1	$CED = 4x$ or $ACB = 180 - y - (90 - x)$	M1	may be on diagram
	$CED = 4x$ and $DCE = \frac{180 - 4x}{2}$ or $ACB = 180 - y - (90 - x)$ and $DCE = 180 - y - (90 - x)$	M1dep	may be on diagram allow $DCE = ACB$ for $DCE = 180 - y - (90 - x)$
	M2 seen and $y + 90 - x + \frac{180 - 4x}{2} = 180$ and $y = 3x$ or M2 seen and $\frac{180 - 4x}{2} = 180 - y - (90 - x)$ and $y = 3x$	A1	M2 seen and $2(180 - y - (90 - x)) + 4x = 180$ and $y = 3x$
	M2A1 seen and all reasons given	A1	eg alt(ernate) seg(ment theorem) and (base angles of) isos(celes) triangle (are equal) and (vertically) opp(osite) angles (are equal) and angles in a triangle (sum to 180°)

	Additional Guidance	
1 cont	Allow $CE = DE$ for the reason (base angles of) isos(celes) triangle (are equal)	
	Allow $90 - y + x$ or $180 - y - 90 + x$ for $180 - y - (90 - x)$	
	Allow $90 - 2x$ for $\frac{180 - 4x}{2}$	
	Allow clear indication of angles eg allow E for CED do not allow C for ACB unless seen on diagram	
	Assuming $y = 3x$	Zero
	For 1st A1, allow equivalent equations eg For $2(180 - y - (90 - x)) + 4x = 180$ allow $2(180 - y - (90 - x)) = 180 - 4x$	

Q	Answer	Mark	Comments
2	**Alternative method 1**		
	OBD and OCD are right angles and BOC (obtuse) = $180 - x$	M1	may be on diagram
	$BAC = 90 - \frac{x}{2}$	M1dep	oe may be on diagram
	BOC (reflex) = $180 + x$ and $ABO + ACO = 360 - (90 - \frac{x}{2} + 180 + x)$ or $90 - \frac{x}{2}$ and $ABO = \frac{1}{2}(90 - \frac{x}{2})$ $= 45 - \frac{x}{4}$ with M2 scored	A1	oe $360 - 90 + \frac{x}{2} - 180 - x$
	All reasons given tangent meets the radius at 90° angles in a quadrilateral add up to 360° angle at the circumference is half the angle at the centre angles around a point add to 360°	A1	

Q	Answer	Mark	Comments
2 cont	**Alternative method 2**		
	OBD and *OCD* are right angles and *BOC* (obtuse) = $180 - x$	M1	may be on diagram
	BAC = $90 - \frac{x}{2}$	M1dep	oe may be on diagram
	BOC (reflex) = $180 + x$ and *BAD* = $\frac{1}{2}(90 - \frac{x}{2})$ or $45 - \frac{x}{4}$ and *ABO* = $180 - (45 - \frac{x}{4}) - (90 + \frac{x}{2})$ $= 45 - \frac{x}{4}$ with M2 scored	A1	
	All reasons given tangent meets the radius at 90° angles in a quadrilateral add up to 360° angle at the circumference is half the angle at the centre angles in a triangle add up to 180°	A1	

Q	Answer	Mark	Comments
2 cont	**Alternative method 3**		
	OBD and *OCD* are right angles and *BOC* (obtuse) = $180 - x$	M1	may be on diagram
	BAC = $90 - \frac{x}{2}$	M1dep	oe may be on diagram
	ABC = $\frac{1}{2}[180 - (90 - \frac{x}{2})]$ = $45 + \frac{x}{4}$ and *OBC* = $\frac{1}{2}[180 - (180 - x)]$ = $\frac{x}{2}$ and *ABO* = $45 + \frac{x}{4} - \frac{x}{2}$ = $45 - \frac{x}{4}$ with M2 scored	A1	
	All reasons given tangent meets the radius at 90° angles in a quadrilateral add up to 360° angle at the circumference is half the angle at the centre angles in a triangle add up to 180° (base angles in an) isosceles triangle (are equal)	A1	

Q	Answer	Mark	Comments
2 cont	**Alternative method 4**		
	OBD is a right angle and $BDO = \frac{x}{2}$	M1	may be on diagram
	$BOD = 90 - \frac{x}{2}$	M1dep	may be on diagram
	$OAB + ABO = 90 - \frac{x}{2}$ and $ABO = 45 - \frac{x}{4}$ with M2 scored	A1	
	All reasons given tangent meets the radius at 90° the diagram is symmetrical oe angles in a triangle add up to 180° exterior angle of a triangle is equal to the sum of the opposite interior angles OA and OB are radii, so triangle ABO is isosceles (base angles in an) isosceles triangle (are equal)	A1	
	Additional Guidance		
	Using a value for x		M0M0A0A0

Q	Answer	Mark	Comments
3	**Alternative method 1 – using angles around *O* and angles inside arrowhead**		
	$ACO = 90 - 83$ or $ACO = 7$	M1	may be seen on diagram
	Acute $BOC = 2 \times 28$ or acute $BOC = 56$	M1	may be seen on diagram
	Reflex $BOC = 360 -$ their 56 or reflex $BOC = 304$	M1dep	may be seen on diagram dep on 2nd M1
	$ABO = 360 -$ their 304 – their 7 – 28 or $ABO = 21$	M1dep	may be seen on diagram dep on M3
	$ABO = 21$ and $ACO = 7$ and 21 : 7 = 3 : 1	A1	all angle values must be seen
	Alternative method 2 – with line *OA* added		
	$ACO = 90 - 83$ or $ACO = 7$	M1	may be seen on diagram
	$OAC = 7$ or $ABO + ACO = 28$	M1dep	may be seen on diagram
	$OAB = 28 - 7$ or $OAB = 21$ or $ABO = 28 - 7$	M1dep	may be seen on diagram dep on M2
	$ABO = 21$	M1dep	may be seen on diagram dep on M3
	$ABO = 21$ and $ACO = 7$ and 21 : 7 = 3 : 1	A1	all angle values must be seen

Q	Answer	Mark	Comments
3 cont	**Alternative method 3 – using alternate segment theorem**		
	$ACO = 90 - 83$ or $ACO = 7$	M1	may be seen on diagram
	Acute $BOC = 2 \times 28$ or acute $BOC = 56$	M1	may be seen on diagram
	$ABC = 83$	M1	may be seen on diagram
	$OBC = \frac{180 - \text{their } 56}{2}$ or $OBC = 62$ and $ABO = 83 - \text{their } 62$ or $ABO = 21$	M1dep	may be seen on diagram, dep on 2nd and 3rd M1
	$ABO = 21$ and $ACO = 7$ and $21 : 7 = 3 : 1$	A1	all angle values must be seen

Q	Answer	Mark	Comments
3 cont	**Alternative method 4 – using triangles *OBC* and *ABC***		
	$ACO = 90 - 83$ or $ACO = 7$	M1	may be seen on diagram
	Acute $BOC = 2 \times 28$ or acute $BOC = 56$	M1	may be seen on diagram
	$OBC = \frac{180 - \text{their } 56}{2}$ or $OBC = 62$	M1dep	may be seen on diagram or angle OCB dep on 2nd M1
	$ABO = 180 - 28 - 62 - 62 - 7$ or $ABO = 21$	M1dep	oe may be seen on diagram dep on M3
	$ABO = 21$ and $ACO = 7$ and $21 : 7 = 3 : 1$	A1	all angle values must be seen
	Additional Guidance		
	If angles are not correctly positioned on the diagram they must be correctly identified in the working, eg $BOC = 56$ is M0 if not correctly positioned on the diagram and not identified as acute		
	$ACO = 7$ and $ABO : ACO = 21 : 7$ with no other correct working		M1M0M0M0A0

Q	Answer	Mark	Comments
4(a)	65	B1	
	Additional Guidance		
	65 unambiguously linked to x on diagram with answer line blank		B1

Q	Answer	Mark	Comments
4(b)	It is greater than the answer to part (a)	B1	
	Additional Guidance		

Q	Answer	Mark	Comments
4(c)	No and valid statement	B1	eg no it is angle ACD that is 70°
	Additional Guidance		
	Angles may be seen on the diagram		
	No may be implied eg1 angle ADC is not 70 eg2 angle y is 55		 B1 B1
	Allow unambiguous indication of angles eg y and D are both 55 so he is wrong		 B1
	No and angle $ADC = 55°$		B1
	y is not 70 so no		B1
	No, neither angle is correct		B1
	No, he thinks AB and DC are parallel		B1
	No, he's used alternate angles		B1
	It should say alternate angles (no implied)		B1
	He has made mistakes		B0
	He used the alternate segment theorem incorrectly		B1
	Ignore irrelevant working but do not ignore incorrect working eg No it is angle ACD that is 70° and angle y is 65		 B0
	Responses saying he is correct		B0

Q	Answer	Mark	Comment
5	**Alternative method 1**		
	$RPQ = y$	M1	may be seen on diagram
	$RPQ = y$ and $RQP = 180 - 2y$	M1dep	may be seen on diagram
	$RQP = 2x$ and $2x = 180 - 2y$ and correct rearrangement to $y = 90 - x$ with M1M1 awarded	A1	$RQP = 2x$ may be implied by 'alternate segment theorem'
	Correct reasons given with M1M1 scored and a correct initial equation for the A mark	B1	(base angles of an) isosceles triangle (are equal) sum of the angles in a triangle is 180° alternate segment (theorem)
	Alternative method 2		
	$RPQ = y$	M1	may be seen on diagram
	$RQP = 2x$	M1	may be seen on diagram
	$2x + 2y = 180$ and correct rearrangement to $y = 90 - x$ with M1M1 awarded	A1	
	Correct reasons given with M1M1 scored and a correct initial equation for the A mark	B1	(base angles of an) isosceles triangle (are equal) alternate segment (theorem) sum of the angles in a triangle is 180°

5 (cont)	**Alternative method 3**		
	$RQP = 2x$	M1	may be seen on diagram
	$RQP = 2x$ and $RPQ = 180 - 2x - y$	M1dep	may be seen on diagram
	$y = 180 - 2x - y$ and correct rearrangement to $y = 90 - x$ with M1M1 awarded	A1	
	Correct reasons given with M1M1 scored and a correct initial equation for the A mark	B1	alternate segment theorem sum of the angles in a triangle is 180° (base angles of an) isosceles triangle (are equal)
	Alternative method 4		
	$RPQ = y$	M1	may be seen on diagram
	SP extended to T and $QPT = y$	M1	may be seen on diagram any or no letter for T
	$2x + 2y = 180$ and correct rearrangement to $y = 90 - x$ with M1M1 awarded	A1	
	Correct reasons given with M1M1 scored and a correct initial equation for the A mark	B1	(base angles of an) isosceles triangle (are equal) alternate segment theorem angles on a straight line sum to 180°
	Additional Guidance		
	Method marks can be scored using angle notation eg $RPQ = QRP$ is equivalent to $RPQ = y$		

	Answer	Mark	Comment
6	$BOD = 2 \times 32$ or 64	M1	oe eg $BOC = 64$ may be seen on diagram
	$OBD = 90$	M1	may be seen on diagram or implied by further working or answer
	26	A1	
	Additional Guidance		
	90 can be implied by a square angle sign		
	180 – 154 implies M1M1		

Q	Answer	Mark	Comments
7	**Alternative method 1: drawing *AO* and *BO* and sum of angles in a quadrilateral**		
	PBO = 90 or *PAO* = 90	M1	may be seen on diagram or implied by subsequent working accept rectangle drawn at angle
	360 – 90 – 90 – 24 or 156	M1dep	oe eg 180 – 24 or 90 – 12 may be seen on diagram
	78	A1	
	Alternative method 2: drawing *AO* and *BO* and using circle theorems		
	AOB = 2*x*	M1	may be seen on diagram
	2*x* = 156	M1dep	
	78	A1	
	Alternative method 3: drawing *AB*, sum of angles in a triangle and alt segment		
	2*PAB* + 24 = 180 or 2*PBA* + 24 = 180	M1	
	(180 – 24) ÷ 2 or 78 or (180 – 24) ÷ 2 or 78	M1dep	may be seen on diagram
	x = 78	A1	
	Alternative method 4: drawing *PO* and *AO* or *BO* and sum of angles in a triangle		
	PBO = 90 or *PAO* = 90	M1	may be seen on diagram or implied by subsequent working accept rectangle drawn at angle
	180 – 90 – 12 or 78	M1dep	oe eg 90 – 12 may be seen on diagram
	78	A1	

Q	Answer	Mark	Comments
7 cont	**Additional Guidance**		
	Answer 78		M1M1A1
	Working takes precedence over diagram		