5 Variables and Constants

Measurable quantities are either variables or constants. A variable is a quantity whose value can change. A constant is an unchanging quantity.

Commonly used constants include:

charge of the electron	-1.60×10^{-19} C
speed of light in a vacuum	3.00×10^{8} m/s

Some quantities *can* have different values (so they are variables), but within a particular experiment we do not expect their value to change. With these quantities, every effort should be taken to make sure their value remains as constant as possible. These are called control variables. Sometimes, deducing a value of a control variable and comparing this to an expected value is a useful way of testing the validity of the experiment. Common control variables include:

gravitational field strength at the surface of the Earth	9.81 N/kg, but taken as 10 N/kg at GCSE level
specific heat capacity of water	4 200 J/(kg °C)
speed of sound in air	330 m/s
refractive index of glass	1.50

In any experiment, the value of one quantity must be systematically changed in order to measure its effect on another quantity. The quantity that the experimenter chooses to change is called the independent variable.

The quantity whose value changes in response to the change of independent variable value is called the dependent variable.

Often, the independent variable and dependent variable values will be plotted on a graph so that the relationship between the two can be deduced and predictions can be made and tested.

5.1 Scientists wish to know the acceleration of a car as it rolls down a sloping ramp. They set the ramp at a certain angle and then release the car from different positions up the ramp, timing how long

it takes to reach the bottom. There are several quantities that can be changed in this experiment. For each of the following, state whether it is a control variable, independent variable or dependent variable.

Variable	Variable type
Length of the ramp	(a)
Distance the car rolls	(b)
Duration of the car's motion	(c)
Mass of the car	(d)
Angle of the ramp	(e)
Surface material of the ramp	(f)

5.2 A sportsman wants to know the bouncing efficiency of a table tennis ball. He drops the ball from various heights and measures the maximum height the ball reaches after the first bounce. For each of the quantities listed in the table, state whether it is a control variable, an independent variable or a dependent variable.

Variable	Variable type
Size of ball	(a)
Material of ball	(b)
Height of ball before being dropped	(c)
Maximum height of ball after one bounce	(d)
Mass of ball	(e)
Material of surface onto which ball is dropped	(f)