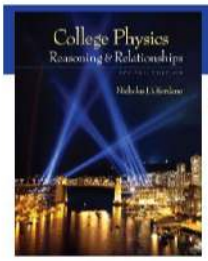
Ph002-week 1,2

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Nicholas J. Giordano

www.cengage.com/physics/giordano

Chapter 1

Introduction

Significant Figures and Scientific Notation

Foundation Physics 002

Grades:

- Classwork 5%, Quizzes 25% , Project 10%
- Midterm 20%
- Final Exam 40%
- Total 100%

Assessments

- Students will have 6 Quizzes during the semester.
- Lowest 2 Quizzes will be dropped.
- A project will be assigned before the end of the course to be done in class.
- Graded unannounced class tasks and activities will be assigned throughout the semester.

Week 1 & 2

Dealing with numbers:

- Physical Quantities
- Units of Measurement
- Prefixes
- Rounding Numbers
- Dimensional Analysis
- Scientific Notation
- Significant Figures

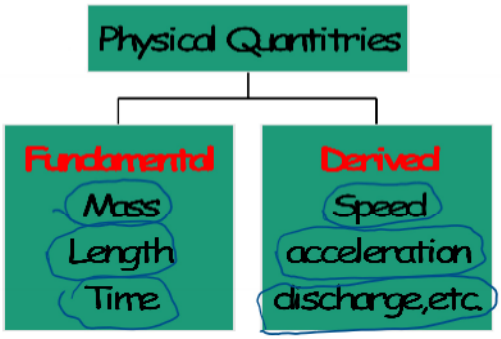
Physical quantities

Fundamental physical quantities: Those physical quantities which are independent to each other (mass, length, time, temperature).

Derived quantities: Physical quantities depend on fundamental ones (velocity, force...).

Units: A definite amount of a physical quantity is taken as its standard unit (Ex: Mass of two objects 10Kg and 10 gram).

Physical Quantities



Physical Quantities
Units of Measurement

- Measurements involve NUMBER and UNIT ~ 5 kg
- Represent a quantity has magnitude, size, or amount 3 m
- Gram = unit of measurement
- Mass = quantity

Units of Measurement

- Scientists around the world agree on one system…
  - International System of Units
    (le Systeme International d'Unites)
  - SI units
  - Built from seven base units

Physical Quantities and Units of Measure

- Units of Measure
- When conducting experiments, you must be able to
- measure various physical quantities
- Will often deal with units of
- Length
- Time
- Mass
- Will use SI system
- Include prefixes and powers of 10

Standards of Units

International standards of units (SI system) .

Quantity	Unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Amount of Substance	mole	mol
Luminous Intensity	candela	cd
Electric Current	ampere	A

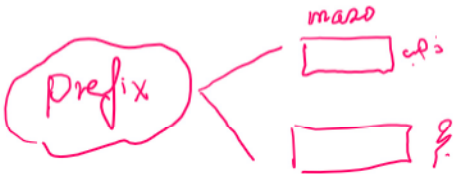
Derived quantities

Examples of derived quantities.

Quantity	Unit	Symbol
Volume الحجم	cubic meter	m^3
Density الكثافة	kilograms per cubic meter	kg/m^3
Speed السرعة	meter per second	m/s
Force القوة	Newton $(kg\ m/s^2)$	N newton
Energy الطاقة	Joule $(kg\ m^2/s^2)$	J joule

Units of Measurement

- Metric Prefixes – make units easier to use
- Make the unit smaller or larger
- Unit = prefix + base unit



Dealing with numbers

Prefixes

Name	Symbol	Factor
tera-	T	10^{12}
giga-	G	10^{9}
mega-	M	10^{6}
kilo-	k	10^{3}
hecto-	h	10^{2}
deka-	da	10^{1}

Name	Symbol	Factor
deci-	d	10^{-1}
centi-	c	10^{-2}
milli-	m	10^{-3}
micro-	μ	10^{-6}
nano-	n	10^{-9}
pico-	p	10^{-12}
femto-	f	10^{-15}

Different standards of units

Quantity	SI units	French system (CGS)	British system (FPS)
Length	m	cm	Feet (ft)
Mass	Kg	gram (gm)	Pound (lb)
Time	s	s	s
Temperature	Kelvin (K)	Celsius (°C)	Fahrenheit (°F)

Conversions:

1 gm=10^{-3} Kg, 1 Kg = 10^{3} gm, 1 lb=0.455 Kg.

1 cm=10^{-2} m, 1 m = 10^{2} cm, 1 ft=0.3054 m.

Temperature units' conversion:

$t_F = 1.8\, t_C + 32$, $t_K = t_C + 273$

More conversions: 1 inch (in.)=2.54 cm, 1 mile=1.6km, 1 min.=60s.

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$T_C = 20^\circ$

$T_K = T_C + 273$

$T_K = 20 + 273 = 293^\circ K$

$T_f = 1.8\, T_C + 32$

$T_f = 1.8(20) + 32 = 68^\circ F$

Unit Conversion Using Conversion Factors

Example:

How many cm are in 1.32 meters?

applicable conversion factors:

$$\frac{1\text{ m}}{100\text{ cm}} \quad \text{or} \quad \frac{100\text{ cm}}{1\text{ m}}$$

$$X\text{ cm} = 1.32\text{ m}\left(\frac{100\text{ cm}}{1\text{ m}}\right) = 132\text{ cm}$$

We use the idea of **unit cancellation** to decide upon which one of the two conversion factors we choose.

1 Cm = 10^{-2} m

$1.32\text{ m} \times \frac{1\text{ Cm}}{10^{-2}\text{ m}}$

$= 132\text{ Cm}$

Unit Conversion Using Conversion Factors

Example:

How many seconds in 1 year ?. Express your answer in scientific notation.

1 year = 1 × 365 day = 1 × 365 day × 24 (hours/day) × 60 (minutes/hour) × 60 (seconds/minute) =

31,536,000 s.

in scientific notation

31,536,000 s = 3.1536×10^{7} s

15

1 year = 365 days

1 day = 24 hours

1 hour = 60 min

1 min = 60 sec

Example: How many meters is 8.72 cm?

applicable conversion factors:

$$\frac{1\text{ m}}{100\text{ cm}} \quad \text{or} \quad \frac{100\text{ cm}}{1\text{ m}}$$

$$X\text{ m} = 8.72\text{ cm}\left(\frac{1\text{ m}}{100\text{ cm}}\right) = \boxed{0.0872\text{ m}}$$

Again, the units must cancel.

$1\text{ cm} = 10^{-2}\text{ m}$

$8.72\text{ cm} \times \frac{10^{-2}\text{ m}}{1\text{ cm}}$

$= 0.0872\text{ m}$

Converting between different systems of units

- Useful Conversion factors:
  - 1 inch = 2.54 cm
  - 1 m = 3.28 ft
  - 1 mile = 5280 ft
  - 1 mile = 1.61 km
- Example: convert miles per hour to meters per second:

$$1\frac{\text{mi}}{\text{hr}} = 1\frac{\text{mi}}{\text{hr}} \times 5280\frac{\text{ft}}{\text{mi}} \times \frac{1\text{ m}}{3.28\text{ ft}} \times \frac{1\text{ hr}}{3600\text{ s}} = 0.447\frac{\text{m}}{\text{s}}$$

$1\ \frac{\text{mile}}{\text{hour}} = \frac{5280\text{ ft}}{1\text{ mile}} \times \frac{1\text{ m}}{3.28\text{ ft}} \times \frac{1\text{ hour}}{60\text{ min}} \times \frac{1\text{ min}}{60\text{ sec}}$

$\frac{5280}{3.28 \times 60 \times 60} = 0.447\ \text{m/s}$

Example: How many feet is 39.37 inches?



equality: 1 ft = 12 in

applicable conversion factors:

$$\frac{1\text{ ft}}{12\text{ in}} \quad \text{or} \quad \frac{12\text{ in}}{1\text{ ft}}$$

$$X\text{ ft} = 39.37\text{ in}\left(\frac{1\text{ ft}}{12\text{ in}}\right) = \boxed{3.28\text{ ft}}$$

Again, the units must cancel.

in → cm → m → ft

$39.37\text{ in} \times \frac{2.54\text{ cm}}{1\text{ in}} \times \frac{10^{-2}\text{ m}}{1\text{ cm}} \times \frac{3.28\text{ ft}}{1\text{ m}}$

$39.37 \times 2.54 \times 10^{-2} \times 3.28$

$= 3.28\text{ ft}$

Example Convert 41.2 cm^2 to m^2.

$$X\ m^2 = 41.2\ cm^2 \left(\frac{1\ m}{100\ cm}\right) = 0.412\ m^2$$ WRONG!

$$= 0.412\ cm \cdot m$$

Recall that… $41.2\ cm^2 = 41.2\ cm \cdot cm$

$$X\ m^2 = 41.2\ cm \cdot cm \left(\frac{1\ m}{100\ cm}\right)\left(\frac{1\ m}{100\ cm}\right)$$

$$= \boxed{0.00412\ m^2}$$

$$X\ m^2 = 41.2\ cm^2 \left(\frac{1\ m}{100\ cm}\right)^2 = \boxed{0.00412\ m^2}$$

$41.2\ cm^2 \times \frac{(10^{-2})^2\ m^2}{1\ cm^2}$

$41.2 \times (10^{-2})^2 = 0.00412\ m^2$

Examples

- **Convert the following to SI system**

(a) Acceleration 5 cm/s^2 m/s^2

$$5\ cm/s^2 = 5 \times 10^{-2}\ m/s^2$$

(b) Temperature 20 °C

$$t_K = t_C + 273$$

$$t_K = 20 + 273 = 293\ K$$

(c) Power of 25 gm. cm^2/s^3

$$25\ gm.\ cm^2/s^3 = 25 \times (10^{-3}\ kg) \times (10^{-2}\ m)^2\ /\ s^3 =$$

$$= 25 \times 10^{-7}\ kg\ m^2/s^3 = 2.5 \times 10^{-6}\ kg\ m^2/s^3$$

20

$5\ \frac{cm}{s^2} \times \frac{10^{-2}\ m}{1\ cm} = 0.005\ m/s^2$

Rounding numbers

Round the following numbers to three significant figures

(a) 0.12725

Less than 5 ? Yes … 7 as it is

(b) 0.12756

5 or greater ? Yes… 7 becomes 8

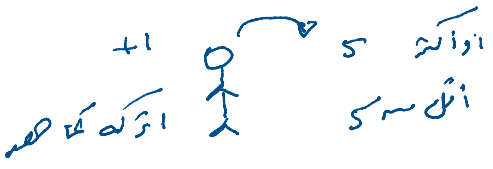
Solution

(a) 0.12725 ≈ 0.127

(b) 0.12756 ≈ 0.128

+1

21



Dealing with numbers

Significant Figures

- You can easily read the temperature on this thermometer to the nearest degree.
- You can also estimate the temperature to about the nearest tenth of a degree by noting the closeness of the liquid inside to the calibrations.
- Suppose you estimate that the temperature lies between 22°C and 23°C, at 22.9°C.



Dealing with numbers

Significant Figures

- This estimated number, 22.9° C, has three digits.
  - The first two digits (20 and 2) are known with certainty, while the rightmost digit (9) has been estimated and involves some uncertainty.
- These reported digits all convey useful information and are called significant figures.



Dealing with numbers

Significant Figures

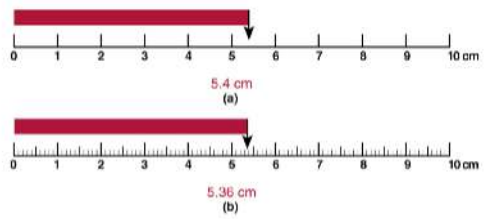
- The **significant figures** in a measurement include all of the digits that are **known**, plus a last digit that is **estimated**.

Measurements must always be reported to the correct number of significant figures because calculated answers cannot be more precise than measured data.

Significant Figures and Scientific Notation

- The measuring device determines the number of significant figures a measurement has.
- Significant figures reflect the accuracy of a result or measurement.
- We need:
  - to determine the correct number of significant figures (sig figs) to record in a measurement
  - to count the number of sig figs in a recorded value
  - to determine the number of sig figs that should be retained in a calculation.

Significant Figures
Figure TA 1.2



Significant figures - all digits in a number representing data or results that are known with certainty plus one uncertain digit.

Rules of Significant Figures

•Any digit that is not zero is significant

1.234 kg 4 significant figures

•Zeros between nonzero digits are significant

606 m 3 significant figures

•Zeros to the left of the first nonzero digit are **not** significant

0.08 L 1 significant figure

•If a number is greater than 1, then all zeros to the right of the decimal point are significant

2.0 mg 2 significant figures

•If whole numbers have zeros to the right with NO DECIMAL, then all zeros to the right are NOT significant

560 mg 2 significant figures

•If a number is less than 1, then only the zeros that are at the end and in the middle of the number are significant

0.00420 g 3 significant figures

Examples on Significant Figures

How many significant figures are in the following?

3.400	4 sig figs
3004	4 sig figs
300.	3 sig figs
0.003040	4 sig figs



How many significant figures are in each of the following measurements?

24 mL	2 significant figures
3001 g	4 significant figures
0.0320 m^3	3 significant figures
6.4 x 10^4 molecules	2 significant figures
560 kg	2 significant figures



1.8

Examples on Significant Figures

Determine the number of significant figures for the following

2130	=	2.13×10^3	(3)
0.00075	=	7.5×10^{-4}	(2)
9800000	=	9.8×10^6	(2)
0.0000000567	=	5.67×10^{-8}	(3)

30

0.00×10^{0}

2130

2.13×10^{3}

0.00075

$= 7.5 \times 10^{-4}$

Scientific Notation

Scientists are Lazy!!!



They decided that by using powers of 10, they can create short versions of long numbers.

Rules for Scientific Notation

To be in proper scientific notation the number must be written with

* a number between 1 and 10
* and multiplied by a power of ten

23×10^5 is not in proper scientific notation. Why?

Soooo

137,000,000 can be rewritten as

$$1.37 \times 10^8$$

Now You Try!

Using scientific notation, rewrite the following numbers.

347,000
3.47×10^5
902,000,000
9.02×10^8
61,400
6.14×10^4

Convert these:

1.23×10^{-5}
.0000123
6.806×10^{-6}
.000006806

1.23×10^{-5}

0.00001 23

0.000006 806×10^{-6}

Try These

4,000
4×10^3
2.48×10^3
2,480
6.123×10^6
6,123,000
306,000,000
3.06×10^8

2.48×10^3

$= 2.480$

$= 2480$

Why does a Negative Exponent give us a small number?

$10000 = 10 \times 10 \times 10 \times 10 = 10^4$

$1000 = 10 \times 10 \times 10 = 10^3$

$100 = 10 \times 10 = 10^2$

$10 = 10^1$

$1 = 10^0$

Do you see a pattern?

Sooooo

$\frac{1}{10} = \frac{1}{10^1} = 10^{-1}$

$\frac{1}{100} = \frac{1}{10^2} = 10^{-2}$

$\frac{1}{1000} = \frac{1}{10^3} = 10^{-3}$

$\frac{1}{10000} = \frac{1}{10^4} = 10^{-4}$

Your Turn

Using Scientific Notation, rewrite the following numbers.

0.000882

8.82×10^{-4}

0.00000059

5.9×10^{-7}

0.00004

4×10^{-5}

0.000882 → 8.82×10^{-4}

0.00000059 → 5.9×10^{-7}

0.00004 → 4×10^{-5}

More Examples

1) 0.0004
   4×10^{-4}
2) 1.248×10^{-6}
   .000001248

More Examples

1) 0.0004
   4 X 10^{-4}
2) 1.248 X 10^{-6}
   .000001248
3) 6.123 X 10^{-5}
   .00006123
4) 0.00000306
   3.06 X 10^{-6}
5) 0.000892
   8.92 X 10^{-4}

0.00005

4×10^{-5}

The nucleus of a human cell is about 7 X 10^{-6} meters in diameter. What is the length in standard notation?

.000007



Practice Questions

Perform each of the following conversions:

a. 0.030 m to millimeters — $0.03\ m \times \frac{1\ mi}{10^{-3}\ m} = 0.00003$

b. 8.43 cm to millimeters — $8.43\ cm \times \frac{10^{-2}\ m}{1\ cm} \times \frac{1\ mi}{10^{-3}\ m} = 84.3$

c. 2.41 x 10^2 cm to meters — H.W

d. 294.5 nm to centimeters — H.W

e. 5.00 g to kilograms — $5g \times \frac{1\ kg}{10^3\ g} = 0.005$

f. ~~33.4 L to milliliters~~

g. ~~600.00 L to deciliters~~

h. 1.445 x 10^4 m to kilometers — $1.445 \times 10^4\ m \times \frac{1\ km}{10^3\ m} = 14.45\ km$

i. 235.3 m to millimeters — H.W

j. 3.45 ng to decigram — n → m → dg H.W

k. 903.3 nm to micrometers — n → m → μ

l. Convert 3°C to K. — $T_K = 3 + 273 = 276°K$

m. Convert 280 K to °C — $T_C = 280 - 273 = 7°C$

Write each number in scientific notation:

a. 0.000000786 — 7.86×10^{-8}

b. 394 — 3.94×10^{2}

c. 47 — 4.7×10^{1}

Write each number in scientific notation:

a. 0.000000786 7.86×10^{-8}
b. 394 3.94×10^{2}
c. 4.7 4.7×10^{0}
d. 1260000 1.26×10^{6}
e. 0.06 6×10^{-2}
f. 175 1.75×10^{2}
g. 0.000006 6×10^{-6}
h. 5400000 5.4×10^{6}
i. 60 6×10^{1}
j. 0.009 9×10^{-3}
k. 6.7 6.7×10^{0}
l. 0.0000002 2×10^{-7}
m. 2000000 2×10^{6}
n. 71×10^{3} $7.1 \times 10^{1} \times 10^{3} = 7.1 \times 10^{4}$
o. 48900 4.89×10^{4}
p. 0.00000009 9×10^{-7}
q. 0.63×10^{1} $6.3 \times 10^{-1} \times 10^{1} = 6.3 \times 10^{0}$
r. 33×10^{-3} $3.3 \times 10^{1} \times 10^{-3} = 3.3 \times 10^{-2}$
s. 0.000216 H.W
t. 0.0042 H.W
u. 0.15×10^{-2} H.W
v. 4.8 H.W

. Write each number in standard notation:

a. 6.17×10^{1} → 6.17
b. 7×10^{4} → 70000 = 70000
c. 7.31×10^{6} H.W
d. 5.4×10^{-8} H.W
e. 6.7×10^{-3} 0.006 7 = 0.0067
f. 9.59×10^{2} H.W
g. 0.9×10^{-1} H.W
h. 2×10^{-1} H.W
i. 2×10^{5} H.W
j. 804×10^{2} 80400 = 80400
k. 2.66×10^{4}
l. 1.5×10^{-2}
m. 7.75×10^{-1}
n. 8.3×10^{7} H.W
o. 9.5×10^{3}
p. 1.71×10^{7}
q. 0.9×10^{-3}
r. 38×10^{2}
s. 7.5×10^{-5}
t. 3×10^{0}
u. 8.4×10^{5}
v. 4×10^{-5}

Round off each of the following numbers to the indicated number of significant digits and write the answer in standard scientific notation.

a. 86 to one significant figure 90 = 9×10^{1}
b. 328 to one significant figure 300 = 3×10^{2}
c. 693 to one significant figure H.W
d. 1823 to one significant figure H.W
e. 8443 to one significant figure H.W
f. 8.63 to one significant figure 6.0×10^{0}
g. 0.34 to one significant figure 0.3 = 3×10^{-1}
h. 0.065 to one significant figure 0.1 = 1×10^{-1}
i. 75089 to one significant figure
j. 62745 to one significant figure

Round off each of the following numbers to the indicated number of significant digits and write the answer in standard scientific notation.

a. 714 to two significant figures 710 = 7.1×10^{2}
b. 3152 to two significant figures H.W
c. 8709 to two significant figures H.W
d. 5.683 to two significant figures 5.7×10^{0}

e. 8.448 to two significant figures H.W
f. 0.647 to two significant figures H.W
g. 0.0652 to two significant figures H.W
h. 1.8344 to two significant figures H.W
i. 72835 to two significant figures 73000 = 7.3×10^{4}
j. 29.69 to two significant figures H.W

Round off each of the following numbers to the indicated number of significant digits and write the answer in standard scientific notation.

a. 8237 to three significant figures $8240 = 8.24 \times 10^3$

b. 273.7 to three significant figures

c. 635.2 to three significant figures

d. 5.683 to three significant figures

e. 1.736 to three significant figures

f. 1868 to three significant figures

g. 0.3837 to three significant figures $0.384 = 3.84 \times 10^{-1}$

h. 225.3 to three significant figures

i. 72.835 to three significant figures

j. 49.69 to three significant figures