KZN 2024

Maths Subject Advisors Workshop

EUCLIDEAN GEOMETRY
Problem Solving

BREAK THE 70% CEILING

LEARN HOW – Remember for a moment

LEARN WHY – Remember for a life time

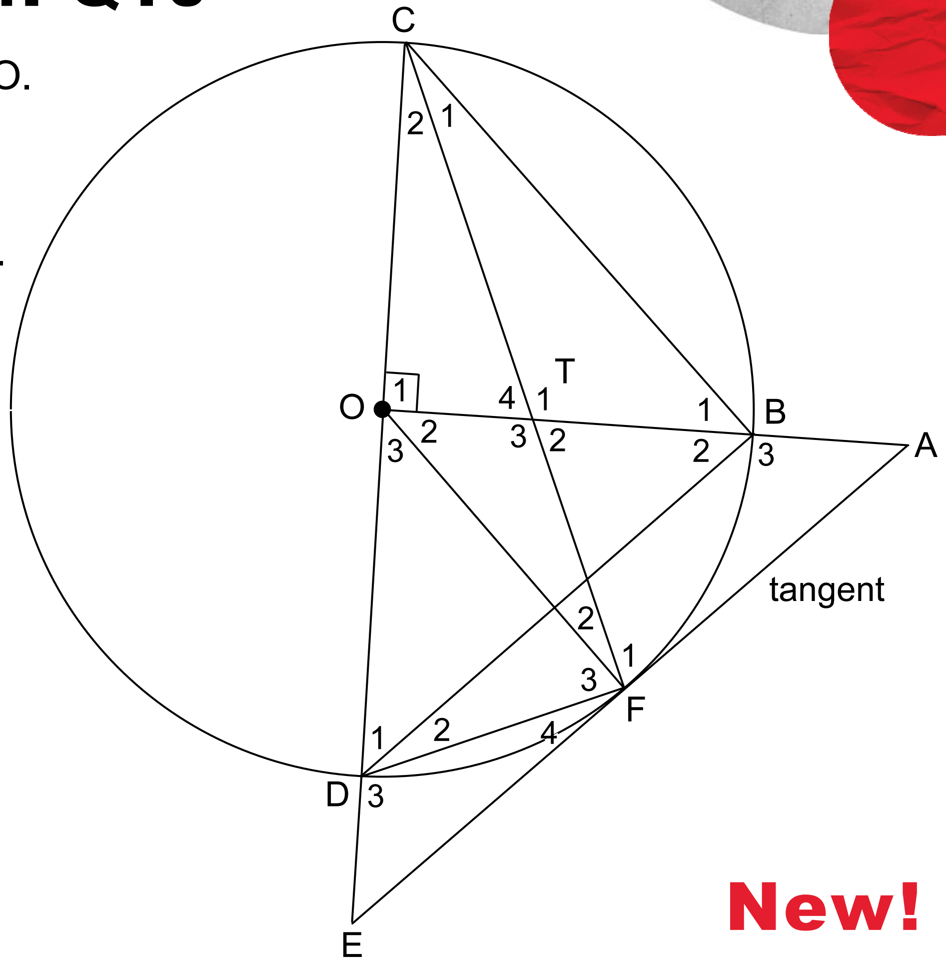
Compiled by
Anne Eadie

THE ANSWER SERIES
Your Key to Exam Success

A Warm-up Example

DBE May 2024: Q10

- In the diagram, COD is the diameter of the circle with centre O.
- EA is a tangent to the circle at F.
- AO ⊥ CE.
- Diameter COD produced intersects the tangent to the circle at E.
- OB produced intersects the tangent to the circle at A.
- CF intersects OB in T.
- CB, BD, OF and FD are drawn.



Prove, with reasons, that:

10.1 TODF is a cyclic quadrilateral (4)

10.2 $\hat{D}_3 = \hat{T}_1$ (3)

10.3 $\Delta TFO \;|||\; \Delta DFE$ (5)

10.4 If $\hat{B}_2 = \hat{E}$, prove that DB || EA. (2)

10.5 Prove that $DO = \dfrac{TO.FE}{AB}$ (5) **[19]**

New!

KZN Grade 12 2024 ATP

TERM 2				
NUMBER OF DAYS	**DATE STARTED**	**DATE COMPLETED**	**TOPIC**	**CURRICULUM STATEMENT**
03 – 10/04 (6 days)			EUCLIDEAN GEOMETRY	1. Revise earlier work on the necessary and sufficient conditions for polygons to be similar. 2. Prove (accepting results established in earlier grades) that a line drawn parallel to one side of a triangle divides the other two sides proportionally (and the Midpoint Theorem as a special case of this theorem). 3. Solve proportionality problems and prove riders.
11 – 18/04 (6 days)			EUCLIDEAN GEOMETRY	4. Prove (accepting results established in earlier grades): 4.1 that equiangular triangles are similar; 4.2 that triangles with sides in proportion are similar; and 4.3 the Pythagorean Theorem by similar triangles. 5. Solve similarity problems and prove riders.

THE ANSWER SERIES
CONTENT FRAMEWORK: Gr 8 – 12

- LINES
- TRIANGLES
- QUADRILATERALS

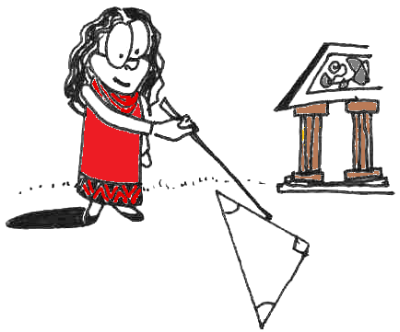
(Gr 8 → 10)

- CIRCLES (Gr 11)

Gr 12?

Gr 12

- THEOREM OF PYTHAGORAS (Gr 8)
- SIMILAR Δ^s (Gr 9)
- MIDPOINT THEOREM (Gr 10)



- THE PROPORTION THEOREM (Gr 12)

Ratio Proportion Area

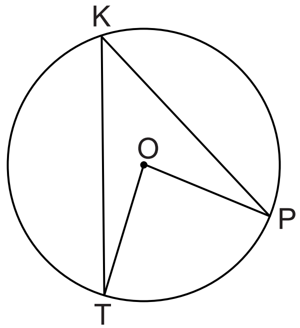
Remember these?

EUCLIDEAN GEOMETRY (41%): DBE NOV 2023 PAPER 2

QUESTION 8 60%

8.1 In the diagram, O is the centre of the circle.
55%

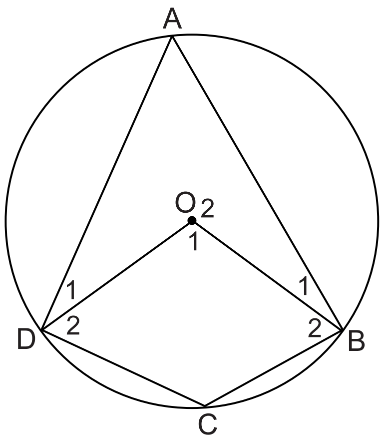
Use the diagram alongside to prove the theorem which states that the angle subtended by a chord at the centre of the circle is equal to twice the angle subtended by the same chord at the circumference, that is, prove that $T\hat{O}P = 2T\hat{K}P$.



(5)

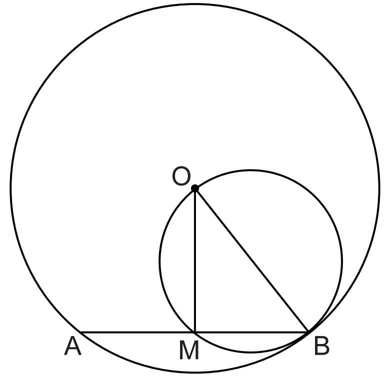
8.2 In the diagram, O is the centre of the circle and ABCD is a cyclic quadrilateral.
59%
OB and OD are drawn.

If $\hat{O}_1 = 4x + 100°$ and $\hat{C} = x + 34°$, calculate, giving reasons, the size of x.



(5)

8.3 In the diagram, O is the centre of the larger circle. OB is a diameter of the smaller circle. Chord AB of the larger circle intersects the smaller circle at M and B.
65%



8.3.1 Write down the size of $O\hat{M}B$. Provide a reason. (2)

8.3.2 If $AB = \sqrt{300}$ units and OM = 5 units, calculate, giving reasons, the length of OB. (4)

[16]

- Gr 12 Maths **Toolkit**: DBE Past Papers, p. 43
- TAS Website: www.theanswer.co.za
- Diagnostic Report: Questions/Memos/Comments
- 2023 Exam Reviews

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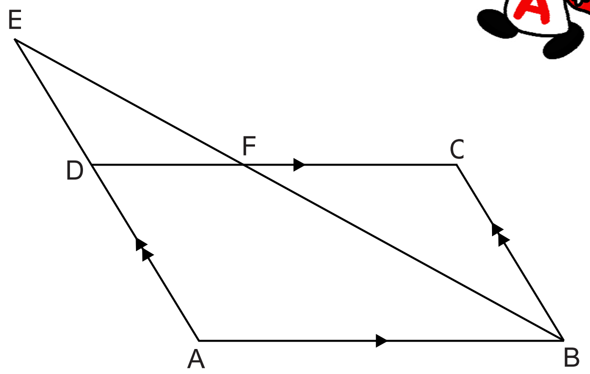
QUESTION 9 44%

In the diagram, ABCD is a parallelogram with AB = 14 units.

AD is produced to E such that AD : DE = 4 : 3.

EB intersects DC in F.

EB = 21 units.



9.1 Calculate, with reasons, the length of FB. (3)

51%

9.2 Prove, with reasons, that ΔEDF ||| ΔEAB. (3)

60%

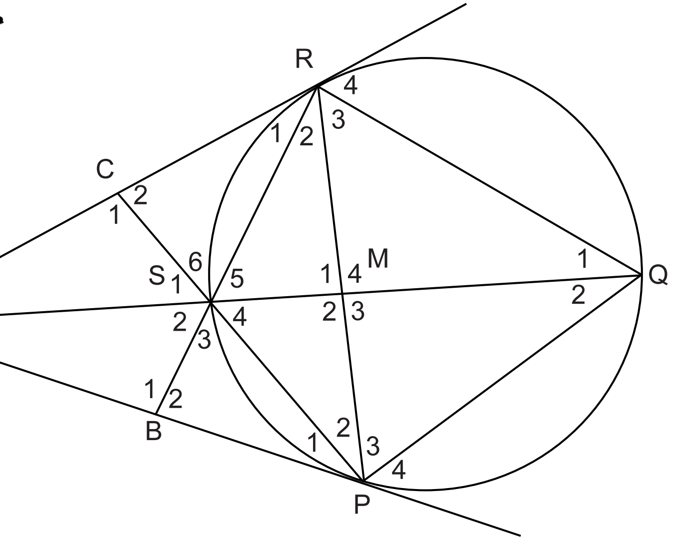
9.3 Calculate, with reasons, the length of FC. (3)

20%

[9]

QUESTION 10 18%

In the diagram, PQRS is a cyclic quadrilateral such that PQ = PR. The tangents to the circle through P and R meet QS produced at A. RS is produced to meet tangent AP at B. PS is produced to meet tangent AR at C. PR and QS intersect at M.



Prove, giving reasons, that:

10.1 $\hat{S}_3 = \hat{S}_4$ (5)

29%

10.2 SMRC is a cyclic quadrilateral. (4)

16%

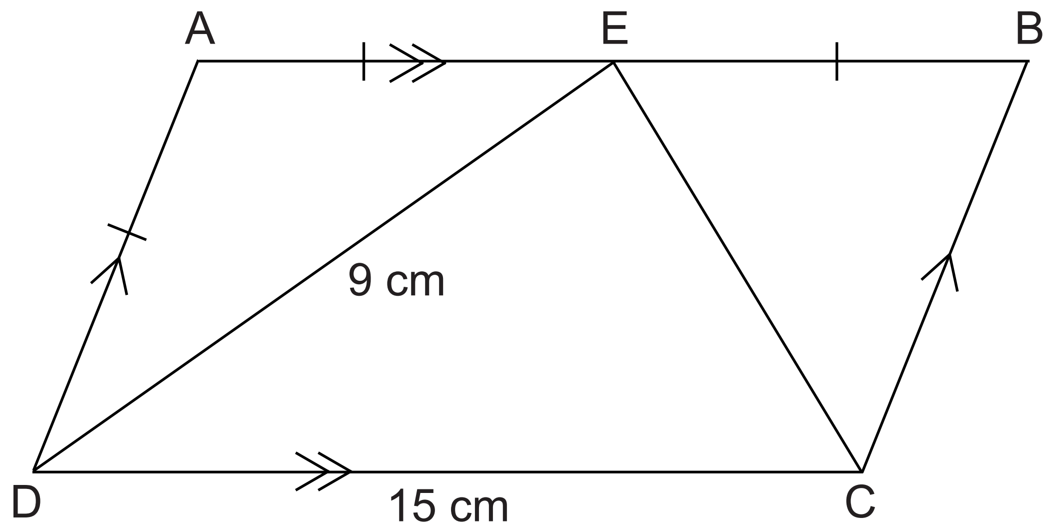
10.3 RP is a tangent to the circle passing through P, S and A at P. (6)

10%

[15]

Problem Solving Questions

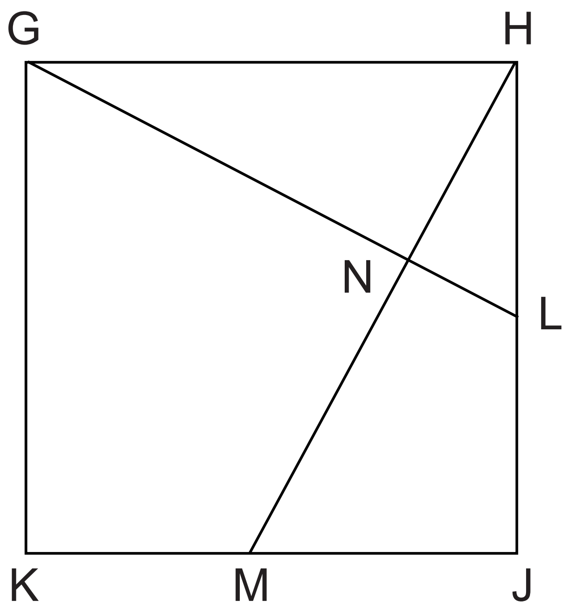
1.



ABCD is a parallelogram with AD = AE = EB. DE = 9 cm and DC = 15 cm.

Determine the length of EC.

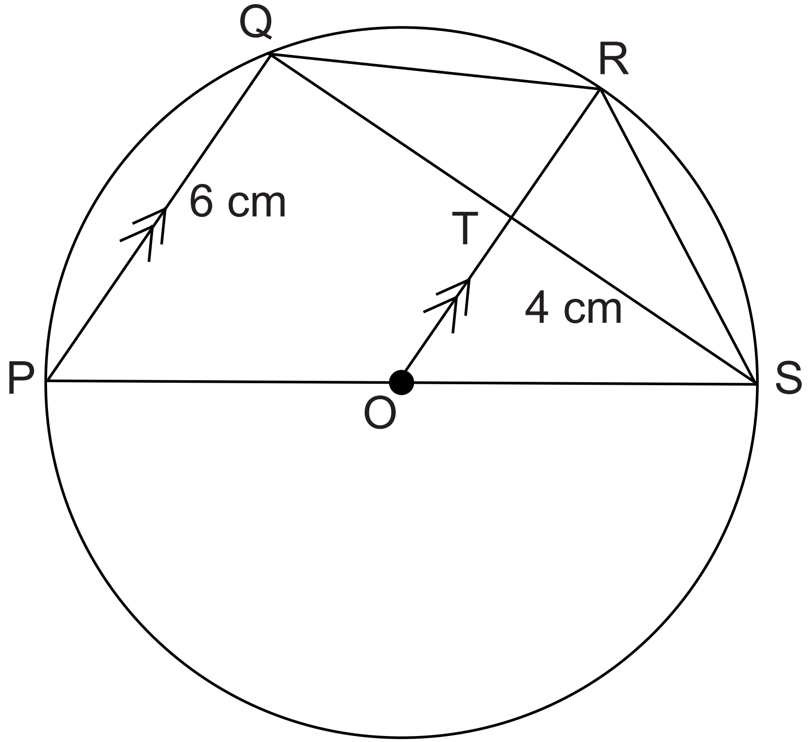
2.



GHJK is a square with L and M the midpoints of HJ and JK respectively.

Prove that GL $\perp$ HM.

3.



P, Q, R and S lie on the circumference of circle O.

PQ = 6 cm, ST = 4 cm, and the radius of the circle is 5 cm.

Determine the area of quadrilateral PQRS.

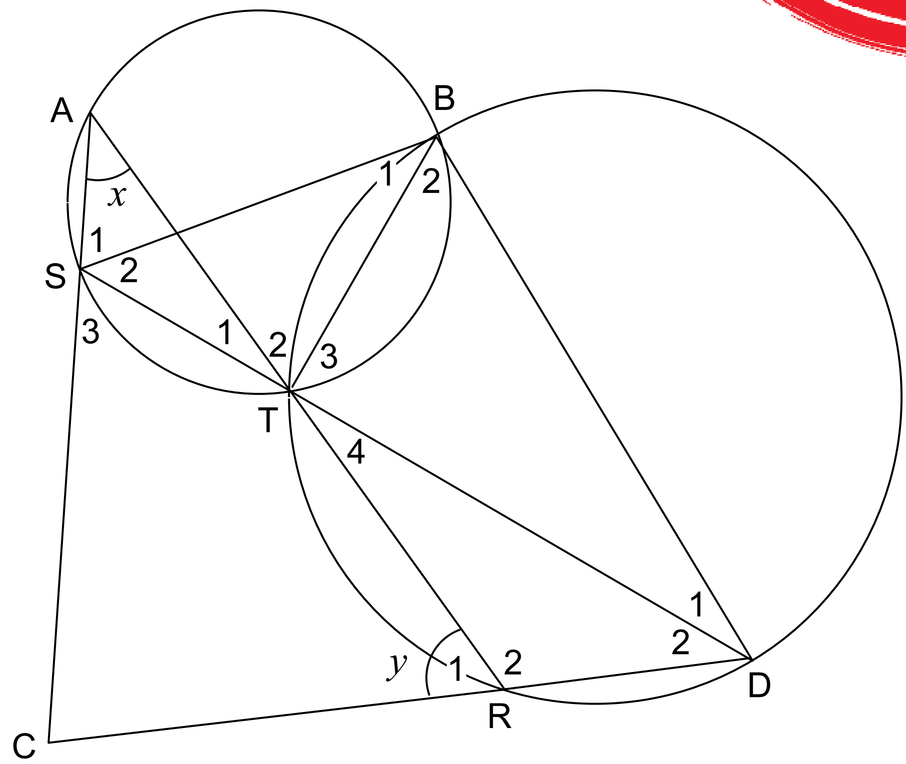
⊙ Geom, no tangents

- Gr 12 Maths **Toolkit**: DBE Past Papers, p. 17
- TAS Gr 12 Euclidean Geometry Video 2

Example 1 (DBE Nov 2018 Q9.2) 44%

- In the diagram, a smaller circle ABTS and a bigger circle BDRT are given.
- BT is a common chord. Straight lines STD and ATR are drawn.
- Chords AS and DR are produced to meet in C, a point outside the two circles.
- BS and BD are drawn.

$\hat{A} = x$ and $\hat{R}_1 = y$.



1.1 Name, giving a reason, another angle equal to:

(a) x (b) y (2)(2)

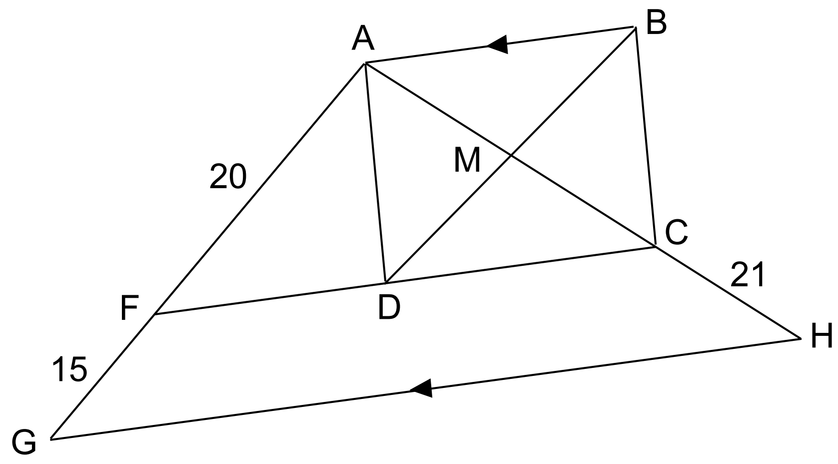
1.2 Prove that SCDB is a cyclic quadrilateral. (3)

1.3 It is further given that $\hat{D}_2 = 30^\circ$ and $A\hat{S}T = 100^\circ$.
Prove that SD is not a diameter of circle BDS. (4)

Proportionality

Example 2 (DBE Nov 2018 Q8.2) 59%

- In the diagram, ΔAGH is drawn.
- F and C are points on AG and AH respectively such that AF = 20 units, FG = 15 units and CH = 21 units.
- D is a point on FC such that ABCD is a rectangle with AB also parallel to GH.
- The diagonals of ABCD intersect at M, a point on AH.



2.1 Explain why FC || GH. (1)

2.2 Calculate, with reasons, the length of DM. (5)

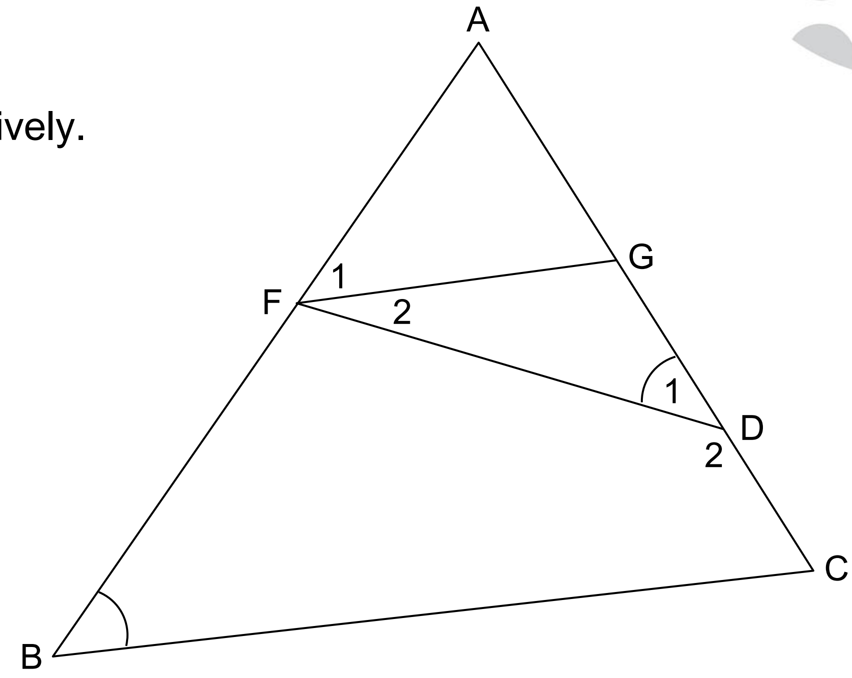
- Gr 12 Maths **Toolkit**: DBE Past Papers, p. 17
- TAS Gr 12 Euclidean Geometry Video 5

Proportionality

Example 3 (DBE Nov 2020 Q8.2) 52%

3. In $\triangle ABC$, F and G are points on sides AB and AC respectively.

   D is a point on GC such that $\hat{D}_1 = \hat{B}$.



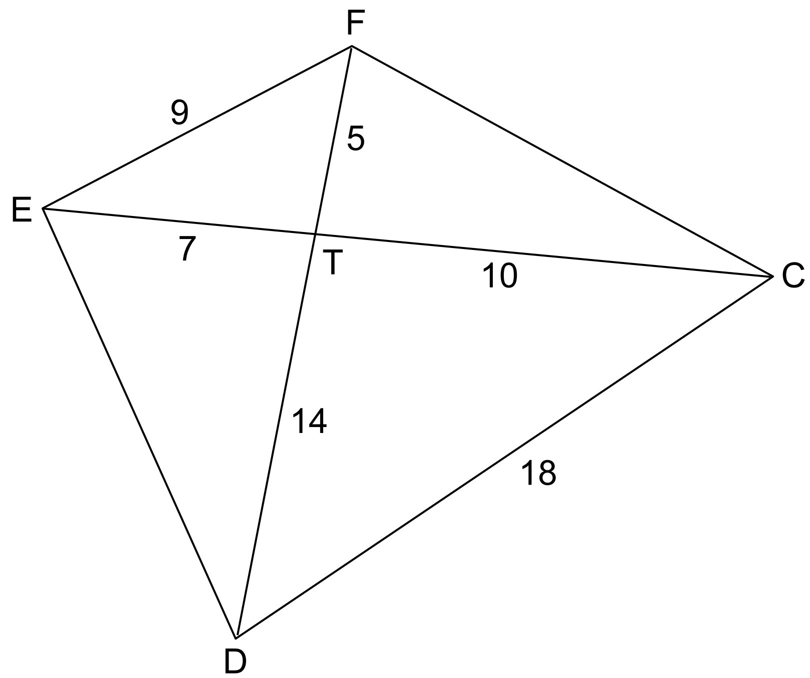
(a) If AF is a tangent to the circle passing through points F, G and D, then prove, giving reasons, that FG || BC. (4)

(b) If it is further given that $\frac{AF}{FB} = \frac{2}{5}$, $AC = 2x - 6$ and $GC = x + 9$, then calculate the value of x. (4)

- Gr 12 Maths **Toolkit**: DBE Past Papers, p. 27
- TAS Gr 12 Euclidean Geometry Video 6

Example 4 (DBE Nov 2019 Q8.2) 25%

- In the diagram, the diagonals of quadrilateral CDEF intersect at T.
- EF = 9 units, DC = 18 units, ET = 7 units, TC = 10 units, FT = 5 units and TD = 14 units.



Prove, with reasons, that:

4.1 $E\hat{F}D = E\hat{C}D$ (4)

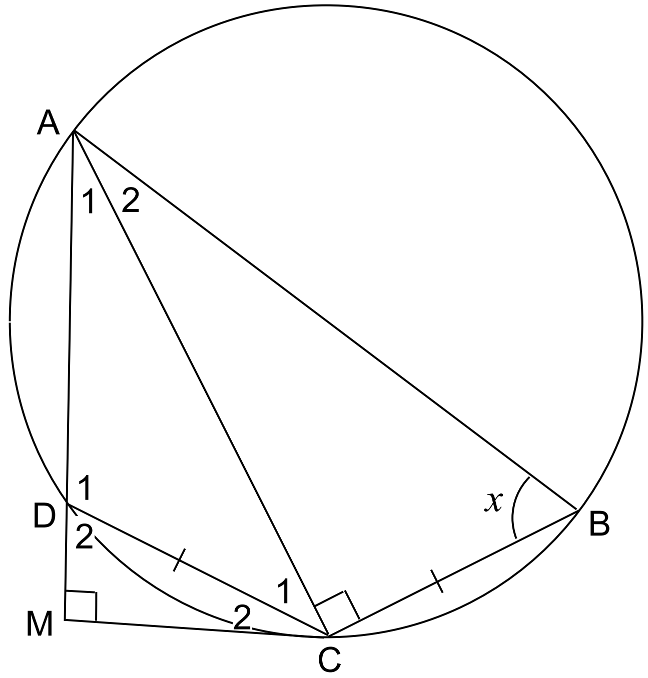
4.2 $D\hat{F}C = D\hat{E}C$ (3)

- Gr 12 Maths **Toolkit**: DBE Past Papers, p. 22
- TAS Gr 12 Euclidean Geometry Video 7

Mixed

Example 5 (DBE Nov 2018 Q10) 31%

- In the diagram, ABCD is a cyclic quadrilateral such that AC ⊥ CB and DC = CB.
- AD is produced to M such that AM ⊥ MC.



Let $\hat{B} = x$.

5.1 Prove that:

48%

(a) MC is a tangent to the circle at C. (5)

(b) ΔACB ||| ΔCMD (3)

5.2 Hence, or otherwise, prove that:

18%

(a) $\frac{CM^2}{DC^2} = \frac{AM}{AB}$ (6)

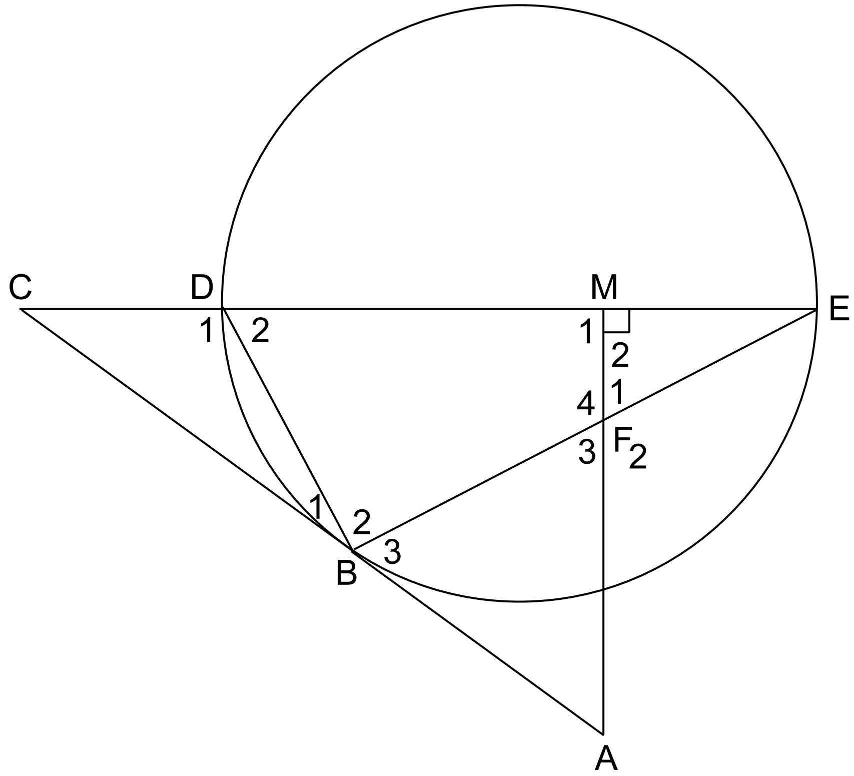
(b) $\frac{AM}{AB} = \sin^2 x$ (2)

- Gr 12 Maths **Toolkit**: DBE Past Papers, p. 17
- TAS Gr 12 Euclidean Geometry Video 7

- Gr 12 Maths **Toolkit**: DBE Past Papers, p. 27
- TAS Gr 12 Euclidean Geometry Video 8

Example 6 (DBE Nov 2020 Q10) 43%

- In the diagram, a circle passes through D, B and E.
- Diameter ED of the circle is produced to C and AC is a tangent to the circle at B.
- M is a point on DE such that AM ⊥ DE.
- AM and chord BE intersect at F.



6.1 Prove, giving reasons, that:
55%

(a) FBDM is a cyclic quadrilateral (3)

(b) $\hat{B}_3 = \hat{F}_1$ (4)

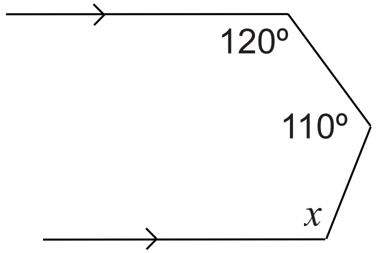
(c) $\Delta CDB \,|||\, \Delta CBE$ (3)

6.2 If it is further given that CD = 2 units and DE = 6 units, calculate the length of:
26%

(a) BC (b) DB (3)(4)

2.2 Calculate, with reasons, the values of x.

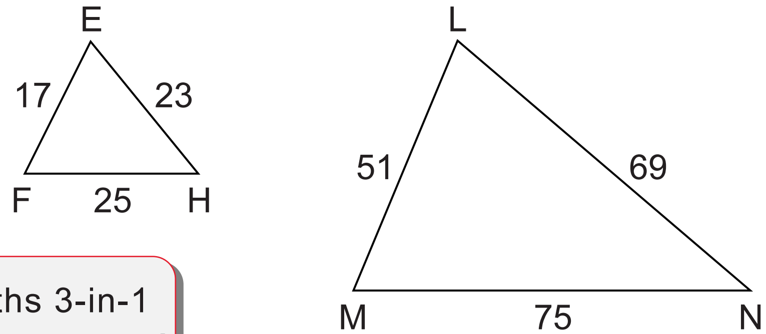
2.2.2



Gr 10 Maths 3-in-1
p. 7.6 Q2.2.2

5. State whether the following pairs of triangles are congruent or similar, giving reasons for your choice.

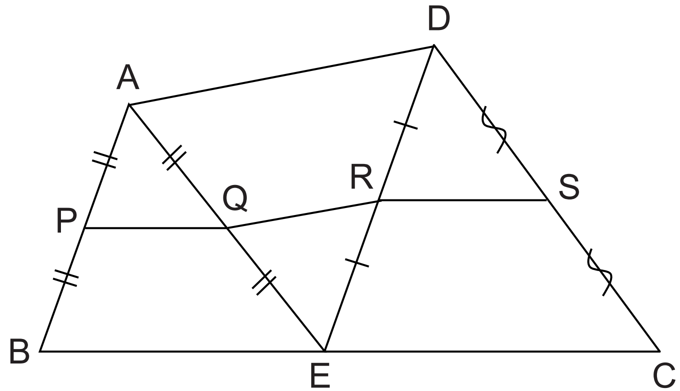
5.2



Gr 10 Maths 3-in-1
p. 7.6 Q5.2

9. ABCD is a quadrilateral.

E is a point on BC. P, Q, R and S are the midpoints of AB, AE, DE and DC respectively.



Prove that:

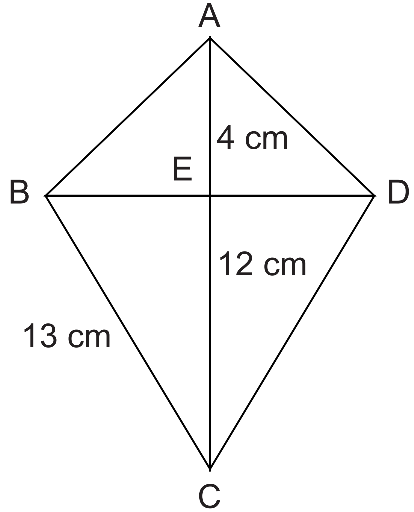
9.1 PQ || RS

9.2 $PQ + QR + RS = \frac{1}{2}(AD + BC)$

Gr 10 Maths 3-in-1
p. 7.17 Q9

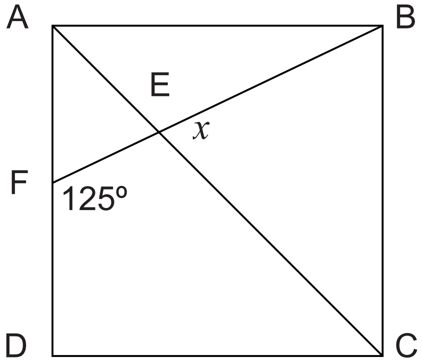
Quadrilaterals

7. Calculate the area of the kite alongside.



Gr 10 Maths 3-in-1 p. 7.6 Q7

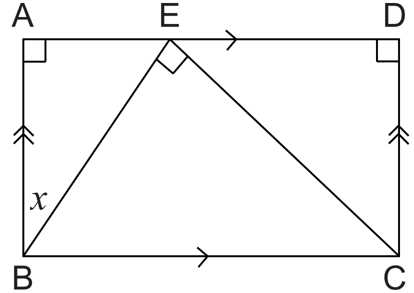
7. Calculate the value of x giving reasons, given that ABCD is a square and $B\hat{F}D = 125^\circ$.



Gr 10 Maths 3-in-1 p. 7.14 Q7.2

15.1 Make a neat copy of this sketch and fill in all the other angles in terms of x.

Reasons are not required.



15.2 Complete the following statement:

$\Delta ABE \;|||\; \Delta \ldots \;|||\; \Delta \ldots$

15.3 If BC = 18 cm and BE = 12 cm, calculate the length of

15.3.1 AE

15.3.2 AB correct to two decimals.

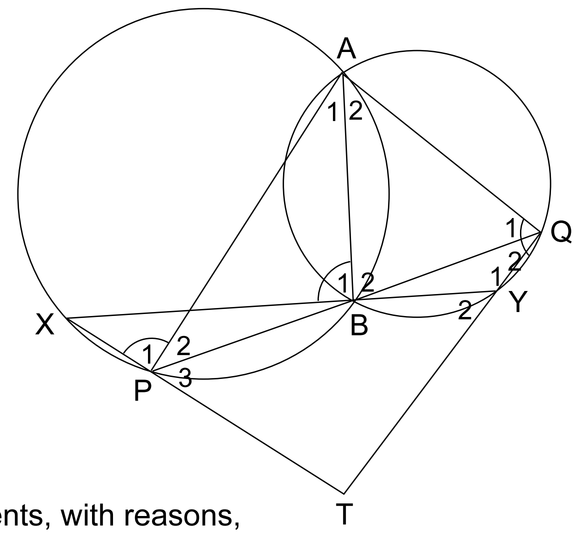
15.4 Hence calculate the area of rectangle ABCD to the nearest cm^2.

Gr 10 Maths 3-in-1 p. 7.7 Q15

Circles

EXAMPLE 7

Don't be put off by this drawing!
Direct your focus to one situation at a time ☺



Make statements, with reasons,

1. In ⊙XPBA: about $\hat{P}_1$ and $\hat{B}_1$
2. In ⊙ABYQ: about $\hat{B}_1$ and $A\hat{Q}Y$
3. In quadrilateral APTQ: about $\hat{P}_1$ and $A\hat{Q}T$
4. What can you conclude about quadrilateral APTQ?

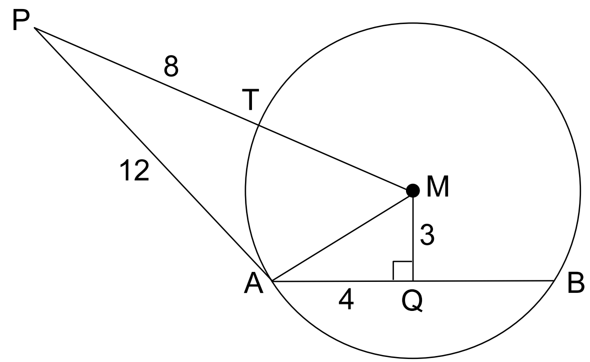
Mark the $\angle^s$ on the drawing as you proceed.

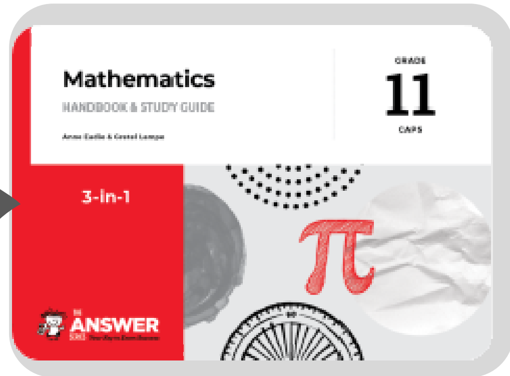
Gr 11 Maths 3-in-1
p. 9.16

EXAMPLE 8

Gr 11 Maths 3-in-1
p. 9.25 Q14

Prove that PA is a tangent to ⊙M.

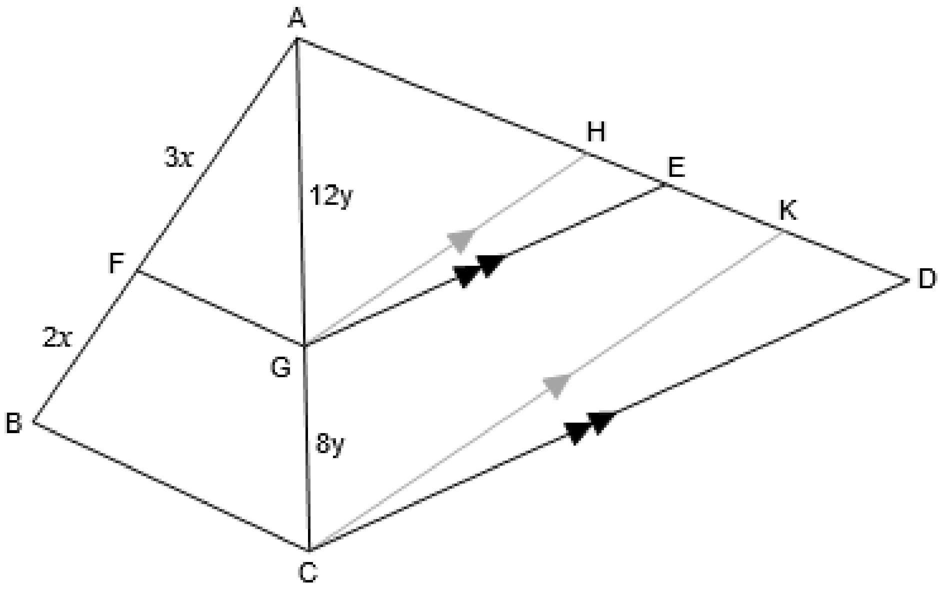




Proportion Theorem

Example 9

In the diagram, ΔABC and ΔACD are drawn. F and G are points on sides AB and AC respectively such that $AF = 3x$, $FB = 2x$, $AG = 12y$ and $GC = 8y$. H, E and K are points on side AD such that $GH \parallel CK$ and $GE \parallel CD$.



1. Prove that:

   1.1 $FG \parallel BC$ 1.2 $\frac{AH}{HK} = \frac{AE}{ED}$ (2)(3)

2. If it is further given that $AH = 15$ and $ED = 12$, calculate the length of EK. (5)

Study and analyse the diagram . . .

- Notice that there are **3** Δs on which to focus.

  And, in ΔACD, **2 pairs of || lines**. Highlight these in colour!
  (And, the first question requires **proof** of || lines.)

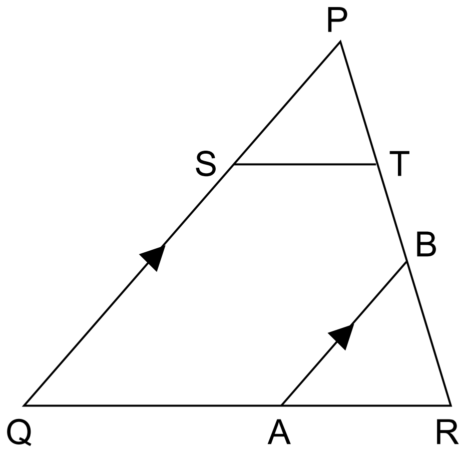
- Clearly, only **2 theorems** are involved:
  the proportion theorem and **its converse** (theorem)
  (Study these 2 theorem statements well!)

Gr 12 Maths 2-in-1
Level 3 & 4 questions booklet p. 32

Gr 12 Maths **Toolkit**:
DBE Past Papers, p. 12 Q9

Worked Example 10

In ΔPQR the lengths of PS, SQ, PT and TR are 3, 9, 2 and 6 units respectively.



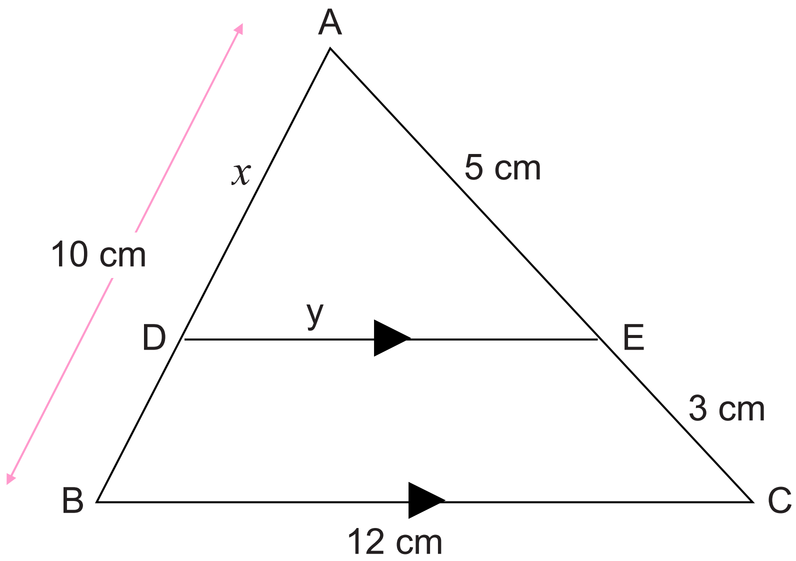
Gr 12 Maths '3-in-1'
p. 1.47 (yet to be published)

1. Give a reason why ST || QR.

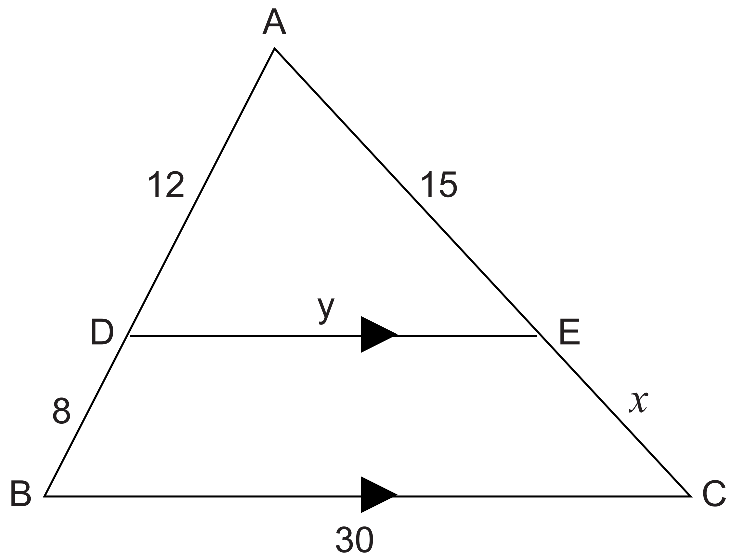
2. If AB || QP and RA : AQ = 1 : 3, calculate the length of TB.

Similar Δ^s vs. Proportion Theorem Application

1 Find the values of x and y in the figure below.



2 Find x and y in the sketch below.



Note:

Distinguish between the applications of the **similar** Δ^s and **proportion** theorems!

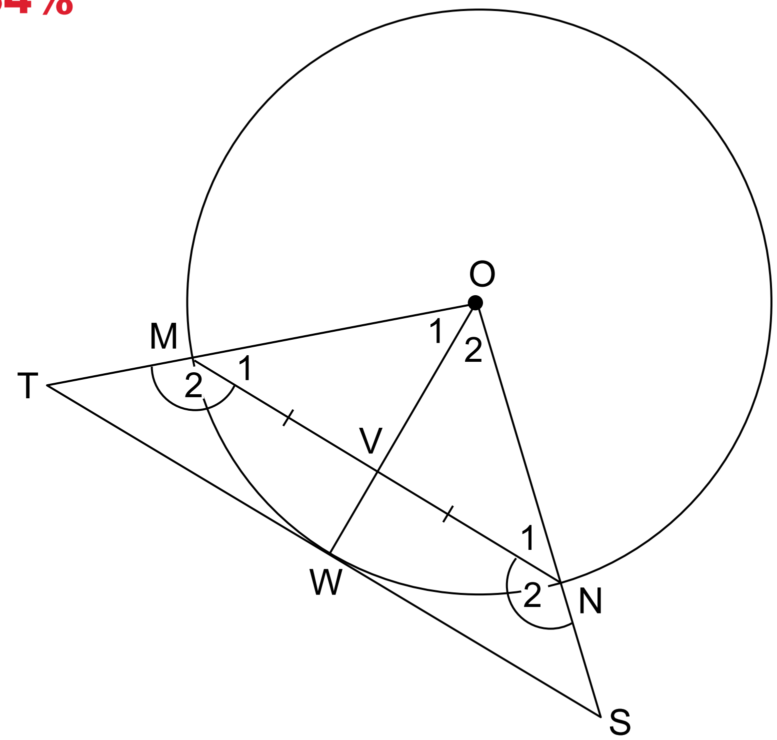
EXAMPLE 11 *(National November 2017 P2, Q10)* **34%**

In the diagram, W is a point on the circle with centre O.

V is a point on OW.

Chord MN is drawn such that MV = VN.

The tangent at W meets OM produced at T and ON produced at S.



(a) Give a reason why OV $\perp$ MN.

44%

(b) Prove that:

24%

(i) MN || TS

(ii) TMNS is a cyclic quadrilateral

(iii) $OS.MN = 2ON.WS$

Gr 12 Maths '3-in-1'
p. 1.57 (yet to be published)

Gr 12 Maths **Toolkit**:
DBE Past Papers, p. 12 Q10

'A Mix' from DBE Nov 2021

Worked Example 12 63%

9. In the diagram, PQRS is a **cyclic quadrilateral**. PS is produced to W.
TR and TS are **tangents** to the circle at R and S respectively.
$\hat{T} = 78^\circ$ and $\hat{Q} = 93^\circ$.

9.1 Give a reason why ST = TR. (1)

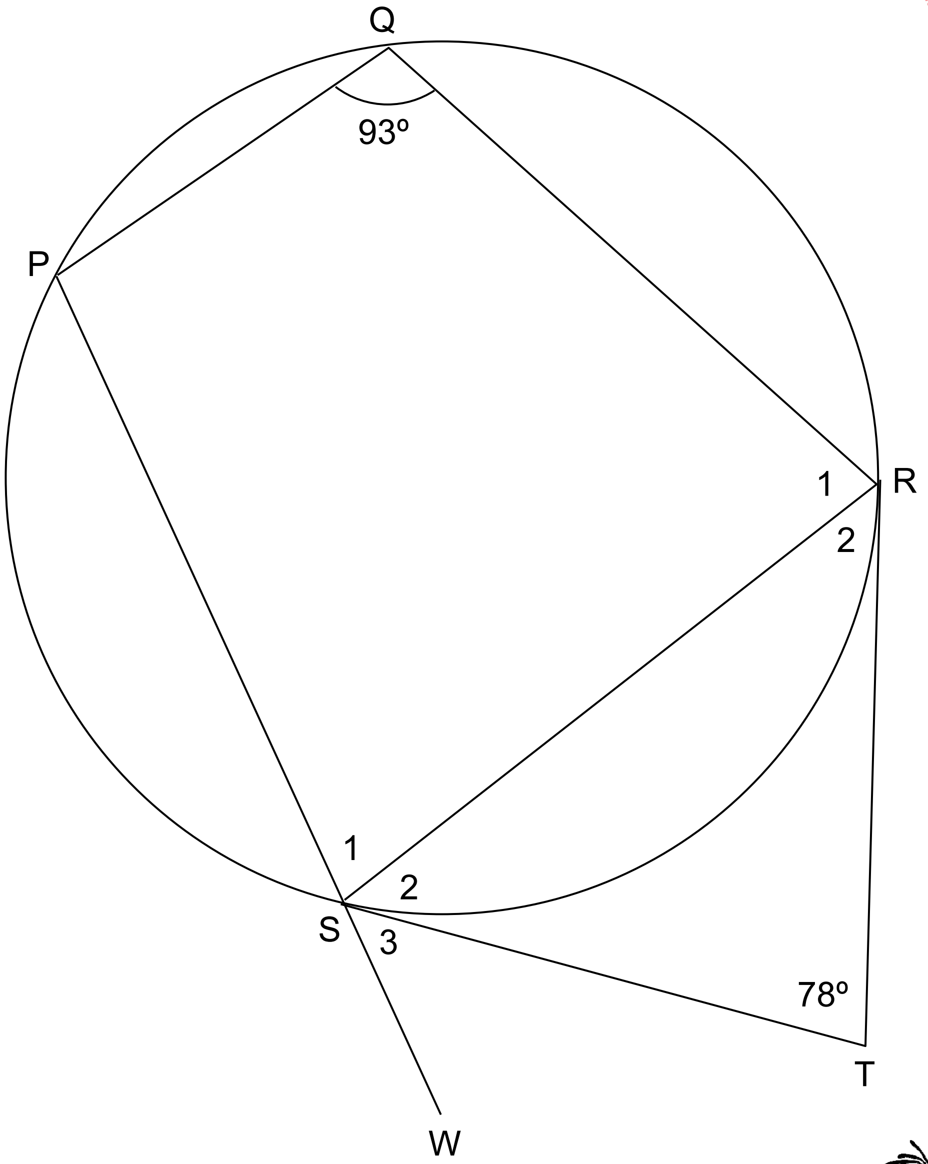
68%

9.2 Calculate, giving reasons, the size of:

62%

9.2.1 $\hat{S}_2$ 9.2.2 $\hat{S}_3$ (2)(2) **[5]**

Gr 12 Maths **Toolkit**:
DBE Past Papers, p. 32



Worked Example 13   24%

10. In the diagram, BE and CD are **diameters** of a circle having M as **centre**. Chord AE is drawn to cut CD at F. **AE ⊥ CD**.
Let $\hat{C} = x$.

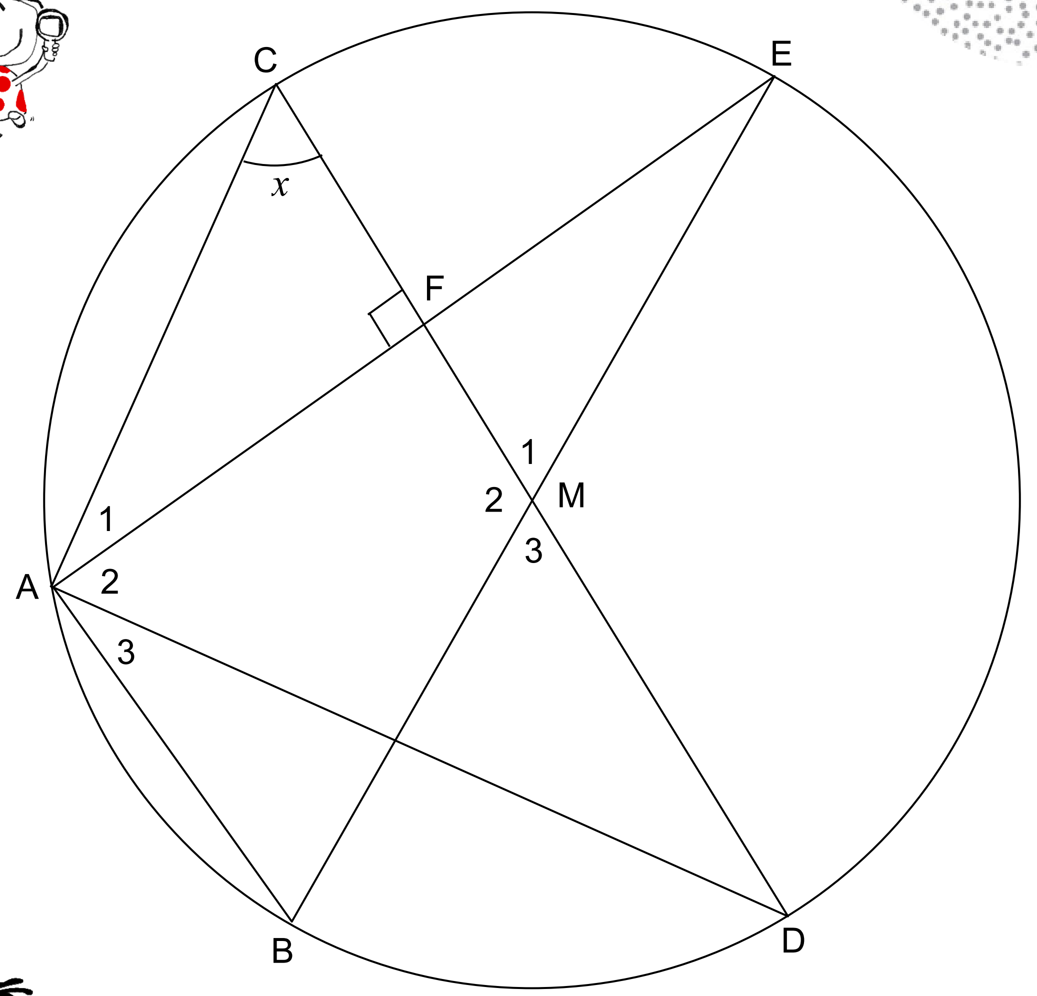
10.1 Give a reason why AF = FE. (1)
47%

10.2 Determine, giving reasons, the size of $\hat{M}_1$ in terms of x. (3)
37%

10.3 **Prove**, giving reasons, that AD is a **tangent** to the circle passing through A, C and F. (4)
37%

10.4 Given that CF = 6 units and AB = 24 units, calculate, giving reasons, the length of AE. (5)
9%

[13]

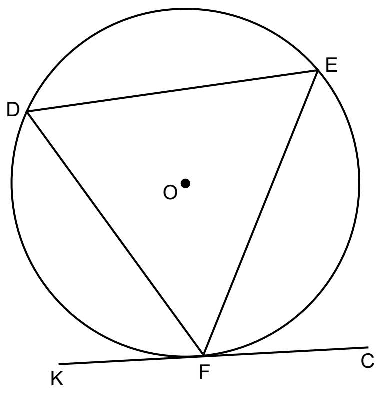


Gr 12 Maths **Toolkit**: DBE Past Papers, p. 32

Worked Example 14 34%

11.1 In the diagram, chords DE, EF and DF are
57% drawn in the circle with centre O.

KFC is a tangent to the circle at F.



Prove the theorem which states that
$D\hat{F}K = \hat{E}$. (5)

Gr 12 Maths **Toolkit**:
DBE Past Papers, p. 32

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11.2 In the diagram, PK is a **tangent** to the circle at K. Chord LS is produced to P. N and M are points on KP and SP respectively such that **MN || SK**. Chord KS and LN intersect at T.

33%

11.2.1 **Prove**, giving reasons, that:

(a) $\hat{K}_4 = N\hat{M}L$ (4)

(b) **KLMN is a cyclic quadrilateral**. (1)

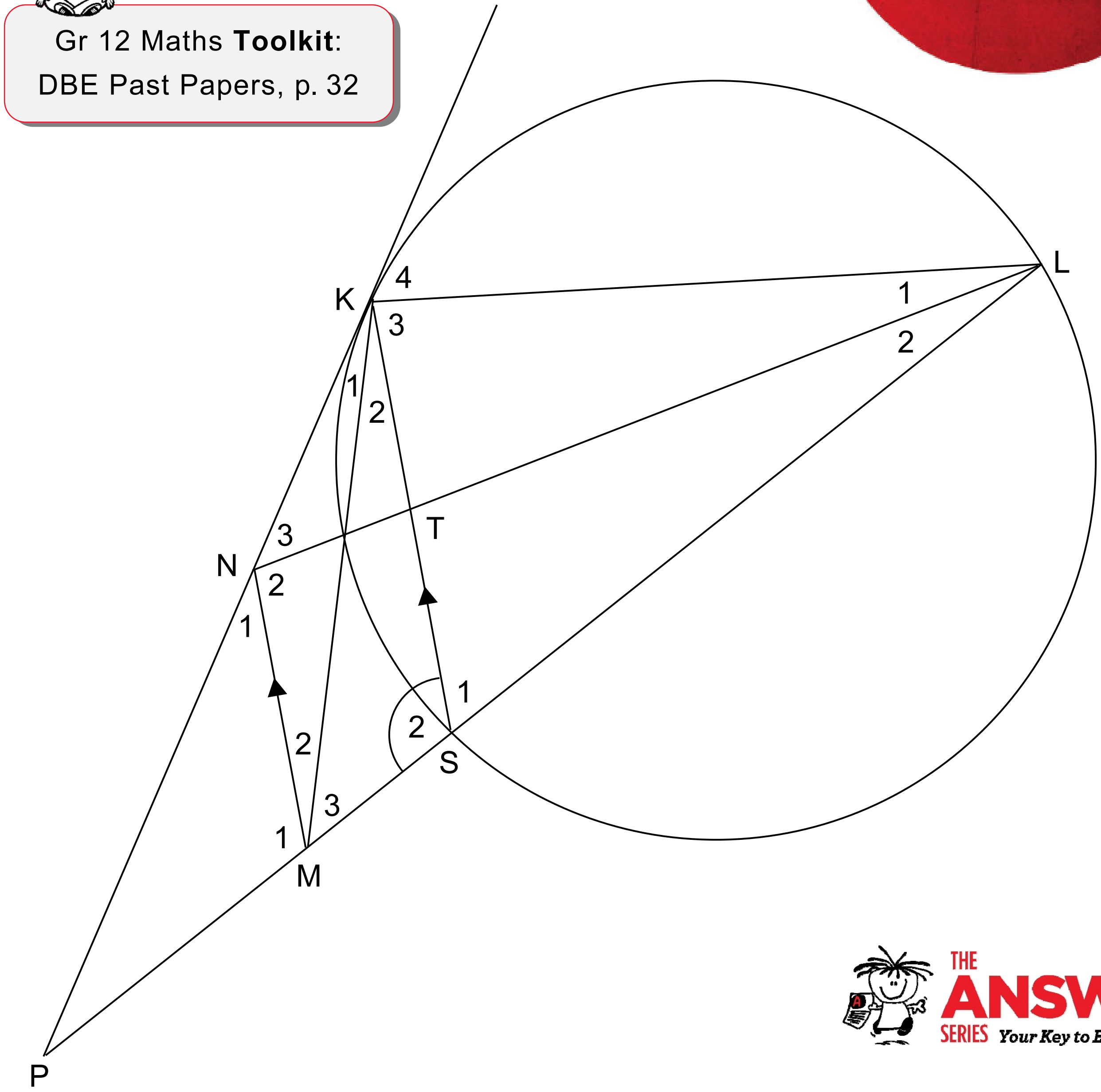
11.2.2 Prove, giving reasons, that $\triangle LKN \,|||\, \triangle KSM$. (5)

11.2.3 If LK = 12 units and 3KN = 4SM, determine the length of KS. (4)

11.2.4 If it is further given that NL = 16 units, LS = 13 units and KN = 8 units, determine, with reasons, the length of LT. (4)

[23]

Gr 12 Maths **Toolkit**: DBE Past Papers, p. 32



THE ANSWER SERIES *Your Key to Exam Success*

THEOREM STATEMENTS & ACCEPTABLE REASONS

The converse theorem statements have been highlighted in yellow

LINES

The adjacent angles on a straight line are supplementary.	$\angle^s$ on a str line
If the adjacent angles are supplementary, the outer arms of these angles form a straight line.	adj $\angle^s$ supp
The adjacent angles in a revolution add up to 360º.	$\angle^s$ around a pt **OR** $\angle^s$ in a rev
Vertically opposite angles are equal.	vert opp $\angle^s$
If AB || CD, then the alternate angles are equal.	alt $\angle^s$; AB || CD
If AB || CD, then the corresponding angles are equal.	corresp $\angle^s$; AB || CD
If AB || CD, then the co-interior angles are supplementary.	co-int $\angle^s$; AB || CD
If the alternate angles between two lines are equal, then the lines are parallel.	alt $\angle^s$ =
If the corresponding angles between two lines are equal, then the lines are parallel.	corresp $\angle^s$ =
If the co-interior angles between two lines are supplementary, then the lines are parallel.	co-int $\angle^s$ supp

TRIANGLES

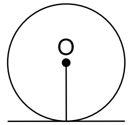
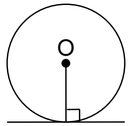
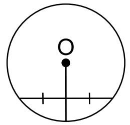
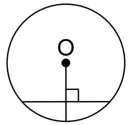
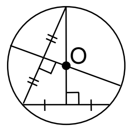
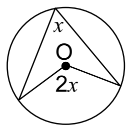
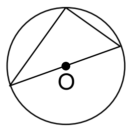
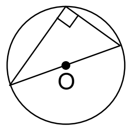
The interior angles of a triangle are supplementary.	$\angle$ sum in Δ **OR** sum of $\angle^s$ in Δ **OR** int $\angle^s$ in Δ
The exterior angle of a triangle is equal to the sum of the interior opposite angles.	ext $\angle$ of Δ
The angles opposite the equal sides in an isosceles triangle are equal.	$\angle^s$ opp equal sides
The sides opposite the equal angles in an isosceles triangle are equal.	sides opp equal $\angle^s$
In a right-angled triangle, the square of the hypotenuse is equal to the sum of the squares of the other two sides.	Pythagoras **OR** Theorem of Pythagoras
If the square of the longest side in a triangle is equal to the sum of the squares of the other two sides then the triangle is right-angled.	**Converse** Pythagoras **OR Converse** Theorem of Pythagoras
If three sides of one triangle are respectively equal to three sides of another triangle, the triangles are congruent.	SSS
If two sides and an included angle of one triangle are respectively equal to two sides and an included angle of another triangle, the triangles are congruent.	SAS **OR** S$\angle$S
If two angles and one side of one triangle are respectively equal to two angles and the corresponding side in another triangle, the triangles are congruent.	AAS **OR** $\angle\angle$S
If in two right angled triangles, the hypotenuse and one side of one triangle are respectively equal to the hypotenuse and one side of the other, the triangles are congruent.	RHS **OR** 90ºHS
The line segment joining the midpoints of two sides of a triangle is parallel to the third side and equal to half the length of the third side.	Midpt Theorem
The line drawn from the midpoint of one side of a triangle, parallel to another side, bisects the third side.	line through midpt || to 2nd side
A line drawn parallel to one side of a triangle divides the other two sides proportionally.	line || one side of Δ **OR** prop theorem; name || lines
If a line divides two sides of a triangle in the same proportion, then the line is parallel to the third side.	line divides two sides of Δ in prop
If two triangles are equiangular, then the corresponding sides are in proportion (and consequently the triangles are similar).	||| Δ^s **OR** equiangular Δ^s
If the corresponding sides of two triangles are proportional, then the triangles are equiangular (and consequently the triangles are similar).	sides of Δ in prop
If triangles (or parallelograms) are on the same base (or on bases of equal length) and between the same parallel lines, then the triangles (or parallelograms) have equal areas.	same base; same height **OR** equal bases; equal height

QUADRILATERALS

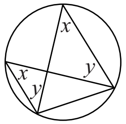
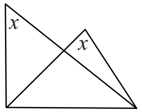
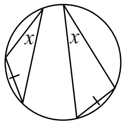
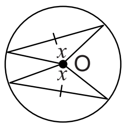
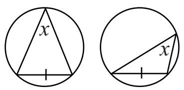
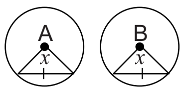
The interior angles of a quadrilateral add up to 360º.	sum of $\angle^s$ in quad
The opposite sides of a parallelogram are parallel.	opp sides of ||m
If the opposite sides of a quadrilateral are parallel, then the quadrilateral is a parallelogram.	opp sides of quad are || **OR** **converse** opp sides of ||m
The opposite sides of a parallelogram are equal in length.	opp sides of ||m
If the opposite sides of a quadrilateral are equal, then the quadrilateral is a parallelogram.	opp sides of quad are = **OR** **converse** opp sides of a parm
The opposite angles of a parallelogram are equal.	opp $\angle^s$ of ||m
If the opposite angles of a quadrilateral are equal then the quadrilateral is a parallelogram.	opp $\angle^s$ of quad are = **OR** **converse** opp angles of a parm
The diagonals of a parallelogram bisect each other.	diag of ||m
If the diagonals of a quadrilateral bisect each other, then the quadrilateral is a parallelogram.	diags of quad bisect each other **OR** **converse** diags of a parm
If one pair of opposite sides of a quadrilateral are equal and parallel, then the quadrilateral is a parallelogram.	pair of opp sides = and ||
The diagonals of a parallelogram bisect its area.	diag bisect area of ||m
The diagonals of a rhombus bisect at right angles.	diags of rhombus
The diagonals of a rhombus bisect the interior angles.	diags of rhombus
All four sides of a rhombus are equal in length.	sides of rhombus
All four sides of a square are equal in length.	sides of square
The diagonals of a rectangle are equal in length.	diags of rect
The diagonals of a kite intersect at right-angles.	diags of kite
A diagonal of a kite bisects the other diagonal.	diag of kite
A diagonal of a kite bisects the opposite angles.	diag of kite

CIRCLES

GROUP I

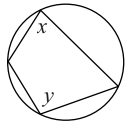
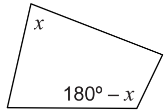
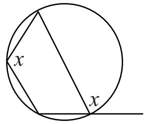
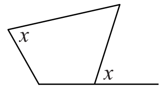
	The tangent to a circle is perpendicular to the radius/diameter of the circle at the point of contact.	tan $\perp$ radius tan $\perp$ diameter
	If a line is drawn perpendicular to a radius/diameter at the point where the radius/diameter meets the circle, then the line is a tangent to the circle.	line $\perp$ radius **OR** **converse** tan $\perp$ radius **OR** **converse** tan $\perp$ diameter
	The line drawn from the centre of a circle to the midpoint of a chord is perpendicular to the chord.	line from centre to midpt of chord
	The line drawn from the centre of a circle perpendicular to a chord bisects the chord.	line from centre $\perp$ to chord
	The perpendicular bisector of a chord passes through the centre of the circle.	perp bisector of chord
	The angle subtended by an arc at the centre of a circle is double the size of the angle subtended by the same arc at the circle (on the same side of the chord as the centre)	$\angle$ at centre = 2 × $\angle$ at circumference No converse
	The angle subtended by the diameter at the circumference of the circle is 90º.	$\angle^s$ in semi circle **OR** diameter subtends right angle **OR** $\angle$ in ½ ⊙
	If the angle subtended by a chord at the circumference of the circle is 90º, then the chord is a diameter.	chord subtends 90º **OR** **converse** $\angle^s$ in semi circle

GROUP II

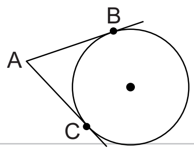
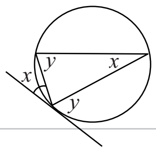
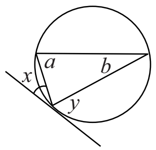
	Angles subtended by a chord of the circle, on the same side of the chord, are equal	$\angle^s$ in the same seg
	If a line segment joining two points subtends equal angles at two points on the same side of the line segment, then the four points are concyclic. (This can be used to prove that the four points are concyclic).	line subtends equal $\angle^s$ **OR** **converse** $\angle^s$ in the same seg
	Equal chords subtend equal angles at the circumference of the circle.	equal chords; equal $\angle^s$
	Equal chords subtend equal angles at the centre of the circle.	equal chords; equal $\angle^s$
	Equal chords in equal circles subtend equal angles at the circumference of the circles.	equal circles; equal chords; equal $\angle^s$
	Equal chords in equal circles subtend equal angles at the centre of the circles. (A and B indicate the centres of the circles)	equal circles; equal chords; equal $\angle^s$

The highlighted statements are CONVERSE theorem statements.

GROUP III

	The opposite angles of a cyclic quadrilateral are supplementary (i.e. x and y are supplementary)	opp $\angle^s$ of cyclic quad
	If the opposite angles of a quadrilateral are supplementary then the quadrilateral is cyclic.	opp $\angle^s$ quad sup **OR** **converse** opp $\angle^s$ of cyclic quad
	The exterior angle of a cyclic quadrilateral is equal to the interior opposite angle.	ext $\angle$ of cyclic quad
	If the exterior angle of a quadrilateral is equal to the interior opposite angle of the quadrilateral, then the quadrilateral is cyclic.	ext $\angle$ = int opp $\angle$ **OR** **converse** ext $\angle$ of cyclic quad

GROUP IV

	Two tangents drawn to a circle from the same point outside the circle are equal in length (AB = AC)	Tans from common pt **OR** Tans from same pt
	The angle between the tangent to a circle and the chord drawn from the point of contact is equal to the angle in the alternate segment.	tan chord theorem
	If a line is drawn through the end-point of a chord, making with the chord an angle equal to an angle in the alternate segment, then the line is a tangent to the circle. (If $x = b$ or if $y = a$ then the line is a tangent to the circle)	**converse** tan chord theorem **OR** $\angle$ between line and chord

Euclidean Geometry

References to TAS Maths books

THE ANSWER SERIES *Your Key to Exam Success*

Gr 10 Maths 3-in-1 (Module 7)

# 1:	Lines, angles & triangles: revision • vocabulary & facts	7.1 ⟶ 7.7
# 2:	Quadrilaterals: revision • definitions • theorems • areas	7.8 ⟶ 7.15
# 3:	Midpoint theorem	7.16 ⟶ 7.17
# 4:	Polygons: definitions & types • interior angles • exterior angles	7.18

Note: The Gr 10 Exemplar Exams and Memos are at the end of the book

Gr 11 Maths 3-in-1 (Module 9)

# 1:	Revision from earlier grades	9.1 ⟶ 9.5
# 2:	Circle Geometry	9.6 ⟶ 9.26

Note: The Gr 11 Exemplar Exams and Memos are at the end of the book

Gr 12 Maths 2-in-1 (Module 10)

# 1:	Circle Geometry	36 ⟶ 40
# 2:	Proportion Theorem	40 ⟶ 42
# 3:	Similar Triangles	42 ⟶ 43
# 4:	Mixed	43

See Challenging Questions booklet: pages 29 ⟶ 38

Back pages:	Circle Geometry, Proportion and Similar Triangles Theorem PROOFS	i ⟶ iii
	Grouping of Circle Geometry Theorems	viii
	Converse Theorems in Circle Geometry	ix
	Theorem Statements & Acceptable Reasons	x ⟶ xii

See the Topic Guide on p. 148 for further exam practice.

Gr 12 Maths Toolkit: DBE Past Papers

Back pages:	Circle Geometry, Proportion and Similar Triangles Theorem PROOFS	i ⟶ iii
	Grouping of Circle Geometry Theorems	xiii
	Theorem Statements & Acceptable Reasons	xiv ⟶ xvi

See the Topic Guide: DBE: p. 2

Theory without practice
is empty

Practice without theory
is blind

Philosopher, Immanuel Kant (18th century philosopher)