The passband signal received at the mobile user is given by

$$y_p(t) = x_p\left(t - \frac{vt}{c}\right).$$

a) Argue why

$$x^I(t) \simeq x^I\left(t - \frac{vt}{c}\right) \quad \text{and}$$

$$x^Q(t) \simeq x^Q\left(t - \frac{vt}{c}\right)$$

are good approximations.

b) Give an expression (using the assumption in (a)) for the complex envelope of $y_p(t)$, i.e., $y(t)$ such that

$$y_p(t) = \mathrm{Re}\left(y(t) e^{j2\pi f_c t}\right).$$

What is the relation between $y(t)$ and $x(t)$? Is there a shift in the frequency occupancy of the baseband signal when it is received.

c) If there is a shift, calculate the value of this shift (in Hz) ~~for~~ when $f_c = 2$ GHz, $v = 30$ m/sec.