# Measurement Systems

## 14 February 2023

Revision: 4010

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# PART I: MONEY

# 1. MONEY

## 1.1 International Currencies

### A. Units of Money

A unit of money is often divided into 100 parts. Coins are often used to represent the various parts. Consider the coins of various denominations

| Value (No. of Parts) | 1 | 2 | 5 | 10 | 25 | 50 | 100 |
|---|---|---|---|---|---|---|---|
| No. of Coins to make a Unit | 100 | 50 | 20 | 10 | 4 | 2 | 1 |

### B. Two-Tier Currency Structure

Different countries have different units of money. Many countries today divide their unit of currency into 100 parts, which is in line with the decimal system. Some countries which follow this system are given below:

| Country | Unit | Part |
|---|---|---|
| India | Rupee | 1 Rupee=100 Paise |
| US | Dollar | 1 Dollar=100 Cents |
| Russia | Rouble | 1 Rouble = 100 Kopeks |
| Mexico | Peso | 1 Peso = 100 Centavos |
| European Union | Euro | 1 Euro = 100 Cents |
| Great Britain | Pound | 1 Pound = 100 Pence |

### C. US Coins

| Value | 1 Cent Coin | 5 Cent Coin | 10 Cent Coin | 25 Cent Coin | 50 Cent Dollar |
|---|---|---|---|---|---|
| Name | Penny | Nickel | Dime | Quarter | Half Dollar Half |

**Example 1.1**

A. Identify the dollars and cents in $3.45
B. Identify the dollars and cents in $2.05
C. Identify the dollars and cents in $9.50

$$\$\ \underbrace{3}_{Dollars}\ .\ \underbrace{45}_{Cents} = 3\ Dollars\ and\ 45\ Cents$$
$$\$\ \underbrace{2}_{Dollars}\ .\ \underbrace{05}_{Cents} = 2\ Dollars\ and\ 5\ Cents$$
$$\$\ \underbrace{9}_{Dollars}\ .\ \underbrace{50}_{Cents} = 9\ Dollars\ and\ 50\ Cents$$

**Example 1.2**

Fill up the table with the missing values.

| Rupees | Paise | | Dollars | Cents | | Rouble | Kopeks | | Peso | Centavos | | Euro | Cents |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | | | 1 | | | 3 | | | 3.5 | | | 2.7 | |
| 2 | | | 7 | | | 4 | | | 2.5 | | | 1.8 | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 200 | | | 30 | | | 70 | | | 210 | | | 250 |
| | 50 | | | 80 | | | 100 | | | 320 | | | 300 |

| Rupees | Paise | | Dollars | Cents | | Rouble | Kopeks | | Peso | Centavos | | Euro | Cents |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 500 | | 1 | 100 | | 3 | 300 | | 3.50 | 350 | | 2.70 | 2 |
| 2 | 200 | | 7 | 700 | | 4 | 400 | | 2.50 | 250 | | 1.80 | 180 |
| | 200 | | 0.30 | 30 | | | 70 | | 2.10 | 210 | | 2.50 | 250 |
| | 50 | | 0.80 | 80 | | | 100 | | 3.20 | 320 | | 3 | 300 |

## Example 1.3

Fill up the table with the missing values.

| Rupees | Paise | | Dollars | Cents | | Rouble | Kopeks | | Peso | Centavos | | Euro | Cents |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.53 | | | 0.53 | | | | 50 | | 24.50 | | | 12.34 | |
| 4.50 | | | 0.47 | | | | 27 | | 12.60 | | | | 4008 |
| | 170 | | 0.04 | | | | 5 | | | 3574 | | 10 | |
| | 225 | | 0.80 | | | | 7 | | | 5000 | | | 6000 |

| Rupees | Paise | | Dollars | Cents | | Rouble | Kopeks | | Peso | Centavos | | Euro | Cents |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.53 | 253 | | 0.53 | 53 | | 0.12 | 12 | | 24.50 | 2450 | | 12.34 | 1234 |
| 4.50 | 450 | | 0.47 | 47 | | 0.27 | 27 | | 12.60 | 1260 | | 40.08 | 4008 |
| 1.70 | 170 | | 0.04 | 4 | | 0.05 | 5 | | 35.74 | 3574 | | 10 | 1000 |
| 2.25 | 225 | | 0.08 | 8 | | 0.07 | 7 | | 50.00 | 5000 | | 60 | 6000 |

## D. Three-Tier Currency Structure

Some countries follow the decimal system, but have a two-part structure. The unit of currency is divided into parts, and those parts are further divided. Some countries which have this system are given below:

| Country | Name | Part | Sub-Part |
|---|---|---|---|
| China | Renminbi | 1 Yuan = 10 Jiao | 1 Jiao = 10 Fen |
| Japan | Yen | 1 Yen = 100 Sen | 1 Sen = 10 Rin |
| India (Old System) | Rupee | 1 Rupee =16 Annas | 1 Anna = 4 Paise |

## Example 1.4

A. What is the number of Fen in 1 Yuan?
B. What is the number of 1 Rin in 1 Yen?
C. What is the number of paise in 1 Rupee in the old Indian currency system?

$$1\ Yuan\ =\ 10\ Jiao = 100\ Fen$$
$$1\ Yen\ =\ 100\ Sen = 1000\ Rin$$
$$1\ \text{Rupee}\ = 16\ \text{Annas} = (16 \times 4)\ Paise = 64\ Paise$$

## Example 1.5

Suppose, you are buying oranges in the old Indian currency system, and 1 orange costs 3 Annas. What is the cost of a dozen oranges in paise?

$$1\ Orange = 3\ Annas$$
$$1\ Dozen\ Oranges = 12\ Oranges = 36\ Annas = 144\ Paise$$

### Example 1.6
Fill in the missing values in the table

| Yuan | Jiao | Fen | | Yen | Sen | Rin |
|---|---|---|---|---|---|---|
| 2 | | | | 4 | | |
| | 30 | | | | 300 | |
| | | 400 | | | | 2000 |
| | | 40 | | | | 200 |
| | | 4 | | | | 20 |
| | | | | | | 2 |

| Yuan | Jiao | Fen | | Yen | Sen | Rin |
|---|---|---|---|---|---|---|
| 2 | 20 | 200 | | 4 | 400 | 4000 |
| 3 | 30 | 300 | | 3 | 300 | 3000 |
| 4 | 40 | 400 | | 2 | 200 | 2000 |
| 0.04 | 0.4 | 40 | | 0.2 | 20 | 200 |
| 0.004 | 0.04 | 4 | | 0.02 | 2 | 20 |
| | | | | 0.002 | 0.2 | 2 |

## E. Indian Currency
The unit of currency in India is the Rupee. Each rupee is divided into a hundred parts, called paise.
**Coins** of smaller denominations (1 paise, 2 paise, 5 paise) are not currently available. Currently, the largest denomination coin which is available is Rs .10.
**Notes** of denominations starting Rupees 5 are generally available.

## F. Change
When you go to buy something, you will hand over the money that you have to the shopkeeper. The money that you get back is called the change.

### Example 1.7
You visit the market to buy a notebook priced at Rs. 30. You hand over a Rs. 50 note to the shopkeeper.

A. What is the change that you get back?
B. If the shopkeeper pays you back using five-rupee coins, how many coins will he hand over to you?

$$Change = 50 - 30 = 20$$
$$No.of\ Coins = \frac{20}{5} = 4$$

# 1.2 Conversions

## A. Conversions

$$1\ pound = 100\ pence$$

### Example 1.8
Convert the following from pence to pounds

A. 300 pence
B. 200 pence
C. 500 pence

D. 800 pence
E. 400 pence

### Example 1.9
Convert the following from pence to pounds
A. 850 pence
B. 430 pence
C. 305 pence
D. 270 pence
E. 520 pence
F. 199 pence

## 1.3 Coins

### Example 1.10
What is the number of 25 paise coins that will make a rupee?

### Example 1.11
What is the number of 10 cent coins that will make a dollar?

### Example 1.12
What is the number of 5 paise coins that will make a rupee?

## 1.4 Addition

### A. No Regrouping

### Example 1.13
Sheela has Rs. 4 and 45 paise. Neela has Rs. 3 and 25 paise. Find the total amount of money that they have.

$$4\ Rs.45\ paise + 3\ Rs.25\ paise = 7\ Rs.70\ Paise$$

### Example 1.14
Vir had 3 pounds and twenty pence in his piggy bank. His uncle gave him forty pence for his birthday. How much money does he have in all now?

$$3\ Pounds\ 20\ Pence + 40\ Pence = 3\ Pounds\ 60\ Pence$$

### B. Regrouping

### Example 1.15
The cost of a doll is two dollars and eighty-five cents. The cost of a toy car is three dollars and seventy-five cents. What is the cost of purchasing both a doll and a toy car?

$$2\ Dollars\ 85\ cents + 3\ Dollars\ 75\ cents = 5\ dollars\ 150\ cents = 6\ dollars\ 50\ cents$$

### Example 1.16
A doll costs two pounds and eighty pence. A plane costs three pounds and ninety pence. What is the total cost of

a doll and a plane?

$$2\ Pounds\ 80\ Pence + 3\ Pounds\ 90\ Pence = 5\ Pounds\ 170\ Pence = 6\ Pounds\ 70\ Pence$$

# 1.5 Subtraction

## A. Regrouping

### Example 1.17
James had Rs. 20 with him. He spent 5 paise. What was the amount left with him?

### Example 1.18
Bharat had Rs. 7 and 35 paise with him. Shaunak had Rs. 5 and 45 paise with him. How much more money did Bharat have compared to Shaunak?

## B. Change

### Example 1.19
Dawn bought notebooks worth Rs. 15 for her math competition preparation. She handed over a Rs. 100 note to the shopkeeper. How much would the shopkeeper return Dawn?

### Example 1.20
Find the change if Seema bought a sandwich costing 2 pounds and forty-five pence and handed over a ten-pound note to the cashier.

To find the change, we need to find:

$$10\ pounds - 2\ pounds - 45\ pence$$
$$= 8\ pounds - 45\ pence$$
$$= 7\ Pounds + 1\ Pound - 45\ Pence$$
$$= 7\ Pounds + 100\ Pence - 45\ Pence$$
$$= 7\ pounds\ 55\ pence$$

| | Pounds | Pence |
|---|---|---|
| | | 100 |
| | 10 9 | 0 |
| - | 2 | 45 |
| | 7 | 55 |

### Example 1.21
Find the change if Simon bought a burger costing 3 pounds and twenty-five pence and handed over a five-pound note to the cashier.

$$5\ pounds - 3\ pounds - 25\ pence$$
$$= 2\ pounds - 25\ pence$$
$$= 1\ pounds + 1\ pound - 25\ pence$$
$$= 1\ pounds + 100\ pence - 25\ pence$$
$$= 1\ pounds + 75\ pence$$
$$= 1\ pound\ 75\ pence$$

| | Pounds | Pence |
|---|---|---|
| | | 100 |
| | 5 4 | 0 |
| - | 3 | 25 |
| | 1 | 75 |

### Example 1.22
Karthik bought a pen costing 2 pounds and 10 pence, and a pencil costing 90 pence. He paid using a five-pound note. Find the change

Total Cost of the Purchase

$$= \underbrace{2\ pounds\ 10\ pence}_{Pen} + \underbrace{90\ pence}_{Pencil} = 2\ Pounds\ 100\ Pence = 3\ pounds$$

Change

$$= 5\ pounds - 3\ pounds = 2\ pounds$$

# 1.6 Multiplication

## A. Smaller Units of Currency

### Example 1.23

A piece of dragon fruit costs 55 pence. Find, in pounds and pence, the cost of four pieces of dragon fruit.

$$55\ pence \times 4 = 220\ pence = 2\ pounds\ 20\ pence$$

### Example 1.24

A notebook costs 1 pound and 30 pence. What is the cost of three notebooks?

$$3\ Notebooks = 3 \times (1\ pound\ 30\ pence) = 3\ pounds\ 90\ pence$$
$$3\ Notebooks = 3 \times 130\ pence = 390\ pence = 3\ pounds\ 90\ pence$$

### Example 1.25

A ticket to the zoo costs 1 pound 55 pence for an adult and 85 *pence* for a child. Dawn's two younger sisters (both adults) visit the zoo. How much did the tickets cost them?

The people visiting the zoo are:

$$Dawn's\ two\ younger\ sisters \Rightarrow 2\ People$$

Cost of Tickets

$$= 2 \times 155 = 310\ pence = 3\ pounds\ 10\ pence$$

### Example 1.26

A doll costs 1 pound and 35 pence. A plane cost 2 pounds and 45 pence. What is the cost of two dolls and three planes?

$$Two\ dolls = 2\ pounds\ 70\ pence$$
$$Three\ planes = (2\ pounds\ 45\ pence) \times 3 = 6\ pounds\ 135\ pence = 7\ pounds\ 35\ pence$$

$$2\ pounds\ 70\ pence + 7\ pounds\ 35\ pence = 9\ pounds\ 105\ pence = 10\ Pounds\ 5\ Pence$$

### Example 1.27

The cost of a pen is 35 paise. The cost of a pencil is one rupee and fifteen paise. In rupees and paise, find the cost of three pens and four pencils.

$$35 \times 3 = 105\ Paise$$
$$115 \times 4 = 460\ Paise$$
$$565\ Paise = 5\ Rupees\ 65\ Paise$$

### B. More Items

**Example 1.28**
Ben went to the zoo with his sister, his brother and his parents. They paid Rs. 20 for petrol, and Rs. 10 for each adult ticket, and Rs. 5 for each child ticket. Ben's parents are adults, while his sister and his brother are both children. Find the total cost of the visit to the zoo.

$$Child\ Tickets = \underbrace{5\ Rs.}_{Per\ Ticket} \times \underbrace{3\ Tickets}_{\substack{Ben \\ Ben's\ Sister \\ Ben's\ Brother}} = 15\ Rs.$$

$$Adult\ Tickets = \underbrace{10\ Rs.}_{Per\ Ticket} \times \underbrace{2\ Tickets}_{Parents} = 20\ Rs.$$

$$Petrol = Rs.\ 20$$

Hence, the total cost is:

$$\underbrace{15}_{\substack{Child \\ Tickets}} + \underbrace{20}_{\substack{Parent \\ Tickets}} + \underbrace{20}_{Petrol} = 55$$

## 1.7 Division

### A. Division

**Example 1.29**
A rope with a length of five meters costs Rs. 40. Find the cost of one meter of rope.

**Example 1.30**
Rupees one hundred and fifty-one are divided into two equal parts. Find each part.

**Example 1.31**
Two friends visited a restaurant, and ran up a bill of 4 pounds and 40 pence. If the bill was shared equally by the two of them, how much did each one of them have to pay?

**1.32: Tip**
When at a hotel, the tip is paid to the hotel staff, and the cost of the tip must be borne by the customer. Hence,

$$Total\ Cost = Bill + Tip$$

**Example 1.33**
A luncheon was attended by three friends. The hotel bill was ten pounds sixty pence, and they tipped the waiter one pound forty pence. If they share the cost equally, what is the share of each person?

$$Tost\ Cost = \underbrace{10\ pounds\ 60\ pence}_{Bill} + \underbrace{1\ pound\ 40\ pence}_{Tip} = 11\ pounds\ 100\ pence = 12\ pounds$$

$$Equal\ Sharing = \frac{12}{3} = 4\ Pounds$$

**Example 1.34**

Four friends had a kitty party and the bill for the kitty party was three pounds, and twenty pence. The tip was eighty pence. The friends shared the cost equally. What was the cost per person?

$$Total\ Cost = \underbrace{3\ Pounds\ 20\ Pence}_{Bill} + \underbrace{80\ Pence}_{Tip} = 4\ Pounds$$
$$Equal\ Sharing = \frac{4}{4} = 1\ Pound\ per\ person$$

### Example 1.35
A quarter is 25 cents. Kevin has twenty quarters. He wants to purchase candies which are twenty cents each. Find the number of candies he can purchase.

$$\frac{25 \times \mathbf{20}}{\mathbf{20}} =$$

# 1.8 Applications

## A. Unit Rates

### Example 1.36
8 chocolates cost 4 Pounds.

A. Find the cost of 1 apple.
B. Find the cost of 5 apples.

$$Cost\ of\ 1\ Chocolate = \frac{No.\ of\ Rupees}{No.\ of\ Apples} = \frac{4}{8} = \frac{1}{2}\ Rupees = 50\ Paise$$
$$Cost\ of\ 5\ Chocolate = 5 \times 50\ Paise = 250\ Paise = 2\ Rupees\ 50\ Paise$$

## B. Bank Accounts
A bank keeps money on your behalf.

### 1.37: Bank Account
- The money in the account is called a bank balance.
- When you deposit money in the account, the bank balance increases.
- When you withdraw money from the account, the bank balance decreases.

### Example 1.38
Tanisha has a savings bank account with a balance of Rs. 100 on $5^{th}$ May 2020. Find the balance in the bank account after each transaction.

A. On $6^{th}\ May$, she deposits Rs. 10 in the bank.
B. On $10^{th}\ May$, she withdrew Rs. 5 in the bank.

$$\underbrace{100}_{\substack{Original\\Balance}} + \underbrace{10}_{\substack{Money\\Deposited}} = \underbrace{110}_{\substack{New\\Balance}}$$
$$\underbrace{110}_{\substack{Original\\Balance}} - \underbrace{5}_{\substack{Money\\Withdrawn}} = \underbrace{105}_{\substack{New\\Balance}}$$

## C. Exchange Rates

## Example 1.39

The conversion rate from dollars to rupees is that seventy rupees is equal to one dollar.

A. Convert 700 Rupees to dollars.
B. Convert 5 dollars to Rupees.
C. Convert 100 dollars to Rupees
D. Convert 2100 Rupees to Dollars
E. Convert 7 Dollars to Rupees

$$Rs.70 = \$1$$

To convert from Rupees to Dollars, we will divide by 70:

**Part A**

$$700\ Rupees = \frac{700}{70} = 10\ Dollars$$

**Part B**

To convert from Dollars to Rupees, we will multiply by 70:

$$5\ Dollars = 5 \times 70 = 350\ Rupees$$

**Part C**

$$100\ Dollars = 100 \times 70 = 7000\ Rupees$$

**Part D**

$$2100\ Rupees = \frac{2100}{70} = \frac{210}{70} = \frac{210}{7} = 30$$

**Part E**

$$7\ Dollars = 7 \times 70 = 490\ Rupees$$

## Example 1.40

Arun travelled from India to the US in the year 2010. The conversion rate was sixty rupees to a dollar. He took 1,20,000 Rupees with him. He stayed in the US for some time, worked there, and came back. When he came back, he had 500 *Dollars* with him.

A. When Arun went to the US, what money did he have with him, in dollars?
B. When Arun came back to India, how much money did he have, in Rupees?

**Part A**

# PART II: MEASUREMENT

# 2. IMPERIAL SYSTEMS

## A. Common Systems

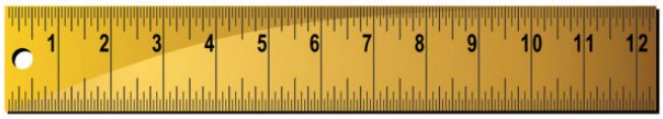
Measurement refers to measuring the length, mass, or the capacity of something. Later on, more types of units can be measured.
Worldwide, a common system for measurement is the decimal system. But, in a number of places, the old system, also called the Imperial system is still in use.

## 2.1 Length

### A. Definition of Foot

**2.1: Length**

$$12\ inches = 1\ foot$$




Length is measured in the imperial system in feet.

$$\underbrace{Foot}_{Singular} \rightarrow \underbrace{Feet}_{Plural}$$

### B. Conversion from Feet to Inches

**2.2: Converting from Feet to Inches**

To convert from feet to inches

$$Multiply\ by\ 12$$

**Example 2.3**

Convert the following measurements given in feet into inches:

**Only Feet**

A. 4 Feet
B. 2 Feet
C. 7 Feet
D. 1 Foot
E. 10 Feet
F. 6 Feet
G. 9 Feet
H. 3 Feet
I. 5 Feet
J. 8 Feet

**Feet and Inches**

K. 3 Feet and 2 Inches
L. 2 Feet and 4 Inches
M. 10 Feet and 10 Inches
N. 3 Feet and 9 Inches
O. 4 Feet and 5 Inches
P. 2 Feet and 9 Inches
Q. 9 Feet and 11 Inches
R. 12 Feet and 10 Inches
S. 1 Foot and 6 Inches

$$4\ Feet = 4 \times 12 = 48\ Inches$$
$$2\ Feet = 2 \times 12 = 24\ Inches$$
$$1\ Foot = 1 \times 12 = 12\ Inches$$
$$10\ Feet = 10 \times 12 = 120\ Inches$$
$$6\ Feet = 6 \times 12 = 72\ Inches$$
$$9\ Feet = 6 \times 12 = 108\ Inches$$
$$3\ feet\ and\ 2\ Inches = 36\ inches + 2\ inches = 38\ Inches$$
$$10\ Feet\ and\ 10\ Inches = 10 \times 12 + 10 = 120 + 10 = 130\ Inches$$

### C. Conversion from Inches to Feet

## 2.4: Converting from Inches to Feet

To convert from inches to feet

$$Divide\ by\ 12$$

Note that converting from inches to feet is the exact opposite of converting from feet to inches.

### Example 2.5

Convert the following measurements given in inches into feet:

**Whole Feet**

A. 24 inches
B. 12 inches
C. 96 inches
D. 36 inches
E. 60 inches
F. 120 inches
G. 48 inches
H. 84 inches
I. 72 inches
J. 108 inches

**Feet and Inches**

K. 14 Inches
L. 18 Inches
M. 22 Inches
N. 28 Inches
O. 13 Inches
P. 35 Inches
Q. 21 Inches
R. 4 Inches
S. 66 Inches
T. 80 Inches

**Whole Feet**

$$24\ Inches = \frac{24}{12} = 2\ Feet$$
$$12\ Inches = 1\ Foot$$
$$96\ Inches = 8\ Feet$$
$$36\ Inches = 3\ Feet$$
$$60\ Inches = 5\ Feet$$
$$120\ Inches = 10\ Feet$$
$$48\ Inches = 4\ Feet$$
$$84\ Inches = 7\ Feet$$
$$72\ Inches =$$
$$108\ Inches =$$

Type equation here.

**Feet and Inches**

Here, we need to break up the inches into whole feet and additional inches:

$$14\ Inches = 12\ Inches + 2\ Inches = 1\ Foot\ 2\ Inches$$
$$14\ Inches = \frac{14}{12}\ Feet = 1\frac{2}{12} = 1\ Feet\ 2\ Inches$$

## D. Comparison

### Example 2.6

A carnival has a ride A meant for children. All children who want to go on the ride must be less than three and a half feet. It has another ride B meant for older children and adults. Adults who want to go the ride must be more than four and a quarter feet. Will, his sister Evelyn, and their parents go to the carnival. Will is 4 feet and 1 inch tall. Evelyn is 3 feet and 3 inches tall. And their parents are 5 Feet 6 Inches, and 5 Feet 8 Inches tall. Who can ride in which ride?

$$Evelyn \rightarrow 3\ Feet\ 3\ Inches \rightarrow Ride\ A$$
$$Parents \rightarrow 5\ Feet\ 6\ Inches, 5\ Feet\ 8\ Inches \rightarrow Ride\ B$$
$$Will \rightarrow Cannot\ go\ in\ any\ of\ the\ rides$$

## E. Addition

### Example 2.7

A blue rope is two feet and five inches long. A red rope is three feet and eight inches long.

A. What is the total length of the two ropes?
B. How much is the red rope longer than the blue rope?

**Part A**

$$\underbrace{2\ Feet\ 5\ Inches}_{Blue\ Rope} + \underbrace{3\ Feet\ 8\ Inches}_{Red\ Rope} = 5\ Feet\ 13\ Inches = 6\ Feet\ 1\ Inch$$

**Part B**

$$\underbrace{3\ Feet\ 8\ Inches}_{Red\ Rope} - \underbrace{2\ Feet\ 5\ Inches}_{Blue\ Rope} = 1\ Foot\ 3\ Inches$$

### Example 2.8

A blue rope is 3 feet and 4 inches long. A red rope is 2 feet and 3 inches. If the ropes are put end to end, what is the combined length of these ropes in feet and inches?

**Add Separately**

Here we add the feet and the inches separately.

$$3\ feet\ 4\ inches + 2\ feet\ 3\ inches = (3+2)\ feet\ (4+3)\ inches = 5\ feet\ 7\ inches$$

**Conversion**

In this method, we convert into inches first, and then do the addition. If needed, we convert back into feet and inches.

$$3\ feet\ 4\ inches + 2\ feet\ 3\ inches = 40\ inches + 27\ inches = 67\ inches = 5\ feet\ 7\ inches$$

### Example 2.9

A snail travelled 4 feet 8 inches in one hour, and 5 feet 9 inches in the next hour. What is the total distance travelled by the snail over two hours?

| | Feet | Inches |
|---|---|---|
| 1st Hour | 4 | 8 |
| 2nd Hour | 5 | 9 |
| | 9 | 17 |
| | +1 | -12 |
| | 10 | 5 inches |

## F. Subtraction

### Example 2.10

The tallest boy in a group is 5 feet 4 inches, while the shortest boy is 3 feet 2 inches. How much is the tallest boy taller than the shortest boy?

| | Feet | Inches |
|---|---|---|
| Tallest | 5 | 4 |
| Shortest | 3 | 2 |
| | 2 | 2 |

### Example 2.11
The tallest boy in a group is 4 feet 2 inches, while the shortest boy is 3 feet 8 inches. How much is the tallest boy taller than the shortest boy?

| | Feet | Inches |
|---|---|---|
| | | 12 |
| Tallest | 43 | 2 |
| Shortest | 3 | 8 |
| | 0 | 6 |

## G. Multiplication and Division

### Example 2.12
A wooden pole used for fencing is 2 feet 7 inches long. What is the total length of ten such poles?

$$1\ Pole = 2\ Feet\ 7\ Inches$$

To find the length of ten poles, we must multiply by 10:

$$(2\ Feet\ 7\ Inches) \times 10$$
$$= 20\ Feet\ 70\ Inches$$
$$= 20\ Feet + 5\ Feet\ 10\ Inches$$
$$= 25\ Feet\ 10\ Inches$$

### Example 2.13
A ship's mast is ten feet long. It cracks, and is cut in twelve pieces, to be used for firewood. What is the length of each piece?

The length of each piece:

$$= \frac{10\ Feet}{12} = \frac{10 \times 12\ Inches}{12} = 10\ Inches$$

### Example 2.14
A stone tile is in the shape of a square, with each side of length 11 inches. If a room has a width of 11 tiles, what is the width of the room, in feet and inches?

$$Width = 11 \times 11\ Tiles = 11 \times 11\ inches = 121\ inches = 10\ Feet\ 1\ Inch$$

# 2.2 Quantity

## A. Dozen

### 2.15: Dozen
$$1\ dozen = 12\ Items$$

Quantity is measured in the imperial system in dozens.
Dozens are used to count the number of items, such as bananas, or mangoes, etc.

### Example 2.16

A. One dozen bananas is how many bananas?
B. Two dozen apples is how many bananas?

$$1\ Dozen = 12 \Rightarrow 1\ Dozen\ Bananas = 12\ Bananas$$
$$2\ Dozen = 12 \Rightarrow 1\ Dozen\ Bananas = 12\ Apples$$

### Example 2.17

Convert the following into numbers:

A. Three dozen
B. Five dozen
C. Ten Dozen
D. Half a dozen
E. One-third of a dozen
F. Quarter of a dozen
G. One-Sixth of a dozen

$$3\ Dozen = 36$$
$$5\ Dozen = 60$$
$$10\ Dozen = 120$$
$$Half\ a\ Dozen = \frac{12}{2} = 6$$
$$One - third\ of\ a\ dozen = \frac{12}{3} = 4$$
$$Quarter\ of\ a\ Dozen = \frac{12}{4} = 3$$
$$One - Sixth\ of\ a\ Dozen = \frac{12}{6} = 2$$

### Example 2.18

A. Half a dozen apples are how many apples?
B. Quarter of a dozen bananas are how many bananas?
C. Two and a half dozen mangoes are how many?
D. Four and a quarter dozen watermelons is how many?
E. Each bag of apples contains a quarter of a dozen apples. Elvis sells twenty bags. How many apples did he sell in all?

$$Half\ a\ dozen = Half\ of\ 12 = 6$$
$$Quarter\ of\ a\ dozen = quarter\ of\ 12 = 12 \div 4 = 3$$
$$Two\ and\ a\ half\ dozen = 2\ Dozen + Half\ Dozen = 24 + 6 = 30$$

## B. Gross

### 2.19: Gross

$$1\ Gross = 12\ Dozen = 144\ Items$$

### Example 2.20

Convert into numbers:

A. One Gross
B. Two Gross

C. Half a Gross
D. One-third of a Gross
E. Quarter of a Gross
F. One-sixth of a Gross
G. One-eighth of a Gross
H. One-ninth of a Gross
I. One-twelfth of a Gross
J. One-sixteenth of a Gross

$$One\ Gross = 144$$
$$Two\ Gross = 288$$
$$Half\ a\ Gross = \frac{144}{2} = 72$$
$$One - third\ of\ a\ Gross = \frac{144}{3} = \frac{99}{3} + \frac{45}{3} = 33 + 15 = 48$$
$$Quarter\ of\ a\ Gross = \frac{144}{4} = \frac{72}{2} = 36$$
$$One - sixth\ of\ a\ Gross = \frac{144}{6} = 24$$
$$One - eighth\ of\ a\ Gross = \frac{144}{8} = 18$$
$$One - ninth\ of\ a\ Gross = \frac{144}{9} = 16$$
$$One - twelfth\ of\ a\ Gross = \frac{144}{12} = 12$$
$$One - sixteenth\ of\ a\ Gross = \frac{144}{16} = 9$$

### Example 2.21

A. 1 gross of bananas is how many dozen bananas? How many bananas in all?
B. Vansh purchased half a gross of mangoes. If half of them were spoilt, how many were good?
C. A quarter of a gross of apples costs Rs. 72. What is the cost of one banana?

$$1\ Gross\ Bananas = 12\ Dozen\ Baanans = 144\ Bananas$$
$$Mangoes\ Purchased = \frac{144}{2} = 72 \Rightarrow Good\ Mangoes = \frac{72}{2} = 36$$
$$Quarter\ of\ a\ Gross = \frac{144}{4} = 36 \Rightarrow Cost\ of\ One\ Banana = \frac{72}{36} = 2$$

## C. Money

### Example 2.22

Carl bought two dozen mangoes from the supermarket. He paid $3 for each of them. He also paid $3 to go the supermarket via bus, and $10 to come back via a shared taxi. How much did he spend in all?

$$2\ Dozen\ Mangoes = 24 \Rightarrow Cost\ of\ Mangoes = 24 \times 3 = \$72$$
$$Transportation\ Cost = 3 + 10 = \$13$$
$$Total\ Cost = 72 + 13 = 85$$

### Example 2.23

If half a dozen bananas cost $Rs.24$, what is the cost of one banana?

$$Half\ a\ dozen = Half\ of\ 12 = 6\ Bananas$$
$$6\ Bananas\ cost\ Rs.24$$
$$One\ Banana\ costs \frac{24}{6} = 4\ Rs.$$

### Example 2.24
If a banana costs Rs. 3, what is the cost of purchasing 2 less than a quarter of a dozen bananas?

$$Quarter\ of\ a\ Dozen = Quarter\ of\ 12 = 3$$
$$Two\ less\ than\ a\ Quarter = 3 - 2 = 1$$
$$Cost\ of\ Purchasing\ 1\ Bananas = 3$$

## D. Baker's Dozen

### 2.25: Baker's Dozen
$$Baker's\ Dozen = 13$$

As a tradition, a baker, when selling wholesale gives 13 for a dozen instead of 12. This is called a baker's dozen.

### Example 2.26
Find the number of items in:

A. 2 Baker's Dozen Pastries
B. A Baker's Dozen Buns
C. 5 Baker's Dozen Loaves of Bread
D. 3 Baker's Dozen Croissants
E. 9 Baker's Dozen Swiss Rolls

$$Pastries = 2 \times 13 = 26$$
$$Buns = 13$$
$$Loaves = 5 \times 13 = 65$$
$$Croissants = 3 \times 13 = 39$$
$$Swiss\ Rolls = 9 \times 13 = 117$$

### Example 2.27
Ishaan bought cakes from a bakery. The bakery uses a Baker's Dozen to count, and Ishaan bought five Baker's Dozen. How many cakes did he buy?

$$5\ Baker's\ Dozen = 5 \times 13 = 65$$

### Example 2.28
John ordered seven dozen cakes from a bakery for his birthday. The bakery delivered seven Baker's Dozen cakes. John has 80 friends, each of whom got a cake. One cake fell on the ground, and was wasted. He ate a cake himself, and gave one cake each to his father, mother, brother and sister. How many cakes were left over?

Cakes that came:

$$7\ Baker's\ Dozen = 7 \times 13 = 91$$

Cakes Eaten

$$\underbrace{1}_{Jake} + \underbrace{1}_{Father} + \underbrace{1}_{Mother} + \underbrace{1}_{Brother} + \underbrace{1}_{Sister} = 5$$

$$Total = \underbrace{80}_{Friends} + \underbrace{5}_{Family} + \underbrace{1}_{Wasted} = 86$$

Cakes Left Over:

$$\underbrace{91}_{\substack{Cakes\ that \\ Came}} - \underbrace{86}_{\substack{Cakes \\ Used}} = 5$$

### Example 2.29

A baker's shop sells muffins by a baker's dozen. If someone pays for a $\underbrace{regular\ dozen\ muffins}_{=12}$, they give them a $\underbrace{baker's\ dozen\ of\ muffins}_{=13}$. One muffin costs Rs. 3. A person comes and buys muffins worth Rs. 108. How many muffins will he get?

$$No.of\ Muffins = \frac{108}{3} = 36 = 3\ Dozen$$

But in this case, when he pays a dozen, he will get a Baker's Dozen instead, which means:

$$3\ Baker's\ Dozen = 3 \times 13 = 39\ Muffins$$

## E. Comparison

### Example 2.30

A bakery baked 37 cakes in the morning. And it baked a few dozen cakes in the evening. If the number of cakes baked in the evening were more than the number of cakes baked in the morning, what is the smallest number of cakes that could have been baked in the evening. ($Use\ 1\ Dozen = 12$)

$$\underbrace{12}_{1\ Dozen}\ ,\ \underbrace{24}_{2\ Dozen}\ ,\ \underbrace{36}_{3\ Dozen}\ ,\ \underbrace{48}_{4\ Dozen}$$

$$Smallest\ No.of\ Cakes\ baked\ in\ evening = 48$$

Repeat the above question, if the bakery uses a baker's dozen?

$$\underbrace{13}_{1\ Dozen}\ ,\ \underbrace{26}_{2\ Dozen}\ ,\ \underbrace{39}_{3\ Dozen}\ ,\ \underbrace{52}_{4\ Dozen}$$

$$Smallest\ No.of\ Cakes\ baked\ in\ evening = 39$$

### Example 2.31

Horace has been asked to buy less than a dozen bananas from the market. What is the maximum number of bananas that he could buy?

$$1\ Dozen = 12$$
$$Max = 11$$

## F. Arithmetic Operations

### Example 2.32

A grocery shop has four more than 2 Dozen Apples. It sells 8 apples, and it orders two crates of apples. Each crate has two more than a dozen apples. Find the number of apples in the grocery shop (in dozens).

#### Method I: Convert Everything Into Numbers

$$2\ Dozen + 4\ Apples = 24 + 4 = 28\ Apples$$
$$28 - \underbrace{8}_{Sold} = 20\ Apples$$

$$1\ Crate = 1\ Dozen + 2 = 12 + 2 = 14\ Apples$$
$$2\ Crates = 14 \times 2 = 28\ Apples$$

Final number of Apples

$$= 20 + 28 = 48\ Apples = 4\ Dozen$$

#### Method II

$$2\ Dozen + 4\ Apples + \underbrace{1\ Dozen + 2}_{1st\ Crate} + \underbrace{1\ Dozen + 2}_{2nd\ Crate} = 4\ Dozen + 8\ Apples$$

$$4\ Dozen + 8\ Apples - \underbrace{8}_{Sold} = 4\ Dozen\ Apples$$

# 2.3 Mass

## A. Units of Mass

### 2.33: Units of Mass

$$1\ Pound = 16\ Ounces$$
$$1\ Stone = 14\ Pounds$$

The smallest unit of mass in the imperial system that we will look at is the Ounce.

### Example 2.34

A. A brick weighs three pounds. How many ounces does it weigh?
B. 32 Ounces of apples are how many pounds?
C. What is the weight, in Stone, of a boy who weighs 70 pounds?
D. 1 Stone is how many Ounces?

$$1\ Brick = 3\ Pounds = 3 \times 16 = 48\ Ounces$$
$$Pounds\ of\ Apples = \frac{Ounces}{16} = \frac{32}{16} = 2$$

$$Weight = 70\ Pounds = \frac{70}{14} = 5$$
$$1\ Stone = 14\ Pounds = 14 \times 16 = 160 + 64 = 224$$

### Example 2.35

Find the value in Pounds:

A. Half a Stone
B. One-Seventh of a Stone

$$Half\ a\ Stone = \frac{14}{2} = 7\ Pounds$$
$$One - Seventh\ of\ a\ Stone = \frac{14}{7} = 2\ Pounds$$

### Example 2.36
Find the value in Ounces:

A. Half a pound
B. One-fourth of a pound
C. One-Eighth of a pound

$$Half\ a\ Pound = \frac{16}{2} = 8\ Ounces$$
$$One - fourth\ of\ a\ pound = \frac{16}{4} = 4\ Ounces$$
$$One\ Eighth\ of\ a\ Pound = \frac{16}{8} = 2\ Ounces$$

### Example 2.37
If Apples cost 3 pounds (of money) per pound (of weight), what is the cost of half a Stone of Apples?

$$Half\ a\ Stone = \frac{14}{2} = 7\ Pounds$$
$$Money = 7 \times 3 = 21\ Pounds$$

## B. Arithmetic Operations

### Example 2.38
One brick weighs 1 Pound and 5 Ounces. What is the weight of 5 bricks?

$$(1\ Pound\ 5\ Ounces) \times 5$$
$$= 5\ Pounds\ 25\ Ounces$$
$$= 5\ Pounds + 16\ Ounces + 9\ Ounces$$
$$= 6\ Pounds\ 9\ Ounces$$

### Example 2.39
An apple weighs 8 ounces, and an orange weighs six ounces. A bag of apples has three apples. And a bag of oranges has equal weight as the bag of apples. Find the number of oranges in the bag,

$$Weight\ of\ Bag\ of\ Apples = 8 \times 3 = 24\ Ounces$$
$$Weigth\ of\ Bag\ of\ Oranges = 24\ Ounces$$
$$No.of\ Oranges = \frac{24}{6} = 4$$

# 2.4 Capacity

## A. Units of Capacity

Units of capacity are used for liquids and gases

### 2.40: Units of Capacity

$$1\ pint = 20\ fluid\ ounces$$
$$1\ Quart = 2\ pints$$
$$1\ Gallon = 4\ Quarts$$

### Example 2.41

Convert the following:

A. 2 pints into fluid ounces
B. 3 Quarts into pints
C. 1 Gallon in Quarts
D. 9 pints into fluid ounces
E. 2 Quarts into pints
F. 3 Gallons into pints
G. 1 Quart into fluid ounces
H. 1 Gallon into pints
I. 1 Gallon into fluid ounces

$$2\ pints = 2 \times 20 = 40\ fluid\ ounces$$
$$3\ Quarts = 2 \times 3 = 6\ pints$$
$$1\ Gallon = 4\ Quarts$$
$$9\ pints = 9 \times 20 = 180\ fluid\ ounces$$
$$2\ Quarts = 4\ pints$$
$$3\ Gallon = 12\ Quarts = 24\ pints$$

## B. Addition and Subtraction

### Example 2.42

| | Litres | | ml | | |
|---|---|---|---|---|---|
| | | 109 | 10 | 10 | |
| | 21 | 0 | 54 | 0 | 0 |
| | | 9 | 7 | 5 | 0 |
| | | | | | |
| | 1 | 0 | 7 | 5 | 0 |

$$20\ L\ 500\ ml - 9\ L\ 750\ ml$$

Subtract $9L$ from $20L$ , leave the 750 $ml$ for now:

$$= 11\ L\ 500\ ml - 750\ ml$$

Rewrite $11L$ as $10L\ + 1L$:

$$= 10\ L + 1L + \ 500\ ml - 750\ ml$$

Convert $1L$ into 1000 $ml$ and add it to 500 $ml$:

$$= 10\ L + 1500\ ml - 750\ ml$$

Subtract 750 ml from 1500 ml

$$= 10\ L\ 750\ ml$$

# 3. Decimal Systems

## 3.1 Basic Conversions

### A. Conversion Facts

| Mass | | Length | | Capacity | |
|---|---|---|---|---|---|
| | | 1 cm | 10 mm | | |
| 1 kg | 1000 g | 1 meter | 100 cm | | |
| 1 Ton | 1000 kg | 1 km | 1000 meter | 1 litre | 1000 ml |

**Example 3.1**
Use the table above to answer this example.

**Mass**
Convert the following to $grams$:
$(1\ kg = 1000\ grams)$
A. 3 kg
B. 5 kg
C. 2 Kg
D. 8 Kg 450 grams
E. 3 kg 400 grams
F. 2 kg 700 grams
G. 8 kg 900 grams
Convert the following to $kilograms$:
$(1\ Ton = 1000\ kg)$
H. 3 Tons
I. 4 Tons
J. 2 Tons 50 Kg
K. 4 Tons 300 Kg

**Capacity**
Convert the following to $milliliters$:
$(1\ l = 1000\ ml)$
L. $4\ l$
M. $2\ l$
N. $5\ l$
O. $7\ l\ 400\ ml$
P. $2\ l\ 100\ ml$
Q. $5\ l\ 200\ ml$

**Length**
Convert the following to $millimeters$:
$(1\ cm = 10\ mm)$
R. 5 cm
S. 7 cm
T. 2 cm
U. 12 cm
Convert the following to $cm$:
$(1\ m = 100\ cm)$
V. 3 m
W. 7 m
X. 2 m
Y. 4 m 30 cm
Z. 7 m 40 cm
Convert the following to $meters$:
$(1\ km = 1000\ m)$
AA. 1 km
BB. 5 km
CC. 7 km
DD. 4 km 200 m
EE. 8 km 20 m

**Example 3.2**
Perform the conversions indicated in the table below.

**Mass**
$1000\ grams = 1\ kg$
Convert into kg and grams
A. 2000 grams
B. 4000 grams
C. 2400 grams
D. 5700 grams
E. 7690 grams
F. 2340 grams

**Capacity**
$1\ Liter = 1000\ ml$
Convert into litres and ml
G. 3000 ml
H. 2000 ml
I. 2500 ml
J. 7200 ml
K. 7280 ml
L. 6170 ml

**Length**
$10\ mm = 1\ cm$
Convert into cm
M. 40 mm
N. 180 mm
O. 20 mm
P. 55 mm
$100\ cm = 1\ m$
Convert to meters and cm
$100\ cm = 1\ m$
Q. 100 cm
R. 300 cm
S. 230 cm
T. 650 cm
Convert to km
$1000\ m = 1\ km$
U. 3000 m
V. 2000 m

W. 2340 m | X. 1280 m |

## 3.2 Addition and Subtraction

### A. Length

**Example 3.3**
A tablecloth is 1 *meters* 20 *cm* wide. If two tablecloths like these are put next to each other, what is the total width?

$$1\ m\ 20\ cm + 1\ m\ 20\ cm = 2\ m\ 40\ cm$$

**Example 3.4**
A pea plant 70 *cm tall* is next to a 1-meter-tall fence. How much taller must the pea plant grow to be as tall as the fence?

$$1\ m - 70\ cm = 100\ cm - 70\ cm = 30\ cm$$

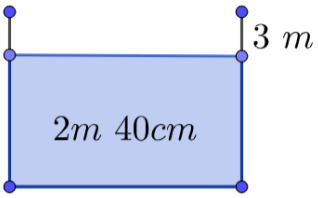
**Example 3.5**
An adult snail can travel 1 meter 10 *cm* in an hour. And a young snail can travel 70 *cm* in a hour.

A. An adult snail travels for an hour, and hands over a parcel to a young snail, who then travels for two hours. What is the total distance travelled?
B. What is the difference between how much an adult snail can travel, and how much a young snail can travel?

$$1\ m\ 10\ cm + 1\ m\ 40\ cm = 2\ m\ 50\ cm$$

$$1\ m\ 10\ cm - 70\ cm = 110\ cm - 70\ cm = 40\ cm$$

**Example 3.6**
A water tank 3 meters high has water in it with a depth of 2 m 40 cm. What is the distance from the top of the tank to the water?




$$3\ m - 2m\ 40 = 300 - 240 = 60\ cm$$

**Example 3.7**
Shirley has a rope measuring 3 meters and 40 cm, and another rope measuring 2 meters and 65 cm. If she puts the ropes end to end, what is the distance covered by the two ropes?

We need to do:

$$3\ m\ 40\ cm + 2\ m\ 65\ cm$$

Put the meters together and the cm together

$$= \underbrace{3+2}_{Meters} + \underbrace{40+65}_{Centimeters} = \underbrace{5}_{Meters} + \underbrace{105}_{Centimeters} = \underbrace{5+1}_{Meters} + \underbrace{5}_{Centimeters}$$

| | $m$ | $cm$ |
|---|---|---|
| | 3 | 40 |
| | 2 | 65 |
| Answer | 5 | 105 |
| Rearrange | +1 | −100 |
| | 6 | 5 |

Hence, the final answer is:

$$= 6\ m\ 5\ cm = 6.05\ m$$

## Example 3.8

A lamppost is 2 meters and 30 cm tall, while a plant is 1 meters and 70 cm tall. How much taller is the lamppost compared to the plant?

### Conversion Method

$$2\ m\ 30\ cm - 1\ m\ 70\ cm = 230\ cm - 170\ cm = 60\ cm$$

### Borrowing: Straight Calculation

$$2\ m\ 30\ cm - 1\ m\ 70\ cm = 1\ m\ 130\ cm - 1\ m\ 70\ cm = 60\ cm$$

### Tabular Method

| | $m$ | $cm$ |
|---|---|---|
| | | 100 |
| | **21** | 30 |
| − | 1 | 70 |
| Answer | 0 | 60 |

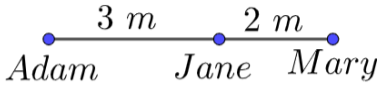
## Example 3.9

Adam is 5 meters away from Mary. Jane is 2 meters away from Mary.

A. What is the minimum distance between Adam and Jane?
B. What is the maximum distance between Adam and Jane?

### Part A

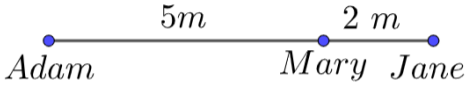
$$Min = 3$$




### Part B

$$Max = 3$$

## B. Mass




## Example 3.10

Which one weighs more? A kilogram of apples, or a kilogram of feathers?

$$\underbrace{1\ kg}_{Apples} = \underbrace{1\ kg}_{Feathers} \Rightarrow Both\ weigh\ the\ same.$$

## Example 3.11

Some apples weigh 3 kg 345 grams. Some oranges weigh 2 kg 787 grams.

A. What is the total weight of the fruits?
B. Which weighs more, and by how much?

$$3\ kg\ 345\ g + 2\ kg\ 787\ g = 5\ kg\ 1132\ g = 6\ kg\ 132\ g = 6.132\ kg$$

$$3\ kg\ 345\ g - 2\ kg\ 787\ g = 3345 - 2787 = 558\ g$$

| Carryover | 1 | 1 | 1 | |
|---|---|---|---|---|
| | Kg | Grams | | |
| | 3 | 7 | 8 | 7 |
| + | 2 | 3 | 4 | 5 |
| | 6 | 1 | 3 | 2 |

### C. Capacity

**Example 3.12**
A milkman has two containers. Container I has capacity of 1.4 litres. Container II has a capacity of 2.1 litres. Both containers are initially empty.

A. He fills milk to the brim in both Container I and Container II, and delivers it to a house. What is the total amount of milk delivered?
B. Milk is filled in Carton II to the brim. It is then used to fill Carton I. How much milk is left in Carton II?

$$1.4\ l + 2.1\ l = 3.5\ l$$

$$2.1\ l\ - 1.4\ l\ = 700\ ml$$

| | | |
|---|---|---|
| | | 10 |
| | 21. | 1 |
| | 1. | 4 |
| | 0. | 7 |

## 3.3 Multiplication and Division

### A. Length

**Example 3.13**
Sean has five blue ropes each of length one meter and 65 centimetres. He puts the ropes end to end. What is the distance between the start of the first rope, and the end of the last rope?

$$1\ m\ 65\ cm \times 5 = 5\ m\ 325\ cm = 8\ m\ 25\ cm = 8.25\ m$$

**Example 3.14**
Tvisha takes a rope and cuts it into three equal parts. If the rope was originally 6 meters and 21 cm, find the length of each of the parts.

$$\frac{6m\ 21\ cm}{3} = \frac{6m}{3} + \frac{21cm}{3} = 2\ m\ 7\ cm$$

**Example 3.15**
Rahul takes a rope and cuts it into three equal parts. If the rope was originally 4 meters and 11 cm, find the length of each of the parts.

$$\frac{4m\ 11\ cm}{3} = \frac{411\ cm}{3} = 137\ cm = 1\ m\ 37\ cm$$

**Example 3.16**
Rohan has to travel a distance of 45 km and 450 meters from his home to the big city. He divides his trip into three equal parts divided over three days. Find the distance that he travels each day.

$$\frac{45\ km\ 450\ meters}{3} = \frac{45}{3}km + \frac{450}{3}m = 15\ km\ 150\ m$$

### Example 3.17
Rishabh has to travel a distance of 96 km and 129 meters from his home to the big city. He divides his trip into nine equal parts over nine days. Find the distance that he travels each day.

$$\frac{96km\ 129m}{9} = \frac{96129\ m}{9} = 10681m = 10\ km\ 681m$$

## B. Mass: Multiplication

### Example 3.18
An apple weighs three hundred and fifty grams. What is the weight of 4 apples in kg?

$$350\ g \times 4 = 1400\ g = 1.4\ kg$$

## C. Mass: Division

### Example 3.19
From the market, Sheetal bought eggplants and bitter gourds, with total weight 2 kg 350 g. If the weight of each vegetable was the same, find that weight.

$$\frac{2\ kg\ 350\ g}{2} = 1kg\ 175\ g$$

### Example 3.20
A box of strawberries has seven strawberries in it. The box weighs 50 grams. The box and the strawberries together weigh 134 grams. If the strawberries have equal weight, find the weight of a box with ten strawberries.

$$Box + 7\ Strawberries = 134$$
$$7\ Strawberries = 134 - 50 = 84$$
$$1\ Strawberry = \frac{84}{7} = 12$$
$$10\ Strawberries = 120\ Grams$$
$$Box + 10\ Strawberries = 120 + 50 = 170$$

### Example 3.21
An apple weighs twice as much as an orange. The weight of one apple and one orange is 600 g.

A. Find the weight of an orange.
B. Find the weight of an apple.
C. Find the weight of two apples and three oranges.

$$One\ Apple + One\ Orange = 600g$$
$$Two\ Oranges + One\ Orange = 600g$$
$$Three\ Oranges = 600g$$
$$One\ \ Orange = \frac{600g}{3} = 200g$$
$$One\ Apple = Two\ Oranges = 200g \times 2 = 400g$$
$$Two\ Apples + Three\ Oranges = 400g \times 2 + 200g \times 3 = 800g + 600g = 1400g$$

### Example 3.22

An apple weighs twice as much as an orange. The weight of ten apples and ten oranges is 3 kg 333 g. Find the weight of one apple.

An apple weighs twice of an orange. Hence, we need to divide the weight given into three equal parts.

$$\frac{3333g}{3} = 1111g \Rightarrow 10\ Apples = 2222g, and\ 10\ Oranges = 1111g$$

$$One\ Apple = 222.2\ g$$

## D. Capacity

### Example 3.23

A carton of milk has a capacity of 650 ml. Sonam buys five cartons of milk and stores them together in a vessel.

A. If 30 ml of milk is spilled in this process, what is the quantity of milk in the vessel?
B. If 30 ml of milk is spilled in this process from each carton, what is the quantity of milk in the vessel?

$$5\ Cartons = 650 \times 5 = 3250\ ml \Rightarrow 3250\ ml - 30\ ml = 3220\ ml$$
$$5\ Cartons = 620 \times 5 = 3100\ ml$$

### Example 3.24

A milkman adds water to milk to dilute it, such that water is one-tenth of the liquid that he hands over to his customers. A customer buys three cartons of "liquid" of one litre each. How much actual milk does he get?

$$One\ carton\ of\ Liquid = 1000\ ml \Rightarrow Milk = 900\ ml, Water = 100\ ml$$
$$Three\ Cartons = 900\ ml \times 3 = 2700\ ml$$

### Example 3.25

A tank of water has capacity of 500 litres. It is currently three-fourths full. Five containers, each of capacity 12 litres are filled from the tank. What is the water left in the tank now?

### Example 3.26

A beaker has a capacity of 600 ml. Half of the beaker is filled with dilute sulfuric acid mixture. The mixture is half water, and half sulfuric acid. Find the quantity of sulfuric acid.

$$\frac{600\ ml}{2} = 300\ ml \rightarrow \frac{300\ ml}{2} = 150\ ml$$

# 3.4 Prefixes

## A. Increasing Prefixes

Prefixes are used to change the value of a unit. Each prefix has a numeric value, and you multiply the numeric value with the unit.

| Prefix | Decimal | Words | Exponents |
|---|---|---|---|
| Deca | 10 | Ten | $10^1$ |
| Hecto | 100 | Hundred | $10^2$ |
| Kilo | 1000 | Thousand | $10^3$ |
| Mega | 1,000,000 | Million | $10^6$ |

| | | | |
|---|---|---|---|
| Giga | | Billion | $10^9$ |

## Example 3.27

Convert the following as specified, using the table

A. 1 kilometer to meters

$$1\ kilometer = 1 \times 1000m = 1000m$$

## Example 3.28

Convert the following as specified. All conversions are from a larger unit to a smaller unit

A. 5 km into meters
B. 12 Decameters into meters
C. 5 Hectometers into meters
D. 100 megameters into meters

**Q1:** Convert the following as specified. All conversions are from a smaller unit to a larger unit

A. 3000 meters into km
B. 400 meters into decameter
C. 7,000,000 meters into kilometers

**S1:**

**S2:**

## B. Decreasing Prefixes

| Prefix | Decimal | Fraction | Words | Exponent | Negative Exponents |
|---|---|---|---|---|---|
| Deci | 0.1 | $\frac{1}{10}$ | One-tenth | $\frac{1}{10^1}$ | $10^{-1}$ |
| Centi | 0.01 | $\frac{1}{100}$ | One-hundredth | $\frac{1}{10^2}$ | $10^{-2}$ |
| Milli | 0.001 | $\frac{1}{1000}$ | One-thousandth | $\frac{1}{10^3}$ | $10^{-3}$ |
| Micro | 0.000001 | $\frac{1}{1,000,000}$ | One-millionth | $\frac{1}{10^6}$ | $10^{-6}$ |
| Nano | | | One-billionth | $\frac{1}{10^9}$ | $10^{-9}$ |

## Example 3.29

Convert the following:

A. 1 cm to meters
B. 3 cm to meters
C. 2 decimeter to meters

$$1\ centimeter = 1 \times \frac{1}{100}m = \frac{1}{100}m = 0.01m$$

$$3\ cm = 3 \times \frac{1}{100}m = \frac{3}{100}m = 0.03m$$

$$2\ decimeters = 2 \times \frac{1}{10}m = \frac{2}{10}m = 0.2m$$

## Example 3.30

**Q2:** Convert the following as specified. All conversions are from a larger unit to a smaller unit

A. 5 cm into meters
B. 12 Decimeters into meters
C. 5 Hectometers into meters
D. 100 megameters into meters

**Q3:** Convert the following as specified. All conversions are from a smaller unit to a larger unit

A. 3000 meters into km
B. 400 meters into decameter
C. 7,000,000 meters into kilometers

**S3:**

**S4:**

# PART III: TIME

# 4. TIME

## 4.1 Introduction

### A. AM and PM

A day has 24 hours. In the am/pm system, there are 12 hours for am, and 12 hours for pm.
AM starts from 12: 00 midnight, and continues till 12: 00 noon.
PM starts from12: 00 noon and continues till 12: 00 midnight.

In the am/pm, system, 12: 00 comes twice in a day.

## 4.2 Arithmetic Operations Within the Hour

### A. End Time

If we are given the start time of an activity, and the time taken for that activity, we can find the end time using the formula:

$$End\ Time = Start\ Time + Time\ Spent$$

In other words, to find the end time, we:

- Add time
- Move forwards on a time line

**Example 4.1**

A. Ankur got into his car to drive to the sports complex at 3:40 pm. He took 15 minutes to reach there. What was the time when he entered the sports complex?
B. Disha left her house to walk to her swimming class at 2:10 pm. The walk to her class takes her 35 minutes. At what time did she reach swimming class?
C. Arjun gets up at 7.20 am, and starts getting ready for school at 8:20 am. He takes 40 minutes to get ready. What is the time when he is ready for school?
D. Ajay started rehearsing for his dance performance. The rehearsal took him 38 minutes, and he started at 8: 07 am. What time did he finish his rehearsal?

$$3{:}40\ pm + 15\ min = 3{:}55\ pm$$
$$2{:}10\ pm + 35\ min = 3{:}45\ pm$$
$$8{:}20\ pm + 40\ min = 8{:}60\ pm = 9{:}00\ pm$$
$$8{:}07\ am + 38\ minutes = 8{:}45\ am$$

**Example 4.2**

Beena has to walk three blocks to the supermarket. Each block takes her three minutes to walk. She starts walking at 8:04 pm.

A. What time will she reach the supermarket?
B. If the queue outside the supermarket takes seven minutes, what time will she go inside the supermarket?
C. If she spends twelve minutes shopping, what time will she finish shopping?

8: 13
8: 20

8: 32

## B. Time Differences Within the Hour

Given a start time and an end time, we can find the time difference between the two times using

$$Time\ Difference = End\ Time - Start\ Time$$

We can also say that time difference is the same as time elapsed, so

$$Time\ Elapsed\ = End\ Time - Start\ Time$$

In other words, to find the time difference, or the time elapsed, we:

- Subtract the start time from the end time
- Move backwards on a timeline from the end time to the start time

### Example 4.3

Find the time difference between the following times:

A. 10: 25 $am$ and 10: 45 $am$
B. 5: 20 $pm$ and 5: 55 $pm$

#### Parts A and B

Since the hour is the same, we only need to focus on the minutes:

$$\mathbf{10}{:}\ 45 - \mathbf{10}{:}\ 25 = 45 - 25 = \ 20\ minutes$$

$$\mathbf{5}{:}\ 55 - \mathbf{5}{:}\ 20 = 55 - 20 = 35\ minutes$$

## C. Start Time

To find the start time, we subtract the time elapsed from the end time.

$$Start\ Time = End\ Time - Time\ Elapsed$$

This is similar to when we want to find the time elapsed.
To find the start time, we:

- Subtract the time elapsed from the end time
- Move backwards on a timeline from the end time to the start time

### Example 4.4

Riddhi got off her school bus at 8: 35 am.

A. If her school bus takes 20 minutes to take her from home to school, what time did she get onto the bus?
B. If Riddhi takes twenty minutes to get ready, and she does that just before leaving home for school, what time did she start getting ready?
C. Riddhi studies for an hour before getting ready for school. What time did she start studying?

$$8{:}\ 35 - 20\ min = 8{:}\ 15\ am$$
$$8{:}\ 15 - 20\ minutes = 7{:}\ 55\ am$$
$$7{:}\ 55 - 1\ hour = 6{:}\ 55\ am$$

# 4.3 Time Conventions

## A. Converting to Regular Times

### Example 4.5: Half Past

Convert the following into times:

A. Half past nine
B. Half past twelve
C. Half past four
D. Half past six
E. Half past ten

$9:30$
$12:30$
$4:30$
$6:30$
$10:30$

### Example 4.6

Convert the following into times:

A. Quarter past four
B. Quarter to five
C. Quarter past ten
D. Quarter past seven
E. Quarter to eleven

$4:15$
$4:45$
$10:15$
$7:15$
$10:45$

### Example 4.7

Convert the following into times:

A. Noon
B. Midnight

$12:00\ pm$
$12:00\ am$

## B. Time before and after

### Example 4.8

A. What is a quarter of an hour after 6:40 pm?
B. What is half an hour before half past seven?
C. What is half an hour after noon?
D. What is half an hour before midnight?
E. What is a quarter of an hour after noon?
F. What is a quarter of an hour before midnight?

$$6:40 + 15\ min = 6:55$$
$$7:30 - 30\ min = 7:00$$
$$12:00 + 30\ min = 12:30$$
$$12:00 - 30\ min = 11:30$$

$$12{:}00 + 15\ min = 12{:}15$$
$$12{:}00 - 15\ min = 11{:}45$$

# 4.4 Conversions

## A. Converting to Minutes

### Example 4.9

Find the following in minutes:

A. 2 Hours
B. 1 Hour
C. 5 Hours
D. 4 Hours
E. 3 Hours

$$120\ min$$
$$60\ min$$
$$300\ min$$
$$240\ min$$
$$180\ min$$

### Example 4.10

Find the following in minutes:

A. 1 Hour 30 Minutes
B. 3 Hours 20 Minutes
C. 4 Hours 10 Minutes
D. 2 Hours 35 Minutes
E. 1 Hour 7 Minutes
F. 2 Hours 12 Minutes
G. 1 Hour and 42 Minutes
H. 4 Hours and 15 Minutes

$$90$$
$$200$$
$$250$$
$$155$$
$$67$$
$$132$$
$$60 + 42 = 102$$
$$255$$

## B. Fractions of an Hour

Recall that $of$ means multiplication. Hence, when we want to find fractional parts of an hour, we replace $of$ with multiplication.

### Example 4.11

Convert the following fractional parts of an hour into minutes:

A. Half an hour
B. One-third of an hour
C. One-fourth of an hour

D. One-fifth of an hour
E. One-sixth of an hour
F. One-tenth of an hour
G. One-twelfth of an hour
H. One-twentieth of an hour
I. One-thirtieth of an hour
J. One-sixtieth of an hour

$$Half\ of\ an\ hour = 60 \div 2 = 30\ min$$
$$60 \div 3 = 20\ min$$
$$60 \div 4 = 15\ min$$
$$One - fifth\ of\ an\ hour = 60 \div 5 = 12$$
$$One - Sixth\ of\ an\ hour = 60 \div 6 = 10$$
$$One - tenth\ of\ an\ hour = 60 \div 10 = 6$$
$$One - twelfth\ of\ an\ hour = 60 \div 12 = 5$$
$$One - twentieth\ of\ an\ hour = 60 \div 20 = 3$$
$$One - thirtieth\ of\ an\ hour = 60 \div 30 = 2$$
$$One - sixtieth\ of\ an\ hour = 60 \div 60 = 1$$

### C. Converting into Hours

**Example 4.12: Convert into Hours**
Find the following in hours:
A. 180 Minutes
B. 60 Minutes
C. 240 Minutes
D. 720 Minutes
E. 1200 Minutes

**Example 4.13: Convert into Hours**
Find the following in hours and minutes:
A. 100 Minutes
B. 200 Minutes
C. 400 Minutes
D. 250 Minutes

## 4.5 Arithmetic Operations Across Hours

### A. End Time

**Example 4.14: Across Hours**
A. Vidita travels to office on a bus starting at 9:30 am. It takes her 45 minutes. What time will she reach office?
B. Vinit was working on history homework. He started working at 9: 43 pm, and he spent 28 minutes on the homework. What time did he finish his homework?

$$9{:}\,43 + 28\ min = 9{:}\,71 = 10{:}\,11\ pm$$

## B. Time Difference

### Example 4.15

A. Find the time difference from 5: 54 *to* 11: 13
B. Find the time difference between 3: 40 *pm* and 4: 20 *pm*
C. Find the time difference between 2: 25 *pm* and 5: 05 *pm*
D. Find the time that Stephan took to drive if he started at 6: 46 *am* and finished at 12: 57 *pm*.

$$\underbrace{5{:}\,54\ to\ 6{:}\,00}_{6\ Minutes} + \underbrace{6{:}\,00\ to\ 11{:}\,00}_{5\ Hours} + \underbrace{11{:}\,00\ to\ 11{:}\,13}_{13\ Minutes} = 5\ Hours\ 19\ Minutes$$

## C. Start Time

### Example 4.16

Ansh finished his homework at 9: 12 *pm*. If he took 34 minutes to do his homework, what time did he start doing the HW?

$$9{:}\,12\ pm - 34\ \text{min} = 9{:}\,00 - 22\ min = 8{:}\,38\ pm$$

**Part C**

Go forward from 3:40 to find the number of minutes needed to reach 4:20

$$3{:}\,40 + 20 = 4{:}\,00\ pm, 4{:}\,00\ pm + 20 = 4{:}\,20 \Rightarrow 20 + 20 = 40\ minutes$$

**Part D**

$$2{:}\,25 + \mathbf{35\ min} = 3{:}\,00\ pm$$
$$3{:}\,00\ pm + \mathbf{1\ hr} = 4{:}\,00\ pm$$
$$4{:}\,00\ pm + \mathbf{1\ hr} = 5{:}\,00\ pm$$
$$5{:}\,00\ pm + \mathbf{5\ min} = 5{:}\,05\ pm$$

So, in all, we added:

$$35\ \text{min} + 1\ hr + 1\ hr + 5\ min = 2\ hr\ 40\ min$$

## D. Multiplication

### Example 4.17

A carpenter takes 20 minutes to make a chair.

A. How much time will he take to make four chairs?
B. If he starts making the chairs at noon, what time will he finish making the chairs?

$$20\ min \times 4 = 80\ min = 1\ hr\ 20\ min$$
$$12{:}\,00 + 1{:}\,20 = 1{:}\,20\ pm$$

# 4.6 24-Hour System

## A. 24-Hour System

In the 23-hour system, the hours run from 00: 00 (Midnight) to 23: 59 (one minute before midnight).

When converting from am/pm to 24-hour system

- AM time does not change
- For PM time, you add 12 hours to the given time

## Example 4.18

Convert the following times from am/pm to the 24-hour system:

A. 4:00 am
B. 4:00 pm

$$\underbrace{4{:}00\ am}_{\textbf{12 Hour Time}} = \underbrace{4{:}00}_{\textbf{24 Hour Time}}$$
$$\underbrace{4{:}00\ pm}_{\textbf{12 Hour Time}} = \underbrace{16{:}00}_{\textbf{24 Hour Time}}$$

# 5. Calendars

## 5.1 Time Elapsed

### A. Days Elapsed

**Example 5.1**
Rehan's spring break started on 7th April. His school resumed on 16th April. How long was his spring break?

We want to find the number of days in the break, which is given by:

$$16 - 7 = 9\ Days$$

And we can also confirm this by manually counting the days:

$$\{7,8,9,10,11,12,13,14,15\} \Rightarrow 9\ Days$$

## 5.2 Days

### A. Days of the Week

**Example 5.2**
The 1st Saturday in a particular year is on 3rd January. What is the date of the 3rd Saturday of January?

| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
|---|---|---|---|---|---|---|
| | | | | | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | |

### B. Days in a Month

The days in the months of the year are given as follows:

| | | | | | |
|---|---|---|---|---|---|
| Jan | 31 | May | 31 | Sep | 30 |
| Feb | 28 or 29 | June | 30 | Oct | 31 |
| Mar | 31 | July | 31 | Nov | 30 |
| Apr | 30 | Aug | 31 | Dec | 31 |

**Example 5.3**
How many months of the year have less than 31 days?

$$Feb, Apr, June, Sep, Nov \Rightarrow 5\ Months$$

**Example 5.4**
What is the maximum number of months in a year that have an even number of days?

$$Feb, Apr, June, Sep, Nov \Rightarrow 5\ Months$$

## C. Repetition of Days in a Month

### Months with 31 Days

From the table, see that:

- Mon, Tue and Wed occur five times
- Thu, Fri, Sat and Sun occur four times.

| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
|---|---|---|---|---|---|---|
| 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 | 26 | 27 | 28 |
| 29 | 30 | 31 | | | | |

In general, any three days of the week will occur five times.

### Months with 30 Days

| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
|---|---|---|---|---|---|---|
| 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 | 26 | 27 | 28 |
| 29 | 30 | | | | | |

- Mon and Tue occur five times
- Other days occur four times.

In general, any two days of the week will occur five times.

### Months with 29 Days

| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
|---|---|---|---|---|---|---|
| 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 | 26 | 27 | 28 |
| 29 | | | | | | |

- Mon occurs five times
- Other days occur four times.

In general, any one day of the week will occur five times.

### Example 5.5

How many months of a year are there such that

A. no days of the week that occur five times in the month?
B. exactly one day of the week occurs five times in the year?
C. exactly two days of the week occur five times in the year?
D. exactly three days of the week that occur five times in the year?

### Part A

This will only happen when the month has 28 days, which happens in February.
Further, the year must be a non-leap-year.

### Part B
This will only happen when the month has 29 days, which happens in February.
Further, the year must be a leap-year.

### Part C
This will only happen when the month has 30 days, which happens in Apr, June, Sep, Nov.

### Part D
This will only happen when the month has 30 days, which happens in Jan, Mar, May, July, Aug, Oct, Dec.

## D. Leap Year versus Non-Years
### Centuries versus Other Years
Years that end in two zeros are centuries. For example:

$$300 \; is \; a \; century$$
$$700 \; is \; a \; century$$

Any year that does not end in two zeroes is not a century:

$$301 \; is \; not \; a \; century$$
$$756 \; is \; not \; a \; century$$

### Non-Century Years
A leap year that is not a century must be divisible by 4:

$$\frac{2004}{4} = 501 \; R0 \Rightarrow Leap \; Year$$

### Century Years
A leap year that is a century must be divisible by 400:

$$\frac{2000}{400} = 5 \Rightarrow Leap \; Year$$
$$\frac{1900}{400} = \frac{19}{4} = 3\frac{3}{4} \Rightarrow Non - Leap \; Year$$

### Example 5.6: Deciding between leap years and non-leap years
State whether the following years are leap years, or non-leap years:

A. 1995
B. 2016
C. 1952
D. 1800

### Part A
$$1995 \; is \; odd \Rightarrow Not \; Divisible \; by \; 4 \Rightarrow Non \; Leap \; Year$$

### Part B
$$2016 \Rightarrow Check \; last \; two \; digits \Rightarrow \frac{16}{4} = 4 \Rightarrow Divisible \; by \; 4 \Rightarrow Leap \; Year$$

### Part C
$$1952 \Rightarrow Check \; last \; two \; digits \Rightarrow \frac{52}{4} = 13 \Rightarrow Divisible \; by \; 4 \Rightarrow Leap \; Year$$

### Part D

$$1800 \Rightarrow \frac{1800}{400} = \frac{18}{4} = \frac{9}{2} = 4\frac{1}{2} \Rightarrow Not\ Divisible\ by\ 4 \Rightarrow Not\ a\ Leap\ Year$$

### Example 5.7
In a particular non-leap year, Republic Day falls on a Sunday. On which day does the last day of the next month fall?

| Mon | Tue | Wed | Thu | Fri | Sat | Sun |
|---|---|---|---|---|---|---|
| | | | | | | 26 |
| 27 | 28 | 29 | 30 | 31 | 1 | 2 |
| | | | | | | 9 |
| | | | | | | 16 |
| | | | | | | 23 |
| 24 | 25 | 26 | 27 | 28 | | |

## E. Changing Years
As we already know:
- A leap year has 366 days
- A non-leap has 365 days

### Example 5.8
A. Convert 366 days into weeks and days.
B. Convert 365 days into weeks and days.

$$366\ Days = 52\ Weeks\ \&\ 2\ Days$$
$$365\ Days = 52\ Weeks\ \&\ 1\ Days$$

### Example 5.9
1st January in a particular leap year falls on a Wednesday. What is 1st January of the next year?

The number of weeks does not count. Because, if today is Wednesday, and you move forward by 1 week, which is 7 days, the day of the week remains the same.

So, we only need to pay attention to the number of days:

$$Wed + 2\ Days = Friday$$

### Example 5.10
1st January in a particular non-leap year falls on a Friday. What is 1st January of the next year?

$$Friday + 1\ Day = Saturday$$

### Example 5.11
1st February of 2021 falls on a Saturday. Which day is 1st February of the next year?

2021 is a non-leap year.

$$Saturday + 1\ Day = Sunday$$

# 6. Clocks

## 6.1 Slow and Fast Clocks

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### A. Slow Clocks

**Example 6.1**

A watch which is set at the correct time at 10.00 am on a particular day shows 10.55 am, when the actual time is 11.00 am.

A. What time will it show when the actual time is 2.00 pm?
B. If the watch shows 11.50 am, what is the actual time?

**Part A**

The watch falls behind by 5 minutes for every hour.

The time between 2.00 pm and 10.00 am

$$2.00\ pm - 10.00\ am = 4\ Hours$$

For every hour that passes, the watch falls behind by

$$5\ minutes$$

In 4 Hours, the watch will fall behind by

$$5 \times 4 = 20\ Minutes$$

Hence, when the actual is 2.00 pm, the watch will show:

$$2{:}00\ pm - 20\ minutes = 1{:}40\ pm$$

**Part B**

The watch falls behind by 5 minutes for every hour.
The watch will fall behind by 10 minutes for every 2 hours.

$$10{:}00\ am + 2\ Hours = 12{:}00$$

And the watch will show:

$$12{:}00 - 10\ Minutes = 11{:}50\ am$$

Hence, the actual time is

$$12{:}00\ noon$$

### B. Fast Clocks

**Example 6.2**

A watch which is set at the correct time at 10.00 am on a particular day shows 10.55 am, when the actual time is 11.00 am.

A. What time will it show when the actual time is 2.00 pm?
B. If the clock shows 11.50 am, what is the actual time?

# Time, Speed and Distance

**Distance**

Distance is the shortest path from one point to another.

**Conversion for Units of Distance**

| → | | × 1000 | × 100 | × 10 |
|---|---|---|---|---|
| | Km | m | cm | mm |
| Km | 1 | 1000 | 1,00,000 | 10,00,000 |
| M | | 1 | 100 | 1,000 |
| Cm | | | 1 | 10 |
| Mm | | | | 1 |
| ← | ÷ 1000 | ÷ 100 | ÷ 10 | |

Example

Make the following conversions as indicated below:

Convert to mm

A. 4 cm 40 mm
B. 4 cm 0.04 $mm$
C. 34 cm 0.34 $m$

Convert to cm

D. 12 mm 1.2 $cm$
E. 27 mm 0.027$m$
F. 2 m 200 $cm$
G. 2.1 m210 $cm$
H. 0.23m 23 $cm$
I. $\frac{1}{2}m$ $\frac{1}{2}m = \frac{1}{2} \times 100\ cm = 50\ cm$
J. $\frac{1}{4}m$ $\frac{1}{4}m = \frac{1}{4} \times 100\ cm = 25\ cm$
K. $\frac{1}{5}m \frac{1}{5}m = \frac{1}{5} \times 100\ cm = 20\ cm$

Convert to m

L. 3 km $3km = 3 \times 1000m = 3000m$

M. 2.34 km$2.34km = 2.34 \times 1000 = 2340m$

N. $\frac{1}{2}km$ $\frac{1}{2}km = \frac{1}{2} \times 1000 = 500\ m$

O. $\frac{1}{4}km \frac{1}{4}km = \frac{1}{4} \times 1000m = 250\ m$

P. $\frac{1}{5}km$ $\frac{1}{5}km = \frac{1}{5} \times 1000m = 200\ m$
Q. $\frac{1}{10}km$ $\frac{1}{10}km = \frac{1}{10} \times 1000m = 100\ m$

**Challenge Questions**

R. $1.5km$ to cm $1.5km = 1.5 \times 1000m = 1500m = 1500 \times 100\ cm = 150000cm$
S. 350 cm to km $350\ cm = 350 \times \frac{1}{100}m = 3.5m = 3.5 \times \frac{1}{1000} = 0.0035km$
T. 25 cm to km $25\ cm = 25 \times \frac{1}{100}m = 0.25\ m = 0.25\ \frac{1}{1000} = 0.00025km$

U. 1127 mm to km

$$1127mm = 1127 \times \frac{1}{1000}m = 1.127m = 1.127 \times \frac{1}{1000}\ km = 0.001127\ km$$

V. $\frac{1}{25}$th of 1 $km = \frac{1}{25} \times 1000m = 40m$

W. $\frac{1}{40}$th of 1 $km = \frac{1}{40} \times 1000m = 25m$

X. $\frac{1}{8}$th of 1 $km = \frac{1}{8} \times 1000m = 125m$

Y. $\frac{1}{125}$th of 1 $m = \frac{1}{8} \times 1000m = 8mm$

Z. 0.5 $m\ to\ km$ 0.0005 $km$

**Word Problems**

A. Half of one-fourth of one-eighth of a km (expressed in m)

$$\frac{1}{2} \times \frac{1}{4} \times \frac{1}{8} \times 1000m = \frac{1}{2} \times \frac{1}{4} \times 125m = \frac{125}{8}m$$

B. A rope is one-third of one-ninth of 12m. What is the length of 81 such ropes?

$$81 \times \frac{1}{3} \times \frac{1}{9} \times 12m = 81 \times \frac{1}{27} \times 12m = 3 \times 12m = 36m$$

**Length**

**Convert to inches (One foot = 12 inches)**

A. 6 feet 72 $inches$

B. 12 feet 144 $inches$

C. 3 feet 5 inches 41 $inches$

D. 2 feet 7 inches 31 $inches$

E. Half of a foot 6 $inches$

F. One-fourth of a foot 3 $inches$

G. One-eighth of a foot $\frac{12}{8}\ inches = \frac{3}{2}\ inches = 1.5\ inches$

H. Three-fourths of a foot $\frac{3}{4} \times 1 foot = \frac{3}{4} \times 12 inches = 9\ inches$

I. Half of 2 feet 6 inches $\frac{1}{2} \times 2ft\ 6\ inches = \frac{1}{2} \times 30\ inches = 15\ inches$

J. Two-thirds of one-fourth of 12 feet 4 inches

$$\frac{2}{3} \times \frac{1}{4} \times 12 feet\ 4\ inches = \frac{2}{3} \times \frac{1}{\mathbf{4}} \times \mathbf{148}\ inches = \frac{2}{3} \times 37\ inches = \frac{74}{3} inches$$

**Miscellaneous Length Conversions**

K. One yard is three feet. Find the number of yards in one-third of a foot.

$$\frac{1}{3} foot = \frac{1}{3} \times \frac{1}{3} yards = \frac{1}{9} yards$$

L. One furlong is one-eighth of a mile. One mile is 5280 feet. Find the length of one furlong in feet.

$$1\ furlong = \frac{1}{8} of\ 1mile = \frac{1}{8} \times 5280 feet = 660\ feet$$

M. One chain is equal to 66 feet. Find the number of chains in 220 feet.

$$220\ feet = 220 \times \frac{1}{66} chains = \frac{220}{66} = \frac{10}{3} chains$$

**Area**

C. A hectare consists of 100 acres. How many acres is $\frac{1}{5}th$ of a hectare?

$$\frac{1}{5} Hectare = \frac{1}{5} \times 100\ Acres = 20\ Acres$$

D. An acre consists of 43560 square feet. What is the area (in square feet) of half of an acre?

$$\frac{1}{2}Acre = \frac{1}{2} \times 43560\ ft^2 = 21780\ ft^2$$

E. An acre consists of 43560 square feet. What is the area (in square feet) of one-fourth of an acre?

$$\frac{1}{4}Acre = \frac{1}{4} \times 43560 ft^2 = 10890\ ft^2$$

**Volume (1 Litre = 1000 ml)**

A. Half of a litre $500\ ml$
B. One-fourth of a litre $250\ ml$
C. One-fifth of a litre $200\ ml$
D. One-eighth of a litre $125\ ml$
E. Two-fifths of a litre $400\ ml$
F. Three-eighths of a litre $375\ ml$
G. One-sixteenth of a litre $\frac{125}{2}\ ml$
H. A thimble contains one-half of one-fourth of one-ninth of a litre. How many ml will 27 such thimbles contain?

$$\mathbf{27} \times \frac{1}{\mathbf{2}} \times \frac{1}{\mathbf{4}} \times \frac{1}{\mathbf{9}} \times 1000ml = 3 \times \frac{1}{8} \times 1000 = 375\ ml$$

**Teaspoons and Tablespoons (Teaspoon = 5ml, Tablespoon=15ml)**

A. A teaspoon is 5 ml. Find how many teaspoons are needed to fill two bottles containing 130 ml.

$$2 \times 130 \times \frac{1}{5} = 52\ Teaspoons$$

B. Find the number of tablespoons in a litre. Also, find the number of teaspoons in a litre.

$$Tablespoons\ in\ a\ litre = \frac{1000}{15} = \frac{200}{3}$$

$$Teaspoons\ in\ a\ litre = \frac{1000}{5} = 200$$

**Gallon, quarts, pints (1 gallon = 4 quarts, 1 quart = 2 pints, 1 pint = 2 cups, 1 cup = 8 ounces)**

A. 2.5 gallons is how many quarts? $2.5\ gallons = 2.5 \times 4\ quarts = 10\ quarts$
B. 3.5 quarts is how many pints? $3.5\ quarts = 3.5 \times 2\ pints = 7\ pints$
C. 12.5 pints is how many cups?

$$12.5\ pints = 12.5 \times 2\ cups = 25\ cups$$

D. Half a cup is how many ounces?

$$\frac{1}{2}cup = \frac{1}{2} \times 8\ ounces = 4\ ounces$$

E. One-fourth of a cup is how many ounces

$$\frac{1}{4}cup = \frac{1}{4} \times 8\ ounces = 2\ ounces$$

F. One gallon is how many ounces?

$$1\ gallon = 4\ quarts = 8\ pints = 16\ cups = 128\ ounces$$

G. One ounce is how many quarts?

$$1\ ounce = \frac{1}{8}cup = \frac{1}{8} \times \frac{1}{2}pints = \frac{1}{8} \times \frac{1}{2} \times \frac{1}{2}quarts = \frac{1}{32}quarts$$

H. One-eighth of a gallon is how many pints?
I. One-fourth of an ounce is how gallon?
J. A container can be filled by 1 gallon, 2 quarts, 3 pints, 4 cups, and 5 ounces. Find the capacity of the container in ounces.