

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 ($\frac{1}{2}mv^2$)		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 (rate of doing work $\frac{dW}{dt}$)		watt (W)
Momentum (mv)		$kg\ m\ s^{-1}$
Impulse (force \times time)		newton second N s
Moment of inertia ($\sum mr^2$)		
Angular velocity ($\omega = \frac{d\theta}{dt}$)		
Density ($\frac{\text{mass}}{\text{volume}}$)		
Pressure ($\frac{\text{force}}{\text{area}}$)		
Time period (time to complete one complete cycle)		
Frequency ($\frac{1}{\text{time period}}$)		hertz (Hz)
Surface tension ($\frac{\text{force}}{\text{length}}$)		
Elastic potential energy ($\frac{1}{2}\frac{\lambda}{l}x^2$)		

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

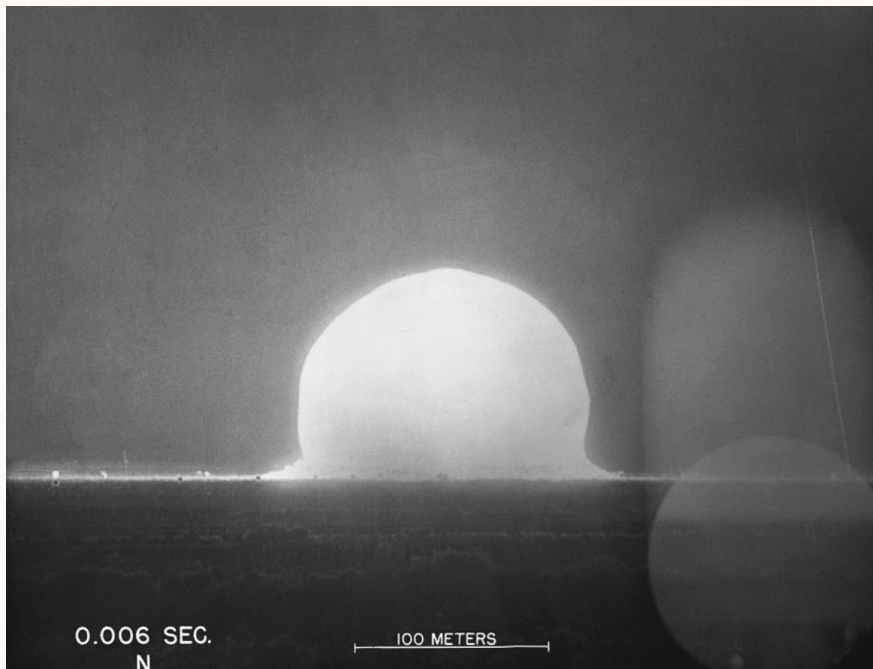
Example

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?



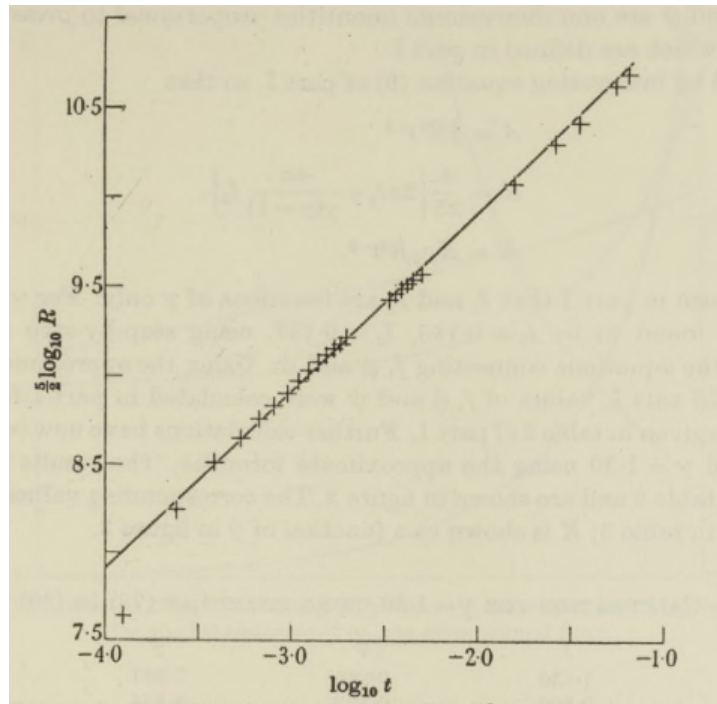


FIGURE 1. Logarithmic plot showing that R^3 is proportional to t .