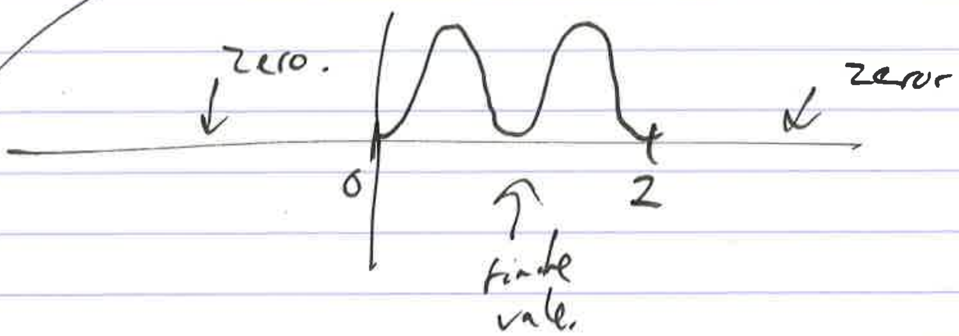
$$\psi(x) = \sin(\pi x) \quad \text{for} \quad 0 \le x \le 2.$$
$$= 0 \quad \text{elsewhere.}$$

Want to check: $\displaystyle\int_{-\infty}^{\infty} |\psi(x)|^2\, dx = 1$



$$= \int_{-\infty}^{0} |\psi(x)|^2 dx + \int_{0}^{2} |\psi(x)|^2 dx + \int_{2}^{\infty} |\psi(x)|^2 dx$$

$$= 0 + \int_0^2 \sin^2(\pi x)\, dx + 0$$

$$\left[\sin^2(x) = \frac{1-\cos(2x)}{2}\right]$$

$$= \int_0^2 \left(\frac{1-\cos(2\pi x)}{2}\right) dx$$

$$= \frac{1}{2}(2-0) - \frac{1}{2}\left[\frac{\sin(2\pi x)}{2\pi}\right]_0^2$$

$$= 1 - \frac{1}{2}(0-0) = 1$$:)

Normalised

$$\text{Prob}(a \le x \le b) = \int_a^b |\psi(x)|^2 \, dx.$$

(assume $a > 0$ $b < 2$ $b > a$)

$$= \int_a^b \sin^2(\pi x) \, dx = \int_a^b \frac{1 - \cos(2\pi x)}{2} \, dx$$

$$= \frac{1}{2}(b-a) - \frac{1}{2}\left(\frac{1}{2\pi}\right)\left(\sin(2\pi b) - \sin(2\pi a)\right)$$