

**11**

Do a run-length encoding of the following sequence of grayscale values. Explain your encoding strategy, and compute the compression rate.

240 240 240 240 240 240 238 238 238 238 230 230 230 230 229 228 228  
 227 227 227 227 227 227 227 227 227 227 227 227 227 227 227 227 227 227  
 227 227

**12**

Do a Shannon-Fano encoding of an image file on the basis of the frequency table below. Fill in the table below using Shannon's entropy equation. Then compare the average number of bits per color arising from your encoding with the minimum possible average number of bits derived from Shannon's entropy equation.

Color	Frequency	Optimum Number of Bits to Encode This Color	Relative Frequency of the Color in the File	Product of Columns 3 and 4
black	200			
white	175			
yellow	90			
orange	75			
red	70			
purple	35			
blue	20			
green	10			

**13**

Say that you have an image that has 100 pixels. The first six colors of the image are W K Y B R Y. Do the first six steps of arithmetic encoding based on the frequency table on next page.

Color	Frequency Out of Total Number of Pixels in File	Probability Interval Assigned to Symbol
black (K)	$40/100 = 0.4$	0–0.4
white (W)	$30/100 = 0.3$	0.4–0.7
yellow (Y)	$15/100 = 0.15$	0.7–0.85
red (R)	$10/100 = 0.1$	0.85–0.95
blue (B)	$5/100 = 0.05$	0.95–1.0