The differential equation $\ddot{x} + x^{1/3} = 0$ where $(\cdot) \equiv d/dt$, is an explicit example of a new class of nonlinear oscillator equation characterized by elastic forces depending on rational powers of the dependent variable [1]. We demonstrate, using two-dim phase-space techniques, that all solutions are periodic and calculate the exact period of the oscillations. In analogy to the solutions of the ODE, $\ddot{x} + x^3 = 0$, for which the solutions include the Jacobi “cosine” and “sine” elliptic functions [2], we define solutions $Lcn(t)$ and $Lsn(t)$ corresponding, respectively, to the initial conditions: $x(0) = 1$, $\dot{x}(0) = 0$ and $x(0) = 0$, $\dot{x}(0) = 1$. Several properties of these new functions are established.

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References