PH-105 Assignment Sheet - 2 (Quantum Mechanics)

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1. **(a) A source of photons of frequency ν is moving with a speed v in laboratory frame of reference. Show that in the limit v is very small then c, the frequency of photon ν' , as observed in laboratory frame of reference is given by the following expression. $\nu' = \nu(1+v/c)$. (b) What is the value of the required speed in case the energy of photons of energy 14.4 keV is to be increased by 10^{-6} eV?**
   Solution :
   (a) We know by doppler effect that
   $\nu' = \nu\sqrt{1+\beta/1-\beta}\beta = v/c$
   Now using approximations we get
   $(1+v/c)^{1/2}$ $1+v/2c$ and
   $(1-v/c)^{-1/2}$ $1+v/2c$
   Now
   $(1+v/2c)^2 = 1+v/c+(v/2c)^2$ but $(v/2c)^2$ is very small compared to rest of expression so
   $\nu' = \nu\sqrt{1+\beta/1-\beta}$ $\nu(1+v/c)$
   (b) $\Delta E = 10^{-6}eV$ $E_i = 14.4KeV$
   $\nu'/\nu = E'/E = 1+\Delta E/E = 1+v/c$
   $v/c = \Delta E/E = 10^{-6}/14.4*10^3 = 10^{-9}/14.4$
   $v = 0.3/14.4$ m/s