Question 4: Qualitative Quantitative Translation (QQT) — 8 points

A

For indicating **one** of the following: — **Point A1**

- The claim is correct if a justification is not provided.
- An indication about the claim that is consistent with the justification provided.

For a correct comparison of **one** of the following: — **Point A2**

- The wavelength of violet light is shorter than the wavelength of red light.
- The frequency of violet light is greater than the frequency of red light.

For indicating that a shorter wavelength corresponds to a shorter path length difference, resulting in a shorter distance between the center of Band A and the center of the central bright band — **Point A3**

Example Response

The claim is correct. The wavelength of violet light is shorter than that of red light. This shorter wavelength leads to a shorter path length difference for violet light as compared to red light. This corresponds to a shorter distance between Band A and the central band.

B

For a multistep derivation that includes $d\left(\frac{y_{\max}}{L}\right) \approx m\lambda$, $d\sin\theta = m\lambda$, $\Delta D = m\lambda$, $\Delta D = d\sin\theta$, $\Delta D \approx d\left(\frac{y_{\max}}{L}\right)$, $d\sin\theta \approx d\left(\frac{y_{\max}}{L}\right)$, $\sin\theta \approx \left(\frac{y_{\max}}{L}\right)$, $\tan\theta \approx \left(\frac{y_{\max}}{L}\right)$, $\theta \approx \left(\frac{y_{\max}}{L}\right)$, an equation that is equivalent to one of the equations listed, or a relevant equation — **Point B1**

For a substitution of $\frac{c}{f}$ for λ — **Point B2**

For correctly relating $y_{\max}$ to the orders of bands A and B — **Point B3**

(e.g., $2\left(y_{\max,2} - y_{\max,0}\right) = 2\left(\frac{(2)cL}{fd}\right)$)

Scoring Note: A correct, isolated, final expression earns points B2 and B3.

Example Response

$$d\left(\frac{y_{\max}}{L}\right) \approx m\lambda$$

$$\lambda = \frac{c}{f}$$

$$d\left(\frac{y_{\max}}{L}\right) = m\frac{c}{f}$$

$$y_{\max} = \frac{mcL}{fd}$$

$$\Delta y = 2\left(y_{\max,2} - y_{\max,0}\right)$$

$$\Delta y = 2\left(\frac{(2)cL}{fd}\right)$$

$$\Delta y = \frac{4cL}{fd}$$

C

For correctly indicating that the expression derived in part B is or is not consistent with the answer provided in part A — **Point C1**

For a justification that includes the consistent functional dependence between the spacing between bright bands on the screen and the frequency or wavelength of light — **Point C2**

Example Response

My derivation in part B is consistent with my answer in part A. Violet light has a greater frequency than red light. Because $\Delta y = \frac{4cL}{fd}$, a greater frequency for violet light results in a shorter distance between bright bands.