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Level 3 Certificate  
**MATHEMATICAL STUDIES**  
**1350/2C**

Paper 2C Graphical Techniques

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Mark scheme

June 2022

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Version: 1.2 Final Mark Scheme



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Q	Answer	Mark	Comments
1 (a)	11 : 5	B1	

Q	Answer	Mark	Comments
1 (b)	<b>Alternative method 1</b>		
	$10 \times 1$ and $15 \times 2$ and $25 \times 2$ and $20 \times 3$ and $5 \times 3$ and $5 \times 4$ or $10 \times 1$ and $40 \times 2$ and $20 \times 3$ and $5 \times 3$ and $5 \times 4$ or 10 and 30 and 50 and 60 and 15 and 20 or 10 and 80 and 60 and 15 and 20	M1	allow one error or omission may be seen beside table
	185 with correct method	A1	may be implied by 185 + their assumed visitor spaces
	185 and no	E1ft	ft their 185 with yes if their total < 185 or no if their total > 185

Q	Answer	Mark	Comments
1 (b) cont	<b>Alternative method 2 (interprets as a total of 3 and 4 spaces for all 4-bed and 5-bed properties)</b>		
	$10 \times 1$ and $15 \times 2$ and $25 \times 2$ and $20 \times 3$ and 3 and 4 or $10 \times 1$ and $40 \times 2$ and $20 \times 3$ and 3 and 4 or 10 and 30 and 50 and 60 and 3 and 4 or 10 and 80 and 60 and 3 and 4	M1	allow one error or omission may be seen beside table
	157 with correct method	A1	
	157 and yes	E1ft	ft their 157 with yes if their total < 157 or no if their total > 157
	<b>Additional Guidance</b>		
	10 + 15 + 25 + 20 + 15 + 20 and 105 and yes	M0 A0 E1ft	
	185 may be implied, eg $10 + 80 + 60 + 15 + 20 + 40 = 225$ (where 40 spaces assumed for visitor parking) and no	M1 A1 E1	
	185 and no with no method seen	M0 A0 E0	

Q	Answer	Mark	Comments
1 (c)	<b>Alternative method 1</b>		
	80 × 23 ÷ 100 or 18(.4) or 19	M1	implied by 9 or 8 for 2-bedroom flat in table with no incorrect working
	9	A1	no incorrect working number of 2-bedroom flats
	31	B1ft	number of 2-bedroom houses ft 40 – their 9 accept decimals
	<b>Alternative method 2</b>		
	80 × ((23 ÷ 100) – (10 ÷ 80)) or 80 × (0.23 – 0.125) or 8.4	M1	implied by 9 or 8 for 2-bedroom flat in table with no incorrect working
	9	A1	no incorrect working number of 2-bedroom flats
	31	B1ft	number of 2-bedroom houses ft 40 – their 9 accept decimals
	<b>Additional Guidance</b>		
	Award M1 for correct percentage calculation, even if 2-bedroom flat value is greater than 9		
	correct values from incorrect method score M0 A0 but can gain B1ft, eg 40 × 23 ÷ 100 or 9.2 and 9 and 31		M0 A0 B1ft
	80 × 23 ÷ 100 or 18.4 and 8 and 32		M1 A0 B1ft



Q	Answer	Mark	Comments
<b>2 (b)</b>	<b>Morning Record</b>		
	<b>Alternative method 1</b>		
	110 221 $\times$ 70 $\div$ 100 or 77 154.(7) or 77 155	M1	oe
	77 154.(7) or 77 155 and True	A1	
	<b>Alternative method 2</b>		
	78 105 $\div$ 70 $\times$ 100 or 111 578.(57...) or 111 579	M1	oe
	111 578.(57...) or 111 579 and True	A1	
	<b>Alternative method 3</b>		
	78 105 $\div$ 110 221 ( $\times$ 100) or 70.8(6...) or 70.9 or 0.708(6...) or 0.709	M1	oe accept 71 or 0.71
	70.8(6...) or 70.9 or 0.708(6...) or 0.709 and True	A1	accept 71 or 0.71

Q	Answer	Mark	Comments
2 (b) cont	<b>Alternative method 4</b>		
	(110 221 – 78 105) ÷ 110 221 (× 100) or 32 116 ÷ 110 221 (× 100) or 0.29(1...) or 29(.1...)	M1	oe
	0.29(1...) or 29(.1...) and True	A1	



Q	Answer	Mark	Comments
<b>2 (b) cont</b>	<b>Daily Bulletin Review</b>		
	<b>Alternative method 1 (comparing proportions of wind to other renewables)</b>		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	33 791 ÷ their 44 314 or 0.76(...) and 13 ÷ 17 or 0.76(...)	M1	
	0.76(...) with full method seen and True	A1	oe percentage
	<b>Alternative method 2 (comparing multiplier from wind to other renewables)</b>		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	their 44 314 ÷ 33 791 = 1.3(1...) and 17 ÷ 13 = 1.3(07...) or 17 ÷ 13 = 1.31	M1	correct for their 44 314
	1.3(...) with full method seen and True	A1	oe percentage

Q	Answer	Mark	Comments
2 (b) cont	<b>Alternative method 3 (what other renewables should be in 13 : 17)</b>		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	33 791 ÷ 13 × 17 or 44 188.(...)	M1	
	44 188.(...) and 44 314 and True	A1	
	<b>Alternative method 4 (comparing one part of wind with one part of other renewables)</b>		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	33 791 ÷ 13 and their 44 314 ÷ 17	M1	oe eg 33 791 ÷ 13 or 2599 and 44 314 ÷ 2599 or 17.05
	2599.(3...) and 2606.(7...) or 2607 and True	A1	allow 2600

Q	Answer	Mark	Comments
<b>2 (b) cont</b>	<b>Alternative method 5 (finding an approximately equivalent ratio)</b>		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	33 791 ÷ [2533, 2685] and 44 314 ÷ [2533, 2685]	M1	both divisors must be the same
	33 791 ÷ [2533, 2685] and 44 314 ÷ [2533, 2685] and correct results for their divisor and True	A1	results may be rounded to 13 and 17 with divisor shown
	<b>Alternative method 6 (working out other renewables as 17 parts of total)</b>		
	78 105 – 33 791 or 129 + 11 228 + 32 957 or 44 314	M1	
	78 105 ÷ 30 × 17 or 44 259(.5) or 44 260	M1	
	44 259(.5) or 44 260 and 44 314 and True	A1	

Q	Answer	Mark	Comments
<b>2 (b) cont</b>	<b>Alternative method 7 (working out wind as 13 parts of total)</b>		
	78 105 ÷ 30 or 2603.5 or 2604	M1	
	their 2603.5 × 13 or 33 845(.5) or 33 846	M1	
	33 845(.5) or 33 846 and True	A1	
	<b>Alternative method 8 (comparing wind as a proportion of total renewables)</b>		
	13 ÷ 30 or 0.43(3...)	M1	
	33 791 ÷ 78 105 or 0.43(2...)	M1	
	0.43 with full method seen and True	A1	oe percentage
	<b>Additional Guidance</b>		
	Variations which mix alternative methods are acceptable. Choose the scheme that favours the student.		
	Accept Yes for True		
	33 791 : 44 314 and 13 : 17.04(8...) and True		M1 M1 A1
	33 791 : 44 314 and 13 : 17.05 and True		M1 M1 A1
	33 791 : 44 314 and 12.96(3...) : 17 and True		M1 M1 A1
33 791 : 44 314 and 13 : 17 and True with no divisor shown		M1 M0 A0	

Q	Answer	Mark	Comments
2 (c)	<b>Alternative method 1 (first finding GWh used)</b>		
	4189 × 1 000 000 or 4 189 000 000	M1	oe
	their 4 189 000 000 × 14.4 ÷ 100 or 603 216 000	M1	oe
	603 216 000 or 603 000 000 and Yes	A1	oe
	<b>Alternative method 2 (first finding price per GWh)</b>		
	14.4 × 1 000 000 or 14 400 000	M1	oe
	their 14 400 000 × 4189 ÷ 100 or 603 216 000	M1	oe
	603 216 000 or 603 000 000 and Yes	A1	oe
	<b>Additional Guidance</b>		
	Accept all values in standard form		
	Accept comparison in pence with 60 000 000 000 seen		
	Condone recovery to pounds after working in pence with division by 100 not seen		

Q	Answer	Mark	Comments
2 (d)	<b>Alternative method 1</b>		
	7700 ÷ 26.9 or 286.2(4...) or 286.25 or 7700 ÷ 0.269	M1	oe
	[28 490, 28 644]	A1	
	<b>Alternative method 2</b>		
	7700 × 73.1 ÷ 26.9 or 20 924.(5...) or 20 925	M1	oe
	[28 490, 28 644]	A1	
	<b>Additional Guidance</b>		
	Ignore further rounding after answer in interval seen		

Q	Answer	Mark	Comments
2 (e)	<p>Any valid reason</p> <p>eg</p> <p>The amount of electricity produced by each nation is not the same</p> <p>England produces more electricity than Scotland</p> <p>He should have worked out a weighted mean</p> <p>He should have worked out the total energy generated by renewables as a percentage of the overall total</p> <p>He should have used actual values (rather than percentages)</p> <p>You can't always just average percentages</p> <p>Each percentage is the percentage of its own country, not the UK as a whole</p> <p>He has calculated the mean percentage based on each country's total, not the UK as a whole</p>	E1	<p>oe</p> <p>condone the sizes of the nations are not the same</p>

Q	Answer	Mark	Comments
3 (a)	Number of enemies values correct 250 300	B1	
	Maximum possible scores all correct 20 000 250 000 3 000 000	B2ft	B1 one or two maximum possible scores correct ft their number of enemies

Q	Answer	Mark	Comments
3(b)(i)	3.76 5.06 6.35	B2	B1 for one or two correct to 2dp or all correct but not to 2dp

Q	Answer	Mark	Comments
3(b)(ii)	All points plotted correctly	B1ft	ft their values
	<b>Additional Guidance</b>		
	Must be between the relevant gridlines eg 5.06 must be plotted between 5.0 and 5.2		



Q	Answer	Mark	Comments	
3(b)(iii)	Valid or likely Any indication that trajectory (gradient) of player two indicates a higher score at levels $\geq 6$ and Assumption made about trend continuing or Not valid and Indication that they are unable to assume that the trend continues or Not valid and their graphs show a trajectory (gradient) of player two that does not indicate a higher score at levels $\geq 6$ and Assumption made about trend continuing	E2ft	E1 valid or likely and trajectory (gradient or rate of improvement) of player two indicates a higher score at levels $\geq 6$  allow reference to trendlines if plotted and player two clearly above player 1 at level 6  extrapolation comment may be a suggested contextualised reason, for example "Game rules may change"  E1ft Not valid and their graphs show a trajectory (gradient) of player two that does not indicate a higher score at levels $\geq 6$	
	<b>Additional Guidance</b>			
	Yes justified by rate of improvement quantified using values from the table		E0	
	Yes justified by the lines getting closer		E0	
	Yes justified by a steeper trajectory with no reference to level 6		E0	
	Yes because the trendlines show this and clearly shows trendlines have crossed by level 6 on the graph		E1	
	Yes if they (both players) improve at same rate they will score higher at level 6		E2	

Q	Answer	Mark	Comments
4 (a)	Horizontal line from $T = 4$ or Mark on curve at $T = 4$	M1	
	[1.8, 1.9]	A1	

Q	Answer	Mark	Comments
4 (b)	Yes and suitable comment or -1 and [-0.3, -0.7] seen and suitable comment	E1	eg rate of temperature decline is greater (steeper) at lower masses of ice  condone positive values if correct conclusion is met
	<b>Additional Guidance</b>		
	Accept reference to gradient rather than rate		
	Accept 'greater' gradient if referring to the magnitude of the negative value		
	Goes down further between 0.2 and 0.3 than 2.0 to 2.1		E1

Q	Answer	Mark	Comments
4 (c)	<b>Alternative method 1</b>		
	$C = 22$	B1	
	Substitutes in a valid coordinate $(m, T)$	M1	may be from table or graph values taken from graph condone error in reading of half a square eg condone (1.5, 6)
	Rearranges to give $B = \frac{T - C - 1.86m^2}{m}$ or Solves for $B$ using correct algebraic manipulation with their values of $m$ and $T$	M1	oe may be implied by correct final answer
	$B = [-13.93, -13]$	A1	must be correct for their values ft their $C$
	<b>Alternative method 2</b>		
	Substitutes in two valid coordinates to form two equations	M1	may be from table or graph values taken from graph condone error in reading of half a square eg condone (1.5, 6)
	Eliminates one variable correctly	M1	using either substitution or elimination, a valid equation for either $B$ or $C$ must be seen based on their coordinates
	$B = [-14.72, -13.36]$	A1	
	$C = [21.43, 22.69]$	A1	

Q	Answer	Mark	Comments	
4 (d)	Not valid for $m > 2.5$ or Temperature cannot be less than temperature of ice or Model predicts temperature will begin to increase or Model only applicable to a starting temperature of $22^{\circ}\text{C}$	E1	Oe      may refer to drinks or atmospheric temperature	
	<b>Additional Guidance</b>			
	Temperature will reach a minimum limit		E1	
	Larger values of mass ( $> 2.5$ ) will have no effect on temperature		E1	
	You cannot have a negative amount of ice		E1	
	Doesn't show you where the trend ends		E0	

Q	Answer	Mark	Comments
5 (a)	$112 \times 2.12$	M1	
	237.4(4) or 237	A1	

Q	Answer	Mark	Comments
5 (b)	[96, 97]	B1	correct lap time
	their $237.44 \times$ their [96, 97] $\div 3600$	M1	ft from 5(a) and their lap time
	[6.162, 6.402]	A1ft	ft from 5(a) and their lap time
	<b>Additional Guidance</b>		
	Within working allow any correct truncation or rounding to at least two decimal places		
	If their 5(a) is 52.8(3) this leads to correct ft answer of [1.4, 1.4235]		
	Using lap time of 90s and 237.44 obtaining 5.936		B0 M1 A1ft
	Using lap time of 90s and 237 obtaining 5.925		B0 M1 A1ft

Q	Answer	Mark	Comments
5 (c)	Tangent seen at $t = 8$ seconds	M1	Valid tangents should be seen to touch the curve at coordinate (8, 280) but not cross the curve for $t > 3$
	Gradient calculated using $\frac{\text{difference in speed}}{\text{difference in time}}$	M1dep	must be correct for their tangent may be before or after unit conversion
	[16, 25]	A1	(km/h) $s^{-1}$ implied by final answer
	their [16, 25] $\div 3600 \times 1000$	M1	oe unit conversion may be seen at any stage
	[4.4, 6.95]	A1ft	ft their [16, 25]
	<b>Additional Guidance</b>		
	If no tangent seen correct gradient implies awarding of first three marks		

Q	Answer	Mark	Comments
6 (a)	Works out difference in $x$ and Works out difference in $y$	M1	correct method or result for any two points in the domain $5 \leq x \leq 38$
	Gradient calculated using <u>their difference in <math>y</math></u> <u>their difference in <math>x</math></u> or [0.78, 0.834]	M1	oe implied by $y = [0.78, 0.834] \times x + C$ if fractions shown without working ensure they lie in the equivalent decimal range
	Substitutes their gradient and a valid pair of coordinates into the form $y = mx + C$ or $C = [-1.16, 0.36]$	M1	coordinates valid in the domain $5 \leq x \leq 38$ values taken from graph condone error in reading of half a square may be seen in any correct rearrangement of equation
	$y = [0.78, 0.834]x + [-1.16, 0.36]$	A1	oe fractions
	<b>Additional Guidance</b>		
	The substitution into $y = mx + C$ must not include an arbitrary value of $C$ read from the graph eg substituting into $y = mx + 2$		
	$y = [0.78, 0.84]x + 2$		M1 M1 M0 A0

Q	Answer	Mark	Comments
6 (b)	$y = 0.001x^3 - 0.06x^2 + 32$	B1	

Q	Answer	Mark	Comments
6 (c)	[69, 70] – [22,24] or [45, 48] (metres)	M1	
	their [45, 48] ÷ 12	M1	
	[3.75, 4]	A1	Must be correct for their [45, 48] if seen
	<b>Additional Guidance</b>		
	Correct answer in range with no working shown		

Q	Answer	Mark	Comments
7	$0.5 L_o = L_o(1 - e^{-10k})$ or $0.5 = 1 - e^{-10k}$	M1	oe
	$-10k = \ln(0.5)$ or $k = 0.069(314\dots)$ or 0.07	M1	oe
	$85000 = L_o(1 - e^{-30k})$ or $85000 = L_o(1 - e^{-30 \times 0.069})$	M1	oe ft their $k$
	$L_o = 85000 \div (1 - e^{-30 \times 0.069})$ or [96861, 97275]	M1	ft their $k$ implies previous M1
	$L = [96861, 97275] \times (1 - e^{-5 \times 0.069})$	M1	ft their $k$ and their $L_o$
	[28262, 29000]	A1	