Here are several questions taken from previous exams (as well as some that have never appeared on an exam...yet) to give you a "flavor" of the types of questions to expect. Questions that are **not** multiple choice or fill in the blank generally require **at most** a sentence or two to be answered correctly. In the actual exam you will be given ample space to provide an answer.

The effects of chromatic aberration on image points are (choose best answer):

a. the same for all points in the image
b. more significant the farther the image point is from the optic axis
c. more significant the closer the image point is to the optic axis
d. minimized by using electrons of longer wavelength
e. minimized by using a lower accelerating voltage

In class we discussed two simple criteria (Abbe and Rayleigh) for estimating the theoretical resolving power of an optical instrument. Which of these provides a more realistic estimate for the TEM? Briefly explain your answer.

In which of the following lenses does the 'object' generally sit closest to the front focal plane of the lens? Circle the best answer. Why are the optics set up in this manner?

a. Condenser

b. Objective

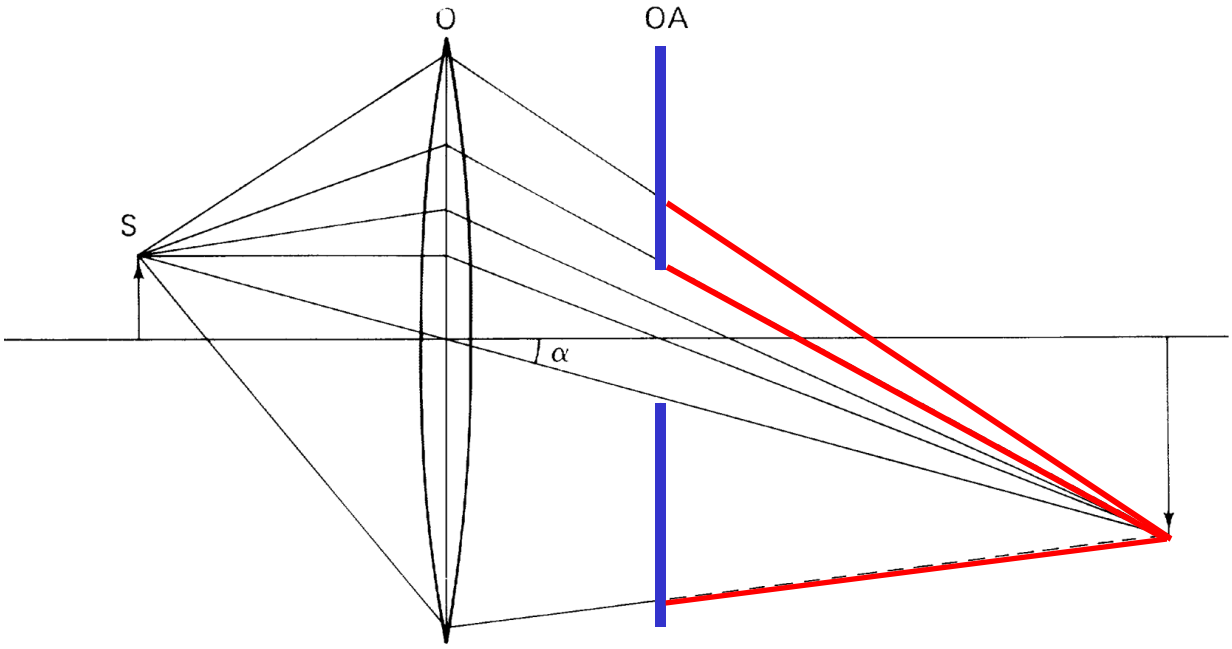
c. Projector

Column #1 of the following table lists the three primary types of electromagnetic lenses used in TEMs. In each of the three remaining columns, circle one phrase or value that **best** describes each lens.

Lens	Distance from electron source	Function	# found in modern TEM
Objective	nearest	beam focusing	0
	farthest	image forming	1
	intermediate		2 or more
Projector	nearest	beam focusing	0
	farthest	image forming	1
	intermediate		2 or more
Condenser	nearest	beam focusing	0
	farthest	image forming	1
	intermediate		2 or more

T/F The focal length of an electromagnetic lens depends on the wavelength of the imaging beam of electrons. Circle T (if statement if true) or F (if false).

The following diagram (taken from the lecture notes, p.44) was used to illustrate how the objective aperture blocks widely scattered electrons from reaching the image plane. On this diagram mark the position of the front focal point of the lens and show or describe how you arrived at your answer. In other words, prove that you are not just guessing.



Using the principles of geometrical lens theory, as an object is brought closer to the front focal plane of a converging lens from a point to the left of the front focal plane, the image formed will (grow to a larger size/ shrink to a smaller size / stay the same size) and appear (behind / in front of / at) the (front / back) focal point and will be (real / virtual) and (erect / inverted). Circle the choices that make the entire statement correct.

Why do modern TEMs have more than one imaging lens?

In the absence of lens asymmetry, the aberration or property of the objective lens that most limits image resolution is (chromatic aberration / spherical aberration / diffraction / distortion). Circle the correct answer.

For a lens in which there are no aberrations (like spherical, chromatic, astigmatism, etc.), is it better to have a large or small semi-angular aperture to see small object details? Or, does it not matter what the semi-angular aperture is?

When working with thin specimens and at the highest possible resolution, which type of contrast is most important? Scattering or Interference? Circle the correct answer.

To optimize interference contrast but without sacrificing resolution in studying most biological specimens, it is best to adjust the strength of the objective lens to a position that is: Circle the best answer.

a. Slightly over focus
b. Well under focus
c. Close to "near" or "true" or "exact" focus
d. Slightly under focus
e. Well over focus

At which point do Fresnel fringes in electron images disappear? When the objective lens is adjusted: Circle the best answer.

a. Well under focus
b. Well over focus
c. Slightly under focus
d. Slightly over focus
e. Close to "near" or "true" or "exact" focus

Assuming all other microscope parameters are held constant, use of a smaller condenser lens aperture will result in which of the following? Circle the correct answer or answers.

a. Increased phase contrast

b. Decreased illumination

c. Increased specimen irradiation due to increase beam coherency

d. Decreased beam coherency

e. Decreased spherical aberration

f. Increased chromatic aberration

Label each of the parts in the following cutaway diagram of a Philips EM400 electron microscope.