MATHEMATICS
Secondary ONE
Year 2021

SCHOOL OF SCIENCE AND TECHNOLOGY, SINGAPORE

Name: ( ) **Class:**

Unit 8 Basic Geometry (Chapter 10)

Topical Enduring Understanding

- Geometry is a branch of mathematics that studies the size, shape and position of 2 dimensional shapes and 3 dimensional figures where these shapes and figures are formed by a collection of points.
- **Measures** are used to quantify geometrical attributes so that they can be analysed or compared.
- In geometry, one explores spatial sense and geometric reasoning and develops problem-solving skills.
- Relationships between points, lines and angles in plane geometry can be represented and visualised in geometrical **diagrams**.

Topical Essential Questions

- What is geometry?
- What can a collection of points form?
- What are the different types of angles?
- What are the properties of the different types of angles?

Key Points

- An angle is a **measure** of the amount of rotation between two lines so that it can be analysed and compared.
- Characteristics of various types of angles (i.e. acute, right, obtuse, straight and reflex angles)
- Properties of angles formed by intersecting lines
- Properties of angles formed by two parallel lines and a transversal
- Apply angle properties to solve geometrical problems

Textbook: *Think! Mathematics New Syllabus Mathematics 1B (8th edition)* Chapter 10
Online Resource: **Student Learning Space** (**learning.moe.edu.sg**) **Geometry** Module

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Pre-requisite (Primary Mathematics Syllabus, implementation starting with 2013 Primary 1 cohort)

- Concepts of angle
- Right angles, angles greater than/ smaller than a right angle
- Using notation such as $\angle ABC$ and $\angle a$ to name angles
- Measuring angles in degrees
- Drawing an angle of given size
- Relating quarter, half and complete turns to angles in degrees
- 8-point compass
- Angles on a straight line, angles at a point, vertically opposite angles
- Finding unknown angles

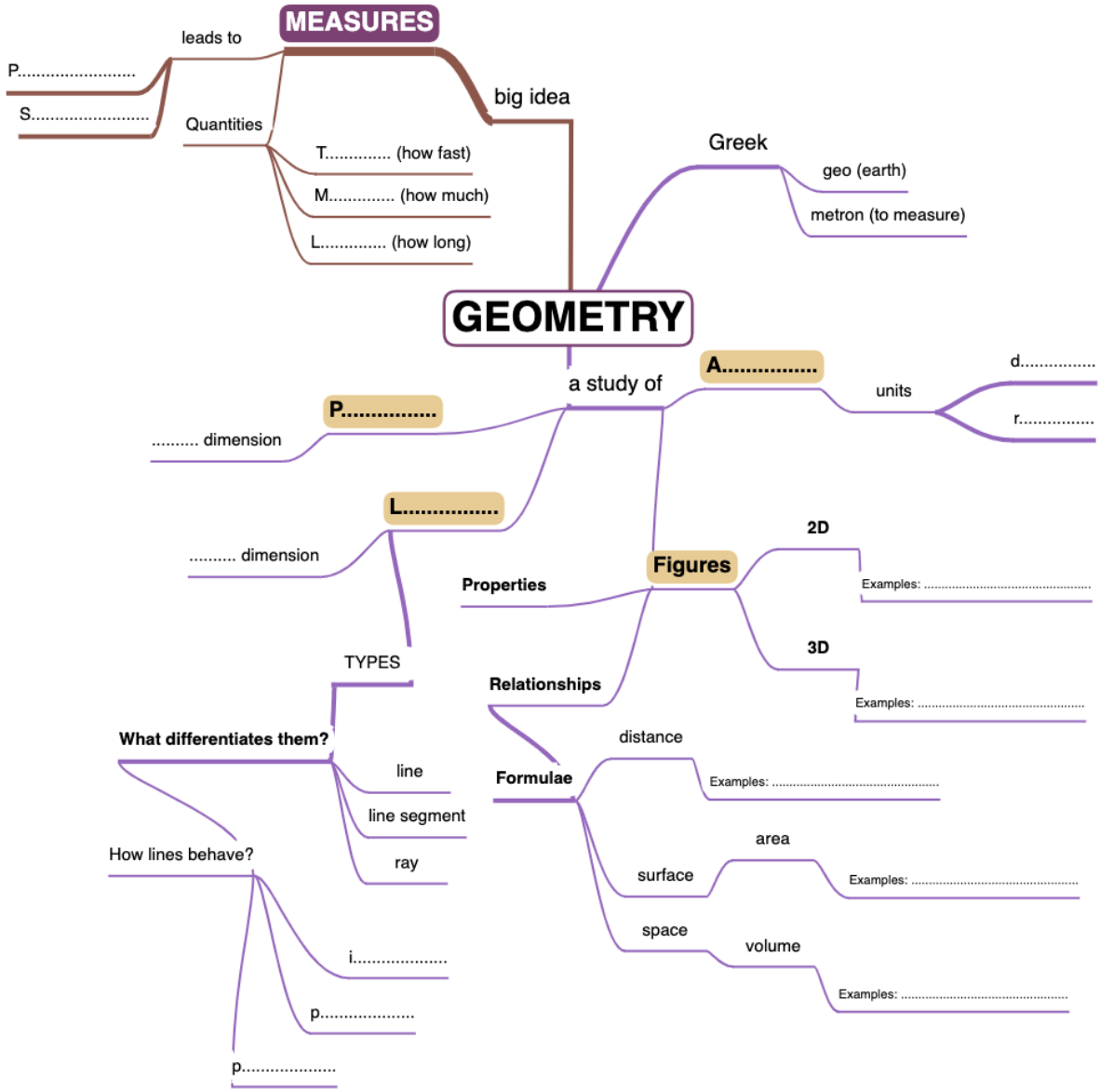
Lesson 1 Overview

(I) Big picture of Geometry (S1)

- What Geometry is, and linking it to the big idea, Measures
- Recap: Types of angles

1. Access the SLS Lesson, 01 Nature of Geometry.
2. Before you watch the video clip (approx. 4min), read the visual organiser first [for planning].
3. With reference to what is presented, complete the visual organiser below (approx. 6min).

Source: https://app.mindmapmaker.org/#m:mm78e183e82338411484727a93dd162043



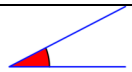
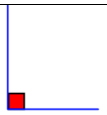
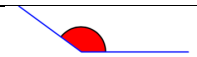
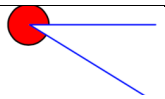
(II) Types of Angles

- Identify various types of angles (i.e. acute, right, obtuse, straight and reflex angles)
- Properties of complementary and supplementary angles

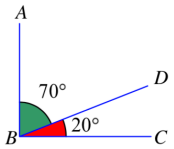
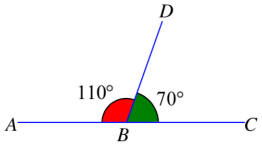
1. Attempt the SLS lesson (and the practices), 02 Types of Angles (approx. 30min)
2. With reference to the materials presented, complete the table below.

The **relationship** of the acute angle, right angle, obtuse angle and reflex angle can be written as shown:

Acute Angle < Right angle < Obtuse angle < Reflex Angle

Name	Definition	Illustration
Acute angle	_____ < Acute angle < _____	
Right angle	Right angle = _____	
Obtuse angle	_____ < Obtuse angle < _____	
Straight line	Straight line = _____	
Reflex angle	_____ < Reflex angle < _____	

When two or more angles are placed **adjacent** to each other

Name	Definition	Illustration
Complementary angles	Two angles are called complementary angles if their sum is 90º. $\angle ABD + \angle CBD = 90º$	
Supplementary angles	Two angles are called supplementary angles if their sum is 180º. $\angle ABD + \angle CBD = 180º$	

Big Idea

Geometrical **diagrams** contain information that help us visualise relationships between points, lines and angles

Lesson 2 Properties of Angles (I)

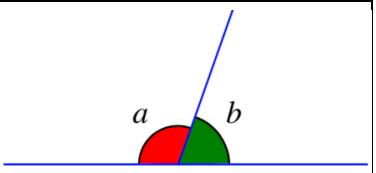
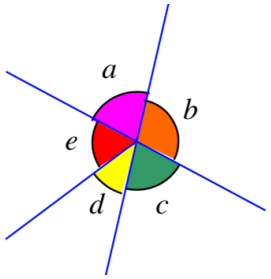
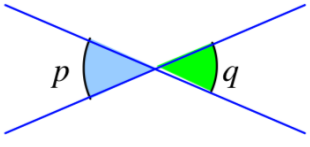
- Properties of angles formed by intersecting lines
- Application of angle properties to solve geometrical problems.

1a. Access the SLS Lesson, 03A Angles formed by Intersection lines (approx. 10min).
1b. Attempt the investigative activity using the GeoGebra applets, and check your understanding with the Practices. (approx. 10min).

You may wish to write down any observations/ notes as you attempt the SLS activities.

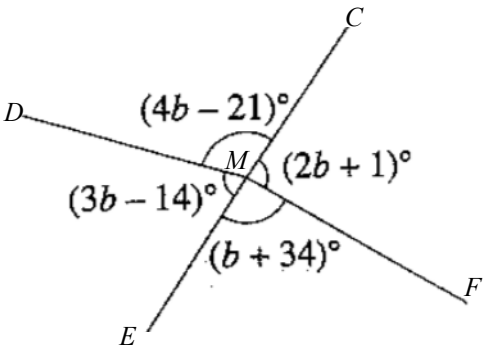
2. With reference to the materials presented, complete the table below.

(I) Angles formed by intersecting lines

Name	Definition *Based on the given description, write an equation for the mathematical relationship of the angles in each case*	Illustration
adj ∠s on a line	Sum of adjacent angles on a straight line = 180°.	
∠s at a point	Sum of angles at a point = 360°.	
vert opp ∠s	Vertically opposite angles are equal.	

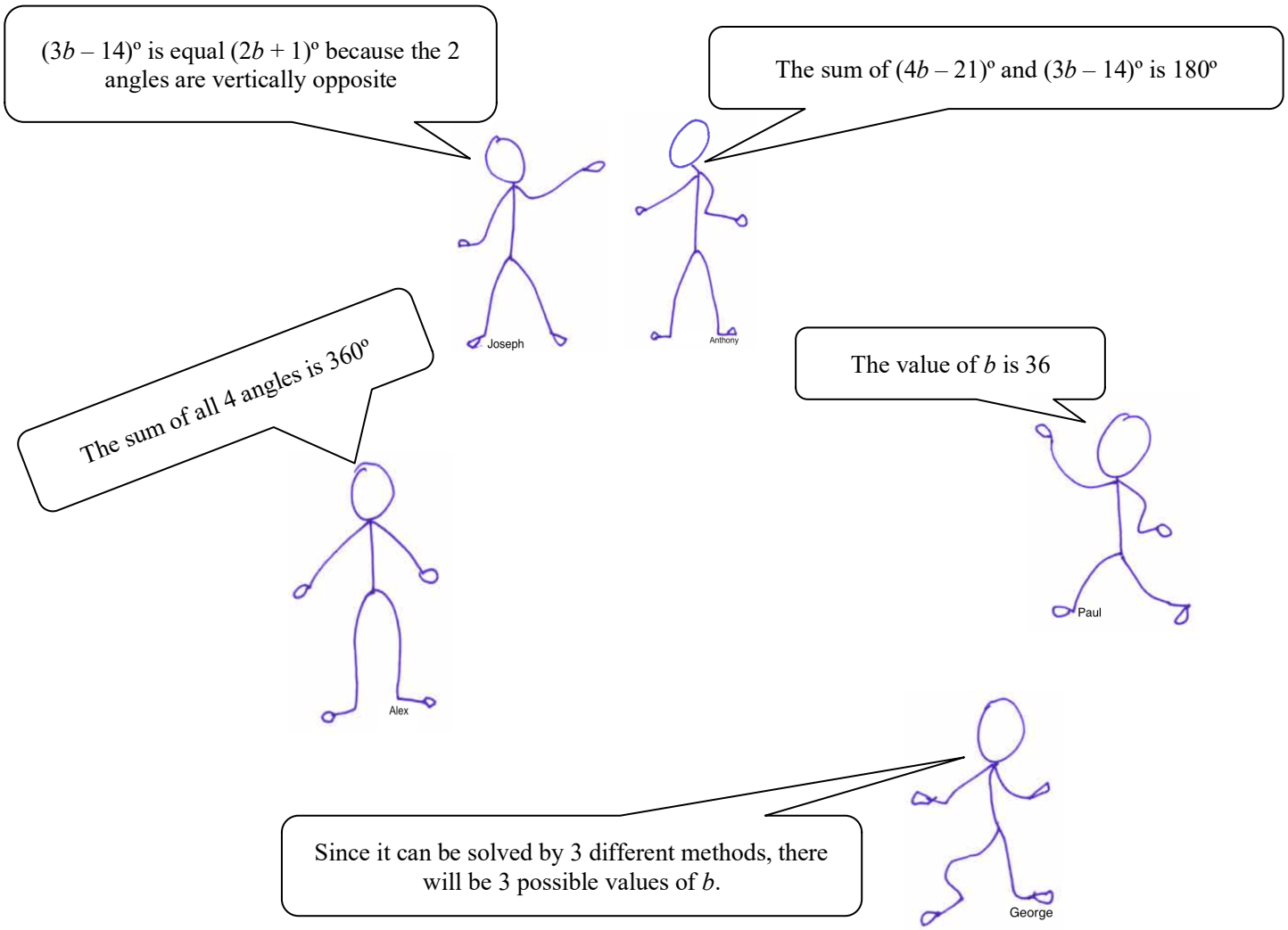
Activity (1)
Source: Textbook 1B (p94) Review Exercise 10 Q2(b)

Question
Find the value of b.
Note: CM, DM, EM, FM are straight lines.

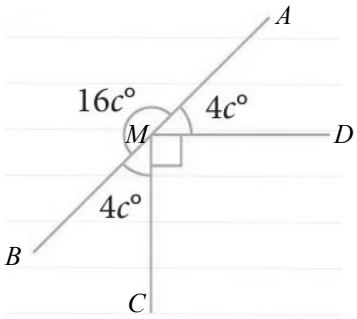


Do you agree with what each of the following says?
State your stand and explain* to justify.

Explain: make a decision about the mathematical claim with **evidence** to support or refute the claim. (e.g. If you do not agree, you may state the assumption made or point out where the error is)*

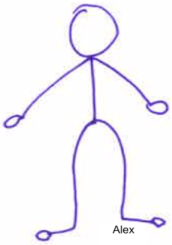


Activity (2)
Source: Textbook 1B (p84) Exercise 10A Q7(c)

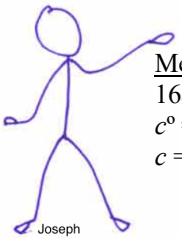


Question
Find the value of the unknown.
Note: AM, BM, CM, DM are straight lines.

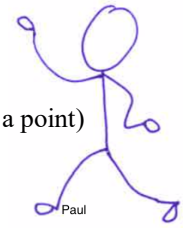
Three methods are presented.
Which is the method without any assumption made?
What "assumption" do other methods made?



Method 1:
$4c^o + 4c^o + 90^o = 180^o$ (angles on a straight line)
$8c^o = 90^o$
$c^o = 11.25^o$
$c = 11.25$ (*Ans*)



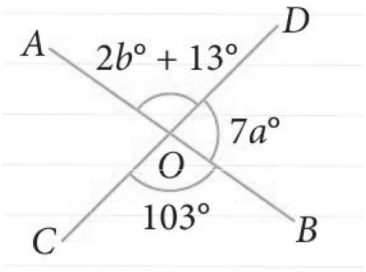
Method 2:
$16c^o = 180^o$ (angles on a straight line)
$c^o = 11.25^o$
$c = 11.25$ (*Ans*)



Method 3:
$16c^o + 4c^o + 90^o + 4c^o = 360^o$ (angles at a point)
$24c^o = 270^o$
$c^o = 11.25^o$
$c = 11.25$ (*Ans*)

Activity (3)
Source: Textbook 1B (p84) Exercise 10A Q12(a)

Question
Given that *AOB* and *COD* are straight lines, find the values of the unknowns.



To find "a", Paul and Joseph presented the same working

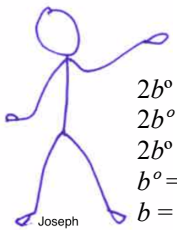
$7a^o + 103^o = 180^o$	*line 1*
$7a^o = 77^o$	*line 2*
$a^o = 11^o$	*line 3*
$a = 11$ (*Ans*)	*line 4*

The angle property used in *line 1* is

……

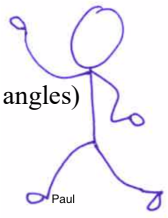
However, Paul and Joseph approached the question slightly differently when finding the value of *b*.

What is the key difference between their working?
Whose method do you prefer, and why?



$2b^o + 13^o + 7a^o = 180^o$ (angles on a straight line)
$2b^o + 13^o + 7(11)^o = 180^o$
$2b^o = 180^o - 90^o$
$b^o = 45^o$
$b = 45$ (*Ans*)

$2b^o + 13^o = 103^o$ (vertically opposite angles)
$2b^o = 90^o$
$b^o = 45^o$
$b = 45$ (*Ans*)

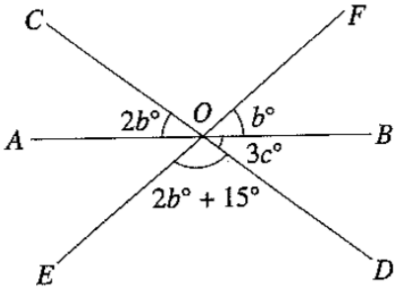


Key Learning Point

📖 Reading:
Source: Textbook 1B (p80-p82) Worked examples 1, 2 & 3
Pay attention to how the angle properties are stated & written.

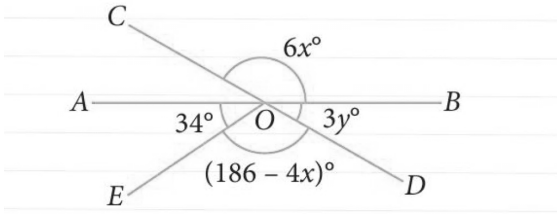
Practice 1
Source: Textbook 1B (p94) Review Exercise 10 Q3(b)
REMEMBER: State the angle properties clearly.

Given that *AOB*, *COD* and *EOF* are straight lines, find the value of the unknowns in the following figure.



Practice 2
Source: Textbook 1B (p84) Exercise 10A Q13
REMEMBER: State the angle properties clearly.

In the figure, *AOB* and *COD* are straight lines.
(i) Find the value of x and of y.
(ii) Find obtuse $A\hat{O}D$ and reflex $C\hat{O}E$.



✍ Assignment

- *State the **ANGLE PROPERTIES** clearly.*
- *When finding unknowns, write the **EQUATION** that describes the **relationship** (with reference to the angle properties) first, then solve for the unknowns. Avoid pure arithmetic working statement.*

Source: Textbook 1B (p84) Exercise 10A Q9(a)
Q10, Q12(b)(d)
Q13

Lesson 3 Properties of Angles (II)

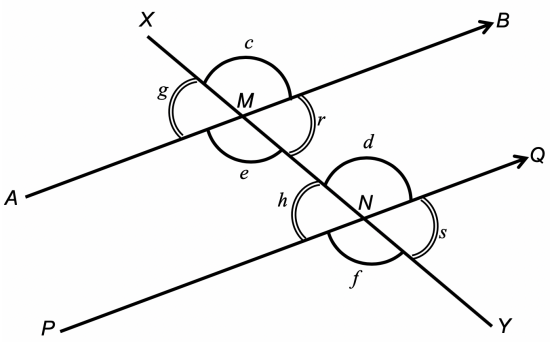
- Properties of angles formed by two parallel lines and transversal
- Application of angle properties to solve geometrical problems.

Angles formed by two parallel lines and transversal

1a. Access the SLS Lesson, 03B Angles formed by Parallel lines and Transversal.
1b. Watch the video clip, attempt the investigative activity using the GeoGebra applets, and check your understanding with the Practices (approx. 30min)

Two or more lines are said to be **parallel** if they are in the same plane and do **not i**……..
We use the symbol **//** to represent "is parallel to".
For example, AB **//** CD means line AB is parallel to line CD.
Arrows are placed on the parallel lines to indicate that they are parallel to one another.

A line that meets two or more parallel lines is called a ***t****……...*



Big Idea

Notations are symbols & conventions to represent mathematical objects (e.g. angles) and their operations, and relationships in a concise & precise manner

Some examples we come across in this topic are:

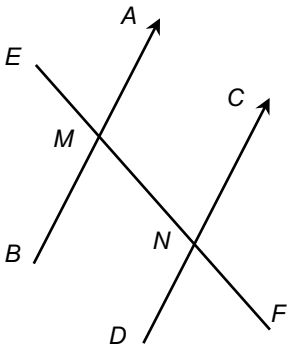
With reference to the diagram above, **AB // PQ**

AB // PQ	Line AB is parallel to line PQ. Take note of how the pair of parallel lines is described (note: Direction). How to name the line: Use 2 capital letters as shown in the diagram, or L_1
XY	Line XY is the transversal to the parallel lines AB and PQ.
Naming of angles	There are two ways to name an angle: • Use small letter (one single letter) ○ E.g. $\angle g$, $\angle f$, $\angle d$ • Use 3 capital letters where the vertex is in the middle ○ E.g. $\angle AMX$, $\angle PNY$, $\angle QNM$
Corresponding angles	$\angle g = \angle h$ (**corresponding angles, AB // PQ**) Name another pair of corresponding angles:
Alternate angles	$\angle e = \angle d$ (**alternate angles, AB // PQ**) Name another pair of alternate angles:
Interior angles	$\angle r + \angle d = 180°$ (**interior angles, AB // PQ**) Name another pair of interior angles:

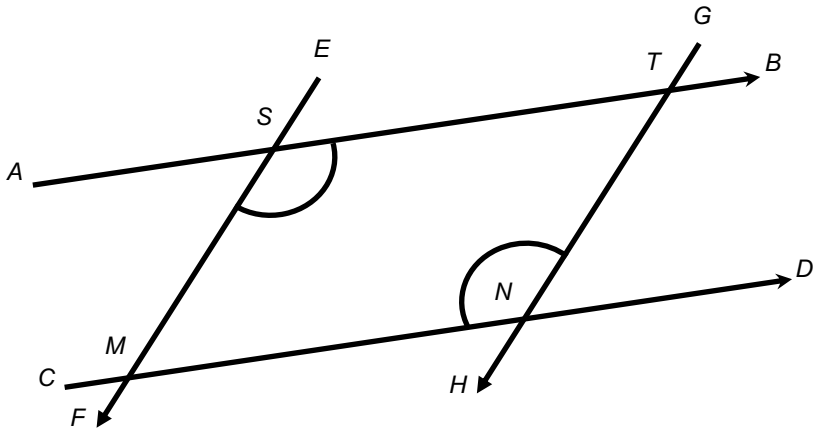
In the video clip, we saw how some angle properties we learnt earlier are used to show why the pairs of corresponding angles and alternate angle are equal. The clip also explains why the pair of interior angles sum up to give 180º.

Activity (4)
Let's recap, using one or more of the following angle properties, show that the sum of two interior angles, ∠*BMN* and ∠*DNM*, is 180º.
Note: Mark these 2 angles in the diagram first.

Angle properties:
- *angles on a straight line*
- *angles at point*
- *vertically opposite angles*
- *corresponding angles*
- *alternate angles*



Activity (5)
Given that *STNM* is a parallelogram, apply angle properties to show that ∠*MST* and ∠*MNT* are equal.
Note: There are at least 2 ways to show the above.



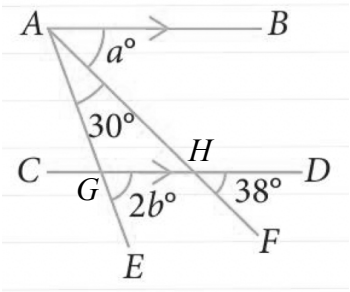
📖 Reading:
Source: Textbook 1B (p88-p90) Worked examples 4, 5 & 6
Pay attention to how the angle properties are cited & written.

Practice 3
Source: Textbook 1B (p91) Exercise 10B Q3(a)(d)
REMEMBER: State the angle properties clearly.

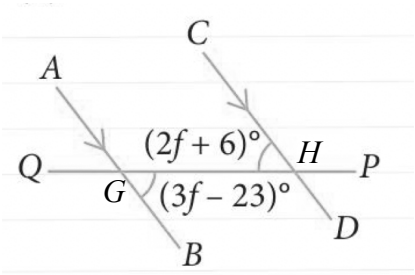
In each of the following figures, *AB // CD.*
Find the value(s) of the unknown(s).

> 👉*Apply **only** these angle properties for this practice*
> - *corresponding angles*
> - *alternate angles*
> - *interior angles*

Q3(a)

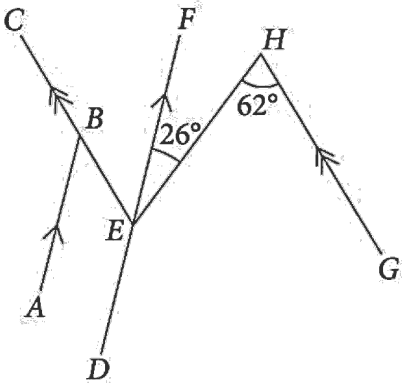


Q3(d)



Practice 4
Source: Textbook 1B (p95) Review Exercise 10 Q7
REMEMBER: State the angle properties clearly.

In the figure, *AB // DF*, *EC // GH*, ∠*FEH* = 26º and ∠*EHG* = 62º.
Find (i) ∠*DEH*,
(ii) ∠*ABC*.

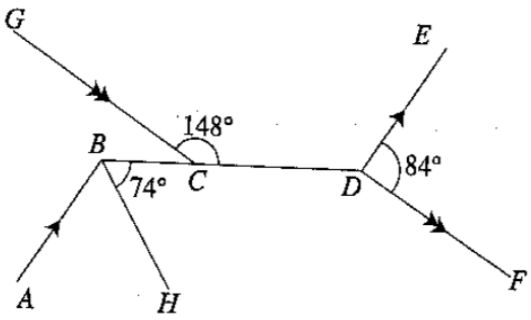


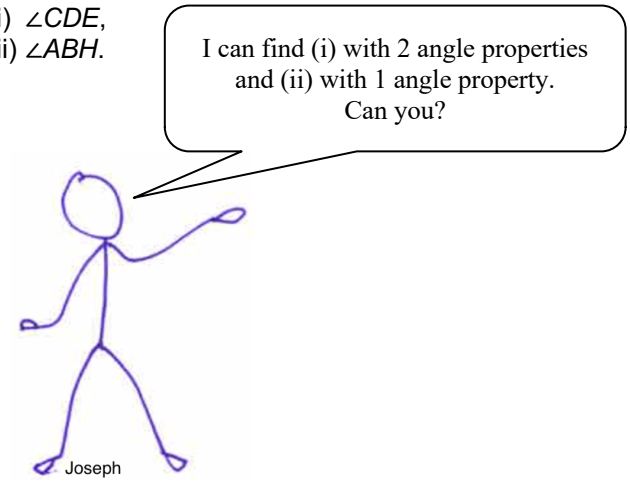
> 👉*Whenever possible, find opportunities to apply these angle properties first*
> - *corresponding angles*
> - *alternate angles*
> - *interior angles*
>
> *then think of using other angle properties like*
> - *angles on a straight line*
> - *angles at a point*
> - *vertically opposite angles*

Practice 5
Source: Textbook 1B (p95) Review Exercise 10 Q5
REMEMBER: State the angle properties clearly.

In the figure, *AB* // *DE* and *GC* // *DF*.
BCD is a straight line

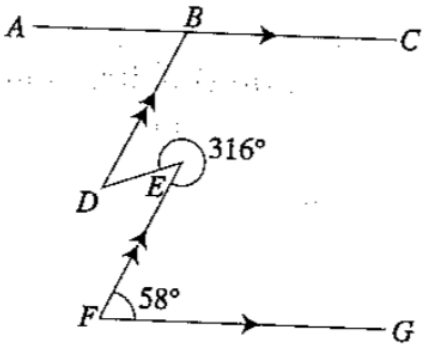
Find
(i) ∠*CDE*,
(ii) ∠*ABH*.

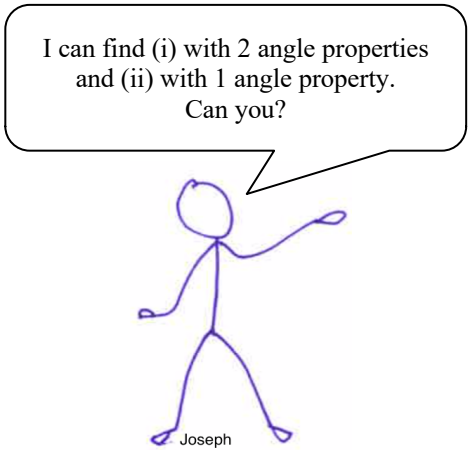




Practice 6
Source: Textbook 1B (p95) Review Exercise 10 Q8
REMEMBER: State the angle properties clearly.

In the following figure, *AC* // *FG*, *DB* // *FE*, reflex ∠*DEF* = 316° and ∠*EFG* = 58°.
Find (i) ∠*BDE*,
(ii) ∠*ABD*.





Assignment

- *State the **ANGLE PROPERTIES** clearly.*
- *When finding unknowns, write the **EQUATION** that describes the relationship (with reference to the angle properties) first, then solve for the unknowns. Avoid pure arithmetic working statement.*

Source: Textbook 1B (p91-p92) Exercise 10B Q4, Q6, Q7, Q12

School of Science and Technology, Singapore
Elementary Mathematics

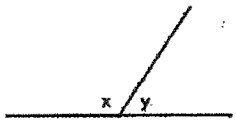
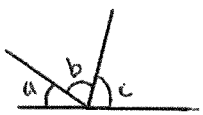
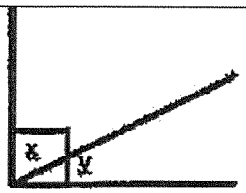
Summary: Angle Properties and Circle Properties
(NOTE THE ABBREVIATIONS)

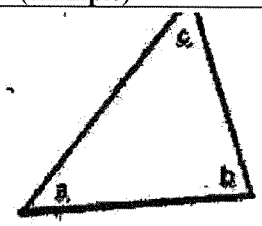
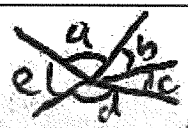
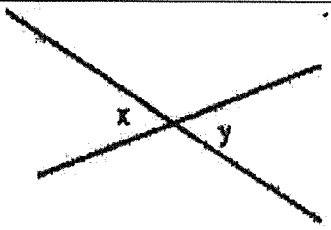
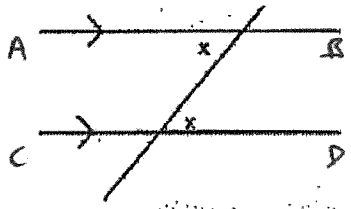
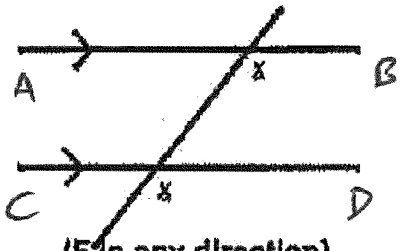
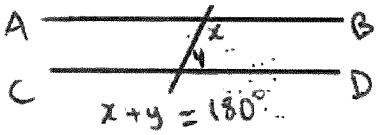
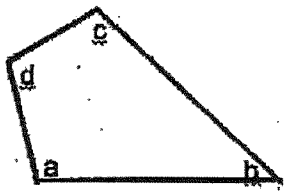
Name:_____( ) Class: _____ Date: _____

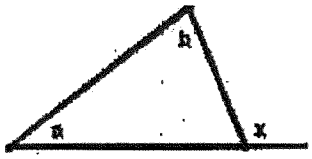
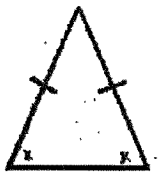
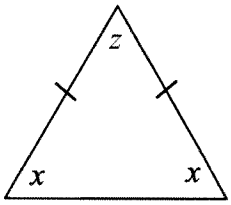
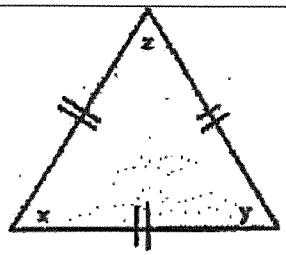
I. E Math Syllabus (SEAB exam syllabus)

G1	**Angles, triangles and polygons**	• right, acute, obtuse and reflex angles • vertically opposite angles, angles on a straight line and angles at a point • angles formed by two parallel lines and a transversal: corresponding angles, alternate angles, interior angles • properties of triangles, special quadrilaterals and regular polygons (pentagon, hexagon, octagon and decagon), including symmetry properties • classifying special quadrilaterals on the basis of their properties • angle sum of interior and exterior angles of any convex polygon • properties of perpendicular bisectors of line segments and angle bisectors • construction of simple geometrical figures from given data (including perpendicular bisectors and angle bisectors) using compasses, ruler, set squares and protractors, where appropriate
G3	**Properties of circles**	• symmetry properties of circles: * equal chords are equidistant from the centre * the perpendicular bisector of a chord passes through the centre * tangents from an external point are equal in length * the line joining an external point to the centre of the circle bisects the angle between the tangents • angle properties of circles: * angle in a semicircle is a right angle * angle between tangent and radius of a circle is a right angle * angle at the centre is twice the angle at the circumference * angles in the same segment are equal * angles in opposite segments are supplementary

II. Properties of Angles

	Property	*Abbreviation*	Diagram (example)
1	Angles that are adjacent on a straight line add up to 180°. Note: supplementary angles refer to 2 angles only.	angles on a straight line	 $x + y = 180^\circ$  $a + b + c = 180^\circ$
2	Complementary Angles (Angles that are adjacent on a right angle. Complementary angles add up to 90°)	complementary angles	 $x + y = 90^\circ$

	Property	*Abbreviation*	Diagram (example)
3	Angles in a triangle add up to 180°	angle sum of triangle/ sum of angles in a triangle	 a + b + c = 180 °
4	Angles at a point add up to 360°	angles at a point	 a+b+c+d+e = 360°
5	Vertically opposite angles are equal	vertically opposite angles	 x = y
6	Alternate angles are equal (Look out for "Z" pattern)	alternate angles, *AB* parallel to *CD*	 (Z can be backwards)
7	Corresponding angles are equal (Look out for "F" pattern)	corresponding angles, *AB* parallel to *CD*	 (F in any direction)
8	Interior angles of parallel lines add up to 180°. (Look out for "C" pattern)	interior angles, *AB* parallel to *CD*	 x + y = 180°
9	Angles in a quadrilateral add up to 360°	angle sum of quadrilateral/ sum of angles in a quadrilateral	 a + b + c + d = 360 °

	Property	*Abbreviation*	Diagram (example)
10	Exterior angles of a triangle add up to the sum of two opposite interior angles	exterior angle of triangle = sum of 2 interior opposite angles	 $x = a + b$
11	In an isosceles triangle, the base angles are equal.	base angles of isosceles triangle	 $x = y$
12	Sum of angles in an isosceles triangle add up to 180°	angle sum of isosceles triangle/ sum of angles in an isosceles triangle	 Angle $x = \frac{180^\circ - z}{2}$
13	In an equilateral triangle, all the angles are equal (60°)	angles of equilateral triangle	 $x = y = z = 60^\circ$
14	Sum of interior angles of an n-sided polygon $= (n-2) \times 180^\circ$ Sum of exterior angles of an n-sided polygon = 360°