

## Some attributes of the Scientific Mind

**INSATIABLE CURIOSITY** – must surely be the mainspring

The need to **OBSERVE** – with objectivity and impartiality

The need to **QUESTION** – seeking answers (through the framing of hypotheses)

The **CREATIVE URGE** – a desire to create new things (with the hands or in the mind)

A talent for **IMMAGINING** possible actions and their consequences – i.e. for abstraction

A capacity for **LOGICAL ARGUMENT** – to connect ideas

The power of **DISCRIMINATION** – what is important to an argument and what is not?

An appreciation of **BEAUTY** – both visual and intellectual

**A SENSE OF WONDER** – at the immensity of the Universe and the diversity of Nature, both living and non-living.

## BASIC BOOKS IN SCIENCE

Book 1. Number and symbols

— from counting to abstract algebras

Book 2. Space

— from Euclid to Einstein

Book 3. Relationships, change

— and Mathematical Analysis

Book 4. Mass and motion

— first steps into Physics

Book 5. Atoms, molecules, and matter

— the stuff of Chemistry

Available for free downloading from the website

<[www.learndev.org](http://www.learndev.org)> (see 'For the Love of Science')



## **Book 1: Contents**

**Chapter 1 About numbers** Why do we need numbers?

Counting: the natural numbers The naming of numbers

**Chapter 2 Combining numbers** Combining by addition

Combining by multiplication

**Chapter 3 Inventing new numbers** Negative numbers

and equations Numbers in a picture – vectors More new numbers – fractions

**Chapter 4 The decimal system** Rational fractions

Powers and their properties Decimal numbers that never end

**Chapter 5 Real and complex numbers** Real numbers

and series Fields - complex numbers

## Book 1: Looking back –

Chapters 1 and 2: all that you learnt as a child, without really understanding. Now you know what it *means*. You use *any* symbols to stand for numbers and then it's 'algebra'

Chapter 3: you met equations, containing a number you don't know (call it 'x'), along with the integers (1,2,3,...), and could *solve* the equations, to get new numbers (0, -1, -2, ...). Then, using *pictures* you got the idea of 'fractions'.

Chapter 4: Between any two fractions there are millions of other numbers! An 'irrational' number is defined only by a *recipe* that tells you how to reach it – and it must be included!

Chapter 5 admitted the last ‘new’ number, called the “imaginary unit” ( $i$ ), with the property  $i \times i = -1$  (*not* 1). And when  $i$  is added the number field is extended to include both ‘Real’ and ‘Complex’ Numbers. Nothing else is needed! – the number field is *closed*.

Chapter 6, however, showed how symbols can be used to stand for other things besides numbers – *operations*, like moving objects in space; or even just for arguing about things, as in *logic*!

## **Book 4: Contents**

**Chapter 1 Mass, force, and weight**    What makes things move?    How can we measure force?    Combining forces  
How to work with vectors

**Chapter 2 Work and energy**    What is work?    Two kinds of energy    Conservation of energy    Doing it using calculus  
Other kinds of energy    Rate of working – power

**Chapter 3 Motion of a particle**    Motion under variable force    Projectiles    A numerical method    Motion of the Earth around the Sun    More about potential energy

**Chapter 4 From one particle to many –**    Many-particle systems    Conservation of linear momentum    Elastic and inelastic collisions

## Book 4: Looking back –

You started this book knowing nothing about Physics. Where do you stand now? Building only on the ideas of number and space (Books 1 and 2) and simple mathematical relationships (Book 3), you've come a long way:

Chapters 1 and 2 showed you how to build physical *concepts* from your own experience of pulling and pushing, working and using your energy. You know about force, mass, weight, and how things move; and about Newton's famous laws. You've learnt that energy is *conserved*, it doesn't just disappear – it changes from one kind to another.

Chapter 3 extended these ideas to the motion of a **particle**, acted on by a force and moving along any path. You learnt how to calculate the path of the Earth as it goes round the Sun, using only simple arithmetic and the same laws that worked for a



small particle. Amazing that it came out right, predicting a year of about 360 days!

Chapter 4 showed how that could be: a big body is just a collection of millions of particles, all following Newton's laws. You learnt about the **centre of mass**, which moves as if all the mass were concentrated at that one point; and about **momentum** and **collisions**.

Chapter 8 brought you to the present day and to problems of the future. You found that *mass is a form of energy* and that *in theory* a bottle of seawater, for example, holds enough energy to run a big city for a week! – if only we could get it out! This is the promise of **nuclear energy**.