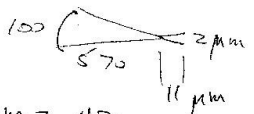
Name_____ Homework #7 415/515

1) Prepare an ISO 10110 drawing of the concave return mirror in the example system. Include nominal radius, blank diameter, clear aperture diameter, thickness, chamfer, figure, surface finish and coating. Most of these should be simple after having done the flat. The radius tolerance will be another problem.

blank ϕ 110-120 mm ϕ
CA ~ 105 mm
thickness ~ 0.5" ~ 12 mm
chamfer 1-2 mm
figure $\Delta sag = \frac{1}{2}\left(\frac{y}{R}\right)^2 \Delta R \approx .004 \times 11\mu m = 42nm$
or ~ $\lambda/13$ P-V so $\lambda/10$ to $\lambda/20$
finish - 80/50, 60/40 but for ISO 5/5x.4 to 5/5x1



$d = \frac{qa^4}{Et^3} = \lambda/10 = \frac{50nm}{2} = 60nm$
$a = 2.4"$ 2μ"
$E \; 1 \times 10^7$

$t^3 = \frac{.08 \times 33}{1 \times 10^7 \times 2 \times 10^{-6}}$
$= \frac{2.64}{2 \times 10^1} = .132$
$t = .509"$

2) Assume we want to keep the f/# and total length the same as the nominal design, what is a reasonable tolerance on the radius of the mirror? Justify your answer in a sentence or two.

± .25 mm Radius can be changed by this much with perhaps 1.5 x worse performance if mirror to doublet spacing changed by about .25 mm.

assumes you can respace the mirror

3) Assume we do not want to geometrical blur circle to get larger than 2 μm in diameter and that we cannot respace the mirror, can you use this calculation to estimate a figure tolerance for the mirror? Show your calculation and thought process briefly.

From first problem 2μm ϕ image means ΔR of ~ 11μm
so $\Delta sag = \frac{1}{2}\left(\frac{y}{R}\right)^2 \Delta R = \frac{1}{2}\left(\frac{50}{570}\right)^2 .011 = .004 \times 11\mu m = 42nm$
or about $\lambda/13$

S Constrained mounting

4) Assume, when the mirror is mounted, there will be a means of adjusting the mirror into the correct position including repacing. Assume the lateral position of the mirror is located by the hardware ~~into which it is mounted, that is~~, you don't have to worry about these two degrees of freedom. How many degrees of freedom does the mount ~~have to have~~ need to precisely position the mirror?

So

3 a sphere has no axis

5) What is the sag of the mirror over the clear aperture you have assigned in 1)?

~~Sag~~ say CA is 105 mm $sag = \frac{y^2}{2R} = 2.418$ mm

6) I am grinding the lens in the shop. What sag will a 3" spherometer (the diameter of the circle on which the balls are located) read when the mirror has the correct nominal radius?

570.594

$R = \frac{sag}{2} + \frac{y^2}{2\,sag} \pm r$ ← use +

1.273 1/8"

Ball radius is ~~2~~ mm

1.2806

~~$sag = R + r - \sqrt{R^2 + r^2 - 2Rr - y^2}$~~

I cheated & used Solver → = 1.2806

7) Assume the spherometer can be read to 2.5 μm. What range of nominal radius does this correspond to? In other words, how well can the radius be determined with the spherometer.

$$Sag \approx \frac{y^2}{2R} \qquad \Delta Sag = \frac{1}{2}\left(\frac{y}{R}\right)^2 \Delta R$$

$$\Delta R = 2\left(\frac{R}{y}\right)^2 \Delta Sag$$

$$= 2\left(\frac{570}{38}\right)^2 .0025$$

$$= 450 \times .0025$$

$$= \pm 1.125 \text{ mm}$$