

PROBLEM SET 5 SOLUTIONS

Physics 2021

1. $d = c t = (3 \times 10^5 \text{ km/s}) (4 \text{ hr}) (3600 \text{ sec/hr}) = 4.3 \times 10^9 \text{ km}$

2. $c = f \lambda \quad \lambda = c / f = (3 \times 10^8 \text{ m/s}) / (3 \times 10^{16} / \text{s}) = 1 \times 10^{-8} \text{ m} = 10 \text{ nm (X-ray)}$

3. $F_s \propto 1 / d_s^2 \quad F_e \propto 1 / d_e^2$
 $F_s / F_e = d_e^2 / d_s^2 = (1 / 10)^2 = 0.01 \text{ times as strong}$

4. $v = -20,000 \text{ km/s} \quad \lambda = 500 \text{ nm}$
 $v / c = \Delta \lambda / \lambda = (\lambda_{\text{obs}} - \lambda) / \lambda$
 $(-20,000 \text{ km/s}) / (3 \times 10^5 \text{ km/s}) = (\lambda_{\text{obs}} - 500 \text{ nm}) / 500 \text{ nm}$
 $(\lambda_{\text{obs}} - 500 \text{ nm}) = -33.3 \text{ nm} \quad \lambda_{\text{obs}} = 466.7 \text{ nm}$

5. $\Delta \lambda / \lambda = v / c$
 $(486.112 - 486.133) / 486.133 = v / (3 \times 10^5 \text{ km/s})$
 $v = -13.0 \text{ km/s} \quad \text{Toward us – the observed wavelength has been shortened.}$

6. $v / c = \Delta \lambda / \lambda \quad \lambda_o = 700 \text{ nm (Red)} \quad \lambda = 500 \text{ nm (Green)}$
 $v = \Delta \lambda / \lambda \quad c = [(500 - 700) / (700)] (3 \times 10^5 \text{ km/s})$
 $= -8.6 \times 10^4 \text{ km/s} = -86,000 \text{ km/s}$