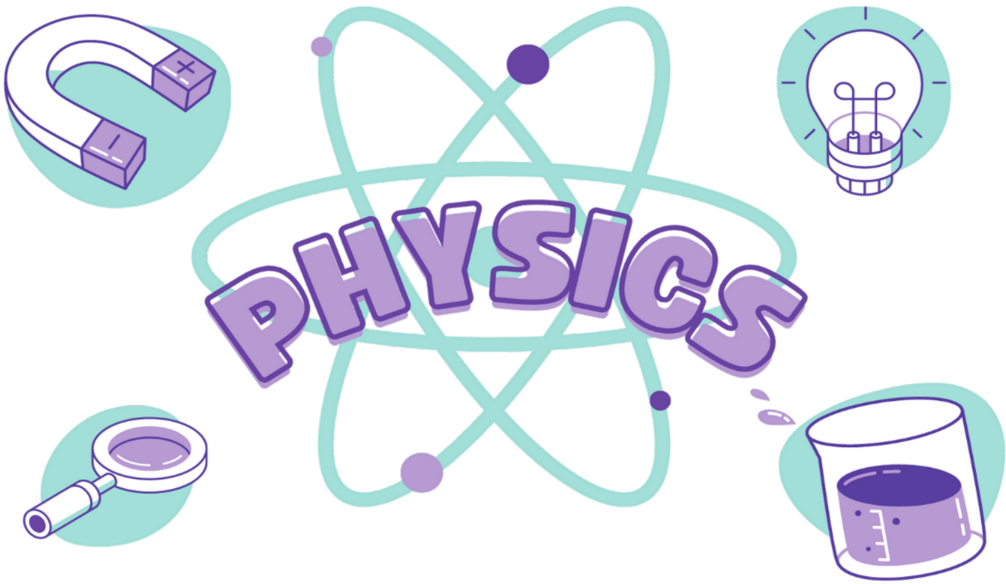
Physics Department

General Physics (PHYS 101)



Updated By: **Dr.Najah Alwadie**

1447 - 2025

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Physics Department

Course Instructor

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Course Objectives

1. To recognize the importance of physics in our daily life.
2. To recognize the importance of the role of physics in science and technology.
3. To develop skills for understanding and interpretation of physical phenomena.
4. To develop working skills for solving different physics problems.

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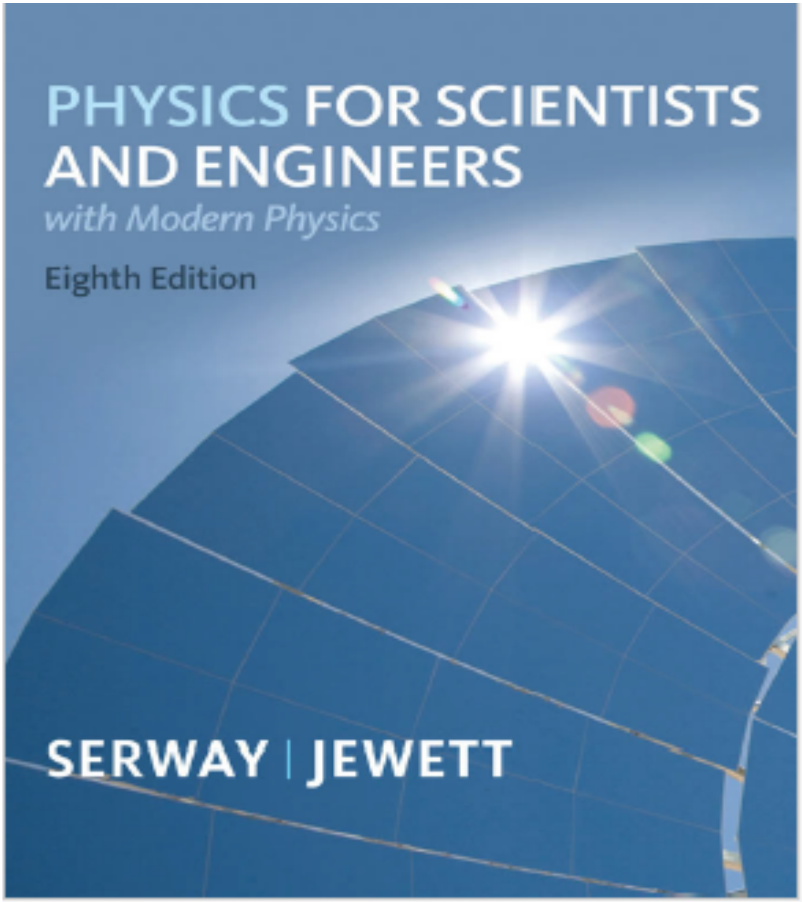
Course Reference

- Physics for Scientist and Engineers (8th edition)

Author: Serway Jewett



Important Notes

Do

- Listen to the lecture
- Raise your hand if you want to ask any question, or just comment.
- Drink water, if you need.
- Turn off or put your mobile to silent.
- Say your word in anything around the lecture.

Don't

- Wander in the class room.
- Interrupt any other speaker.
- Chew gum.
- I Don't want to hear any ringing tones.
- Interrupt the class and come after me.

Course Syllabus

- **Mechanics:**

Physics units and measurements

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Course Assessments

Assessment task	Week due	Proportion of final assessment
Monthly quizzes	5-9-13	30%
Midterm exams	“7+10” week	30%
Final Examination	17	40%

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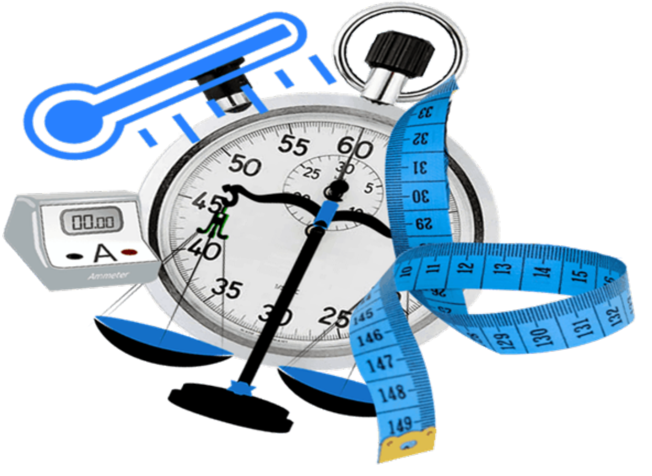
Lecture 1: Introduction



Chapter 1

Updated By: Dr.Najah Alwadie

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Learning Outcomes

In this chapter, you'll learn…

1-The four steps you can use to solve any physics problem.

الكميات الأساسية

2- Three fundamental quantities of physics and the units physicists use to measure them.

الأرقام المهمة

3-How to work with units and significant figures in your calculations.

أطرح

4-How to add and subtract vectors graphically and using vector components.

→ مكونات متجهة　　بيانياً

Solving Problems in Physics

All of the Problem-Solving Strategies and Examples in this book will follow these four steps:

- Identify the relevant concepts, target variables, and known quantities, as stated or implied in the problem.
- Set Up the problem: Choose the equations that you'll use to solve the problem, and draw a sketch of the situation.
- Execute the solution: This is where you "do the math."
- Evaluate your answer: Compare your answer with your estimates, and reconsider things if there's a discrepancy.

Standards of Length, Mass, and Time

The basic laws of physics involve such physical quantities as force, velocity, volume, and acceleration, all of which can be described in terms of more fundamental quantities.

In mechanics, the three most *fundamental (basic) quantities* are **length** (L), **mass** (M), and **time** (T).

All other physical quantities can be *constructed* *(derived)* from these three.

Unit Systems

SI Units

- System International

CGS

- Centimeter-gram-second

BE

- British Engineering system

Basic Units of Measurements in mechanics

Time	Mass	Length	
Second(s)	Kilogram(kg)	Meter(m)	SI units
Second(s)	Gram(g)	Centimeter(cm)	CGS units
Second(s)	slug(sl)	Foot(ft)	BE

Dimensional Analysis

- The dimensional analysis is important in checking the validity of any mathematical expression. To be dimensionally correct, terms on both sides of an equation must have the same dimensions.
- The dimension of any quantity will be defined in brackets [ ].

For example, the dimension of velocity V is [V] = L/T

Dimensional Analysis

- **Example:**

This equation is for the position x of a car at a time t if it starts from rest and moves with constant acceleration a.

The dimensional form of this equation can be written as:

$$x = 1/2\, at^2$$

$$[x] = [at^2]$$

$$L = \frac{L}{T^2} \times T^2 = L$$

Dimensional Analysis

Problem:

Show that the expression v = v0 + at , is *dimensionally correct* , where v and v0 represent velocities, a is acceleration , and t is a time interval.

Ans. :

$$[v] = [v_0] = \frac{L}{T}$$

$$[at] = \frac{L}{T^2}(T) = \frac{L}{T}$$

All other quantities can be derived from the basic units.. for example :

TABLE 2–1 The Three Basic Unit Systems

QUANTITY	SI	CGS	BRITISH
Length	meter (m)	centimeter	foot
Time	second (sec)	second	second
Mass	kilogram (kg)	gram	slug

QUANTITY	SI	CGS	BRITISH
Velocity	m/sec	cm/sec	ft/sec
Acceleration	m/sec²	cm/sec²	ft/sec²
Force	newton (kg · m/sec²)	dyne (gm · cm/sec²)	pound (slug · ft/sec²)
Work, energy	joule (N · m)	erg (dyne · cm)	ft · lb
Power	watt (joule/sec)	erg/sec	ft · lb/sec
Torque	N · m	dyne · cm	lb · ft
Pressure	pascal (N/m²)	dyne/cm²	lb/ft²

- [Video Tutor Solution: Example 1.3]

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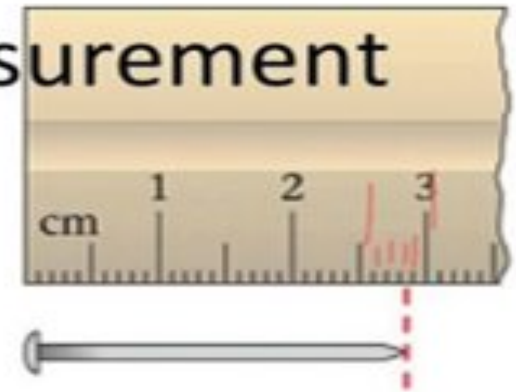
Uncertainty and Significant Figures

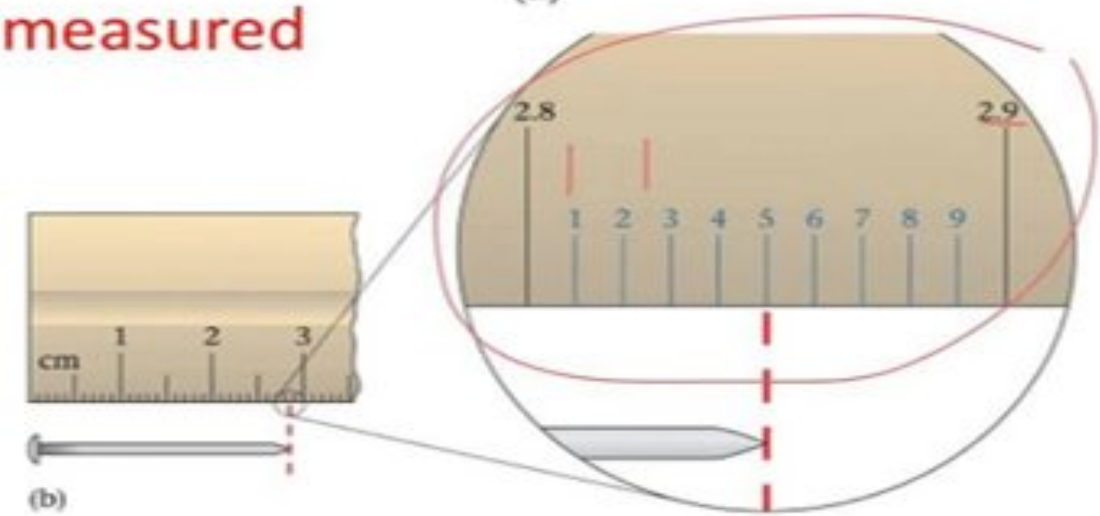
- The uncertainty of a measured quantity is indicated by its number of **significant figures**.
- For multiplication and division, the answer can have no more significant figures than the **smallest** number of significant figures in the factors.
- For addition and subtraction, the number of significant figures is determined by the term having the fewest digits to the right of the decimal point.
- As this train mishap illustrates, even a small percent error can have spectacular results!

Uncertainty in Measurement

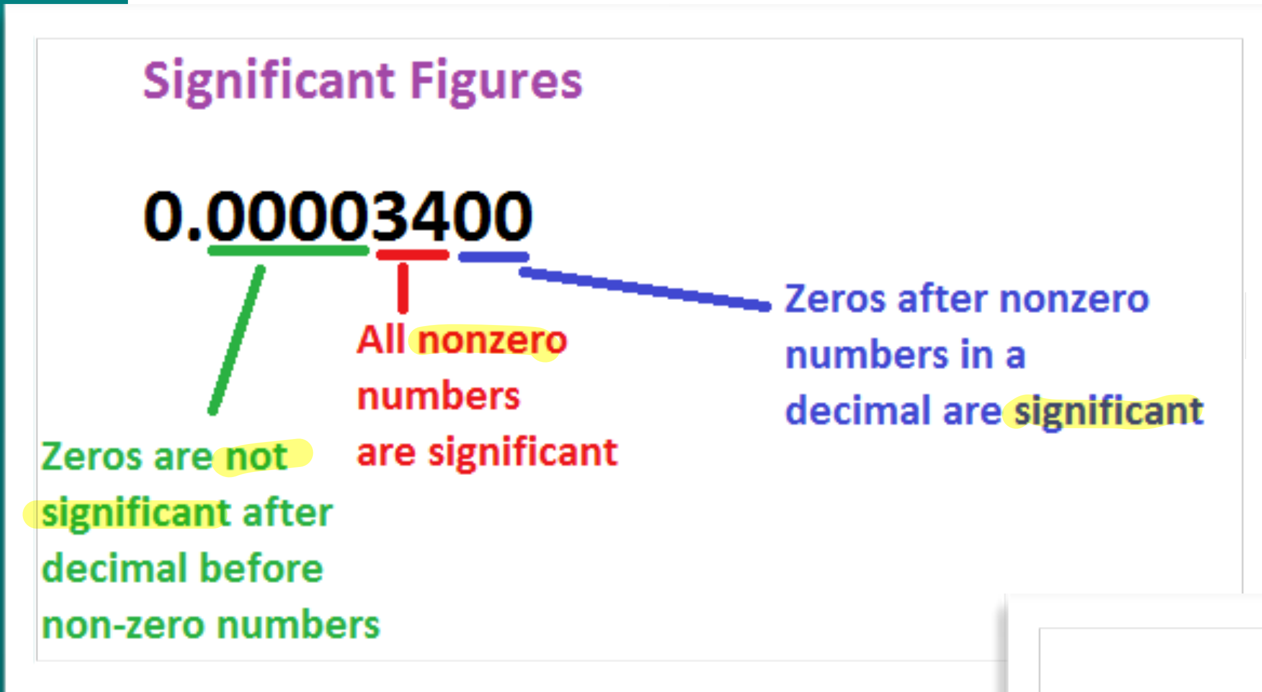
- Significant Figures are used to indicate the precision of a measured number or to express the precision of a calculation with measured numbers.



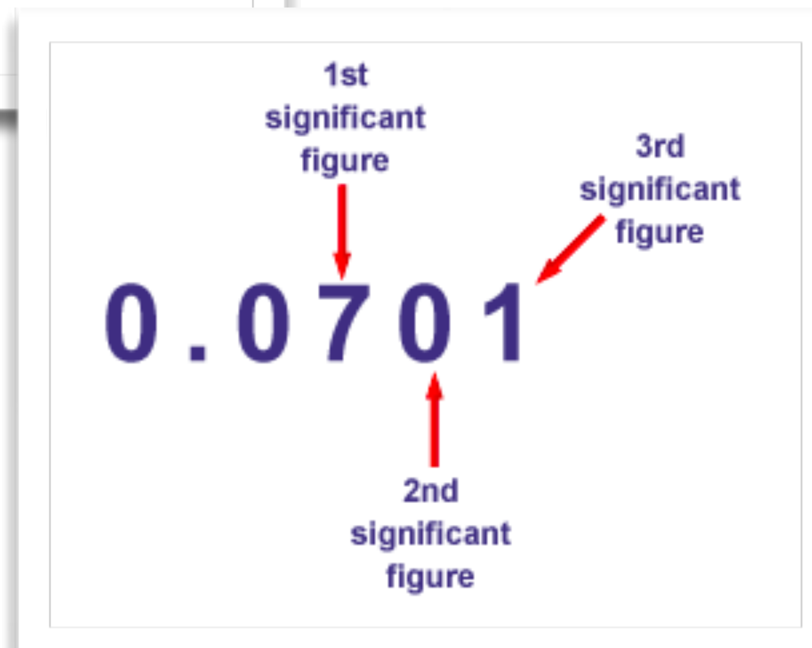
(a)



(b)


Significant Figures
0.00003400
Zeros are not significant after decimal before non-zero numbers
All nonzero numbers are significant
Zeros after nonzero numbers in a decimal are significant

[redacted]


1st significant figure
3rd significant figure
0.0701
2nd significant figure

Trailing zeros are significant **if there is decimal point**.

23.470 ← **5** significant figures

126000. ← **6** sig figs

0.00230 ← **3** sig figs

Numbers into Scientific Notation

1000

The Number is **Greater than 10**, so the **Exponent will be Positive**.

= 1,0,0,0

3 places

Move the Decimal point to the LEFT to create a number between 1 and 10.

= 1.0̸0̸0̸

Remove Zeroes that are not needed.

$= 1 \times 10^3$ or 10^3 ✓

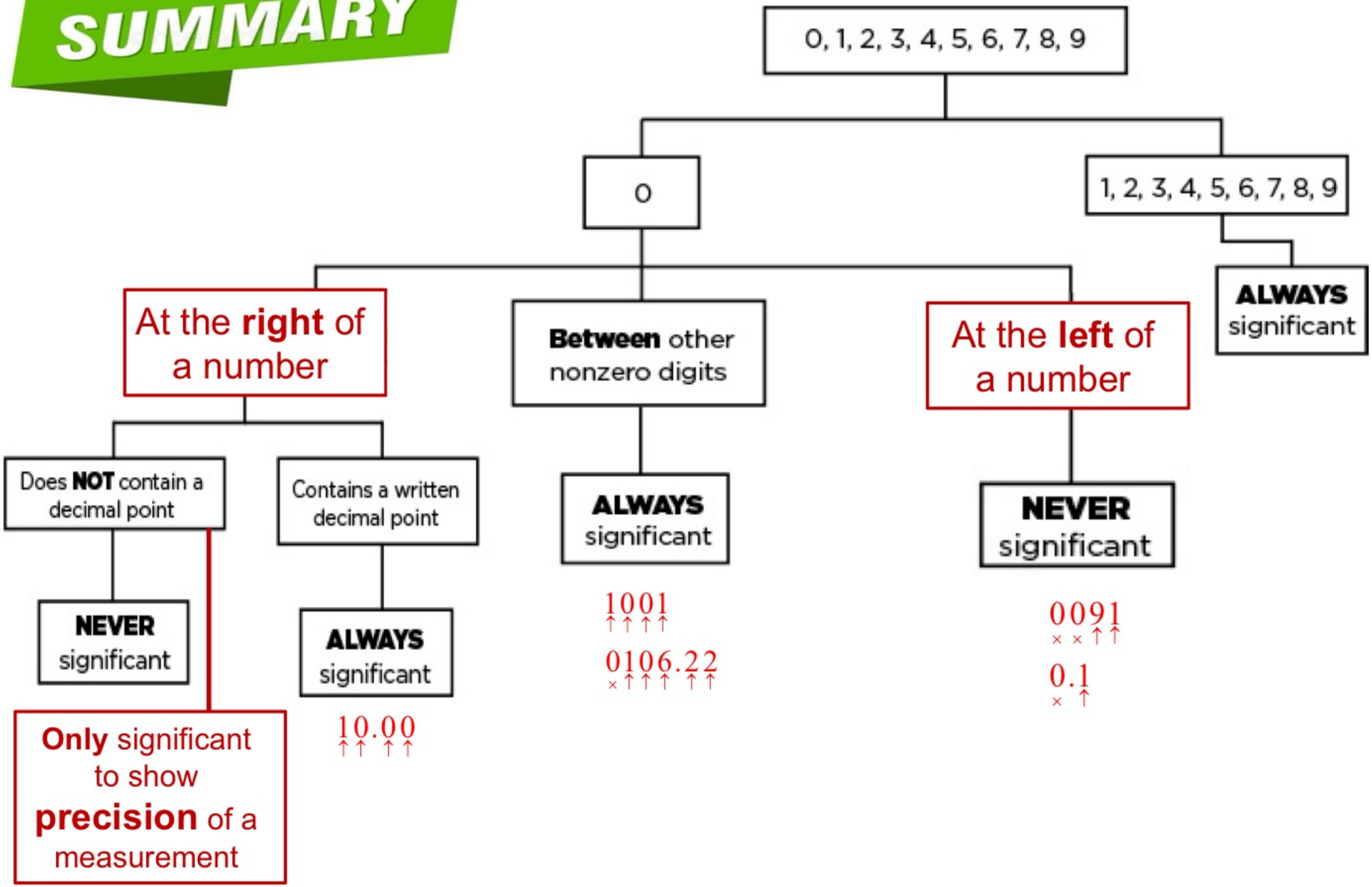
We moved **3 places** so Power of 10 is three : $\mathbf{10^3}$

Rules of Determining Significant Figures

- Any digit that is not zero is significant
  - 4.2183 m : 5 significant figures
- Zeros between nonzero digits are significant
  - 80.0054 lb : 6 significant figures
- Zeros to the left of the first nonzero digit are not significant
  - 0.0000349 g : 3 significant figures
- For numbers contain decimal point; all the trailing zeros count as significant figures
  - 3.400 cm : 4 significant figures
  - 0.0200500 kg : 6 significant figures
- For numbers do not contain decimal point; the trailing zeros may or may not be significant
  - 6800 mi : 4, 3, or 2 significant figures
  - Use scientific notation to avoid this ambiguity.

Henry R. Kang (1/2010)

SUMMARY



0, 1, 2, 3, 4, 5, 6, 7, 8, 9
0
1, 2, 3, 4, 5, 6, 7, 8, 9
ALWAYS significant
At the right of a number
Between other nonzero digits
At the left of a number
Does NOT contain a decimal point
Contains a written decimal point
ALWAYS significant
NEVER significant
NEVER significant
ALWAYS significant
Only significant to show precision of a measurement
1001
0106.22
0091
0.1
10.00

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Question:

Round each number to 3 significant figures

5 لذلك تعطي اللي قبلها وتروح

اعطت اللي قبلها

A)	4055 =	4060
B)	315.3 (3 ما تعطي اللي قبلها لذلك بس تروح) =	315
C)	0.006572	0.00657
D)	1.0880	1.09
E)	6.415×10^{5}	6.42×10^{5}
F)	2.0056	2.01
G)	5.608×10^{-4}	5.61×10^{-4}

- إذا كان العدد الأخير من اليمين 4 أو أقل بيروح بدون ما يأثر على اللي فاليسار
- إذا كان العدد اللي فاليمين يساوي 5 أو أكبر بيعطي اللي قبله من اليسار +1 وبيروح.

The Conversion of Units

وحدة

We can convert any unit from one system to another by using the conversion factors.

معامل التحويل

Table of Conversion

Length

- 1 in. = 2.54 em (exact)
- 1 m = 39.37 in. = 3.281 ft
- 1 ft= 0.304 8m
- 12 in. = 1 ft
- 3 ft= 1 yd
- 1yd = 0.9144m
- 1 km = 0.621 mi
- 1 mi = 1.609 km
- 1 mi = 5 280ft
- 1 *J.Lm*= 10^{-6} m = 10^3 nm
- 1 lightyear = 9.461 x 10^{15} m

Area

- 1 m^2 = 10^4 cm^2 = 10.76 ft^2
- 1 ft^2 = 0.092 9m2 = 144 in.2
- 1 $in.^2$ = 6.452 cm^2

Volume

- 1 m^3 = 10^6 cm^3 = 6.102 x 10^4 $in.^3$
- 1 ft^3 = 1728 $in.^3$ = 2.83 x 10-2 m^3
- 1 L = 1 000 cm^3 = 1.0576 qt = 0.035 3 ft^3
- 1 ft^3 = 7.481 gal = 28.32 L = 2.832 × 10^{-2} m^3
- 1 gal = 3.786 L = 231 in.3

Mass

- 1 000 kg = 1 t (metric ton)
- 1 slug = 14.59 kg
- 1 u = 1.66 × 10^{-27} kg = 931.5 MeV/c^2

Some Approximations Useful for Estimation Problems

- 1 m= 1 yd
- 1 kg= 2lb
- 1 N = $\frac{1}{4}$lb
- 1 L = $\frac{1}{4}$g

Force

- 1 N = 0.224 8lb
- 1lb = 4.448 N

Velocity

- 1 mi/h = 1.47ft/s = 0.447 m/s = 1.61 km/h
- 1 m/s = 100 cm/s = 3.281 ft/s
- 1 mi/min = 60 mi/h = 88ft/s

Acceleration

- 1 m/s^2 = 3.28ft/s^2 = 100 cm/s^2
- 1 ft/s^2 = 0.304 8 m/s^2 = 30.48 cm/s^2

Pressure

- 1 bar = 10^5 N/m^2 = 14.50 lb/$in.^2$
- 1 atm = 760 mm Hg = 76.0 em Hg
- 1 atm = 14.7lb/in.2 = 1.013 x 10^5 N/m2
- 1 Pa = 1 N/m^2 = 1.45 × 10^{-4} lb/$in.^2$

Time

- 1 yr = 365 days = 3.16 × 10^7 s
- 1 day= 24h = 1.44 × 10^3 min = 8.64 × 10^4 s

Energy

- 1J = 0.738ft·lb
- 1 cal = 4.186 J
- 1 Btu = 252 cal = 1.054 × 10^3 J
- 1 eV = 1.6 × 10^{-19} J
- 1 kWh = 3.60 x 10^6 J

Power

- 1 hp = 550ft·lb/s = 0.746kW
- 1 W = 1J/s = 0.738ft·lb/s
- 1 Btu/h = 0.293 W

- 1 m/s = 2mi/h
- 1 yr = π × 10^7 s
- 60 mi/h = 100 ft/s
- 1km = $\frac{1}{2}$mi

SI Prefixes

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Prefix	Symbol	10^n	Decimal
yotta	Y	10^{24}	1,000,000,000,000,000,000,000,000
zetta	Z	10^{21}	1,000,000,000,000,000,000,000
exa	E	10^{18}	1,000,000,000,000,000,000
peta	P	10^{15}	1,000,000,000,000,000
tera	T	10^{12}	1,000,000,000,000
giga	G	10^{9}	1,000,000,000
mega	M	10^{6}	1,000,000
kilo	k	10^{3}	1,000
hecto	h	10^{2}	100
deca	da	10^{1}	10
Base Unit		10^{0}	1
deci	d	10^{-1}	0.1
centi	c	10^{-2}	0.01
milli	m	10^{-3}	0.001
micro	µ	10^{-6}	0.000 001
nano	n	10^{-9}	0.000 000 001
pico	p	10^{-12}	0.000 000 000 001
femto	f	10^{-15}	0.000 000 000 000 001
atto	a	10^{-18}	0.000 000 000 000 000 001
zepto	z	10^{-21}	0.000 000 000 000 000 000 001
yocto	y	10^{-24}	0.000 000 000 000 000 000 000 001

Larger ↑

Smaller ↓

Example -1

Convert 12 inches to centimeters.

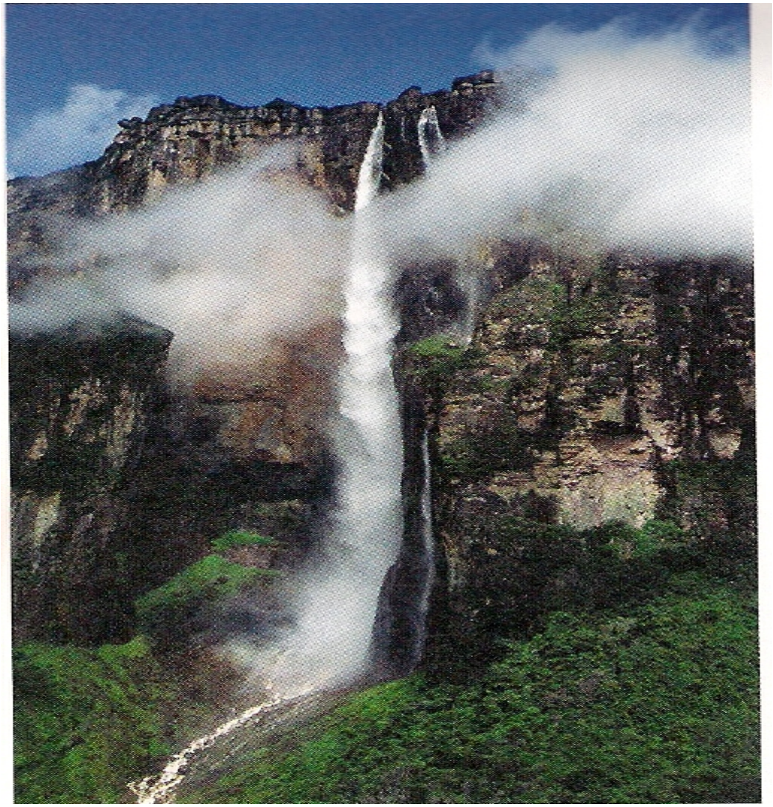
Ans. : From the table: 1 inch = 2.54 cm

12 = x cm

we find that 12 in. = (12 inches) x ($\frac{2.54 \text{ cm}}{1 \text{ inch}}$) = 30.5 cm

Example -2

The highest waterfall in the world is in Venezuela, with a total drop of 979.0 m. Express this drop in feet.



Ans. : From the table: 1 m = 3.281 ft

so Length = 3212 ft.

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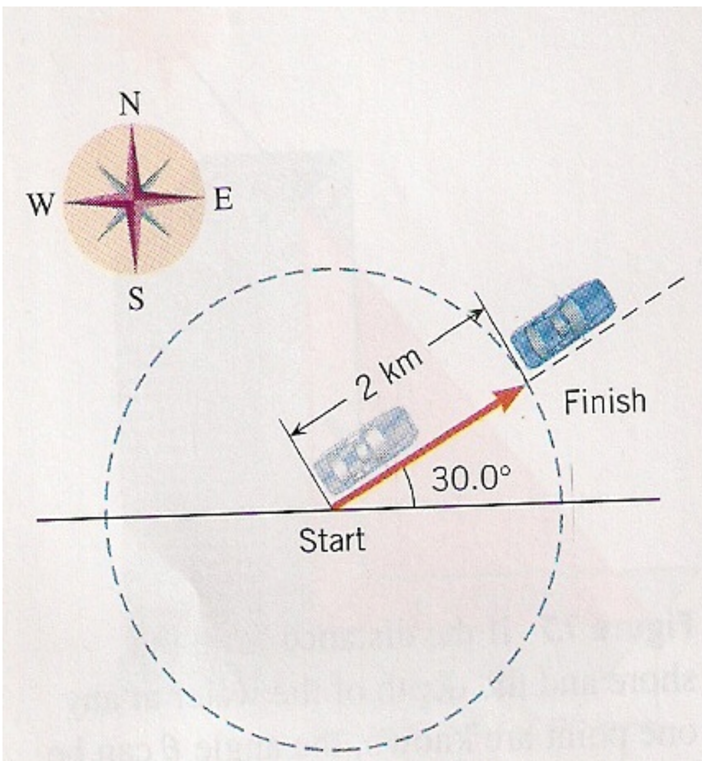
القياسية المتجهة الكمية

Scalar and Vector Quantity



- A scalar quantity is one that can be described with a single number (including any units) giving its size or magnitude.

- A vector quantity is one that deals inherently with both magnitude and direction.

Note:

arrows are used to present the direction of the vector, and the length of the arrow represents the magnitude.

Scalars and Vectors

Glenn Research Center

A **scalar quantity** has only **magnitude.**

A **vector quantity** has both **magnitude** and **direction.**

Scalar Quantities

length, area, volume
speed
mass, density
pressure
temperature
energy, entropy
work, power

Vector Quantities

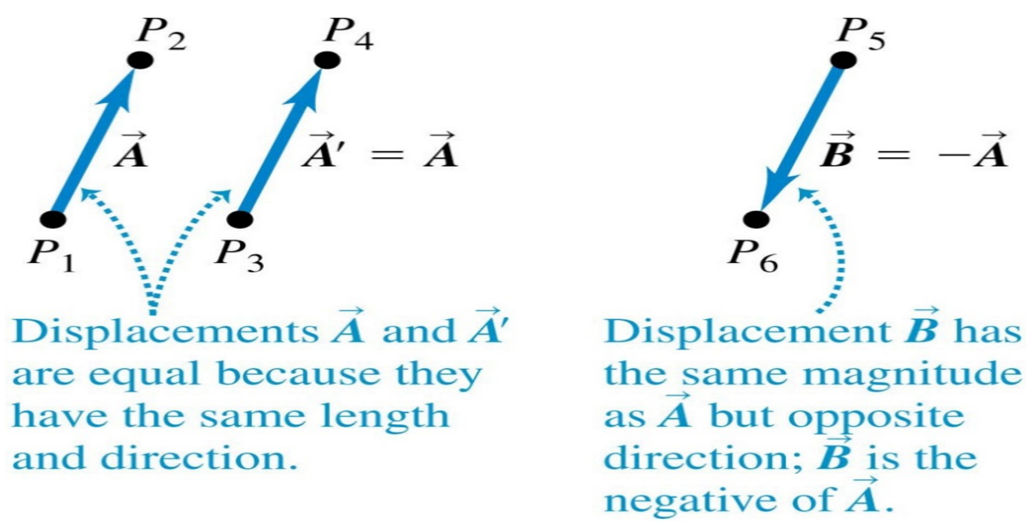
displacement, direction
velocity
acceleration
momentum
force
lift , drag , thrust
weight

Vectors and scalars are used to represent physical situations or phenomena and to make a variety of motion calculations in various fields.

air sea navigation | sports tactics | electronic games | space exploration

Drawing Vectors

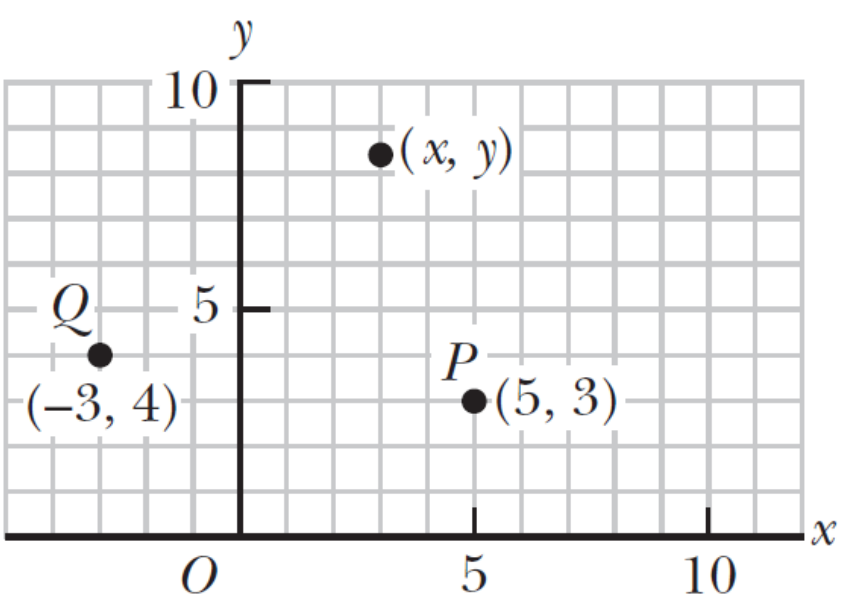
- Draw a vector as a line with an arrowhead at its tip.
- The **length** of the line shows the vector's **magnitude**.
- The **direction** of the line shows the vector's **direction**.



Coordinate Systems and Trigonometry

Many aspects of physics involve a description of a location in space. One of them the Cartesian coordinates, which are also called ***rectangular coordinates***

Fig: Designation of points in a Cartesian coordinate system. Every point is labeled with coordinates (x, y).



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Coordinate Systems and Trigonometry

Sometimes it is more convenient to represent a point in a plane by its *plane polar coordinates* (r, θ) as shown in Active Figure 3.2a. In this *polar coordinate system*, r is the distance from the origin to the point having Cartesian coordinates (x, y) and θ is the angle between a fixed axis and a line drawn from the origin to the point. The fixed axis is often the positive x axis, and θ is usually measured counterclockwise from it. From the right triangle in Active Figure 3.2b, we find that $\sin\theta = y/r$ and that $\cos\theta = x/r$. (A review of trigonometric functions is given in Appendix B.4.) Therefore, starting with the plane polar coordinates of any point, we can obtain the Cartesian coordinates by using the equations

$$x = r\cos\theta \quad (3.1)$$

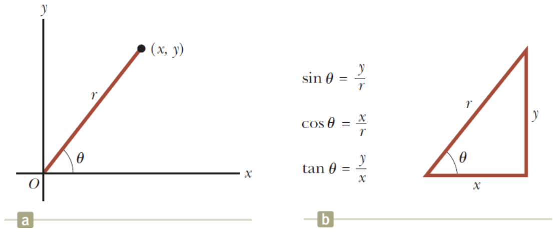
$$y = r\sin\theta \quad (3.2)$$

Furthermore, if we know the Cartesian coordinates, the definitions of trigonometry tell us that

$$\tan\theta = \frac{y}{x} \quad (3.3)$$

$$r = \sqrt{x^2 + y^2} \quad (3.4)$$

Equation 3.4 is the familiar Pythagorean theorem.



Trigonometry

EXAMPLE

$$R = \sqrt{A^2 + B^2}$$
$$= \sqrt{40^2 + 30^2}$$
$$= \sqrt{2500}$$
$$= 50 \text{ m}$$

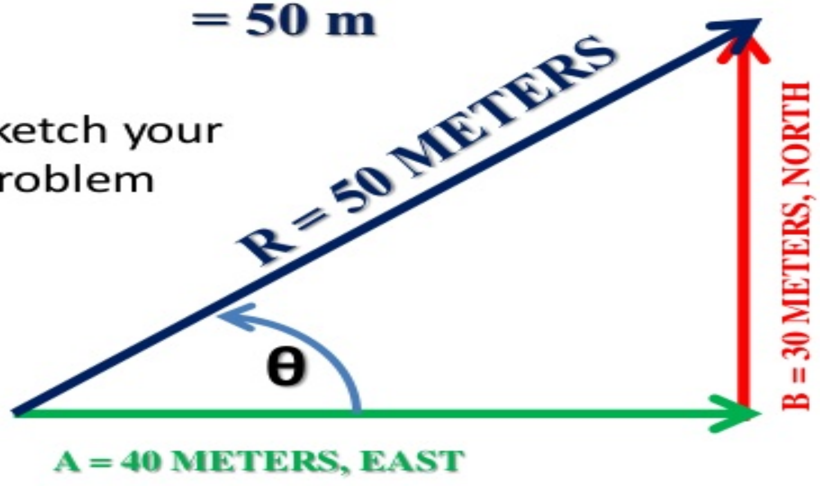
$$\theta = \tan^{-1}\frac{opp}{adj}$$

$$\theta = \tan^{-1}\frac{30}{40}$$

use calculator

$$\theta = 36.87° \ N \ of \ E$$

sketch your problem



Problems & Exercises

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Problem 1 : No.13(page 16) Units

A rectangular building lot has a width of 100.0 ft and a length of 150 ft. Determine the area of this lot in square meters.

Rectangular Area : $100 \times 150 = 15000 \ ft^2$

$1 ft^2 = 0.0929 \ m^2$

$15000 ft^2 = x$

$$x = \frac{15000 \times 0.0929}{1} = 1393.5 \ m^2$$

the Rectangular Area $= 1393.5 \ m^2$

IQ ACADEMY

Problem 3 : No.9 (page 15)

Which of the following equations are dimensionally correct?

A- $V_f = v_i + ax$

B- $Y = (2m)cos(kx)$, where $k = 2m^{-1}$

$v_f = v_i + ax$	$y = (2m)\cos(kx)$, $k = 2m^{-1}$
$v_f = v_i = \frac{L}{T}$	$kx = [L^{-1}].[L] = 1$
$a = \frac{L}{T^2}$, $x = L$	$2m = [L]$, $y = [L]$
$\frac{L}{T} \neq \frac{L^2}{T^2}$	$\cos(kx) =$ dimentionless $[L] = [L] \cdot 1 = [L]$

IQ ACADEMY

Problem 3: **No.32(page 16)**

How many significant figures are in the following numbers ?

A- 78.9±0.2 B- 3.788×10^{9} C- 2.46×10^{-6} D- 0.0053

3 Sig.fig 4 Sig.fig 3 Sig fig 5 Sig.fig

Problem 4 : (Pb 1 pg-67)

(r, θ)

The polar coordinates of a point are r = 5.50 m and θ= 240°.

(x,y)

What are the Cartesian coordinates of this point?

$x = r\cos(\theta) \rightarrow 5.5\cos(240) = -2.75\,m$

$y = r\sin(\theta) \rightarrow 5.5\sin(240) = -4.763\,m$

$(x, y) = (-2.75\,m, -4.76\,m)$

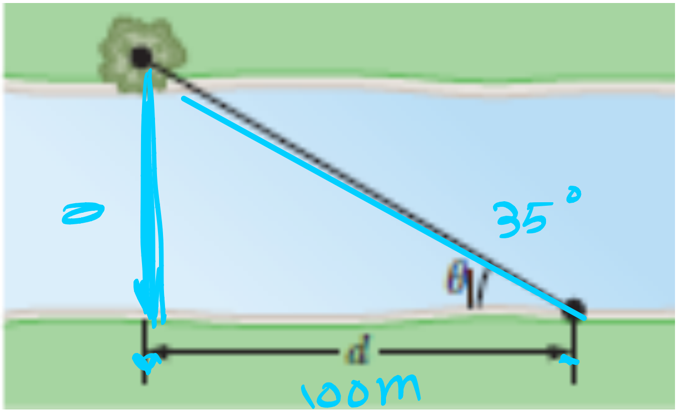
Problem 5:

Surveyor measures the distance across a straight river by the following method (Fig). Starting directly across from a tree on the opposite bank, she walks *d* =100 m along the riverbank to establish a baseline. Then she sights across to the tree. The angle from her baseline to the tree is θ =35.0°. How wide is the river?

$$\tan\theta = \frac{opp}{adj} = \frac{w}{d}$$

$$100 \times \tan(35) = w$$

$$w = 70\,m$$



End of Chapter 1