



- MX** **13** A device playing a signal given by $x = \sqrt{2} \sin t + \cos t$ produces distortion whenever **4**
SP **b** $|x| \geq 1.5$.
For what fraction of the time will the device produce distortion if the signal is played continuously?

Rewrite $\sqrt{2} \sin t + \cos t$ as $\cos t + \sqrt{2} \sin t$ and express in the form $R \cos(t - \alpha)$:

$$r = \sqrt{1^2 + (\sqrt{2})^2} = \sqrt{3}, \text{ and } \tan \alpha = \sqrt{2}.$$

$$\text{As } |x| \geq 1.5 \text{ then consider } |\sqrt{3} \cos(t - \alpha)| \geq \frac{3}{2}$$

$$|\cos(t - \alpha)| \geq \frac{3}{2\sqrt{3}}$$

$$|\cos(t - \alpha)| \geq \frac{\sqrt{3}}{2}$$

Now in the domain $[0, \frac{\pi}{2}]$, $\cos(t - \alpha) \geq \frac{\sqrt{3}}{2}$ when $[0, \frac{\pi}{6}]$, which is one-third of the time.

This fraction is consistent for all multiples of $\frac{\pi}{2}$ s, so the fraction is $\frac{1}{3}$.

* These solutions have been provided by [projectmaths](http://projectmaths.com.au) and are not supplied or endorsed by NESA.

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