1	(i)		grad AB = $\dfrac{7-1}{4-2}$ oe or 3	M1		
			$y-7$ = their m $(x-4)$ or $y-1$ = their m $(x-2)$	M1	or use of y = their gradient $x + c$ with coords of A or B or M2 for $\dfrac{y-1}{7-1}=\dfrac{x-2}{4-2}$ o.e.	allow step methods used or eg M1 for $7 = 4m + c$ and $1 = 2m + c$ then M1 for correctly finding one of m and c
			$y = 3x - 5$ oe	A1 **[3]**	accept equivalents if simplified eg $3x - y = 5$ allow B3 for correct eqn www	allow A1 for $c = -5$ oe if $y = 3x + c$ oe already seen B2 for eg $y - 1 = 3(x - 2)$
1	(ii)		showing grad BC = $\dfrac{2-1}{-1-2}=-\dfrac{1}{3}$ oe	B1	may be calculation or showing on diagram	
			and $-1/3 \times 3 = -1$ or grad BC is neg reciprocal of grad AB, [so 90°]	B1	may be earned for statement / use of $m_1m_2 = -1$ oe, even if first B1 not earned for B1+B1, must be fully correct, with 3 as gradient in (i)	eg allow 2nd B1 for statement grad BC $= -1/3$ with no working if first B1 not earned
			<u>or</u> for finding AC or AC^2 independently of AB and BC	<u>or</u> B1	working needed such as AC^2 = $5^2 + 5^2 = 50$	condone any confusion between squares and square roots etc for first B1 and for two M1s eg AC = 25 + 25 = $\sqrt{50}$
			for correctly showing AC^2 = BC^2 + AB^2 oe	B1	working needed using correct notation such as BC^2 = $3^2 + 1^2 = 10$; AB^2 = $6^2 + 2^2$ =40, 40 + 10 = 50 [hence A ^{2} = BC^2 + AB^2]	accept eg 3 and 1 shown on diagram and BC^2 = 10 etc 0 for eg $\sqrt{40}+\sqrt{10}=\sqrt{50}$

			<u>or</u> finding equation of line through C perpendicular to AB ($y = -\frac{1}{3}x + \frac{5}{3}$ oe)	<u>or</u> B1		eg B1 for $x + 3y = 5$
			showing B is on this line either by substitution or finding intersection of this line with AB	B1		or B1 for finding the equation of the line through B and C as $y = -\frac{1}{3}x + \frac{5}{3}$ oe and B1 for using condition for perp lines and showing true
			BC = $\sqrt{3^2 + 1^2}$ or $\sqrt{10}$	M1		
			AB= $\sqrt{6^2 + 2^2}$ or $\sqrt{40}$ or $2\sqrt{10}$	M1	both these Ms may be earned earlier if Pythag used to show angle ABC = 90°, but are for BC and AB, not BC^2 and AB^2	for both M1s accept unsimplified equivs
			Area = 10 [square units]	A1	must be simplified to 10	
			<u>or</u> area under AC – area under AB – area under BC	<u>or</u> M1		mark equivalently for other valid methods, eg trapezium – 2 triangles method, omitting below $y = 1$: $\frac{1}{2} \times 7 \times 5 - (\frac{1}{2} \times 3 \times 1 + \frac{1}{2} \times 2 \times 6)$ $= 17.5 - (1.5 + 6)$
			at least two of 22.5, 8 and 4.5 oe	M1		
			Area = 10 [square units]	A1	must be simplified to 10	
				[5]		

1	(iii)		(1.5, 4.5) oe angle in semicircle oe is a right-angle [so B is on circle] and must mention AC as diameter or D as centre [hence A, B, C all same distance from D]	2 E1 **[3]**	B1 each coordinate or '[since b = 90°,] ABC are three vertices of a rectangle. D is the midpoint of one diagonal <u>and</u> so D is the centre of the rectangle <u>or</u> the diagonals of a rectangle are equal and bisect each other, [hence DA=DB=DC] or condone showing that line from D to mid point of AB is perp to AB, so DBA is isos [hence DB = DA = DC] [or equiv using DBC]	 E0 for just stating 'D is midpt of the hypotenuse of a rt angled triangle ABC so DAB is isos' without showing that it is isw eg wrong calcn of radius NB some wrongly asserting that ABC is isos

2	7	**2**	condone $y = 7$ or (5, 7); **M1** for $\frac{k-(-5)}{5-1}=3$ or other correct use of gradient eg triangle with 4 across, 12 up	condone omission of brackets; or **M1** for correct method for eqn of line and $x = 5$ subst in their eqn and evaluated to find k; or **M1** for both of $y - k = 3(x - 5)$ oe and $y - (-5) = 3(x - 1)$ oe

3	$y = 5x + 3$	**3**	**M2** for $y - 13 = 5(x - 2)$ oe or **M1** for $y = 5x$ [+ k] [k = letter or number other than −4] and **M1** for $13 =$ their $m \times 2 + k$	or **M1** for $y - b = 5(x - a)$ with wrong a, b or for $y - 13 =$ their $5(x - 2)$ oe **M0** for first M if −1/5 used as gradient even if 5 seen first; second M still available if earned

4	(7/11, 24/11) oe www	**3**	**B2** for one coord correct; condone not expressed as coords, isw or **M1** for subst or elimination; eg $x + 2(5x - 1) = 5$ oe; condone one error **SC2** for mixed fractions and decimals eg (3.5/5.5, 12/5.5)	

5	(i) ½ $x \times (x + 2 + 3x + 6)$ oe $x(4x + 8) = 140$ oe and given ans $x^2 + 2x - 35 = 0$ obtained correctly with at least one further interim step	**M1** **A1**	correct statement of area of trap; may be rectangle ± triangle, or two triangles	eg $2x(x + 2) + ½ \times 2x \times (2x + 4)$ condone missing brackets for **M1;** condone also for **A1** if expansion is treated as if they were there
	(ii) [AB 1 www	**3**	or **B2** for $x = [-7$ or$]$ 5 cao www or for AB = 21 or –15 or **M1** for $(x + 7)(x - 5)$ [= 0]or formula or completing square used eg $(x + 1)^2 - 36$ [= 0]; condone one error eg factors with sign wrong or which give two terms correct when expanded or **M1** for showing f(5) = 0 without stating $x = 5$	may be done in (i) if not here – allow the marks if seen in either part of the image – some candidates are omitting the request in (i) and going straight to solving the equation (in which case give 0 [not NR] for (i), but annotate when the image appears again in (ii)) 5 on its own or AB = 5 with no working scores 0; we need to see $x = 5$

6	(i) rad AB = $\frac{0-6}{1-(-1)}$ oe [= −3] isw grad BC = $\frac{0-4}{1-13}$ oe [= 1/3] isw product of grads = −1 [so lines perp] stated or shown numerically	**M1** **M1** **M1**	for full marks, it should be clear that grads are independently obtained or 'one grad is neg. reciprocal of other' **or** **M1** for length of one side (or square of it) **M1** for length of other two sides (or their squares) found independently **M1** for showing or stating that Pythag holds [so triangle rt angled]	eg grads of –3 and 1/3 without earlier working earn **M1M0** for **M3**, must be fully correct, with gradients evaluated at least to –6/2 and –4/–12 stage $AB^2 = 6^2 + 2^2 = 40$, $BC^2 = 4^2 + 12^2 = 160$, $AC^2 = 14^2 + {}^2 = 200$
6	(ii) A √40 or BC = √160 ½ × √40 × √160 oe or ft their AB, BC 40	**M1** **M1** **A1**	**or M1** for one of area under AC (=70), under AB (=6) under BC (=24) (accept unsimplified) and **M1** for their trap. – two triangles	allow **M1** for $\sqrt{(1-(-1))^2+(6-0)^2}$ or for $\sqrt{(13-1)^2+(4-0)^2}$ **or** for rectangle – 3 triangles method, [$6\times14-\frac{1}{2}(2)(6)-\frac{1}{2}(4)(12)-\frac{1}{2}(2)(14)$ =84 – 6 – 24 – 14] **M1** for two of the 4 areas correct and **M1** for the subtraction

6	(iii) le subtended by diameter = 90° soi mid point M of AC = (6, 5) rad of circle = $\frac{1}{2}\sqrt{14^2+2^2}\,[=]\,\frac{1}{2}\sqrt{200}$ oe or equiv using r^2 $(x-a)^2+(y-b)^2=r^2$ seen or $(x - \text{their } 6)^2 + (y - \text{their } 5)^2 = k$ used, with $k > 0$ $(x-6)^2+(y-5)^2=50$ cao	**B1** **B2** **M1** **M1** **A1**	or angle at centre = twice angle at circumf = 2 × 90 = 180 soi or showing BM = AM or CM, where M is midpt of AC; or showing that BM = ½ AC allow if seen in circle equation ; **M1** for correct working seen for **both** coords accept unsimplified; or eg $r^2 = 7^2 + 1^2$ or $5^2 + 5^2$; may be implied by correct equation for circle or by correct method for AM, BM or CM ft their M or $x^2+y^2-12x-10y+11=0$	condone ‘AB and BC are perpendicular’ or ‘ABC is right angled triangle’ provided no spurious extra reasoning allow **M1** bod intent for AC = $\sqrt{200}$ followed by $r = \sqrt{100}$ must be simplified (no surds)
6	(iv) (11, 10)	**1**		

7	(i) (0, −2) or ‘crosses y-axis at −2’ oe isw $(\pm 2^{\frac{1}{4}}, 0)$ oe isw	**B1** **B2**	or [when $y = 0$], $[x=]\pm 2^{\frac{1}{4}}$ or $\pm\sqrt{\sqrt{2}}$ or $\pm\sqrt[4]{2}$ isw **B1** for one root correct	condone $y = -2$

7	(ii) [y =] $x^2 = x^4 - 2$ oe and rearrangement to $x^4 - x^2 - 2$ [= 0] or $y^2 - y - 2$ [=0]	**M1**		
	$(x^2 - 2)(x^2 + 1) = 0$ oe in y	**M1**	or formula or completing square; condone one error; condone replacement of x^2 by another letter or by x for 2nd M1 (but not the 3rd M1)	if completing square, and haven't arranged to zero, can earn first **M1** as well for an attempt such as $(x^2 - 0.5)^2 = 2.25$
	$x^2 = 2$ [or −1] or $y = 2$ or −1 or ft or $x = \sqrt{2}$ or $x = -\sqrt{2}$ or ft	**M1**	dep on 2nd **M1;** allow inclusion of correct complex roots; **M0** if any incorrect roots are included for x^2 or x	NB for second and third M: **M0** for $x^2 - 2 = 0$ or $x^2 = 2$ oe straight from quartic eqn – some candidates probably thinking $x^4 - x^2$ simplifies to x^2; last two marks for roots are available as B marks
	$(\sqrt{2}, 2)$ and $(-\sqrt{2}, 2)$; with no other intersections given	**B2**	or **B1** for one of these two intersections (even if extra intersections given) or for $x = \pm\sqrt{2}$ (and no other roots) or for y = 2 (and no other roots), marking to candidates' advantage	some candidates having several attempts at solving this equation – mark the best in this particular case

7	(iii) from $x^4 - kx^2 - 2$ [= 0]: $k^2 + 8 > 0$ oe $k + \sqrt{k^2 + 8} \geq 0$ for all k [so there is a positive root for x^2 and hence real root for x and so intersection]	 **B1** **B1**	Allow x^2 replaced by other letters or x or from $y^2 - k^2y - 2k^2$ [= 0] $k^4 + 8k^2 > 0$ oe $k^2 + \sqrt{k^4 + 8k^2} > 0$ oe for all k [so there is a positive root for y and hence real root for x and so intersection] if **B0B0**, allow **SC1** for $\frac{k \pm \sqrt{k^2+8}}{2}$ or $\frac{k^2 \pm \sqrt{k^4+8k^2}}{2}$ obtained [need not be simplified]	[alt methods: may use completing square to show similarly, or comment that at $x = 0$ the quadratic is above the quartic and that as $x \to \infty$, $x^4 - 2 > kx^2$ for all k] condone lack of brackets in $(-k)^2$

8	$y = 3x + c$ or $y - y_1 = 3(x - x_1)$ $y - 5 =$ their $m(x - 4)$ o.e. $y = 3x - 7$ or simplified equiv.	**M1** **M1** **A1**	allow M1 for 3 clearly stated/ used as gradient of required line or (4, 5) subst in their $y = mx + c$; allow M1 for $y - 5 = m(x - 4)$ o.e. condone $y = 3x + c$ and $c = -7$ or **B3** www