

Mark scheme for Extension Worksheet – Option A, Worksheet 1

- 1 Insert left graph on page 84 from *Physics for the IB Diploma Exam Preparation Guide*. Peak to the left; higher. [2]
- 2 Insert right graph on page 84 of *Physics for the IB Diploma Exam Preparation Guide*. [1] for each of the three correct curves. [3]
- 3
 - a With low intensity light the rods will be used; and so there will be no detail or colour seen. [2]
 - b With high intensity light cones will be used; and so there will be colour and detail seen. [2]
- 4 The response curves for green and red cones show peaks very close to each other; and so green and red cannot easily be distinguished. [2]
- 5 In twilight it will be the rods that will be responsible for vision; the peak in the sensitivity for rods cells is close the peak in the sensitivity for green so green will not be much affected by the low intensity light; but the peak for red is away from that of the rods meaning that the sensation of red will not be very intense. [3]
- 6
 - a The angular separation of the two objects is

$$\theta_A = \frac{12 \times 10^{-3}}{35} = 3.429 \times 10^{-4} \approx 3.4 \times 10^{-4}$$
; the diffraction angle is

$$\theta_D = 1.22 \times \frac{560 \times 10^{-9}}{2.0 \times 10^{-3}} = 3.416 \times 10^{-4} \approx 3.4 \times 10^{-4}$$
; since $\theta_A \approx \theta_D$ objects can just be resolved. [3]
 - b The separation of the images of the two objects on the retina is

$$s = d\theta_A = 20 \times 10^{-3} \times 3.429 \times 10^{-4} \approx 6.9 \times 10^{-6} \text{ m}$$
; this distance must be about two cone cells diameters and so the diameter is estimated to be

$$\frac{6.9 \times 10^{-6}}{2} \approx 3 \times 10^{-6} \text{ m}$$
 at most. [2]