March 2000

Activity 3: Geometry of Lenses
Solutions

1. Some students may have a hard time getting the focus right. Help them to move the lens slowly and steadily while looking at the white paper. It may help to prop up some books to shade the paper from stray light.

2. The triangles are similar. The apex angles are the same, and the sides of each triangle are equal.

3. The correct angles, in degrees, are 45.6 (25 mm), 23.7 (50 mm), 15.9 (75 mm) 12.0 (100 mm). The formula, for student who know trig, is A = 2 atan(10.5/f).

4. The area is 28.7 mm^2 = pi times (6/2) squared

5. By a factor of four.

6. 4.24 mm = 6 mm/square root of 2

7. Lenses with a longer focal length have a narrower field of view and therefore capture less light.

8.
a. A setting of f/2 has a bigger aperture than f/4 because dividing f by two results in a larger number than dividing f by 4.

b. and c. f/2 admits four times as much light as f/4 (= (pi x $(f/2)^2$)/(pi x $(f/4)^2$))

9. The stops are f/2, f/2.8, f/4, f/5.6, f/8, f/11, and f/16. These are the standard settings on most cameras. To get these numbers, start with 2 and keep multiplying by the square root of 2. Note that the exact value for f/5.6 is f/5.65685, which should round to f/5.7, but photographers aren't mathematicians.

10. There is no point in having the aperture wider than the lens itself. The lowest f-stop is usually when the aperture is wide open. Therefore a bigger (and usually more expensive) lens might have an f/1.2 setting, while a less expensive lens might only have an f/1.8 setting.