Sequences and Series- Mark Scheme

June 2019 Mathematics Advanced Paper 1: Pure Mathematics 1

1.

Question	Scheme	Marks	AOs
11 (a)	Total time for 6 km = 24 minutes + $6\times1.05+6\times1.05^2$ minutes	M1	3.4
	= 36.915 minutes = 36 minutes 55 seconds *	A1*	1.1b
		(2)	
(b)	**5** th km is $6\times1.05=6\times1.05^1$ **6**th km is $6\times1.05\times1.05=6\times1.05^2$ **7**th km is $6\times1.05\times1.05\times1.05=6\times1.05^3$ Hence the time for the r^{th} km is $6\times1.05^{r-4}$	B1	3.4
		(1)	
(c)	Attempts the total time for the race = Eg. 24 minutes + $\sum_{r=5}^{r=20} 6\times1.05^{r-4}$ minutes	M1	3.1a
	Uses the series formula to find an allowable sum Eg. Time for 5 th to 20th km $= \frac{6.3\left(1.05^{16}-1\right)}{1.05-1} = (149.04)$	M1	3.4
	Correct calculation that leads to the **total time** Eg. Total time = $24 + \frac{6.3\left(1.05^{16}-1\right)}{1.05-1}$	A1	1.1b
	Total time = awrt 173 minutes and 3 seconds	A1	1.1b
		(4)	
			(7 marks)

(a)

M1: For using model to calculate the total time.

Sight of 24 minutes + $6\times1.05+6\times1.05^2$ or equivalent is required. Eg $24+6.3+6.615$

Alternatively in seconds 24 minutes + 378 sec (6min 18 s) +396.9 (6 min 37 s)

A1*: 36 minutes 55 seconds following 36.915, $24+6.3+6.615$, $24+6\times1.05+6\times1.05^2$ or equivalent working in seconds

(b) Must be seen in (b)

B1: As seen in scheme. For making the link between the r th km and the index of 1.05

Or for EXPLAINING that "the time taken per km (6 mins) only starts to increase by 5% after the first 4 km"

(c) The correct sum formula $\frac{a\left(r^n-1\right)}{r-1}$, if seen, must be correct in part (c) for all relevant marks

M1: For the overall strategy of finding the total time.

Award for adding 18, 24, 30.3 or awrt 36.9 and the sum of a geometric sequence

So award the mark for expressions such as $6\times4+\sum6\times1.05^n$ or $24+\frac{6\left(1.05^{20}-1\right)}{1.05-1}$

The geometric sequence formula, must be used with $r=1.05$ oe but condone slips on a and n

M1: For an attempt at using a correct sum formula for a GP to find an allowable sum

The value of r must be 1.05 oe such as 105% but you should allow a slip on the value of n used for their value of a (See below: We are going to allow the correct value of n or one less)

If you don't see a calculation it may be implied by sight of one of the values seen below

Allow for $a=6,\ n=17$ or 16 Eg. $\frac{6\left(1.05^{17}-1\right)}{1.05-1}=(155.0)$ or $\frac{6\left(1.05^{16}-1\right)}{1.05-1}=(141.9)$

Allow for $a=6.3, n=16$ or 15 Eg $\frac{6.3\left(1.05^{16}-1\right)}{1.05-1}=(149.0)$ or $\frac{6.3\left(1.05^{15}-1\right)}{1.05-1}=(135.9)$

Allow for $a=6.615,\ n=15$ or 14 Eg $\frac{6.615\left(1.05^{15}-1\right)}{1.05-1}=(142.7)$ or $\frac{6.615\left(1.05^{14}-1\right)}{1.05-1}=(129.6)$

A1: For a correct calculation that will find the **total time**. It does not need to be processed

Allow for example, amongst others, $24+\frac{6.3\left(1.05^{16}-1\right)}{1.05-1}$, $18+\frac{6\left(1.05^{17}-1\right)}{1.05-1}$, $30.3+\frac{6.615\left(1.05^{15}-1\right)}{1.05-1}$

A1: For a total time of awrt 173 minutes and 3 seconds

This answer alone can be awarded 4 marks as long as there is some evidence of where it has come from.

.....

Candidates that list values: Handy Table for Guidance

M1: For a correct overall strategy which would involve adding four sixes followed by at least 16 other values

The values which may be written in the form 6×1.05^2 or as numbers

Can be implied by $6+6+6+6+(6\times1.05)+.....+(6\times1.05^{16})$

M1: For an attempt to add the numbers from (6×1.05) to (6×1.05^{16}). This could be done on a calculator in which case expect to see awrt 149

Alternatively, if written out, look for 16 values with 8 correct or follow through correct to 1 dp

A1: Awrt 173 minutes

A1: Awrt 173 minutes and 3 seconds

Km	Time per km	Total Time
1	6.0000	
2	6.0000	12
3	6.0000	18
4	6.0000	24
5	6.3000	30.3
6	6.6150	36.915
7	6.9458	43.86075
8	7.2930	51.15379
9	7.6577	58.81148
10	8.0406	66.85205
11	8.4426	75.29465
12	8.8647	84.15939
13	9.3080	93.46736
14	9.7734	103.2407
15	10.2620	113.5028
16	10.7751	124.2779
17	11.3139	135.5918
18	11.8796	147.4714
19	12.4736	159.945
20	13.0972	173.0422

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2.

Question Number	Scheme		Marks
4. (a)	$206=140+(12-1)\times d\Rightarrow d=...$	Uses $206=140+(12-1)\times d$ and proceeds as far as $d=...$	M1
	$(d=)6$	Correct answer only can score both marks.	A1
			(2)

(b)	$S_{12}=\frac{12}{2}(140+206)$ or $S_{12}=\frac{12}{2}(2\times140+(12-1)\times"6")$ or $S_{11}=\frac{11}{2}(140+206-"6")$ or $S_{11}=\frac{11}{2}(2\times140+(11-1)\times"6")$	Attempts $S_n=\frac{n}{2}(a+l)$ or $S_n=\frac{n}{2}(2a+(n-1)d)$ with $n=12$, $a=140, l=206, d='6'$ **WAY 1** Or Attempts $S_n=\frac{n}{2}(a+l)$ or $S_n=\frac{n}{2}(2a+(n-1)d)$ with $n=11$, $a=140, l=206-'6', d='6'$ **WAY2** If they are using $S_n=\frac{n}{2}(2a+(n-1)d)$, the n must be used consistently.	M1
	$S=2076$ **WAY1** or $S=1870$ **WAY 2**	Correct sum (may be implied)	A1
	$(52-12)\times206=...$ or $(52-11)\times206=...$	Attempts to find $(52-12)\times206$ or $(52-11)\times206$. Does **not** have to be consistent with their n used for the first Method mark.	M1
	Total $="2076"+"8240"=...$ **(WAY 1)** or Total $="1870"+"8446"=...$ **(WAY 2)**	Attempts to find the total by adding the sum to 12 terms with (52 - 12) lots of 206 or attempts to find the total by adding the sum to 11 terms with (52 - 11) lots of 206. I.e. consistency is now required for this mark. **Dependent on both previous method marks.**	**dd**M1
	10316	cao	A1
			(5)
			(7 marks)

3.

Question Number	Scheme		Marks
3.(a)	$\left(a_2 =\right)2k$	$2k$ only	B1
[redacted]			

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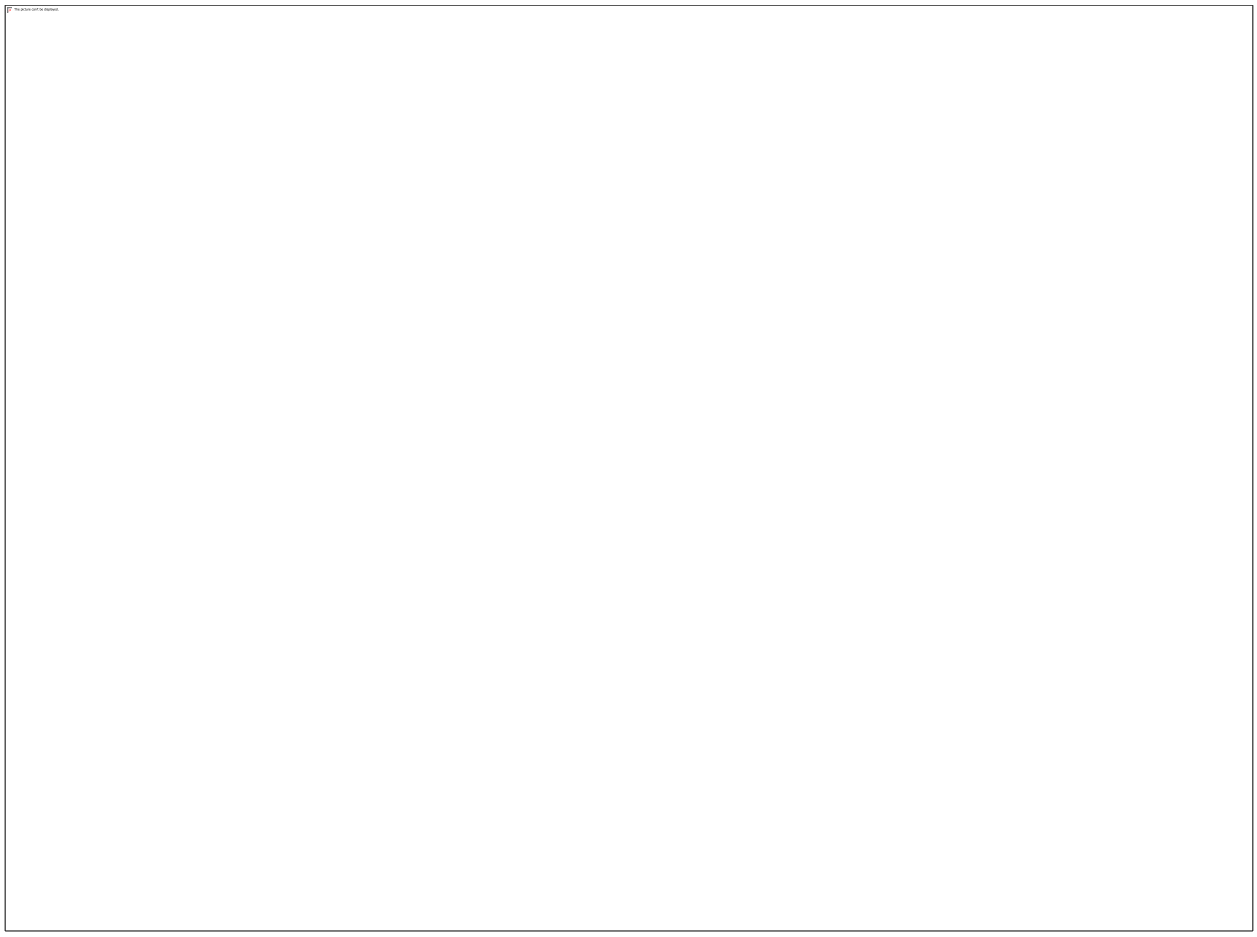
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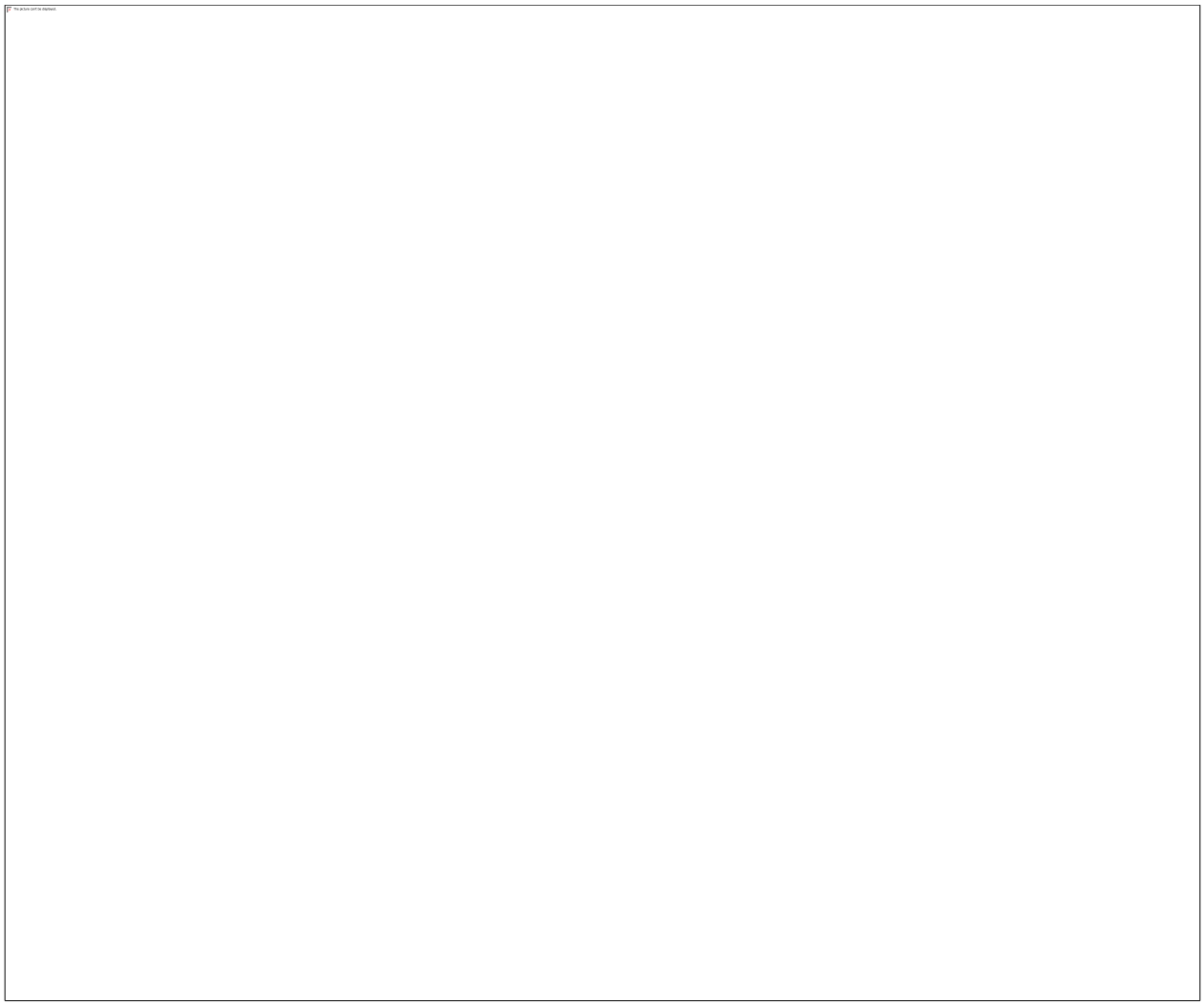

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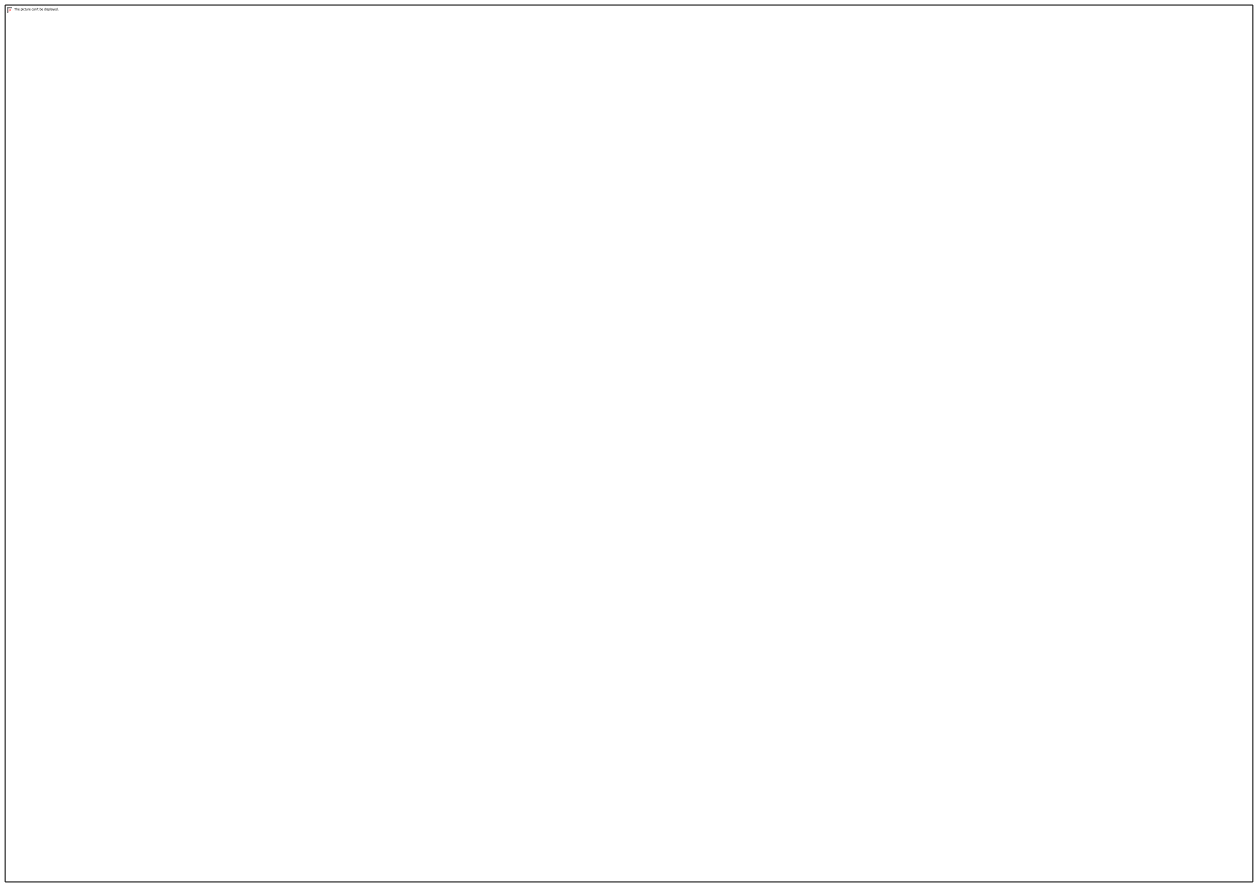
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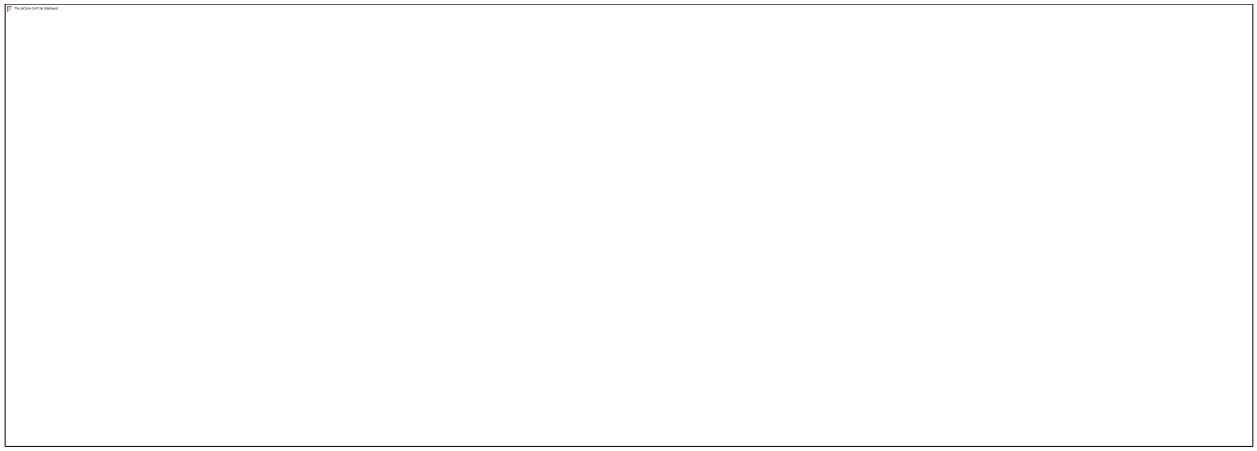

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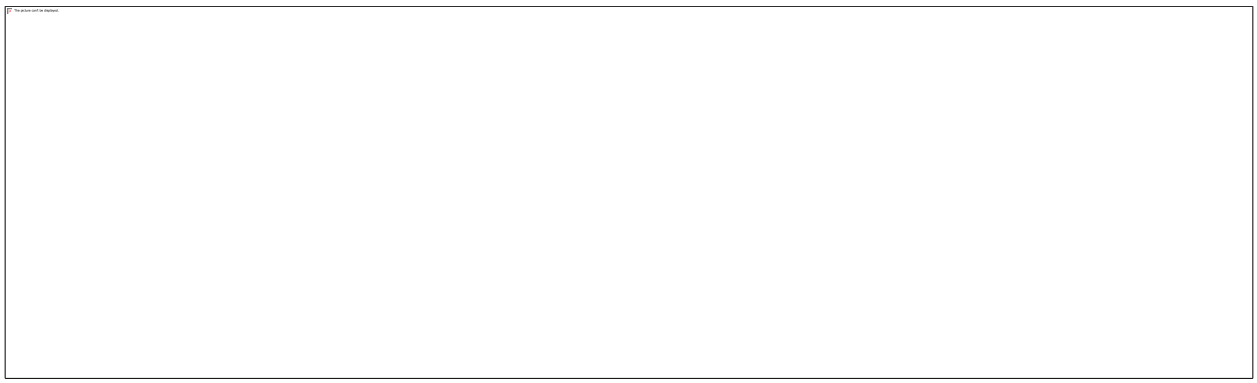
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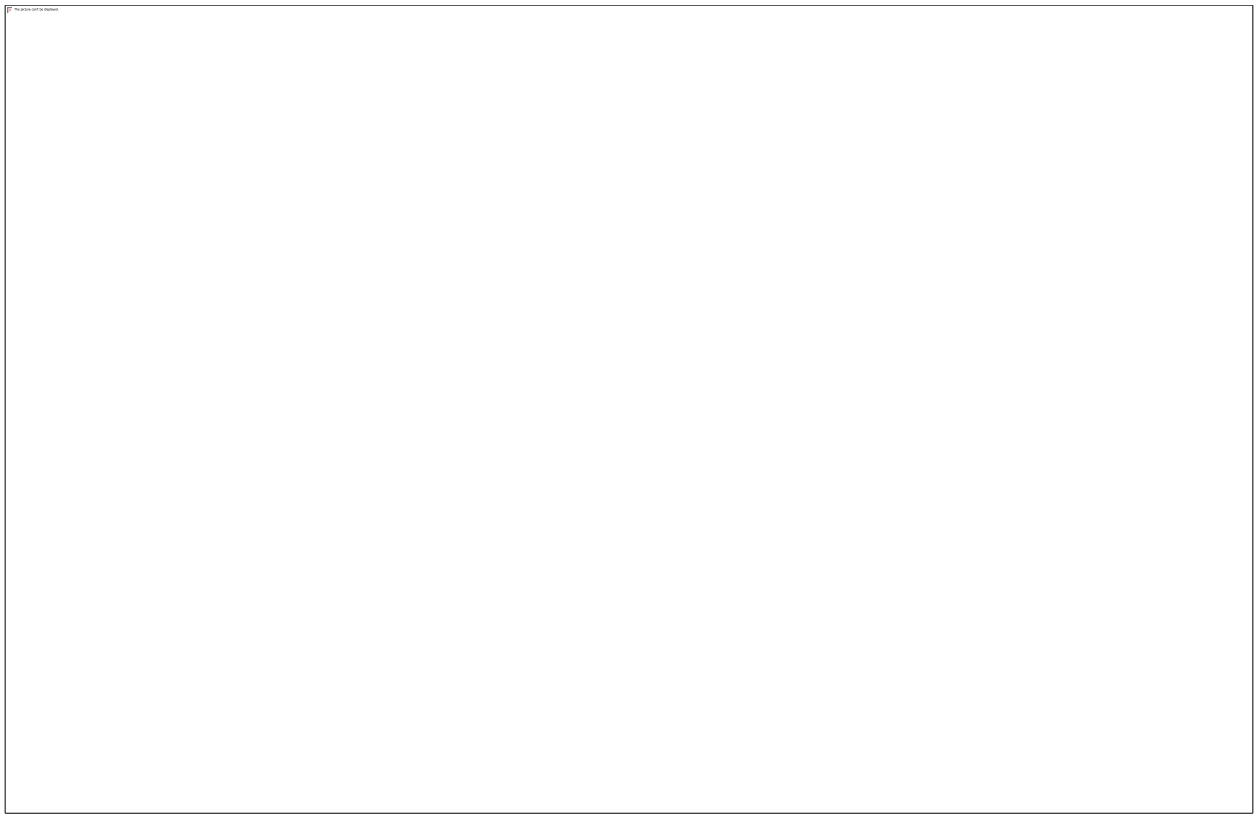

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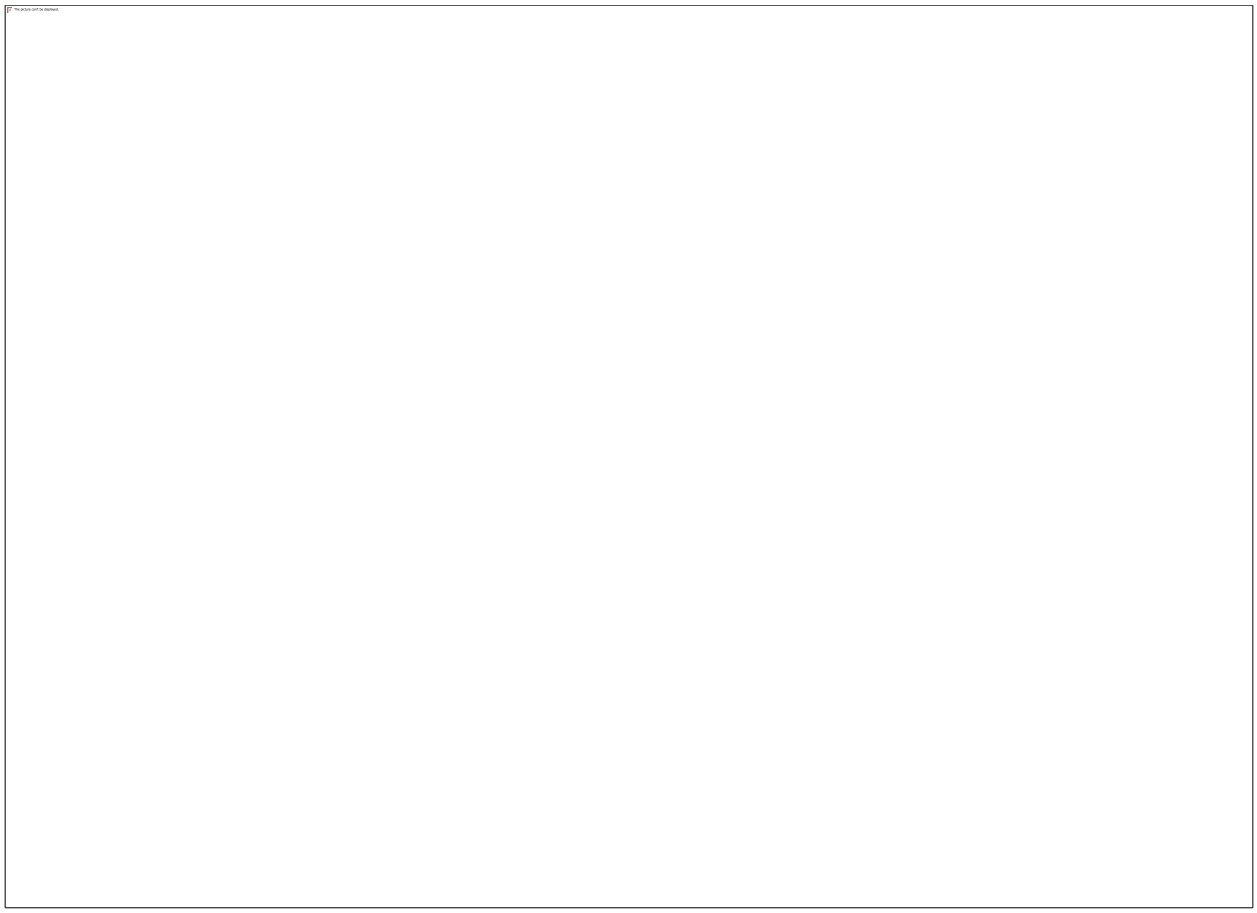

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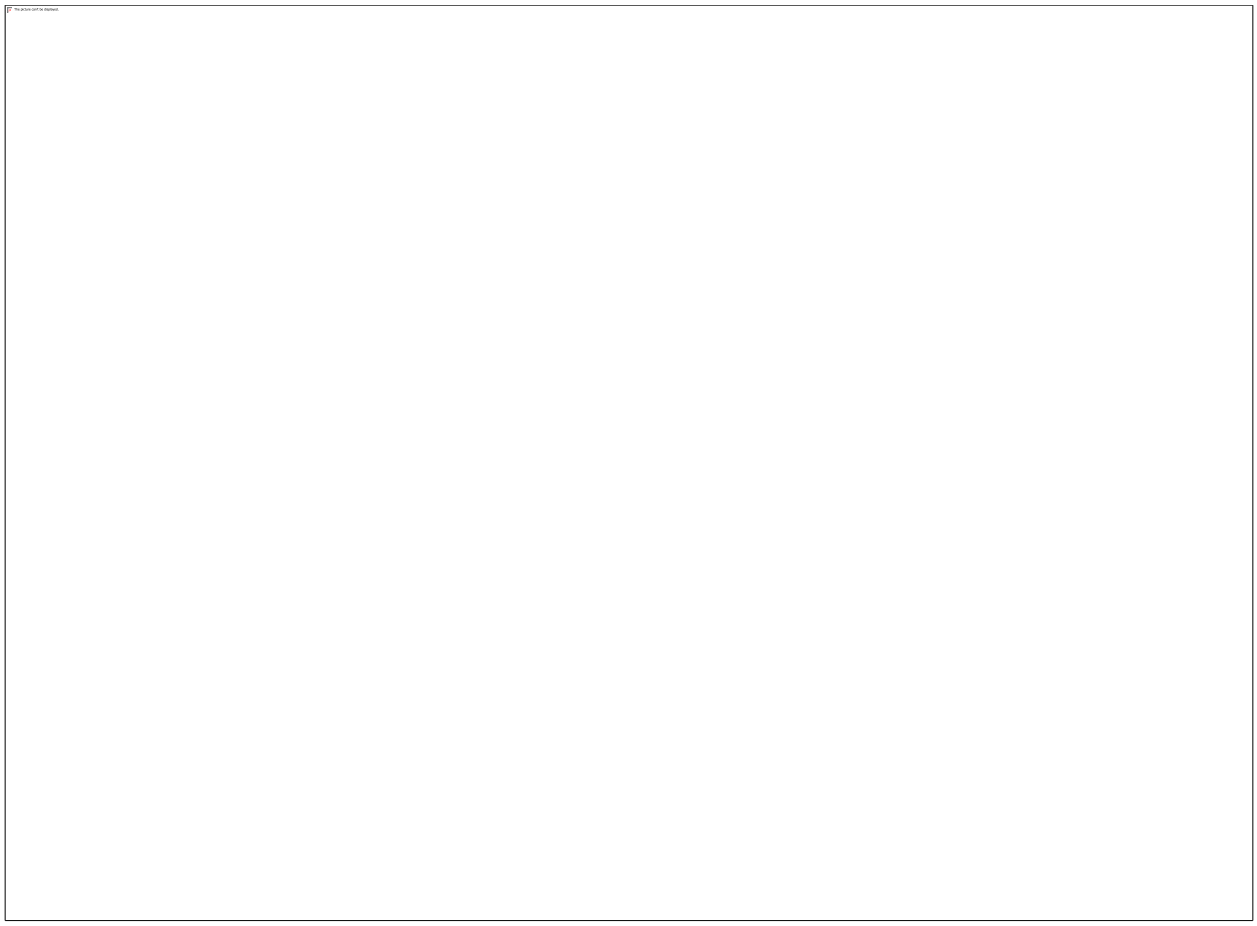
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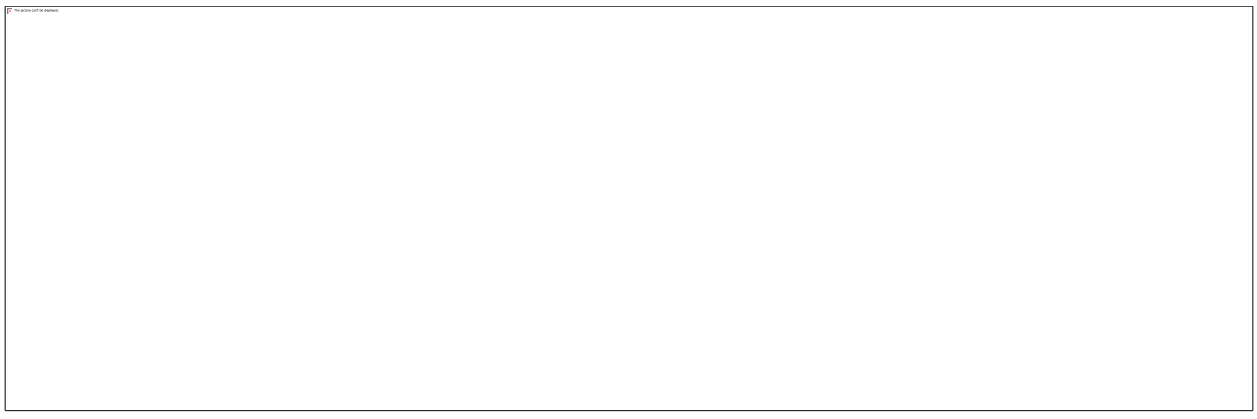
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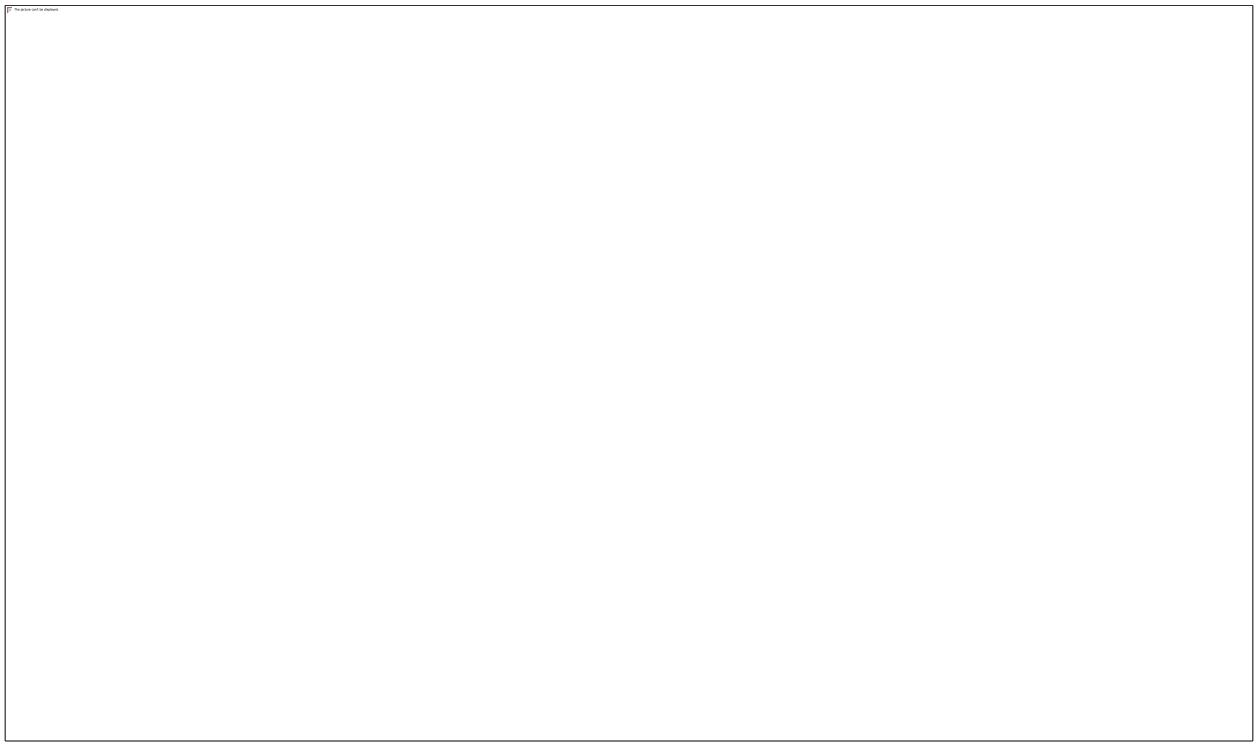
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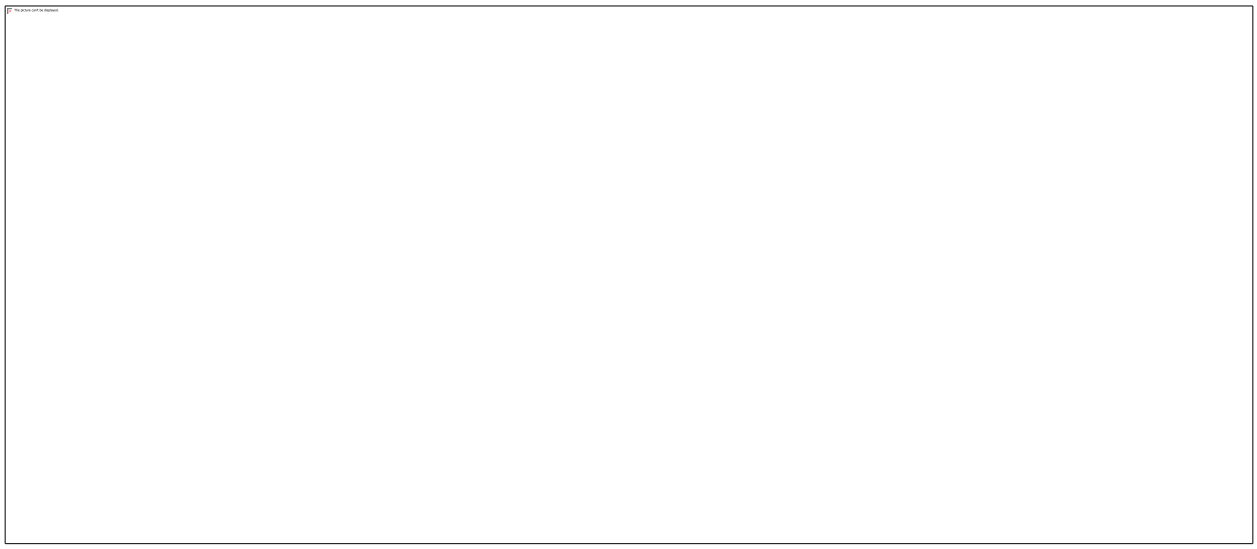

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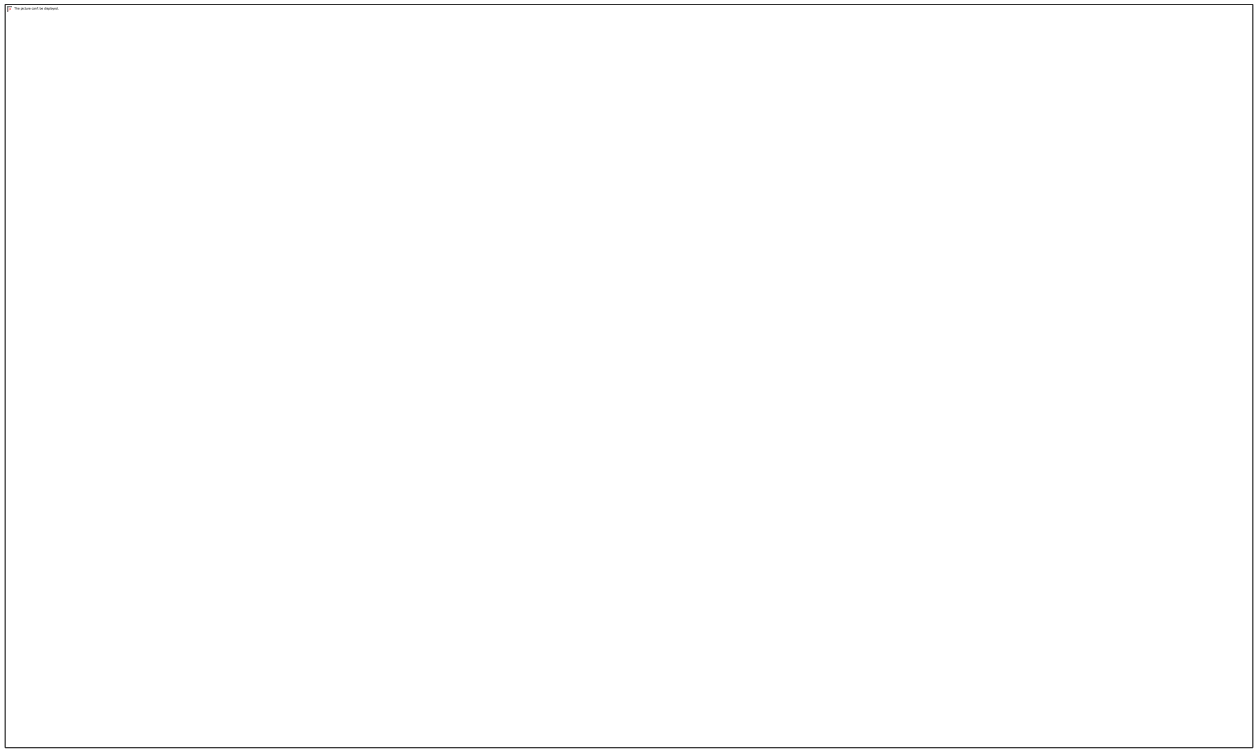
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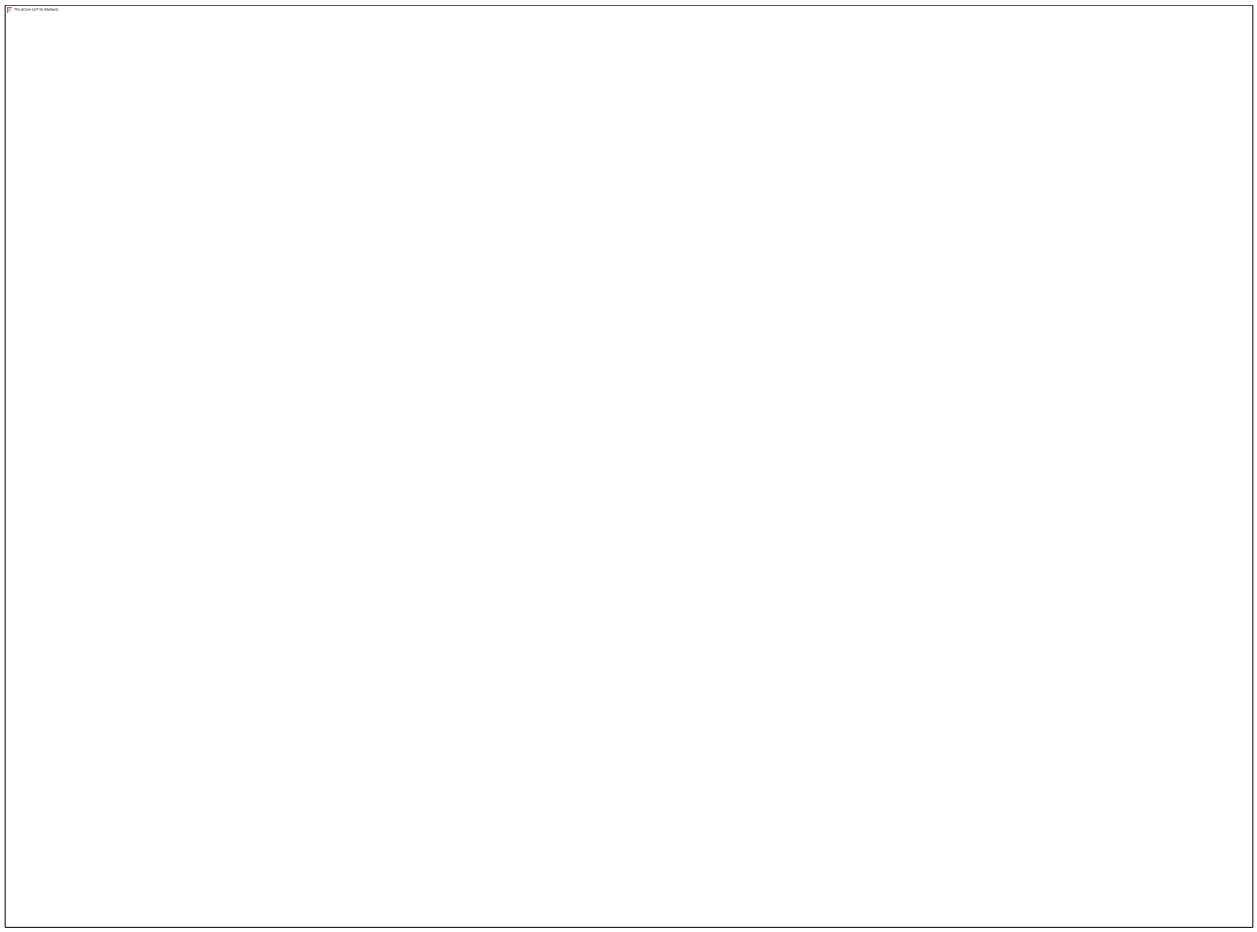

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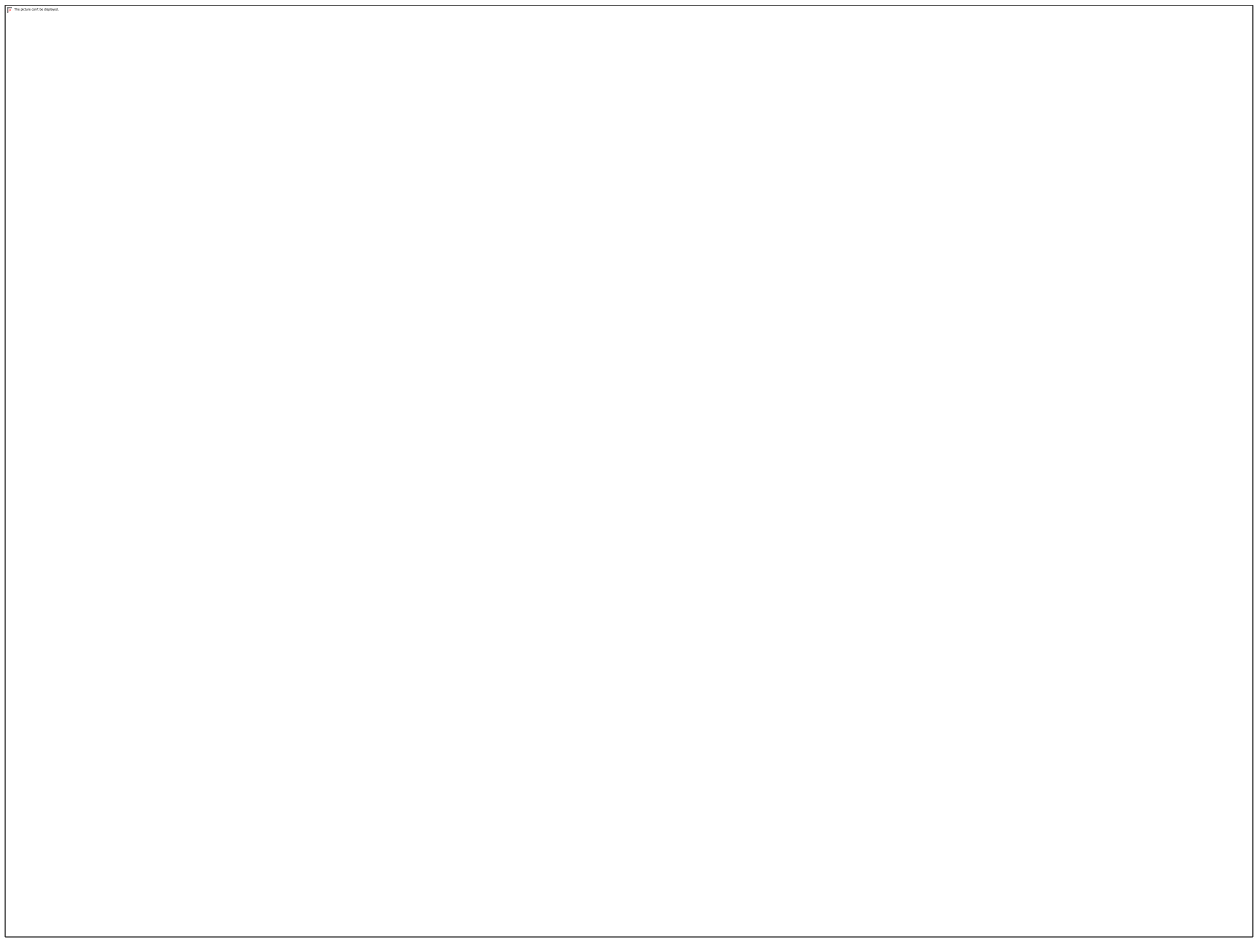

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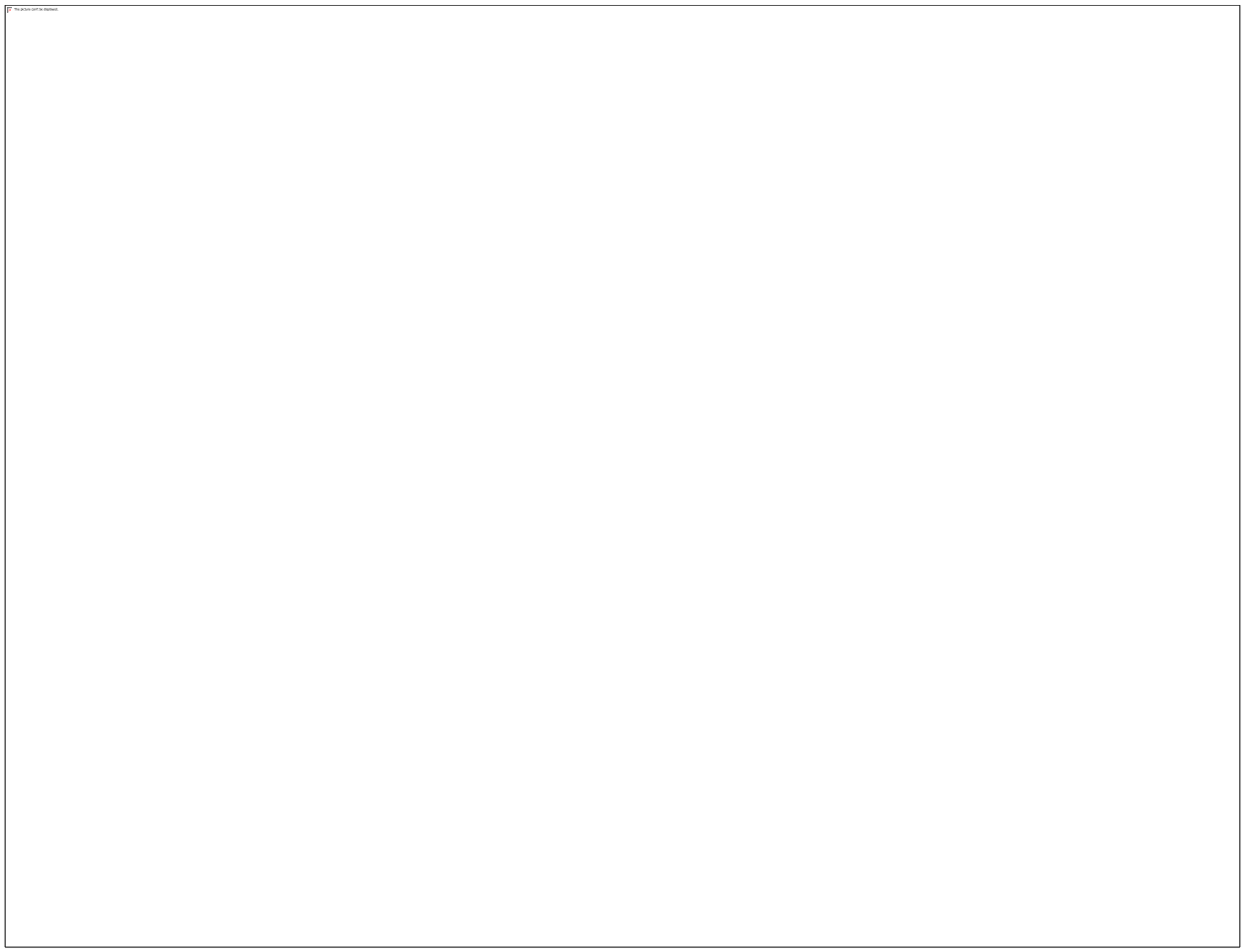

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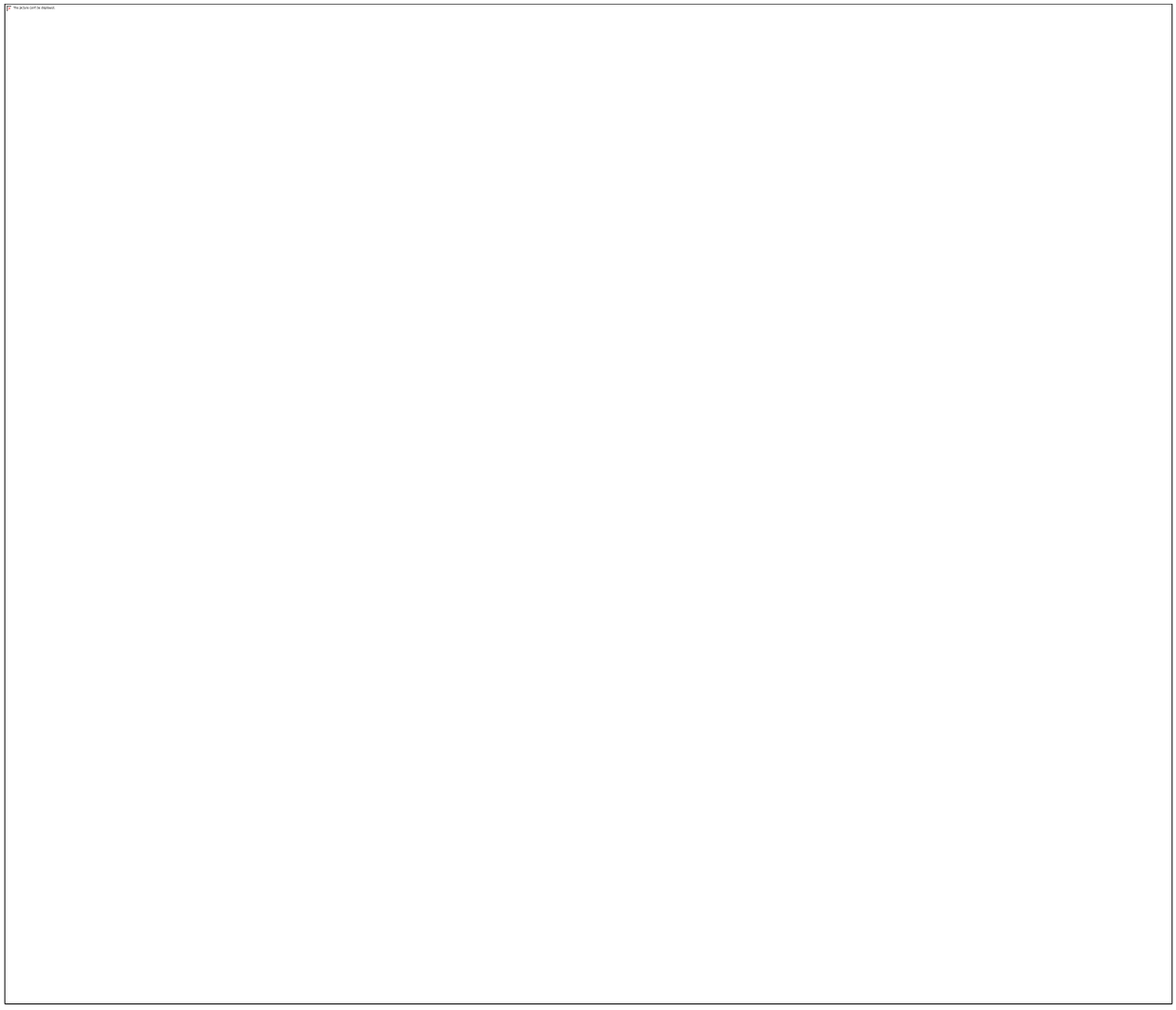

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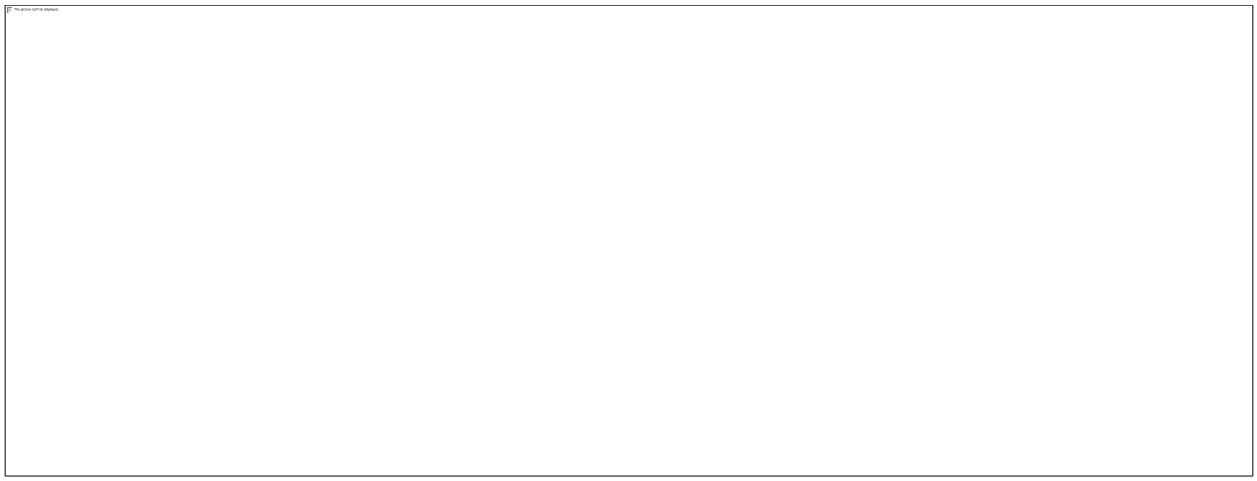
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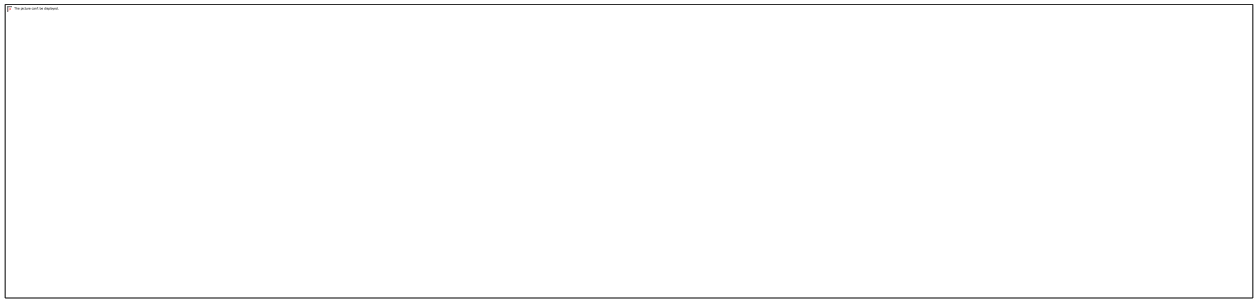
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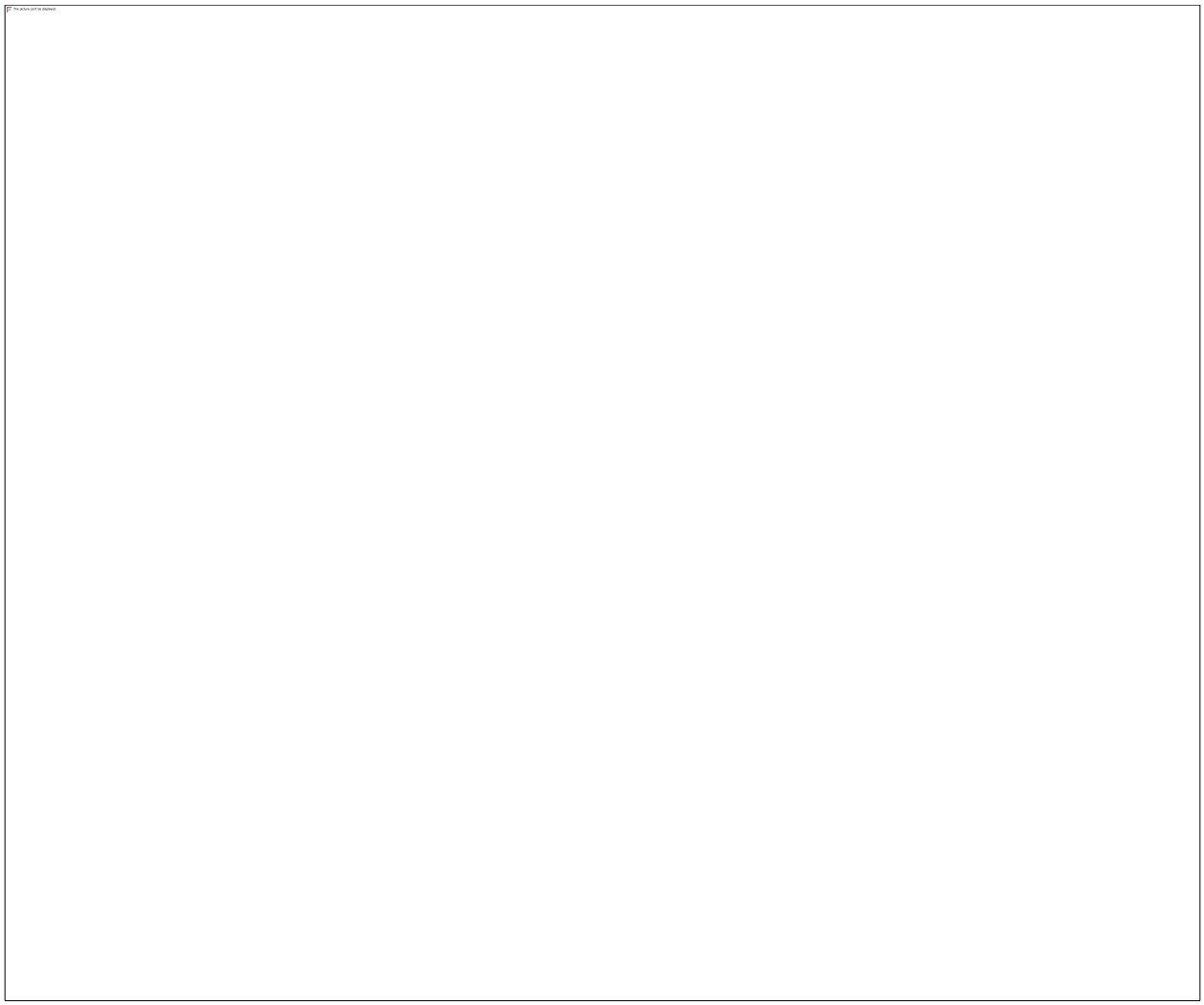

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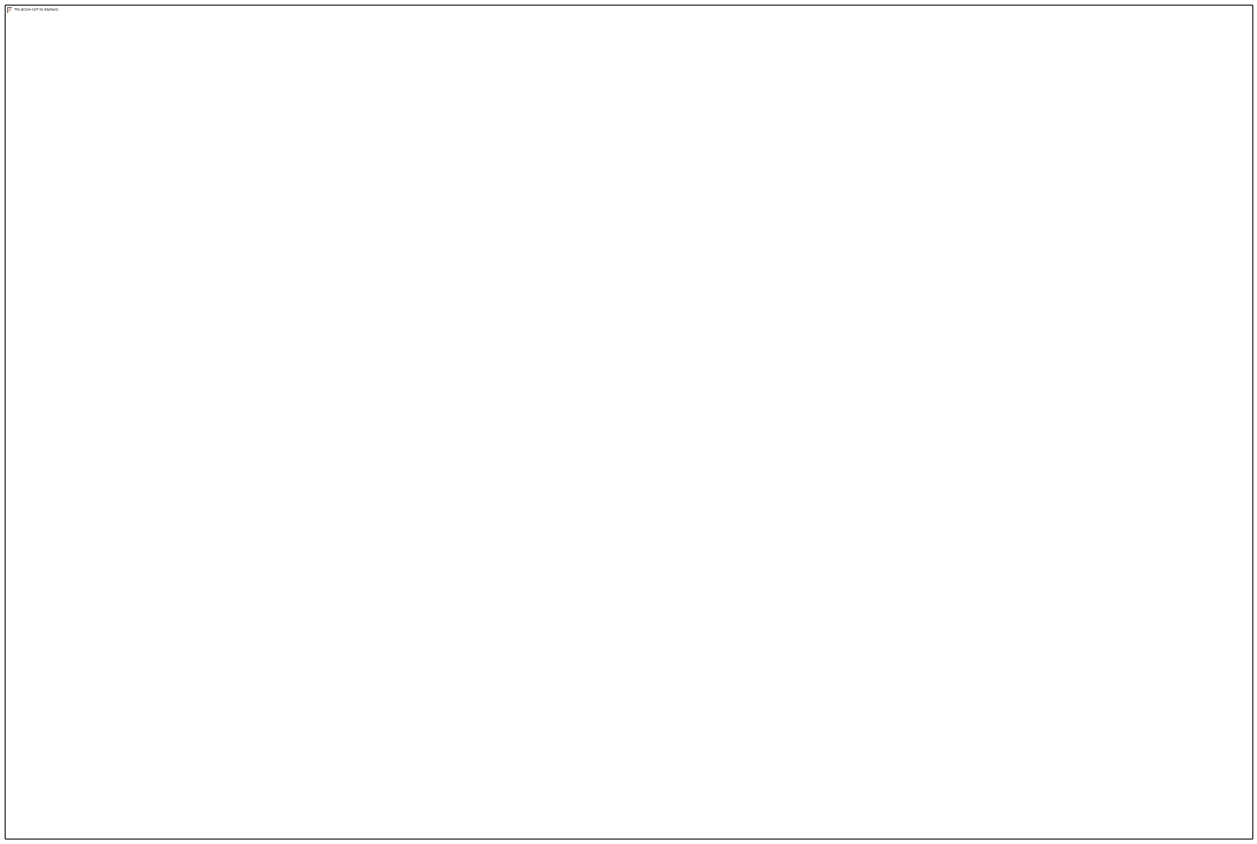
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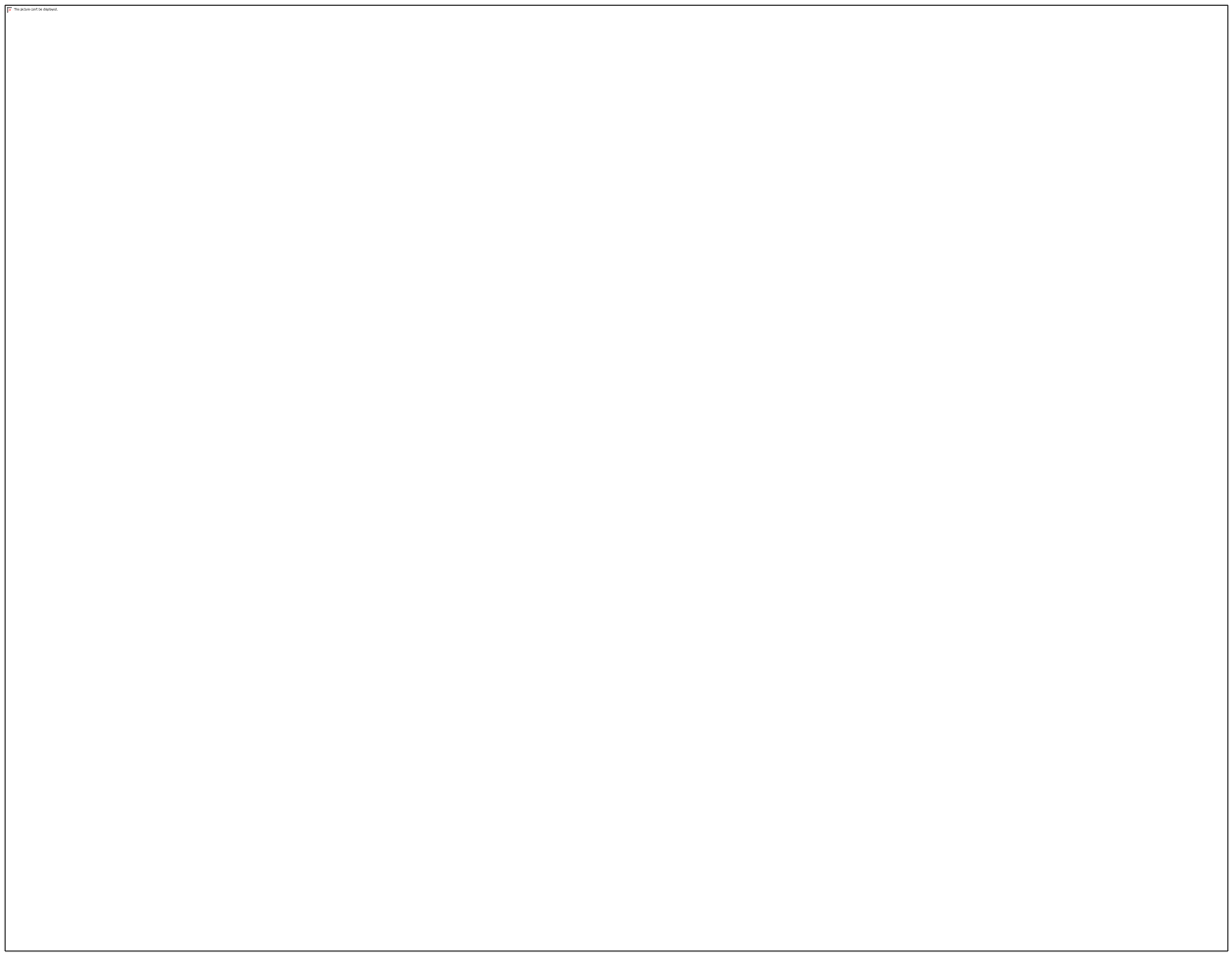
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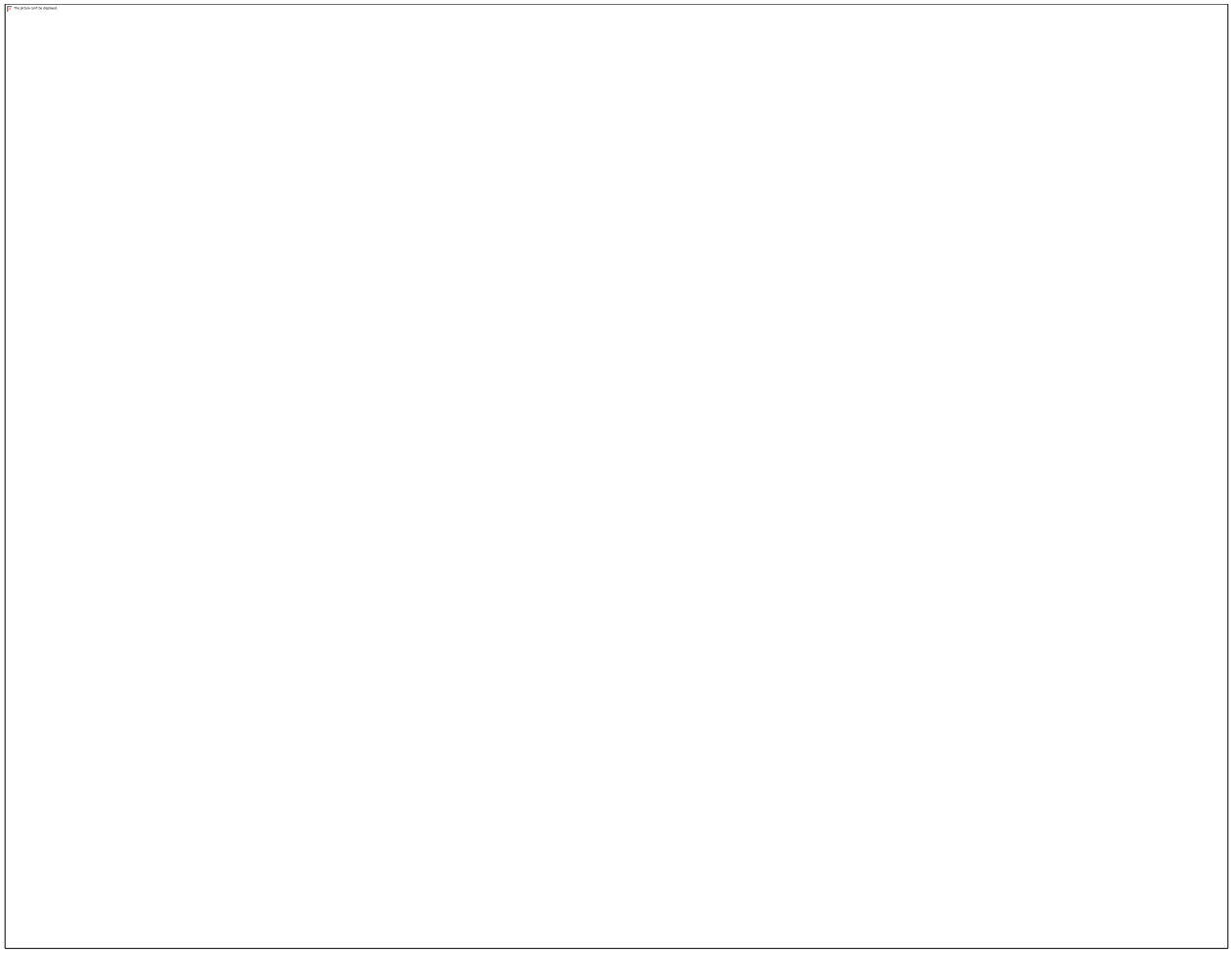

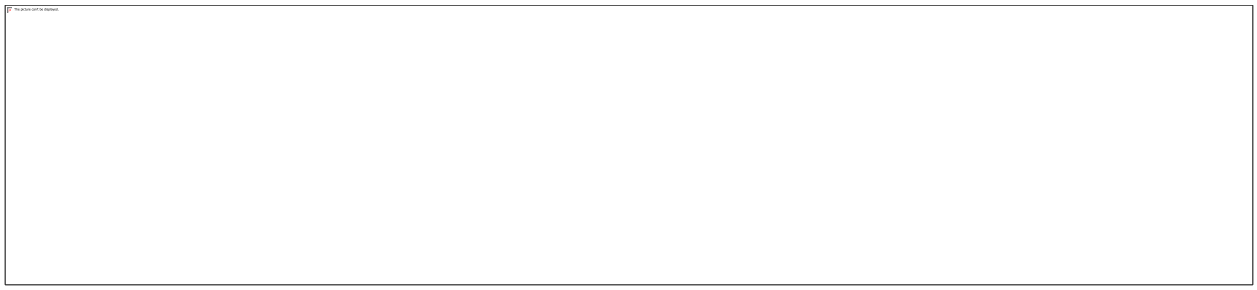

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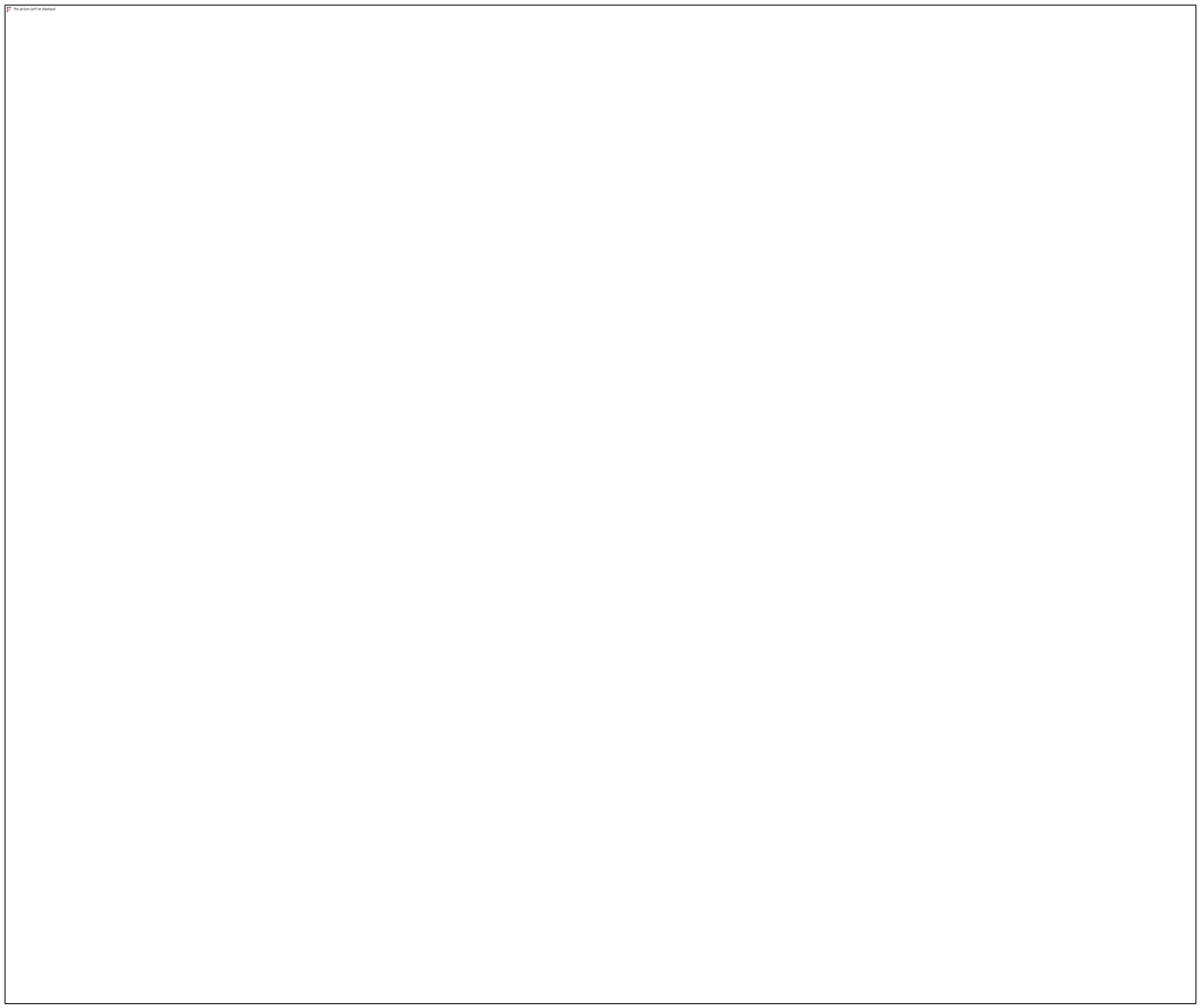

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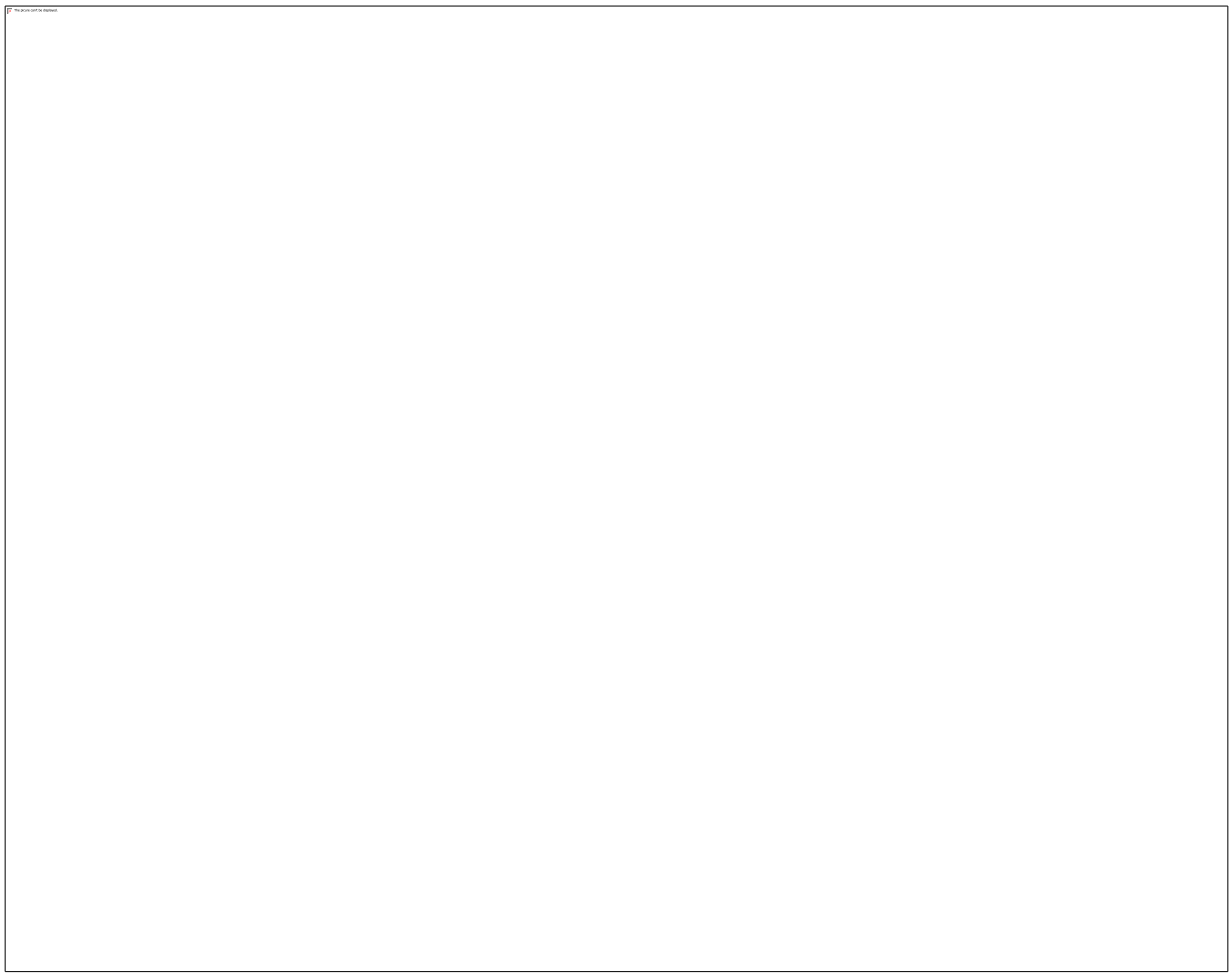
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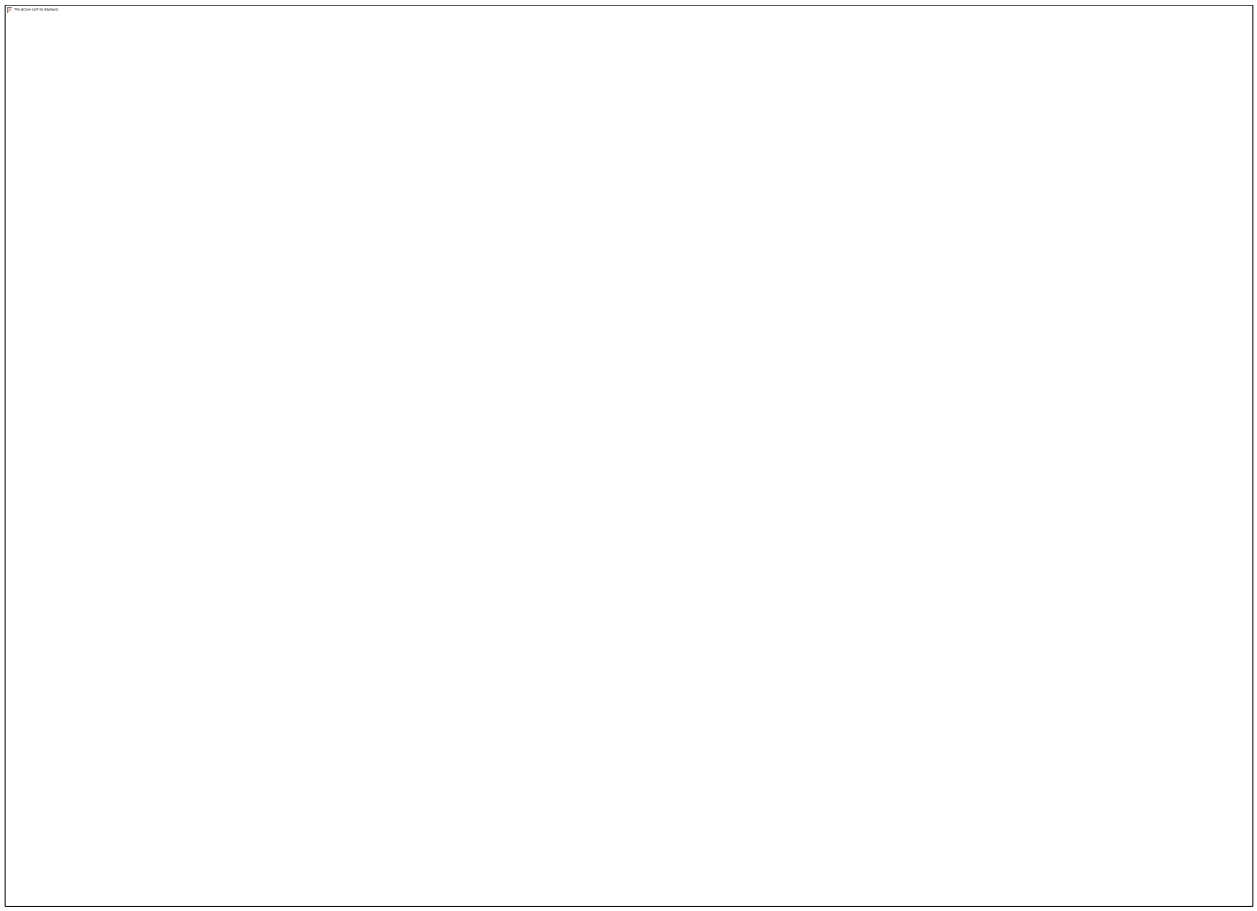
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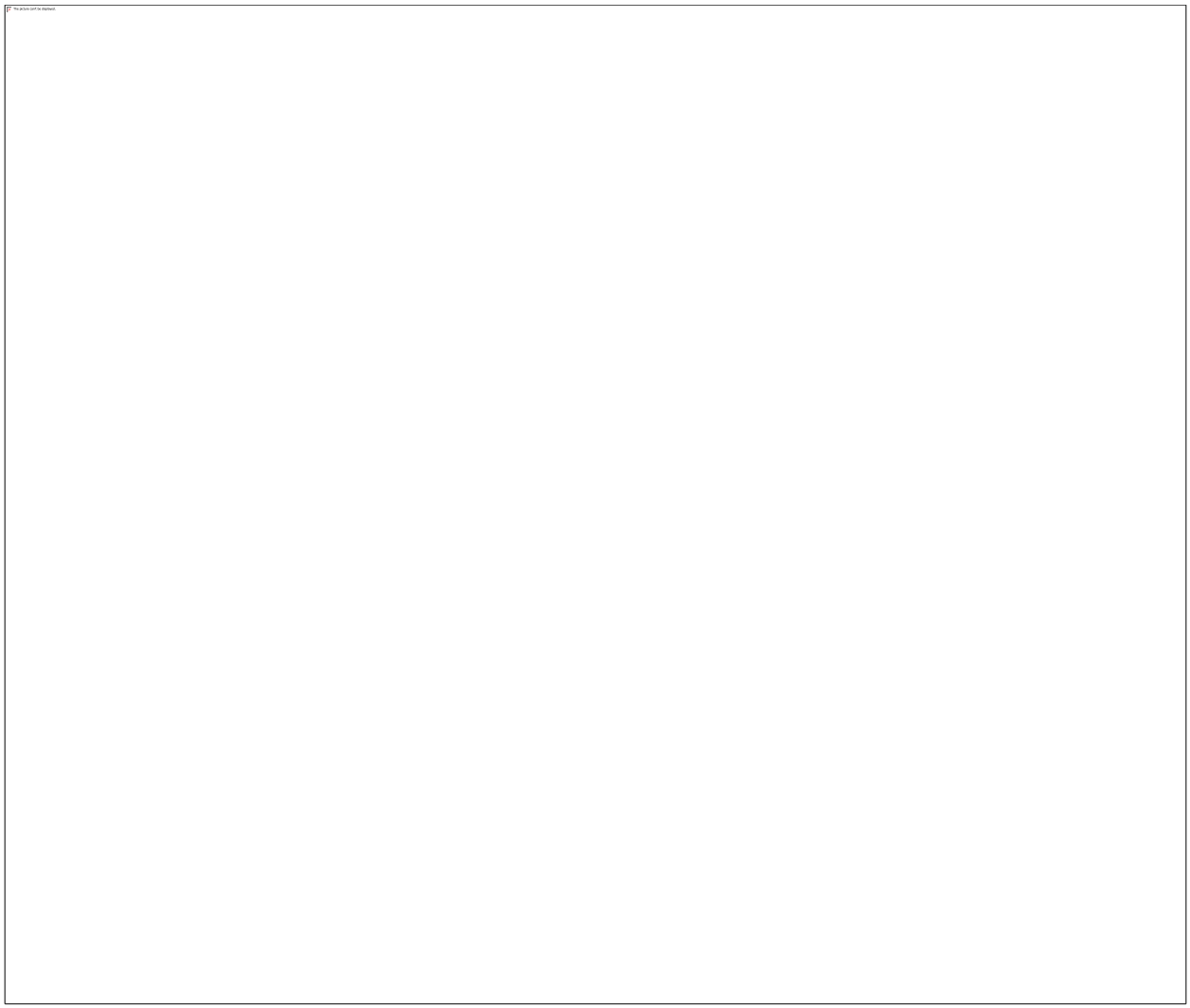

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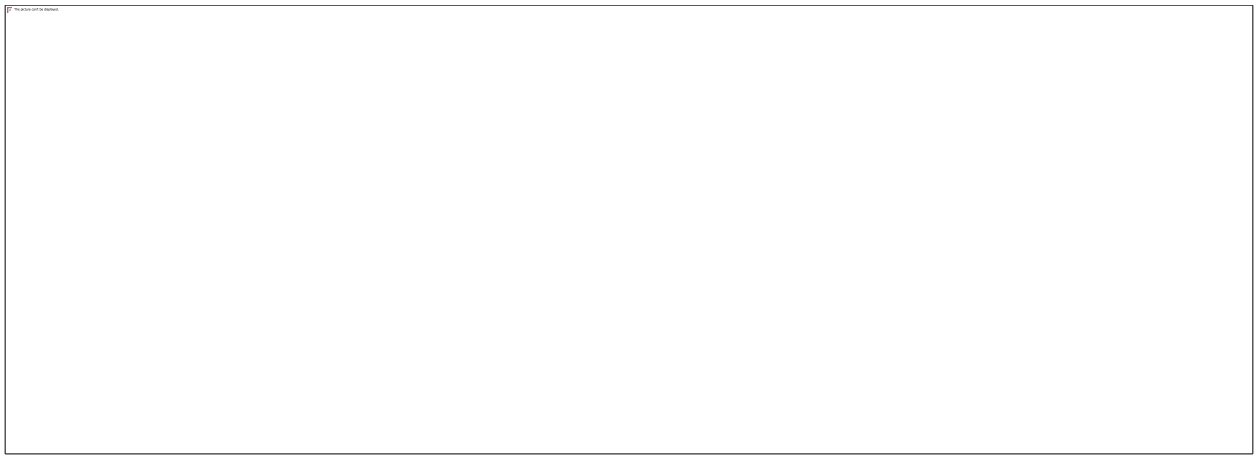

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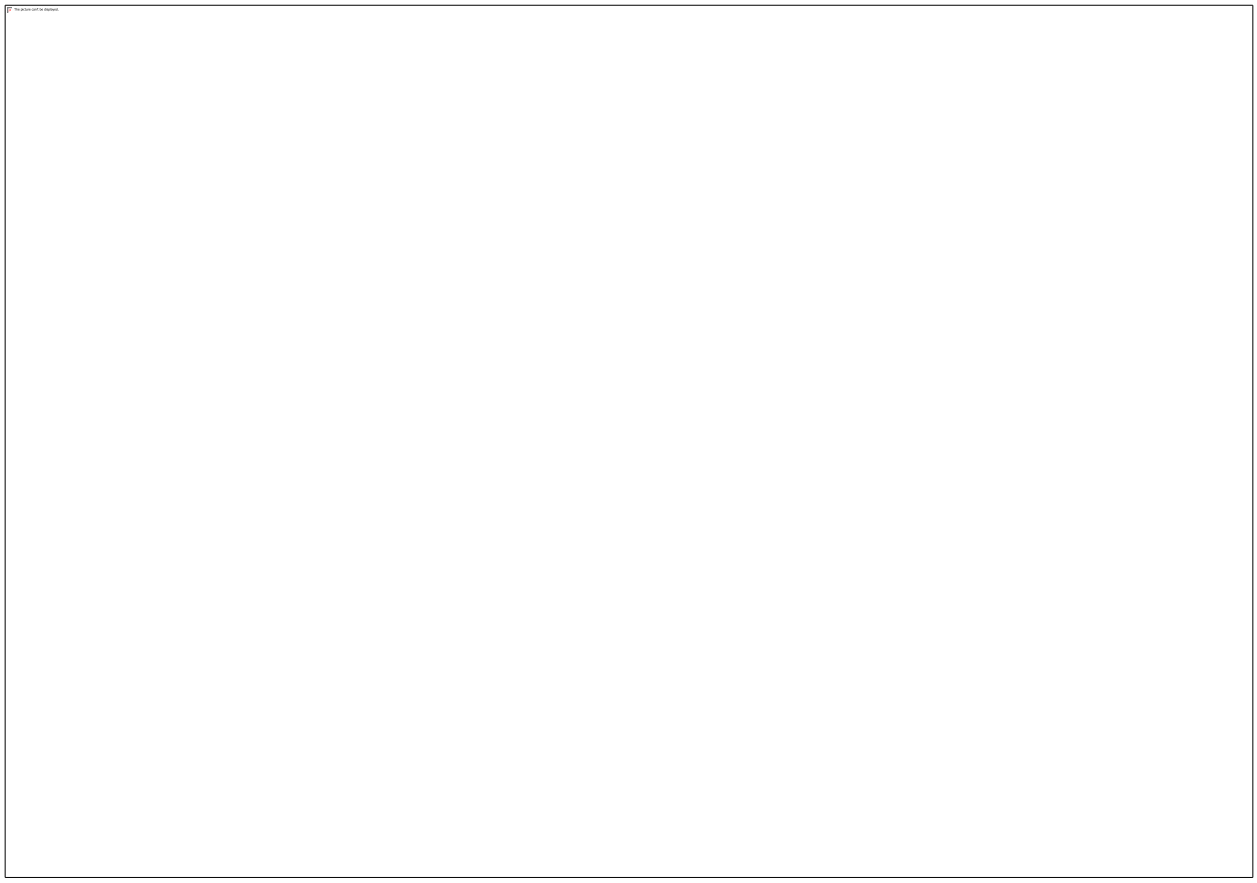

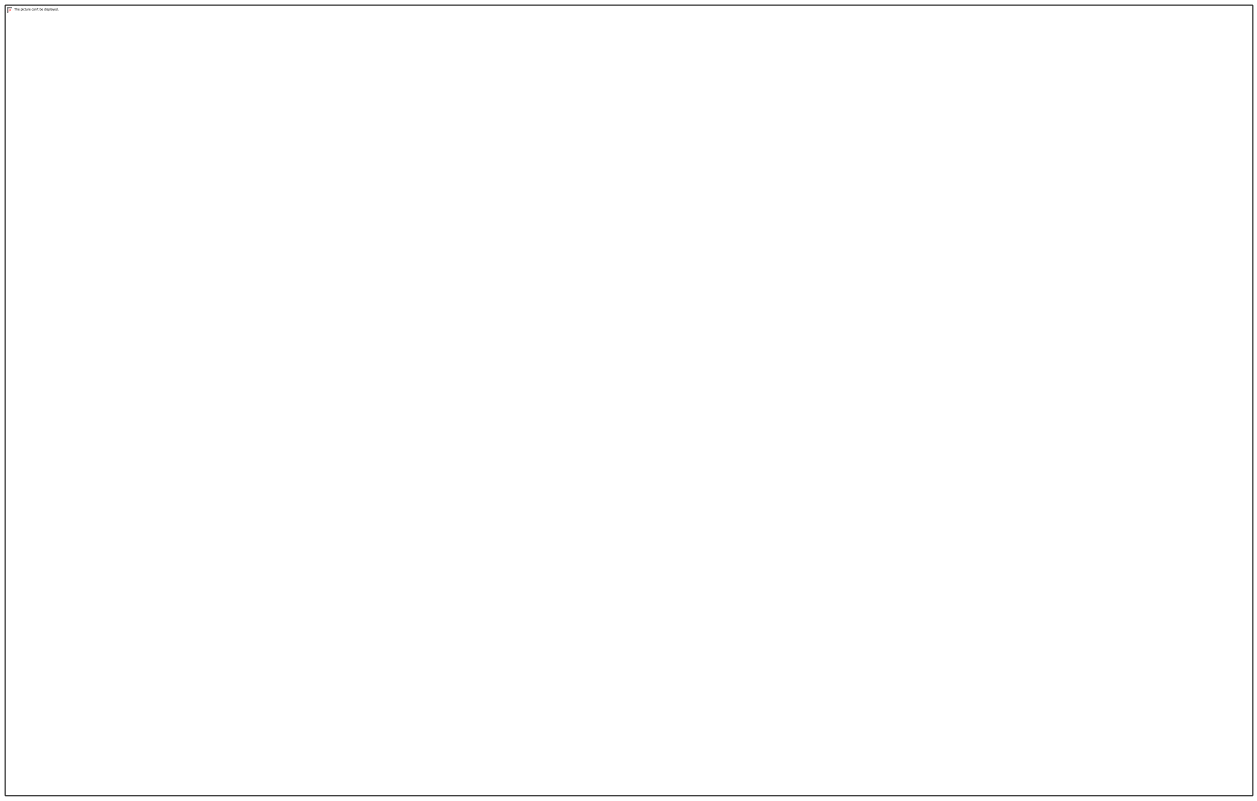

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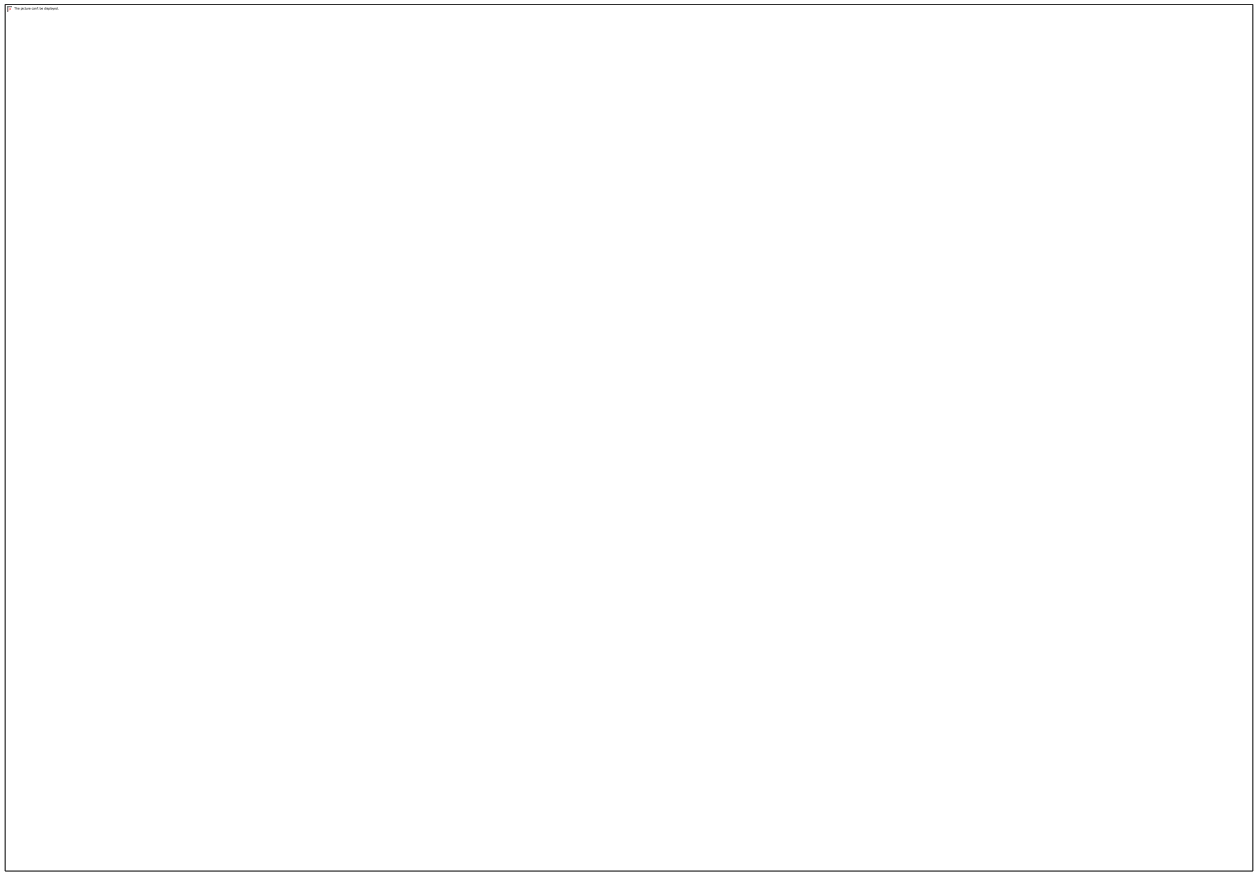

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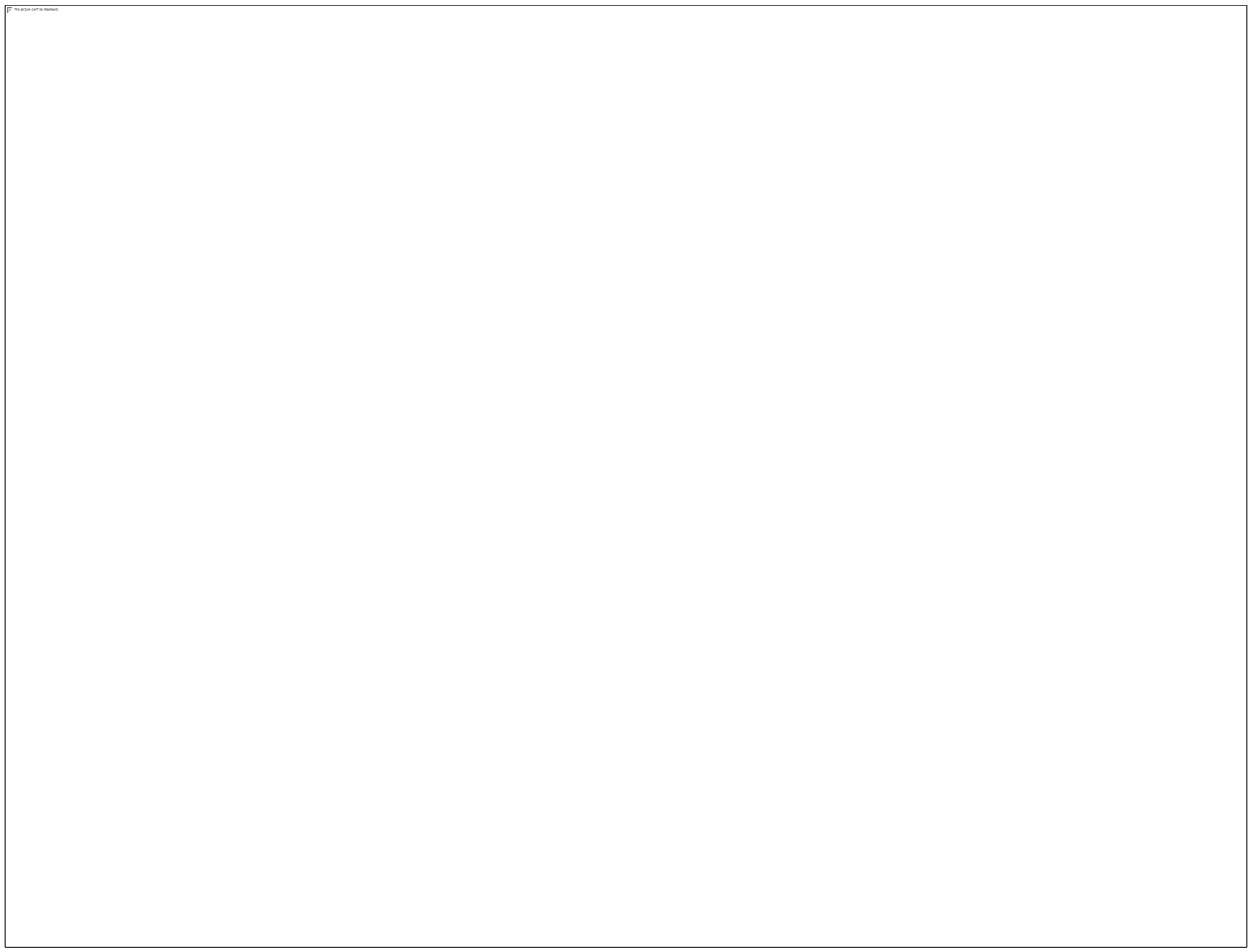
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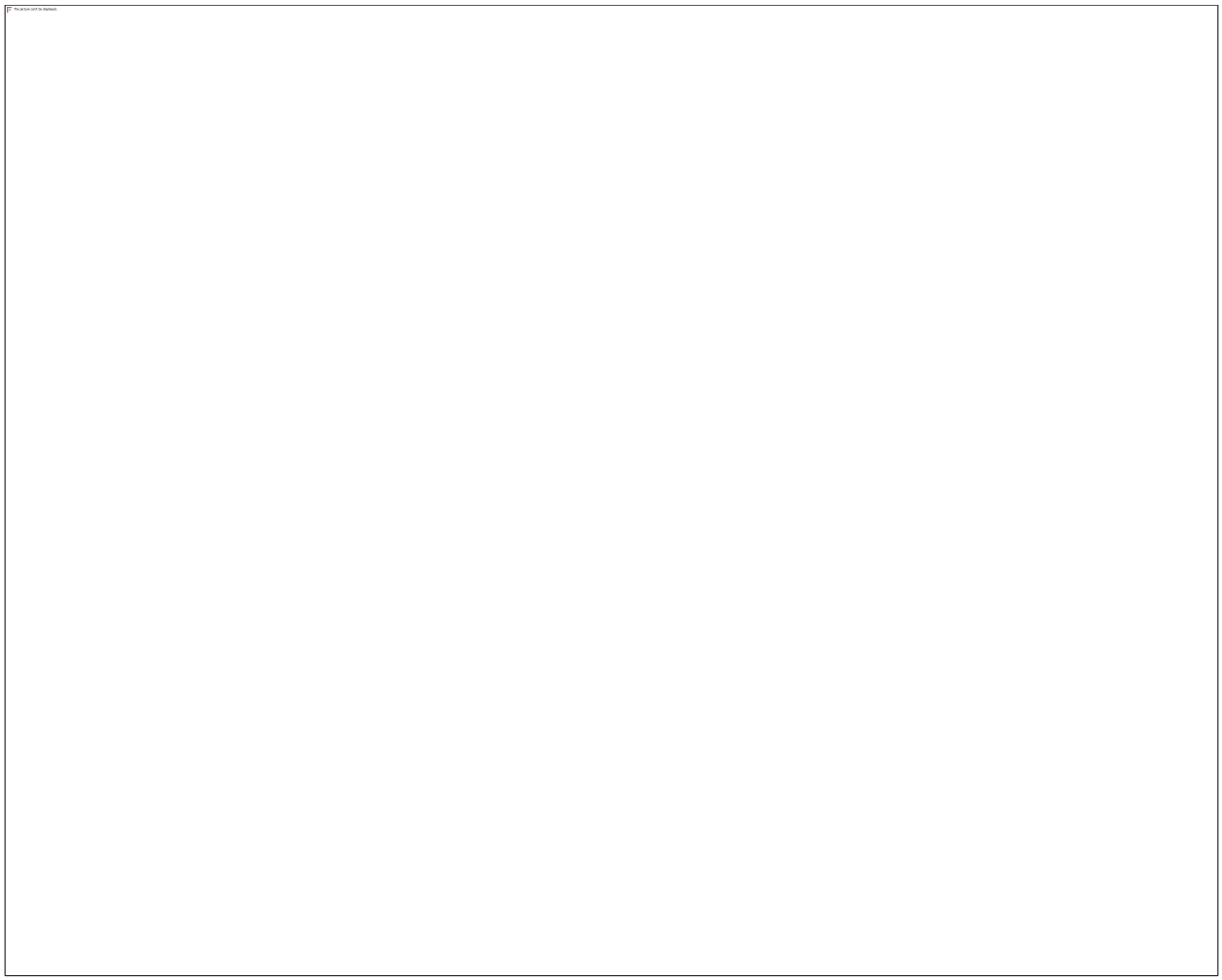
Question Number	Scheme	Marks
3. **(a)**	$ar = 750$ and $ar^4 = -6$ (could be implied from later working in either (a) or (b)).	B1
	$r^3 = \frac{-6}{750}$	M1
	$r = -\frac{1}{5}$ Correct answer from no working, except for special case below gains all three marks.	A1
		(3)
(b)	$a(-0.2) = 750$	M1
	$a\left\{=\frac{750}{-0.2}\right\} = -3750$	A1 ft
		(2)
(c)	Applies $\frac{a}{1-r}$ correctly using both their a and their $\lvert r\rvert < 1$. Eg. $\frac{-3750}{1--0.2}$	M1
	So, $S_\infty = -3125$	A1
		(2)
		[7]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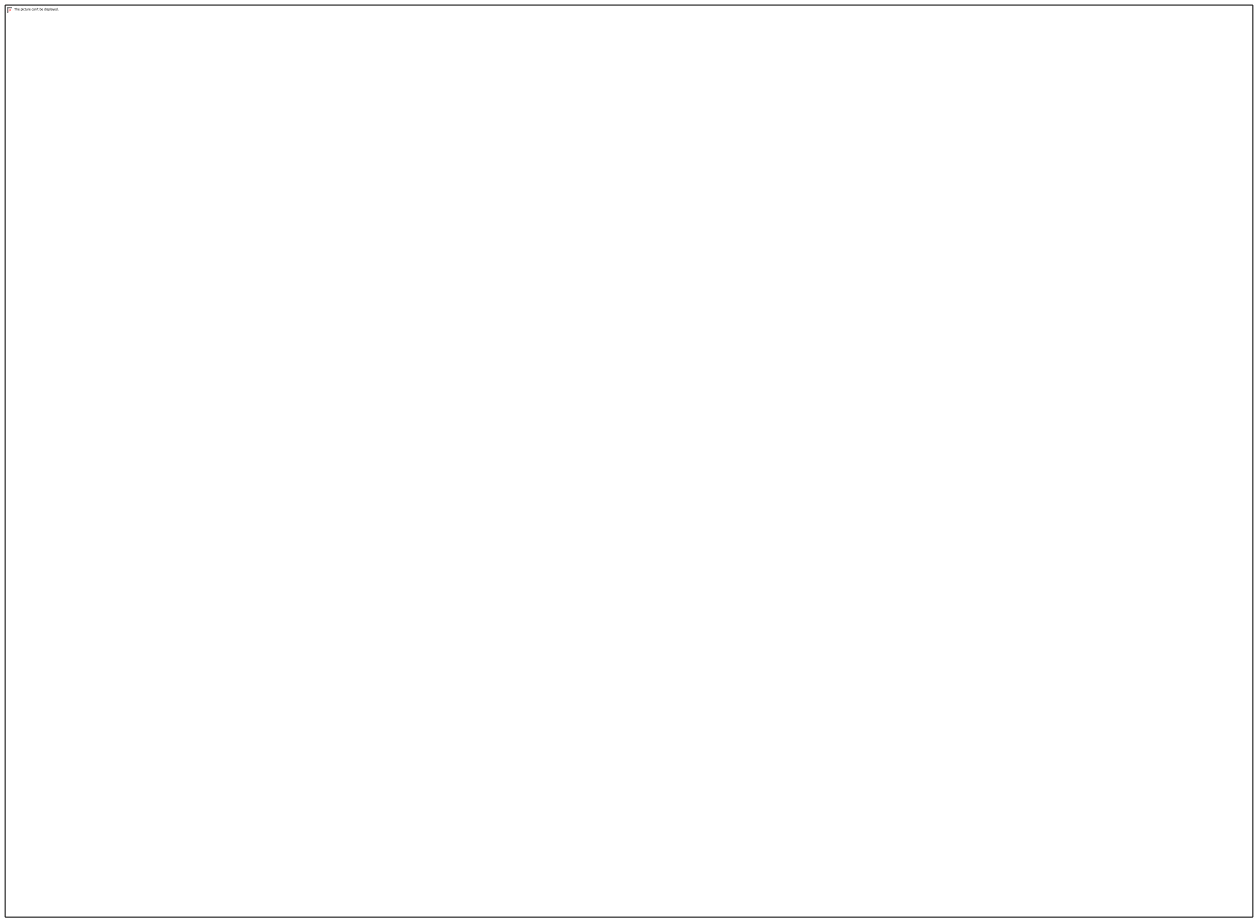


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