Chapter 1

Physics and Measurement

CHAPTER OUTLINE

1.1 Standards of Length, Mass, and Time

1.2 Matter and Model Building

1.3 Density and Atomic Mass

1.4 Dimensional Analysis

1.5 Conversion of Units

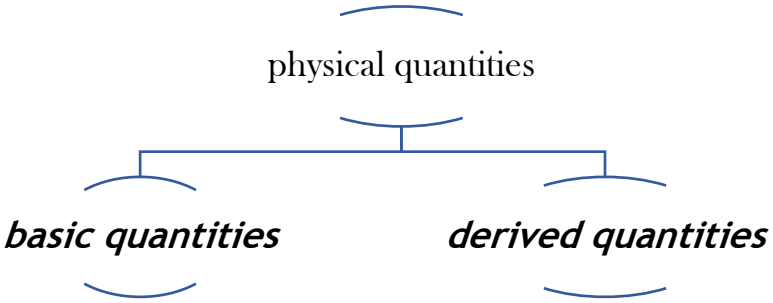
1.6 Estimates and Order-of-Magnitude Calculations

1.7 Significant Figures

▲ *The workings of a mechanical clock. Complicated timepieces have been built for centuries in an effort to measure time accurately. Time is one of the basic quantities that we use in studying the motion of objects. (elektraVision/Index Stock Imagery)*

Chapter 1 (Physics and measurement)

1.1 Standards of Length, Mass, and Time



the SI (Système International)

basic quantities.	*SI units*	*derived quantities,*	*SI units*
length	*meter*		
mass	*kilogram*		
time	*second*		
temperature	*kelvin*		
electric current	*ampere*		
luminous intensity	*candela*		
the amount of substance	*mole*		

1.3 Density and Atomic Mass

density. The density ρ (Greek letter rho) of any substance is defined as its mass per unit volume:

$$\rho = \frac{m}{V}$$

The density is independent of the quantity of substance, but depend on the type of material only

Quick Quiz 1.1

In a machine shop, two cams are produced, one of aluminum and one of iron. Both cams have the same mass. Which cam is larger?

(a) the aluminum cam

(b) the iron cam

(c) Both cams have the same size .

Example 1.1 How Many Atoms in the Cube?

A solid cube of aluminum (density $2.70\ g/cm^3$*) has a volume of* $0.200\ cm^3$*. It is known that 27.0 g of aluminum contains* 6.02×10^{23} *atoms. How many aluminum atoms are contained in the cube?*

1- *You want to carry a boulder home from the beach. It is 30 centimeters on each side. It is made of granite, which has a typical density of 2.8 g/cm3. How much will this boulder weigh?*

A) $84g$
B) $2.52Kg$
C) $75.6Kg$
D) $9.64kg$

2- *The standard kilogram is a platinum–iridium cylinder 39.0 mm in height and 39.0 mm in diameter. What is the density of the material?*

A) $21.46g/cm^3$
B) $0.02146g/cm^3$
C) $20.93g/cm^3$
D) $5.366g/cm^3$

3- *Two spheres are cut from a certain uniform rock. One has radius 4.50 cm. The mass of the other is five times greater. Find its radius.*

A) 7.7cm
B) 2.63cm
C) 22.5cm
D) Information is not enough

1.4 Dimensional Analysis

The physical qaintity	the dimensions
length	L
mass	M
time	T

useing brackets [ ] to denote the dimensions of a physical quantity.

the dimensions of speed is ……..

Practice: - Complete this table

The physical qaintity	the dimensions	SI unit
Velocity		
Acceleration		
Force		
Work		
Energy		
Power		
Pressure		
Momentum		
Area		
Volume		
Density		
Circumference		

- dimensions can be treated as algebraic quantities.
- quantities can be added or subtracted only if they have the same dimensions
- The relationship can be correct only if the dimensions on both sides of the equation are the same.

quick Quiz 1.2 True or False:

Dimensional analysis can give you the numerical value of constants of proportionality that may appear in an algebraic expression.

Example 1.2 Analysis of an Equation

Show that the expression $v = at$ is dimensionally correct, where v represents speed, a acceleration, and t an instant of time.

Example 1.3 Analysis of a Power Law

Suppose we are told that the acceleration a of a particle moving with uniform speed v, in a circle of radius r is proportional to some power of r, say r^n, and some power of v, say v^m . Determine the values of n and m and write the simplest form of an equation for the acceleration.

The acceleration a of a particle moving with uniform speed v in a circle of radius r is given by the expression $a = k\, r^n\, v^m$ (k is dimensionless). Using the dimensional analysis, the values of n and m respectively are:

A) 1, -2
B) -1, 2
C) 1, 2
D) 2, 3
E) -2, 3

4- The dimension of $\frac{1}{2}\rho v^2$ (where ρ is the density and v is the speed) is

A) $M^{-1}L^5T^2$
B) $M\,L\,T^2$
C) $M\,L^{-1}T^{-2}$
D) $M\,L^2T^{-2}$
E) $M^{-1}L^3T^{-2}$

5- *Which of the following quantities has the same dimension as the centripetal acceleration.* $a_c = \frac{v^2}{r}$

A) mgt^{-1}
B) mvt^{-1}
C) gt^2
D) mgt
E) vt^{-1}

6- *Newton's law of universal gravitation is represented by* $F = \frac{GMm}{r^2}$
Where F is the gravitational force exerted by one bject on another (force has the SI units $Kg.m/s^2$ *) , M and m are the masses of the objects, and r is a distance. The SI units of the proportionality constant G is:*

A) $m^2/Kg.s^3$
B) $m^3/Kg.s^2$
C) $s^3/Kg.m^2$
D) $s^2/Kg.m^3$
E) $Kg/s^2.m^3$

7- *Suppose we can express the velocity by the following equation :* $v = 3kx + at$, *where* x *is displacement (in meters), t is time (in seconds), a is the acceleration, and k is a variable. So, for this equation to be dimensionally correct, the unit of k must be:*

A) m/s
B) $1/s$
C) m/s^2
D) m
E) s^2

8- *The equation for the change of the position of a train is given by* $x = \frac{1}{2}at^2 + bt^3$, *the dimensions of b are:*

A) T^{-3}
B) LT^{-3}
C) LT^{-2}
D) LT^{-1}

9- The acceleration a of a aparticle moving with uniform speed v in acircle of radius r is given by the expression $a = kr^n v^m$ (k is dimensionless). Using the dimensional analysis, the values of n and m respectively are :

A) 1, -2
B) -1, 2
C) 1, 2
D) 2, 3
E) -2 , 3

10- In Einstein's equation $E = mc^2$, where m: mass, c: speed of light. The dimensions of energy E is :

A) ML^2T^{-1}
B) MLT^{-2}
C) MLT^{-1}
D) ML^2
E) ML^2T^{-2}

11- Adimensinally wrong equation (formula) in physics

A) must be wrong
B) may be wrong
C) may be correct
D) must be correct
E) none of these

12- If the volume of an object as a function of time is calculated by $V = At^3 + B/t$, where V is volumme, t is time, and A&B are constants, the dimension of A is :

A) T^{-3}
B) L^3T^{-3}
C) L^3T
D) $L^{-1}T^{-3}$
E) L^2T^{-1}

13- *Which of the following quantities has the same dimensions as kinetic energy, $\frac{1}{2}mv^2$?*

A) mvt
B) ma
C) mvr
D) mgh
E) mgt

14- *Which of the following quantities has the same dimension as $force\ (F) \times time(t)$? where force F dimension is MLT^{-2}*

A) mv
B) mvr
C) mv^2r
D) ma
E) $\frac{mv^2}{r}$

15- *The equation for the final velocity of train stating from rest is given by $v_f = av_i + bt$. The dimensin of b is*

A) L^2T
B) L^oT
C) LT^2
D) LT^{-1}
E) LT^{-2}

16- *Assume the equation $x = At^3 + Bt^2 + Ct$ describes the motion of an object, with x having the dimension of length and t. having the dimension of time. A,B, and C are constants. The dimension of the constant B is:*

A) LT
B) LT^2
C) LT^{-3}
D) LT^{-2}
E) LT^{-1}

1.5 Conversion of Units

1) convert units from one measurement system to another,

1 mile = 1 609 m = 1.609 km
1 ft = 0.304 8 m = 30.48 cm
1 m = 39.37 in. = 3.281 ft
1 in. = 0.025 4 m = 2.54 cm

Practice: - *Convert 15.0 in. to centimeters*

quick Quiz 1.3

The distance between two cities is 100 mi. The number of kilometers between the two cities is

(a) smaller than 100

(b) larger than 100

(c) equal to 100.

Example 1.4 Is He Speeding?

On an interstate highway in a rural region of Wyoming, a car is traveling at a speed of 38.0 m/s. Is this car exceeding the speed limit of 75.0 mi/h?

17- A cubic box with an edge of 1.5ft has a volume of: (1 m = 3.281 ft)

A) $3.28 \times 10^{3} m^{3}$
B) $7.55 \times 10^{2} m^{3}$
C) $9.55 \times 10^{-2} m^{3}$
D) $22.7 \times 10^{-2} m^{3}$
E) $44 \times 10^{-2} m^{3}$

2) convert within a system,

peta-	P	10^{15}
tera-	T	10^{12}
giga-	G	10^{9}
mega-	M	10^{6}
kilo-	k	10^{3}
hecto-	h	10^{2}
deka-	da	10^{1}

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

18- A worker is to point the walls of a square room 8.00 ft high and 12.0ft along each side . what surface area in square meters must she cover (total walls) ? (1m = 39.37in = 3.281 ft)

A) $3.6\ m^2$
B) $9\ m^2$
C) $36\ m^2$
D) $72\ m^2$
E) $81\ m^2$

19- The distance between two cities is 150 mi. the number of kilometers between the two cities is:

A) Equal to 100
B) Larger than 100
C) Smaller than 100
D) Larger than 200
E) Larger than 300

Exercise

Section 1.4 Dimensional Analysis

1) The position of a particle moving under uniform acceleration is some function of time and the acceleration. Suppose we write this position $s = ka^m t^n$, where k is a dimensionless constant. Show by dimensional analysis that this expression is satisfied if m = 1 and n = 2. Can this analysis give the value of k?

2) Which of the following equations are dimensionally correct?
(a) $v_f = v_i + ax$
(b) $y = (2\ m)cos(kx)$, where $k = 2\ m^{-1}$.

Section 1.5 Conversion of Units

3) A worker is to paint the walls of a square room 8.00 ft high and 12.0 ft along each side. What surface area in square meters must she cover?

4) The volume of a wallet is $8.50\ in^3$ Convert this value to m^3, using the definition (1in=2.54cm).

5) *A rectangular building lot is 100 ft by 150 ft. Determine the area of this lot in* m^2.

6) *A solid piece of lead has a mass of* $23.94\ g$ *and a volume of* $2.10\ cm^3$. *From these data, calculate the density of lead in SI units* (kg/m^3).

7) *One gallon of paint* ($volume = 3.78 \times 10^{-3} m^3$) *covers an area of* $25.0\ m^2$. *What is the thickness of the paint on the wall?*

Test your self **Chapter 1** Phys 103 KSU

1- *The position of a particle moving under uniform acceleration is some function of time and the acceleration. Suppose we write this position* $s = ka^m t^n$ *, where k is a dimensionless constant. The value of m and n are ……..*

a) *m=1, n=1* b) *m=2, n=1*

c) *m=1, n=2* d) *m=1, n=1*

2- *A solid cube of aluminum (density* $2.70\ g/cm^3$*) has a volume of* $0.200\ cm^3$*. It is known that 27.0 g of aluminum contains* $6.02 \times 10^{23}\ atoms$*. How many aluminum atoms are contained in the cube?*

a) 2.70×10^{23} b) 2.70×10^{-22}

c) 1.20×10^{22} d) 4.8×10^{21}

3- *Dimensional analysis can give you the numerical value of constants of proportionality that may appear in an algebraic expression.*

a) *True* b) *False*

4- *The distance between two cities is 100 mi. The number of kilometers between the two cities is*

a) *smaller than 100* b) *larger than 100*

c) *equal to 100.*

5- *On an interstate highway in a rural region of Wyoming, a car is traveling at a speed of 38.0 m/s. Is this car exceeding the speed limit of 75.0 mi/h?*

a) *Yes* b) *No*

c) *we can't determine*

6- *The standard kilogram is a platinum–iridium cylinder 39.0 mm in height and 39.0 mm in diameter. What is the density of the material?*

a) $1.521 \times 10^{-3} kg/m^3$ b) $675.2 kg/m^3$

c) $21475 kg/m^3$ d) $4.6565 \times 10^{-5} kg/m^3$

7- *A small cube of iron is observed under a microscope. The edge of the cube is* $5.00 \times 10^{-6} cm$ *long. Find the mass of the cube (density of iron is* $7.86\ g/cm^3$*)*

a) $9.8 \times 10^{-16} g$ b) $5.21 \times 10^{-13} g$

c) $6.73 \times 10^{-12} g$ d) $4.21 \times 10^{-23} g$

8- *In a machine shop, two cams are produced, one of aluminum and one of iron. Both cams have the same mass. Which cam is larger?*

a) *the aluminum cam* b) *the iron cam*

c) *Both cams have the same size* d)

9- *Newton's law of universal gravitation is represented by.* $F = G\frac{Mm}{r^2}$ *Here F is the magnitude of the gravitational force exerted by one small object on another, M and m are the masses of the objects, and r is a distance. Force has the SI units* $kg \cdot m/s^2$*. What are the SI units of the proportionality constant G ?*

a) kgm^3/s^2 b) kgm^3/s^2

c) $m^3/kg.s^2$ d) kg^3m^2/s^2

10- *A worker is to paint the walls of a square room 8.00 ft high and 12.0 ft along each side. What surface area in square meters must she cover? (1m = 3.28 ft)*

a) $4131\ m^2$ b) $472\ m^2$

c) $8.92\ m^2$ d) $35.7\ m^2$

11- *The volume of a wallet is* $8.50\ in^3$ *Convert this value to* m^3*, using the definition (1 in=2.54 cm)*

a) $1.39 \times 10^{-4}\ m^3$ b) $21.6\ m^3$

c) $0.0055\ m^2$ d) $0.015\ m^2$

12- *A rectangular building lot is 100 ft by 150 ft. Determine the area of this lot in m^2. (1m = 3.28 ft)*

a) $1394\ m^2$ b) $4.9 \times 10^4\ m^2$

c) $1.6 \times 10^5\ m^2$ d) $4573\ m^2$

13- *An auditorium measures $40.0\ m \times 20.0\ m \times 12.0\ m$. The density of air is $1.20\ kg/m^3$. What are (a) the volume of the room in cubic feet and (b) the weight of air in the room in pounds? (1m = 3.28 ft, 1kg= 2.2 lbs)*

a) $3.39 \times 10^5\ ft^3$, 2.53×10^4 *lbs* b) $9.6 \times 10^4\ ft^3$, 1.22×10^5 *lbs*

c) $7.32 \times 10^3\ ft^2$, 3.93×10^5 *lbs* d) $8.81 \times 10^6\ ft^2$, 4.32×10^6 *lbs*

14- *A solid piece of lead has a mass of 23.94 g and a volume of $2.10\ cm^3$. From these data, calculate the density of lead in SI units (kg/m^3)*

a) 11400 b) 0.0114

c) 11.4 d) 1.14×10^6

15- *A section of land has an area of 1 square mile and contains 640 acres. Determine the number of square meters in 1 acre.*

a) $1\ acre = 75m^2$ b) $1\ acre = 7.5m^2$

c) $1\ acre = 2.5m^2$ d) $1\ acre = 25m^2$

16- *An ore loader moves 1200 tons/h from a mine to the surface. Convert this rate to lb/s, using (1 ton=2000 lb).*

a) *667* b) *778*

c) *889* d) *112*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
c	c	b	b	a	c	a	a	c	d	a	a	a	a	c	a

Chapter 2 (Motion in One Dimension)

Introduction

Classical mechanics:
which is

29- *A truck on a straight road starts from rest, accelerating at 2.00 m/s^2 until it reaches a speed of 20.0 m/s. Then the truck travels for 20.0 s at constant speed until the brakes are applied, stopping the truck in a uniform manner in an additional 5.00 s. (a) How long is the truck in motion? (b) What is the average velocity of the truck for the motion described?*

a) 25 s , 18.3 m/s b) 30 s , 16.5 m/s
c) 35 s , 15.7m/s d) 40 s , 12.9 m/s

30- *A ball is thrown directly downward, with an initial speed of 8.00 m/s, from a height of 30.0 m. After what time interval does the ball strike the ground?*

a) 0.9 s b) 1.8 s
c) 2.6 s d) 4.1 s

31- *A student throws a set of keys vertically upward to her sorority sister, who is in a window 4.00 m above. The keys are caught 1.50 s later by the sister's outstretched hand. (a) With what initial velocity were the keys thrown? (b) What was the velocity of the keys just before they were caught?*

a) 10m/s , -4.7m/s b) 19.6 m/s , -14.2 m/s
c) 0m/s , -9.8m/s d) 4.6m/s , -7.2m/s

33- *A baseball is hit so that it travels straight upward after being struck by the bat. A fan observes that it takes 3.00 s for the ball to reach its maximum height. Find (a) its initial velocity and (b) the height it reaches.*

a) 44.1m , 29.4m/s b) 54.4m , 18.6m/s
c) 132.6 m , 34.2m/s d) 65.1m , 8.9m/s

34- *It is possible to shoot an arrow at a speed as high as 100 m/s. (a) If friction is neglected, how high would an arrow launched at this speed rise if shot straight up? (b) How long would the arrow be in the air?*

a) 510.2m , 20.4 s b) 1000m , 24.1 s
c) 920.1m , 32.1 s d) 510.2m , 10.4 s

34- The height of a helicopter above the ground is given by $h = 3.00t^3$, where h is in meters and t is in seconds. After 2.00 s, the helicopter releases a small mailbag. How long after its release does the mailbag reach the ground?

a) 3 b) 5
c) 8 d) 10

35- A freely falling object requires 1.50 s to travel the last 30.0 m before it hits the ground. From what height above the ground did it fall?

a) 212.3m b) 140.4m
c) 114.5m d) 90.6m

36- The coordinate of a particle in meters is given by $x(t) = 16t - 3.0t^3$, where the time t is in seconds. The particle is momentarily at rest at t =

a) 0.75 s b) 1.3 s
c) 5.3 s d) 7.3 s

37- A ball rolls up a slope. At the end of three seconds its velocity is 20 cm/s; at the end of eight seconds its velocity is 0. What is the average acceleration from the third to the eighth second?

a) 2.5 cm/s^2 b) 4.0 cm/s^2
c) 5.0 cm/s^2 d) 6.67 cm/s^2

38- Each of four particles move along an x axis. Their coordinates (in meters) as functions of time (in seconds) are given by

particle 1: $x(t) = 3.5 - 2.7t3$
particle 2: $x(t) = 3.5 + 2.7t3$
particle 3: $x(t) = 3.5 + 2.7t2$
particle 4: $x(t) = 3.5 - 3.4t - 2.7t2$

Which of these particles have constant acceleration?

a) All four b) Only 3 and 4
c) Only 2 and 3 d) Only1 and 2

39- An object starts from rest at the origin and moves along the x axis with a constant acceleration of 4m/s2. Its average velocity as it goes from x = 2m to x = 8m is:

a) 2m/s b) 3m/s
c) 5m/s d) 6m/s

40- *A car, initially at rest, travels 20 m in 4 s along a straight line with constant acceleration. The acceleration of the car is:*

a) $0.4\ m/s^2$ b) $1.3\ m/s^2$

c) $2.5\ m/s^2$ d) $4.9\ m/s^2$

41- *A car moving with an initial velocity of 25 m/s north has a constant acceleration of 3 m/s2 south. After 6 seconds its velocity will be:*

a) *7 m/s north* b) *7 m/s south*

c) *20 m/s north* d) *20 m/s south*

42- *A baseball is thrown vertically into the air. The acceleration of the ball at its highest point is:*

a) *zero* b) *g, down*

c) *g, up* d) *2g, down*

43- *An object is thrown straight up from ground level with a speed of 50 m/s. If g = 10 m/s2 its distance above ground level 1.0 s later is:*

a) *40m* b) *45m*

c) *50m* d) *55m*

44- *An object is thrown vertically upward at 35 m/s. Taking g = 10 m/s2, the velocity of the object 5 s later is:*

a) *15 m/s down* b) *15 m/s up*

c) *85 m/s down* d) *85 m/s up*

45- *A heavy ball falls freely, starting from rest. Between the third and fourth second of time it travels a distance of:*

a) *4.9m* b) *9.8m*

c) *29.4 m* d) *34.3 m*

46- *An object is thrown straight down with an initial speed of 4 m/s from a window which is 8 m above the ground. The time it takes the object to reach the ground is:*

a) *0.80 s* b) *0.93 s*

c) *1.3s* d) *1.7s*

47- An object is thrown straight down with an initial speed of 4 m/s from a window which is 8 m above the ground. The time it takes the object to reach the ground is:

a) 0.80 s b) 0.93 s

c) 1.3s d) 1.7s

48- How long does it take for a train to come to rest if it decelerates at $2.0 m/s^2$ from an initial velocity of 90 km/h

a) 45 s 22.5 s

c) 12.5 s 7.5 s

49- A projectile is shot vertically upward with a given initial velocity. It reaches a maximum height of 100 m. If, on a second shot, the initial velocity is doubled then the projectile will reach a maximum height of:

a) 141.4 m b) 200m

c) 241m d) 400m

50- A ball is tossed straight up at 25 m/s. what is its velocity after 1s? .

a) 25 b) 15

c) 10 d) 5

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	C	A	B	B	D	C	D	B	E	D	B	A	A	B	A	A	A	C	C	A	C	A	D	C

The answers

26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
B	A	A	C	B	A	A	A	C	D	B	B	B	D	C	A	B	B	A	D	B	D	C	D	B

انتظروا

Chapter 2

مع تحيات

Mr. Abdullah Mohamed

دعواتي للجميع بالتفوق والنجاح