GENERAL PHYSICS-I (PHYS 111-451)

Grading Scheme-451

LABORATORY : LAB REPORTS - 20 MARKS
FINAL LAB EXAM - 10 MARKS

30 Marks

THEORY:

QUIZ-I&II	- 15 MARKS
ASSIGNMENT/HW	- 10 MARK
MID-TERM EXAM	- 15 MARKS
FINAL THEORY EXAM	- 30 MARKS

70 Marks

Book for this Course

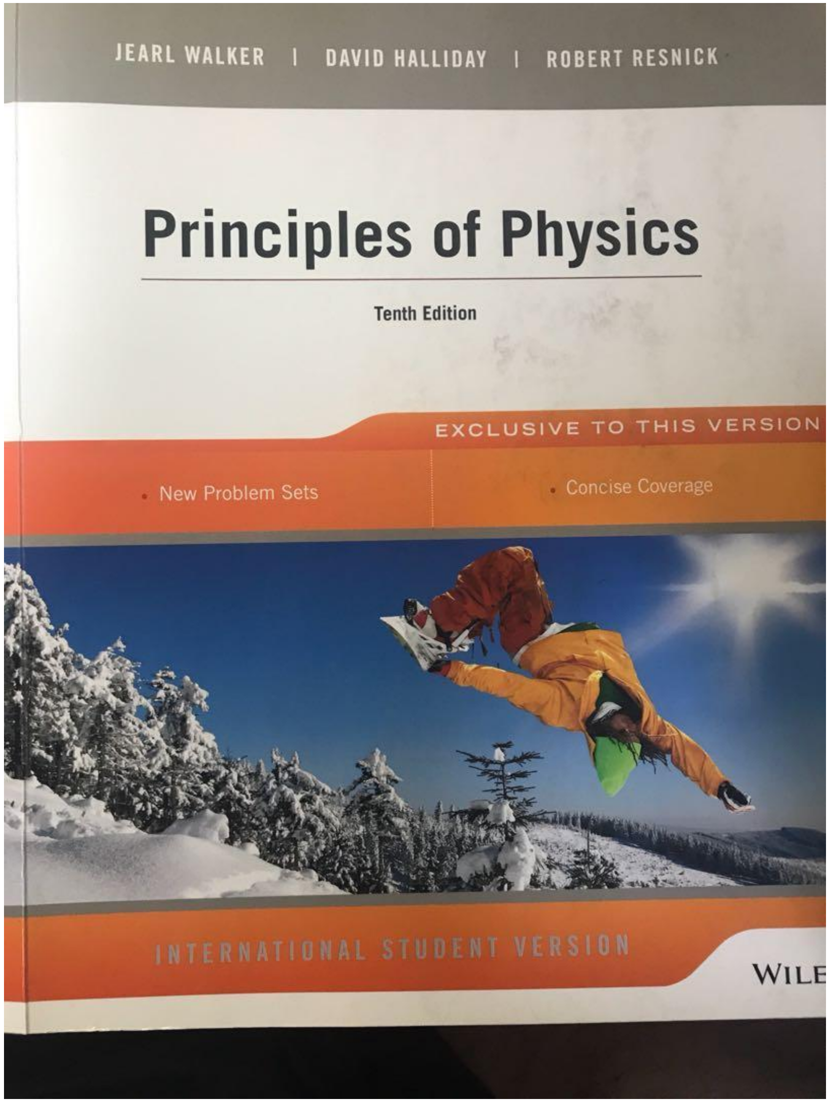
PRINCIPLES OF PHYSICS

10Th Edition

Authors: JEARL WALKER/DAVID HALLIDAY/ROBERT RESNICK

Wiley Publishers

International Student Version



كلية الجبيل الصناعية
JUBAIL INDUSTRIAL COLLEGE

Introduction-Measurements

Chapter:1

Contents

- Basic Units (Length, Mass, and Time)
- Dimensional Analysis
- Significant figures
- Unit conversion

What is PHYSICS?

- The study of matter, energy, and the interactions between them……in other words, everything

Measurements

- Collection of quantitative data
- Made by comparing an unknown quantity with a standard unit.
- For example:

The length of the piece of the string can be measured by comparing the string against a meter stick

Measurement in everyday life

Measurement of mass

Measurement of volume

Measurement of length

Measurement of temperature

You are making a measurement when you

- Check your weight
- Read your watch
- Take your temperature
- Check your height

What kinds of measurements did you make today?

International System of Units

The SI system, or the International System of Units, is also called the metric system.

Physical Quantity : Quantities which can be measured using an equipment and reported in numbers and units

Physical Quantity and units are of two type :

1. Base (Fundamental) quantities and base units
2. Derived quantities and derived units

Table 1 showing the seven (7) Fundamental Quantities of the International System of Units.

Fundamental Quantity		S.I. Unit	
Name	**Symbol**	**Name**	**Symbol**
Mass	m	kilogram	kg
Length	l	metre	m
Time	t	second	s
Current	I	ampere	A
Temperature	T	kelvin	K
Amount of Substance	n	mole	mol
Luminous Intensity	Iv	candela	cd

Derived quantity

Derived Quantity	Units
Volume, V	m^3
Density, ρ	kgm^{-3}
Velocity, v	ms^{-1}
Force, F	N
Acceleration, a	ms^{-2}

Basic Units- **Length: Meter (m); Mass: The kilogram (kg); Time: second (s)**

Prefixes for SI Units

Table 1-2

Prefixes for SI Units

Factor	Prefix[a]	Symbol	Factor	Prefix[a]	Symbol
10^{24}	yotta-	Y	10^{-1}	deci-	d
10^{21}	zetta-	Z	$\mathbf{10^{-2}}$	**centi-**	**c**
10^{18}	exa-	E	$\mathbf{10^{-3}}$	**milli-**	**m**
10^{15}	peta-	P	$\mathbf{10^{-6}}$	**micro-**	$\boldsymbol{\mu}$
10^{12}	tera-	T	$\mathbf{10^{-9}}$	**nano-**	**n**
$\mathbf{10^{9}}$	**giga-**	**G**	$\mathbf{10^{-12}}$	**pico-**	**p**
$\mathbf{10^{6}}$	**mega-**	**M**	10^{-15}	femto-	f
$\mathbf{10^{3}}$	**kilo-**	**k**	10^{-18}	atto-	a
10^{2}	hecto-	h	10^{-21}	zepto-	z
10^{1}	deka-	da	10^{-24}	yocto-	y

[a]The most frequently used prefixes are shown in bold type.

Scientific notation uses the power of 10.

Example:

3 560 000 000 m = 3.56 x 10^9m.

Definition of metre

The metre is the length of the path travelled by light in a vacuum during a time interval of 1/29,97,92,458 of a second.

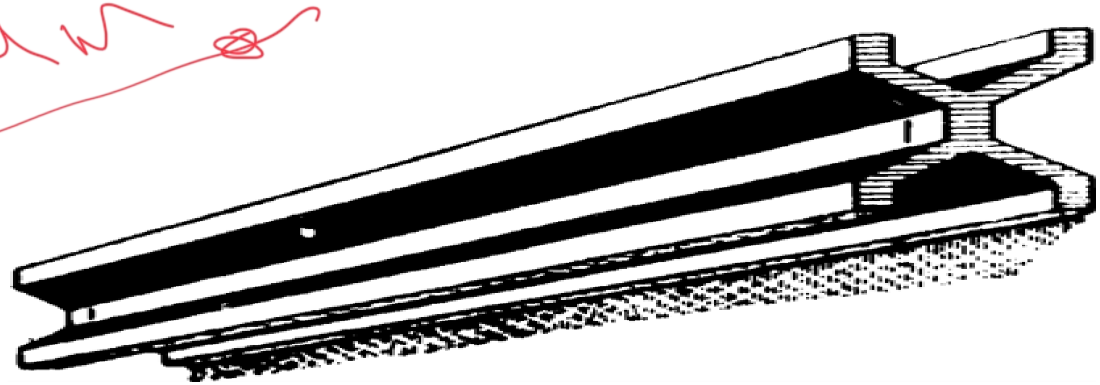
Table 1-3

Some Approximate Lengths

Measurement	Length in Meters
Distance to the first galaxies formed	2×10^{26}
Distance to the Andromeda galaxy	2×10^{22}
Distance to the nearby star Proxima Centauri	4×10^{16}
Distance to Pluto	6×10^{12}
Radius of Earth	6×10^{6}
Height of Mt. Everest	9×10^{3}
Thickness of this page	1×10^{-4}
Length of a typical virus	1×10^{-8}
Radius of a hydrogen atom	5×10^{-11}
Radius of a proton	1×10^{-15}

It is a bar of Platinum-Iridium kept at a constant temperature.

Physical Measurement Laboratory, US National Institute of Standards and Technology (NIST)



Definition of kilogram

اسطوانة

The kilogram is the mass of prototype cylinder of platinum-iridium alloy preserved at the International Bureau of Weights and Measures, at Sevres, near Paris.

Table 1-5

Some Approximate Masses

Object	Mass in Kilograms
Known universe	1×10^{53}
Our galaxy	2×10^{41}
Sun	2×10^{30}
Moon	7×10^{22}
Asteroid Eros	5×10^{15}
Small mountain	1×10^{12}
Ocean liner	7×10^{7}
Elephant	5×10^{3}
Grape	3×10^{-3}
Speck of dust	7×10^{-10}
Penicillin molecule	5×10^{-17}
Uranium atom	4×10^{-25}
Proton	2×10^{-27}
Electron	9×10^{-31}

Prototype cylinder of platinum-iridium alloy

Definition of second

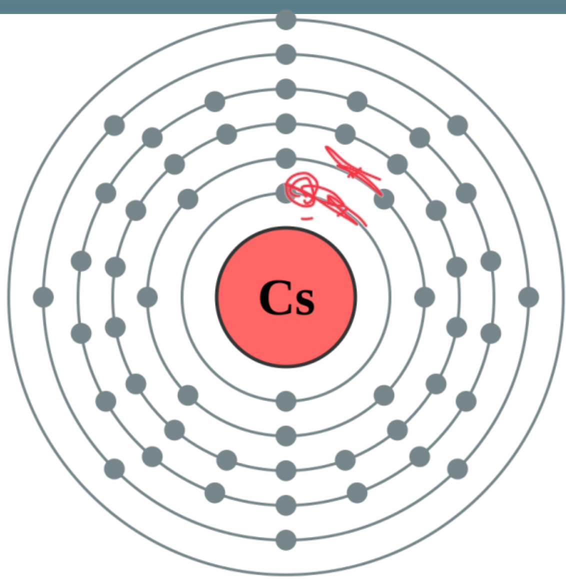
One second is the time taken by 9,19,26,31,770 oscillations of the light emitted by a cesium-133 atom.

Table 1-4

Some Approximate Time Intervals

Measurement	Time Interval in Seconds
Lifetime of the proton (predicted)	3×10^{40}
Age of the universe	5×10^{17}
Age of the pyramid of Cheops	1×10^{11}
Human life expectancy	2×10^{9}
Length of a day	9×10^{4}
Time between human heartbeats	8×10^{-1}
Lifetime of the muon	2×10^{-6}
Shortest lab light pulse	1×10^{-16}
Lifetime of the most unstable particle	1×10^{-23}
The Planck time[a]	1×10^{-43}

[a] This is the earliest time after the big bang at which the laws of physics as we know them can be applied.



The first **caesium** clock was built by Louis Essen in 1955 at the National Physical Laboratory in the UK.

Atomic clocks give very precise time measurements

Dimensions

Table 1.5 Dimensions and Some Units of Area, Volume, Velocity, and Acceleration

System	Area (L^2)	Volume (L^3)	Velocity (L/T)	Acceleration (L/T^2)
SI	m^2	m^3	m/s	m/s^2
cgs	cm^2	cm^3	cm/s	cm/s^2
U.S. customary	ft^2	ft^3	ft/s	ft/s^2

$$[v] = L/T$$

Dimensional Analysis

$[x] = \text{L}$ $[t] = \text{T}$ $[v] = \text{L/T}$ $[a] = \text{L/T}^2$

$$[v] = \frac{\text{L}}{\text{T}}$$

$$[v] = \frac{\text{L}}{\text{T}^2} \cdot \text{T}$$

$$[v] = [a][t]$$

$$[x] = \text{L}$$

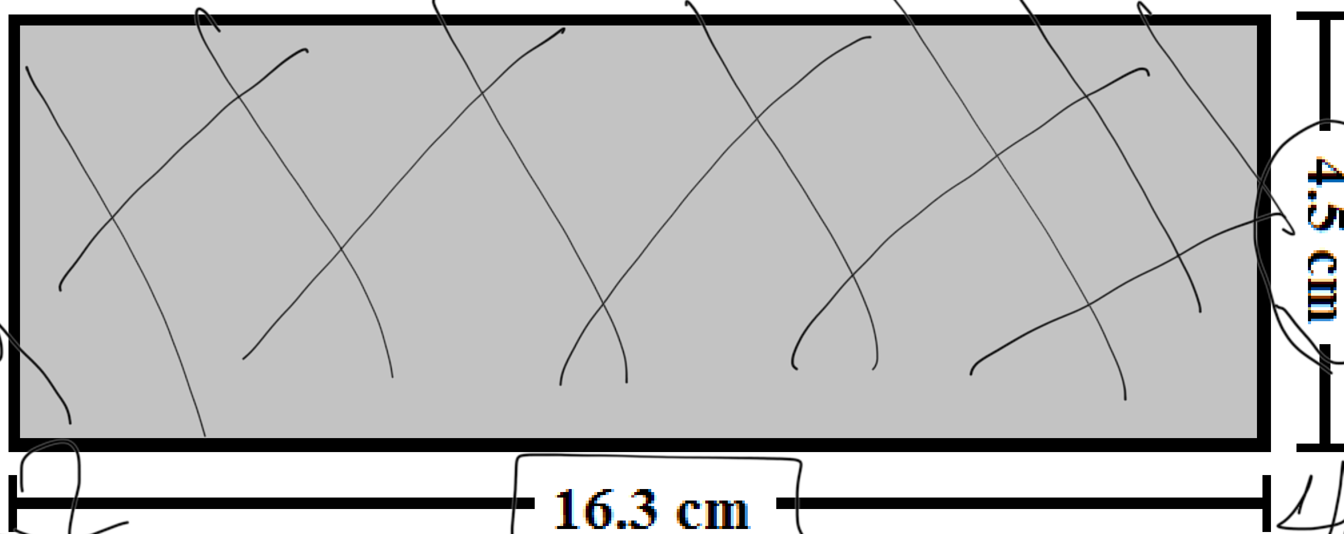
$$[x] = \text{L} \cdot \frac{\text{T}}{\text{T}}$$

$$[x] = \frac{\text{L}}{\text{T}} \cdot \text{T}$$

$$[x] = [v][t]$$

$$[x] = [a][t]^2$$

Uncertainty in Measurement and Significant Figures



$$L = 16.3 \pm 0.1 \text{ cm} \qquad W = 4.5 \pm 0.1 \text{ cm}$$

$$L \times W = (16.3 \text{ cm})(4.5 \text{ cm}) = 73.35 \text{ cm}^2 \rightarrow 73 \text{ cm}^2$$

Rules-Significant figures

- Every non zero number is a significant figure

  Examples: 846 -3 significant figures

- All zeros between two non zero numbers will be significant

  Examples: 704 - 3 significant figures

  5006- 4 significant figures

Rules-Significant figures continues

- Zeros to the right of non zero number will not be significant

 Examples: 500 -1 significant figures

- Zeros to the right of non zero number will be significant if it have decimal point

 Examples: 500. - 3 significant figures

 500.0- 4 significant figures

Rules-Significant figures continues

- Zeros to the left of non zero numbers will not be significant

Examples: 0.075 - 2 significant figures

0.00836- 3 significant figures

Exercises:

1) 0.0050830
2) 7080
3) 30050.
4) 0.00703
5) 0.08060
6) 5030.0
7) 750.064080

Converting units in the SI system

- SI system based on powers of ten
- Each prefix represents a different power of ten

For example unit of memory is Byte

Kilobyte Megabyte Gigabyte Terabyte

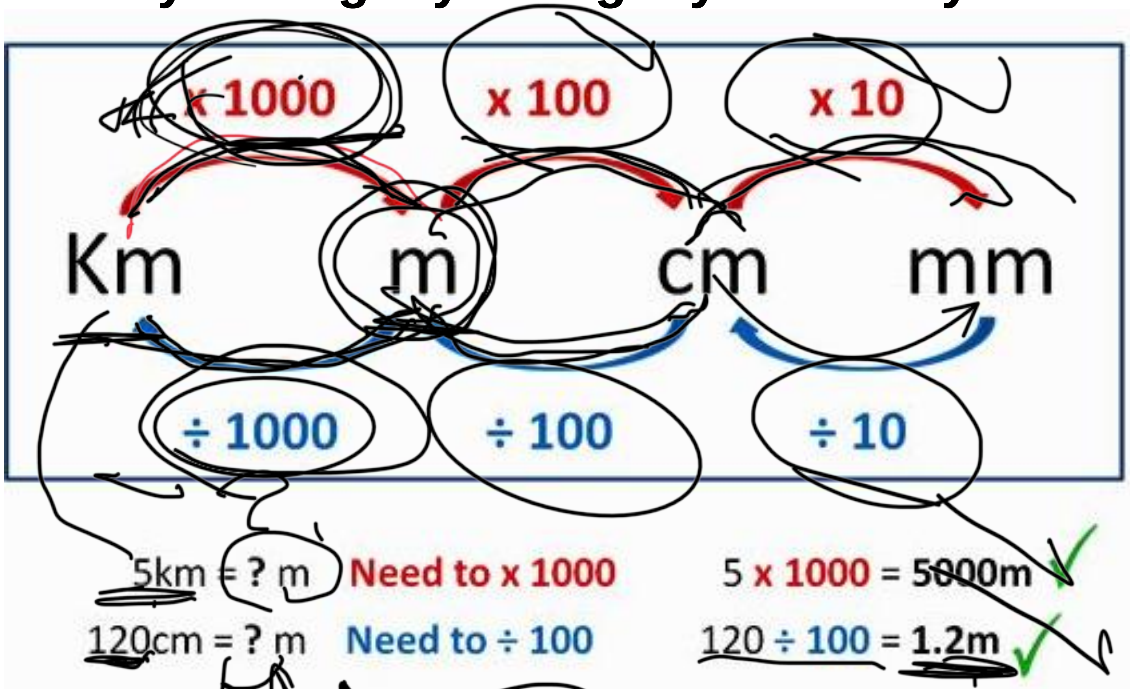
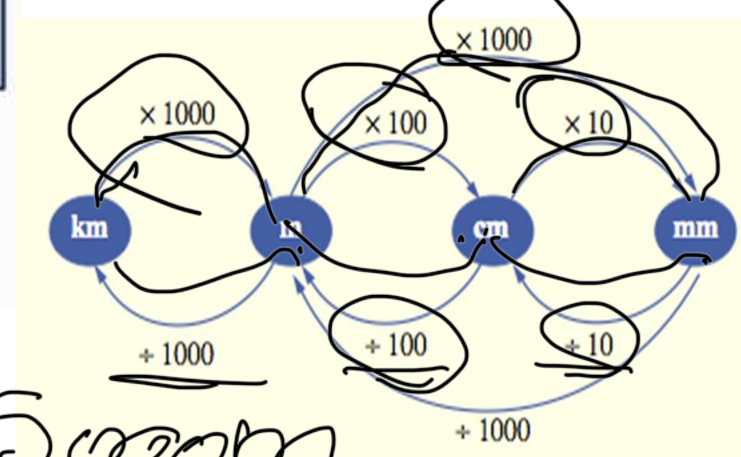


TABLE 1–4 Common Prefixes

Power	Prefix	Abbreviation
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f



Unit Conversions for Physical Quantities

$1\ \text{mi} = 1\,609\ \text{m} = 1.609\ \text{km}$ $\quad$ $1\ \text{ft} = 0.304\,8\ \text{m} = 30.48\ \text{cm}$

$1\ \text{m} = 39.37\ \text{in.} = 3.281\ \text{ft}$ $\quad$ $1\ \text{in.} = 0.025\,4\ \text{m} = 2.54\ \text{cm}$

Convert 15.0 in. to centimeters.

$$1\ \text{in.} = 2.54\ \text{cm} \rightarrow \frac{2.54\ \text{cm}}{1\ \text{in.}}$$

$$15.0\ \text{in.} \times \left(\frac{2.54\ \text{cm}}{1\ \text{in.}}\right) = 38.1\ \text{cm}$$

Examples 1.2

EXAMPLE 1.2 Find an Equation

GOAL Derive an equation by using dimensional analysis.

PROBLEM Find a relationship between a constant acceleration a, speed v, and distance r from the origin for a particle traveling in a circle.

STRATEGY Start with the term having the most dimensionality, a. Find its dimensions, and then rewrite those dimensions in terms of the dimensions of v and r. The dimensions of time will have to be eliminated with v, because that's the only quantity (other than a, itself) in which the dimension of time appears.

SOLUTION

Write down the dimensions of a:

$$[a] = \frac{L}{T^2}$$

Solve the dimensions of speed for T:

$$[v] = \frac{L}{T} \rightarrow T = \frac{L}{[v]}$$

Substitute the expression for T into the equation for $[a]$:

$$[a] = \frac{L}{T^2} = \frac{L}{(L/[v])^2} = \frac{[v]^2}{L}$$

Substitute $L = [r]$, and guess at the equation:

$$[a] = \frac{[v]^2}{[r]} \rightarrow a = \frac{v^2}{r}$$

Examples 1.3

EXAMPLE 1.3 Carpet Calculations

GOAL Apply the rules for significant figures.

PROBLEM Several carpet installers make measurements for carpet installation in the different rooms of a restaurant, reporting their measurements with inconsistent accuracy, as compiled in Table 1.6. Compute the areas for (a) the banquet hall, (b) the meeting room, and (c) the dining room, taking into account significant figures. (d) What total area of carpet is required for these rooms?

Table 1.6 Dimensions of Rooms in Example 1.3

	Length (m)	Width (m)
Banquet hall	14.71	7.46
Meeting room	4.822	5.1
Dining room	13.8	9

area

Area = L × W

Examples 1.3

SOLUTION

(a) Compute the area of the banquet hall.

Count significant figures:

14.71 m → 4 significant figures

7.46 m → 3 significant figures

To find the area, multiply the numbers keeping only three digits:

$14.71 \text{ m} \times 7.46 \text{ m} = 109.74 \text{ m}^2 \rightarrow 1.10 \times 10^2 \text{ m}^2$

(b) Compute the area of the meeting room.

Count significant figures:

4.822 m → 4 significant figures

5.1 m → 2 significant figures

To find the area, multiply the numbers keeping only two digits:

$4.822 \text{ m} \times 5.1 \text{ m} = 24.59 \text{ m}^2 \rightarrow 25 \text{ m}^2$

(c) Compute the area of the dining room.

Count significant figures:

13.8 m → 3 significant figures

9 m → 1 significant figure

To find the area, multiply the numbers keeping only one digit:

$13.8 \text{ m} \times 9 \text{ m} = 124.2 \text{ m}^2 \rightarrow 100 \text{ m}^2$

Area = L × W

(d) Calculate the total area of carpet required, with the proper number of significant figures.

Sum all three answers without regard to significant figures:

$$1.10 \times 10^2\ m^2 + 25\ m^2 + 100\ m^2 = 235\ m^2$$

The least accurate number is 100 m^2, with one significant figure in the hundred's decimal place:

$$235\ m^2 \rightarrow 2 \times 10^2\ m^2$$

200

235

300

200

2 × 10

$1 \text{ mi} = 1\,609 \text{ m} = 1.609 \text{ km}$

$1 \text{ m} = 39.37 \text{ in.} = 3.281 \text{ ft}$

$1 \text{ ft} = 0.304\,8 \text{ m} = 30.48 \text{ cm}$

$1 \text{ in.} = 0.025\,4 \text{ m} = 2.54 \text{ cm}$

EXAMPLE 1.4 Pull Over, Buddy!

GOAL Convert units using several conversion factors.

PROBLEM If a car is traveling at a speed of 28.0 m/s, is the driver exceeding the speed limit of 55.0 mi/h?

STRATEGY Meters must be converted to miles and seconds to hours, using the conversion factors listed on the front endsheets of the book. Here, three factors will be used.

SOLUTION

Convert meters to miles:

$$28.0 \text{ m/s} = \left(28.0 \frac{\text{m}}{\text{s}}\right)\left(\frac{1.00 \text{ mi}}{1\,609 \text{ m}}\right) = 1.74 \times 10^{-2} \text{ mi/s}$$

Convert seconds to hours:

$$1.74 \times 10^{-2} \text{ mi/s} = \left(1.74 \times 10^{-2} \frac{\text{mi}}{\text{s}}\right)\left(60.0 \frac{\text{s}}{\text{min}}\right)\left(60.0 \frac{\text{min}}{\text{h}}\right)$$

$$= 62.6 \text{ mi/h}$$

EXAMPLE 1.5 Press the Pedal to the Metal

GOAL Convert a quantity featuring powers of a unit.

PROBLEM The traffic light turns green, and the driver of a high-performance car slams the accelerator to the floor. The accelerometer registers 22.0 m/s². Convert this reading to km/min².

STRATEGY Here we need one factor to convert meters to kilometers and another two factors to convert seconds squared to minutes squared.

SOLUTION

Multiply by the three factors:

$$\frac{22.0\ \text{m}}{1.00\ \text{s}^2}\left(\frac{1.00\ \text{km}}{1.00\times 10^3\ \text{m}}\right)\left(\frac{60.0\ \text{s}}{1.00\ \text{min}}\right)^2 = 79.2\ \frac{\text{km}}{\text{min}^2}$$

3 How many m/s are there in 1.0 mi/h?

H.W

23 A 2.00 m × 3.00 m plate of aluminium has a mass of 324 kg. What is the thickness of the plate? (The density of aluminium is 2.70×10^3 kg/m^3.)