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$$a = \frac{d^2x}{dt^2} = Kt - k^2x$$

or  $\frac{d^2x}{dt^2} + k^2x = Kt$ , a second-order, linear differential equation whose solution is

$$x = x_h + x_p = A \sin kt + B \cos kt + \frac{K}{k^2}t$$

Initial conditions:

$$x(0) = B = 0$$

$$\dot{x}(0) = kA + \frac{K}{k^2} = 0, \quad A = -\frac{K}{k^3}$$

$$\text{So } x = \frac{K}{k^3}(kt - \sin kt)$$