Compensated Power** would be **+10.50**

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**(Vertex Distance Continued)**

**Minus lenses are the exact opposites.** Example: **−10.00** refracted at a vertex distance of **13mm.** The frame is fit at a Vertex distance of **18mm** the effective power would be **−9.50** the Compensated Power would be **−10.50**
If the same patient has a frame fit at a Vertex distance of **8 mm** the **Effective** power would be **−10.50** the **Compensated** power would be **−9.50**.

(***Note: all lenses gain in plus power when moved away from the eye***)

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**Index of Refraction**
The index of refraction of any given material is calculated by dividing the speed of light in air by the speed of light in that material.
Example: **n = <u>speed of light in air</u>**
**speed of light in material**

**(n) Index of refraction = 1.490** speed of light in air **<u>186,000</u>** miles per second
speed of light in ***CR- 39*** **124,832** miles per second

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**Slab Off** **<u>How to Calculate Slab Off</u>**

1. Determine power of each lens in 90˚ meridian.
2. Determine distance from optical center of carrier lens to reading level.
3. Apply Prentice's Rule (**Δ = f x dec ÷ 10)** to calculate amount of vertical prism induced in each eye at the reading level.
4. The difference in amount of vertical prism in each eye is approximately equivalent to amount of prism to be"slabbed off."
5. *Conventional Slab off:* Is always ground base up on the lens with the **most minus** or **least plus** power in the 90˚ meridian.
6. *Reverse Slab Off:* A relatively new lens which is available to the laboratory from the lens manufacturer in which the prism has already been molded into the semi-finished lens. As the name suggests, the prism base is oriented base down, or in the reverse direction of the conventional base up orientation. In this case the slab off is placed in the lens with the **least minus** or most **plus**.

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**Horizontal Lens Decentration**
The amount of decentration required in each eye is equal to the **GCD** (*A **eye size*** + *DBL distance between lenses = GCD*) **minus PD** (*pupillary distance*) **divided by 2**
Expressed as **( GCD − PD ) ÷ 2**

Example: GCD = eye size 52 + dbl 20 = 72 GCD − PD 68 = 4 ÷ 2 = 2in OU.
**( 72 − 68 ) = 4 ÷ 2 = 2**
In the case of monocular PD i.e. (*O.D.= 33 O.S.= 35*) divide GCD by 2 (*O.D.=36 O.S.=36*)
Expressed as **( GCD ÷ 2 = monocular GCD) − (monocular PD) = (monocular decentration)** Example: 72÷2=36 **O.D.** 72÷2=36 **O.S. O.D.** 36−33=3 **O.S.** 36−35=1
Decentration will be **<u>3 in</u>** in the right lens and **<u>1 in</u>** in the left lens.

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**Vertical Decentration**
It is necessary to calculate vertical decentration when determining where the line of a bifocal segments or progressive MRP is positioned relative to the datum line of the frame. This may be expressed in the following formula.
***Vertical Decentration = seg height −(B measurement ÷ 2)***

Example: (seg ht. = 18 mm) − (frame B measurement = 40mm ÷ 2 = 20mm)

20 mm
−<u>18 mm</u>
**2 mm down O.U.**

Example #2: (seg ht. OD 18) (OS 17) − (frame B measurement = 40mm ÷ 2 = 20mm)

| OD | OS |
|---|---|
| 20 mm | 20 mm |
| −<u>18 mm</u> | −<u>17 mm</u> |
| **2 mm down O.D.** | **3 mm down O.S.** |

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**Minimum Blank Size**

The formula for determining the smallest possible lens blank which will work for any given frame and PD combination is as follows.

***Minimum Blank Size (MBS) = (Geometric Center Distance GCD −Pupil Distance PD) + (Effective Diameter ED)***

**Or: (MBS) = (GCD − PD) + ED**

Example: frame size ***50-20***, PD ***63***, ED ***58***

***70 − 63 = 7 + 58 = 65***

Minimum blank size would be **65.**

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**Spliting Prism**

*It is possible to redistribute prism between two lenses without altering its effective power.*

Example: O.D. + 1.00 sph with 1.0 Δ base up
O.S. + 1.00 sph with 1.0 Δ base down

Could also be written as:

O.D. + 1.00 sph with 2.0 Δ base up
O.S. + 1.00 sph

O.D. + 1.00 sph
O.D. + 1.00 sph with 2.0 Δ base down

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