C. Learning Objectives and Notes on Teaching (KS4)

Unit	Learning objectives	Notes on Teaching	Time ratio
Learning Geometry through an Intuitive Approach			
Qualitative Treatment of Locus	● describe verbally or sketch the locus of points moving under a condition or conditions ● appreciate different conditions can give rise to same type of locus	In this learning unit, students are expected to explore locus problems in an intuitive approach. Students can make use of the functions in dynamic geometric software to explore the locus of a point moving under the given condition. Examples are: ◆ points moving at equal distances from fixed point(s) or fixed line(s); ◆ a variety of loci including conics, cycloids and the locus of points such that the sum of the distances of the point from two fixed points is a constant. With the help of this software, it is not difficult for students to visualize the loci by moving the points bounded by the conditions. Teachers can encourage students to vary the points or segments in their diagrams in order to verify if there is any unexpected change of the locus. Teachers can also raise the issue that different conditions can give rise to the same locus. For example, a circle can be the locus of points which are equidistant from a fixed point or the locus of the intersecting points of two perpendicular lines respectively passing through 2 fixed points.	6
Learning Geometry through a Deductive Approach			
Basic Properties of Circles	● understand and use the basic properties of chords and arcs of a circle ● understand and use the angle properties of a circle ● understand and use the basic properties of cyclic quadrilateral and tangent to a circle ● appreciate the intuitive and inductive ways of recognizing the properties of circles and see the importance of deductive approach ● perform geometric proofs related with circles ● appreciate the structures of Euclidean Geometry such as definitions, axioms & postulates etc. and its deductive approach in handling geometric problems	In KS3, students have experiences in studying problems involving rectilinear figures from both inductive and deductive approaches. At this stage, students will extend the study to circles. Teachers can ask students to use dynamic geometric software to explore the properties of circles, including ◆ properties related to arcs and chords; ◆ angle properties of a circle; ◆ basic properties of cyclic quadrilaterals; ◆ properties of tangents to a circle. Through these exploratory activities, students can induce the properties related. Hence, teachers can introduce their deductive proofs. Students are expected to write simple geometric proofs and to integrate properties of parallel lines and triangles they learnt in junior forms in solving problems. Teachers can guide students to appreciate the importance of inductive reasoning and deductive reasoning in studying the properties of geometric figures and also observe their limitations. Stories on Euclidean Geometry and the book – *Elements* with its structure in handling deductive proofs should be mentioned. For more able students, teachers can introduce the discussion on the 5th postulate to extend their horizon to non-Euclidean Geometry.	39

Note: The Objectives underlined are considered as non-foundation part of the syllabus.

Unit	Learning objectives	Note on Teaching	Time Ratio
Learning Geometry through an Analytic Approach			
Coordinate Treatment of Simple Locus Problems	● explore and visualize straight line as loci of moving points and describe the loci with equations ● recognize the characteristic of equation form that represents a straight line ● understand and apply the point-slope form to find the equations of straight lines from various given conditions ● describe the properties of the line from a given linear equation ● explore and visualize circles as loci of moving points ● find the equation of circles from given conditions	With the exploratory activities in the learning unit "Qualitative Treatment of Locus", students have come across various types of loci. Teachers can base on the foundation built on that unit to request students to describe the loci in algebraic language. However, only the loci in the form of straight lines or circles will be treated at this stage. Teachers can use the straight line as an example to demonstrate how to describe the loci with equations. The significance of using analytic geometry in linking algebra and geometry should also be highlighted. Finding the equation of a circle is considered as the elaboration of the coordinate treatment and hence is regarded as non-foundation. For the foundation part, students are expected to be able to apply fluently the point-slope form to find equations of straight lines from various given conditions. After sufficient activities in finding equations, students should be asked to identify the characteristics of the form of the equation that describes a straight line, that is, the linear form $\mathrm{A}x + \mathrm{B}y + \mathrm{C} = 0$. With the ready visualization provided by graphing software tools, teachers can plot different graphs of straight lines in one screen. By observing the graphs, comparisons on the signs and magnitudes of the slopes, intercepts of different forms can be made. If students have learnt the learning unit "More about Trigonometry", the condition for parallel and perpendicular lines with obtuse inclinations should also be discussed. Otherwise, this idea should be discussed in the unit "More about Trigonometry" as an application of trigonometric functions. For the loci as circles, students should be led to derive the equation of a circle with given conditions such as points at a constant distance from a fixed point. Teachers should guide students to identify the characteristics of the equation that describes a circle, that is, in the form of $x^2+y^2+\mathrm{D}x+\mathrm{E}y+\mathrm{F}=0$ or in the form of $(x-\mathrm{h})^2 + (y-\mathrm{k})^2 = \mathrm{r}^2$. Students should be able to find the corresponding centre and radius from the equation.	14
Trigonometry			
More about Trigonometry	● understand the sine, cosine and tangent functions & their graphs ● use graphs to explore properties of trigonometric functions including periodicity etc.	At this stage, students are expected to study trigonometry from the perspective of a function. The coordinates of points on a unit circle, with centre at the origin of the rectangular coordinate system, are used to define the trigonometric functions. It is easy for students to observe the patterns of values of sine, cosine and tangent functions by tracing the coordinates as the point moving around the circle.	29

Unit	Learning objectives	Notes on Teaching	Time Ratio
More about Trigonometry (Cont'd)	● use graphs of the functions to find roots of an equation such as $\sin\theta$ = constant, where $0° \leq \theta \leq 360°$ ● recognize the limitation of Pythagoras' Theorem in solving triangles ● understand and use sine and cosine formulas to solve triangles ● understand and use the formula $\frac{1}{2}ab\sin C$ and Heron's Formula for areas of triangles ● investigate and find the angle between 2 intersecting lines, between a line and a plane, between 2 intersecting planes ● apply trigonometric knowledge in solving 2-dimensional and 3-dimensional problems	Teachers can arrange students in groups to set up tables of trigonometric functions for angles in the range 0° to 360° by measuring the corresponding values in the unit circle. Students can then sketch the graphs of the trigonometric functions from the values in the tables. Discussions can be made on the properties of the trigonometric functions such as increasing or decreasing trends, etc. from the sketch. However, further explorations on the trigonometric functions, such as ◆ tracing values of the functions; ◆ finding the periods of the functions; ◆ identifying the shape of the graphs; ◆ finding the extremum; ◆ exploring angles leading to the same value of a certain trigonometric function; ◆ exploring effects of transformations on the functions; and ◆ solving equations in the form such as $\sin\theta$ = constant, where $0° \leq \theta \leq 360°$. can be conducted by reading the graphs of the functions generated from graphing calculators or some graphical software packages. Teachers should make full use of the ready visualization of the graphs, the zoom-in-and-zoom-out functions of these software packages in plotting the functions and observing the effects. In KS3, students have learnt to apply Pythagoras' Theorem and trigonometric ratios in solving right-angled triangles or figures reducible to right-angled triangles. At this stage, students are expected to solve any triangle provided that enough number of sides and angles are given to fix the triangle. Teachers can request students to solve triangles that cannot be solved without sine or cosine rules as a motivation activity. Sufficient examples and exercises should be given to enable students to select and apply the appropriate rule to solve triangles. It is worthwhile to note that Pythagoras' Theorem is a special case of the cosine formula. In applying the trigonometric functions to solve 3-D problems, teachers can help students to consolidate their intuitive ideas on the relations between lines and relations between planes learnt in the unit "More about 3-D Figures". At this stage, students should be able to calculate the followings: ◆ the angle between 2 intersecting lines; ◆ the angle between a line and a plane; and ◆ the angle between two intersecting planes. After then, students should proceed to solve 3-D practical problems involving the line of greatest slope, etc.	