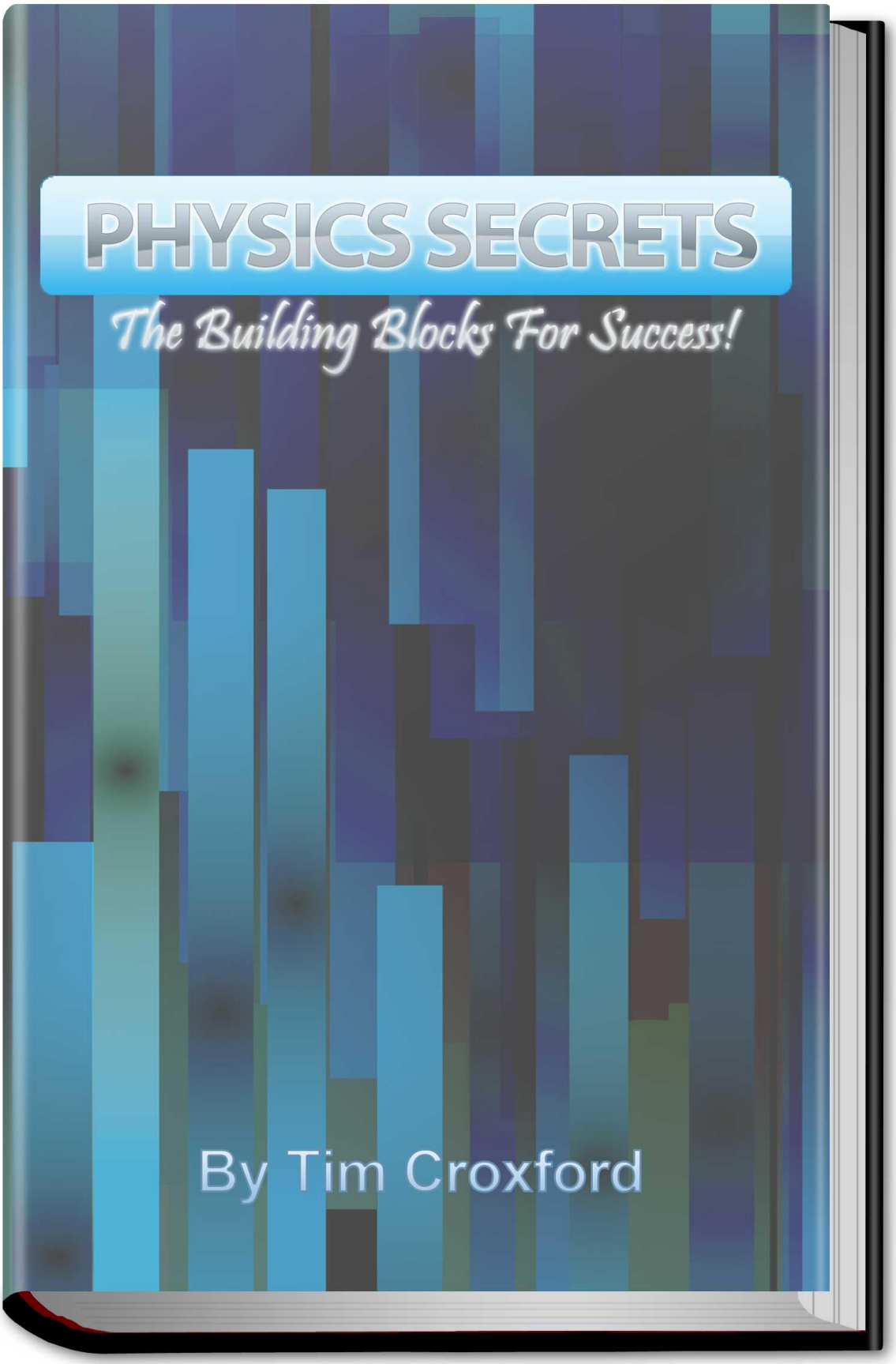
PHYSICS SECRETS
The Building Blocks For Success!
By Tim Croxford

Physics Secrets

http://www.PhysicsSecrets.com

Acknowledgements
For the inspiration and help I have received as both a student and a teacher thanks go to Crown Woods Comprehensive School, City University Physics Department, Brisbane Grammar School, Australian Academy of Science, Institute of Physics (UK), Australian and Queensland Science Teachers' Associations (ASTA and STAQ) and Merthyr Village Secretarial Services.

Tim Croxford

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Physics Secrets

Tim Croxford *CPhys MInstP (UK), BSc(Hons), PGCE*

Contents

About the Author

After receiving an honors degree in Physics with Electronics from City University in London, Tim Croxford spent two years in research and development in telecommunications and satellite navigation systems. Since then he has taught in a college of technology in the UK and two schools in Brisbane, Australia, San Sisto College and Brisbane Grammar School.

Tim enjoys teaching and developing methods and resources that enable people to both learn efficiently and gain appropriate confidence in their acquired knowledge and skill.

Preface

This book has been written for people of fifteen years of age and above.

To develop a sound understanding of the fundamentals in Physics, knowledge of the language and terminology o f the subject is essential.

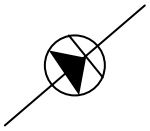
Physics Secrets provides illustrations and explanations of physical quantities and all the associated SI units, details of conventions, symbols, submultiples, multiples, useful data and constants.

In the introduction, on the next page, details are given as to how to get the best out of this book.

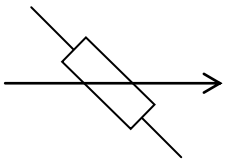
T J Croxford

INTRODUCTION

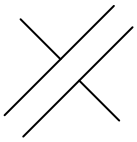
Knowing the language of a subject is the corner-stone for real understanding.

nanosecond  potential difference $^{238}_{92}U$ MeV $\leq$

In addition to new concepts, topics in physics come with new physical quantities, units, constants, conventions and symbols – we may think of these as the language of the subject.

ϕ voltage GHz 

Through simple explanation and illustrations this book will give you a comprehensive knowledge of the language of physics. This book has been written to help you learn efficiently and effectively.

tesla $\vec{V}$ force  picofarad

How to use this book

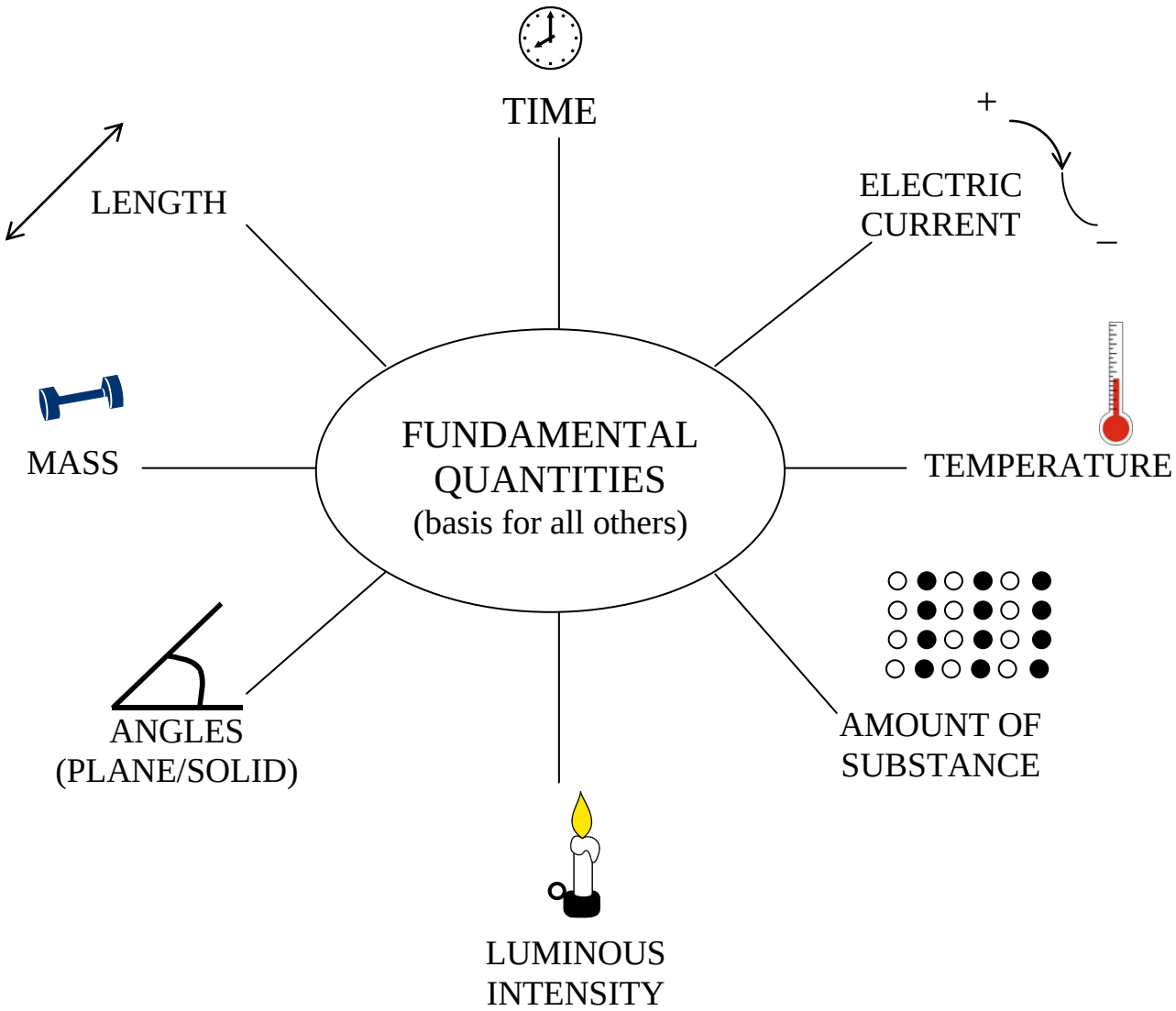
1. Have a look through the whole book to become familiar with the contents.
2. Use the Appendix at the end of the book to help you. It includes relationships, data and space to record useful references.
3. Complete the questions at the end of each section to increase your understanding and to put what you learn into context.
4. Use the book to look up the units, symbols and data that have already been provided or that you have noted down. When you learn something new tick it off on the checklist.
5. Keep it with you in class at all times to help you.
6. To get the best out of this book write in it and refer to it regularly.

QUANTITIES, UNITS AND MENTAL PICTURES

A complete and comprehensive illustration

of physical quantities and their units.

You need to know about the physical quantities in physics. Here are the ones that are the basis for ALL the others:



First, let's get a clear understanding of the quantities (and their units), seen on this page.

So that scientists can make measurements a set of units for physical quantities has been adopted. The majority of physicists and countries use the Système International (SI) units.

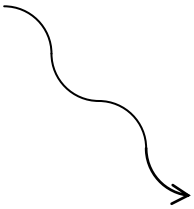
Mass – kilogram (kg)

A bar of platinum and another metal, iridium held in France is defined as the kilogram.

A plastic container holding a litre of water has a mass of about 1kg. A litre of water or soft drink is an easy way to imagine a mass of 1kg.

Time – second (s)

Atoms can radiate energy, for example atoms in a fluorescent lamp give off light.

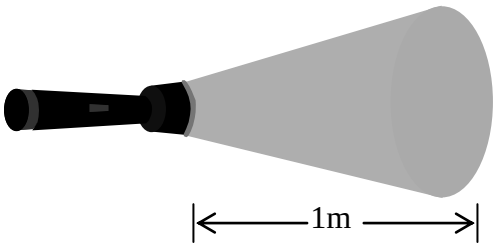


The time taken for a certain number of cycles of radiation from a particular atom is defined as the second.

This is an excellent way of defining the unit of time because it will be the same anywhere in the world.

Length – metre (m)

The unit for length is easy to define after defining the second.



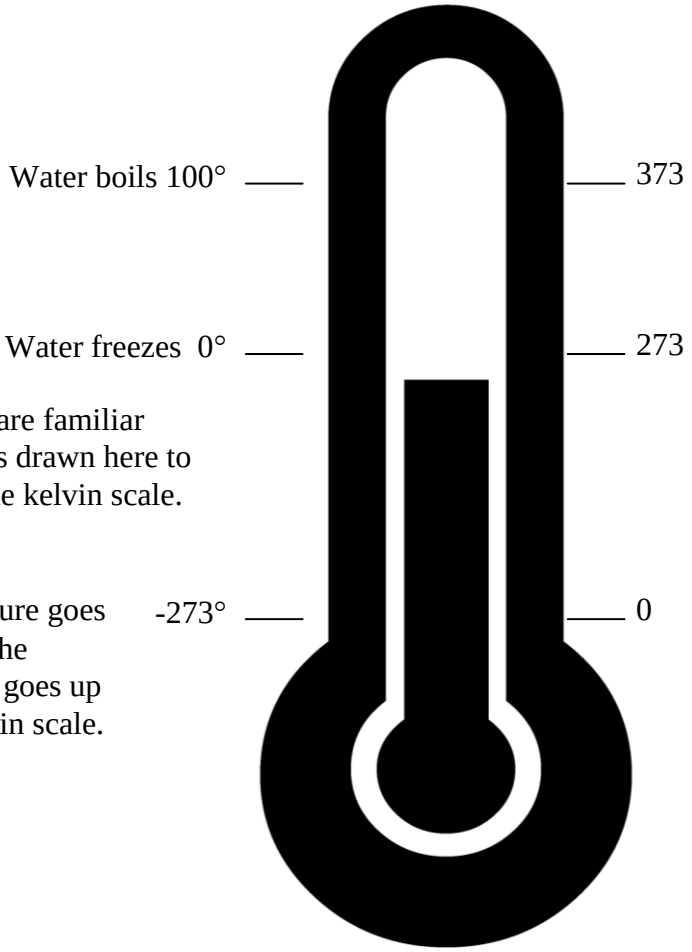
A metre is the distance travelled by light (in a vacuum) in a given fraction of a second.

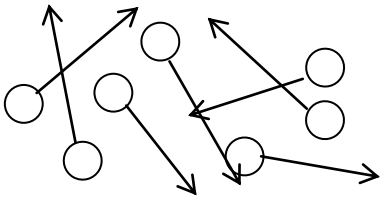
celsius (°C)

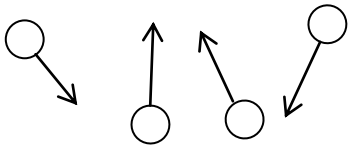
kelvin (K) (SI unit)

Temperature

celsius °C K kelvin



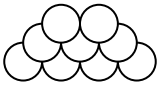




The scale you are familiar with, celsius, is drawn here to help explain the kelvin scale.

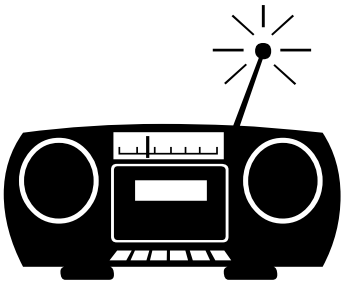
If the temperature goes up by 1°C on the celsius scale it goes up 1K on the kelvin scale.

Temperature is a measure of hotness.



Zero kelvin is the lowest temperature possible. It occurs when atoms stop moving.

Electric current – ampere (amp or A)



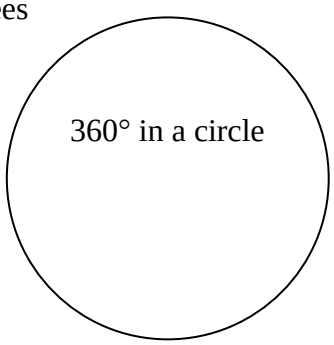
The current flowing is 1A if the power and voltage have the same numerical value. For example, 12 watts and 12 volts. Power and voltage are usually printed on the appliance, if you look closely. If the power is bigger numerically than the voltage the current is more than 1A.

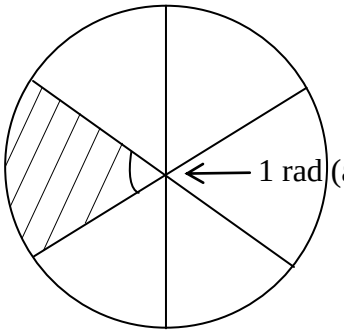
[The actual definition for the amp is based on the force that exists between two current carrying wires.]

Plane angles — degrees (°) are used below to help explain radians

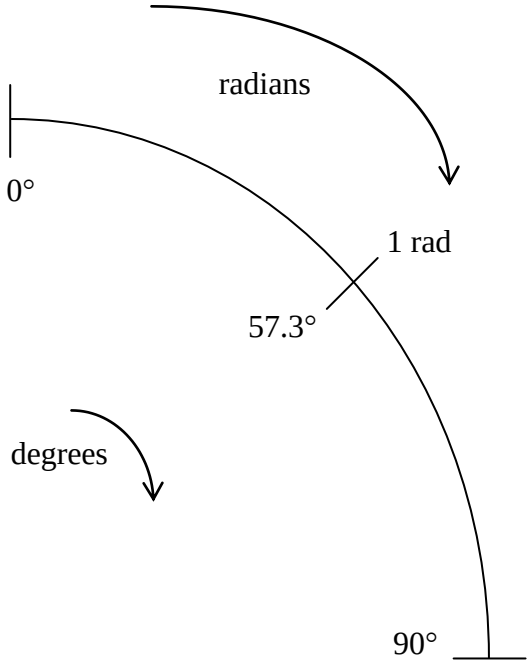
radian (rad) (SI Unit)

degrees





If a cake is divided into 6 equal slices, the angle formed by 1 slice is about 1 rad.

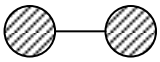


1 rad = 57.3°

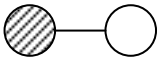
When you learn something new tick it off on the checklist on the inside of the back cover.

Amount of substance – mole (mol)

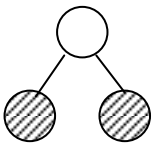
atom



molecule formed by one element (same type of atoms)

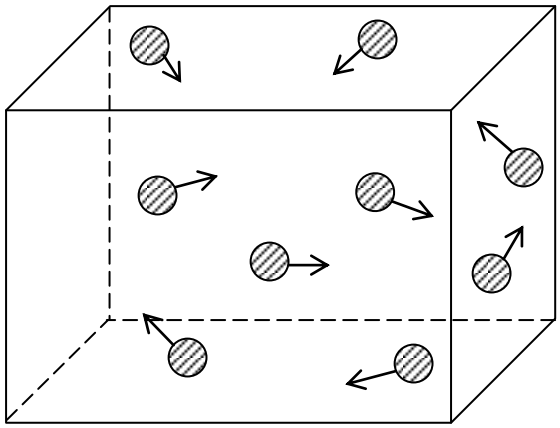


molecule formed by atoms of different elements



molecules can have two or more atoms

If there are 6.022×10^{23} atoms or molecules of one type we say we have a mole of them.



A mole of atoms in a gas.

[The number 6.022×10^{23} is called Avogadro's constant. It is a huge number – far too large to draw all the atoms.]

A mole of graphite, which is made of carbon atoms has a mass of 12 grams and is about the size of a wine cork.

Atoms and molecules are very small. Whilst a mole of carbon may only occupy the volume of a wine cork, a mole of tennis balls would take up a volume similar to the size of the moon.

The moon ———  About the volume of one mole of tennis balls.

Note: Solid angles and luminous intensity are explained in the appendix because they are less commonly required.

Before continuing answer the following questions:

Consolidation Questions 1 - Write your answers on this page.

Use the illustrations on the previous pages to help you.

1. The temperature in a room is 24°C. What is this in kelvin? _____

2. What is the temperature in kelvin of a freezer that keeps food at -18°C? _____

3. Look at the page on electric current and at the details written on some appliances around you.

   Estimate whether each appliance you look at draws more or less than an amp.

Appliance	More or Less than 1amp

4. Some sound systems draw a current of about 1 amp. Dividing the power by the voltage gives current.

   Find out or calculate typical values for the current drawn by a:

   i) television _____

   ii) hand held calculator _____

   iii) electric jug _____

   iv) car's starter motor _____

5. Estimate and then find out how much current flows when a lightning bolt strikes.

   _____

6. Approximately how many radians are there in:

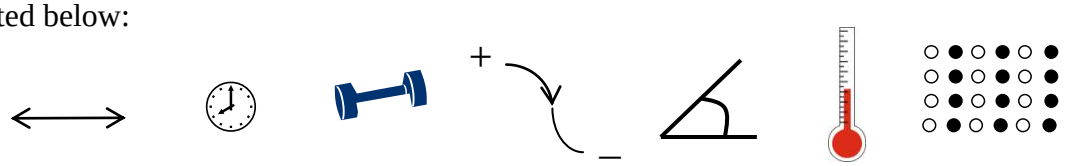
   i) 120° ? _____

   ii) 300° ? _____

7. If on average a grain of salt has a volume of $2 \times 10^{-11} m^3$, what would be the volume of one mole of salt grains? _____

   This volume would form a cube having sides of nearly 23km.

8. From memory see if you can note down the fundamental physical quantities and their SI unit, for the quantities illustrated below:



Quantity: _____ _____ _____ _____ _____ _____ _____

Unit: _____ _____ _____ _____ _____ _____ _____

9. For multiplication and division, units operate just like numbers (except the multiplication sign need not be written in). Look at the examples below and then complete the questions.

$kg^2kg^3 = kg^5$

$\frac{m^6}{m^2} = m^4$

$\frac{kg^3\,kg^4\,m^3}{kg^2\,m^2} = \frac{kg^7\,m^3}{kg^2\,m^2} = kg^5\ m^1 = kg^5\,m$

a) $kg^2kg^2 =$

b) $m^3m =$

c) $kg^{-1}kg^2 =$

d) $A^3A^{-1} =$

e) $\frac{kgm^3}{kg^2} =$

f) $\frac{A^2\,m^2}{m^{-1}} =$

INDEX AND CHECKLIST

Tick the things you have learned, whenever you use this book.