



GuideMyGrades

— YOUR GOALS. OUR EXPERTISE. —

EDEXCEL GCSE (9-1) MATHS: QUESTIONS BY TOPIC

Circle Theorems (G6)

GCSE (9-1) Mathematics (1MA1) · Higher tier

20 questions · 77 marks · Mark schemes included

Past papers June 2017 - June 2025 · 1 sub-topic

 guidemygrades.com

 [@Guidemygrades](https://www.instagram.com/Guidemygrades)

 [@Guidemygrades](https://twitter.com/Guidemygrades)

 [@Guidemygrades](https://www.youtube.com/Guidemygrades)

 info@guidemygrades.com

 Piccadilly Business Centre, Unit C, Aldow Enterprise Park
Blackett Street, Manchester, M12 6AE

HOW TO USE THIS BOOKLET

Questions are grouped by sub-topic and run from the lowest to the highest mark tariff, then oldest paper first.

Click any row below to jump straight to that sub-topic or question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme; < QUESTION brings you back.

A gold bar in the left margin marks exactly where the question sits on the original page.

Diagrams, graphs, grids and tables are printed exactly as they appear in the original papers.

Each question is filed under its main topic; longer questions may also test skills from other topics.

QUESTION	SOURCE	MARKS	PAGE
G6a CIRCLE THEOREMS		20 Qs · 77 marks	2
1. Q15	GCSE Paper 2H June 2017	3	3
2. Q12	GCSE Paper 1H November 2018	3	4
3. Q17	GCSE Paper 2H November 2019	3	5
4. Q18	GCSE Paper 1H November 2022	3	6
5. Q18	GCSE Paper 2H November 2024	3	7
6. Q20	GCSE Paper 3H November 2017	4	8
7. Q13	GCSE Paper 2H June 2018	4	9
8. Q21	GCSE Paper 2H November 2018	4	10
9. Q14	GCSE Paper 3H November 2020	4	11
10. Q14	GCSE Paper 2H November 2021	4	12
11. Q20	GCSE Paper 2H June 2022	4	13
12. Q16	GCSE Paper 3H November 2022	4	14
13. Q21	GCSE Paper 1H June 2023	4	15
14. Q21	GCSE Paper 3H November 2023	4	16
15. Q22	GCSE Paper 2H June 2024	4	17
16. Q21	GCSE Paper 3H June 2024	4	18
17. Q17	GCSE Paper 1H November 2024	4	19
18. Q20	GCSE Paper 3H June 2025	4	20
19. Q11	GCSE Paper 1H June 2018	5	21
20. Q18	GCSE Paper 2H June 2019	5	22



QUESTIONS

20 questions · 77 marks · 1 sub-topic

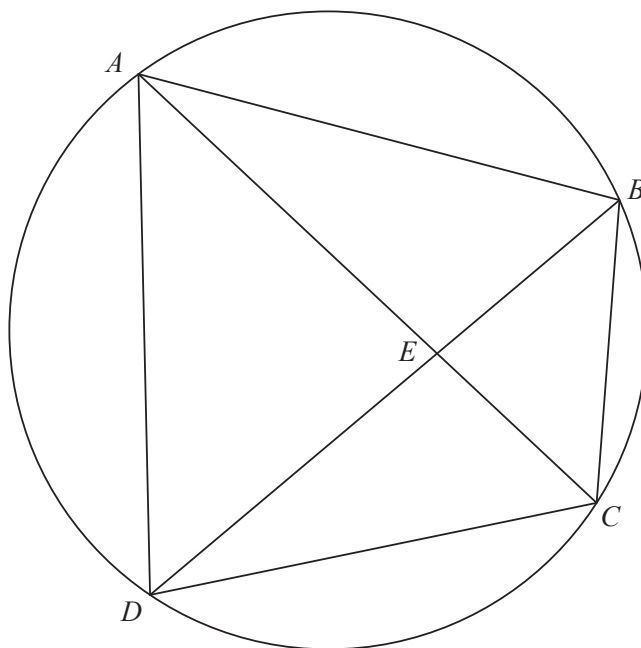
SUB-TOPIC G6a

CIRCLE THEOREMS

Sub-topic G6a · 20 questions · 77 marks · lowest tariff first



15 A , B , C and D are four points on the circumference of a circle.



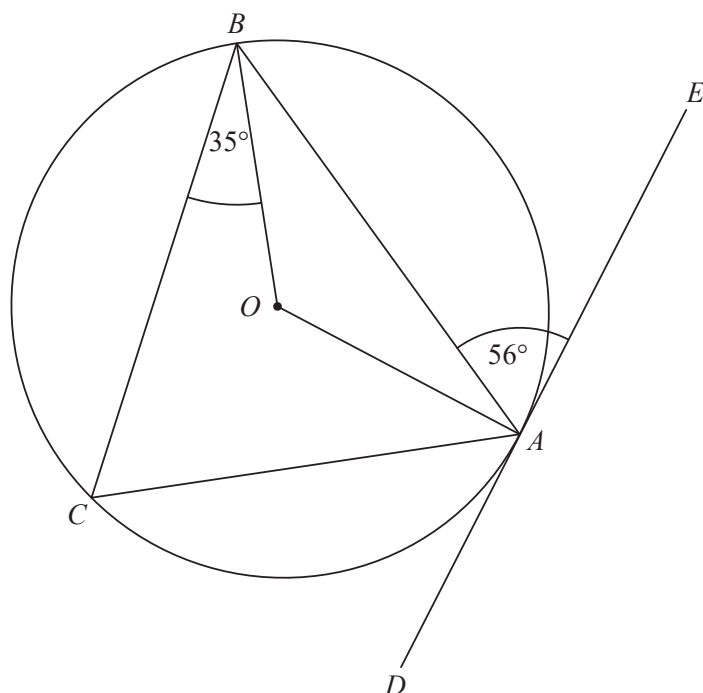
AEC and BED are straight lines.

Prove that triangle ABE and triangle DCE are similar.
You must give reasons for each stage of your working.

(Total for Question 15 is 3 marks)



12



A , B and C are points on the circumference of a circle, centre O .
 DAE is the tangent to the circle at A .

Angle $BAE = 56^\circ$

Angle $CBO = 35^\circ$

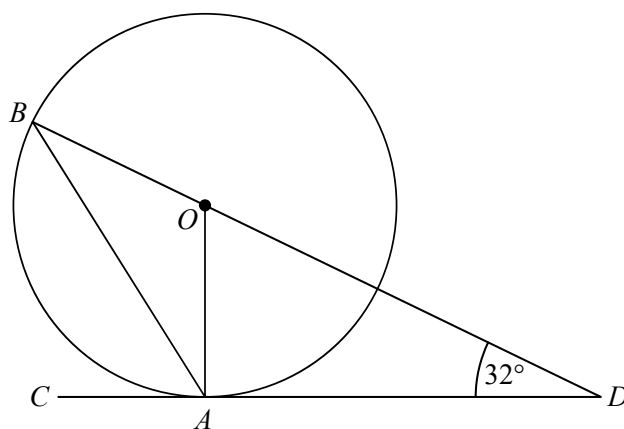
Work out the size of angle CAO .

You must show all your working.

(Total for Question 12 is 3 marks)



17



A and B are points on a circle with centre O .

CAD is the tangent to the circle at A .

BOD is a straight line.

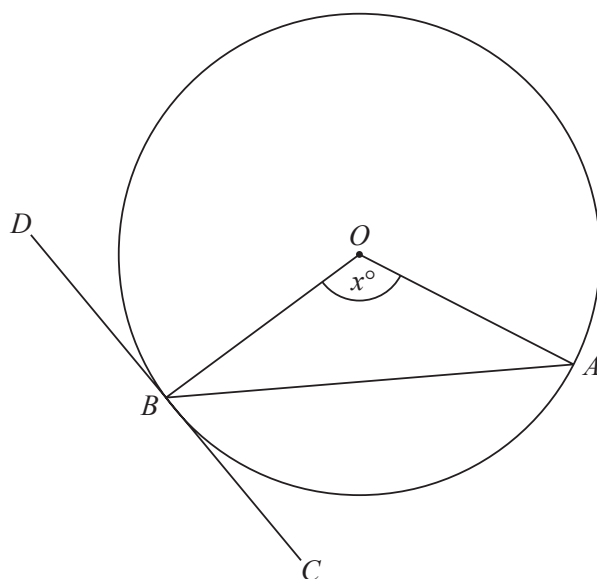
Angle $ODA = 32^\circ$

Work out the size of angle CAB .

You must show all your working.

(Total for Question 17 is 3 marks)

18



A and *B* are points on a circle, centre *O*.

DBC is the tangent to the circle at *B*.

Angle $AOB = x^\circ$

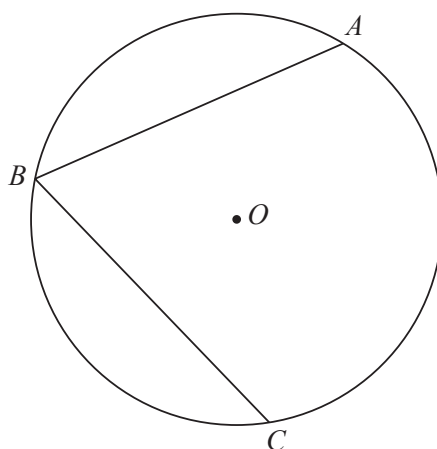
Show that angle $ABC = \frac{1}{2}x^\circ$

You must give a reason for each stage of your working.

(Total for Question 18 is 3 marks)



18 A , B and C are three points on a circle, centre O .



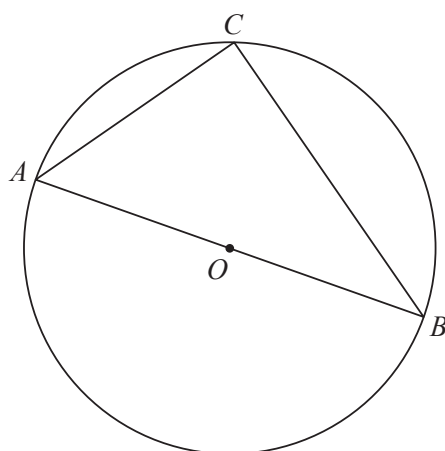
$$BA = BC$$

Prove that OB bisects angle ABC .

(Total for Question 18 is 3 marks)



20



A , B and C are points on the circumference of a circle, centre O .
 AOB is a diameter of the circle.

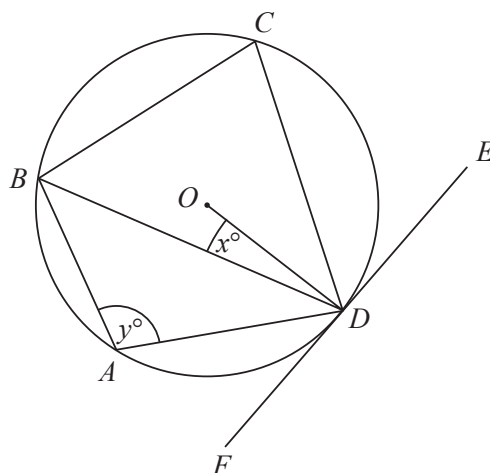
Prove that angle ACB is 90°

You must **not** use any circle theorems in your proof.

(Total for Question 20 is 4 marks)



13



A , B , C and D are points on the circumference of a circle, centre O .
 FDE is a tangent to the circle.

- (a) Show that $y - x = 90$
 You must give a reason for each stage of your working.

(3)

Dylan was asked to give some possible values for x and y .

He said,

“ y could be 200 and x could be 110, because $200 - 110 = 90$ ”

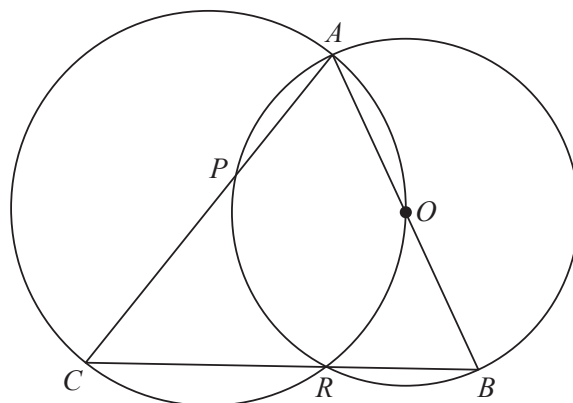
- (b) Is Dylan correct?
 You must give a reason for your answer.

(1)

(Total for Question 13 is 4 marks)



21



A , B , R and P are four points on a circle with centre O .

A , O , R and C are four points on a different circle.

The two circles intersect at the points A and R .

CPA , CRB and AOB are straight lines.

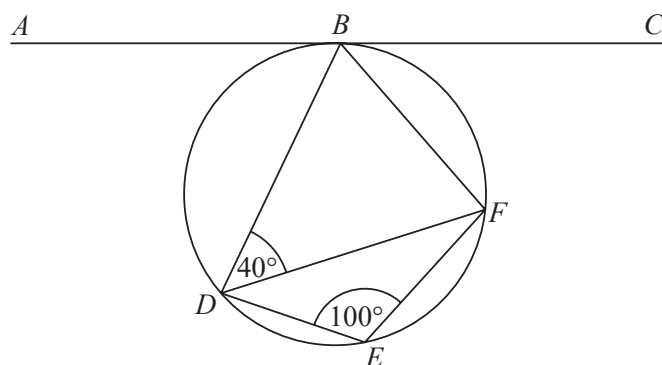
Prove that $\text{angle } CAB = \text{angle } ABC$.

(Total for Question 21 is 4 marks)

TOTAL FOR PAPER IS 80 MARKS



14



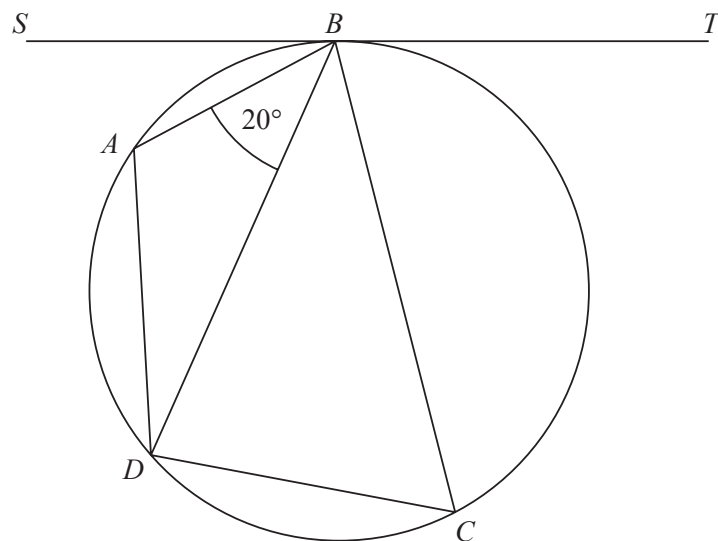
Points B , D , E and F lie on a circle.
 ABC is the tangent to the circle at B .

Find the size of angle ABD .
You must give a reason for each stage of your working.

(Total for Question 14 is 4 marks)



14



A , B , C and D are four points on a circle.

SBT is a tangent to the circle.

Angle $ABD = 20^\circ$

the size of angle BAD : the size of angle $BCD = 3 : 1$

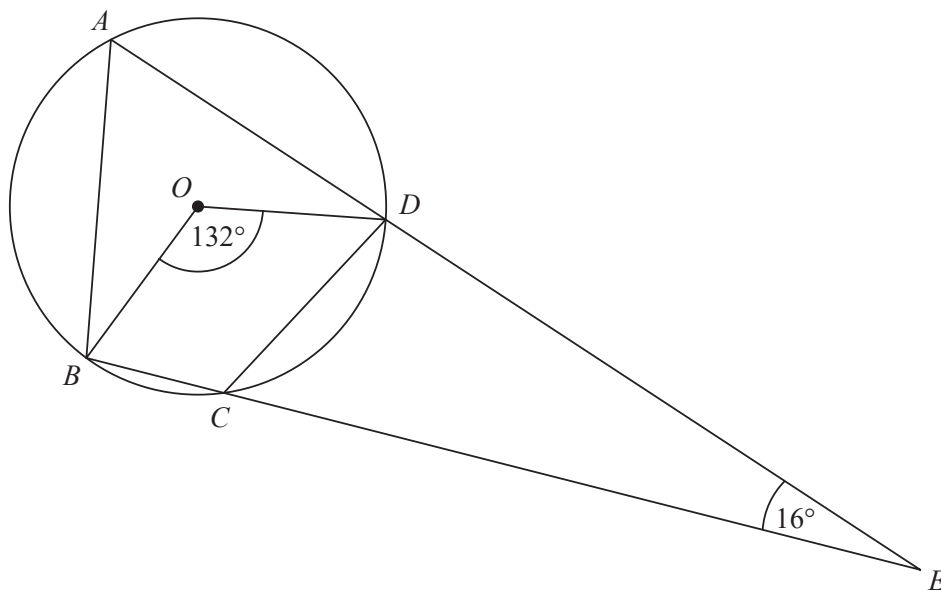
Find the size of angle SBA .

Give a reason for each stage of your working.

(Total for Question 14 is 4 marks)



- 20 A, B, C and D are points on the circumference of a circle, centre O .
 ADE and BCE are straight lines.

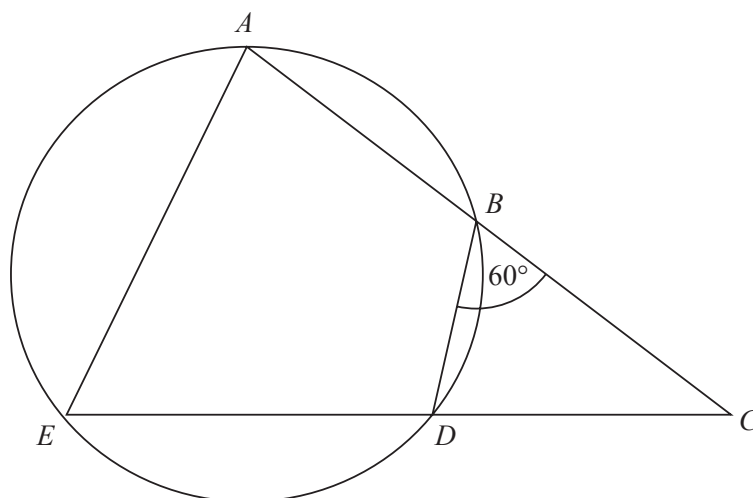


Work out the size of angle CDE .
 Give a reason for each stage of your working.

(Total for Question 20 is 4 marks)



16



$ABDE$ is a cyclic quadrilateral.
 ABC and EDC are straight lines.
 Angle $DBC = 60^\circ$

Given that

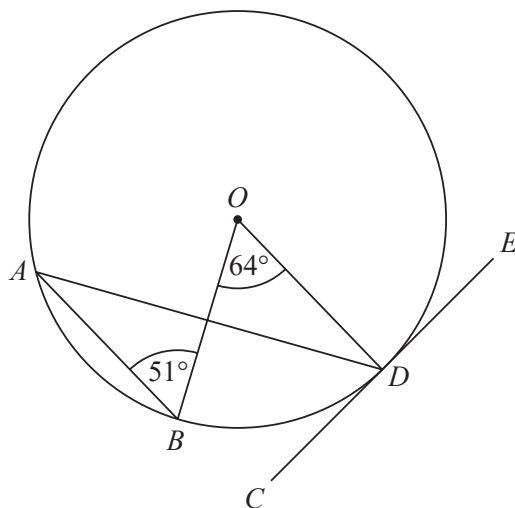
$$\text{size of angle } EAB : \text{size of angle } BCD = 2 : 1$$

work out the size of angle BCD .
 You must show all your working.

(Total for Question 16 is 4 marks)



- 21 A , B and D are points on a circle with centre O .
 CDE is the tangent to the circle at D .

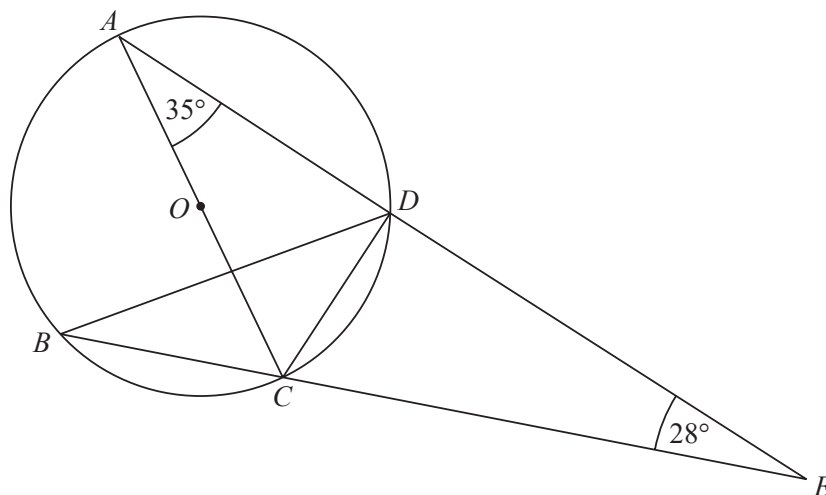


Work out the size of angle ADC .
Write down any circle theorems you use.

(Total for Question 21 is 4 marks)



21



A , B , C and D are points on the circumference of a circle, centre O .
 AC is a diameter of the circle.

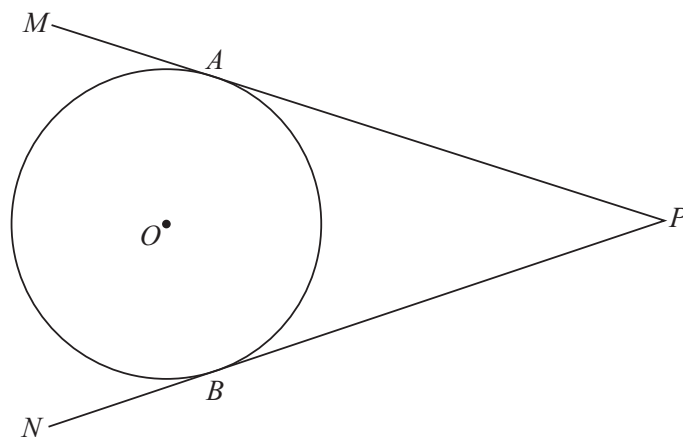
ADE and BCE are straight lines.

Work out the size of angle BDC .
 Write down any circle theorems that you use.

(Total for Question 21 is 4 marks)



22 A and B are points on a circle, centre O .



MAP and NBP are tangents to the circle.

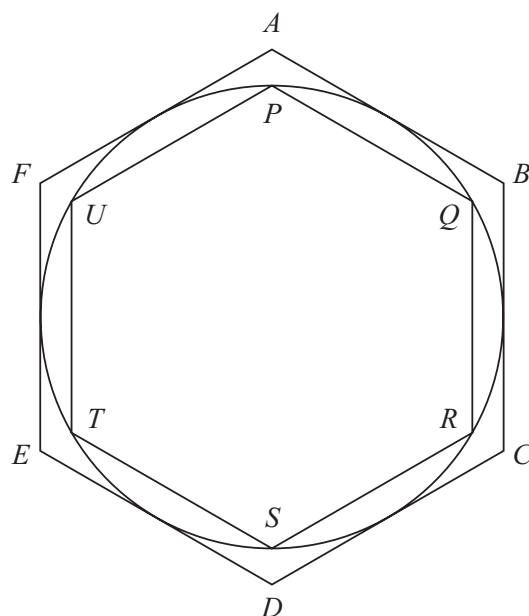
Prove that $AP = BP$

(Total for Question 22 is 4 marks)

TOTAL FOR PAPER IS 80 MARKS



21 The diagram shows a circle, radius r cm and two regular hexagons.



Each side of the larger hexagon $ABCDEF$ is a tangent to the circle.
Each side of the smaller hexagon $PQRSTU$ is a chord of the circle.

By considering perimeters, show that

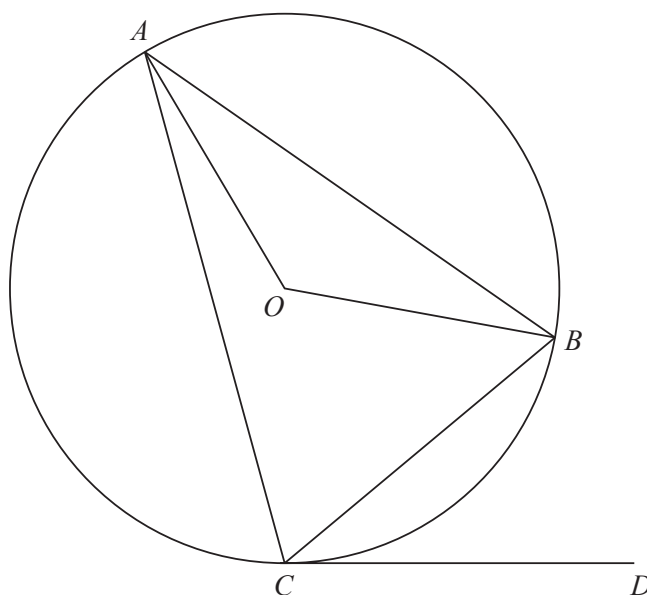
$$3 < \pi < 2\sqrt{3}$$

(Total for Question 21 is 4 marks)

TOTAL FOR PAPER IS 80 MARKS



17 A , B and C are points on a circle, centre O .



CD is a tangent to the circle.

Angle $BCD = 40^\circ$

Angle $OAB = 3 \times \text{angle } OAC$

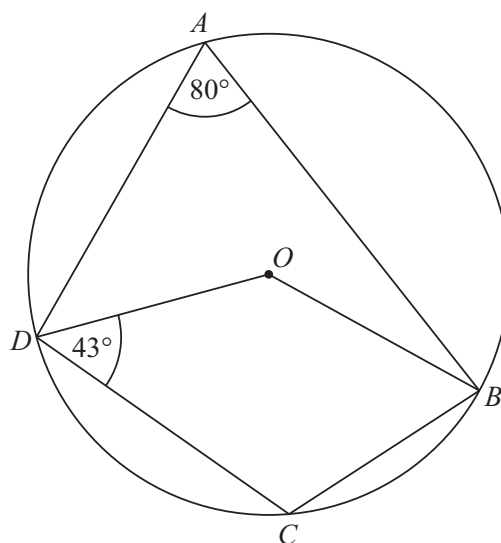
Work out the size of angle ACD .

Write down any circle theorems that you use.

(Total for Question 17 is 4 marks)



20 A , B , C and D are points on a circle with centre O .



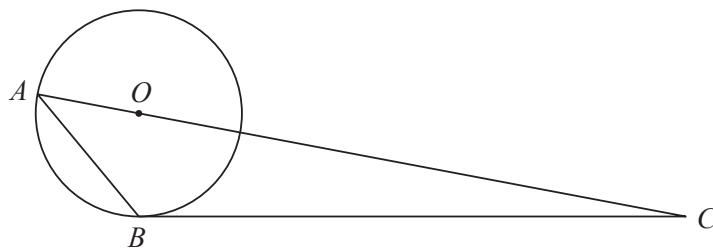
Find the size of angle OBC .

Write down any circle theorems that you use.

(Total for Question 20 is 4 marks)



11



A and B are points on a circle, centre O .

BC is a tangent to the circle.

AOC is a straight line.

Angle $ABO = x^\circ$.

Find the size of angle ACB , in terms of x .

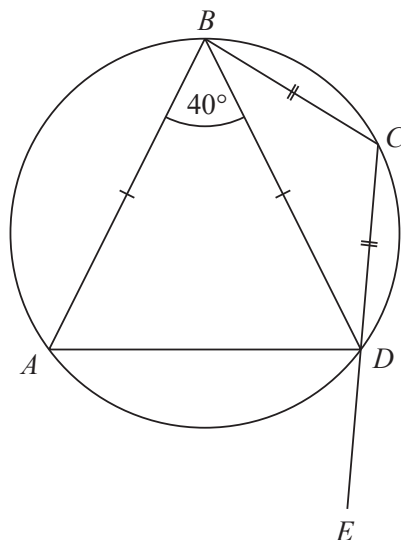
Give your answer in its simplest form.

Give reasons for each stage of your working.

(Total for Question 11 is 5 marks)



- 18 The points A , B , C and D lie on a circle.
 CDE is a straight line.



$BA = BD$
 $CB = CD$
 Angle $ABD = 40^\circ$

Work out the size of angle ADE .
 You must give a reason for each stage of your working.

(Total for Question 18 is 5 marks)

MARK SCHEMES

official mark schemes, in the same order as the questions



Paper: 1MA1/2H				
Question	Working	Answer	Mark	Notes
15		Proof	C1	for identifying one pair of equal angles with a correct reason, e.g. (angle) $BAE =$ (angle) CDE ; <u>angles</u> in the same <u>segment</u> are equal or <u>angles</u> at the circumference <u>subtended</u> on the same <u>arc</u> are equal or for identifying two pairs of equal angles with no correct reasons given (angles must be within the appropriate triangles)
			C1	for identifying a second pair of equal angles with a correct reason, e.g. (angle) $AEB =$ (angle) DEC ; <u>opposite angles</u> or <u>vertically opposite angles</u> are equal or for identifying the three pairs of equal angles with no correct reasons given
			C1	for stating the three pairs of equal angles of the two triangles e.g. $ABE = DCE$, $BEA = CED$, $EAB = EDC$ with fully correct reasons
16			M1	for the start of a method to convert 0.22... to a fraction, eg $10y = 2.22\ldots$ or $(y =) \frac{2}{9}$
			M1	for the start of a method to convert 0.13636... to a fraction, $10x = 1.3636\ldots$ or $100x = 13.6363\ldots$ or $1000x = 136.3636\ldots$ or $(x =) \frac{13.5}{99}$ or $(x =) \frac{135}{990}$
			C1	for correct arithmetic and concluding the proof
			OR	
			M1	for $0.13\bar{6} \times 0.2 = 0.0\bar{3} (= z)$
			M1	for complete method to find two appropriate recurring decimals the difference of which is a rational number, eg. $100z = 3.0303\ldots (z =) 0.0303\ldots$ or $\frac{3}{99}$
			C1	for correct arithmetic and concluding the proof



Paper: 1MA1/1H				
Question	Answer	Mark	Mark scheme	Additional guidance
11	20	P1 P1 A1	for start of process, eg $\frac{125}{100}$ oe or $\frac{100}{125}$ oe or $\frac{25}{125}$ for a suitable process to develop a percentage, either 80% or 20% eg. $\frac{100}{125} = \frac{x}{100}$ or $\frac{125-100}{125} = \frac{x}{100}$ or $\frac{p}{1.25m} = \frac{xp}{m}$ or $\frac{0.25p}{1.25m} = \frac{xp}{m}$ cao	Values of amount of cereal and cost may be used, eg. 100g of cereal costing £10 An acceptable start of a process would then be: 125g of cereal costing £10 using Jack's idea
12	21	C1 C1 C1	for angle $OAB = 90 - 56 (= 34)$ for process to find angle $CAD (= 69)$ or angle $BCA (= 56)$ or angle $COA (= 138)$, eg use of alternate segment theorem or angle at centre is twice the angle at the circumference cao	Throughout, angles may be written on the diagram; accept as evidence if correct. Ignore absence of degree sign Reasons need not be given.
13	enlargement scale factor $-\frac{1}{3}$ centre (2, 2)	C2 (C1)	for all of: enlargement, (scale factor $= -\frac{1}{3}$ oe, (centre $=$) (2, 2) for two of: enlargement, (scale factor $= -\frac{1}{3}$ oe, (centre $=$) (2, 2)) Note: award no marks if more than one transformation is given	



Paper: 1MA1/2H				
Question	Answer	Mark	Mark scheme	Additional guidance
16	$\frac{52}{72}$	P1 P1 A1	for $\frac{4}{9} \times \frac{3}{8} \left(\frac{12}{72} \right)$ or $\frac{4}{9} \times \frac{5}{8}$ or $\frac{5}{9} \times \frac{4}{8} \left(\frac{20}{72} \right)$ for $1 - \left(\frac{5}{9} \times \frac{4}{8} \right)$ or $\frac{4}{9} \times \frac{3}{8} + \frac{4}{9} \times \frac{5}{8} + \frac{5}{9} \times \frac{4}{8}$ oe for $\frac{52}{72}$, $\frac{13}{18}$ oe SC B1 for answer of $\frac{56}{81}$ (replacement)	Accept equivalent fractions, decimals (0.72...) or percentages (72.22.....%)
17	61	B1 M1 A1	angle OAD = 90, may be marked on diagram method to work out angle OAB (=29) cao	Angle could be shown by a right-angle symbol Correct method can be implied from angles on the diagram if no ambiguity or contradiction. Reasons need not be given. Award 0 marks for an answer of 61 with no other working.
18	Bar of height 3.2	M1 M1 C1	method to find any frequency eg $1.2 \times 2.5 (=3)$ or $2 \times 2.5 (=5)$ or $2.8 \times 5 (=14)$ or $0.8 \times 12.5 (=10)$ or method to use areas eg $12 \times 5 (=60)$ or $20 \times 5 (=100)$ or $28 \times 10 (=280)$ or $8 \times 25 (=200)$ complete method to find total frequency for the four intervals eg "3" + "5" + "14" + "10" (=32) or "60" + "100" + "280" + "200" (=640) cao	Accept equivalent methods proportional to those shown



Paper: 1MA1/1H				
Question	Answer	Mark	Mark scheme	Additional guidance
18	Result shown	M1	for angle $OBC = 90$ or for method to find angle OBA or angle OAB , eg $\frac{180-x}{2}$ oe or for angle $ABC = 90 - \text{angle } OBA$, eg angle $ABC = 90 - y$ or marks point on circumference and draws triangle using A and B and point marked	Angles must be clearly labelled on the diagram or otherwise identified. Correct method can be implied from angles on the diagram if no ambiguity or contradiction.
		M1	for method to find angle ABC , eg $90 - \frac{180-x}{2}$ oe or for $x = 180 - 2 \times \text{angle } OBA$, eg $x = 180 - 2y$ or for angle at circumference = $\frac{1}{2}x$	
		C1	for correct algebra leading to angle $ABC = \frac{1}{2}x$ and one circle theorem relevant to their method, eg The <u>tangent</u> to a circle is perpendicular to the <u>radius</u> OR for $x = 180 - 2y$ and angle $ABC = 90 - y$ and one circle theorem relevant to their method, eg The <u>tangent</u> to a circle is perpendicular to the <u>radius</u> OR for angle $ABC = \frac{1}{2}x$ and one circle theorem relevant to their method, eg The <u>angle</u> at the <u>centre</u> of a circle is <u>twice</u> the <u>angle</u> at the <u>circumference</u> or <u>Alternate segment</u> theorem	Underlined words need to be shown; reasons need to be linked to their method.



Paper: 1MA1/2H				
Question	Answer	Mark	Mark scheme	Additional guidance
18	Proof	M1	begins proof to show that triangles ABO and CBO or triangles ABD and CBD are congruent by giving one pair of equal sides or equal angles with reason	Where D is point such that BOD is diameter
		M1	for different pair of equal sides or angles with reason	
		C1	for full proof that triangles ABO and CBO are congruent, SSS, or triangles ABD and CBD are congruent, RHS, and therefore angle $ABO = \text{angle } CBO$	
			$AB = CB$ (given) BO (or BD) is <u>common</u> $AO = CO$ <u>radii</u> of circle angle $BAD = \text{angle } BCD$ <u>angles</u> in a <u>semicircle</u> are 90 $(BO = AO = CO$ <u>radii</u> of circle) counts as two sides with reasons	
			OR	
		M1	draws OA , OC and AC and labels angle $OAC = x$ and angle $OCA = x$ with reason given, $AO = CO$ <u>radii</u> of circle and base angles of an <u>isosceles triangle</u> are equal or $BAC = BCA$ since ABC is isosceles	
		M1	shows $OAC = OCA$ and shows $BAC = BCA$ and uses these to show $OAB = OCB$ with all reasons given	
		C1	for full proof concluding with angle $ABO = y$ and angle $CBO = y$ with reason given, eg $OA = OB = OC$ radii of circle and OBC and OAC are isosceles	



Paper: 1MA1/3H				
Question	Working	Answer	Mark	Notes
18 (a)	values 0, 2, 5, 10, 18	130	M1	for starting to find area under the curve, eg $0.5 \times 5 \times 2 (= 5)$
			M1	for a complete method to find the area under the curve using 4 strips of equal width, eg $"5" + 0.5 \times 5 \times (2+5) (= 17.5) + 0.5 \times 5 \times (5+10) (= 37.5) + 0.5 \times 5 \times (10+18) (= 70)$
			A1	for 130 or answer in range 130.1 to 132 supported by accurate working
(b)		overestimate with reason	C1	for "overestimate" and appropriate reason linked to method eg area between trapeziums and curve also included
19		Proof (supported)	M1	starts process to find point of intersection by substituting, eg $(10 + 2y)^2 + y^2 (= 20)$
			M1	for expanding, eg $4y^2 + 20y + 20y + 100$ (3 out of 4 terms correct)
			M1	(dep M2) for 3-term quadratic equation ready for solving, eg $5y^2 + 40y + 80 = 0$
			M1	(dep on previous M1) for method to solve an equation of the form $ay^2 + by + c = 0$, eg by factorising or correct substitution into quadratic formula
			C1	fully correct method leading to $y = -4$ or $x = 2$ or $(y + 4)^2 = 0$ or $(x - 2)^2 = 0$ and statement, eg only one point of intersection so the line is a tangent to the circle
20		Proof	C1	draws OC and considers angles in an isosceles triangle (algebraic notation may be used, eg two angles labelled x)
			C1	finds sum of angles in triangle ABC , eg $x + x + y + y = 180$, or sum of angles at O , eg $180 - 2x + 180 - 2y$
			C1	complete method leading to $ACB = 90$
			C1	complete proof with all reasons given, eg base angles of an isosceles triangle are equal, angles in a triangle add up to 180° , angles on a straight line add up to 180°



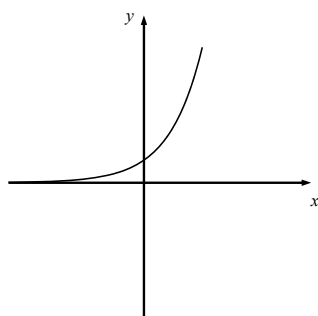
Paper: 1MA1/2H				
Question	Answer	Mark	Mark scheme	Additional guidance
13 (a)	Shown	M1	for finding one missing angle eg $BDE = y$ or $ODE = 90$ or $ODF = 90$ or $DBO = x$ or $BCD = 180 - y$ or (reflex) $BOD = 2y$	Could be shown on the diagram or in working
		A1	for a complete correct method leading to $y - x = 90$	
(b)	Explanation	C1	(dep on A1) for all correct circle theorems given appropriate for their working eg The <u>tangent</u> to a circle is perpendicular (90°) to the <u>radius</u> (<u>diameter</u>) <u>Alternate segment</u> theorem OR <u>Angle</u> at the <u>centre</u> is <u>twice</u> the <u>angle</u> at the <u>circumference</u> Opposite angles in a <u>cyclic quadrilateral</u> sum to 180°	
		C1	for explanation eg No as y must be less than 180 as it is an angle in a triangle	
14	11 – 19	P1	for drawing a tangent to the curve at time = 5	Using their drawn tangent, eg change in y ÷ change in x Must come from gradient of a tangent.
		P1	for process to find the gradient, eg $70 \div 5$	
		A1	(dep on 1 st P1) for answer in the range 11 - 19 m/s	



Paper: 1MA1/2H				
Question	Answer	Mark	Mark scheme	Additional guidance
20	3.75	P1	works to find vol of frustum eg $\frac{1}{3}\pi(3.6)^2 \times 6.4 - \frac{1}{3}\pi(1.8)^2 \times 3.2$ or $86.858... - 10.857... (=24.192\pi \text{ or } 76.00...)$	781.7... by use of diameter does not get the mark [vol] is their volume which could be ft using the radius, using the diameter, or could be another value as long as it is stated as being the volume, or clearly intended from working. All figures must come from correct method shown.
		P1	works to find vol of hemisphere eg $\frac{1}{2} \times \frac{4}{3} \pi \times 3.6^3 (=31.104\pi \text{ or } 97.7....)$	
		P1	mass of frustum as [vol]×density eg “76.00” × 2.4 (=182.4..) or mass of hemisphere as [vol]×density eg “97.7....”×4.8 (=469.037...)	
		P1	mean density as total mass ÷ total volume eg (“182.4..” + “469.037”) ÷ (“76...” + “97.7..”) or “651.4..” ÷ “173.7....”	
		A1	answer in the range 3.7 to 3.8	
21	proof	C1	uses cyclic quad eg if $CAB = x$ then $CRO = 180 - x$ (<u>Opposite angles</u> of a <u>cyclic quadrilateral</u> add up to 180° .)	Underlined words need to be shown; reasons need to be linked to their method; any reasons not linked do not credit. Correct method can be implied from angles on the diagram if no ambiguity or contradiction. Full reasons given without any redundant reasons and correct reasoning throughout.
		C1	establishes relationship outside a circle eg $ORB = x$ (<u>Angles</u> on a straight <u>line</u> add up to 180)	
		C1	uses properties of a circle eg $RO = OB$ (both radii) so $ABC = x$ (Base angles of an <u>isosceles triangle</u> are equal.)	
		C1	Complete proof and conclusion	



Question 14: sketch of $y = 2^x$



Paper: 1MA1/3H				
Question	Answer	Mark	Mark scheme	Additional guidance
14	60 (supported)	M1 M1 A1 C1	for angle DBF, eg $180 - 100 (= 80)$ for angle BFD, eg $180 - "80" - 40 (= 60)$ or for angle $CBF = 40$ for angle $ABD = 60$ (dep M2) for at least 2 reasons from <u>Opposite angles</u> of a <u>cyclic quadrilateral</u> add up to 180 <u>Angles</u> in a <u>triangle</u> add up to 180 <u>Alternate segment</u> theorem OR <u>Opposite angles</u> of a <u>cyclic quadrilateral</u> add up to 180 <u>Alternate segment</u> theorem <u>Angles</u> on a straight <u>line</u> add up to 180	Angles may be shown on the diagram or in working Underlined words need to be shown; reasons need to be linked to their method
15	Proof	M1 A1	for $10x = 7.333\dots (7.\bar{3})$ and for finding difference that would lead to a terminating decimal for completing algebra to reach $\frac{11}{15}$	100x and 1000x, etc could also be used

Paper: 1MA1/2H				
Question	Answer	Mark	Mark scheme	Additional guidance
12	$6x^3 + x^2 - 20x - 12$	M1 M1 A1	for method to find the product of any two linear expressions (3 out of no more than 4 terms correct with correct signs or 4 correct terms ignoring signs), eg. $6x^2 + 9x + 4x + 6$ or $3x^2 + 2x - 6x - 4$ or $2x^2 + 3x - 4x - 6$ for method of multiplying out remaining products, half of which are correct (ft their first product), eg. $6x^3 + 13x^2 - 12x^2 + 6x - 26x - 12$ cao	Note that, for example, $6x^2 + 13x$ or $13x + 6$ are regarded as three terms in the expansion of $(x-2)(3x+2)$ First product must be quadratic but need not be simplified or may be simplified incorrectly.
13	192 000	M1 A1	for $16 \times 120 \times 100$ oe cao	
14	25 with reasons	M1 M1 C2 (C1)	for method to find angle BCD eg $180 \div (3+1)$ (=45) or $BAD = 180 \div (3+1) \times 3$ (=135) for method to find angle BDA eg $180 - 20 - (180 - "45")$ (=25) or method to find angle SBD eg $SBD = BCD$ (=45) for finding SBA (=25) and both reasons given, eg <u>Opposite angles</u> of a <u>cyclic quadrilateral</u> add up to 180 for angle $SBD = 45$ because <u>alternate segment</u> theorem (dep M1) for one reason given <u>Opposite angles</u> of a <u>cyclic quadrilateral</u> add up to 180 for angle $SBD = 45$ because <u>alternate segment</u> theorem)	Could be shown on the diagram or in working Do not award if it ambiguous as to which angle is being found Underlined words need to be shown; reasons need to be linked to their method



Paper: 1MA1/2H						
Question		Answer	Mark	Mark scheme	Additional guidance	
19	(a)	3	B1	cao		$[g^{-1}(x)]$ must be their inverse function and cannot be $\sqrt[3]{2x-5}$
	(b)	$\frac{2}{x^3+5}$	M1	for finding $(g^{-1}(x)) = \frac{x^3+5}{2}$ oe		
			M1	for $(hg^{-1}(x)) = \frac{1}{[g^{-1}(x)]}$ oe		
			A1	Accept $\left(\frac{x^3+5}{2}\right)^{-1}$		
20		98	M1	for $BAD = 132 \div 2 (= 66)$	Angles may be seen on diagram	
		M1	eg $BCD = 180 - "66" (= 114)$ or $ABE = 180 - "66" - 16 (= 98)$	M2 for reflex $BOD = 360 - 132 (= 228)$ and $BCD = "228" \div 2 (= 114)$		
		A1	for finding $CDE = 98$			
		C1	(dep on at least M2) for one circle theorem relevant to their method eg The <u>angle</u> at the <u>centre</u> of a circle is <u>twice</u> the <u>angle</u> at the <u>circumference</u> or <u>Opposite angles</u> of a <u>cyclic quadrilateral</u> add up to 180			
Underlined words need to be shown; reasons need to be linked to their method.						



Paper: 1MA1/3H				
Question	Answer	Mark	Mark scheme	Additional guidance
16	40	M1	for $ABD = 120$ and $AED = 60$ or for using the properties of a cyclic quadrilateral eg $EAB + BDE = 180$	Angles may be shown on the diagram
		M1	for using the ratio of 2 : 1 eg showing sizes of angles such that $EAB : BCD = 2 : 1$	May be expressed using algebra eg $EAB = 2x$ and $BCD = x$
		M1	(dep on M1) for linking an angle from the cyclic quadrilateral with angle(s) in the triangle (other than $EAB : BCD = 2 : 1$) eg $BDE = BCD + 60$ or $BDE = 180 - BDC$ or $EAB + BCD + AEC = 180$	Could be expressed using algebra eg $x + 60 = 180 - 2x$
		A1	for $BCD = 40$ from correct working	
17	42 : 63 : 15 : 20	P1	for a first step to write a relationship between 2 weights, eg $A + B : C + D = 3 : 1$ or $A : B = 2 : 3$ or $C : D = 3 : 4$ or $A + B = 3(C + D)$ or $A = \frac{2}{3}B$ or $C = \frac{3}{4}D$	
		P1	for giving all 3 relationships in the same form eg $A + B : C + D = 3 : 1$ and $A : B = 2 : 3$ and $C : D = 3 : 4$ or $A + B = 3(C + D)$ and $A = \frac{2}{3}B$ and $C = \frac{3}{4}D$	
		P1	for complete process to link all 4 weights, eg $\frac{2}{3}B + B = 3\left(\frac{3}{4}D + D\right)$ and $A = \frac{2}{3}B$ and $C = \frac{3}{4}D$ or $A : B : C : D = A : 63 : C : 20$ and $A = \frac{2}{3}B$ and $C = \frac{3}{4}D$ or $C : D = 3 : 4$ and $A : B : D = 42 : 63 : 20$	
		A1	oe	



Paper: 1MA1/1H				
Question	Answer	Mark	Mark scheme	Additional guidance
21	71	M1	for method to find angle BAD or angle OAB or angle OBD , eg angle $BAD = 64 \div 2 (= 32)$ or angle $OAB = 51$ or angle $OBD = (180 - 64) \div 2 (= 58)$	Angles may be seen on the diagram
		M1	for method to find angle ADO or angle AXD (where X is a point on the major arc AD) eg $ADO = 180 - 64 - (180 - 51 - "32") (= 19)$ or $ADO = (180 - 64 - (180 - 2 \times "51")) \div 2 (= 19)$ or angle $AXD = 180 - "58" - 51 (= 71)$	
		A1	for angle $ADC = 71$	
		C1	(dep on M1) for one circle theorem relevant to their method, eg The <u>angle</u> at the <u>centre</u> of a circle is <u>twice</u> the angle at the <u>circumference</u> or The <u>tangent</u> to a circle is perpendicular to the <u>radius</u> (<u>diameter</u>) or <u>Opposite angles</u> of a <u>cyclic quadrilateral</u> add up to 180 or <u>Alternate segment</u> theorem	
22	30	P1	for a correct trig statement using angle ACF , eg $\sin x = \frac{6.8}{13.6}$ or $x = \sin^{-1}(\frac{6.8}{13.6})$ or $\sin x = 0.5$ or $\frac{6.8}{\sin x} = \frac{13.6}{\sin 90}$ oe	Check diagram for working
		A1	cao	



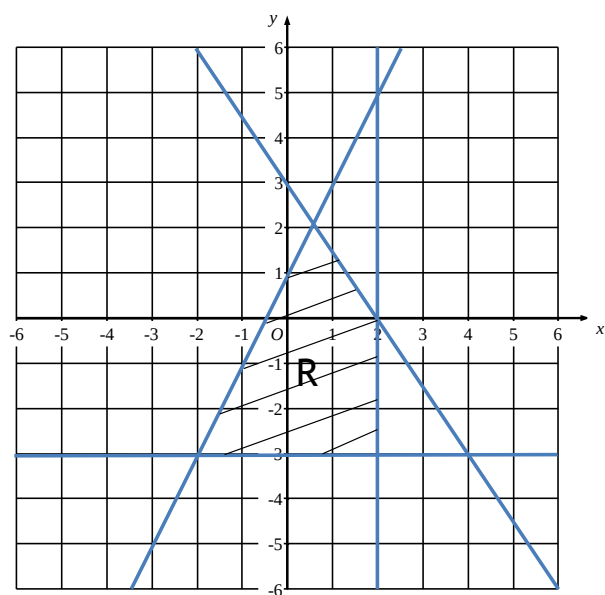
Paper: 1MA1/3H				
Question	Answer	Mark	Mark scheme	Additional guidance
20 (a)	(4, 6)	B1	cao	see end of mark scheme
	(b) Sketch	B2 (B1)	for a fully correct sketch including points (2, 6), (−2, −4), (6, −4) for a correct sketch of $f(-x)$ or $f(x) + 3$ including the maximum point and the endpoints	
21	27	M1 M1 A1 C1	for start by finding one missing angle, eg angle $CBD = 35$ or angle $ADC = 90$ or angle $ACE = 117$ for making progress by finding a second angle, eg angle $BDE = 117$ or angle $DCE = 62$ or angle $BCA = 63$ for angle $BDC = 27$ (dep on M1) for stating one correct circle theorem used eg <u>Angles</u> in a <u>semicircle</u> are 90 or <u>Angles</u> in the <u>same segment</u> are equal or <u>Angles</u> at the circumference <u>subtended</u> from the same <u>arc</u> of a circle are equal or The <u>angle</u> at the <u>centre</u> of a circle is <u>twice</u> the <u>angle</u> at the <u>circumference</u>	Angles clearly identified on the diagram or in the working space may be awarded marks provided there is no ambiguity or contradiction. Underlined words need to be shown; circle theorems stated need to be linked to their method, which can be implied from correctly identified angles (stated or written on the diagram).



Paper: 1MA1/2H				
Question	Answer	Mark	Mark scheme	Additional guidance
22	Proof	C1	for angle $OAP = \text{angle } OBP = 90^\circ$ angle between <u>radius</u> and <u>tangent</u> is 90°	May be seen as 2 separate diagrams
		C1	for $OA = OB$ both <u>radii</u>	All reasons given must be clearly linked to the appropriate statement
		C1	OP is <u>common</u>	Underlined words need to be shown
		C1	(dep on C3) for a complete proof with all reasons given, eg triangles OAP and OBP are congruent RHS so $AP = BP$ or $AP = \sqrt{OP^2 - OA^2}$ and $BP = \sqrt{OP^2 - OB^2}$ and $OA = OB$ so $AP = BP$	
22 ALT	Proof	C1	for $\cos AOP = \frac{AO}{OP} = \frac{r}{OP}$ or $\cos BOP = \frac{BO}{OP} = \frac{r}{OP}$ angle between <u>radius</u> and <u>tangent</u> is 90°	May be seen as 2 separate diagrams
		C1	for $\cos AOP = \frac{AO}{OP} = \frac{r}{OP}$ and $\cos BOP = \frac{BO}{OP} = \frac{r}{OP}$ and $AOP = BOP$ both <u>radii</u>	
		C1	OP is <u>common</u>	Underlined words need to be shown
		C1	(dep on C3) for a complete proof with all reasons given, eg triangles OAP and OBP are congruent SAS so $AP = BP$	



13



Paper: 1MA1/3H				
Question	Answer	Mark	Mark scheme	Additional guidance
21	Result shown	P1	for process to find the length of half a side or a side or the perimeter of the smaller hexagon $PQRSTU$, eg $r \sin 30$ ($= \frac{r}{2}$) oe or $2r \sin 30$ ($= r$) oe or $6 \times 2r \sin 30$ ($= 6r$) oe	May use Sine Rule or $\cos 60$ instead of $\sin 30$
		P1	for process to find the length of half a side or a side or the perimeter of the larger hexagon $ABCDEF$ eg Length of half side = $r \tan 30$ or $\frac{r}{\tan 60}$ ($= \frac{\sqrt{3}r}{3}$) oe or Length of side = $2r \tan 30$ or $\frac{2r}{\tan 60}$ or $\frac{r}{\sin 60}$ or $\frac{r}{\cos 30}$ ($= \frac{2\sqrt{3}r}{3}$) oe or Length of perimeter = $6 \times 2r \tan 30$ or $6 \times \frac{2r}{\tan 60}$ oe	May use Sine Rule Note this mark is not for just the sight of $\frac{\sqrt{3}r}{3}$ or $\frac{2\sqrt{3}r}{3}$ or $\frac{12\sqrt{3}r}{3}$ oe, they need to be associated with the correct length Perimeter = $4\sqrt{3}r$ alone does not get this mark
		P1	(dep P2) for process of forming a correct inequality, eg using half lengths eg $\frac{r}{2} < \frac{2\pi r}{12} < r \tan 30$ oe or using lengths eg $r < \frac{2\pi r}{6} < 2r \tan 30$ oe or using perimeters eg $6 \times r < 2\pi r < 6 \times 2r \tan 30$ oe	
		C1	(dep P2) correct algebra leading to given result, $3 < \pi < 2\sqrt{3}$	

Paper: 1MA1/1H				
Question	Answer	Mark	Mark scheme	Additional guidance
17	100	M1	for angle $BAC = 40$	
		M1	for angle OAC or angle $OCA = 10$ or angle OAB or angle $OBA = 30$	angle $AOB = 120$ gets M1M1
		M1	for angle $ACB = (180 - 30 - 30) \div 2 (= 60)$ or angle $ OCD = 90$ or angle $OCB = 50$	Award M3C0 for answer of 100 with no correct appropriate circle theorem
		C1	for angle $ACD = 100$ and one correct appropriate circle theorem from <u>alternate segment</u> theorem <u>angle at the centre is twice the angle at the circumference</u> the <u>tangent</u> to a circle is perpendicular to the <u>radius</u>	Underlined words need to be shown Reason needs to be linked to their method, which can be implied from correctly identified angles (stated or written on the diagram)
18 (a)	$\frac{4x+3}{5}$	M1	for first step to change the subject of $y = \frac{5x-3}{4}$ or $x = \frac{5y-3}{4}$ eg $4y = 5x - 3$ or $4x = 5y - 3$	Answer of $\frac{4y+3}{5}$ gets M1A0
(b)	100	A1	oe	
		M1	for $h(5) = 1 - 2 \times 5 (= -9)$ and a clear intention to find $g(" - 9")$ or for $((1 - 2 \times 5) - 1)^2$ or for stating $gh(x)$, eg $(1 - 2x - 1)^2$ oe	
		A1	cao	



Paper: 1MA1/3H				
Question	Answer	Mark	Mark scheme	Additional guidance
20	57	M1	for method to find angle BCD eg $BCD = 180 - 80 (= 100)$	Angles may be seen on diagram Method marks can be awarded in either order Correct method can be implied from angles on the diagram if no ambiguity or contradiction. eg Angle $O = 160$ is too ambiguous accept angle $C = 100$
		M1	for method to find angle DOB eg $DOB = 80 \times 2 (= 160)$	
		A1	for $OBC = 57$	
		C1	(dep on M1) for one correct circle theorem appropriate to their method eg The <u>angle</u> at the <u>centre</u> of a circle is <u>twice</u> the <u>angle</u> at the <u>circumference</u> or The <u>angle</u> at the <u>circumference</u> of a circle is <u>half</u> the <u>angle</u> at the <u>centre</u> or <u>Opposite angles</u> of a <u>cyclic quadrilateral</u> add up to 180	



Paper: 1MA1/1H				
Question	Answer	Mark	Mark scheme	Additional guidance
10 (a)	Box plot drawn	B3	for a fully correct box plot	Condone the lack of a vertical marker at the end of the tails
		(B2)	for at least 3 correctly plotted values including box and whiskers/tails)	Note that a box must be present, as must "tails"
		(B1)	for at least 2 correctly plotted values including box or whiskers/tails or 5 correct values plotted or clearly identified and no box or whiskers/tails)	
(b)	60	M1	for a method to find $\frac{3}{4}$ of 80 eg $20 + 20 + 20$ or $\frac{3}{4} \times 80$	
		A1	cao	
11	$90 - 2x$	M1	for identifying an unknown angle eg $BAO = x$, $AOB = 180 - 2x$, $OBC = 90$, $ABC = 90 + x$	Could be shown on the diagram alone
		M1	full method to find the required angle eg a method leading to $180 - x - x - 90$	Needs to be an algebraic method Accept $x + x + 90 + y = 180$ for M2
		A1	for $90 - 2x$	Underlined words need to be shown; reasons need to be linked to their method; any reasons not linked do not credit.
		C2	(dep M2) full reasons for their method, from base angles in an <u>isosceles triangle</u> are equal <u>angles</u> in a <u>triangle</u> add up to 180° a <u>tangent</u> to a circle is perpendicular to the <u>radius (diameter)</u> <u>angles</u> on a straight <u>line</u> equal 180° the <u>exterior angle</u> of a triangle is <u>equal</u> to the sum of the <u>interior opposite angles</u>	
		(C1)	(dep M1) for a <u>tangent</u> to a circle is perpendicular to the <u>radius (diameter)</u>	
				Apply the above criteria



Paper: 1MA1/2H				
Question	Answer	Mark	Mark scheme	Additional guidance
18	75° with reasons	M1	for finding angle $BAD = \frac{180 - 40}{2}$ (= 70) or angle $BDA = \frac{180 - 40}{2}$ (= 70)	Could be shown on the diagram or in working
		M1	for finding angle $BCD = 180 - "70"$ (=110) or $40 + x + 70 + x = 180$	
		A1	for finding angle $ADE = 75$	
		C2	(dep M2) for <u>Opposite angles</u> of a <u>cyclic quadrilateral</u> add up to 180 and one other reason; all reasons given must be appropriate for their working Base angles of an <u>isosceles triangle</u> are equal <u>Angles</u> in a <u>triangle</u> add up to 180, <u>Angles</u> on a <u>straight line</u> add up to 180 [or <u>exterior angle</u> of a <u>cyclic quadrilateral</u> is equal to the <u>interior opposite angle</u>]	
		(C1	(dep M2) for <u>Opposite angles</u> of a <u>cyclic quadrilateral</u> add up to 180, or all other reasons given appropriate for their working)	
				Underlined words need to be shown; reasons need to be linked to their method
				Apply the above criteria

