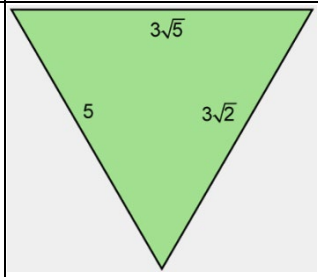
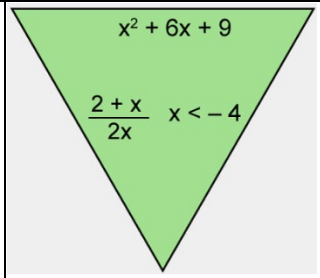
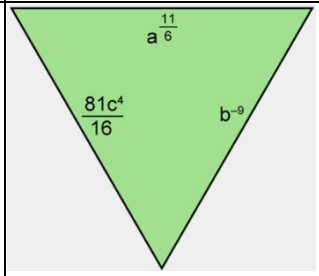
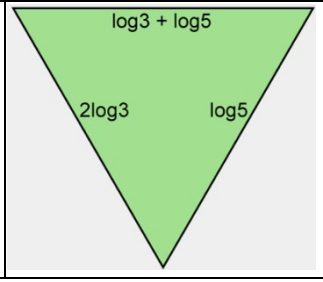
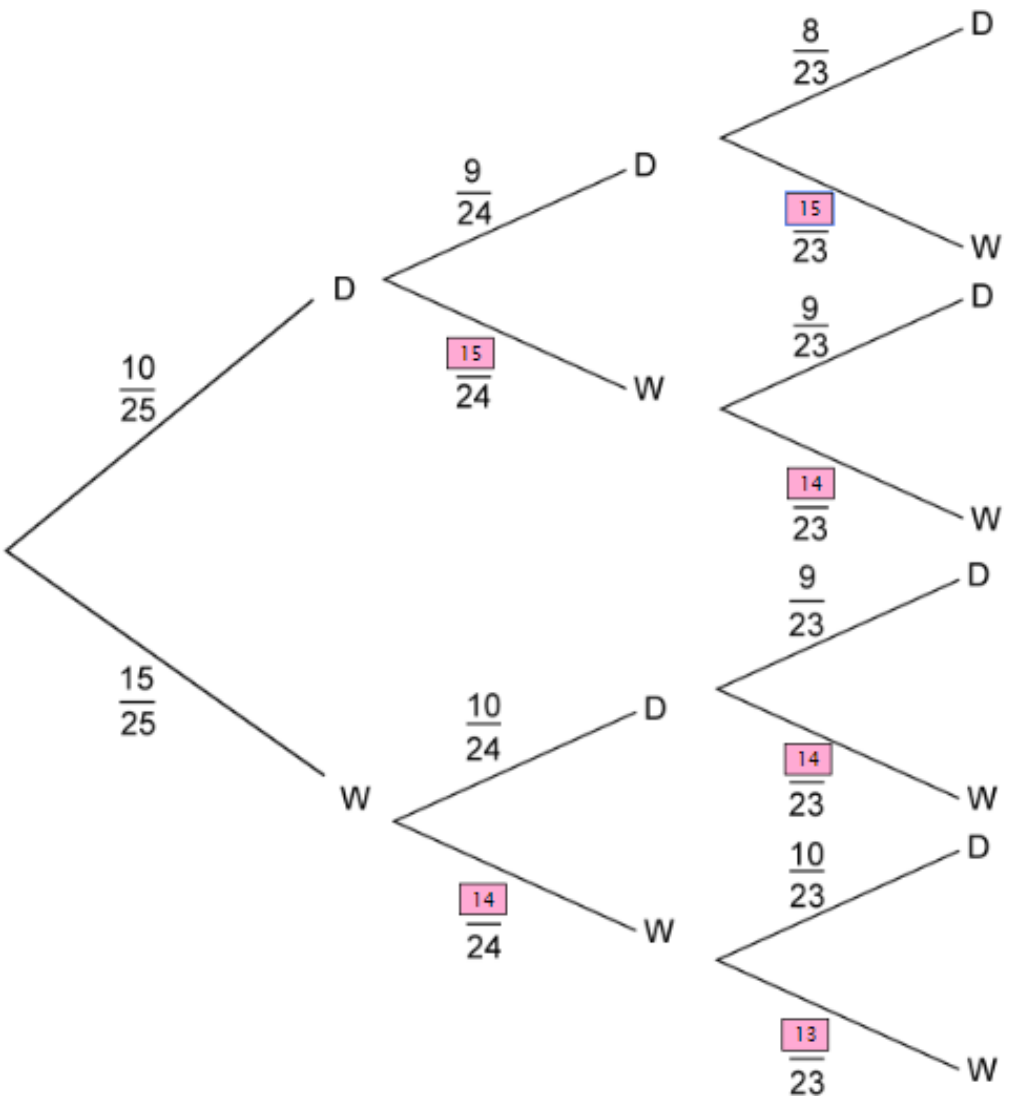
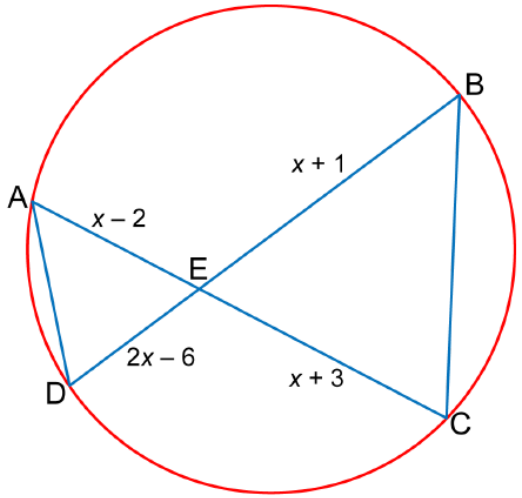
Q1		Answers	Notes	Total
	a	Place the correct triangle		**1**
	b	Place the correct triangle		**1**
	c	Place the correct triangle		**1**
	d	Place the correct triangle		**1**

Q2		Answers	Notes	Total
	a	.1 Three correct numerators .2 All correct numerators		**2**

	b	.1 One correct product of three probabilities (DDW or DWD or WDD) .2 The other two correct products of three probabilities OR 3 × their .1 .3 Correctly add their three probabilities OR their correct probability after multiplying by 3	.1 $\frac{10}{25}\times\frac{9}{24}\times\text{their}\frac{15}{23}$ OR $\frac{10}{25}\times\text{their}\frac{15}{24}\times\frac{9}{23}$ OR $\frac{15}{25}\times\frac{10}{24}\times\frac{9}{23}$ OR $\frac{9}{92}$ OR 0.0978(3…) ACCEPT 0.098 or 0.1 .2 $\frac{10}{25}\times\frac{9}{24}\times\text{their}\frac{15}{23}$ AND $\frac{10}{25}\times\text{their}\frac{15}{24}\times\frac{9}{23}$ AND $\frac{15}{25}\times\frac{10}{24}\times\frac{9}{23}$ OR $3\times\text{their}\frac{9}{92}$ OR $3\times0.0978(3...)$ .3 their $\frac{27}{92}$ or 0.29(3478…) OE ACCEPT 27/92 .3 DO NOT ACCEPT if they add more than three .3 ONLY ACCEPT if their probability is less than 1	**3**
	c	.1 Correctly substitute P(A ∩ B) and their part b) into the correct conditional probability formula .2 Correctly determine their P(A|B)	.1 $\frac{\frac{15}{25}\times\frac{10}{24}\times\frac{9}{23}}{\text{their part b)}}$ or $\frac{0.0978(260...)}{0.29(3478...)}$ or $\frac{\frac{9}{92}}{\text{their part b)}}$ or $\frac{0.0978(260...)}{\text{their part b)}}$ ACCEPT $\frac{0.1}{\text{their part b)}}$ .1 DO NOT ACCEPT P(AnB) being P(A) × theirP(B) .2 their $\frac{1}{3}$ .2 ACCEPT only if their $\frac{1}{3}$ is less than 1	**2**
	d	.1 Correctly multiply P(A) and their P(B) from part b) .2 Correctly state their .1 does not equal P (A ∩ B) Event A and B are not independent AG	.1 ($\frac{15}{25}\times\text{their}\frac{27}{92}=$) their $\frac{81}{460}$ or their 0.176(08695...) ACCEPT 0.18 .1 DO NOT ACCEPT if they don't have a calculated product .2 Their .1 does not equal to their $\frac{9}{92}$ WTTE .2 DO NOT ACCEPT if they don't have a calculated product from .1 DO NOT ACCEPT any explanation about independency of events even though it seems correct	**2**

Q3		Answers	Notes	Total
	a	**AM1** .1 Recognize a first pair of congruent angles (with or without reason) .2 Recognize a second pair of congruent angles (with or without reason) **AM2** .1 Correctly apply chords inside circle theorem to recognize that sides are in the same proportion. .2 Recognize vertically opposite angles  	**AM1** .1 One from the list of possibilities .2 Another from the list of possibilities List of possibilities : - inscribed angles subtended by the same arc ∠ADE=∠BCE or ∠DAE=∠CBE - the vertically opposite angles ∠AED=∠BEC **AM2** .1 $\overline{BE}\times\overline{ED}=\overline{AE}\times\overline{EC}$ OE AND $\frac{\overline{BE}}{\overline{EC}}=\frac{\overline{AE}}{\overline{ED}}$ or $\frac{\overline{BE}}{\overline{AE}}=\frac{\overline{CE}}{\overline{DE}}$ OE .2 ∠AED=∠BEC ACCEPT correct angles using different labels CAD or A for ∠EAD DAC or A for ∠DAE DBC or B for ∠EBC CBD or B for ∠CBE ACB or C for ∠ECB BCA or C for ∠BCE ADB or D for ∠ADE BDA or D for ∠EDA ACCEPT saying equal WTTE ex: congruent, the same, etc DO NOT ACCEPT E for any angle around E DO NOT ACCEPT ∠E = ∠E or lines create two congruent angles at E DO NOT ACCEPT AC and BD are chords on the circumference DO NOT ACCEPT AED similar to BEC	**2**

	b	.1 Correctly apply the similarity	.1 $\frac{2x-6}{x+3}=\frac{x-2}{x+1}$ OE or $\frac{x+1}{x+3}=\frac{x-2}{2x-6}$ OE ACCEPT $\frac{DE}{CE}=\frac{AE}{BE}$ OE or $\frac{DE}{AE}=\frac{CE}{BE}$ OE .1 ACCEPT without brackets written as 2x-6 / x+3 = x-2/x+1 OE .1 ACCEPT (x-2):(x+1) = (2x-6):(x+3) OE or (x-2):(2x-6)=(x+1):(x+3) OE .1 DO NOT ACCEPT using ratio 0.5 or 2. Ex: (x+3)=2(2x-6)	
		.2 Correctly cross multiply their ratios	.2 their(2x−6)(x+1)=their(x−2)(x+3) OR their$2x^2$-4x-6=x^2+x-6 .2 Accept not seeing this step .2 DO NOT ACCEPT incorrect cross multiplication without seeing their ratios Seeing (2x-6)(x+1)=(x-2)(x+3) implies .1	
		.3 Correctly rearrange their correct quadratic	.3 (0=) their x^2-5x or their $(0=)-x^2+5x$ OR $x^2=5x$	
		.4 Correctly factorize x^2-5x OE OR substitute the correct coefficients into the quadratic formula OR divide by x. (x =) 5 AG	.4 $(0=)x(x-5)$ OE OR $\frac{5\pm\sqrt{(-5)^2-4(1)(0)}}{2(1)}$ OE OR $\frac{-5\pm\sqrt{(5)^2-4(-1)(0)}}{2(-1)}$ OE OR from $x^2=5x$ to $x=5$ .4 ACCEPT seeing $x=0$ AND 5 (x=) 5 AG **For 4 marks .1.3.4 or .2.3.4 must be seen**	**4**

	c	.1 Correctly substitute using x=5 into cosine rule .2 Correctly calculate their BC^2 after substituting into cosine rule .3 Correctly calculate their BC from their BC^2 .4 Their correct values of m and n	.1 $(BC^2 =)6^2 + 8^2 - 2 \times 6 \times 8 \times \cos 60$ OE .2 (BC=) their 52 .3 their $\sqrt{52}$ ACCEPT decimals their 7.2(111) .3 Seeing $\sqrt{52}$ or 7.2(111) implies .2 .4 m=2 and n = 13 ACCEPT seeing $2\sqrt{13}$ .4 ACCEPT m=1 and n=their52 only if their52 is an integer .4 ACCEPT their correct m and n from their 52	**4**
	d	.1 Correct ratio .2 Correctly apply their ratio to their $2\sqrt{13}$ to find AD .3 Their perimeter correct after adding 21 to their $2\sqrt{13}$ and their $\sqrt{13}$ in surd form	.1 0.5 or 2 OE seen .1 ACCEPT seeing $2 \times$ their $2\sqrt{13}$ .2 their $\sqrt{13}$ .2 implies .1 .2 ACCEPT in decimals i.e. their3.6(0555…) .2 DO NOT ACCEPT if theirAD = theirBC .3 21 + their $3\sqrt{13}$ .3 DO NOT ACCEPT decimals .3 DO NOT ACCEPT if answer does not include surd .3 DO NOT ACCEPT the use of “root” in words. .3 DO NOT ACCEPT a perimeter that does not include theirAD	**3**

Q4		Answers	Notes	Total
	a	**AM1 (Using slant height)** .1 Correctly substitute into Pythagoras OR correctly substitute into correct trig ratio OR correctly use area of triangle formula to find slant height .2 Correct value for slant height .3 Correctly substitute their .2 into Pythagoras to find h .4 Correct value of h before simplifying $12\sqrt{2}$ AG **AM2 (Using square base)** .1 Correctly substitute into Pythagoras OR correctly use trig ratio to find diagonal of the base or half diagonal of the base .2 Correct value for diagonal of the base or half diagonal of the base .3 Correctly substitute half of base into Pythagoras to find h .4 Correct value of h before simplifying $12\sqrt{2}$ AG	**AM1** .1 $\sqrt{24^2-12^2}$ OR 12 x tan60 OE OR $(\frac{1}{2}\times 24\times 24\times \sin 60)\div 12$ OE ACCEPT $24^2=12^2+L^2$ OE or $(h^2=)24^2-12^2$ .2 $\sqrt{432}$ or $12\sqrt{3}$ or 20.78(4609…) OE .3 $\sqrt{(\text{their}\sqrt{432})^2-12^2}$ or $\sqrt{\text{their}(12\sqrt{3})^2-12^2}$ or $h^2+12^2=\text{their}432$ OE or their $20.78(4609)^2-12^2$ OE .4 $\sqrt{288}$ .4 ACCEPT 16.97 AND $12\sqrt{2}$ =16.97 **AM2** .1 $\sqrt{24^2+24^2}$ OE OR $\frac{24}{\sin 45}$ OE ACCEPT 24^2+24^2 or 12^2+12^2 OE .2 $\sqrt{1152}$ or $24\sqrt{2}$ or 33.9(4111) OE .2 ACCEPT 16.97 or $12\sqrt{2}$ .3 $\sqrt{24^2-(12\sqrt{2})^2}$ OE or $h^2+(12\sqrt{2})^2=24^2$ OE .3 ACCEPT in decimals .3 DO NOT ACCEPT trig ratio using angle 45 .4 $\sqrt{288}$ .4 ACCEPT 16.97 AND $12\sqrt{2}$ =16.97 .4 ACCEPT only if .2 and .3 are awarded Reaching $\sqrt{288}$ coming from half of 576, **award 0 marks** **See notes on next page**	**4**

			Seeing pyramid made with equilateral triangles so height is half of side $\sqrt{2}$, **award 0 marks** Calculating the height using the volume of part b, **award 0 marks.**	
	b	.1 Correctly substitute $12\sqrt{2}$ and 24 into volume of pyramid formula .2 Correctly calculate their result after substituting into their volume formula .3 Correctly rounded their volume to the nearest integer	.1 $\frac{1}{3}\times 24\times 24\times 12\sqrt{2}$ ACCEPT $\frac{1}{3}\times 24\times 24\times 16.97$ .1 ACCEPT $\frac{1}{3}\times 576\times 12\sqrt{2}$ .2 their3258.34(80…) .2 ACCEPT incorrect volume formula providing it includes $24\times 24\times 12\sqrt{2}$ .2 DO NOT ACCEPT their result if it comes from $\frac{1}{3}\times \text{length}\times 12\sqrt{2}$ .3 their3258	**3**
	c	.1 Correctly calculate the modified ratio for the height .2 The correct value of h	.1 $\sqrt[3]{0.75}$ or 0.9(0856…) OE seen ACCEPT $\frac{1}{\sqrt[3]{0.75}}$ or 1.1 (the inverse ratio) ACCEPT $0.75=(\frac{h}{12\sqrt{2}})^3$ OE .2 ($\sqrt[3]{0.75}\times 12\sqrt{2}$ =)15.4(187...)	**2**

Q5		Answers	Notes	Total
	a	Correct result	$(0.16 \times 4500 =) 720 (t)$	**1**
	b	.1 Correct ratio .2 Correctly apply <u>the correct</u> ratio on their720	.1 $\frac{3}{8}$ (=0.375) OE or $\frac{8}{3}$ or 3:8 or 8:3 OE or seen within calculations Ex: $\frac{\text{their}720}{2.67}$ OE .1 ACCEPT seeing $\frac{3}{8}$ as 0.4 or $\frac{8}{3}$ as 2.6 or 2.7 in bp1 only .1 DO NOT ACCEPT 3×8 as ratio or seen within calculations .2 $(\frac{3}{8} \times \text{their}\,720$ or $\text{their}720 \div \frac{8}{3} =) \text{their}\,270$	**2**

<table>
<tr>
<td></td>
<td>c</td>
<td>.1 Correctly write two values

.2 Correctly write a third values

.3 Correctly write a fourth value

.4 Correctly write fifth and sixth values</td>
<td>
<table>
<tr><th colspan="2"></th><th>Weight, tonnes (t)</th><th>Production ratio Energy per tonne (TJ / t)</th><th>Energy Tera-joules (TJ)</th></tr>
<tr><td rowspan="3">Category</td><td>Domestic</td><td>1350</td><td>r = 0.1 or 1/10 or 1:10 or “1 to 10”</td><td>135</td></tr>
<tr><td>Commercial</td><td>Answer from (a)
their 720</td><td>r = their 0.1 (above)</td><td>(0.1 × their720=) their72</td></tr>
<tr><td>Industrial</td><td>Answer from (b)
their 270</td><td>2r = (2 × their 0.1 =) their 0.2 OE</td><td>(0.2 × their270=) their54</td></tr>
</table>
Total energy produced by the organization this months (135 + their72 + their54=) their261

Answers from (a) and (b) are not counted as one of the six values
<u>The six values are:</u>
r domestic=0.1 OE ACCEPT 1/10 or “1:10” or “1 to 10” OE
r commercial= their r for domestic
2r=(2xtheir r domestic=)their0.2 ACCEPT their2/10 or their “2:10” or their“2 to 10” OE

Energy commercial=(0.1 × their720=) their72
Energy industrial=(0.2 × their270=) their54
Total Energy=(135+their72+their54=) their261

ACCEPT Energy Commercial 72 or Energy industrial 54 regardless their r value
</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>d</td>
<td>.1 Correct mid-interval values

.2 Add the product of their mid-interval values by frequency

.3 Divide their sum by 12

.4 Correct mean before rounding AG 900</td>
<td>.1 860, 880, 900,920, 940 ACCEPT seeing only three correct

.2 $2\times\text{their}860+4\times\text{their}880+2\times\text{their}900+1\times\text{their}920+3\times\text{their}940$ OE or 10780

.2 ACCEPT seeing only three correct products OE added

.3 Ex: $\frac{\text{their bp2}}{2+4+2+1+3}$

.4 898(.333…)</td>
<td>4</td>
</tr>
</table>

	e	.1 Correct ratio seen <u>in any notation</u>	.1 "if 68420 is 900 then their261 is" WTTE or 68420:900 or $\frac{68420}{900}$ OE $(=\frac{3421}{45}=76.022...)$ ACCEPT 76 .1 ACCEPT 900:68420 or $\frac{900}{68420}$ OE $(=\frac{45}{3421}=0.013(154...))$	
		.2 Correctly apply <u>the correct</u> ratio on their total energy from c)	.2 $\frac{68420}{900}\text{OE}\times\text{their261}$ or $\text{their261}\div\frac{900}{68420}\text{OE}$ or their19841.8 .2 ACCEPT using 76 instead $\frac{68420}{900}$ or using 0.013 instead of $\frac{900}{68420}$	**3**
		.3 Correctly write their result as an integer	.3 their 19842 .3 ACCEPT their rounding being up or down .3 ACCEPT only if .1 or .2 is awarded	

Q6		Answers	Notes	Total
	a	.1 Correctly substitute (0,120) into the equation .2 Correct value of *a* as a product after the substitution of (0,120) *a* = 330 AG	.1 $120 = \frac{a}{(0+6)} + 65$ or $120 = \frac{a}{6} + 65$ ACCEPT substitution of other points (*n*,*E*) from the graph in .1 Accepted points (*n*,*E*) from the graph: (0,120), (1,112), (2,106), (3,102), (4,98), (5,95), (6, 93), (7,90), (8, 89) ACCEPT *E* being ± 5 the values indicated above .2 (*a* =) 55×6 .2 ACCEPT $55 = \frac{a}{6}$	**2**
	b	.1 Correctly substitute 2 into the equation .2 Correct answer after their substitution	.1 $E = \frac{330}{(2+6)} + 65$ or $E = \frac{330}{8} + 65$ .2 their106.25 OE .2 ACCEPT 106.3 or 106 or 107	**2**
	c	.1 Correctly subtract their result in b) from 120 .2 Correctly multiply their13.75 by 60 000	.1 (their120 − their part b) =) their13.75 .1 ACCEPT their part b) being correctly rounded up or down as an integer Ex: (120-their106=) their 14 or (120-their107=) their13 .2 (their13.75 × 60 000 =) their825 000 825 000 without working, **award 2 marks** (their part b) × 60 000 or their6 375 000, **award 1 mark** 120 × 60 000 or 7 200 000, **award 0 marks**	**2**

	d	**AM1 (Solving)** .1 Correctly equate to 95 .2 Correctly rearrange for their *n* .3 The correct value of *n* **AM2 (using numbers)** .1 Correctly substitute one number $n \neq 5$ and correctly calculate corresponding E .2 Correctly substitute 5 and equate to 95 .3 Correctly identify the value of *n*	**AM1 (Solving)** .1 $95 = \frac{330}{(n+6)} + 65$ or $30 = \frac{330}{(n+6)}$ or $30(n+6) = 330$ OE .1 ACCEPT the use of inequalities .2 $n = \frac{330}{\text{their}30} - 6$ OE .2 ACCEPT $(n+6) = \frac{330}{\text{their}30}$ .2 ACCEPT their30*n*=their150 .2 implies .1 .3 (*n*=)5 .3 ACCEPT 2027 **AM2 (using numbers)** .1 Ex: $\frac{330}{(1+6)} + 65 = 112.14$ ACCEPT 112 .2 $\frac{330}{(5+6)} + 65 = 95$ .3 (*n*=) 5 ACCEPT 2027	**3**

Q6e total 10 marks

Mark	1	2		
Factors (F)	**Two** from the keywords/phrases below mentioned in the factors box • filter(s) • carbon or unit(s) or kt or emission(s) • limit(s) or restriction(s) or requirement(s) or regulation(s) or “difference in emission(s)” or “value(s) of difference” DO NOT ACCEPT other similar keywords Ex: “excess” or “reduction” **ACCEPT** multiple keywords in one sentence and ignore additional irrelevant factors	**The three** keywords/phrases below mentioned in the factors box • filter(s) • carbon or unit(s) or kt or emission(s) • limit(s) or restriction(s) or requirement(s) or regulation(s) or “difference in emission(s)” or “value(s) of difference” DO NOT ACCEPT other similar keywords Ex: “excess” or “reduction” **ACCEPT** multiple keywords in one sentence and ignore additional irrelevant factors		

Key
DC: The missing values in the row of Difference in carbon emissions
VC: The missing values in the row of Value of difference in carbon emissions ACCEPT negative values for buying (Ex: -0.48,-0.63,-0.72)

Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Difference in carbon emissions (kt)	28	19.5	12	5.5	0	4.5	8	10.5	12
Value of difference in carbon emissions ($ million)	1.68	1.17	0.72	0.33		0.27	0.48	0.63	0.72
Buy or sell	sell	sell	sell	sell		buy	buy	buy	buy

Total of Sell is: 1.68+1.17+0.72+0.33=3.9 **Total of Buy is: 0.27+0.48+0.63+0.72=2.1**

Mark	1	2	3	4
Calculate (C)	**One** from: (see table above) • Correctly write **three** DC • Correctly calculate **four** of their VC • Correctly calculate cost if no filters installed: (222x60k=)13.32 ($ mil) **ACCEPT** – 13.32 • Weak attempt to calculate their cost if filters installed: They forget the cost of filters or income from selling or price of buying Ex: their3.9 – their2.1 or their1.8 Ex: 14 – their3.9 or their10.1 Ex: 14 + their2.1 or their16.1	**Two** from: (see table above) • Correctly write **three** DC • Correctly calculate **four** of their VC • Correctly calculate cost if no filters installed : (222x60k=)13.32 ($ mil) **ACCEPT** – 13.32 • Good attempt to calculate their cost if filters installed: They include cost of filters, income from selling, and price of buying but incorrect final result Ex: 14 + their3.9 – their2.1 or their 15.8($mil) **ACCEPT** the correct costs without final result Ex: filters 14 then sell for 3.9 then buy for 2.1 WTTE	**Three** from: (see table above) • Correctly write **all** DC • Correctly calculate **all** of their VC • Correctly calculate cost if no filters installed: (222x60k=)13.32 ($ mil) **ACCEPT** – 13.32 • Correctly calculate their cost if filters installed (14 – their3.9 + their2.1 =)their12.2 **ACCEPT** – their12.2($mil)	The **four**: (see table above) • Correctly write **all** DC • Correctly calculate **all** of the VC • Correctly calculate cost if no filters installed: (222x60k=)13.32 ($ mil) **ACCEPT** – 13.32 • Correctly calculate the cost if filters installed: (14 – 3.9 + 2.1 =)12.2 ($mil) **ACCEPT** – 12.2($mil)

Mark	1	2
Recommendation (J)	**ACCEPT only if C1 is achieved** Recommendation with **one weak** justification considering the 8 years period or beyond the 8 years period **Examples considering the 8 years period** Ex: Filters will save money WTTE (and we see values aligned with this recommendation even if incorrectly calculated) Ex: Should install filters but in 4 years they will have to buy new ones WTTE Ex: Should not install filters because after 2026 (or starting 2027) filters will not be efficient enough WTTE Ex: Should not install because it is not economic (and we see values aligned with this recommendation even if incorrectly calculated) Ex: should not install filters because the price of filters is paid upfront WTTE. **DO NOT ACCEPT** seeing only price of filters too high **OR** **Examples considering beyond 8 years period** Ex: After 2030 (or after 8 years), installing filters will be no good or they will have to buy new filters or take new measures WTTE Ex: On the long run (in the future) they will have to buy more filters WTTE **ACCEPT** not recommending filters if their justification supports it **DO NOT ACCEPT** “install filters because it is better for environment” WTTE	**ACCEPT only if C4 is achieved** <u>Recommendation to install filters</u> with **one good** justification aligned with the correct calculations Ex: Should install filters because they will save 1.12 (mil$) WTTE Ex: Should install filters because without filters they will spend 13.32(mil) while with filters only 12.2 WTTE **ACCEPT** Should install filters because it will save money WTTE, and we see 13.32(mil$) and 12.2(mil$) in the calculations

<table>
<tr><th>Mark</th><th>1</th><th>2</th></tr>
<tr><td rowspan="3">Accuracy
(A)</td><td>Implies inaccurate with one justification

• Price of buying/selling (60000) carbon units is approximate WTTE OR Limits/restrictions could change (based on world events or to decrease pollution or because climate change). WTTE</td><td rowspan="2">Implies inaccurate with two justifications

• Price of buying/selling (60000) carbon units is approximate WTTE OR Limits/restrictions could change (based on world events or to decrease pollution or because climate change). WTTE

AND

• (Carbon) emissions are predictions/estimates or might change over the years WTTE</td></tr>
<tr><td>OR

• (Carbon) emissions are predictions/estimates or might change over the years WTTE</td></tr>
<tr><td>ACCEPT
“values used are estimations or approximated” WTTE for A1

DO NOT ACCEPT

“inaccurate because I rounded” WTTE

accurate regardless their justification

just rounding their results</td><td>DO NOT ACCEPT

“inaccurate because I rounded” WTTE

accurate regardless their justification

just rounding their results</td></tr>
</table>

Q7 Task 3

Glossary for task 3

Term used	Clarification
General rule	Rule in terms of only n (if they use x, it is still general rule but penalise in notation)
The general rule	The correct general rule in terms of only n (if they use x, it is still the general rule but penalise in notation)
Their general rule	valid attempt for the general rule but in terms of only n (if they use x, it is still their general rule but penalise in notation)
Their rule	Correct rule not in terms of only n
Recursive rule	$A = \frac{A_{n-1}}{4}OE$

We accept subsequent use of their general rule provided it is of similar complexity. In general, the complexity of the rule depends on its form. The table below shows examples.

The general rule	ACCEPT for their general rule	DO NOT ACCEPT for their general rule
$T = 8n - 8$	Linear	
$A = \frac{8}{2^n}$	Quadratic or exponential	Linear

7		Answers	Notes		Total
	a	Correctly place 32 and 40	5	32	**1**
			6	40	

	b	.1 correctly describe one pattern for T in words .2 correctly describe a second pattern for *T* in words	ACCEPT complete terminology only, for example (below are four different descriptions) divisible by 8, multiples of 8 Increasing by 8, adds 8, goes up by 8, moving up by 8 difference 8, common difference 8, linear with difference 8, arithmetic with difference 8 Second difference zero DO NOT ACCEPT incomplete terminology, for example: Arithmetic, linear, increasing by a constant, constant difference DO NOT ACCEPT general description, for example: Integers, whole numbers, positive, even numbers, divisible by 2, multiples of 2, multiples of 4 DO NOT ACCEPT the rule in words or description related to n for example: 8 times n minus 8, n multiplied by 8 minus 8, WTTE **Note, in the case when they have more than two different patterns:** If two are accepted and the rest are all correct: **award 2 marks** Ex: even numbers and adds 8 and Second difference is zero and it is 8 times n then subtract 8. Ex: multiples of 2 and 4 and linear and increases by 8 and divisible by 8 If two are accepted and any of the rest is incorrect: **award 1 mark** Ex: <u>increases by 2</u> and Second difference is zero and it is divisible by 8 If only one is accepted, ignore the rest and **award 1 mark**	**2**
	c	.1 the correct general rule .2 the correct simplified general rule with correct notation for *T* in terms of *n*.	.1 $8n-8$ or $8(n-1)$ or $T=8\times n-8$ or $(T=)8*n-8$ or $T=8\times(n-1)$ or $T=0+8(n-1)$ .2 $T=8n-8$ or $T=8(n-1)$ .2 ACCEPT using Tn instead of T .2 ACCEPT $T=n8-8$ or $T=(n-1)8$ .2 ACCEPT using t and N DO NOT ACCEPT description in words	**2**

	d	.1 correctly substitute $n \geq 5$ into their general rule (from 7c or 7b) .2 correctly calculate their value of T after substituting $n \geq 5$ .3 recognise that their correctly calculated value of T is the same as their predicted value	.1 Ex: $8 \times 5 - 8$ .2 Ex: 32 (for $n = 5$) .3 "the same as when we continue the pattern" WTTE and states how Ex: for n=7, 48 is obtained from pattern of adding 8 to 40 .3 ACCEPT if their value from .2 is the same as their value in the table in part a) or seen here in part d) Ex: we see their calculated T=32 and we see T=32 in their table	**3**
	e	**AM1 (rhombus)** Correctly half the product of the two diagonals **AM2 (rectangle – triangles)** Correctly subtract area of 4 triangles from the rectangle **AM3 (4 triangles)** Correct area of 4 triangles or 2 big triangles that form 1 rhombus $\frac{1}{16}$ AG	**AM1** $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{4}$ **AM2** $\frac{1}{8} - \frac{1}{16}$ Comes from 4 triangles each being $\frac{1}{2} \times \frac{1}{4} \times \frac{1}{8} = \frac{1}{64}$ and 1 rectangle $\frac{1}{2} \times \frac{1}{4} = \frac{1}{8}$ **AM3** $4 \times \frac{1}{64}$ or $2 \times \frac{1}{32}$ Comes from area of 4 triangles each being $\frac{1}{2} \times \frac{1}{4} \times \frac{1}{8}$ or 2 triangles each being $\frac{1}{2} \times \frac{1}{8} \times \frac{1}{2}$ or $\frac{1}{2} \times \frac{1}{4} \times \frac{1}{4}$ ACCEPT notation errors ACCEPT lengths in decimals only if $\frac{1}{16} = 0.0625$ is seen Ex : $0.5 \times 0.5 \times 0.25 = 0.625$ AND $\frac{1}{16} = 0.0625$ DO NOT ACCEPT $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{4}$ that comes from $A = b^2 \times h$ DO NOT ACCEPT $\frac{1}{4} \times \frac{1}{4}$ DO NOT ACCEPT working only with denominators Ex : denominators $2 \times 2 \times 4 = 16$	**1**

Q7e 23 marks

Mark	1	2	3
Predictions (P) **ACCEPT** whether in the table or in the response box	Correctly predict **two** terms for *L* or *W*	Correctly predict **two** terms for *L* or *W* **AND** Correctly predict **one** term for *A*	Correctly predict **two** terms for *L* and **two** terms for *W* **AND** Correctly predict **two** terms for *A*
	OR Correctly predict **one** term for *A*	**OR** Correctly predict **two** terms for *A*	
	Ignore additional incorrect predictions **ACCEPT** fractions or index form **ACCEPT** in the table or in the response box **DO NOT ACCEPT** decimals	Ignore additional incorrect predictions **ACCEPT** fractions or index form **ACCEPT** in the table or in the response box **DO NOT ACCEPT** decimals	Ignore additional incorrect predictions **ACCEPT** fractions or index form **ACCEPT** in the table or in the response box **DO NOT ACCEPT** decimals

Stage number (n)	Length of big diagonal (L)	Length of small diagonal (W)	Area of rhombus (A)
5	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{256}$
6	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{1024}$
7	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{4096}$
8	$\frac{1}{64}$	$\frac{1}{128}$	$\frac{1}{16384}$

Examples of rules in equivalent forms (accept decimals) :

$$L = \frac{4}{2^n} = 2 \times (\frac{1}{2})^{n-1} = \frac{1}{2^{n-2}} = 2^{2-n}$$

$$W = \frac{2}{2^n} = 1 \times (\frac{1}{2})^{n-1} = \frac{1}{2^{n-1}} = 2^{1-n}$$

$$A = \frac{1}{4^{n-1}} \text{ or } A = \frac{1}{2^{2n-2}} \text{ or } A = 4^{1-n} \text{ or } A = 2^{2-2n}$$

<table>
<tr><th>Mark</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr>
<tr>
<td rowspan="8">Description (D)

ACCEPT notation errors but penalized in notation (N)</td>
<td>Correctly describe a pattern in words for A
Ex: Multiply by $\frac{1}{4}$ OE, Divide by 4, Divide by 2 two times
(Geometric with) ratio $\frac{1}{4}$ OE.
Denominators multiply by 4 or they are divisible by 4 or they all have 4 as a factor or they are all powers of 4.
Denominators <u>except first</u> are multiples of 4.</td>
<td rowspan="2">Correctly describe a pattern in words for A

AND

Correct recursive rule for A or rule $A=4^n$ or Valid attempt to write down general rule for L or W</td>
<td rowspan="2">Correctly describe a pattern in words or recursive rule for A

AND

Valid attempt to write down a general rule for A (at least seeing $(an+b)$ as an exponent)</td>
<td rowspan="2">Correctly describe a pattern in words or recursive rule for A

AND

Correctly write down the general rule for L or W</td>
<td rowspan="8">Correctly describe a pattern in words or recursive rule for A

AND

Correctly write down the general rule for A</td>
</tr>
<tr><td>OR

Recursive rule for A
$A=\frac{A_{n-1}}{4}$ OE or the rule $A=4^n$</td></tr>
<tr>
<td>OR

Valid attempt to write down a general rule for L or W
(at least seeing n as an exponent)
ACCEPT if they correctly describe a pattern in words or recursive rule for L or W
Ex: Multiply by $\frac{1}{2}$ OE, Divide by 2
(Geometric with) ratio $\frac{1}{2}$ OE
Denominators are multiples of 2 or divisible by 2 or even numbers or powers of 2
$L=\frac{L_{n-1}}{2}$ or $W=\frac{W_{n-1}}{2}$ OE</td>
<td rowspan="5">OR

Valid attempt to write down a general rule for A (may be incorrect but contains at least $(an+b)$ as an exponent)</td>
<td rowspan="5">OR

Correctly write down the general rule for L or W
$L=\frac{4}{2^n}OE$
$W=\frac{2}{2^n}OE$</td>
<td rowspan="5">OR
Correctly write down the general rule for A
$A=\frac{1}{4^{n-1}}$
OE</td>
</tr>
<tr><td>IGNORE additional incorrect patterns</td></tr>
<tr>
<td>DO NOT ACCEPT
Exponential, geometric, arithmetic sequence, denominators are multiples of 2 or even numbers, the square numbers, A is decreasing
$A=\frac{1}{2}(L\times W)$
The rule for A in words as a pattern.</td>
</tr>
</table>

Mark	1	2	3
Testing (T) **ACCEPT transforming into decimals when testing**	Attempt to test their general rule for A using $n \leq 4$ Ex: Substitute in their general rule for A value of $n \leq 4$ **OR** Correctly test their described pattern or their rule (e.g. recursive rule) or their rule for L or W in terms of n **DO NOT ACCEPT** testing their rule of A=0.5xLxW	Correctly test their general rule for A, using $n \leq 4$ Ex: Correctly calculate their value for A in their general rule using $n \leq 4$ **AND** Recognise that their correctly calculated value for A is the same as the given value. ACCEPT seeing their correctly calculated value for A and the given value in the table being equal	
Verifying (V) **ACCEPT transforming into decimals when verifying**	Attempt to verify their general rule for A using $n \geq 5$ Ex**:** Correctly substitute in their general rule for A value of $n \geq 5$ **OR** Correctly verify their described pattern or their rule (e.g. recursive rule) or their rule for L or W in terms of n **DO NOT ACCEPT** verifying their rule of A=0.5xLxW	Correctly calculate their value for A in their general rule, using $n \geq 5$	Correctly calculate their value for A in the general rule using $n \geq 5$ **AND** Recognise that their correctly calculated value for A is the same as the correct predicted value obtained by continuing the pattern ACCEPT seeing their correctly calculated value for A and the correctly predicted value in the table being equal

Mark	1	2	3	4
Justify (J)	**ACCEPT only if D1 is achieved**	**ACCEPT only if D4 is achieved**	**ACCEPT only if D4 is achieved**	**ACCEPT only if D4 is achieved**
	Attempt to use geometric sequence to justify <u>their</u> general rule for *A* or described pattern or rule or recursive rule Ex : Every time we multiply by $\frac{1}{4}$ so it makes sense to have 4 in my general rule WTTE and we see 4 or $\frac{1}{4}$ in <u>their</u> general rule for *A*	Correctly use geometric sequence to justify <u>the</u> general rule aligned with their notation for <u>the</u> general rule for *A* Ex : Assume $a \times r^n$ and substitute $r = \frac{1}{4}$ and a value for *A* and *n* then find *a* = 4	Attempt to justify geometrically the general rule for *A* Half of the product of correct *L* and *W* rules without complete simplification Seeing $\frac{L \times W}{2} = \frac{4 \times 2}{2 \times 2^n \times 2^n}$ OE or $\frac{4 \times 2}{2 \times 2^n \times 2^n} = \frac{4}{4^n}$ OE	Correctly justify geometrically the general rule for *A* Half the product of correct *L* and *W* with simplification. ACCEPT simplification using factor 4 instead of 2. They show how it simplifies to $A = \frac{1}{4^{n-1}}$ or $A = 4^{1-n}$ $A = \frac{1}{4^{n-1}}$ or $A = \frac{1}{2^{2n-2}}$ or $A = 4^{1-n}$ or $A = 2^{2-2n}$
	OR using parameters Assume $a \times r^n$ and substitute $r = \frac{1}{4}$ and a value for *A* and *n* then find incorrect *a*	**OR** Weak attempt to justify <u>the</u> general rule for *A* geometrically by using half the product of <u>i</u>ncorrect *L* and *W* rules or by using correct *L* and *W* rules but incorrectly halved or with mistakes in simplification		
	OR Weak attempt to justify <u>their</u> general rule for *A* geometrically by using the product of <u>incorrect</u> *L* and W <u>rules</u> OR *L* is halved and *W* is halved so *A* is divide 4 WTTE			
	OR Substitute at least two other values of *n* in their general rule for *A, L* or *W* and say they are the same or the rule works WTTE			
	OR Recognize it is geometric progression and define first term 1 and ratio $\frac{1}{4}$ WTTE			
	DO NOT ACCEPT *A* is square of *W*			

<table>
<tr><th>Mark</th><th>1</th><th>2</th><th>3</th></tr>
<tr><td>Notation and terminology (N)</td><td colspan="3">CORRECT NOTATION
- using U_n instead of A only if they mention that $A = U_n$
- Using decimals

NOTATION WITH ERRORS
- using * for multiplication
- using / for division
- using ^ for power
- using x instead of n
- “the rule for A is:” instead of “A=”</td></tr>
<tr><td></td><td>ACCEPT only if D1 is achieved</td><td>ACCEPT only if D4 is achieved</td><td>ACCEPT only if D5 is achieved</td></tr>
<tr><td></td><td>Correct notation of their general rule for A or rule for L or W
Ex:
$A = 4^n$ or $L = \frac{4}{2^n}$ or $W = \frac{2}{2^n}$

OR

The notation of the general rule includes errors or non-simplified or in words

Ex:
A=1/4^(n-1) or A=4/4^n or $A = \frac{4}{4^n}$

or Missing the “A=”
Ex: The rule for A is $\frac{1}{4^{n-1}}$

OR

Correctly describe a pattern or recursive rule in words for A

Ex: $A = \frac{A_{n-1}}{4}$</td><td>Correct notation of the general rule for A in simplest form (see examples below and above)

ACCEPT simplification using factor 4 instead of 2.
Ex: $A = \frac{1}{4^{n-1}}$ or $A = \frac{1}{2^{2n-2}}$

or $A = 4^{1-n}$ or $A = 2^{2-2n}$

And OE for decimals
Ex: $A = 0.25^{n-1}$ or $A = 0.5^{2n-2}$

OR

The notation of the general rule includes errors or not simplified or in words (see examples in N1 and above)

AND

Correctly describe a pattern in words for A</td><td>Correct notation of the general rule for A in simplest form (see examples in N2 and above)

AND

Correctly describe a pattern in words for A</td></tr>
</table>

Communication (L) Organisation and coherence can be awarded even if there are errors For items: Describing pattern and writing rule can be considered an item even if D0 awarded Test, verify, and justify may include errors but cannot be considered item (or identified for coherence) if they are zeros	**At least three** of the following items are seen: - describe a pattern in words - write a rule - test their general rule or rule or recursive rule or pattern (at least T1) - verify their general rule or rule or recursive rule or pattern (at least V1) - justify their general rule or rule or recursive rule or pattern (at least J1)	**At least four** of the following items are seen: - describe a pattern in words - write a general rule - test their general rule - verify their general rule - justify their general rule **AND** For coherence, they identify the processes correctly. **At least one** from the following: - test - verify - justify Ex: • **For test:** they say “test” and they substitute in their general rule value(s) of $n \leq 4$ only • **For verify:** they say “verify” and they substitute in their general rule value(s) of $n \geq 5$ only • **For justify:** They say “justify” and they write a justification **Note for coherence:** If they say “test and verify” and they substitute in their general rule value(s) of $n \leq 4$ followed by value(s) of $n \geq 5$, consider it as only one identified process	**ACCEPT only if D4 and J2 are achieved** **At least four** of the following are seen: - describe a pattern or rule in words - write the general rule - test the general rule - verify the general rule - justify the general rule **AND** For coherence, they identify the processes correctly. **At least two** from the following: · test · verify · justify Ex: • **For test:** they say “test” and they substitute in their general rule value(s) of $n \leq 4$ only • **For verify:** they say “verify” and they substitute in their general rule value(s) of $n \geq 5$ only • **For justify:** They say “justify” and they write a justification **Note for coherence:** If they say “test and verify” and they substitute in their general rule value(s) of $n \leq 4$ followed by value(s) of $n \geq 5$, consider it as only one identified process