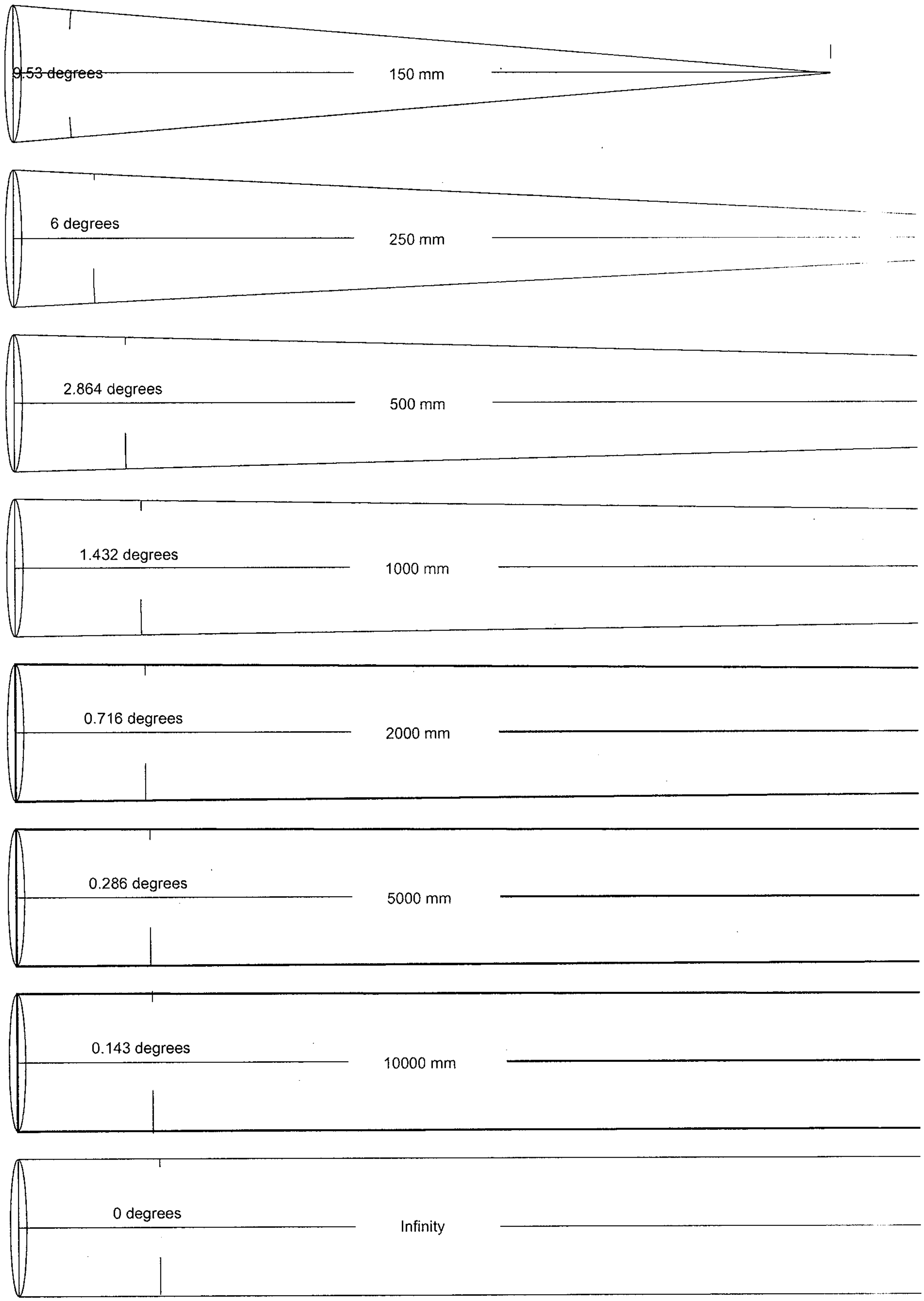
DERIVATION OF THE DEFINITION OF OPTICAL INFINITY

As an object moves further from a lens, the tip angle of the cone of light rays from a certain object point that enter the lens gets smaller and smaller. When an object is really far away, like the sun (93,000,000 miles) the angle is practically zero.

The tip angle of the rays of light coming from a single object point going into a 50 mm focal length lens working at f/2 is given for a variety of object distances. Notice the trend in angular dimension as the object moves further away.

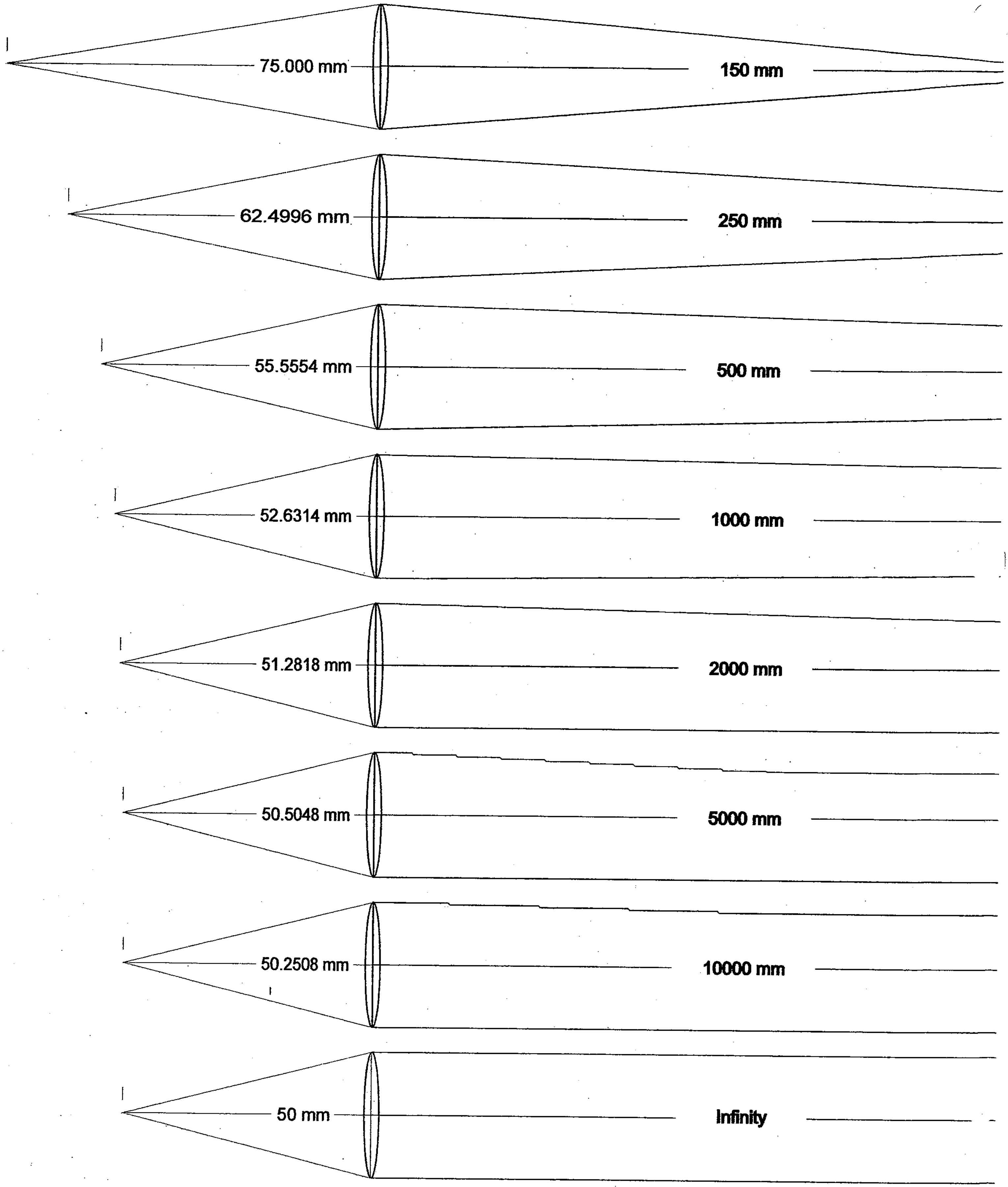
At very fa r distances there is such a small angle that the rays can be considered parallel to each other. This is the definition of optical infinity.

Light rays coming from infinity will focus one focal length away from the lens, the shortest real image distance for that lens.



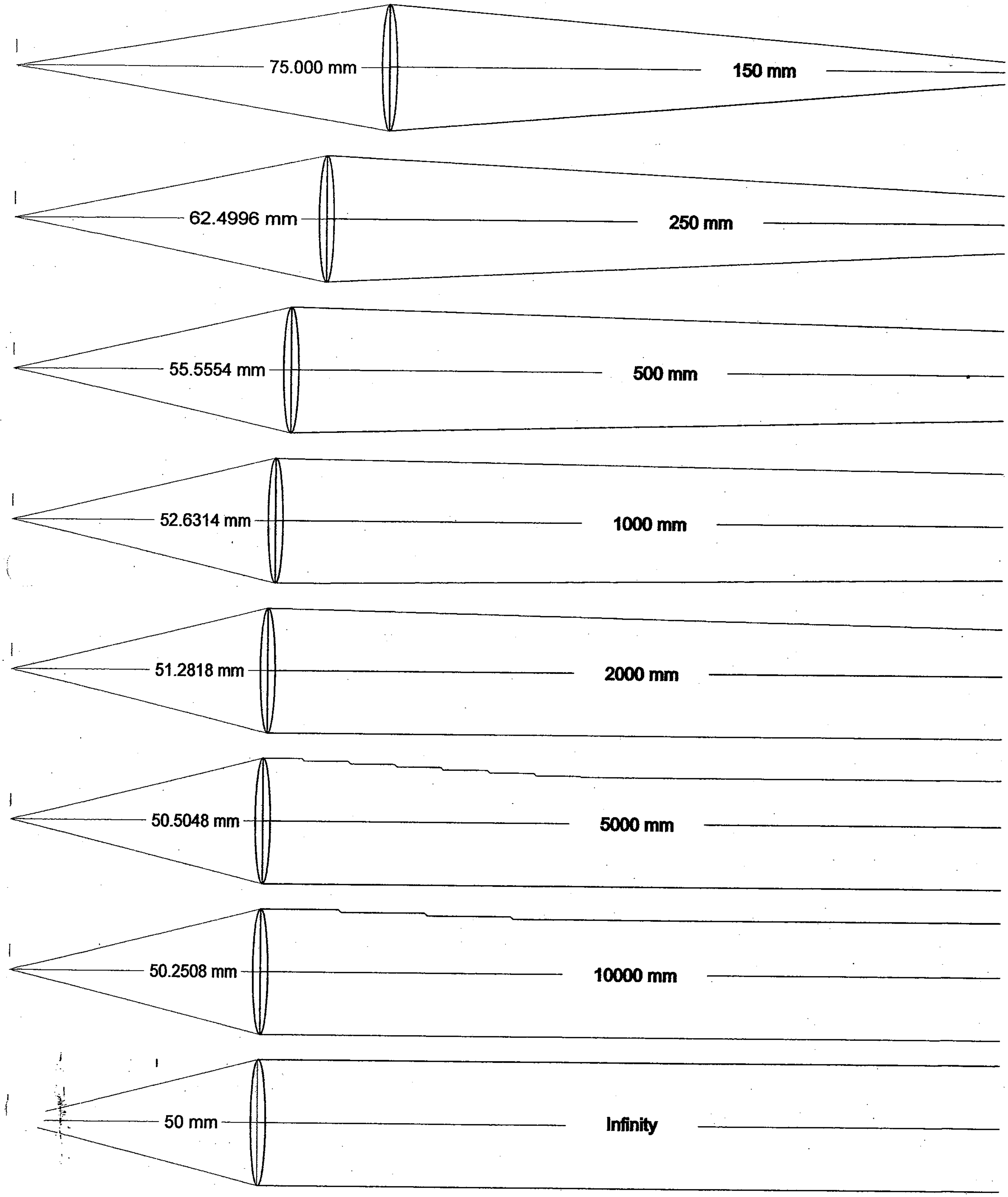
OBJECT AND IMAGE DISTANCES

Here are conjugate pairs of object and image distances measured from a 50 mm single element lens, based on the object distances given in the **Handout, DERIVATION OF THE DEFINITION OF OPTICAL INFINITY**. Notice that at far distances the large changes result in in small image position changes! (The distances are to scale!)



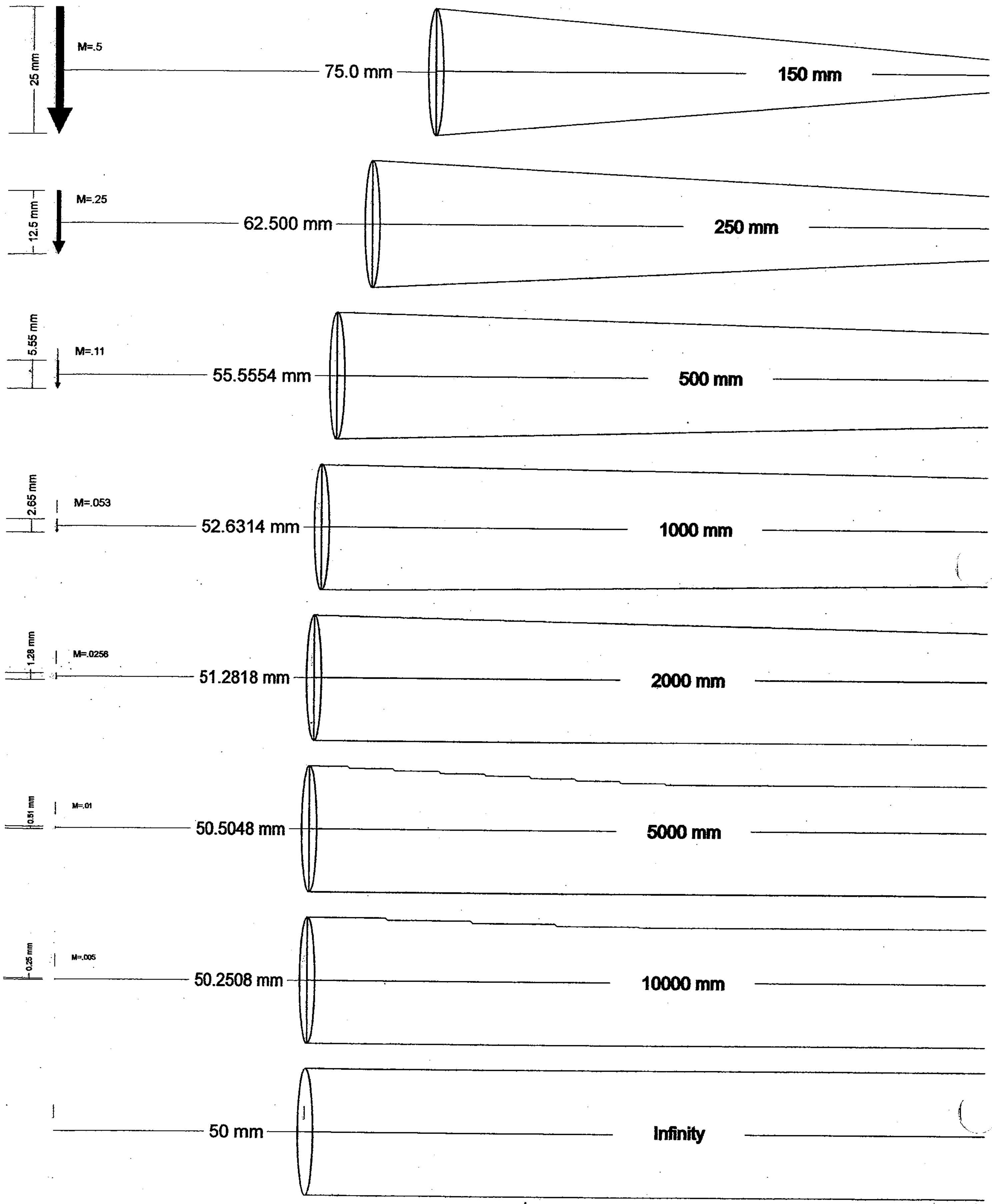
OBJECT AND IMAGE DISTANCES WITH A COMMON IMAGE PLANE

Here are the conjugate pairs of object and image distances from the previous **Handout**, but this time the graphics have been shifted so that the tip of the image point cones are all at the at the same plane. Notice now why the lens of the camera moves **outward** from the film plane as you move in closer to an object! (The distances are to scale!)



OBJECT DISTANCE AND IMAGE SIZE

Here are the same conjugate pairs of object and image distances using a 50 mm single element lens again, but this time a 50 mm arrow is placed at the object distance (off the page!) and its corresponding image is shown. Notice how the image size changes rapidly in the near zone but slowly at the longer distances.



OBJECT DISTANCE	IMAGE DISTANCE	MAGNIFICATION
150	75	.5
250	62.5	.25
500	55.555	.111
1000	52.631	.053
2000	51.282	.025
5000	50.505	.010
10000	50.251	.005

This is the table of values for the previous graphics, showing the various object distances, their corresponding image distances, and the rate of magnification.

The Simple Lens Formula:

1/image distance + 1/object distance = 1/focal length

is changed to:

1/focal length - 1/object distance = 1/image distance

to find the image distance.

Magnification is simply the ratio of image distance to object distance:

image distance/object distance = magnification

Another way is to use the object distance and focal length:

focal length/(object distance - focal length) = magnification

Multiply the magnification ratio times the object's size and you will find the image size.