

A Light on Physics: F-Number and Exposure Time

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Your group is a team that is going to submit a photograph to a competition. Only one photograph per team can be submitted. Each member of your team has a role assigned to insure the group completes the assignment: Recorder, Leader, Monitor and Timekeeper. For this assignment you will also have a role to play as a member of the team.

The Recorder and the Monitor believe in aperture priority: pictures should be taken with as large an $f/\#$ as possible. The Leader and the Timekeeper are advocates of exposure time priority: pictures should be taken with as short an exposure time as possible. Each of these positions has its advantages and disadvantages, which the advocates need to research before coming to class.

You all want to win the contest by submitting the most artistic photograph. The group must decide on a single pair of settings for $f/\#$ and exposure time to use for the photograph you are going to submit to the contest. Your solution should describe what about these settings will make your picture the best. Make sure to address the following:

1. What are the effects of exposure time and $f/\#$ on photographs?
2. How can different settings result in the same film exposure?
3. What defines the “best” picture and how does your solution insure you will get this result?

The subject of your photograph is the tropical rainforest bird exhibit at the local zoo. The cage has several large parrots perched quietly in trees, some close to the observation window and some at the back of the exhibit. There are also some brightly colored parakeets flying near a feeding station in the middle of the exhibit. A standard light meter indicates that an $f/\#$ setting of $f/8$ with an exposure time of $1/100$ of a second will give proper exposure of the scene. At this setting the depth of field will be less than the depth of the cage, and the exposure time is longer than the time it takes the flying birds to move a significant distance.

On the following pages are two sets of photographs that illustrate the effect of exposure time and $f/\#$. The photos in the first set were taken with exposure times ranging from 0.001 s to 0.5 s of a cyclist passing by the camera. Short exposure times give sharp images of the cyclist and even the spokes in the wheels of the bicycle, while the cyclist disappears entirely in the long exposure photographs.

The second set of photographs looks down a row of tea tins on a shelf, with the $f/\#$ setting varying from $f/16$ to $f/2$. In the $f/16$ photo all the tins are in focus, while only the center tin on the shelf is in focus in the $f/2$ photo. This series of photos also gives the exposure times for each photograph, showing how the time gets progressively shorter for the smaller $f/\#$'s.

Figure 4.21. **The action-stopping power of a shutter.** Falk, Brill & Stork. *Seeing the Light: Optics in Nature, Photography, Color, Vision, and Holograph.* (John Wiley & Sons, Inc., 1986): Figure 4.21, pp. 123-4. This material is used by permission of John Wiley & Sons, Inc. Copyright © 1986 by John Wiley & Sons, Inc.



(a) 1/1000 s



(b) 1/500 s



(c) 1/250 s



(d) 1/125 s



(e) 1/60 s



(f) 1/30 s



(g) 1/15 s



(h) 1/8 s



(i) 1/4 s



(j) 1/2 s

Figure 4.31. 35-mm photographs with increasing stop sizes, decreasing depth of field. Falk, Brill & Stork. *Seeing the Light: Optics in Nature, Photography, Color, Vision, and Holography*. (John Wiley & Sons, Inc., 1986): Figure 4.31, p. 131. This material is used by permission of John Wiley & Sons, Inc. Copyright © 1986 by John Wiley & Sons, Inc.



(a) $f/16$ at $1/15$ s



(b) $f/11$ at $1/30$ s



(c) $f/8$ at $1/60$ s



(d) $f/5.6$ at $1/125$ s



(e) $f/4$ at $1/250$ s



(f) $f/2.8$ at $1/500$ s



(g) $f/2$ at $1/1000$ s

References

- Falk, D., D. Brill, and D. Stork. 1986. *Seeing the Light: Optics in Nature, Photography, Color, Vision, and Holography*. New York: John Wiley & Sons.
- Pedrotti, F.L. and L.S. Pedrotti. 1993. *Introduction to Optics*, 2nd ed. New Jersey: Prentice Hall.
- Adams, A. 1983. *Examples: The Making of 40 Photographs*. Boston: Little Brown & Co., pp. 29–30.



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