Task 1

Answers			Notes	Total
1	a	$A \cap B \cap C$	1 mark ACCEPT $(A \cap B) \cap C$ ACCEPT $(A \cap B) \cap (B \cap C) \cap (C \cap A)$ or similar	**1**
	b	{5, 6}		**1**
	c	•[1] For $A \cap (B \cup C) = \{2, 5, 6\}$ •[2] For $(A \cap B) \cup (A \cap C) = \{2, 5, 6\}$	Correct answers might be seen in part (d) Note: The name of the set must be seen to get the mark. for {2, 5, 6} seen without being named: Award 1 mark for {2, 5, 6} seen twice but without any name: Award 1 mark	**2**
	d	They are the same (or equal)	ACCEPT: It illustrates the distributive law (for sets, for ∩ over U) *or* $A \cap (B \cup C) = A \cap B) \cup (A \cap C)$ ACCEPT "both contain 2,5,6 WTTE, ECF from (c) for example {2, 5, 6} and {2, 5, 7} and response in (d) - "2 and 5 are in both sets" or similar	**1**
	e	•[1] {1, 2, 5, 6} Alternative method using set algebra •[1] simplifies eg $A \cap (B \cup B')$ using rule from b) •[2] (It is the same as) A.	1 mark for set Do not ACCEPT partial answers for •[1] eg {2, 5, } U {1, 6} •[2] WTTE.	**2**

Answers			Notes	Total
2	a	•[1] (The medians) 57 and 52 seen	•[1] Is for mathematical observation for example: (Median Q2 medicine =) 57 (Median Q2 physics =) 52 •[1] for both values seen and no comment award 1 mark •[1] ACCEPT 5 seen for 1 mark	
		•[2] This means the average age of medicine is older/bigger than physics WTTE	•[1] and •[2] "in general medicine is older by 5 years" WTTE award 2 marks	
		•[3] (The interquartile ranges) 20 and 15	•[3] Is for mathematical observation for example: (IQR for medicine 67-47=) 20 (IQR for physics 62-47 =) 15 •[3] award for both values seen and no comment, accept differences 67-47; 62-47 •[3] DO NOT ACCEPT 'IQR is between 47 and 67' or WTTE •[3] DO NOT ACCEPT 'the majority is between 47 and 67' or WTTE •[3] must refer to IQR not range in general	**4**
		•[4] This means the winners in physics are more close/less spread in age. This comment must refer to spread.	•[4] Do not accept "less skewed" •[4] ACCEPT 50% (in this range)	
	b	•[1] 155 seen		
		•[2] $\frac{\text{their } 155}{210}$	•[2] **OE** for example 0.7 **OR** 0.738 **OR** 0.74 **OR** 73.8 % **OR** 74 % **OR** better:	**2**
	c	•[1] 11 seen	•[1] 11 can be seen anywhere in *their* working	
		•[2] $\frac{11}{\text{their } 155}$	•[2] **OE** for example 0.071 **OR** 0.07 **OR** 7.1 % **OR** 7% **OR** better:	**2**

Answers			Notes	Total
2	d	•[1] Applying the 20% to 210 •[2] Read off the graph the corresponding age	•[1] $\frac{20}{100}\times 210$ **OR** 42 **OR** $\frac{80}{100}\times 210$ **OR** 168	**2**

		Answers	Notes	Total
3	a	Step a: 14,3 . Step c: 5,7, 3 •[1] All step a correct •[2] All step c correct	 •[1] 14, 3 •[2] their 5, 7, their 3 Allow ECF for from their step a	**2**
	b	 •[1] Correct sum of their numbers •[2] Not divisible by 10 *or* Not a multiple of 10	 •[1] their 83 •[2] Accept 'must be a multiple of 10' Sum their values correctly to a number divisible by 10 and saying it is valid because sum is divisible by 10 award •[1] only	**2**
	c	•[1] (61 + X =) 70 •[2] (X =) 9	 9 seen no working: Award 2 marks	**2**

Answers			Notes	Total
3	d	•[1] Instruction F correct •[2] Instruction G correct •[3] Instruction H correct	•[1] (If the doubled digit is a two-digit number) add the two digits together Accept "add the two numbers together" **OR** WTTE •[2] Add the numbers Accept "plus" the numbers **OR** "sum" the numbers **OR** WTTE •[3] If the sum is divisible by 10 then it is valid **OR** if the sum is not divisible by 10 then not valid **OR** check if (make sure) the number is divisible by 10 **OR** WTTE The instruction has to be in the correct place to award the mark **SC:** Step G adding **and** if sum divisible by 10 valid. Step H adding **and** if sum not divisible by 10 invalid Award only 1 mark for •[2] and •[3] .Award •[1] as appropriate **SC:** Step G adding **and** if sum divisible by 10 valid Step H if the sum not divisible by 10 invalid Award 2 marks for •[2] and •[3] .Award •[1] as appropriate	**3**

Answers			Notes	Total
4	a	•[1] $2f(x-2)=6$ •[2] $f(x-2)=3$ •[3] $x-2=6$ **OR** $f(6)=3$ •[4] $x=8$	Marks awarded for •[1] first algebra step, number to other side •[2] second algebra step, divide by 2 •[3] refers back to table •[4] algebra step	**4**
	b	•[1] 0 •[2] 2		**2**
	c	•[1] f(g(0)) = f(g(4)) (= -4) •[2] The inverse function of -4 has two different values	•[1] May be implied Accept for 2 marks • 0 and 4 both go to -4 • f(g(*x*)) is not a one to one function • f(g(*x*)) is a two or many – one function • Horizontal line test for f(g(x)) gives two values • Vertical line test for the inverse of f(g(*x*)) gives two values • The inverse function has two different values for the same value • for a single value of x there are two values of y • f(g(x)) has several values in x for the same value in y, so the reciprocal/inverse will have several values in y for the same value in x Accept for 1 mark The inverse function has two different values	**2**

Task 2

Answers			Notes	Total
5	a	(BCA) = 57		**1**
	b	**Alternative method 1** •1 Use of sine rule •2 $\frac{100}{\sin(\textit{their}\ 57)} = \frac{R}{\sin 3}$ •3 Attempt to solve for R •4 (R=) 6.240347…. (m) 6.24 AG Note: Some candidates notice that ABE is a 30,60,90 triangle and can write down without working that BE is 50 and AE is 50√3 **Alternative method 2** •1 $\sin 30 = \frac{BE}{100}$ **OR** $\cos 30 = \frac{AE}{100}$ •2 $\tan 33 = \frac{\textit{their}\ BE + R}{\textit{their}\ AE}$ •3 $\tan 33 = \frac{\text{correct } BE + R}{\text{correct } AE}$ •4 (R=) 6.2403478…(m) 6.24 AG BE = 50 AE = 86.6025… AC = 103.26… EC=56.2403 **Alternative method 3** •1 $\cos 30 = \frac{AE}{100}$ •2 $\cos 33 = \frac{\textit{their} AE}{AC}$ •3 *their* $03.3^2 = (50\sqrt{3})^2 + EC^2$ **and** EC = 56.2403478… •4 (R=) 6.2403478…(m) AG 6.24m	**Alternative method 1** •1 1 mark for use of sine rule •2 1 mark for correct substitution in sine rule •3 1 mark for attempt to solve (do not have to see this step) •4 1 mark for showing the answer before approximations **Alternative method 2** •1 1 mark for using correctly sin or cos •2 1 mark for using tan •3 1 mark for correct values used with tan •4 1 mark for showing the answer before approximation (may be seen as 56.24034.. earlier) **Alternative method 3** •1 1 mark for finding AE, cos30 = AE/100 **OR** by inspection $50\sqrt{3}$ •2 1 mark for finding AC = 103.3 •3 1 mark for correct values in Pythagoras **and** find EC •4 1 mark for showing the answer before approximation (may be seen as 56.24034.. earlier)	**4**

Marks			Notes	Total
5	b	**Alternative method 4** •3 Sin 33° = EC/their AC **and** their EC •4 (R=) 6.2403478…(m) AG 6.24 m **Alternative method 5** Cos rule •3 $R = \sqrt{100^2 + 103.26^2 - (2x100x103.26 \times \cos 3°)}$ •4 (R=) 6.2403478…(m)	**Alternaive method 4** •3 1 mark for their values in SOH **and** find EC •4 1 mark for showing the answer before approximation (may be seen as 56.24034.. earlier) **Alternative method 5** •3 1 mark for correct substitution in cosine rule •4 1 mark for showing the answer before approximation	
	c	•1 Substituting 6.24 correctly into volume formula •2 Volume calculated correctly using *their* radius •3 Their value correctly approximated to nearest m^3	•1 $\frac{4}{3}\pi(6.24)^3$ Accept: 4/3*π6.24^3 •2 *their*1017.7529..(using π) **OR** *their*1017.237.. (using 3.14) **OR** 323.96π **OE** •3 1018 (m^3) **OR** 1017 (m^3)	**3**

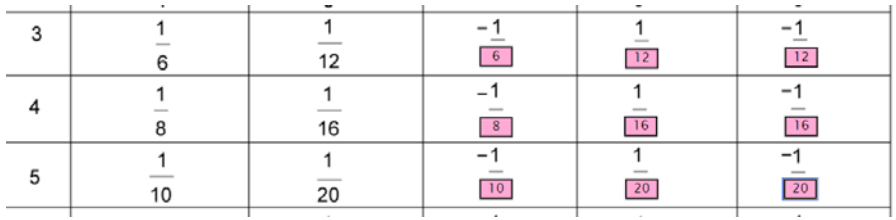
Answers			Notes	Total
5	d	•[1] A valid mathematical reason •[2] Another valid reason (mathematical or not)	Mathematical reasons: (i) Referring to rounding of measurements **OR** calculations (ii) Referring to inner and outer diameter **OR** thickness of sphere Examples of real-life reasons: (i) Referring to shape not a perfect sphere (ii) Referring to the sphere is not totally filled with water (regardless of the reason) (iii) Expansion of water DO NOT ACCEPT the vertical/pipes post may include water as well DO NOT ACCEPT referring to errors in measurements given Do NOT ACCEPT "because maybe I made mistakes"	**2**

5	e		**Marks**	**1**	**2**	
			(H) Calculate total water consumption for the households in the community	Two attempts from any of the calculations below: Dividing 300000 by 4 to find the number of households 300 000/4 (= 75 000) households **OR** Multiplying their 366 by their 75000 to find the amount of water consumed per day by households their366 * their 75000 (= 27 450 000) litres per day **OR** Dividing their 366 by 24 to find the amount of water in litres per hour for each household their366/24(=15.25) l/h **OR** Calculating how many litres for every household during the 4 hours outage time **OR** Acceptable estimation for the amount of water used by household per hour (between 1100 000 and 1200000) without calculations	Calculate correctly the amount of water used by households per hour: (27 450 000/24 =) 1 143 750 litres per hour **OR** (15.25*75000=)1143750 litres per hour	**10**
			(L) Calculate total water consumption for individuals in the community	**One** attempt from the calculations below: Multiplying 300000 by their 51 to find the amount of water consumed per day by the individuals Ex: $300\,000 \times \textit{their}\,51\ (=15\,300\,000)$ litres per day **OR** Dividing by 24 to find amount of water consumed per individual per hour *Their* 51/24(=2.125) l/h **OR** Calculating how much litres for every individual during the 4 hours outage time **OR** Acceptable estimation for the amount of water used by individuals per hour (between 630000 and 650000 l/h) without calculations	Calculate correctly the amount of water used by individuals per hour: Ex: (15300000/24=)637500 litres per hour **OR** (2.125*300000=)637500 litres per hour	

5	e			
		Marks	**1**	**2**
		(T) Estimate amount of time before the water runs out	Attempt to calculate estimate for time: Household $\frac{950\ 000}{their\ 1\,143\ 750}(\approx 0.830.....\text{hrs} \approx 50\ \text{mins})$ **OR** Individual $\frac{950\ 000}{their\ 637\ 500}(\approx 1.49.....\text{hrs} \cong 89\ \text{mins})$ **OR** attempt for household and individuals but wrong result $\frac{950\ 000}{their\ 1\,143\ 750 + their\ 637\ 500}(\approx not\ 0.5)$	Calculating their estimate combining both household and individual information correctly $(\frac{950\ 000}{their\ 1\,143\ 750 + their\ 637\ 500}) \approx 0.5(33.....)\text{hrs} \approx 30\ to\ 35\ \text{mins}$
		(A) Advice for the community	Advice related to minimizing the use in general **OR** Advise related to minimize/stop one specific activity	Advice requesting clearly to stop/reduce at least two of the following activities that consume too much water: Showers, wash dishes, washing clothes, or garden watering
		(J) Justification of degree if accuracy	Weak justification not supported Examples: This is just an estimate **OR** We never know for sure the actual amount **OR** This is just an average **OR** Correct and sensible rounding for their value(s) of time Example 30 min or 0.5 hours **Do not accept**: "my time is very accurate because I made the correct calculations"	Good justification supported Examples: Comment that the time calculated is if all population do not respond to advice and that the estimate of time can be more if they respond to advice **OR** Calculate time if they respond to advice **OR** the number of persons per household is an average so not accurate **OR** Referring to fact that during the specific 4 hours of outage not all activities considered in calculations are actually performed
		ATTENTION: Seeing the total consumption for households and individuals (1 143 750 + 637500 =) 1781250 l/h allows the award of H2 and L2		

Notes **Ignore incorrect units** **Apply ECF in E and J**			**Total 10 marks**	
6		**Marks**	**1**	**2**
	C	Calculates the area of the **C**ircle	$\pi \times 10^2$ method/formula eg finds area of circle. Seen or implied at T	
	T	Calculation for the equilateral **T**riangle	$\frac{1}{6}$ of circle seen **OR** $3 \times \frac{1}{6}$ of circle seen **OR** $\frac{1}{2}$ of circle seen	Their area of three sectors (50π) **OR** their157(.0796327)
	A	Correct **A**rea for the triangle without a signal	$173 - 50\pi$, accept their 50π, sets up subtraction **OR** 15.9(…) **OR** 16 **OR** answer to 173 - their 157(.0796327)	
	S	Calculation for the **S**quare without a signal	Implies that full circle inside the square **OR** $4 \times \frac{1}{4}$ of circle seen **OR** 100π	$400 - \pi \times 10^2$ sets up subtraction **OR** 85.8(…) **OR** 86
	E	Comparison of the **E**fficiency of the two ways the transmitters have been positioned	Triangle is smaller in area than the square **OR** Triangle has a smaller area without signal than the square (Their 85.8 – their 15.9)	Triangle is smaller in area than the square **AND** Triangle has a smaller area without signal than the square (Their 85.8 – their 15.9)
	J	**J**ustification of the most efficient layout	One numerical statement/comparison from eg • Triangle has 9.2% not covered • Square has 21.45% not covered • Double the triangle to 346 and its 31.86 not covered • Doubling the triangle shows that there is a lot smaller area not covered than the square	Two numerical statement/comparison from eg • Triangle has 9.2% not covered • Square has 21.45% not covered • Double the triangle to 346 and its 31.86 not covered • Doubling the triangle shows that there is a lot smaller area not covered than the square

Task 3

		Answers	Notes	Total
7	a	•1 Any three correct: award 1 mark •2 All correct		**2**
	b	$y_C = -\frac{1}{4k}$		**1**
	c	•1 Completing the pattern for another value not in the table k≥ 6 adding 4 to denominator (20+4=24 seen) •2 Calculating $y_c = -\frac{1}{4(6)} = -\frac{1}{24}$ •3 Comment that they are equal	Award 1 mark for testing a value from the table k ≤ 5 but only if the three verify steps are seen • value from the table • calculate from the rule • say they are the same/values are correct.	**3**
	d	**Alternative method 1** •1 $\frac{y_A - y_C}{x_A - x_C} = 1$ **and** $\frac{y_A - y_C}{\frac{1}{2k} - 0} = 1$ •2 $\frac{k(x_A)^2 - y_C}{\frac{1}{2k} - 0} = 1$ **OR** $\frac{k\left(\frac{1}{2k}\right)^2 - y_C}{\frac{1}{2k} - 0} = 1$ •3 $k(x_A)^2 - y_C = \frac{1}{2k}$ **OR** $k\left(\frac{1}{2k}\right)^2 - y_C = \frac{1}{2k}$ $y_C = -\frac{1}{4k}$ AG	•1 Gradient formula = 1 and correct substitution for x_A •2 Correctly substitutes $y_A = k(x_A)^2$ or $y_A = k\left(\frac{1}{2k}\right)^2$ •3 further working to $y_C = -\frac{1}{4k}$ $y_C = -\frac{1}{4k}$ is seen at part b) and here it is the same as AG	**3**

Answers			Notes	Total
7	d	**Alternative method 2** •1 $\dfrac{k\left(x_A\right)^2 - y_C}{\dfrac{1}{2k} - 0} = 1$ •2 $k\left(x_A\right)^2 - y_C = \dfrac{1}{2k}$ •3 $k\left(\dfrac{1}{2k}\right)^2 - y_C = \dfrac{1}{2k}$ $-y_C = \dfrac{1}{2k} - k\left(\dfrac{1}{2k}\right)^2$ $-\dfrac{1}{4k} = y_C$ AG	•1 Gradient formula = 1 and correct substitution for x_A and $y_A = k\left(x_A\right)^2$ •2 Cross multiplies correctly •3 Substitutes $k\left(\dfrac{1}{2k}\right)^2$ for $k\left(x_A\right)^2$ and further working to $y_C = -\dfrac{1}{4k}$ $y_C = -\dfrac{1}{4k}$ is seen at part b) and here it is the same as AG **SC** Award 2 mark for a "proof" similar to example below. It is based on $y_A = -y_C$ which has been found by inspection. $\dfrac{y_A - y_C}{x_A - x_C} = 1$ $\dfrac{-y_C - y_C}{\dfrac{1}{2k} - 0} = 1$ $-2y_C = \dfrac{1}{2k}$ $-\dfrac{1}{4k} = y_C$	

Answers			Notes	Total
7	e	x_c has the same value as p	$x_c = p$	1
	f	**Alternative method 1** •1 The denominators of y_c are always 8 •2 The numerator of y_c goes up by 8 **Alternative method 2** •1 It is an arithmetic progression •2 The common difference is 1	ACCEPT: The values of y_c go up by 1 : award 2 marks	**2**
	g	•1 The rule can be obtained by substituting $k = 2$ into $-1/4k$ and then testing/trial and error **OR** by inspection 0 -1/8; 1 - 1/8 etc •2 $y_c = \frac{8q-1}{8}$ **OR** $y_c = q - \frac{1}{8}$ **OR** If no working seen award 1 for each part	•1 for suitable working •2 working can be implied by a correct answer.	**2**

7	h	**Mark**	**Predictions** **P**	**Description** **D**	**Testing** **T**	**Verifying** **V**	**Justify/proof** **J**	**Notation and terminology** **N**	**Communication** **C**	**22**
		1	Attempted to make predictions	Attempted to describe a pattern	Attempted to test their described pattern **OR** general rule	Attempted to verify their described pattern or general rule	Attempted to justify their described pattern **OR** general rule	The notation **OR** terminology are not always correct	No communication. Only calculations or algebraic steps	
		2	Correctly predicted one term	Correctly described one pattern **OR** a simple pattern	Tested correctly their described pattern	Verified correctly their described pattern **OR** general rule	Justified their general rule correctly	The notation and terminology are correct **Award only if D3 is awarded**	Some coherent communication	
		3	Correctly predicted more than one term Accept predictions with $p = 0$ **OR** $q = 0$	Correctly described more than one pattern **OR** one complex pattern	Uses a correct general rule to generate a value given in the table **Award only if D5 is awarded**		Attempted to prove their general rule		Good coherent communication **Award only if J2 is achieved**	
		4		Attempted to describe pattern as general rule			Correctly proved their general rule			
		5		Correctly described pattern as general rule						

Exemplification

-Prediction: Makes entries in the table. Accept predictions with $p = 0$ or $q = 0$

-Description of the pattern: $x_c = p$

y_c denominator multiple of 4 ($4k$), numerator $4kq$ -1 $y_c \uparrow q$

-General rule : $x_c = p$ **and** $y_c = -1/4k + q$ **OR** $y_C = \frac{-1+4kq}{4k}$ **OR** $y_C = q - \frac{1}{4k}$

- Testing the rule using values given in the table

Ex. k =2 , p = 2 , q =1 $x_c = 2$ $y_c = 7/8$ $\Rightarrow$ $x_c = p = 2$ and this agrees with table $y_C = q - \frac{1}{4k}$ $y_C = 1 - \frac{1}{4(2)} = \frac{7}{8}$ and same as the table

- Verifying the rule by one value not given in the table

Ex. k = 4, p = 2, q =1, $x_c = 2$ $y_c = 15/16$ $\Rightarrow$ $x_c = p = 2$ and this agrees my table $y_C = q - \frac{1}{4k}$ $y_C = 1 - \frac{1}{4(4)} = \frac{15}{16}$ and this agrees with the table

- Proving

C(0, y_c) where $y_c = -1/4k$ so C(0, $-1/4k$)

After (p, q) is applied $\Rightarrow$ C become C(0 + p, $-1/4k + q$)

So $x_c = p$ **and** $y_c = -1/k + q$ **OR** $y_C = \frac{-1+4kq}{4k}$