Let$Y = \alpha \tan \pi X$, where X is uniformly distributed in the interval (-1, 1).

a) Show that Y is a Cauchy random variable
b) Find the pdf of $Y = 1/X$

My problem is with the interval. I don't have a problem with the first part of the question.

Relevant Equations:

$$f_Y(y) = \frac{f_X\left(x^{(1)}\right)}{\left|g'\left(x^{(1)}\right)\right|}$$

$$Cauchy: f_X(x) = \frac{\alpha/\pi}{\alpha^2 + x^2}$$

Here is what I was able to do

After differentiating, I got:

$$g'\left(x^{(1)}\right) = \pi\alpha \sec^2 \pi x$$

Making x the subject, I had:

$$x = \frac{1}{\pi} \tan^{-1}\left(\frac{y}{\alpha}\right)$$

$$\therefore\ f_Y(y) = \frac{f_X\left(\frac{1}{\pi}\tan^{-1}\frac{y}{\alpha}\right)}{|\pi\alpha \sec^2 \pi x|}$$