Name: _____

Student Assignment E: Optics Challenge 1 Assignment – "Go Public"

You design and build a ….

Compound Microscope

A compound microscope goes a step beyond a magnifying glass because it uses two lenses to magnify an object. The two lenses are called the eyepiece and the objective. Your task is to design and build a simple compound microscope. You must first decide which type of lenses to use. Then you will have to decide what focal length lenses would be appropriate and how far to space them apart. You should actually build your microscope and make sure that it works as well as possible. You will also need to create a to-scale ray-diagram of your working microscope. Calculate the magnification created by your microscope. State any limitations of your working compound microscope.

O***verhead Projector***

An overhead projector goes a step beyond a magnifying glass for several reasons. The direction and size of the image must be changed. Your task is to design and build a simple overhead projector. You must first decide which type of lenses and/or mirrors to use. Then you will have to decide what focal length lenses would be appropriate and how far to space them and any other parts apart. You should actually build your overhead projector and make sure that it works as well as possible. You will also need to create a to-scale ray-diagram of your working overhead projector. State any limitations of your working overhead projector.

Simple Camera

Your task is to design and build a simple camera. You must first decide which type of lens(es) to use. Then you will have to decide what focal length lens(es) would be appropriate and where to place the lens(es) relative to the film. Remember that the film is a known size for 35mm film. You should actually build your camera and make sure that it works as well as possible. You will also need to create a to-scale ray-diagram of your working camera. State any limitations of your working camera.

Things to consider for all projects

1) Refer back to the chart you created about the types of images produced by using converging and diverging lenses to help you select where to place the object and the lens(es).
2) It will be difficult, if not impossible, to magnify a virtual image.
3) You will need to find the focal length of your lenses before you build with them.
4) Sketch a ray tracing diagram and/or use the lensmaker's equation early. Do this before you attach any parts together!
5) Magnification of two lenses is calculated by multiplying the magnification of the first lens by the magnification of the second lens.

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Student Assignment E: Optics Challenge 1 Assignment – "Go Public"
Solution

You design and build a ….

Compound Microscope

A compound microscope requires two converging lenses with the focal points as small as possible. Place the object to be magnified just beyond the focal point of the first lens. This will create an enlarged, inverted, and real image. The second lens should then be positioned so that this enlarged, inverted, and real image lies just within the focal point of the second converging lens. The real image formed by the objective will become the object for the second lens. The second lens, the eyepiece, then creates an enlarged, virtual image. The overall magnification of the microscope is the product of the magnifications of the individual lenses.

The example solution given here uses an objective lens with focal length of 15cm and an eyepiece lens with focal length of 27cm. Ideally, the objects would be placed closer to the focal points of the lenses. This was not done here simply to create a ray tracing diagram that would fit on one page!

For this example solution, we have an object distance for the objective lens of 20cm with its focal length of 15cm.

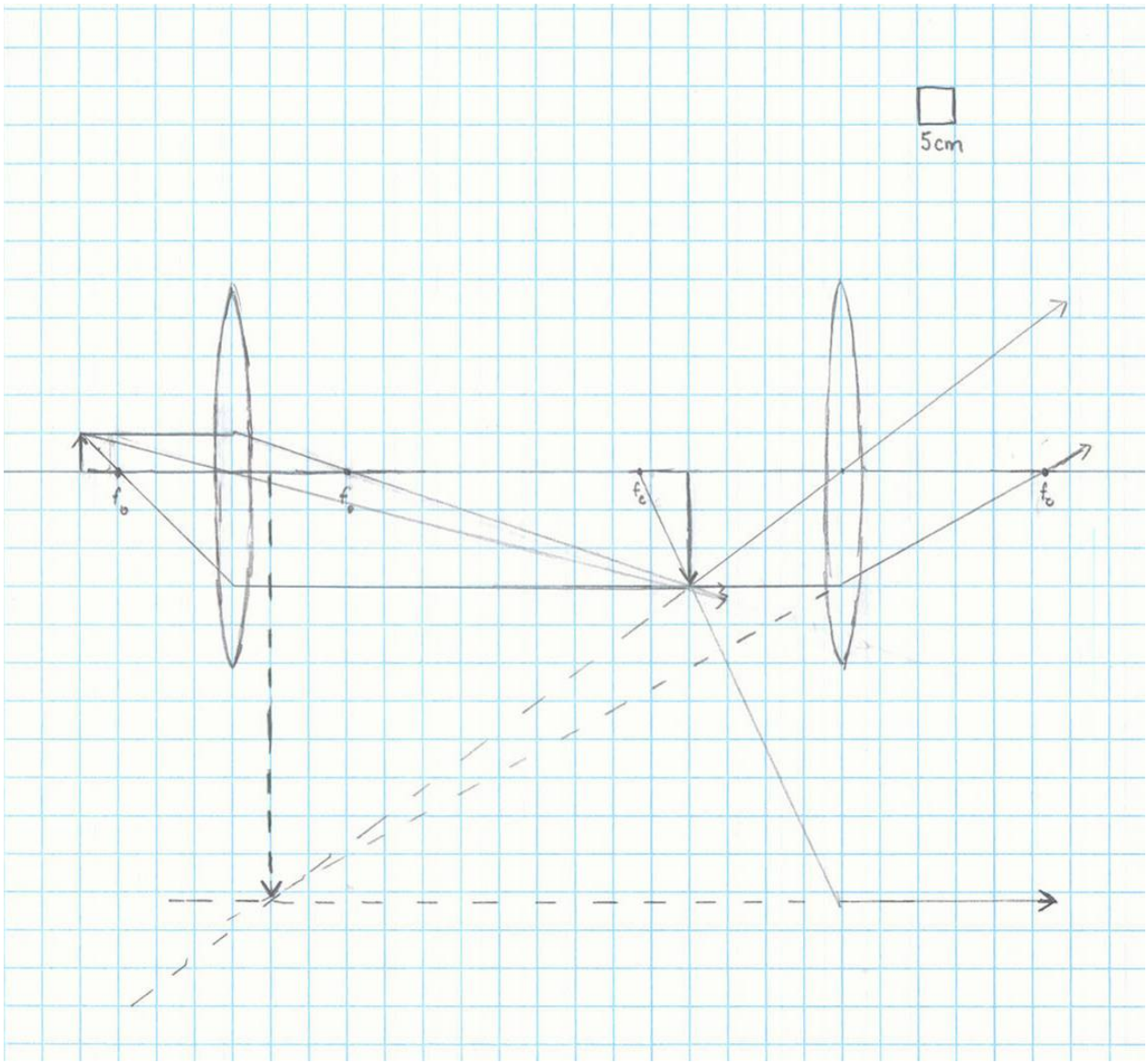
$$\frac{1}{20}+\frac{1}{d_i}=\frac{1}{15}$$
$$d_i = 60cm$$
$$m = -\frac{d_i}{d_o} = -\frac{60}{20} = 3$$

Putting this image just inside the focal point of the eyepiece lens, an object distance of 20cm is created with the focal length of 27cm.

$$\frac{1}{20}+\frac{1}{d_i}=\frac{1}{27}$$
$$d_i = -77cm$$
$$m = -\frac{d_i}{d_o} = -\frac{-77}{20} = 3.86$$

The total magnification is then

$$m = m_o m_e = (-3)(3.86) = -11.57$$



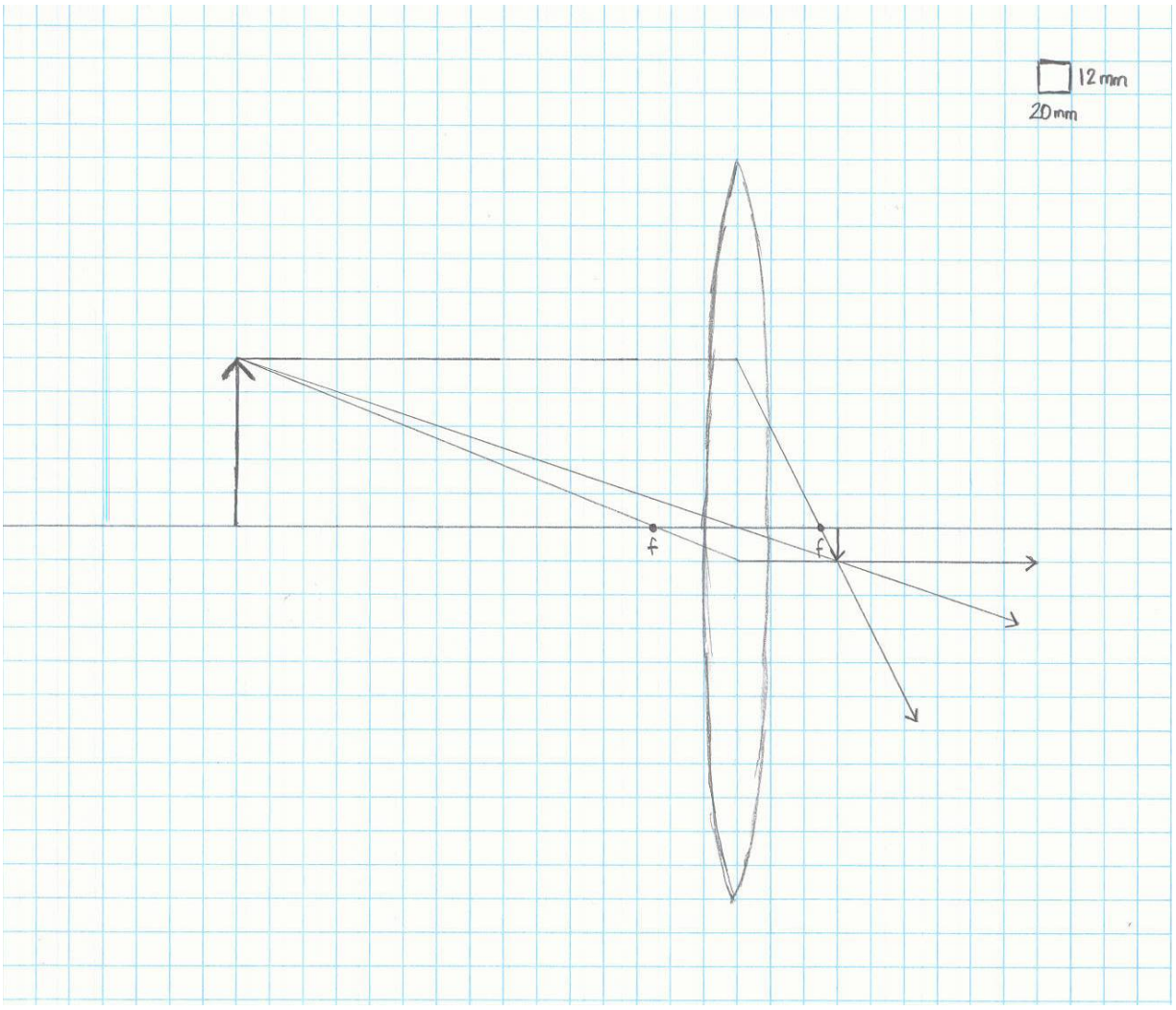
Overhead Projector

An overhead projector begins with a light source that passes through a converging lens (typically a Fresnel lens) and immediately through the object to be projected. This first lens directs the light toward the main projector lens. The projector lens focuses the image on the mirror. These rays are then reflected off of a small mirror placed at approximately 45P^{o} angle. This allows the light to be bent from vertical light rays to horizontal ones and also re-inverts the image so that the final product is upright to the viewer.

Simple Camera

The simple camera should use one converging lens, typically with a focal length of 50mm. The lens should be positioned at a set distance away from the 'film'. This distance must be greater than the focal length of the lens. If one assumes 35mm film, then the image height should fit into a rectangle that is 35mm wide, with the actual image size being 36 x 24 mm. Place the object more than two focal lengths away from the lens. It is often easiest to create a camera that works for an object at an infinite distance from the camera.

In the example shown here, this camera works only for an object placed at 300mm away from the 50mm focal length lens. Note that the 'film' would have to be placed exactly at 60mm away from the lens.



Name: _____

Student Assignment E: Optics Challenge 1 Assignment – "Go Public"
Rubric

You design and build a ….

Compound Microscope

Uses two converging lenses	_____/10
Place the object just beyond the F of the objective lens	_____/10
The image formed by the first lens image is placed at the focal point of the eyepiece lens	_____/10
A final virtual and enlarged image is formed	_____/10
Ray tracing diagram	
Drawn to scale	_____/10
Found and marked focal point of objective lens	_____/10
Found and marked focal point of eyepiece lens	_____/10
Rays accurate through objective lens	_____/10
Rays accurate through eyepiece lens	_____/10
Limitations stated	_____/10
Total:	_____/100

Comments:

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Student Assignment E: Optics Challenge 1 Assignment – "Go Public"
Rubric

You design and build a ….

Overhead Projector

Uses Fresnel (converging lens) to direct rays towards	
main projector lens	_____/10
Uses converging main projector lens to focus image on the mirror	_____/10
Uses mirror to change direction of light and invert image	_____/10
Ray tracing diagram	
Drawn to scale	_____/10
Found and marked focal point of first lens	_____/10
Found and marked focal point of second lens	_____/10
Angle of incidence equals angle of reflection on mirror	_____/5
Rays accurate through first lens	_____/10
Rays accurate through second lens	_____/10
Rays accurate into and off of mirror	_____/5
Limitations stated	_____/10
Total:	_____/100

Comments:

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Student Assignment E: Optics Challenge 1 Assignment – "Go Public"
Rubric

You design and build a ….

Simple Camera

Uses converging lens	_____/10
Produces an image that fits with the size of a film negative	_____/10
Image is within light tight box	_____/10
The object is located more than 2F away from lens	_____/15
Ray tracing diagram	
Drawn to scale	_____/10
Found and marked focal point of lens	_____/15
Rays accurate through first lens	_____/15
Limitations stated	_____/15
Total:	_____/100

Comments: