EUCLIDEAN GEOMETRY

Every question, eight papers

DBE · National Senior Certificate · Mathematics Paper 2

November 2021 - 2024 and May/June 2021, 2022, 2024, 2025

22 questions · 333 marks · 8 papers

Each question is a clip of the original DBE page. The wording, the mark allocations and the diagrams are exactly as they were printed - nothing has been retyped or redrawn. Only the blank answer space has been removed, so work in a separate book.

How it is arranged

One chapter per topic, so you can work through a whole skill at a time.

Inside a chapter the questions run from fewest marks to most. That is an order by size, not by difficulty: unlike the IEB, the DBE does not split its papers into an easier and a harder section, and its marking guidelines carry no cognitive-level tags. Nothing in these papers ranks one question as harder than another, so this booklet does not pretend otherwise.

Contents

Circle geometry: finding angles, with reasons

The circle theorems used the way DBE uses them: a couple of angles are given and every other angle in the diagram follows. Every statement needs its reason, and the reason carries as much of the mark as the number does. Diameters, tangents, cyclic quadrilaterals, and often two circles sharing a point.

12 questions · 163 marks

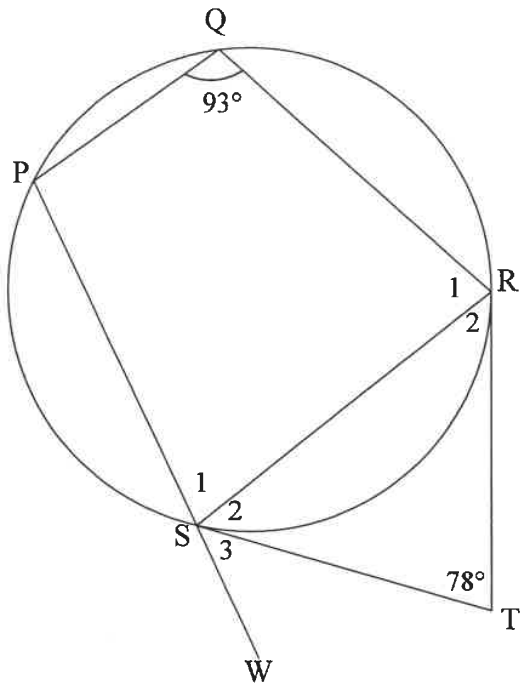
5 to 20 marks each

1. Why ST = TR, then two angles in a cyclic quadrilateral

DBE NSC Paper 2 · November 2021 · Q9 · 5 marks

QUESTION 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. $\hat{T}=78°$ and $\hat{Q}=93°$.



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

9.2 Calculate, giving reasons, the size of:

9.2.1 $\hat{S}_2$ (2)

9.2.2 $\hat{S}_3$ (2)

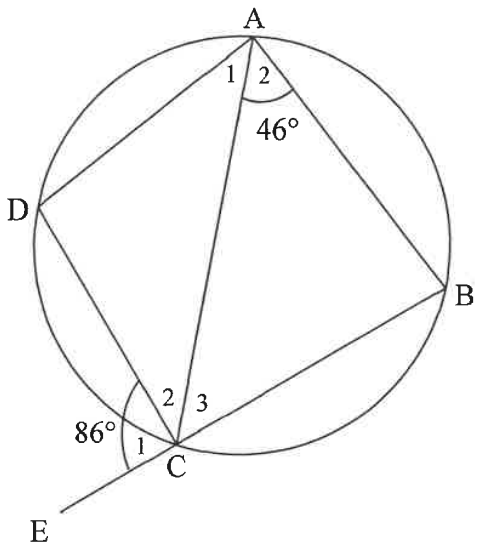
[5]

2. An exterior angle of a cyclic quadrilateral, then AD = DC

DBE NSC Paper 2 · November 2024 · Q9 · 6 marks

QUESTION 9

In the diagram, ABCD is a cyclic quadrilateral. BC is produced to E. AC is drawn.
$\hat{A}_1 = \frac{1}{2}\hat{B}$, $\hat{A}_2 = 46°$ and $\hat{C}_1 = 86°$.



9.1 Calculate, with a reason, the value of $\hat{A}_1$. (2)

9.2 Hence, prove that AD = DC. (4)

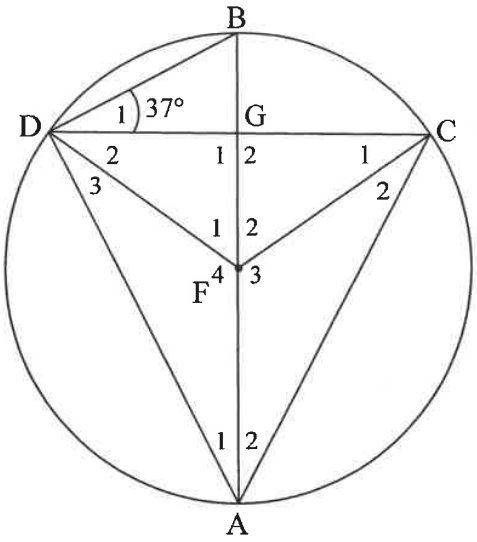
[6]

3. A diameter and a bisected angle: find three more

DBE NSC Paper 2 · May/June 2024 · Q9 · 12 marks

QUESTION 9

In the diagram, AB is a diameter of the circle, with centre F. AB and CD intersect at G. FD and FC are drawn. BA bisects $C\hat{A}D$ and $\hat{D}_1 = 37°$.



9.1 Determine, giving reasons, any three other angles equal to $\hat{D}_1$. (4)

9.2 Show that DG = GC. (4)

9.3 If it is further given that the radius of the circle is 20 units, calculate the length of BG. (4)

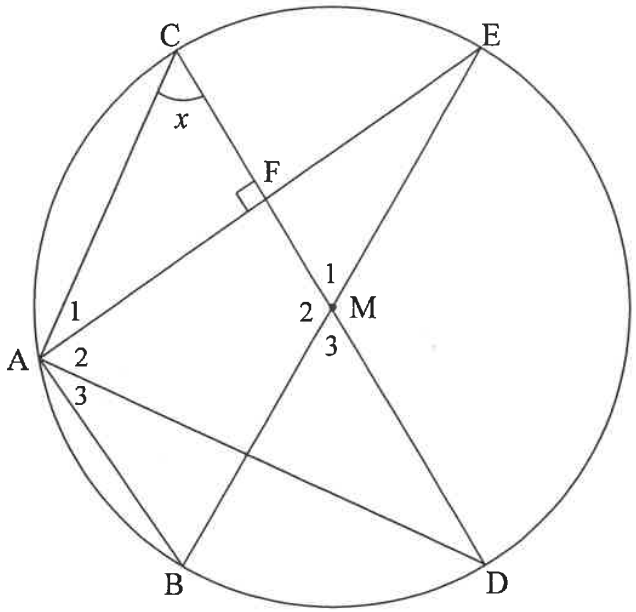
[12]

4. Two diameters, a perpendicular chord, everything in terms of x

DBE NSC Paper 2 · November 2021 · Q10 · 13 marks

QUESTION 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. $AE \perp CD$. Let $\hat{C} = x$.



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

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

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

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

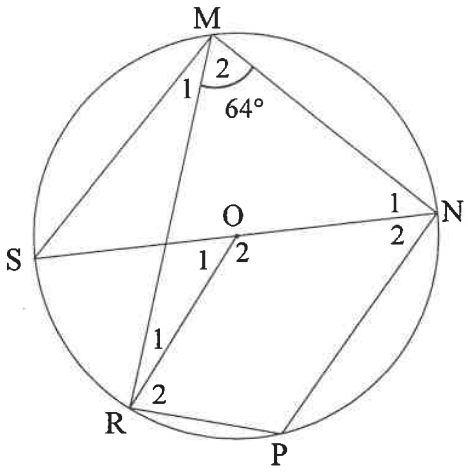
[13]

5. A diameter drawn through a cyclic quadrilateral

DBE NSC Paper 2 · November 2022 · Q8 · 13 marks

QUESTION 8

8.1 In the diagram, O is the centre of the circle. MNPR is a cyclic quadrilateral and SN is a diameter of the circle. Chord MS and radius OR are drawn. $\hat{M}_2 = 64°$.



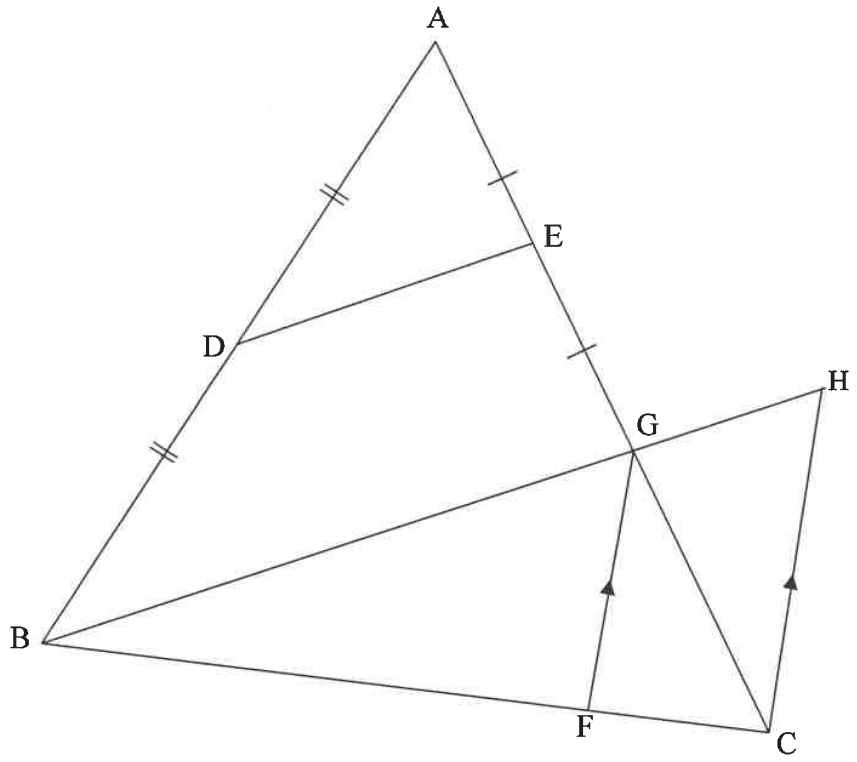
Determine, giving reasons, the size of the following angles:

8.1.1 $\hat{P}$ (2)

8.1.2 $\hat{M}_1$ (2)

8.1.3 $\hat{O}_1$ (2)

8.2 In the diagram, ΔABG is drawn. D and E are midpoints of AB and AG respectively. AG and BG are produced to C and H respectively. F is a point on BC such that FG || CH.



8.2.1 Give a reason why DE || BH. (1)

8.2.2 If it is further given that $\frac{FC}{BF} = \frac{1}{4}$, DE = $3x - 1$ and GH = $x + 1$, calculate, giving reasons, the value of x. (6)

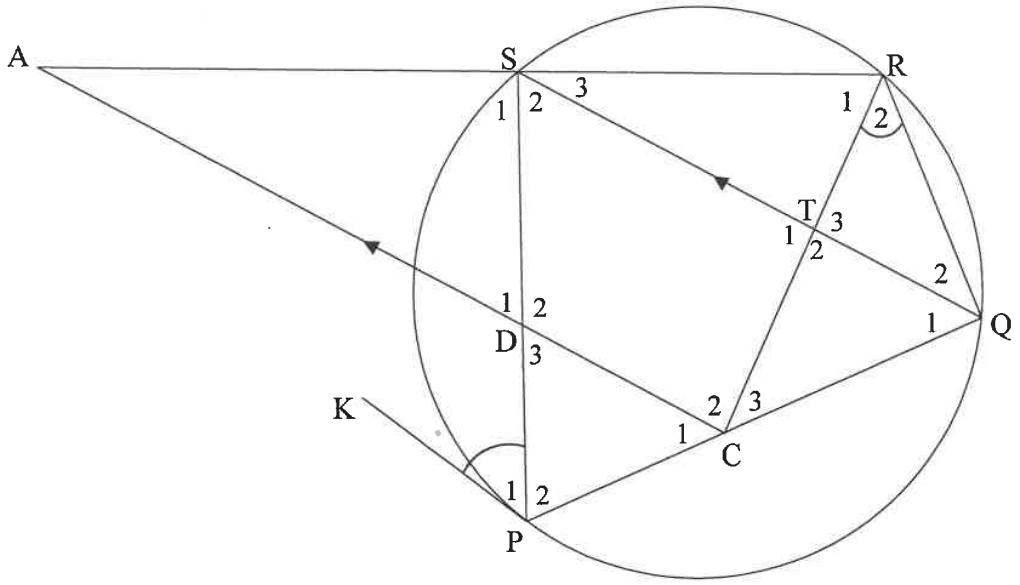
[13]

6. A tangent, a parallel line, and a cyclic quadrilateral to prove

DBE NSC Paper 2 · November 2022 · Q10 · 13 marks

QUESTION 10

In the diagram, PQRS is a cyclic quadrilateral. KP is a tangent to the circle at P. C and D are points on chords PQ and PS respectively and CD produced meets RS produced at A. CA ∥ QS. RC is drawn. $\hat{P}_1 = \hat{R}_2$.



Prove, giving reasons, that:

10.1 $\hat{S}_1 = \hat{T}_2$ (4)

10.2 $\frac{AD}{AR} = \frac{AS}{AC}$ (5)

10.3 $AC \times SD = AR \times TC$ (4)

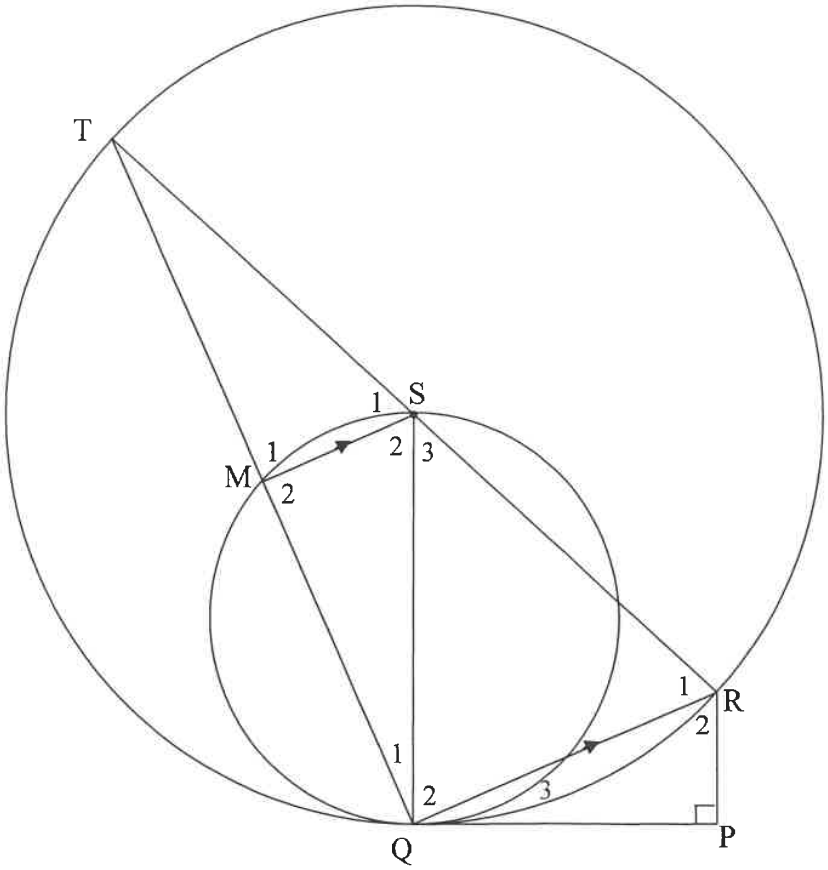
[13]

7. Two circles with a tangent common to both at Q

DBE NSC Paper 2 · May/June 2021 · Q10 · 15 marks

QUESTION 10

In the diagram, TSR is a diameter of the larger circle having centre S. Chord TQ of the larger circle cuts the smaller circle at M. PQ is a common tangent to the two circles at Q. SQ is drawn.
RP ⊥ PQ and MS || QR.



10.1 Prove, giving reasons that:

10.1.1 SQ is the diameter of the smaller circle (3)

10.1.2 $RT = \frac{RQ^2}{RP}$ (6)

10.2 If MS = 14 units and $PQ = \sqrt{640}$ units, calculate, giving reasons, the length of the radius of the larger circle. (6)

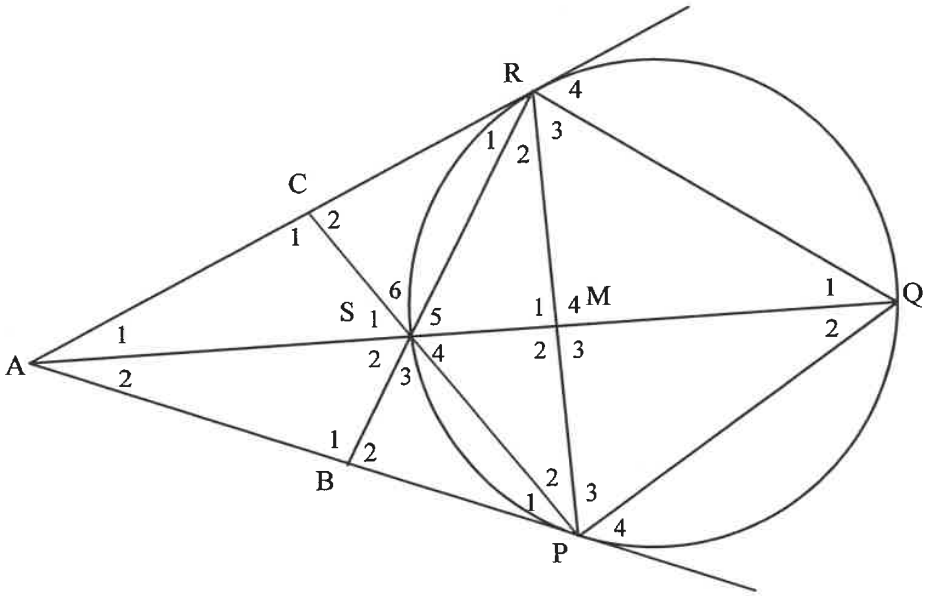
[15]

8. Two tangents meeting a chord that has been produced

DBE NSC Paper 2 · November 2023 · Q10 · 15 marks

QUESTION 10

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)

10.2 SMRC is a cyclic quadrilateral (4)

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

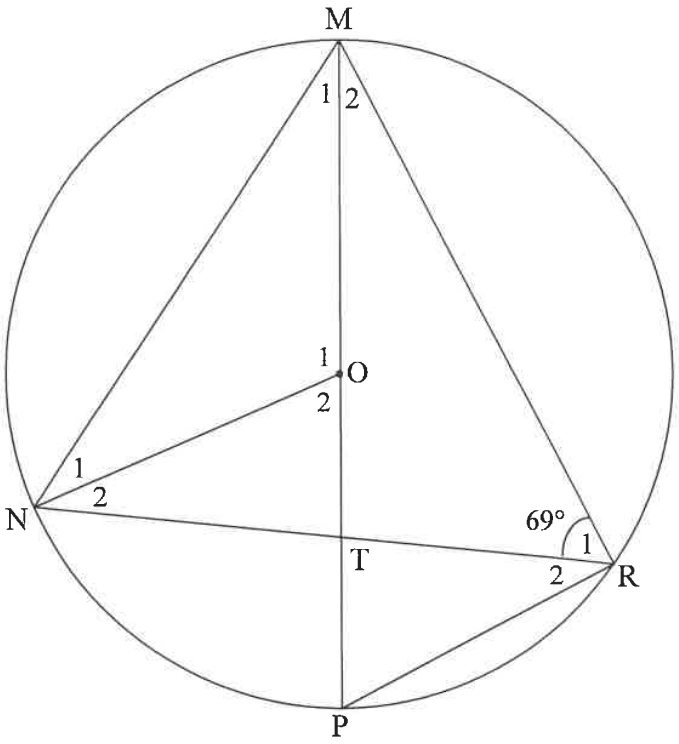
[15]

9. A diameter cutting a chord, and the angles around it

DBE NSC Paper 2 · May/June 2021 · Q8 · 16 marks

QUESTION 8

8.1 In the diagram, MP is a diameter of a circle centered at O. MP cuts the chord NR at T. Radius NO and chords PR, MN and MR are drawn. $\hat{R}_1 = 69°$.



Determine, giving reasons, the size of:

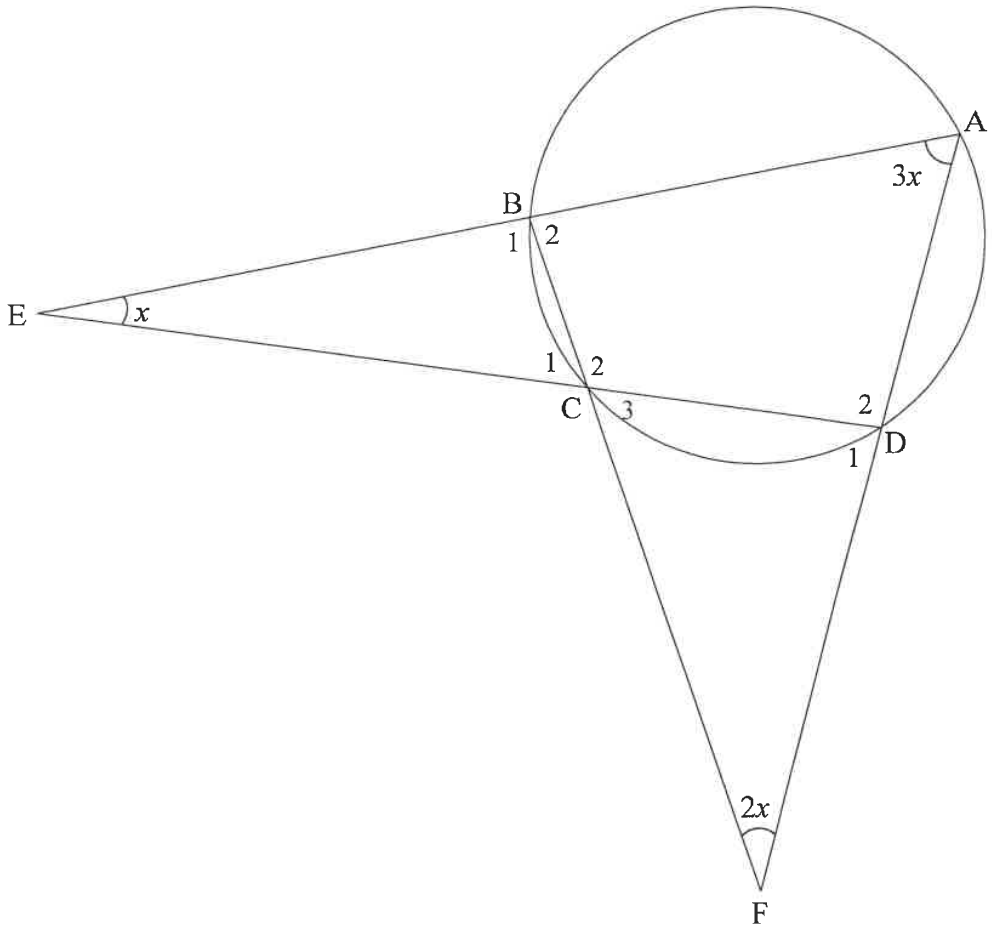
8.1.1 $\hat{R}_2$ (2)

8.1.2 $\hat{O}_1$ (2)

8.1.3 $\hat{M}_1$ (2)

8.1.4 $\hat{M}_2$, if it is further given that NO || PR (4)

8.2 In the diagram below, ABCD is a cyclic quadrilateral. AB and DC are produced to meet at E. AD and BC are produced to meet at F. $A\hat{F}B = 2x$, $D\hat{A}B = 3x$ and $A\hat{E}D = x$.



Determine, giving reasons, the value of x. (6)

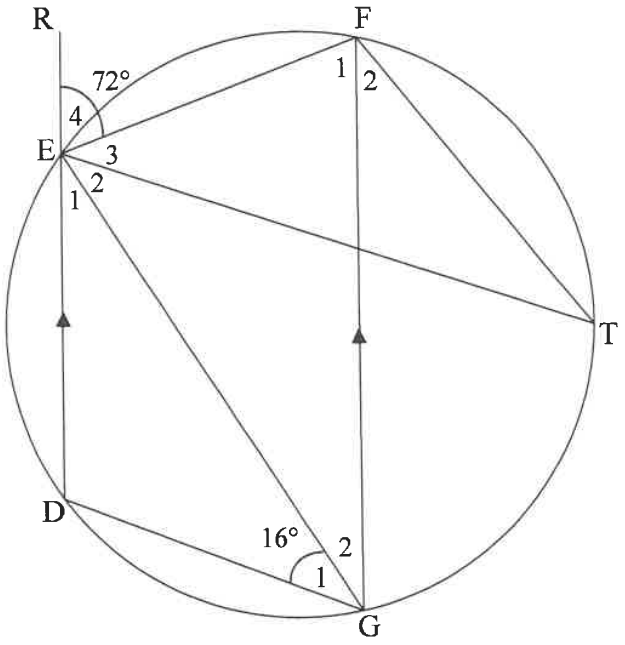
[16]

10. A cyclic quadrilateral with one pair of sides parallel

DBE NSC Paper 2 · May/June 2022 · Q9 · 16 marks

QUESTION 9

9.1 In the diagram, DEFG is a cyclic quadrilateral with DE || GF. DE is produced to R. T is another point on the circle. EG, FT and ET are drawn. $\hat{E}_4 = 72°$ and $\hat{G}_1 = 16°$.



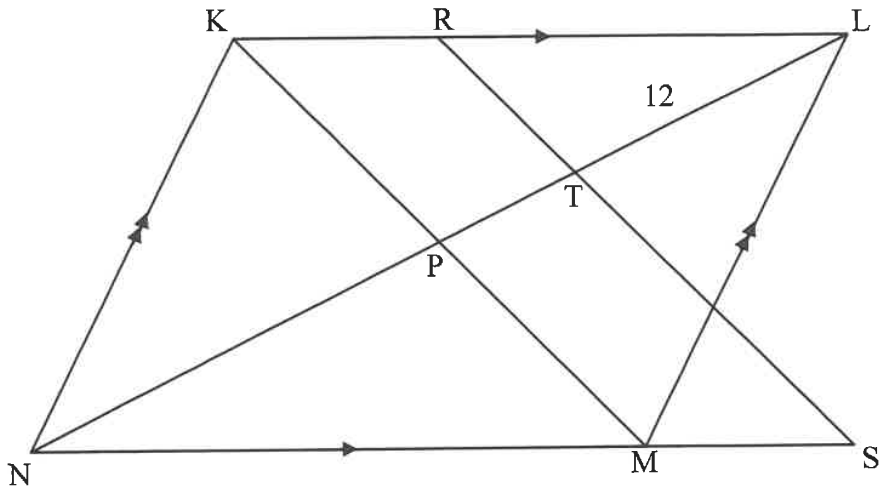
Determine, with reasons, the size of the following angles:

9.1.1 $D\hat{G}F$ (2)

9.1.2 $\hat{T}$ (2)

9.1.3 $G\hat{E}F$ (2)

9.2 In the diagram, the diagonals of parallelogram KLMN intersect at P. NM is produced to S. R is a point on KL and RS cuts PL at T.
NM : MS = 4 : 1, NL = 32 units and TL = 12 units.



9.2.1 Determine, with reasons, the value of the ratio NP : PT in simplest form. (4)

9.2.2 Prove, with reasons, that KM || RS. (2)

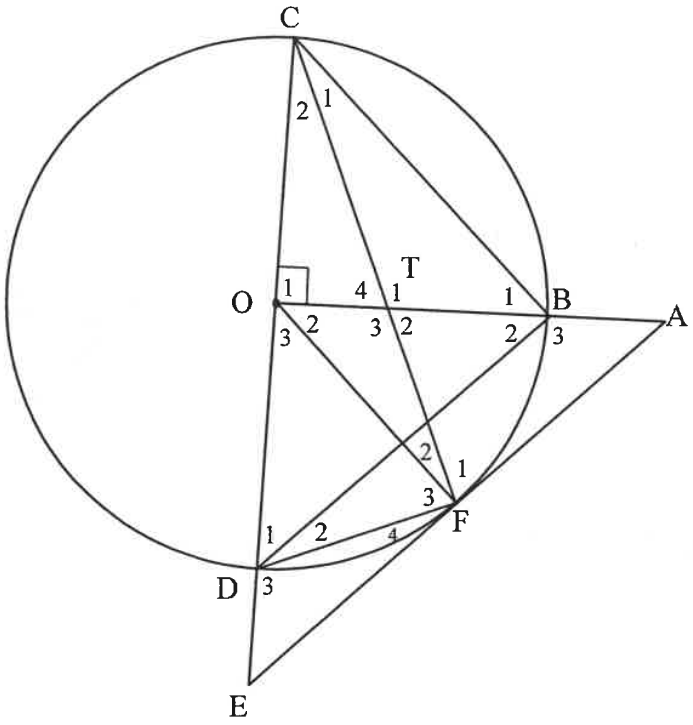
9.2.3 If NM = 21 units, determine, with reasons, the length of RL. (4)
[16]

11. A diameter produced until it meets a tangent

DBE NSC Paper 2 · May/June 2024 · Q10 · 19 marks

QUESTION 10

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)

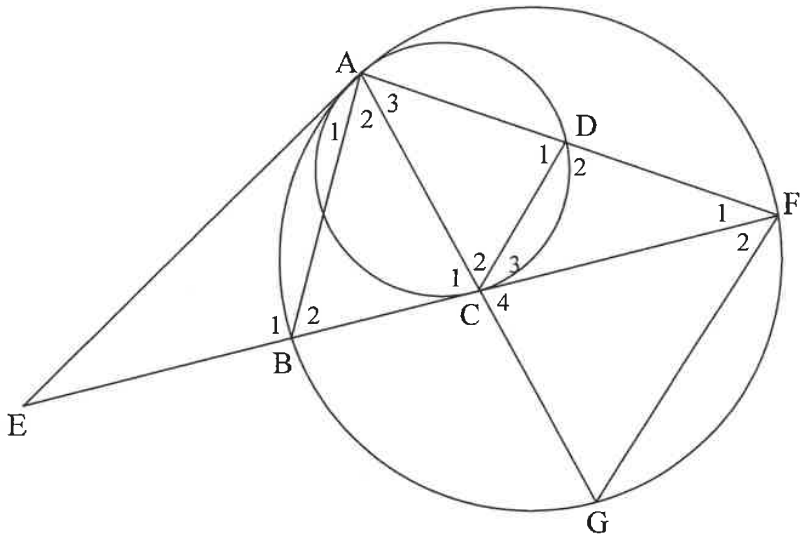
10.5 Prove that $DO = \dfrac{TO.FE}{AB}$ (5)
[19]

12. Two circles touching internally, and a tangent common to both

DBE NSC Paper 2 · November 2024 · Q11 · 20 marks

QUESTION 11

In the diagram, A, B, G and F lie on the larger circle. A smaller circle is drawn to touch the larger circle internally at A. EA is a common tangent to both circles. EBCF is a tangent to the smaller circle at C. AC is produced to G. AF cuts the smaller circle at D. AB, CD and GF are drawn.



11.1 If $E\hat{A}G = x$, determine with reasons, FOUR other angles that are equal to x. (6)

11.2 Prove that AG.AD = AC.AF (4)

11.3 Prove that $\Delta AGF \;|||\; \Delta ABC$ (4)

11.4 Prove that $GF^2 = \dfrac{BC.FC.AF}{AD}$ (6)

[20]

Proportion and similar triangles

Triangles of the same shape but different size, and lines that cut the sides of a triangle proportionally. Only two questions here stand on their own - most of the similarity work in these papers sits inside the riders of the bookwork chapter.

2 questions · 29 marks

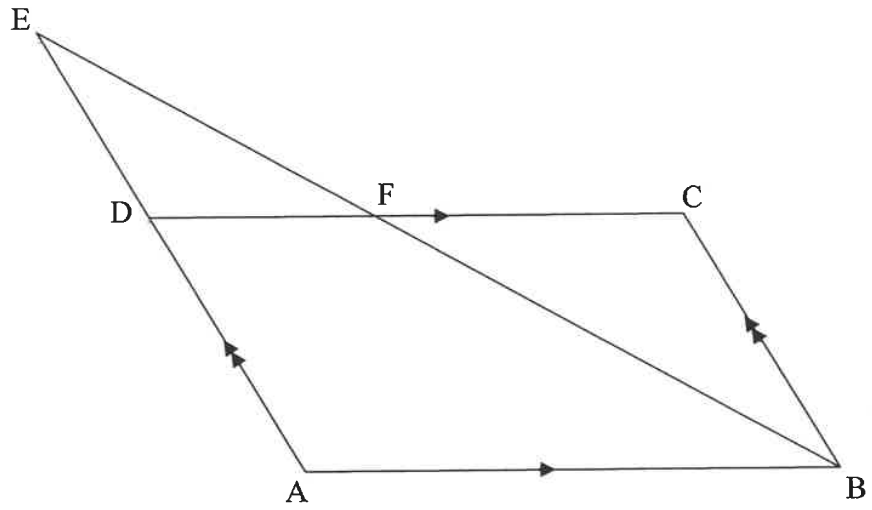
9 to 20 marks each

13. A parallelogram cut by a line, and the length of FB

DBE NSC Paper 2 · November 2023 · Q9 · 9 marks

QUESTION 9

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)

9.2 Prove, with reasons, that $\Delta EDF \;|||\; \Delta EAB$. (3)

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

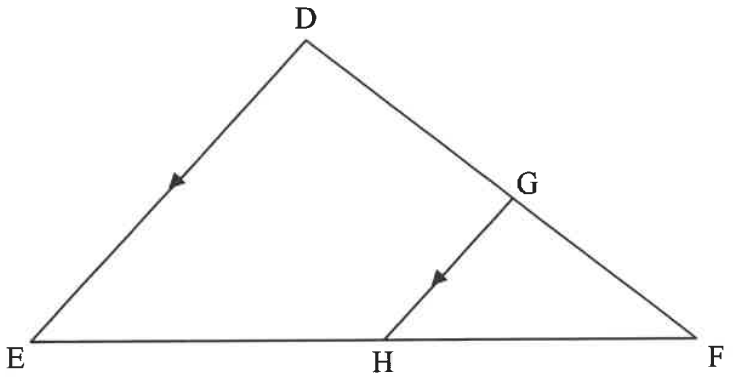
[9]

14. A line drawn across a triangle, and the ratios it creates

DBE NSC Paper 2 · May/June 2025 · Q9 · 20 marks

QUESTION 9

9.1 In the diagram, ΔDEF is drawn. Line GH intersects DF and EF at G and H respectively such that $GH \parallel DE$ and $\frac{GF}{DG} = \frac{2}{5}$.



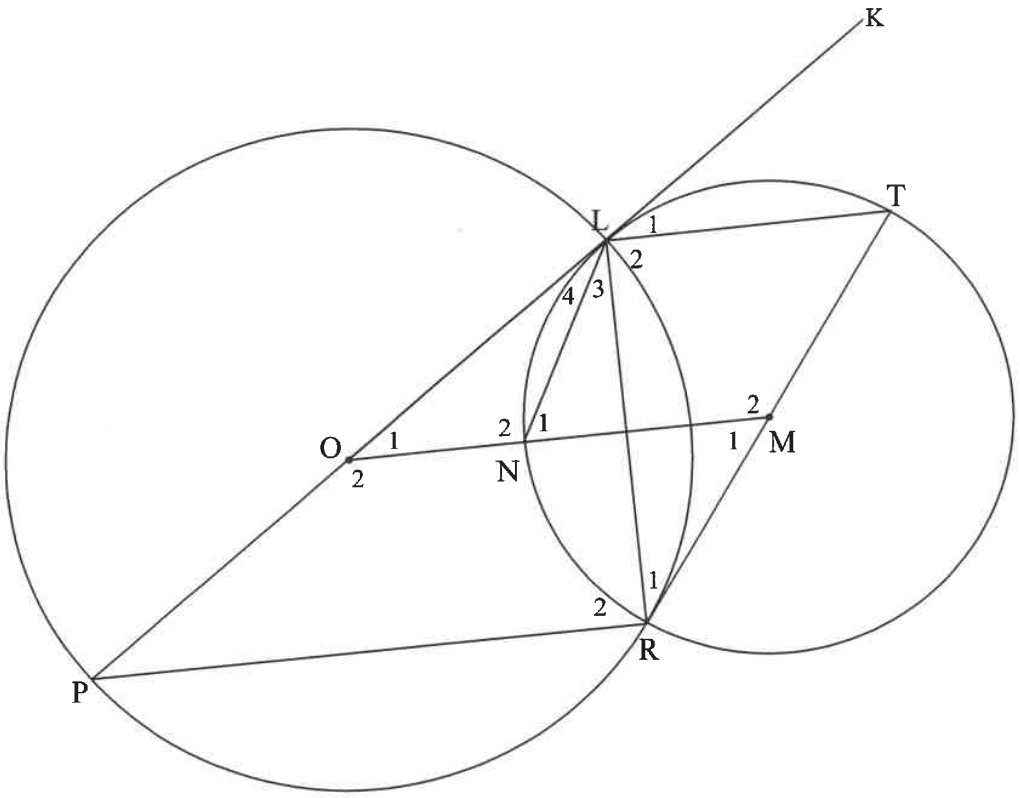
9.1.1 Write down, with a reason, the value of $\frac{HF}{EH}$. (2)

9.1.2 If EF = 21 cm, calculate the length of EH. (2)

9.1.3 Write down a triangle which is similar to ΔFGH. (1)

9.1.4 Hence, calculate the value of $\frac{GH}{DE}$. (2)

9.2 In the diagram, POL is a diameter of the larger circle with centre O. TMR is a diameter of the smaller circle with centre M. The two circles intersect at L and R. PLK is a tangent to the smaller circle at L and TR is a tangent to the larger circle at R. OM intersects the smaller circle at N. Straight lines LT, LR, LN and PR are drawn.



Prove, giving reasons, that:

9.2.1 LT || PR (4)

9.2.2 LORM is a cyclic quadrilateral, if it is also given that LT || OM (5)

9.2.3 LN bisects $O\hat{L}R$ (4)

[20]

Proving the theorems

The proofs that have to be known rather than derived. DBE sets exactly one in every paper, always at the start of a question, and the rest of that question is an ordinary rider - so each one here is followed by the work DBE set with it.

8 questions · 141 marks

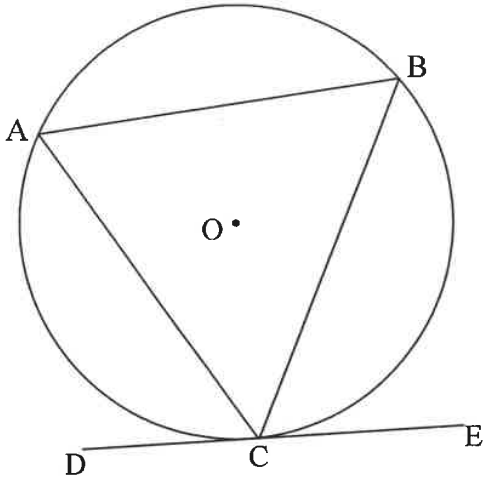
11 to 25 marks each

15. The tangent-chord theorem, proved and then used

DBE NSC Paper 2 · May/June 2024 · Q8 · 11 marks

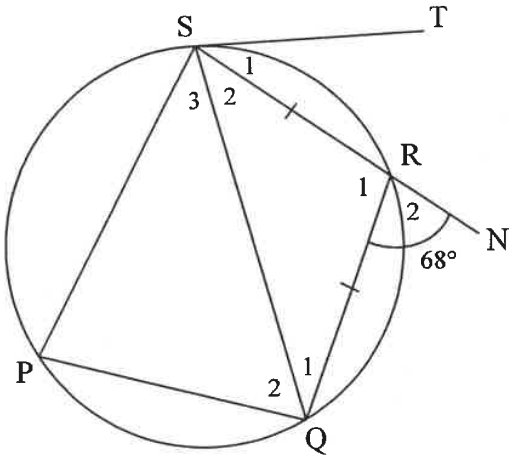
QUESTION 8

8.1 In the diagram, chords AB, BC and AC are drawn in the circle with centre O. DCE is a tangent to the circle at C.



Prove the theorem which states that 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, i.e. $B\hat{C}E = \hat{A}$. (5)

8.2 In the diagram, PQRS is a cyclic quadrilateral with RQ = RS. ST is a tangent to the circle at S. SR is produced to N. $\hat{R}_2 = 68°$.



Determine, with reasons, the size of:

8.2.1 $\hat{P}$ (2)

8.2.2 $\hat{Q}_1$ (2)

8.2.3 $\hat{S}_1$ (2)

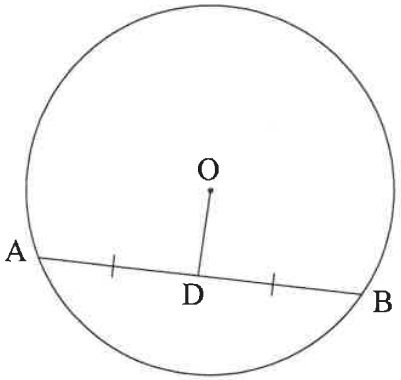
[11]

16. The line from the centre that bisects a chord

DBE NSC Paper 2 · November 2022 · Q9 · 14 marks

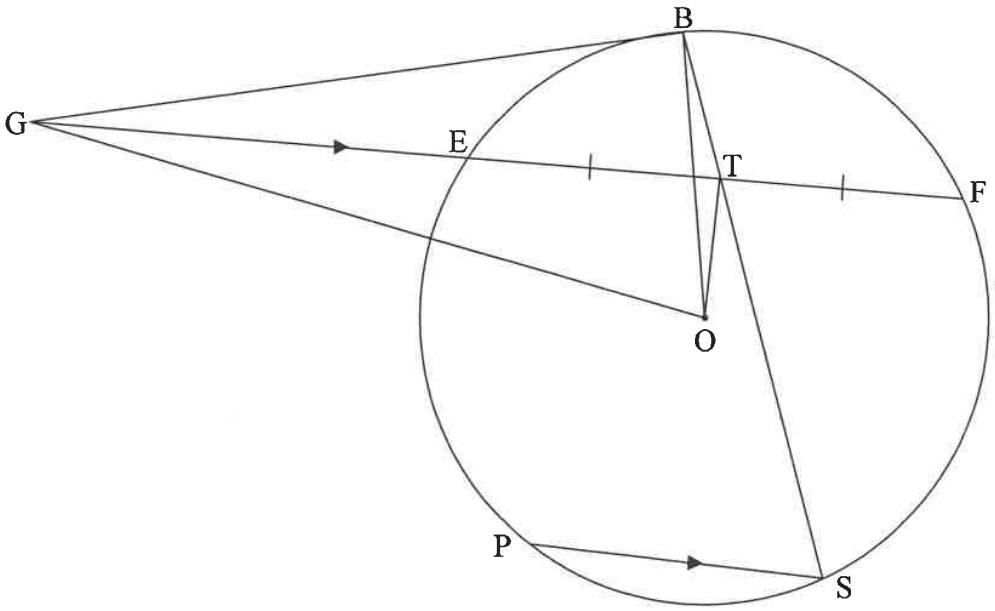
QUESTION 9

9.1 In the diagram, O is the centre of a circle. OD bisects chord AB.



Prove the theorem that states that the line from the centre of a circle that bisects a chord is perpendicular to the chord, i.e. OD ⊥ AB. (5)

9.2 In the diagram, E, B, F, S and P are points on the circle centred at O. GB is a tangent to the circle at B. FE is produced to meet the tangent at G. OT is drawn such that T is the midpoint of EF. GO and BO are drawn. BS is drawn through T. PS || GF.



Prove, giving reasons, that:

9.2.1 OTBG is a cyclic quadrilateral (5)

9.2.2 $G\hat{O}B = \hat{S}$ (4)

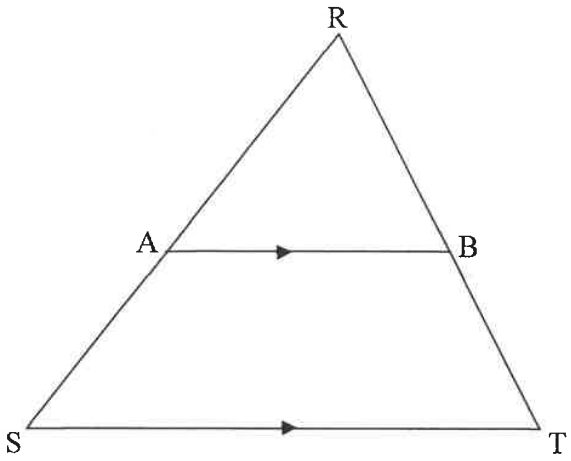
[14]

17. A line parallel to one side of a triangle, proved

DBE NSC Paper 2 · November 2024 · Q10 · 15 marks

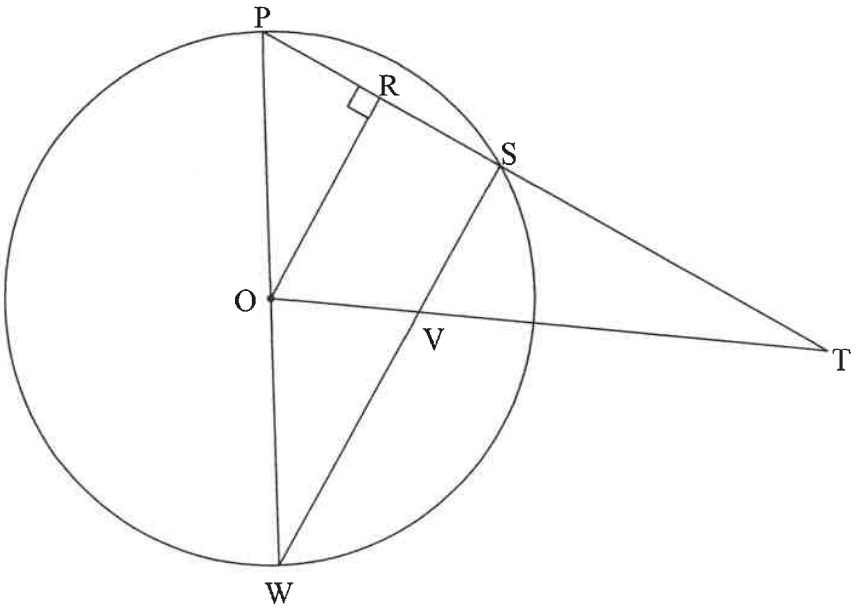
QUESTION 10

10.1 In the diagram, ΔRST is drawn. Line AB intersects RS and RT at A and B respectively such that AB || ST.



Prove the theorem which states that a line drawn parallel to one side of a triangle divides the other two sides proportionally, i.e. $\frac{RA}{AS} = \frac{RB}{BT}$ (6)

10.2 In the diagram, O is the centre of the circle. ΔPWS is drawn with P, W and S on the circle. $OR \perp PS$. PRS is produced to T. SW and OT intersect at V. OV : OT = 1 : 4



10.2.1 Prove, with reasons, that OR : WS = 1 : 2 (5)

10.2.2 Calculate the length of PT if ST = 15 units. (4)

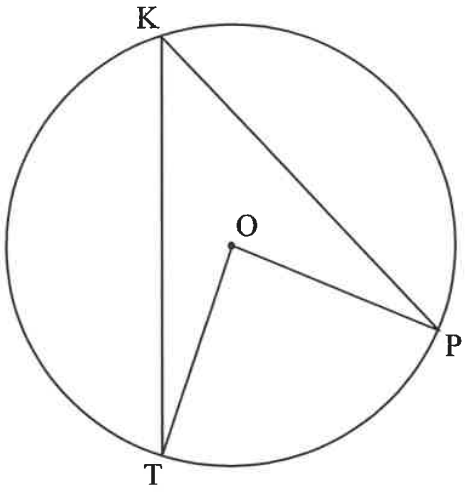
[15]

18. The angle at the centre is twice the angle at the circumference

DBE NSC Paper 2 · November 2023 · Q8 · 16 marks

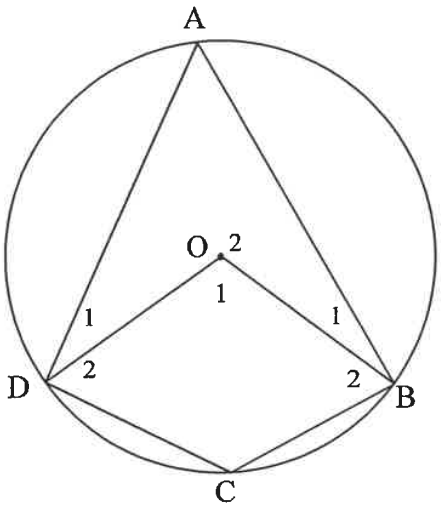
QUESTION 8

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



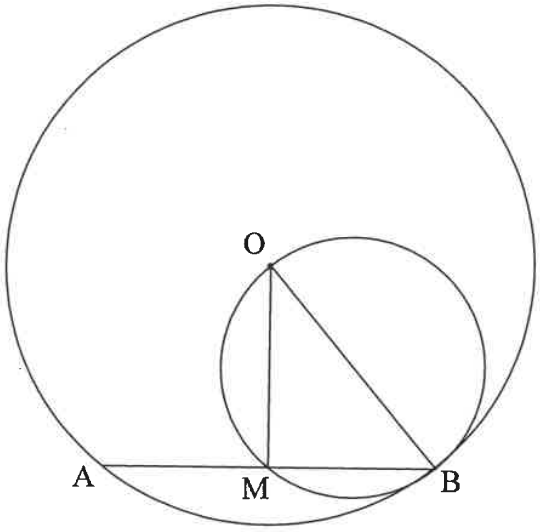
Use the diagram above to prove the theorem which states that the angle subtended by a chord at the centre of the circle is equal to twice the angle subtended by the same chord at the circumference, that is, prove that $T\hat{O}P = 2T\hat{K}P$. (5)

8.2 In the diagram, O is the centre of the circle and ABCD is a cyclic quadrilateral. 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.



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)

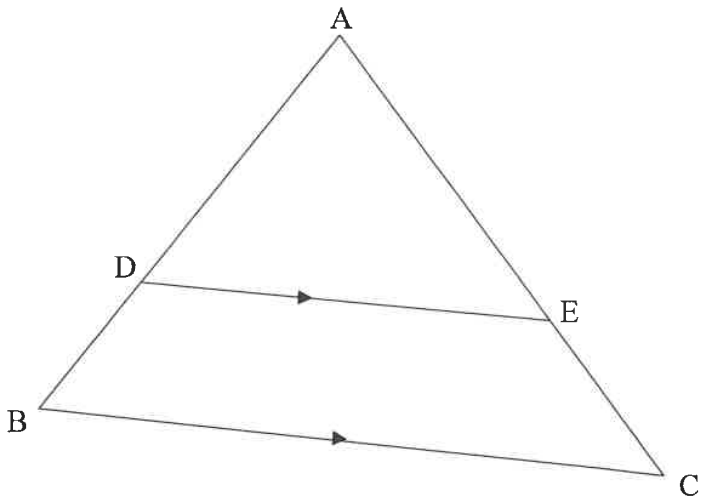
[16]

19. The proportion theorem, then the rider that follows it

DBE NSC Paper 2 · May/June 2021 · Q9 · 17 marks

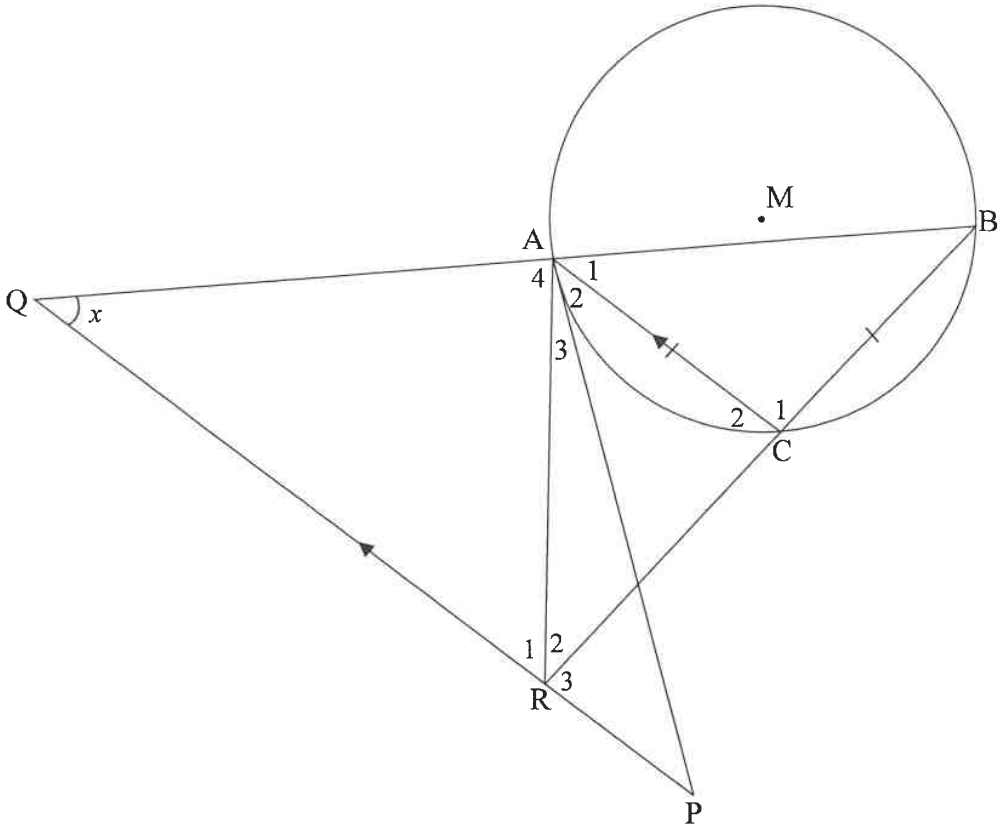
QUESTION 9

9.1 In the diagram, ABC is a triangle. D and E are points on sides AB and AC respectively such that $DE \parallel BC$.



Use the diagram above to prove the theorem which states that a line drawn parallel to one side of a triangle divides the other two sides proportionally, i.e. prove that $\frac{AD}{DB} = \frac{AE}{EC}$. (6)

9.2 In the diagram, M is the centre of the circle. A, B and C are points on the circle such that $AC = BC$. PA is a tangent to the circle at A. PQ is drawn parallel to CA to meet BA produced at Q. BC produced meets PQ at R and AR is drawn.
Let $\hat{Q} = x$.



9.2.1 Determine, giving reasons, FOUR other angles EACH equal to x. (6)

9.2.2 Prove that ABPR is a cyclic quadrilateral. (2)

9.2.3 Prove that $\frac{BA}{BQ}=\frac{BC}{QR}$. (3)

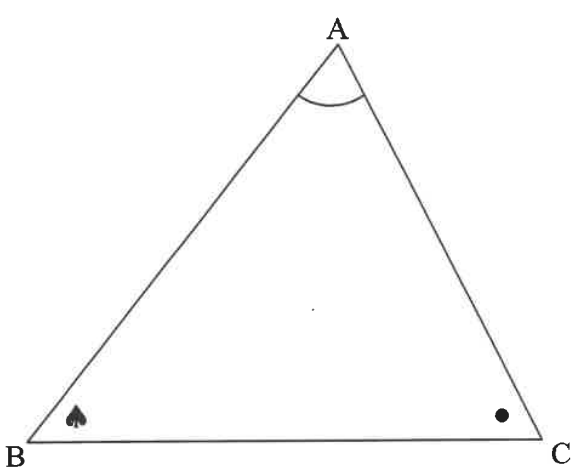
[17]

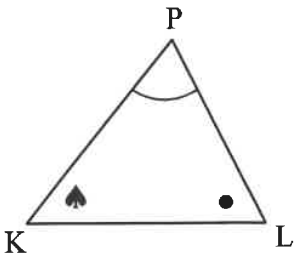
20. Equiangular triangles have their sides in proportion

DBE NSC Paper 2 · May/June 2025 · Q10 · 20 marks

QUESTION 10

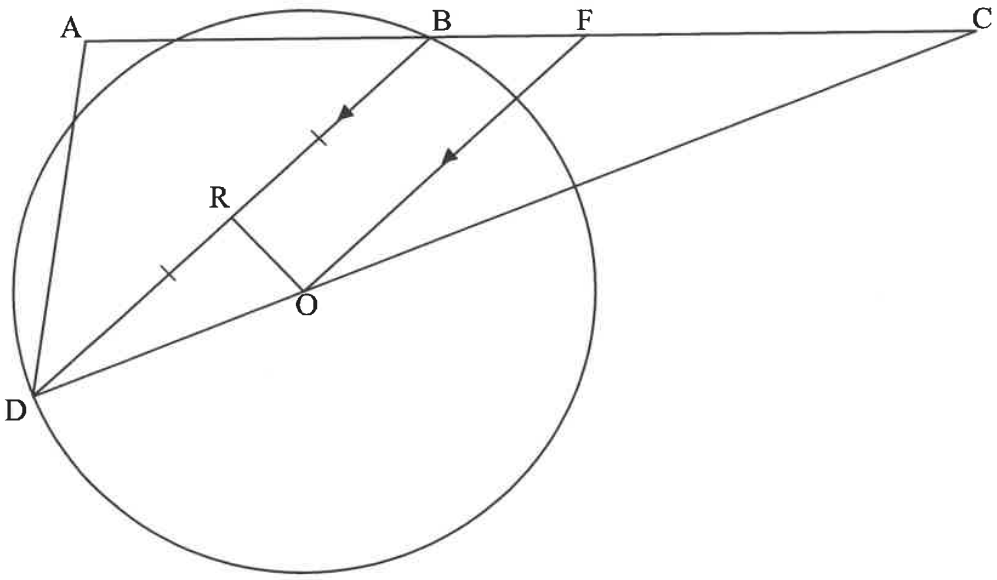
10.1 In the diagram, ΔABC and ΔPKL are drawn such that $\hat{A} = \hat{P}$, $\hat{B} = \hat{K}$ and $\hat{C} = \hat{L}$.





Use the diagram in the ANSWER BOOK to prove the theorem which states that if two triangles are equiangular, then the corresponding sides are in proportion, i.e. that $\frac{AB}{PK} = \frac{AC}{PL}$. (6)

10.2 In the diagram, O is the centre of the circle. Points D and B lie on the circle. Points A and C lie outside the circle such that side AC of ΔADC passes through B. F is a point on BC such that FO || BD. DR = RB and RO is drawn.



10.2.1 Prove, with reasons, that $\Delta CFO \,|||\, \Delta CBD$. (3)

10.2.2 If it is given that $R\hat{D}O = F\hat{C}O$, show, with reasons, that $OF.CD = CO.BC$ (2)

10.2.3 It is further given that $DC = 19{,}2$ units, $BD = 12$ units and $\frac{RO}{RD} = \frac{3}{4}$

Prove, with reasons, that $BF = \frac{75}{16}$ (6)

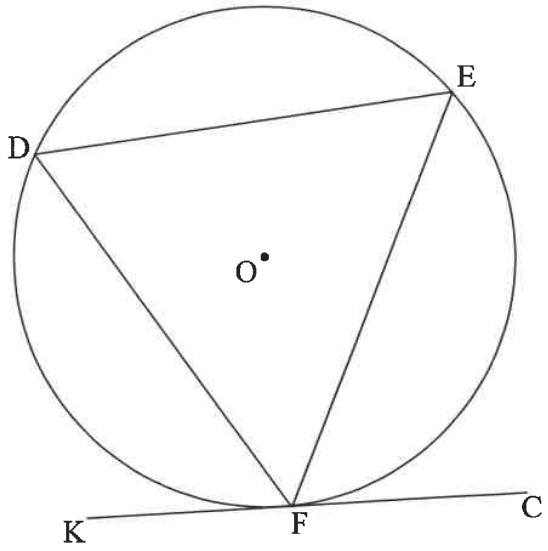
10.2.4 Calculate the size of $A\hat{B}D$. (3)
[20]

21. The tangent-chord theorem again, and a long rider after it

DBE NSC Paper 2 · November 2021 · Q11 · 23 marks

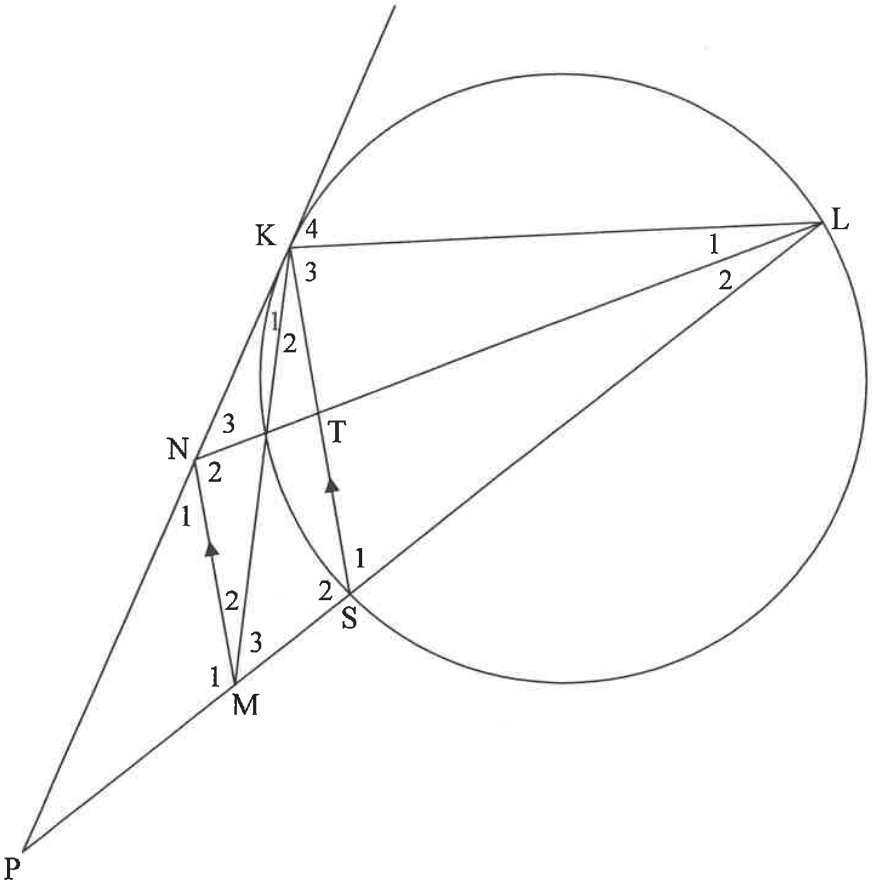
QUESTION 11

11.1 In the diagram, chords DE, EF and DF are 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)

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.



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 $\Delta LKN \,|||\, \Delta KSM$. (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)

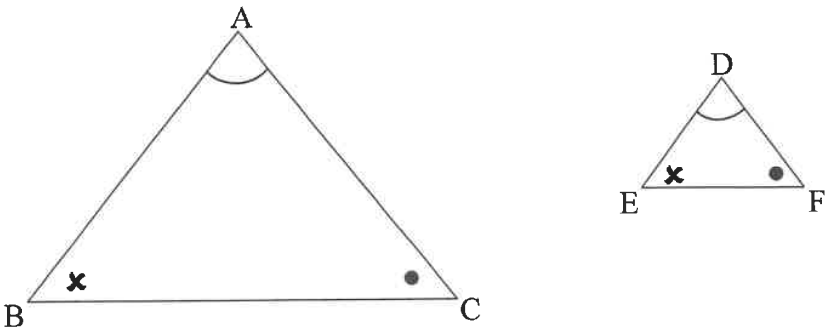
[23]

22. Equiangular triangles, then the longest rider in the book

DBE NSC Paper 2 · May/June 2022 · Q10 · 25 marks

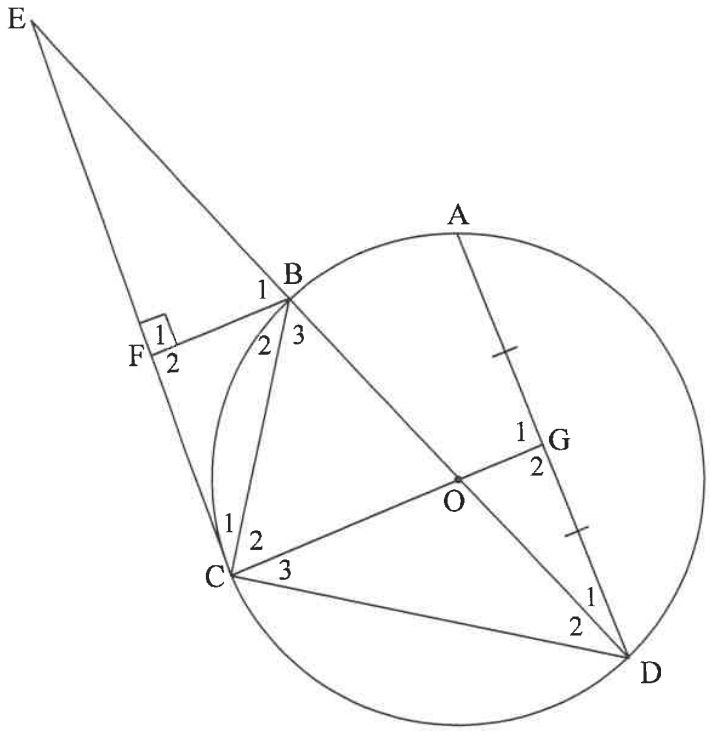
QUESTION 10

10.1 In the diagram, ΔABC and ΔDEF are drawn such that $\hat{A} = \hat{D}$, $\hat{B} = \hat{E}$ and $\hat{C} = \hat{F}$.



Use the diagram in the ANSWER BOOK to prove the theorem which states that if two triangles are equiangular, then the corresponding sides are in proportion, i.e. $\frac{AB}{DE} = \frac{AC}{DF}$. (6)

10.2 In the diagram, O is the centre of a circle passing through A, B, C and D. EC is a tangent to the circle at C. Diameter DB produced meets tangent EC at E. F is a point on EC such that BF $\perp$ EC. Radius CO produced bisects AD at G. BC and CD are drawn.



10.2.1 Prove, with reasons, that:

(a) FB || CG (3)

(b) $\Delta FCB \;|||\; \Delta CDB$ (5)

10.2.2 Give a reason why $\hat{G}_1 = 90°$. (1)

10.2.3 Prove, with reasons, that $CD^2 = CG.DB$. (5)

10.2.4 Hence, prove that $DB = CG + FB$. (5)
[25]

Index by paper

Every Euclidean geometry question in each paper, and where it sits in this booklet.

Index by topic

A question appears under every topic it uses, so it can be found even when it is filed in another chapter.

Chords, and the line from the centre — 4 questions

Proving the theorem itself, not using it — 8 questions

Similar triangles — 4 questions

The proportion theorem — 5 questions

Products and ratios of lengths — 3 questions

Where these came from

So that "every Euclidean geometry question" is a claim you can check.

Eight DBE NSC Mathematics Paper 2 papers were read end to end:
November 2021, 2022, 2023, 2024 and May/June 2021, 2022, 2024, 2025.

All 338 questions in them were classified. These papers are scans - they carry no text layer at all - so the structure was rebuilt by reading them with OCR, and then checked three ways: every paper adds back up to exactly 150, the Afrikaans paper matches the English question for question, and the official marking guideline, which IS ordinary text, agrees with the marks read off every question.

DBE publishes an official marking guideline for every one of these papers. The companion file "CAPS_P2_Euclidean_Solutions.pdf" carries the guideline for each question here, in the same order and under the same numbers.