

— STUDY NOTES

Cambridge Mathematics D

{ 4024 }

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SUBJECT

Mathematics D

SUBJECT CODE

4024

CURRICULUM

Cambridge — O Level

ACADEMIC SESSION

DECLARATION OF AUTHENTICITY

I hereby declare that this study notes document is my own original work prepared under the guidance of my instructor at Neuratech Academy. All content contained herein is accurate to the best of my knowledge and has been prepared with academic integrity in accordance with the institution's code of conduct and scholarly standards.

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REFERENCE COMPENDIUM

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A complete formula and concept reference for Cambridge O Level Mathematics D (4024) — organised by topic for rapid revision and study.

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COMING IN FULL EDITION

20+	Mensuration, Geometry & Circles	11+
..	Trigonometry & Bearings	..
..	Vectors, Matrices, Transformations	..
..	Statistics & Probability	..



How to use these notes: Each chapter combines core definitions, key formulae, visual aids, and worked examples. Look for the highlighted formula cards for memorisation and the diagrams for spatial reasoning. Annotate freely — these are *your* notes.

01

CHAPTER ONE

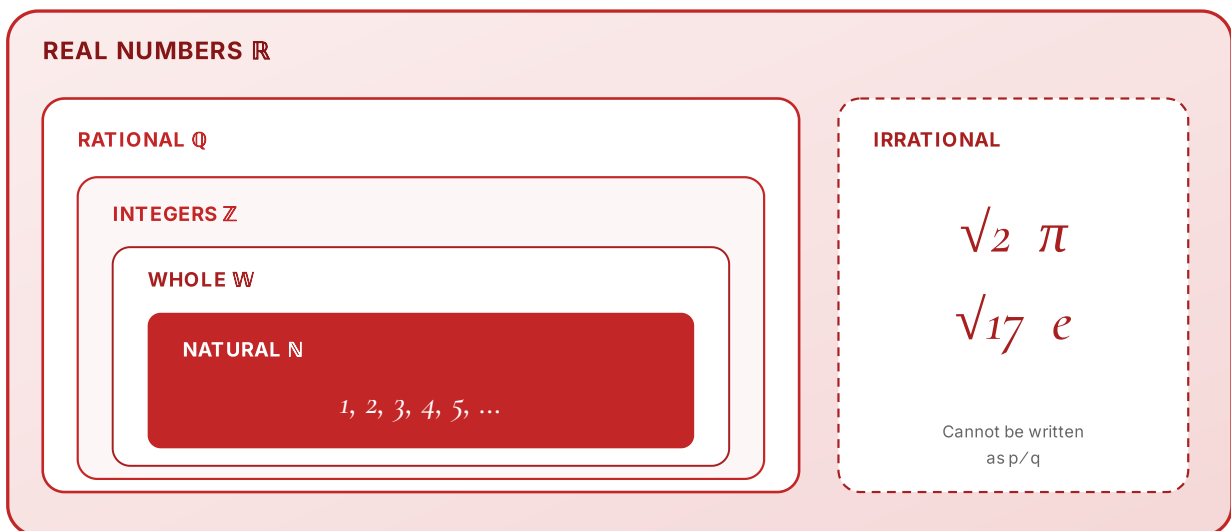
The Number System

Every mathematical idea begins with numbers. Before we can multiply, factorise, or solve, we must first understand the families to which numbers belong — and how each family fits inside the next.

The Hierarchy of Numbers

Numbers are organised in nested sets. Each set *contains* the one before it, expanding our mathematical vocabulary one ring at a time.

FIGURE 1.1 — HIERARCHY OF NUMBER SETS



Natural → Whole adds **zero** · Whole → Integer adds **negatives** · Integer → Rational adds **fractions** · Together with the irrationals, they form the real numbers.

QUICK RECALL

Natural \subset Whole \subset Integer \subset Rational \subset Real
 (The " \subset " symbol means "is a subset of")

★ **EXAM POINTER**

When asked "is X rational?", check if it can be written as a fraction p/q where $q \neq 0$. If not — it's irrational.

Number Types — Defined

Natural Numbers (N) The counting numbers. 1, 2, 3, 4, ... They never include zero or negatives.

Whole Numbers (W) Natural numbers *together with zero*: 0, 1, 2, 3, ...

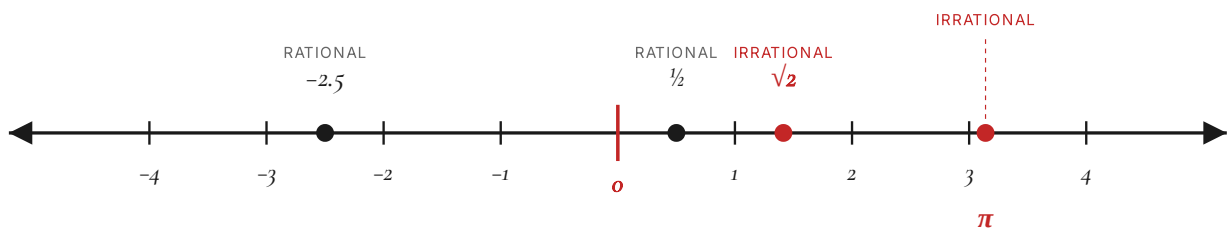
Integers (Z) Whole numbers and their negatives: ..., -3, -2, -1, 0, 1, 2, 3, ...

Rational Numbers (Q) Any number expressible as p/q , with $q \neq 0$. Examples: $\frac{1}{2}$, $\frac{3}{4}$, $-\frac{5}{2}$, $49 \div 56$.

Irrational Numbers Cannot be expressed as a fraction. Their decimal expansion never terminates and never repeats. Examples: $\sqrt{2}$, $\sqrt{5}$, $\sqrt{17}$, π .

Real Numbers (R) All rational and irrational numbers — every number on the number line.

FIGURE 1.2 — NUMBERS ALONG THE REAL LINE



Every point on this line is a real number. Integers sit at whole positions; rationals fill in the fractions; irrationals like $\sqrt{2}$ and π occupy the gaps in between.

Terminating Decimals type 1

Decimals that *stop* after a finite number of digits.

$$7/8 = 0.875 \text{ (terminates after 3 places)}$$

Recurring Decimals type 2

Decimals where a digit or block of digits *repeats forever*.

$$137/259 = 0.528957\overline{7}$$



Notation tip. Dots are placed above the *first* and *last* digits of the repeating block to indicate recurrence. For a single repeating digit, place one dot above it.

Order of Operations — BODMAS

When an expression mixes operations, BODMAS sets the order of execution. Work left to right within each tier.



Significant Figures

Significant figures (s.f.) measure the *precision* of a number — the meaningful digits from the first non-zero digit onwards.

ORIGINAL	1 S.F.	2 S.F.	3 S.F.
8064	8000	8100	8060
0.00508	0.005	0.0051	0.00508
2.00508	2	2.0	2.01

Decimal Places

Decimal places (d.p.) simply count digits *after* the decimal point. Round using the next digit.

ORIGINAL	1 D.P.	2 D.P.	3 D.P.
0.0647	0.1	0.06	0.065
2.0647	2.1	2.06	2.065

Standard Form

Standard form expresses very large or very small numbers concisely.

STANDARD FORM

$$a \times 10^n, \text{ where } 1 \leq a < 10, n \in \mathbb{Z}$$

FIGURE 1.3 — ANATOMY OF STANDARD FORM

$$\begin{array}{ccc}
 & & \text{exponent (power of 10)} \\
 & & \nearrow \\
 & 2.4 \times 10^3 & = 2400 \\
 \begin{array}{c} | \\ \text{coefficient} \\ 1 \leq a < 10 \end{array} & & \begin{array}{c} | \\ \text{base} \end{array}
 \end{array}$$

LARGE NUMBER

$$2400 = 2.4 \times 10^3$$

Decimal moves 3 places *left* → positive exponent.

SMALL NUMBER

$$0.0035 = 3.5 \times 10^{-3}$$

Decimal moves 3 places *right* → negative exponent.

02

CHAPTER TWO

Quantities & Percentages

Conversion Factors

LENGTH

1 km = 1000 m
1 m = 100 cm
1 cm = 10 mm

MASS

1 tonne = 1000 kg
1 kg = 1000 g
1 g = 1000 mg

VOLUME

1 litre = 1000 cm³
1 m³ = 1000 litres
1 kL = 1000 L

Time

60s

= 1 MINUTE

60min

= 1 HOUR

24h

= 1 DAY

7d

= 1 WEEK

365.25

DAYS = 1 YEAR

366d

= 1 LEAP YEAR

Percentages

Percent means *per hundred*. To write one quantity as a percentage of another, form a fraction and multiply by 100.

PROFIT / LOSS

$$\text{Profit} = \text{SP} - \text{CP}$$

$$\text{Loss} = \text{CP} - \text{SP}$$

PERCENTAGE

$$\text{Profit \%} = \frac{(\text{SP} - \text{CP})}{\text{CP}} \times 100$$

$$\text{Loss \%} = \frac{(\text{CP} - \text{SP})}{\text{CP}} \times 100$$



SP = Selling Price · **CP** = Cost Price. Profit and loss percentages are always calculated *on the cost price*, not on the selling price.

WORKED EXAMPLE

A shopkeeper buys an item for **Tk 800** and sells it for **Tk 960**.

$$\text{Profit} = 960 - 800 = \text{Tk } 160$$

$$\text{Profit \%} = (160/800) \times 100 = 20\%$$

★ MIND THE DIRECTION

If $\text{SP} > \text{CP}$ → **profit**. If $\text{SP} < \text{CP}$ → **loss**. If $\text{SP} = \text{CP}$ → break-even (no profit, no loss).

03

CHAPTER THREE

Simple & Compound Interest

Interest is the cost of borrowing — or the reward of investing. Simple interest grows linearly; compound interest grows on top of itself, producing the unmistakable curve of exponential growth.

Simple Interest

INTEREST

$$I = P \times R \times T / 100$$

AMOUNT

$$A = P + I$$

P Principal — the amount invested or borrowed.

R Rate of interest, expressed as a percentage per annum.

T Time period, in years.

A Total amount = Principal plus accumulated interest.

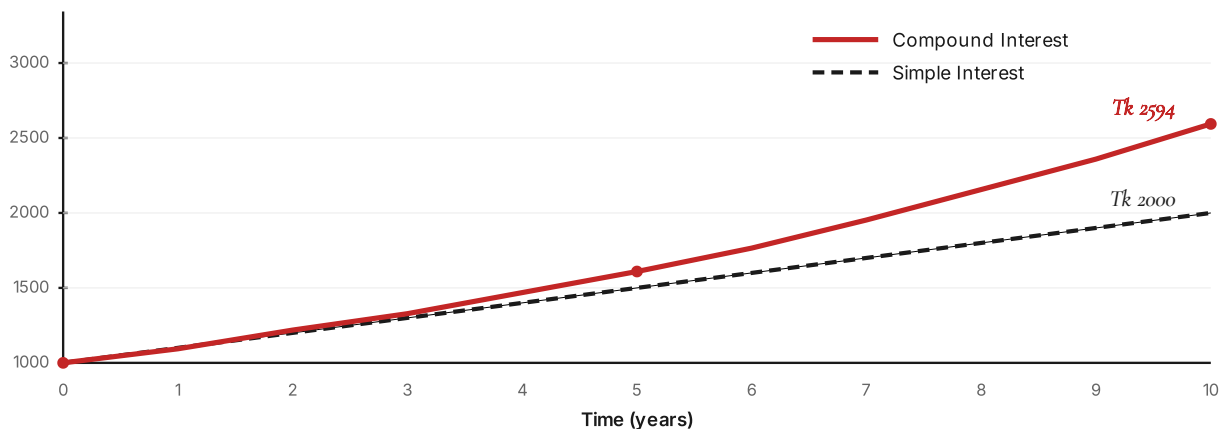
Compound Interest

With compound interest, each year's interest is added to the principal, so the next year's interest is calculated on a larger base.

COMPOUND AMOUNT

$$A = P (1 + R/100)^n$$

FIGURE 3.1 — SIMPLE VS COMPOUND INTEREST (TK 1000 AT 10% OVER 10 YEARS)



Same principal, same rate, same time — compound interest delivers Tk 594 more, because interest earns interest.

04

CHAPTER FOUR

Speed, Distance & Time

Three quantities, one triangle. Cover the one you want, and the remaining two reveal the formula. This simple memory device transforms motion problems into one-step calculations.

Core Formulae

THE THREE EQUATIONS

$$\text{Distance} = \text{Speed} \times \text{Time}$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

AVERAGE SPEED

$$\text{Avg Speed} = \frac{\text{Total Distance}}{\text{Total Time}}$$

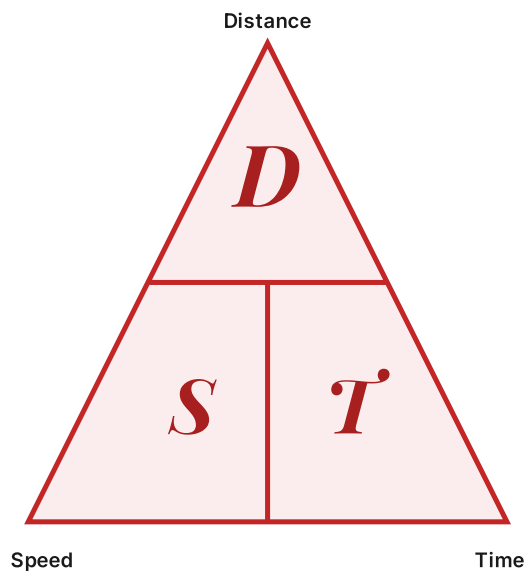
Unit Conversions

KM/H ↔ M/S

$$\text{km/h} \times \frac{5}{18} = \text{m/s}$$

$$\text{m/s} \times \frac{18}{5} = \text{km/h}$$

FIGURE 4.1 — THE SDT TRIANGLE



Cover the unknown:
 $D = S \times T \mid S = D/T \mid T = D/S$

km/h
SPEED

km
DISTANCE

hr
TIME

WORKED EXAMPLE — AVERAGE SPEED

A car travels **120 km** in 2 hours, then **180 km** in the next 3 hours.

$$\text{Total distance} = 120 + 180 = 300 \text{ km}$$

$$\text{Total time} = 2 + 3 = 5 \text{ hr}$$

$$\text{Average speed} = 300/5 = 60 \text{ km/h}$$



Watch your units. If speed is in km/h, time must be in hours and distance in km. Always convert *before* calculating.

05

CHAPTER FIVE

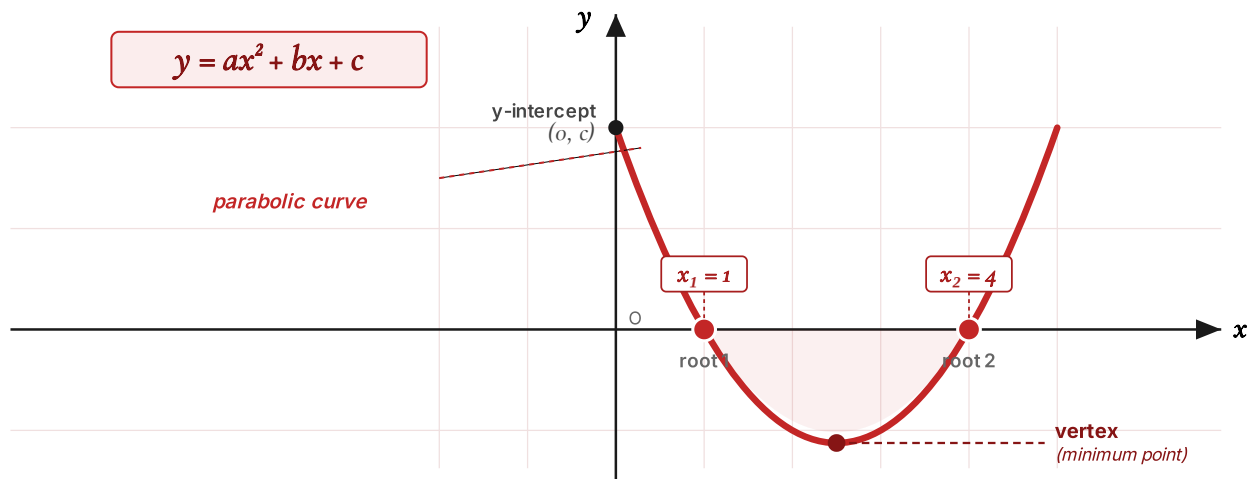
Quadratic Equations

A **quadratic equation** is one in which the highest power of the variable is 2. Its standard form is:

GENERAL QUADRATIC

$$ax^2 + bx + c = 0, \quad a \neq 0$$

FIGURE 5.1 — A QUADRATIC AS A PARABOLA



The **roots** are where the parabola crosses the x-axis ($y = 0$); the **vertex** is the turning point (minimum if $a > 0$, maximum if $a < 0$).

Three Methods to Solve

A SOLUTION BY FACTORISATION

QUICKEST WHEN FACTORS ARE CLEAN

If $c \times d = 0$, then either $c = 0$ or $d = 0$ (or both). Factor the quadratic into two brackets, then set each bracket to zero.

B THE QUADRATIC FORMULA

ALWAYS WORKS

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

The expression $b^2 - 4ac$ is the **discriminant**: if *positive* → two distinct real roots; if *zero* → one repeated root; if *negative* → no real roots.

C COMPLETING THE SQUARE

REVEALS THE VERTEX

- 1 Make the coefficient of x^2 equal to 1.
- 2 Move the constant c to the right side.
- 3 Take half the coefficient of x , square it, and add to both sides: $(b/2)^2$.
- 4 Factorise the left side as a perfect square and solve.