QUESTION:

The displacement of a block attached to a horizontal spring whose spring constant is 6 N/m is given by x = 0.4 \cos(4.1 t - 0.8) m. What is the earliest time (t > 0) when the kinetic energy equals one-half the potential energy?*** I saw the answer to this question but I didn't understand why the following was done:At the time when the potential energy equals to the half of it, the displacement of the block would be x = radic (2*0.24/k) = 0.28 m.

SOLUTION:

The potential energy is

$$E_p = \frac{k \cdot x^2}{2} = \frac{k \cdot (0.4\cos(4.1t - 0.8)^2}{2}$$

The kinetic energy is

$$E_k = \frac{m\upsilon^2}{2}$$

$$\upsilon = \frac{dx}{dt} = -4.1 \cdot 0.4 \sin(4.1t - 0.8)$$

$$E_k = \frac{m\upsilon^2}{2} = \frac{m \cdot 1.64^2 \cdot \sin^2(4.1t - 0.8)}{2}$$

Total energy is $E_{tot} = \frac{kx_m^2}{2} = 0.48 \text{ J}$

So when the potential energy is equals to half of it

$$\frac{k \cdot x^2}{2} = \frac{0.48}{2} = 0.24$$

$$x = \sqrt{\frac{2 \cdot 0.24}{k}} = 0.283 \text{ m}$$