

1	$a + 5d = 39$ or $a + 18d = 7.8$ or $13d = -31.2$ oe		4	M1
	$a = 51$ or $d = -2.4$			A1
	e.g. $\frac{25}{2}(2 \times 51 + (25 - 1) \times -2.4)$ oe or $12.5(2a + 23d + d) = 12.5(39 + 7.8 - 2.4)$ oe			M1 for substituting their values for a and d into S_n , a and d must be clearly stated.
		555		A1
Total 4 marks				

2	$a = 8$ $d = 7$		4	M1 can be implied
	$(S_{100} =) \frac{100}{2}(2 \times 8 + (100 - 1) \times 7) (= 35\,450)$ or $(S_{49} =) \frac{49}{2}(2 \times 8 + (49 - 1) \times 7) (= 8624)$ or $(S_{50} =) \frac{50}{2}(2 \times 8 + (50 - 1) \times 7) (= 8975)$			M1
	'35450' - '8624' or '35450' - '8975' + $(8 + (50 - 1) \times 7)$			M1
		26 826		A1
Total 4 marks				
Alternative scheme				
	$(u_n =) 7n + 1$	$a = 8$ and $d = 7$	4	M1 can be implied
	$(u_{50} =) 7 \times 50 + 1 (= 351)$ or $(u_{100} =) 7 \times 100 + 1 (= 701)$	$(u_{50} =) 8 + (50 - 1) \times 7$ (= 351)		M1
	$\frac{51}{2}('351' + '701')$	$\frac{51}{2}(2 \times 351 + (51 - 1) \times 7)$		M1
		26 826		A1
Total 4 marks				

3	$(2865 =) \frac{30}{2}(2 \times -6 + 29d)$		4	M1 Correct expression for sum of 30 terms
	$d = 7$			A1 Correct value for d
	$-6 + 8 \times "7"$ or $(n\text{th term} =) -6 + "7"(n - 1)$			M1 fit their d . Dep on M1
		50		A1
Total 4 marks				

4	$n = 50$		3	B1
	$33125 = \frac{50}{2}[2 \times 50 + (50 - 1) \times k]$ oe $33125 = 25[100 + 49k]$ oe $1325 = 100 + 49k$ oe $1225 = 49k$ oe			M1 For correct equation, using formula with $a = 50$ and $n = 50$ substituted (for this mark, allow $n = 49$) (k may be written as d)
		25		A1
Total 3 marks				

5		$91 - 6n$	2	B2
				For a correct answer in any form eg $91 - 6 \times n$ or $-6n + 91$ or $85 + (n - 1)(-6)$ oe (B1 for $-6n + k$ oe (k may be zero or absent)) NB: award full marks for eg $x = 91 - 6n$ or $n\text{th term} = 91 - 6n$ but only B1 for $n = 91 - 6n$
Total 2 marks				

6		$a + d = 8.5, a + 4d = 13$ oe		5	M1	for at least 1 correct equation or for $d = 1.5$
		$a = 7, d = 1.5$			A1	both values correct
		$\frac{N}{2}(2 \times 7 + (N - 1)1.5) = 292$ (eg $3N^2 + 25N - 1168 [= 0]$ or $1.5N^2 + 12.5N - 584 [= 0]$)			M1	A correct equation for the total of the first N terms of the series with a and d substituted in. The mark can be gained by using their values of a and d even if no previous marks awarded.
		eg $(3N + 73)(N - 16) [= 0]$ $[N =] \frac{-25 \pm \sqrt{25^2 - 4 \times 3 \times -1168}}{2 \times 3}$			M1	A correct method dep on the previous M1 for solving their 3 term quadratic equation using any correct method (allow one sign error and some simplification – allow as far as $\frac{-25 \pm \sqrt{625 + 14016}}{6}$) oe (may be \pm or just $+$) or if factorising, allow brackets which expanded give 2 out of 3 terms correct, or if completing the square allow as far as the stage $3((N + \frac{25}{6})^2 - \frac{25^2}{6^2}) - 1168 (= 0)$
		<i>Working required</i>	16		A1	dep on M2
					Total 5 marks	

7	E.g. $a + 3d = 6$ oe		6	M1	for forming an equation for the 4 th term of the sequence
	E.g. $\frac{11}{2}(2a + 10d) = (a + 5d)^2 + 18$			M1	for forming an equation for the sum of the first 11 terms of the sequence
	E.g. $a = 6 - 3d$ and $\frac{11}{2}[2(6 - 3d) + 10d] = (6 - 3d + 5d)^2 + 18$ or $d = \frac{6 - a}{3}$ and $\frac{11}{2}\left[2a + 10\left(\frac{6 - a}{3}\right)\right] = \left(a + 5\left(\frac{6 - a}{3}\right)\right)^2 + 18$			M1	dep on M2 for a correct first step to solve the two equations (writing the equation in terms of one variable) Note: If $\frac{11}{2}(2a + 10d) = (a + 5d)^2 + 18$ is expanded then this must be a correct expansion E.g. $11a + 55d = a^2 + 10ad + 25d^2 + 18$
	E.g. $2d^2 + d - 6 (= 0)$ oe or $2a^2 - 27a + 36 (= 0)$ oe			A1	for a correct 3 term quadratic equation
	$d = 1.5$ oe and $a = 1.5$ oe			A1	for a correct value of d and a
		30		A1	cao
					Total 6 marks

8	$\frac{2n}{2}[2a + (2n-1)d]$ oe		4	M1	for a correct expression for S_{2n}
	$\frac{2n}{2}[2a + (2n-1)d] = 4 \times \frac{n}{2}[2a + (n-1)d]$ oe			M1	dep on M1 for setting up a correct equation for $S_{2n} = 4 \times S_n$
	$2a - d = 4a - 2d$ oe			M1	for a correct linear expression in a and d
		$\frac{d}{2}$		A1	(dep on M2) for $\frac{d}{2}$ oe
					Total 4 marks

9	(a)	eg $6 \times 2.4 + 5 \times 3.5$		2	M1	
			31.9		A1	oe
	(b)	$(W =) 5.9n$ or $(W =) 5.9(n - 1) + 2.4$ or $(W =) 2.4n + 3.5(n - 1)$		2	M1	for $2.4n + 3.5n$ or $5.9n$ seen
			$5.9n - 3.5$		A1	oe but must be in simplest form eg $-3.5 + 5.9n$
Total 4 marks						

10	$(S_{10}) = \frac{10}{2}(2a+9d)$ or $(S_5) = \frac{5}{2}(2a+4d)$ oe or $a+7d=45$		5	M1	for a correct expression for the sum of the first 10 terms (S_{10}) or the first 5 terms (S_5) or a correct equation for the 8 th term Take 9 as their $10-1$ and 4 as their $5-1$ and 7 as their $8-1$
	$\frac{10}{2}(2a+9d) = 4 \times \frac{5}{2}(2a+4d)$ oe			M1	for a correct equation relating S_{10} and S_5
	eg $d=2a$ oe or $a = \frac{d}{2}$ oe or $a+7d=45$ oe and eg $10a-5d=0$ oe or eg $\frac{10}{2}(2(45-7d)+9d) = 4 \times \frac{5}{2}(2(45-7d)+4d)$ oe or $5d=10(45-7d)$ oe			M1	(dep on M1) for d in terms of a , or vice-versa (must be correct) or for $a+7d=45$ oe and correctly reducing the equation relating S_{10} and S_5 to an equation with one term in a and one term in d eg $10a-5d=0$ oe or substituting a correct expression into their correct equation to obtain an equation in just d
	eg $a+7(2a)=45$ or $d=6$ or eg $70a-35d=0$ or $10a-5d=0$ $5a+35d=225$ + $10a+70d=450$ - $(75a=225)$ $(-75d=-450)$			M1	(dep on M2) for a correct equation in just a or for $d=6$ or for a correct method to eliminate a or d : coefficients of a or d the same and correct operation to eliminate selected variable (condone 1 arithmetical error)
		3		A1	Dep on M3
Total 5 marks					

11	(a)			2	M1 for $4n+k$ ($k \neq -3$) or $4 \times n + k$ ($k \neq -3$) or $n \times 4 + k$ ($k \neq -3$) (k may be zero or absent)
		$4n-3$			A1 oe e.g. $1+(n-1)4$ oe or $4 \times n-3$ oe or $n \times 4-3$ oe NB: award full marks for eg $x=4n-3$ oe or $x=4 \times n-3$ oe or $x=n \times 4-3$ oe or n th term $= 4n-3$ oe or n th term $= 4 \times n-3$ oe or n th term $= n \times 4-3$ oe but only M1 for $n=4n-3$ oe
	(b)	$6m+5$		1	B1 for $3(2m)+5$ oe or $6m+5$ or $3 \times 2m+5$ oe or $6 \times m+5$ Allow $3(2n)+5$ or $6n+5$ oe
Total 3 marks					

12		$d=-2$		6	M1 for common difference
		$(S_n) = \frac{n}{2}[2(177)+(n-1)(-2)]$ or $(S_n) = \frac{n}{2}[354-2n+2]$ or $(S_n) = \frac{n}{2}[356-2n]$ oe			M1 for correctly substituting 177 and -2 into $(S_n) = \frac{n}{2}[2a+(n-1)d]$
		$\frac{n}{2}[2(177)+(n-1)(-2)] = (n-2) \times 180$			M1 dep on M2 for equating S_n with $(n-2) \times 180$
		E.g. $2n^2+4n-720=0$ or $n^2+2n-360=0$ oe Allow $n^2+2n=360$			A1 (dep on M3) writing a correct 3-term quadratic expression in form ax^2+bx+c ($=0$) allow $ax^2+bx=c$
		E.g. $(x-18)(x+20)=0$ $x = \frac{-2 \pm \sqrt{2^2 - 4 \times 1 \times -360}}{2}$ e.g. $(x+1)^2 - (1)^2 = 360$			M1 (dep on M2) for a complete method to solve their 3-term quadratic equation Allow one sign error and some simplification – allow as far as $\frac{-2 \pm \sqrt{4+1440}}{2}$
			18		A1 dep on M3 for 18 only
Total 6 marks					

12	3, 5, 7, ... and $d = 2$ or $a = 3$ and $d = 2$		6	M1 for identifying exterior angle sequence for at least 3 terms and $d = 2$ or first term and common difference
ALT	$(S_n =) \frac{n}{2} [2(3) + (n-1)(2)]$ or $(S_n =) \frac{n}{2} [6 + 2n - 2]$ or $(S_n =) \frac{n}{2} [4 + 2n]$ oe			M1 for correctly substituting 3 and 2 into $(S_n =) \frac{n}{2} [2a + (n-1)d]$
	$\frac{n}{2} [2(3) + (n-1)(2)] = 360$			M1 dep on M2 for equating S_n with 360
	E.g. $2n^2 + 4n - 720 = 0$ or $n^2 + 2n - 360 = 0$ oe Allow $n^2 + 2n = 360$			A1 (dep on M3) writing a correct 3-term quadratic expression in form $ax^2 + bx + c (= 0)$ allow $ax^2 + bx = c$
	E.g. $(x-18)(x+20) (= 0)$ $x = \frac{-2 \pm \sqrt{2^2 - 4 \times 1 \times -360}}{2}$ e.g. $(x+1)^2 - (1)^2 = 360$			M1 (dep on M2) for a complete method to solve their 3-term quadratic equation Allow one sign error and some simplification – allow as far as $\frac{-2 \pm \sqrt{4 + 1440}}{2}$
		18		A1 dep on M3 for 18 only
Total 6 marks				

13	$\frac{100}{2} [2 \times 1 + (100-1) \times 4] (= 19\,900)$ oe or $1 + (41-1) \times 4 (= 161)$ oe or $1 + (100-1) \times 4 (= 397)$ oe		4	M1 for method to find the sum of the first 100 terms or for finding the 41 st term or for finding the 100 th term
	$\frac{40}{2} (2 \times 1 + (40-1) \times 4) (= 3160)$ oe or $\frac{41}{2} (2 \times 1 + (41-1) \times 4) (= 3321)$ oe or $100 - 41 + 1 (= 60)$ oe			M1 for method to find the sum of the first 40 terms or 41 terms or for finding the number of terms from the 41 st term to the 100 th term
	"19 900" – "3160" or $\frac{60}{2} ["161" + "397"]$ or $\frac{60}{2} [2 \times "161" + ("60" - 1) \times 4]$ oe			M1 for finding the difference or for finding the sum from the 41 st term to the 100 th term
		16 740		A1
Total 4 marks				

14	$(S_m =) \frac{m}{2} (2a + (m-1)d) = 39$ oe or $(S_{2m} =) \frac{2m}{2} (2a + (2m-1)d) = 320$ oe		5	M1 one correct equation for S_m or S_{2m} (condone consistent use of n instead of m)
	$(S_m =) \frac{m}{2} (2a + (m-1)d) = 39$ oe and $(S_{2m} =) \frac{2m}{2} (2a + (2m-1)d) = 320$ oe			M1 both equations correct
	eliminate to get $dm^2 = 242$ oe			M1
	$242 = 2 \times 11 \times 11$ or $242 = 2 \times 121$ oe			M1
		$d = 2$ $m = 11$		A1 Dep on M2 Both correct
Total 5 marks				

15	$(S_{20} =) 10[2A + 19 \times 11] = 10170$ oe (where A is the $u_{(k-19)}$ th term)		5	M1
	$A = \left(\frac{10170}{10} - 19 \times 11 \right) \div 2 (= 404)$			M1
	$8 + (P-1)11 = "404"$ oe (where P is the number of terms from 20 to the end)			M1
	$P = \frac{"404" - 8 + 11}{11} (= 37)$			M1
	Working required	56		A1 dep on M1
	ALTERNATIVE METHOD			
	$(S_k =) \frac{k}{2}[2 \times 8 + (k-1)11]$ or $(S_{k-20} =) \frac{(k-20)}{2}[2 \times 8 + (k-21)11]$ or $(u_{k-19} =) 8 + 11(k-20)$ or $(u_k =) 8 + 11(k-1)$ (allow use of letter other than k)		5	M1 for S_k or S_{k-20} or u_k or u_{k-19} a and d must be substituted correctly
	$(S_k =) \frac{k}{2}[2 \times 8 + (k-1)11]$ and $(S_{k-20} =) \frac{(k-20)}{2}[2 \times 8 + (k-21)11]$ or $(u_{k-19} =) 8 + 11(k-20)$ and $(u_k =) 8 + 11(k-1)$			M1 For correct expressions for both S_k and S_{k-20} or u_k and u_{k-19}
	$10170 = \frac{k}{2}["16" + (k-1)11] - \frac{(k-20)}{2}["16" + (k-21)11]$ oe or $10170 = \frac{20}{2}([8 + 11(k-20)] + [8 + 11(k-1)])$ oe			M1
	eg $10170 = 160 + \frac{11}{2}[40k - 420]$ oe eg $440k = 24640$ or $2240 = 40k$ oe			M1 Expanding to obtain a linear equation and collecting terms in k
	Working required	56		A1 dep on M1
				Total 5 marks

16	$2t + 1 + (n-1)3 = 14t - 5$		4	M1 for the use of n th term $= a + (n-1)d$ to find n
	$(n =) 4t - 1$ or $(n =) -1 + 4t$			A1
	$(S_n =) \frac{"4t-1"}{2}[2(2t+1) + ("4t-1"-1)3]$ or $(S_n =) \frac{"4t-1"}{2}[2t+1 + 14t-5]$ oe			M1 for the use of S_n formula (must be in terms of t) Allow their expression for n dep on M1
	Working required	$p = 2$ $q = 4$ $r = 2$		A1 dep on M2 allow $(S_n =) 2(4t-1)^2$ Values of p , q and r must come from correct working
				Total 4 marks

17			2	M1 for $-7n + k$ ($k \neq 45$) or $-7 \times n + k$ ($k \neq 45$) or $n \times -7 + k$ ($k \neq 45$) (k may be zero or absent or negative)
		$45 - 7n$		A1 oe eg $45 - 7 \times n$ oe or $-7 \times n + 45$ oe or $U_n = 45 - 7n$ oe or $38 - 7(n-1)$ oe NB: award full marks for eg $x = 45 - 7n$ oe or n th term $= -7 \times n + 45$ oe or but only M1 for $n = 45 - 7n$ oe
	Correct answer scores full marks (unless from obvious incorrect working)			Total 2 marks

18	$(7p-3)-(8p) = (4p+2)-(7p-3)$ oe or $-p-3 = -3p+5$ oe or $(p =) 4$		5	M1 for using $U_2 - U_1 = U_3 - U_2$ or $U_1 - U_2 = U_2 - U_3$ Condone missing brackets around $7p-3$
	$a = 32$ or $d = -7$ or 32 25 18			A1 dep on M1 (32 and -7 may be embedded in the S_n formula or embedded in U_n formula)
	$\frac{n}{2}[2(32) + (n-1)(-7)] = -1914$			M1 The values of a and d must be correct Condone missing brackets around $n-1$
	$7n^2 - 71n - 3828 (= 0)$ oe			A1 (can be implied by $n = 29$ and/or $n = -\frac{132}{7}$)
	Working required	29		A1 dep on M2
				Total 5 marks

18 ALT	$7p - 3 = 8p + d$ $4p + 2 = 8p + 2d$ $4p + 2 = 7p - 3 + d$	$-3 = p + d$ $2 = 4p + 2d$ $5 = 3p + d$		5	M1 for using $U_n = a + (n-1)d$ to set up 2 equations for U_2 and U_3
	$a = 32$ or $d = -7$ or 32 25 18				A1 dep on M1 (32 and -7 may be embedded in the S_n formula or embedded in U_n formula)
	$\frac{n}{2}[2(32) + (n-1)(-7)] = -1914$				M1 The values of a and d must be correct Condone missing brackets around $n-1$
	$7n^2 - 71n - 3828 (= 0)$ oe				A1 (can be implied by $n = 29$ and/or $n = -\frac{132}{7}$)
	<i>Working required</i>		29		A1 dep on M2
Total 5 marks					

19	$\frac{80}{2}(2a+79d)=470$ oe		6	M1	for substituting into the sum of arithmetic series formula
	$a+74d=14.5$ oe			M1	for substituting into the nth term of arithmetic sequence formula
	correct method to find the value of a or d eg $2a+148d=29$ $2a+79d=11.75$ –			M1	solve the correct equations simultaneously, eg make the coefficients of a or d the same and show the intention to subtract or rearrange one equation to make a or d the subject and substitute into the other equation
	correct values of $a=-4$ and $d=0.25$ oe			A1	dep on M2
	$\frac{X}{2}(2\times"-4"+(X-1)"0.25")=171$ oe			M1	correctly substituting the found values of a and d into a correct equation, can be their values of a and d as long as clearly stated
	<i>Working required</i>	57		A1	dep on M2
Total 6 marks					