

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF PHYSICS

PHYSICS 212 Modern Physics
TERM 022
EXAM #1

Date: Saturday 29 March 2003

Grade = /40

Instructor: Dr. A. Mekki

Name: _____ Id#: _____

SHOW THE DETAILS OF YOUR WORK

1. A physics student claims in court that the reason he went through the red light ($\lambda = 650 \text{ nm}$) was that, due to his motion, the red color was Doppler shifted to green ($\lambda = 550 \text{ nm}$). How fast was he going? (5 pts)

Since the observer is approaching the source $\left\{ \begin{array}{l} \lambda_{\text{source}} = 650 \text{ nm} \\ \lambda_{\text{obs}} = 550 \text{ nm} \end{array} \right.$

$$f_{\text{obs}} = \frac{\sqrt{1 + v/c}}{\sqrt{1 - v/c}} f_{\text{source}}$$

$$\Rightarrow \left(\frac{f_{\text{obs}}}{f_{\text{source}}} \right)^2 = \frac{1 + v/c}{1 - v/c} \Rightarrow \left(1 - \frac{v}{c} \right) \left(\frac{f_{\text{obs}}}{f_{\text{source}}} \right)^2 = 1 + v/c$$

$$\Rightarrow \frac{v}{c} = \frac{\left(\frac{f_{\text{obs}}}{f_{\text{source}}} \right)^2 - 1}{\left(\frac{f_{\text{obs}}}{f_{\text{source}}} \right)^2 + 1} \Rightarrow v = c \frac{\left(\frac{\lambda_{\text{source}}}{\lambda_{\text{obs}}} \right)^2 - 1}{\left(\frac{\lambda_{\text{source}}}{\lambda_{\text{obs}}} \right)^2 + 1} = \frac{(650)^2 - 1}{(650)^2 + 1} c$$

$$\Rightarrow \boxed{v = 4.97 \times 10^7 \text{ m/s}}$$

2. The period of a pendulum on the earth is 2 seconds. What is the period of this pendulum when measured by an observer in a spaceship moving with a speed of $0.9c$ with respect to the inertial system of the pendulum? (5 points)

$$\Delta T = \gamma \Delta T' = \frac{1}{\sqrt{1 - v^2/c^2}} \Delta T'$$

$$= \frac{1}{\sqrt{1 - (0.9)^2}} \times 2 = \boxed{4.6 \text{ sec}}$$