

VCE VM Numeracy Unit 1

Chapter 9 — Formula sheet

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Contents

Section	Page
Formula Sheet — every formula used in this book	2
The toolkit (Chapter 1)	3
Number (Chapter 2)	4
Shape and scaling (Chapter 3)	6
Metric conversion (Chapter 4)	7
Perimeter, area and volume (Chapter 4)	8
Time and temperature (Chapter 4)	9
Rates and formulas (Chapter 5)	10
Personal and civic numeracy (Chapter 6)	12
Financial numeracy (Chapter 6)	13
Health, vocational and recreational numeracy (Chapter 6)	14

Formula Sheet — every formula used in this book

This sheet collects every formula used anywhere in this book, together with the meaning of every letter. Keep it beside you as you work through Chapters 1 to 6, and use it for the practice assessments in Chapters 7 and 8 wherever your teacher allows — those assessments use nothing that is not on this sheet. Within one entry, each letter always means the same thing; but the same letter can stand for different things in different entries, so always read the definitions written with the formula.

Three things to remember before you start.

- **Work in the right order.** Brackets first, then $\times$ and $\div$ (left to right), then $+$ and $-$ (left to right). With $C = 60 + 35h$ and $h = 3$: multiply first — $35 \times 3 = 105$ — then add: $60 + 105 = \$165$. It is NOT $(60 + 35) \times 3 = 285$.
- **Keep every digit until the end; round only at the end, and only where the question says to.** Round to the stated accuracy — “to the nearest cent”, “to 2 decimal places”, “to the nearest whole number”. Halfway always rounds up. Then round the way that fits real life: round UP when buying whole packs or bags; round DOWN when fitting whole items into a space.
- **Use the numbers the question gives you.** GST is 10% everywhere in this book, but tax rates, interest rates, pay rates and commission rates change from question to question and are always stated. Use the question’s number, never one you remember.

The toolkit (Chapter 1)

Description	Formula
Symbols used in this book	$=$ means equals; $\approx$ means approximately equal to (“close to”); % means percent (“out of 100”); $\times$ means multiply; $\div$ means divide; / inside a unit means “per” — \$ 9/m is dollars per metre, km/hr is kilometres per hour
The problem-solving cycle	Four stages, in order: 1 Identify the maths (what is asked, which numbers matter, which operations, make a plan); 2 Act on the maths (estimate first, then calculate exactly); 3 Evaluate (compare with the estimate; does the answer fit real life?); 4 Report (a full sentence, with units)
Three ways to estimate	Round to friendly numbers (4 bottles at \$ 3.20: estimate $4 \times \$3 = \$12$; exact is \$ 12.80 — close, so it passes). Compare with a benchmark (a size you know from everyday life). Work backwards with the opposite operation (is $\$236 \div 4 = \$59$? check $59 \times 4 = 236$ ✓)
Reading any scale	one small space = (gap between two labels) $\div$ (spaces between them); reading = lower label + (spaces past the label $\times$ value of one space). Labels 40 and 50 with 5 spaces: one space = $10 \div 5 = 2$ g; pointer 4 spaces past 50: $50 + 4 \times 2 = 58$ g
Measuring from a mark that is not zero	length = end reading – start reading

Number (Chapter 2)

Description	Formula
Place value	each place is 10 times the place to its right; after the decimal point, each place is one tenth of the place to its left
Money	\$1 = 100 cents; money is always written to 2 decimal places
Multiply by 10, 100, 1000	the digits move left — the value gets bigger ($0.37 \times 10 = 3.7$)
Divide by 10, 100, 1000	the digits move right — the value gets smaller ($37 \div 100 = 0.37$)
The rounding rule	find the rounding digit; look one place to its right (the decider digit). Decider 0–4: the rounding digit stays; decider 5–9: add 1 to it. Then drop all digits to the right. Halfway (5) always rounds up. 4528 to the nearest hundred: decider 2, so 4500. 3.49 to a whole number: decider 4, so 3
Fact families	one fact gives you four: if $6 \times 7 = 42$, then $42 \div 6 = 7$ and $42 \div 7 = 6$
Division with a remainder	$47 \div 6 = 7$ remainder 5 (because $6 \times 7 = 42$ and $47 - 42 = 5$). The remainder is always smaller than the group size. For whole things (packs, trips, tables), count one more: 50 bottles in packs of 8: $50 \div 8 = 6$ remainder 2, so buy 7 packs
Four quick tests for multiples	2: last digit 0, 2, 4, 6 or 8; 5: last digit 0 or 5; 10: last digit 0; 3: the digits add to a multiple of 3 ($27: 2 + 7 = 9$, and 9 is a multiple of 3, so 27 is too)
Equivalences — halves and tenths	$\frac{1}{2} = 0.5 = 50\%$; $\frac{1}{10} = 0.1 = 10\%$
Equivalences — quarters	$\frac{1}{4} = 0.25 = 25\%$; $\frac{3}{4} = 0.75 = 75\%$
Equivalences — fifths	$\frac{1}{5} = 0.2 = 20\%$; $\frac{2}{5} = 0.4 = 40\%$; $\frac{3}{5} = 0.6 = 60\%$; $\frac{4}{5} = 0.8 = 80\%$
Equivalences — thirds	$\frac{1}{3} \approx 0.33 = 33\%$; $\frac{2}{3} \approx 0.67 = 67\%$ (decimals to 2 decimal places)
Fraction → decimal	top $\div$ bottom ($\frac{1}{4}$ is $1 \div 4 = 0.25$)
Decimal → percent	$\times 100$ ($0.6 \times 100 = 60$, so $0.6 = 60\%$)
Percent → decimal	$\div 100$ ($25\% = 25 \div 100 = 0.25$)
Fraction of an amount	divide by the bottom, multiply by the top: $\frac{3}{5}$ of 45 is $45 \div 5 = 9$, then $9 \times 3 = 27$
Percent of an amount	percent as a decimal $\times$ amount: 20% of \$60 is $0.2 \times 60 = \$12$
Building from 10%	$10\% = \div 10$; $5\% = \text{half of } 10\%$; $20\% = \text{double } 10\%$;

Description	Formula
	$25\% = \div 4$; $50\% = \text{half}$; $75\% = 50\% + 25\%$. On \$ 250 $: 10\% = \$ 25$, $5\% = \$ 12.50$, $20\% = \$ 50$, $25\% = \$ 62.50$, $50\% = \$ 125$, $75\% = \$ 187.50$
1 % of an amount	$\text{amount} \div 100$: 1 % of \$ 90 000 is $\$ 90\,000 \div 100 = \$ 900$
Percentage increase	$\text{new amount} = \text{old amount} + (\text{percent of old amount})$. Shortcut: multiply by 1 + the percent as a decimal. $+ 10\%$ means $\times 1.10$: $200 \times 1.10 = \$ 220$
Percentage decrease (discount)	$\text{sale price} = \text{price} - \text{discount}$. Shortcut: multiply by 1 – the percent as a decimal. 25 % off means $\times 0.75$: $80 \times 0.75 = \$ 60$
Simple proportion — one-first method	$\text{value of one} = \text{total} \div \text{number}$; $\text{new total} = \text{value of one}$ $\times \text{new number}$. \$ 9.60 for 2: one costs $\$ 9.60 \div 2 = \$ 4.80$; 5 cost $\$ 4.80 \times 5 = \$ 24.00$
Simple proportion — multiplier method	$\text{multiplier} = \text{new number} \div \text{old number}$; $\text{new amount} =$ $\text{old amount} \times \text{multiplier}$. From 4 serves to 6: multiplier $= 6 \div 4 = 1.5$; $400 \times 1.5 = 600 \text{ mL}$
Two equal fractions	whatever you do to the top, do to the bottom: $\frac{5}{8} = \frac{15}{24}$ (top $\times 3$, so bottom $\times 3$)
Unit price and the best buy	$\text{unit price} = \text{price} \div \text{amount in one unit (1 L, 1 kg or 100 g)}$; the lowest unit price is the best buy. $\$ 3.60 \div 2 = \$ 1.80$ per L against $\$ 5.10 \div 3 = \$ 1.70$ per L — the \$ 1.70 bottle is the better buy
Splitting in a given ratio — the parts method	to share in the ratio $a : b$ (a and b are numbers of parts): ADD — $\text{total parts} = a + b$; DIVIDE — value of one $\text{part} = \text{whole} \div (a + b)$; MULTIPLY — $\text{each share} = \text{its}$ $\text{parts} \times \text{value of one part}$; CHECK — the shares add back to the whole. 20 shared 2 : 3: $2 + 3 = 5$ parts; $20 \div 5 = 4$; shares $2 \times 4 = 8$ and $3 \times 4 = 12$; $8 + 12 = 20$ $\checkmark$. \$ 50 shared 1 : 2: one part $= 50 \div 3 = \$ 16.67$, shares $\$ 16.67$ and $\$ 33.33$ (to the nearest cent)
Ratio shares as fractions	the a share is $\frac{a}{a+b}$ of the whole and the b share is $\frac{b}{a+b}$; the two fractions add to 1. For 2 : 3: $\frac{2}{5}$ and $\frac{3}{5}$

Shape and scaling (Chapter 3)

Description	Formula
Scaling	multiply every length by the same number — the scale factor
New length	new length = original length $\times$ scale factor ($15 \times 0.4 = 6$ cm — a reduction)
Original length	original length = new length $\div$ scale factor ($6 \div 0.4 = 15$ cm)
Finding the scale factor	scale factor = new length $\div$ original length (4 cm growing to 12 cm: $12 \div 4 = 3$; 10 cm shrinking to 5 cm: $5 \div 10 = 0.5$)
What the scale factor tells you	greater than 1: enlargement; between 0 and 1: reduction; equal to 1: same size
Plans — “1 cm represents 2 m”	real length = plan length $\times$ what 1 cm represents ($3 \times 2 = 6$ m); plan length = real length $\div$ what 1 cm represents ($10 \div 2 = 5$ cm)

Metric conversion (Chapter 4)

Description	Formula
Length	$10\text{ mm} = 1\text{ cm}$; $100\text{ cm} = 1\text{ m}$; $1000\text{ mm} = 1\text{ m}$; $1000\text{ m} = 1\text{ km}$
Mass	$1000\text{ g} = 1\text{ kg}$
Capacity	$1000\text{ mL} = 1\text{ L}$
Which way to go	big unit $\rightarrow$ small unit: MULTIPLY; small unit $\rightarrow$ big unit: DIVIDE. $3.5\text{ km} = 3.5 \times 1000 = 3500\text{ m}$; $750\text{ g} = 750 \div 1000 = 0.75\text{ kg}$
The size check	the smaller the unit, the bigger the number — the same length has more mm than cm, and more cm than m
Capacity and volume bridges	$1\text{ mL} = 1\text{ cm}^3$; $1\text{ L} = 1000\text{ mL} = 1000\text{ cm}^3$; $1\text{ m}^3 = 1\,000\,000\text{ cm}^3 = 1000\text{ L}$
Cups and litres	$1\text{ cup} \approx 250\text{ mL}$; $4 \times 250 = 1000\text{ mL} = 1\text{ L}$

Perimeter, area and volume (Chapter 4)

Description	Formula
Perimeter of any shape	add all the sides
Perimeter of a rectangle	$P = 2 \times (l + w)$, where P = perimeter, l = length, w = width. With $l = 12$ cm and $w = 4$ cm: $P = 2 \times (12 + 4) = 2 \times 16 = 32$ cm
Perimeter of a square	$P = 4 \times s$, where s = side length
Missing side from the perimeter	$P \div 2$ gives $l + w$; missing side = $(P \div 2) - \text{known side}$. With $P = 32$ cm and $l = 12$ cm: $32 \div 2 = 16$, and $16 - 12 = 4$ cm
Area of a rectangle	$A = l \times w$, where A = area; the answer is in square units (cm^2 , m^2). A lot 150 m by 80 m: $A = 150 \times 80 = 12\,000$ m^2
Area of a square	$A = s \times s$
Volume of a rectangular box	$V = l \times w \times h$, where V = volume and h = height; two steps — base area $l \times w$, then multiply by h ; the answer is in cubic units (cm^3 , m^3). $V = 5 \times 3 \times 4 = 60$ cm^3
Missing height	height = volume $\div$ base area ($h = V \div (l \times w)$). With $V = 7500$ cm^3 and base area 250 cm^2 : $h = 7500 \div 250 = 30$ cm
Box volume in litres	find V in cm^3 , then use 1000 $\text{cm}^3 = 1$ L. A tub 40 cm by 30 cm by 25 cm: $V = 40 \times 30 \times 25 = 30\,000$ cm^3 $= 30\,000$ mL = 30 L
Fitting cubes into a box	count along each edge, then multiply: number that fit = (length $\div$ cube side) $\times$ (width $\div$ cube side) $\times$ (height $\div$ cube side). A 20 cm by 10 cm by 10 cm box with 5 cm cubes: $(20 \div 5) \times (10 \div 5) \times (10 \div 5) = 4 \times 2 \times 2 = 16$ cubes
Which way to round	buying concrete, soil or packs: round UP; fitting whole items into a space: round DOWN

Time and temperature (Chapter 4)

Description	Formula
Time facts	60 s = 1 min; 60 min = 1 h; 1 h = 3600 s; 24 h = 1 day; 7 days = 1 week = 168 h; 1 year = 12 months = 365 days (366 in a leap year)
Leap years	a year that divides by 4 exactly is a leap year — its February has 29 days
Converting time units	big → small: multiply ($4 \text{ min} = 4 \times 60 = 240 \text{ s}$); small → big: divide and keep the remainder (155 min : $155 \div 60 = 2 \text{ remainder } 35$, so 2 h 35 min)
Decimal hours	minutes $\div 60$ = the decimal part of an hour ($15 \div 60 = 0.25$, so 6 h 15 min = 6.25 h); decimal part $\times 60$ = minutes ($0.25 \times 60 = 15 \text{ min}$)
12-hour → 24-hour	for pm times, add 12 to the hour ($7 + 12 = 19$, so 7:20 pm = 19:20); for am times the hour stays; midnight = 00:00; noon = 12:00
Clock minutes	minutes = (number the minute hand points at) $\times 5$ (pointing at 8: $8 \times 5 = 40$ minutes past)
“Minutes to”	60 – minutes past = minutes to ($60 - 40 = 20$: “twenty to”)
How long between two times	duration = finish time – start time (use 24-hour times; borrow 1 h = 60 min when needed), or add jumps on a timeline. From 11:40 to 14:15: $15 + 60 = 75$, $75 - 40 = 35 \text{ min}$ and $13 - 11 = 2 \text{ h}$, so 2 h 35 min. Jumps: $20 + 120 + 15 = 155 \text{ min} = 2 \text{ h } 35 \text{ min}$
Reading a thermometer	the scale rule again: one space = (gap between labels) $\div$ (spaces); reading = lower label + (spaces $\times$ one space). Labels 10 and 20 with 5 spaces: one space = $10 \div 5 = 2$ °C; top 3 spaces past 10: $10 + 3 \times 2 = 16$ °C
Rises and falls	rise: add; fall: subtract; difference = higher – lower
Everyday temperature landmarks	water freezes at 0 °C; a fridge is about 4 °C; a room is about 20 °C; a hot day is about 35 °C; body temperature is about 37 °C; a fever is 38 °C or more; water boils at 100 °C; a moderate oven is about 180 °C
Rounding a temperature	to the nearest whole degree, the decider is the first decimal place: 5 or more rounds up (38.6 °C → 39 °C; 36.4 °C → 36 °C)

Rates and formulas (Chapter 5)

Description	Formula
What a rate is	rate = total $\div$ number of ones — the value of ONE, written with two units (\$9 per metre, 60 km per hour)
Price per metre (\$/m)	price per metre = total cost $\div$ metres ($27 \div 3 = \$9/\text{m}$); total cost = price per metre $\times$ metres ($9 \times 3 = \$27$); metres = total cost $\div$ price per metre
Speed (km/hr)	speed = distance $\div$ time ($180 \div 3 = 60 \text{ km/hr}$); distance = speed $\times$ time ($70 \times 2 = 140 \text{ km}$); time = distance $\div$ speed ($210 \div 70 = 3 \text{ h}$)
Match the units first	a rate in km/hr needs kilometres and hours: metres $\rightarrow$ kilometres, $\div 1000$ ($900 \text{ m} = 0.9 \text{ km}$); minutes $\rightarrow$ decimal hours, $\div 60$
Cost per hour	$C = h \times r$, where C = total cost (\$), h = number of hours, r = cost per hour (\$/h). $C = 4 \times 32 = \$128$
Cost per hour, backwards	hourly rate = total cost $\div$ hours ($r = C \div h$): $\$167.50 \div 5 = \$33.50$ per hour
Call-out fee plus hourly rate	$C = f + h \times r$, where f = the call-out fee, paid once. Multiply $h \times r$ FIRST, then add f : $C = 60 + 3 \times 45 = 60 + 135 = \$195$. Wrong: $(60 + 3) \times 45 = \$2835$
Distance formula	$D = s \times t$, where D = distance (km), s = speed (km/hr), t = time (h). $D = 90 \times 1.5 = 135 \text{ km}$
Letters used in this book	A = area; P = perimeter; V = volume; C = cost or pay; D = distance; l = length; w = width; h = height or hours; s = speed or side length; t = time; n = number of people or things; r = rate per hour; f = fixed fee. Always read the key that comes with a rule — one letter can stand for different things
Dropping the $\times$ sign	a number times a letter: $4n = 4 \times n$; the number comes first ($5m$, not $m5$); the 1 is dropped (k , not $1k$); between two numbers the sign stays ($3 \times 4 = 12$, never 34)
Brackets	the number in front multiplies EVERYTHING inside: $2(l + w) = 2l + 2w$. With $l = 5$ and $w = 3$: $2 \times (5 + 3) = 2 \times 8 = 16$, and $2 \times 5 + 2 \times 3 = 10 + 6 = 16$ ✓
Like terms	only the same letter joins: $3a + 5a = 8a$; $3a + 5b$ stays as it is
Division as a fraction	$n \div 4 = \frac{n}{4}$. Half of 640 g of flour: $\frac{640}{2} = 320 \text{ g}$
A measurement vs a rule	5 m (with a space) = five metres — a measurement; $5m$ (no space) = $5 \times m$ — a rule
Substitution — three steps	1 write the formula; 2 replace each letter with its number, writing the $\times$ sign back in; 3 work it out in the right order and put the unit on. $C = 13n$ with $n = 4$: $C = 13 \times 4 = \$52$ — NOT \$134
Two-step rules	fixed part + per-one part — multiply first, then add:

Description	Formula
	$C = 95 + 26h$ with $h = 2$: $26 \times 2 = 52$, then $95 + 52 = \$147$
Spreadsheet rules	on screen $*$ is $\times$ and $/$ is $\div$: $=95+26*A2$ means $C = 95 + 26h$ with h in cell A2; $=B2*C2$ multiplies two cells; $=SUM(D2:D4)$ adds a block of cells

Personal and civic numeracy (Chapter 6)

Description	Formula
Arrival time	arrival time = departure time + trip time
Cost per person	total cost = cost per person $\times$ number of people ($0.90 \times 75 = \$67.50$)
Whole packs only	divide, then round UP: 26 bread rolls sold in packs of 12: $26 \div 12 = 2$ remainder 2, so buy 3 packs
A rate as a percent	rate = part $\div$ whole $\times 100$. 1800 of 2400 seats sold: $1800 \div 2400 = 0.75$, and $0.75 \times 100 = 75\%$
Percentage-point change	change = new percent – old percent ($6.4 - 4.9 = 1.5$ percentage points)
Interest for one year	interest = interest rate (as a decimal) $\times$ amount ($0.05 \times 1000 = \$50$)

Financial numeracy (Chapter 6)

Description	Formula
Pay from an hourly rate	pay = rate per hour $\times$ hours worked; a week's total = the sum of each day's pay (=SUM (D2 : D5))
Penalty rates	time-and-a-half = rate $\times$ 1.5 ($24 \times 1.5 = \$36$ per hour); double time = rate $\times$ 2 ($24 \times 2 = \$48$ per hour)
Commission	commission = commission rate (as a decimal) $\times$ sales ($0.05 \times 1400 = \$70$); pay = retainer + commission ($150 + 70 = \$220$)
Tax on pay	tax = tax rate (as a decimal) $\times$ gross pay ($0.20 \times 800 = \$160$); take-home pay = gross pay – tax ($800 - 160 = \$640$)
GST	GST = 10 % of the price before GST; price with GST = price + GST ($80 + 8 = \$88$). The 10 % rate is the standard one used throughout this book
Superannuation	super = super rate (as a decimal) $\times$ gross pay — paid ON TOP of pay, not taken out of it (10 % of $\$800 = \$80$)
Student loan repayment	repayment = stated percent of pay (5 % of $\$900 = \$45$)
Travel allowance	allowance = rate per km $\times$ km travelled ($0.85 \times 40 = \$34$)
A usage bill	bill = supply charge + (usage rate $\times$ units used): $18 + 0.25 \times 120 = 18 + 30 = \$48$
A loan	interest = percent of the amount borrowed ($0.20 \times 1500 = \$300$); total to repay = borrowed + interest ($1500 + 300 = \$1800$); each equal repayment = total to repay $\div$ number of repayments ($1800 \div 12 = \$150$)
Buy now, pay later	each payment = price $\div$ number of payments ($120 \div 4 = \$30$)
Minimum repayment	minimum = percent of the amount owed ($0.05 \times 400 = \$20$); still owed = amount owed – amount paid ($400 - 20 = \$380$)
Total cost over several years	total = buy price + (years $\times$ running cost per year). Machine A: $400 + 3 \times 80 = \$640$; machine B: $550 + 3 \times 20 = \$610$ — over 3 years, machine B costs less in total
Yearly from monthly	yearly cost = monthly cost $\times$ 12 ($105.30 \times 12 = \$1263.60$)

Health, vocational and recreational numeracy (Chapter 6)

Description	Formula
Pulse and breathing rate	count for 30 s, then $\times 2$ for the per-minute rate ($33 \times 2 = 66$ beats per minute)
Nutrition panel	total energy = serves $\times$ kJ per serve ($2 \times 780 = 1560$ kJ); packet weight = serves $\times$ grams per serve ($2 \times 40 = 80$ g)
Medicine — doses in a day	doses in 24 h = $24 \div$ hours between doses ($24 \div 6 = 4$ doses)
Medicine — amount per day	amount per day = one dose $\times$ times per day ($5 \times 4 = 20$ mL); days a bottle lasts = bottle amount $\div$ amount per day ($100 \div 20 = 5$ days)
Medicine — whole doses only	full doses = amount $\div$ one dose, and drop the remainder ($200 \div 15 = 13$ full doses with 5 mL left over)
Medicare rebate	rebate = rebate rate (as a decimal) $\times$ the schedule fee ($0.85 \times 70 = \$59.50$); out-of-pocket cost = fee – rebate ($70 - 59.50 = \$10.50$)
Mixing 1 to 2 — the parts method	$1 + 2 = 3$ parts; one part = total $\div 3$; concentrate = $1 \times$ one part; water = $2 \times$ one part. 6 L of mix: $6 \div 3 = 2$, so 2 L of concentrate and 4 L of water
Concentrate per litre	concentrate = (mL per 1 L of water) $\times$ litres ($50 \times 4 = 200$ mL; $50 \times 0.5 = 25$ mL)
Grounds, gardens and courts	fence or edging cost = perimeter $\times$ price per metre ($14 \times 4.50 = \$63$); a court 20 m by 10 m: $P = 2 \times (20 + 10) = 60$ m and $A = 20 \times 10 = 200$ m ²
Venue hire	$C = f + p \times n$, where C = total cost, f = flat hire fee (paid once), p = price per person, n = number of people. $C = 100 + 8 \times 15 = 100 + 120 = \$220$. For an all-in venue there is no hire fee: $f = 0$
Game points	points = (points per goal $\times$ goals) + bonus points. With letters, $P = 3g + b$, where P = total points, g = goals, b = bonus points: $g = 7$ and $b = 4$ gives $P = 3 \times 7 + 4 = 21 + 4 = 25$ points
Match length	total minutes = (quarters $\times$ minutes per quarter) + (breaks $\times$ minutes per break): $4 \times 10 + 3 \times 3 = 40 + 9 = 49$ min; finish time = start time + total minutes
Budgets	money left = budget – total cost ($180 - 150 = \$30$)
Screen-time limits	limit in minutes = hours $\times 60$ ($2 \times 60 = 120$ min); over or under = time used – limit ($135 - 120 = 15$ min over); $3 \times 90 = 270$ min = 4 h 30 min
Time saved	time saved = old time – new time ($80 - 50 = 30$ min)

End of Formula Sheet