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# SEC G3 E-Math Cheat Sheet

## Numbers

|                     |                                                                                                     |
|---------------------|-----------------------------------------------------------------------------------------------------|
| Prime Numbers       | Numbers greater than 1 with only 2 factors<br>- 1 and itself                                        |
| Composite Numbers   | Numbers with more than 2 factors                                                                    |
| Rational Numbers    | Numbers which can be expressed as a fraction<br>- Inclusive of recurring decimals and whole numbers |
| Irrational Numbers  | Numbers which cannot be expressed as a fraction<br>Eg. $\pi$ , $\sqrt{2}$                           |
| Prime Factorisation | Expressing a number as the product of its prime factors                                             |
| HCF                 | Take the product of the <b>lowest common</b> power of prime factors                                 |
| LCM                 | Take the product of the <b>highest</b> power of <b>each</b> prime factor                            |

## Standard Form

$$A \times 10^n$$

where n is an integer and  $1 \leq A < 10$

## Percentage

A fraction with 100 as the denominator:  
Eg.  $50\% = \frac{50}{100}$

### Percentage change

$$\frac{\text{new} - \text{old}}{\text{old}} \times 100\%$$

Decrease = negative %

Increase = positive %

## Inequalities

## Indices

- $a^m \times a^n = a^{m+n}$
- $a^m \div a^n = a^{m-n}$
- $a^m \times b^m = (a \times b)^m$
- $a^m \div a^n = \left(\frac{a}{b}\right)^m$
- $a^{-m} = \frac{1}{a^m}$
- $a^{\frac{m}{n}} = \sqrt[n]{a^m}$
- $a^0 = 1$

\*\*Answers to be expressed in **positive indices** unless otherwise stated

## Hire-Purchase

Total Hire Purchase Amount = Total installments + Deposit

Interest = Total Hire Purchase Amount - Cash Price

## Interest

### Simple Interest

$$I = \frac{P \times r \times t}{100}$$

where

I = Interest

P = Principal Amount

r: **Annual** rate

t: Number of years

### Compound Interest

$$A = P \left(1 + \frac{r}{100}\right)^n$$

where

A = Amount after compounding (P + I)

P = Principal Amount

r: Interest rate **per compounding period**

n: Number of times compounded

Eg. 24% **Annual** interest, compounded **monthly** over a period of **1 year**

r = Interest rate per month

=  $24/12 = 2$

n = 12

## Set Notation

A  $\cup$  B: Union of A and B

A  $\cap$  B: Intersection of A and B

$\in / \notin$ : is/ is not an element of

n(A): number of elements in set A

A': Complement of Set A

$\emptyset$  or  $\{\}$ : Null/ empty set

A  $\subseteq$  B: Set A is a subset of Set B

\*Every element of A is an element of B, where **A can be equal to B**

A  $\subset$  B: Set A is a proper subset of Set B

\*Every element of A is an element of B, where **A  $\neq$  B**

## Matrix Multiplication

step1: Check order of matrix

# of rows in left matrix must = # of columns in right matrix

Step 2: Determine order of final matrix

Step 2: Row of left matrix X Column of right matrix

Order:  $1 \times 2$   $2 \times 2$   $1 \times 2$

$$\begin{pmatrix} a & b \end{pmatrix} \times \begin{pmatrix} p & q \\ r & s \end{pmatrix} = \begin{pmatrix} ap + br & aq + bs \end{pmatrix}$$

## Algebraic Identities

$$(a + b)^2 = a^2 + 2ab + b^2$$

$$(a - b)^2 = a^2 - 2ab + b^2$$

$$(a - b)(a + b) = a^2 - b^2$$

## Number Patterns

### Common Difference

3,5,7,9...

General Term:  $T_n = a + (n - 1)d$

### Common Ratio

2,4,8,16...

General Term:  $T_n = ar^{n-1}$

where

a = first term

d = common difference

r = common ratio

### Shortcuts!

Factorised form  $(x - a)(x - b) = y$

x-intercepts =  $(a, 0)$  and  $(b, 0)$

Turning point:  $\frac{a + b}{2}$

x-coordinate =  $\frac{a + b}{2}$

y-coordinate = sub  $x = \frac{a + b}{2}$  to find y

Completed square form  $y = \pm(x - h)^2 + k$

Turning point =  $(h, k)$

## Approximation to 3s.f.

All final answers to be 3s.f. unless otherwise stated

(except angles which are to 1d.p.)

### EXAMPLES OF 3s.f. ROUNDING

$0.09876 \approx 0.0988$

$1.1234 \approx 1.12$

$12345 \approx 12300$

## Direct and Inverse

### Proportion

**Direct Proportion**  $y = kx$

**Inverse Proportion**  $y = \frac{k}{x}$

where k is a constant

### General guide to proportion qns

- Form equation using formula above
- Sub values for x and y to solve for k
- Form new equation with k and new value of x or y subbed in
- Solve for unknown

## Map Scale

**Always** represented as 1:n

\*Make sure both sides are **based on** the same unit

\*Do not include units in scale

### Area ratio

Square length ratio on both sides

Eg. Length ratio = 1 : n

Area ratio =  $1^2 : n^2$

### Unit Conversions

$1m = 100cm$

$1m^2 = (100)^2 cm^2 = 10,000cm^2$

$1km = 1000m$

$1km^2 = (1000)^2 m^2 = 1,000,000m^2$

## Solving quadratic equations

Eg.  $2x^2 - 4x - 6 = 0$

### Method 1: Factorisation

1. Factorise to form:  $(2x + 2)(x - 3) = 0$

2. Solve:  $(2x + 2) = 0$  **or**  $(x - 3) = 0$   
 $x = -1$   $x = 3$

### Method 2: Completing the square

1. Make coefficient of x = 1:  $2(x^2 - 2x - 3) = 0$

2. Divide  $x^2$  term by x  $\frac{x^2}{x} = x$   $\frac{2x}{2x} = 1$

3. Divide x term by 2x

4. Subtract square of result from step 3

$$2(x^2 - 2x - 3) = 2((x - 1)^2 - 1^2 - 3)$$
$$= 2(x - 1)^2 - 8$$

Solve for x:  $2(x - 1)^2 - 8 = 0$

$$(x - 1)^2 = 4$$

$$x - 1 = \pm\sqrt{4}$$

$$x = -1 \quad \text{or} \quad x = 3$$

### Method 3: Quadratic Equation

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{for } ax^2 + bx + c = 0$$

a = 2, b = -4, c = -6:  $x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(2)(-6)}}{2(2)}$

$$x = -1 \quad \text{or} \quad x = 3$$

## Sketching quadratic graphs

### Steps

- Determine shape of curve  
(positive  $x^2$  = smile, negative  $x^2$  = frown)
- Find y-intercept by subbing x=0
- Find x-intercepts (if any) by subbing y=0
- Find turning point
- Join points to form a symmetrical curve

### Shortcuts!

Factorised form  $(x - a)(x - b) = y$

x-intercepts =  $(a, 0)$  and  $(b, 0)$

Turning point:  $\frac{a + b}{2}$

x-coordinate =  $\frac{a + b}{2}$

y-coordinate = sub  $x = \frac{a + b}{2}$  to find y

Completed square form  $y = \pm(x - h)^2 + k$

Turning point =  $(h, k)$



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## Radian

$2\pi \text{ rad} = 360 \text{ degrees}$

### Arc length

Degree:  $\frac{x^\circ}{360^\circ} \times 2\pi r$

Radian:  $r\theta$

### Sector Area

Degree:  $\frac{x^\circ}{360^\circ} \times \pi r^2$

Radian:  $\frac{1}{2}r^2\theta$

### Segment Area

$$= \frac{1}{2}r^2\theta - \frac{1}{2}r^2 \sin \theta$$

where  
 $x^\circ$  is the angle in degrees  
 $\theta$  is the angle in radians

## Area/ Volume of Similar Figures

$$\frac{A_1}{A_2} = \left(\frac{l_1}{l_2}\right)^2 \quad \frac{V_1}{V_2} = \left(\frac{l_1}{l_2}\right)^3$$

## Statistics

Mean: Calculated Average  
Mode: Most frequent data value  
Median: Middle value of the entire range  
Lower/ Upper Quartile: 25<sup>th</sup> / 75<sup>th</sup> percentile  
Interquartile range = Upper Quartile - Lower Quartile

## Mensuration

### Parallelogram

Area = Base x Perpendicular Height



### Sphere

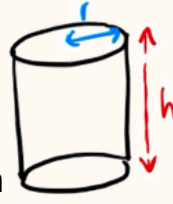
Volume =  $\frac{4}{3} \times \pi r^3$   
Surface Area =  $4\pi r^2$

### Hemisphere

Volume =  $\frac{2}{3} \times \pi r^3$   
Curved Surface Area =  $2\pi r^2$

### Prism/ Cylinder

Volume = Base Area x Height  
Eg. Cylinder volume =  $\pi r^2 h$



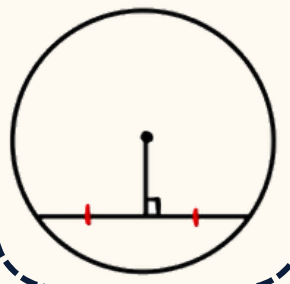
### Pyramid/ Cone

Volume =  $\frac{1}{3} \times \text{Base Area} \times \text{Height}$   
Surface Area = Curved SA + Base Area  
=  $\pi r l + \pi r^2$

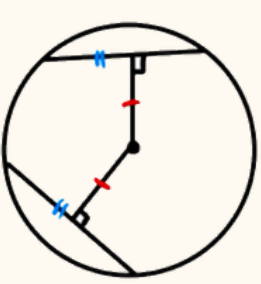


## Properties of Circles

$\perp$  bisector of chord



2 equal chords are equidistant from centre



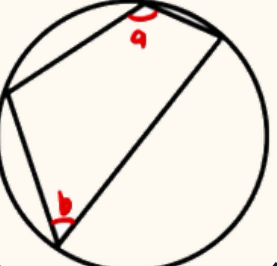
Angles in the same segment

$$\angle a = \angle b$$
$$\angle c = \angle d$$



Angles in opp. segments

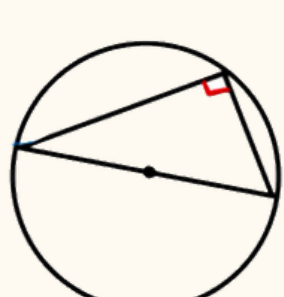
$$\angle a + \angle b = 180^\circ$$



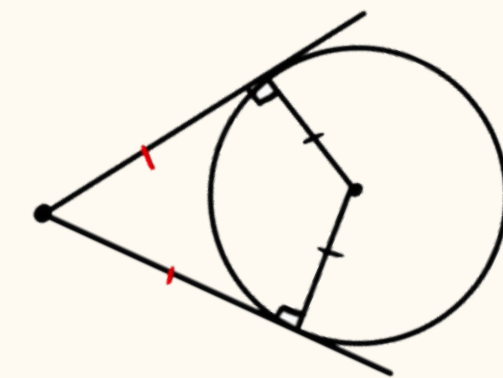
Tan  $\perp$  Rad



Right angle in semicircle

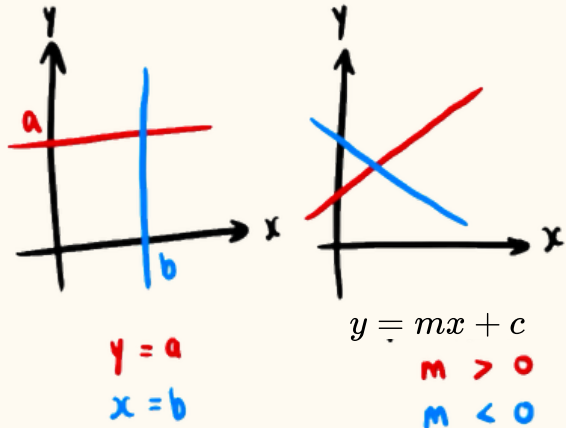


Tangents from external point

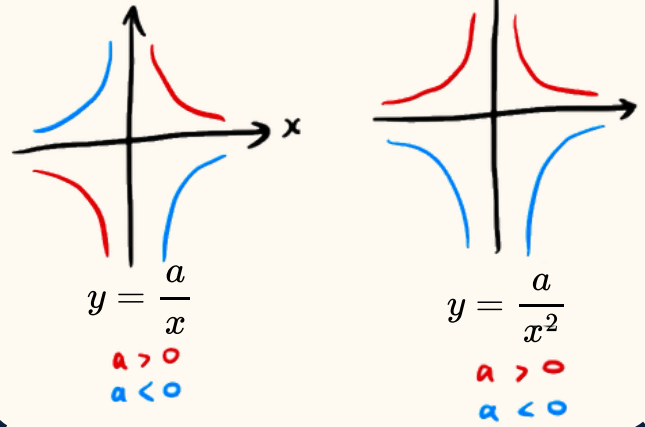


## Graphs

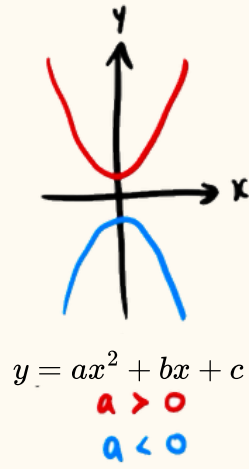
### Linear



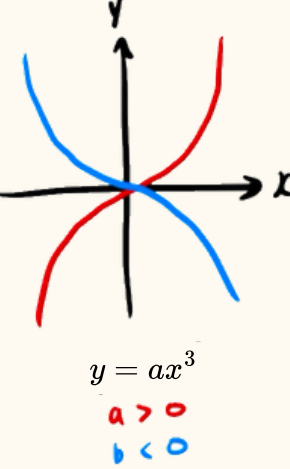
### Reciprocal



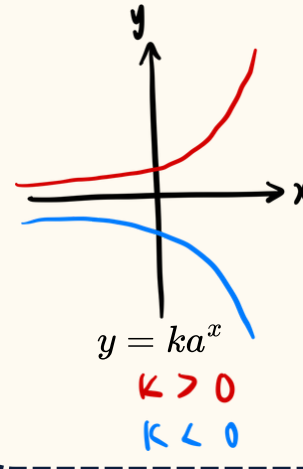
### Quadratic



### Cubic



### Exponential



## Congruence Tests

1. SSS test
2. SAS test (Angle must be in between 2 sides)
3. AAS test (Side must be in between the 2 angles)
4. RHS test (Right angle, Hypotenuse, Side - for  $\triangle$  triangles)

\*A: Corresponding angles are equal

S: Corresponding sides are equal

## Similarity Tests

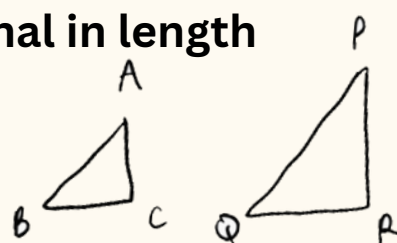
1. AA test
2. SSS test
3. ASA test (Angle must be in between the 2 sides)

\*A: Corresponding angles are equal

S: Corresponding sides are proportional in length

Eg.

$$\frac{AB}{PQ} = \frac{BC}{QR} = \frac{CA}{RP}$$



## Coordinate Geometry

For the equation of a straight line:  $y=mx+c$

m: gradient

c: y-intercept

Distance between 2 points=

$$\text{gradient} = \frac{y_1 - y_2}{x_1 - x_2}$$
$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

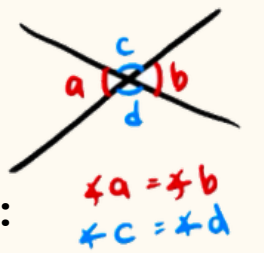
## Angles

### Types of angles

1. Acute angle:  $0^\circ < \theta \leq 90^\circ$
2. Obtuse angle:  $90^\circ < \theta \leq 180^\circ$
3. Reflex angle:  $180^\circ < \theta \leq 360^\circ$

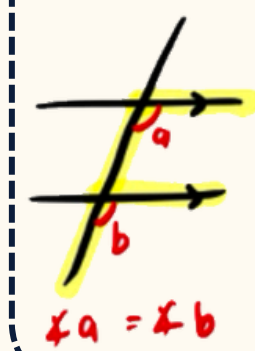
### Common Angle Properties

1. Sum of angles on a straight line =  $180^\circ$
2. Sum of angles at a point =  $360^\circ$
3. Vertically opposite angles:



### Parallel Lines Angle Properties:

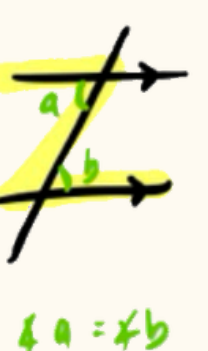
#### Corresponding Angles



#### Interior Angles



#### Alternate Angles



## Properties of polygons

In a regular polygon with  $n$  sides,

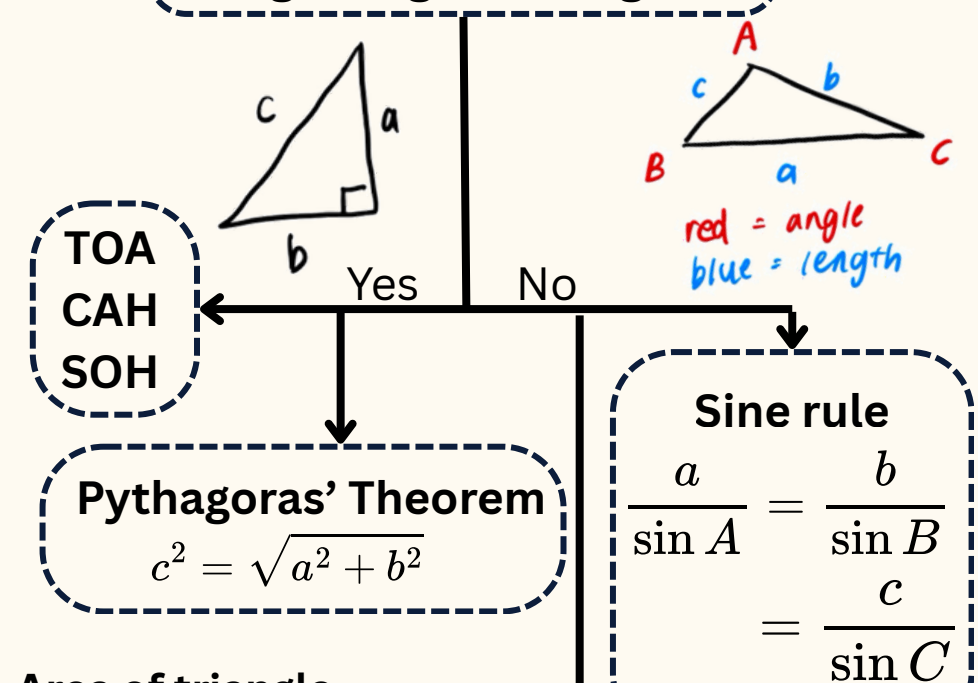
$$\text{Each interior angle} = \frac{(n - 2) \times 180^\circ}{n}$$

$$\text{Each exterior angle} = \frac{360^\circ}{n}$$

\*Interior angle + exterior angle =  $360^\circ$

## Trigonometry

### Right angled triangle?



### Area of triangle

$$= \frac{1}{2} \times \text{base} \times \text{height}$$

$$= \frac{1}{2}ab \sin C$$

### Bearings:

- Measured from the North in a clockwise direction
- Represented by a 3 figure number (and to 1d.p if needed)  
Eg.  $12.34^\circ$  will be represented as  $012.3^\circ$

## Vectors

Position Vector of A =  $\vec{OA}$

If  $\vec{OA} = \begin{pmatrix} x \\ y \end{pmatrix}$ , coordinates of A =  $(x, y)$

Magnitude (Length) of vector  $\begin{pmatrix} x \\ y \end{pmatrix} = \sqrt{x^2 + y^2}$

Finding a vector from its position vectors:

$$\vec{AB} = \vec{OB} - \vec{OA}$$

Not included in cheat sheet

- Speed/ Speed-Time Graphs  
- Probability  
- Construction