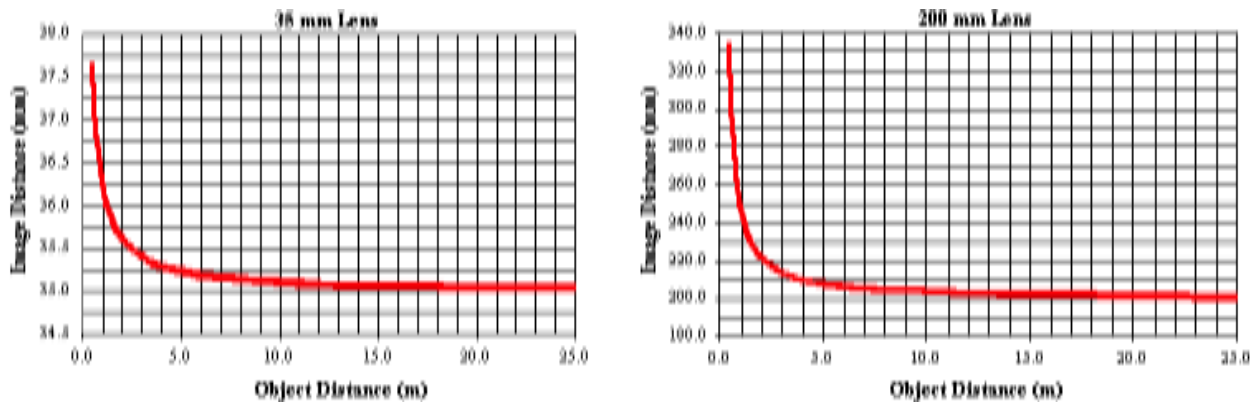


Depth of Field

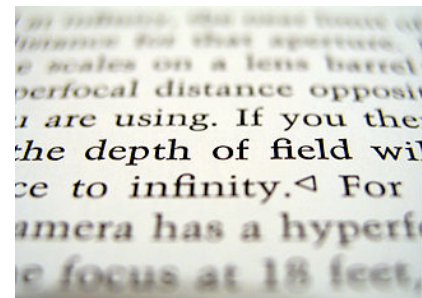
Lenses form images of objects a predictable distance away from the lens. The distance from the image to the lens is the **image distance**. Image distance depends on the **object distance** (distance from object to the lens) and the **focal length** of the lens. **Figure 1** shows how the image distance depends on object distance for lenses with focal lengths of 35 mm and 200 mm.

Figure 1: Dependence Of Image Distance Upon Object Distance



Cameras use lenses to focus the images of object upon the film or exposure medium. Objects within a photographic scene are usually a varying distance from the lens. Because a lens is capable of precisely focusing objects of a single distance, some objects will be precisely focused while others will be out of focus and even blurred. Skilled photographers strive to maximize the depth of field within their photographs. Depth of field refers to the distance between the nearest and the farthest objects within a photographic scene that are acceptably focused. **Figure 2** is an example of a photograph with a shallow depth of field.

Figure 2



One variable that affects depth of field is the f-number. The f-number is the ratio of the focal length to the diameter of the aperture. The aperture is the circular opening through which light travels before reaching the lens. **Table 1** shows the dependence of the depth of field (DOF) upon the f-number of a digital camera.

Table 1: Dependence of Depth of Field Upon f-Number and Camera Lens

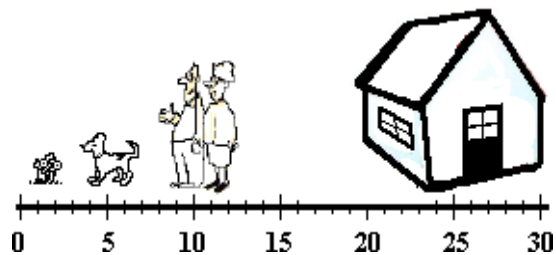
f-Number	35-mm Camera Lens			200-mm Camera Lens		
	D_N (m)	D_F (m)	DOF (m)	D_N (m)	D_F (m)	DOF (m)
2.8	4.11	6.39	2.29	4.97	5.03	0.06
4.0	3.82	7.23	3.39	4.95	5.05	0.10
5.6	3.48	8.86	5.38	4.94	5.07	0.13
8.0	3.09	13.02	9.93	4.91	5.09	0.18
22.0	1.82	Infinity	Infinite	4.775	5.27	0.52

The D_N value represents the nearest object distance that is acceptably focused. The D_F values represent the farthest object distance that is acceptably focused.

Questions:

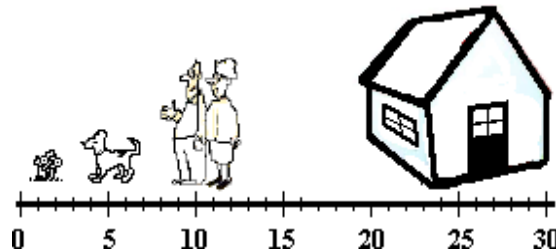
1. How does the location of an image change as an object moves further from the lens?
 - a. The image moves closer to the lens.
 - b. The image moves farther from the lens.
 - c. The answer varies, depending upon the object distance.
 - d. Nonsense! The image does not actually move.
2. Based on the information presented in **Figure 1** for 35-mm lenses, which range of object distances would present the greatest challenge for precisely focusing all images within the range?
 - a. 2.5 m to 5.0 m
 - b. 10.0 m to 12.5 m
 - c. 15.0 m to 20.0 m
 - d. 17.5 m to 25.0 m

3. The diagram below includes a photographic scene with objects that are varying distances from the camera. The camera is positioned at 0 meters. What object will be acceptably focused if a 200-mm camera lens is used and the distance from lens to exposure medium is 208 mm?



- a. Flowers (at 1 m)
 - b. Dog (at 5 m)
 - c. People (at 10 m)
 - d. House (at 25 m)
4. The lines of text in **Figure 2** are all different distances from the camera lens used to take the photograph. Which line seems to be the optimal distance from the lens such that it is acceptably focused?
 - a. The line that reads "the depth of field wi..."
 - b. The line that reads "...amera has a hyperf..."
 - c. The line that reads "...focus at 18 feet ..."
 - d. All the lines seem to be acceptably focused.

5. A photographer is taking a picture of the scene at the right using a 35 mm camera lens. The scene includes flowers (at 1 meter), a dog (at 5 meters), people (at 10 meters) and a house (at 25 meters). The photographer stands at the 0-meter mark to take the photograph. Which of the subjects in the scene will be acceptably focused if the f-number is 22.0.



- a. Only the flowers.
- b. Only the dog.
- c. The flowers and the dog.
- d. The dog and the people.
- e. The dog, the people and the house.

Answers and Explanations

1. **Answer:** A

Explanation: The graphs in **Figure 1** show that the image distance decreases as the object distance increases. The passage states that the object distance is the distance between the object and the lens; the image distance is the distance between the image and the lens. When this mathematical relationship is applied to the context of the passage, one can conclude that the image will move closer to the lens as the object moves farther from the lens.

2. **Answer:** A

Explanation: The second paragraph states that a camera lens can only precisely focus objects that are at a given object distance. The objects within the scene that are focused are those that have a very similar image distance value. The images of these objects would be acceptably focused at the location of the film or exposure medium. The collection of objects that have vastly different image distance values cannot all be acceptably focused on the film or exposure medium. Thus, the range of object distances that would present the greatest challenge for focusing would be the range for which the two extremes have vastly different image distances. To determine which range this would be, one must use the left graph (35 mm lens) of **Figure 1**. Between object distances of 2.5 mm and 5.0 mm, the line on the graph is steeply sloped. This indicates that there is a relatively large range of image distance values – from about 35.25 mm to 35.50 mm. Compared to the other choices in this question, this makes choice A the best answer.

3. **Answer:** B

Explanation: Cameras focus images on the film of a camera. The distance between the image (of film) and the camera lens is known as the image distance. In this question, the image distance is stated to be 208 mm. The question involves finding the object distance that corresponds to this image distance of 208 mm. The graph on the right (200 mm lens) must be used to answer this question. The process involves finding the coordinate of (approximately) 208 mm along the vertical axis (image distance) and tracing straight across to the line on the graph. At the intersection point with the line, trace straight downward to the horizontal axis and read the horizontal coordinate (object distance value). The result is an object distance of approximately 5.0 meters. The best answer is choice B.

4. **Answer:** A

Explanation: The line of text within **Figure 2** that seems to be most focused is the one that has the greatest clarity. This is the line that reads “the depth of field wi...”. This is the line that is the optimal distance from the lens.

5. **Answer:** E

Explanation: **Table 1** lists the nearest and the farthest objects within a photographic scene that will be acceptably focused for a stated focal length and f-Number. This question pertains to a focal length of 35 mm and an f-Number of 22.0. This corresponds to the fifth row of the table and the second and third columns. These columns indicate that objects as near as 1.82 m (d_N) and an infinite distance away will be in focus. The dog, the people and the house are the objects in the scene that will be in focus. Choice E is the best answer.

Figure 2 is a Wikimedia Commons image. The image comes with permissions to share/distribute. The WikiMedia Commons page for this image can be found at: <http://commons.wikimedia.org/wiki/File:DOF-ShallowDepthofField.jpg>.