**Exercise #6: Optical microscopy basics**

*Chem 6614 Chemical Instrumentation*

**Incident beam**

**6.1. Ray tracing and lens character**

**glass**

**a)** Sketch the ray diagram of

the incident beam as it air

traverses from **glass->**air->**glass**

**glass**

**b)** Given the ray behavior shown,

**na**

what is the relationship of

na to nb ? (n= refractive index

**nb**

of the glass slabs)

1. na = nb
2. na > nb
3. na < nb
4. cant’ be determined

f f

**c)** draw the ray diagram

for both rays taken

from the arrow imaged

by the double convex

**6.2 Magnifier and Microscope Ray Diagrams**

*10 inches*

*Tiny*

*object*

Sketch the real and virtual image in the magnifier arrangement to the left.

**f f**

Back of retina

**eyeball**

Sketch the real and virtual images in the objective + eyepiece (microscope) arrangement below

*10 inches*

**6.3. Language check-up**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ draw a convex-concave lens here

a)NA= \_\_\_\_\_\_\_\_\_\_\_\_ and is a measure of an objective’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b)R= \_\_\_\_\_\_\_\_\_\_\_\_\_\_ = 0.61 λ(nm)/NA and measures the ability of the lens to \_\_\_\_\_\_\_\_

objects

c) 4 letter word to describe spherically and field curvature-corrected lens \_\_\_\_\_\_\_\_\_

d) Refractive index of x= (an equation)

e) Spherically corrected microscope objective lenses are usually:

i) plano-concave ii) double convex iii) convex-concave iv) plano-convex

f)What is meant when we say E-plan apochromatic ?

g)What is meant when we describe the Alfred BH-2 scope as a positive phase contrast instrument ?

**6.4 Seeing eye-to-eye**

a) Which way does the cornea flex (thicker or thinner) when it tries to focus on an

object as it moves closer ?

b) Near-sighted people (like the instructor) can only see things clearly close up.

What does this probably mean is `wrong’ with their eye muscles and why ?

c) The basic microscope stage is almost always 10 inches from the eyepiece . Why ?

**6.5 Microscope practicalities**

**a) What two microscope components produce phase contrast ?**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**a)** You have two objectives. Objective #1 is an S-plan apochromatic 10X (NA=0.2) Objective #2 is an E-plan-achromatic 25X (NA=0.8). Your eyepiece is a 5X

power lens and you have the good fortune to have a single wavelength source

(green light, =565 nm). For both objectives:

1) compute the minimum diameter object (assume it is a circle) you can

expect to see, given that your eye can detect things down to about 0.2 mm in diameter.

2) compute the mimimum distance between two objects your lens set can resolve.

3) What practical problem negates the apparent advantage of always using the higher power lens ?

**b)** You want to see a monocococcal bacteria suspected of causing a new kind of intestinal illness. It’s diameter is about 5 u. (1 u=10-4 cm) . The bacteria is virtually the same in refractive index as water and doesn’t hold stain of any sort. List some of the steps and some of the equipment you would take to maximize your chances of seeing this little booger under the `scope.