Limitations of Dimensional Analysis.

Although dimensional analysis is very useful it cannot lead us too far as,

(1) If dimensions are given, physical quantity may not be unique as many physical quantities have same dimensions. For example if the dimensional formula of a physical quantity is $[ML^2T^{-2}]$ it may be work or energy or torque.

(2) Numerical constant having no dimensions [K] such as (1/2), 1 or 2π etc. cannot be deduced by the methods of dimensions.

(3) The method of dimensions cannot be used to derive relations other than product of power functions.

For example: $s = ut + (1/2)at^2$ or $y = a\sin\omega t$

Cannot be derived by using this theory (try if you can). However, the dimensional correctness of these can be checked.

(4) The method of dimensions cannot be applied to derive formula if in mechanics a physical quantity depends on more than 3 physical quantities as then there will be less number (= 3) of equations than the unknowns (>3). However still we can check correctness of the given equation dimensionally. For example $T = 2\pi\sqrt{1/mgl}$ cannot be derived by theory of dimensions but its dimensional correctness can be checked.

(5) Even if a physical quantity depends on 3 physical quantities, out of which two have same dimensions, the formula cannot be derived by theory of dimensions, e.g., formula for the frequency of a tuning fork $f = (d/L^2)v$ cannot be derived by theory of dimensions but can be checked.