Introduction

All physical variables come with either a dimension or are dimensionless. The main dimensions we will be using are **length** L, **mass** M, and **time** T.

To analyse the dimension of a quantity, e.g. kinetic energy, we write:

Table of values

Quantity	Dimension	SI Unit
Time		
Mass		
Weight (mg)		newton (N)
Length (displacement)		
Area		
Volume		
Velocity		
Acceleration	LT^{-2}	
Acceleration due to gravity		ms^{-2}
Force (ma)		newton (N)
Kinetic energy $\left(\frac{1}{2}mv^2\right)$		joule (J)
Gravitational potential energy (mgh)		
Work done (force $\times$ distance moved)		joule (J)
Moment of a force (force $\times$ perpendicular distance)		newton metre (Nm)
Power $\left(\text{rate of doing work } \frac{dW}{dt}\right)$		watt (W)
Momentum (mv)		kg m s^{-1}
Impulse (force $\times$ time)		newton second N s
Moment of inertia $\left(\sum mr^2\right)$		
Angular velocity $\left(\omega = \frac{d\theta}{dt}\right)$		
Density $\left(\frac{\text{mass}}{\text{volume}}\right)$		
Pressure $\left(\frac{\text{force}}{\text{area}}\right)$		
Time period (time to complete one complete cycle)		
Frequency $\left(\frac{1}{\text{time period}}\right)$		hertz (Hz)
Surface tension $\left(\frac{\text{force}}{\text{length}}\right)$		
Elastic potential energy $\left(\frac{1}{2}\frac{\lambda}{l}x^2\right)$		

Rules

Fact — To **add** or **subtract** quantities they must have the same dimension

Fact — When taking a derivative, this is equivalent to dividing by the dimension

Calculations involving Dimensional analysis

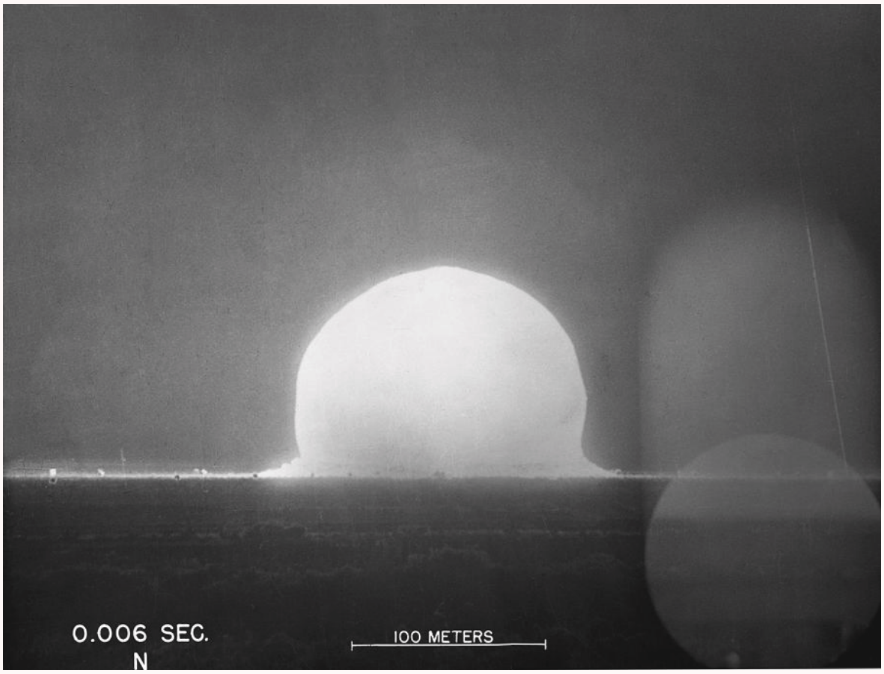
Example

A simple pendulum consists of a particle of mass m suspended at the end of an inextensible string of length l. The pendulum is initially hanging at rest and then it is displaced through a small angle θ and released to make small oscillations. Derive a formula for using a dimensional argument.

Nuclear Approximations

Example

In 1947, a film of the Trinity test was released by the US Atomic Energy Commission along with a number of still photographs. According to folk-legend, G.I. Taylor, a British physicist managed to deduce from these a good approximation of the yield from the first nuclear explosion. How did he do it?



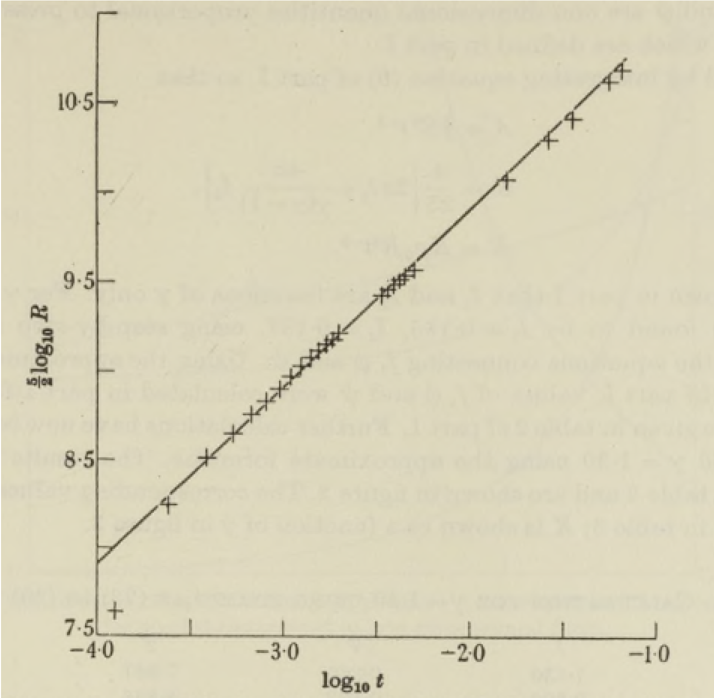


FIGURE 1. Logarithmic plot showing that $R^{5/2}$ is proportional to t.