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Department: Mechatronics Engineering

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Ia and Ib

1200 gal of water

150 lb of salt $\Rightarrow M_{out}$

In = 50 gal each containing $(1 + \sin t)$ $\frac{lb}{gal}$

Out = 30 gal/min

$$\frac{dM}{dt} = M_{in} - M_{out}$$

$$M_{in} = \frac{50 \text{ gal}}{\text{min}} \times (1 + \sin t) \frac{lb}{gal} = 50(1 + \sin t)$$

$$M_{out} = \frac{30}{200} = 0.025 = 2.5\% \text{ of } M$$

$$\frac{dM}{dt} = 50(1 + \sin t) - 2.5\% \text{ of } M$$

$$\frac{dM}{dt} = 50(1 + \sin t) - 0.025M$$

Compare with $\frac{dy}{dx} + Py = Q$

$$\frac{dM}{dt} + 0.025M = 50(1 + \sin t)$$

$$\therefore P = 0.025$$

$$I.F = e^{\int P dt} = e^{0.025at} = e^{0.025t}$$

$$M \cdot I.F = \int Q \cdot I.F dt = \int (50 + 50 \sin t) \cdot e^{0.025t}$$

$$R.H.S \Rightarrow \int 50(1 + \sin t) \cdot e^{t/40} dt$$

$$= 50 \int e^{t/40} (\sin t + 1) dt$$

$$\Rightarrow \int e^{t/40} (\sin t + 1) dt$$

$$\text{let } u = \frac{t}{40}; \frac{du}{dt} = \frac{1}{40}; dt = 40 du$$

$$= \int e^u (\sin(40u) + 1) 40 du$$

$$\Rightarrow 40 \int e^u (\sin(40u) + 1) du$$

$$f'g' = fg - \int f'g$$

$$\text{let } f = \sin(40u) + 1; g' = e^u$$

$$f' = 40 \cos(40u); g = e^u$$

$$= e^u (\sin(40u) + 1) - \int 40e^u \cos(40u) du$$

$$\downarrow$$
$$40e^u \cos(40u) du = 40 \int e^u \cos(40u) du$$

$$= e^u \cos(40u) du$$

$$\therefore \int f'g' = fg - \int f'g$$

$$f = \cos(40u); g' = e^u$$

$$f' = -40 \sin(40u); g = e^u$$

$$\Rightarrow e^u \cos(40u) - \int -40e^u \sin(40u) du$$

$$\Rightarrow e^u \cos(40u) - (-40e^u \sin(40u)) -$$

$$\int -1600e^u \cos(40u) du$$

$$\Rightarrow e^u \cos(40u) - (-40e^u \sin(40u)) +$$

$$1600 \int e^u \cos(40u) du$$

$$\Rightarrow 40e^u \sin(40u) + e^u \cos(40u)$$

1601

$$\text{recall } \int e^u \cos(40u) du$$

$$\Rightarrow 40(40e^u \sin(40u) + e^u \cos(40u))$$

1601

$$\frac{e^u (\sin(40u) + 1) - 40(40e^u \sin(40u)) + e^u \cos(40u)}{1601}$$

multiply through by 40

$$\frac{40e^u (\sin(40u) + 1) - 1600(40e^u \sin(40u)) + e^u \cos(40u)}{1601}$$

recall that $u = t/40$

$$\frac{40^{t/40} (\sin t + 1) - 1600(40^{t/40} \sin t + e^{t/40} \cos t)}{1601}$$

multiply through by 50

$$\frac{2000e^{t/40} (\sin t + 1) - 80000(40^{t/40} \sin t + e^{t/40} \cos t) + C}{1601}$$

$$\frac{2000e^{t/40} (\sin t + 1) - 80000(40^{t/40} \sin t + e^{t/40} \cos t) + C}{1601}$$

$$\frac{2000e^{t/40} (\sin t - 40 \cos t + 1601) + C}{1601}$$

$$\frac{m e^{0.025t} = 2000e^{t/40} (\sin t - 40 \cos t + 1601) + C}{1601}$$

at $t=0$ (initially) $- m = 150$

let $C = m_0$

$$m_0 = m e^{0.025 \cdot 0} - 2000(1)(1 - 40 + 1601)$$

$$m_0 = -1800.03123$$

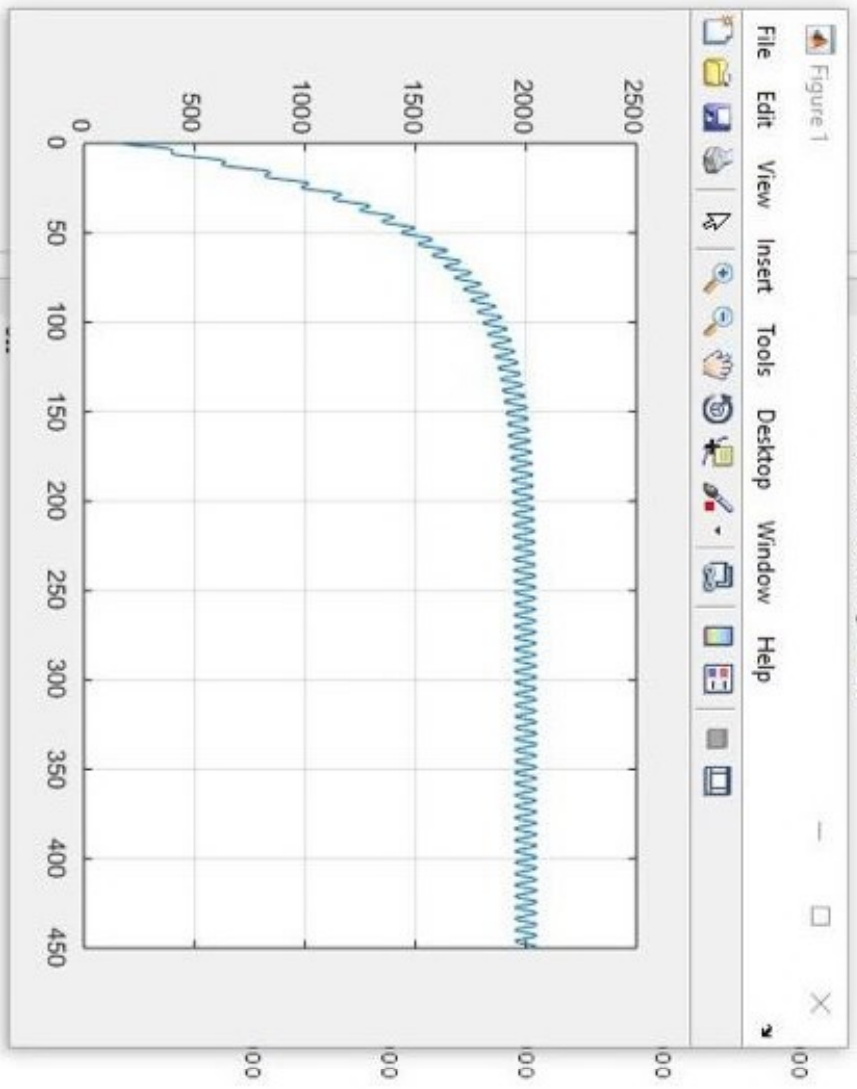
$$m = \frac{2000e^{t/40} (\sin t - 40 \cos t + 1601) - 1800.03123}{1601}$$

$$m = \frac{2000e^{t/40} (\sin t - 40 \cos t + 1601) - 1800.03123}{1601 \times (e^{t/40})}$$

```

1 - CommandWindow
2 - clear
3 - clc
4 - close all
5 - syms m t
6 - ans=dsolve('Dm+0.025*m=50+50*sin(t)', 'm(0)=150')
7 - t=0:0.5:450
8 - tn=subs(ans,t)
9 - plot(t,tn)
10 - grid on

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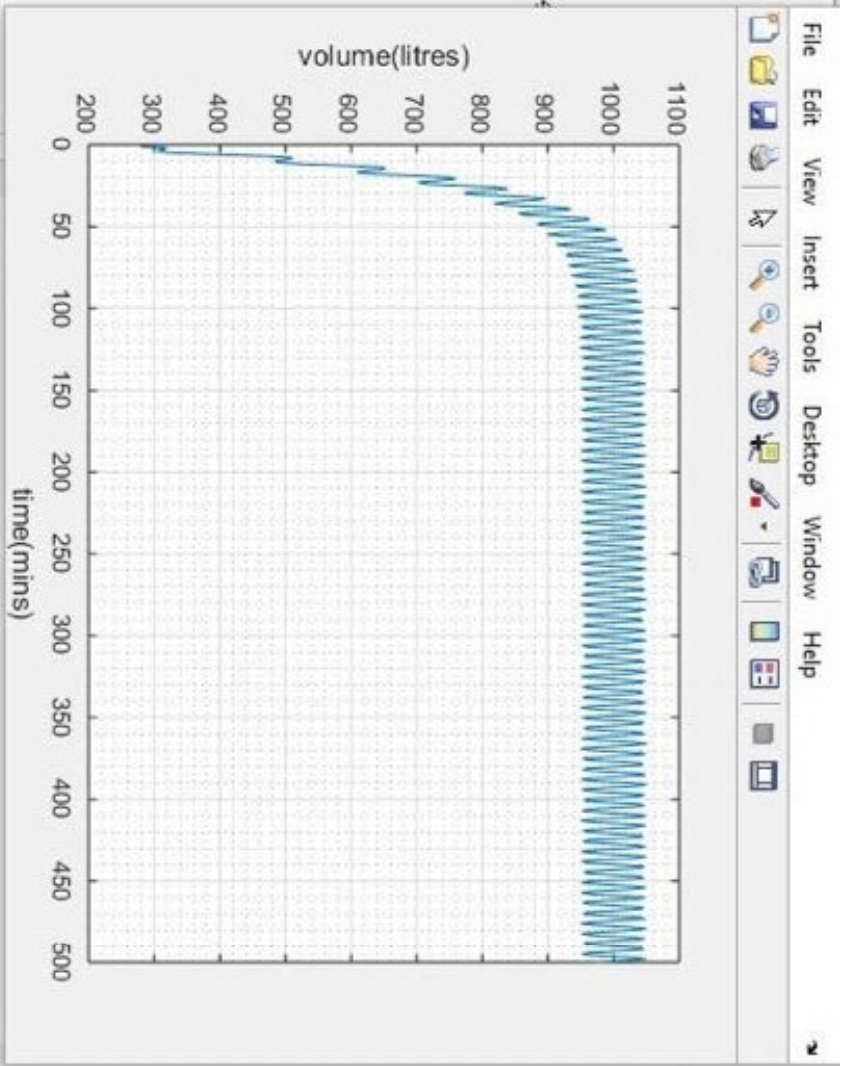
>> [ 150, 2000 - (2000+1601^(1/2))*cos(atan(1/40) + 1/2)]/1.

```

```

1 - commandwindow
2 - clear
3 - clc
4 - close all
5 - syms t
6 - values=[]
7 - t=1:1:500
8 - mean=1000-(exp(-0.05*t))*800)
9 - y=1000+(50/1.0025)*sin(t)+(2.5/1.0025)*cos(t)-((exp(-0.05*t))*802.4
10
11 - if rem(t,2) ==0
12 -     values=[values,mean]
13 - else
14 -     values=[values,y]
15 - end
16 - excelvalues=transpose(values)
17 - mins=transpose(t)
18 - plot(t,values)
19 - grid on
20 - grid minor
21 - xlabel('time(mins)')
22 - ylabel('volume(litres)')
23 - xlsxwrite('odevbesdata.xlsx',{'t(min)'},'veriller','A1')
24 - xlsxwrite('odevbesdata.xlsx',mins,'veriller','A2')
25 - xlsxwrite('odevbesdata.xlsx',{'V(litre)'},'veriller','B1')
26 - xlsxwrite('odevbesdata.xlsx',excelvalues,'veriller','B2')
27

```



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498
499
500

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Alignment

Number

Cond Forms

	A	B	C	D	E	F	G	H	I	J	K	L
1	t(min)	v(litre)										
2		279.9639										
3		313.8601										
4		327.9009										
5		469.1423										
6		506.5922										
7		487.1398										
8		604.2824										
9		651.4694										
10		608.3676										
11		699.585										
12		759.541										
13		702.3679										
14		765.9535										
15		838.9333										
16		776.7953										
17		811.8028										
18		895.7197										
19		836.9388										
20		843.6308										
21		934.561										
22		886.318										
23		866.4219										
24		959.1673										
25		977.1558										

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Clipboard

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Alignment:

Number: General, Percentage, Decimals, Percentages and Decimals

Conditional Formatting

	A	B	C	D	E	F	G	H	I	J	K	L	M
25	48	927.1558											
26	50	883.9312											
27	52	972.6189											
28	54	960.76											
29	56	898.8906											
30	58	977.5784											
31	60	987.8325											
32	62	913.1659											
33	64	976.4171											
34	66	1008.72											
35	68	927.8846											
36	70	971.2768											
37	72	1023.612											
38	74	943.5523											
39	76	964.0851											
40	78	1032.697											
41	80	960.1637											
42	82	956.5397											
43	84	1036.269											
44	86	977.3165											
45	88	950.0748											
46	90	1034.797											
47	92	994.3264											
48	94	945.8226											
49	96	1028.956											

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[Align Left] [Align Center] [Align Right] [Justify] [Wrap Text]

[Merge & Center]

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Condition Formattin

	A	B	C	D	E	F	G	H	I	J	K	L
49	96	1028.956										
50	98	1010.344										
51	100	944.5792										
52	102	1019.626										
53	104	1024.467										
54	106	946.7823										
55	108	1007.857										
56	110	1035.849										
57	112	952.5074										
58	114	994.8122										
59	116	1043.787										
60	118	961.4843										
61	120	981.7003										
62	122	1047.803										
63	124	973.1357										
64	126	969.69										
65	128	1047.688										
66	130	986.6355										
67	132	959.8303										
68	134	1043.536										
69	136	1000.984										
70	138	952.9749										
71	140	1035.738										
72	142	1015.094										
73	144	949.7708										

Clipboard

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Alignment:

Number: General, %, %>, %<, %>>

Conditional Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
73	144	949.7208										
74	146	1024.963										
75	148	1027.883										
76	150	950.3645										
77	152	1012.102										
78	154	1038.363										
79	156	954.8828										
80	158	998.2056										
81	160	1045.722										
82	162	962.9361										
83	164	984.3985										
84	166	1049.39										
85	168	973.8983										
86	170	971.7947										
87	172	1049.089										
88	174	986.9075										
89	176	961.4085										
90	178	1044.851										
91	180	1000.936										
92	182	954.0748										
93	184	1037.02										
94	186	1014.872										
95	188	950.3834										
96	190	1026.226										
97	192	1077.61										

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Alignment:      

Number: General, Percentage, Thousand Separator, Comma Separator

Condition Formatting 

	A	B	C	D	E	F	G	H	I	J	K	L
97	192	1027.61										
98	194	950.6326										
99	196	1013.332										
100	198	1038.139										
101	200	954.8056										
102	202	999.3675										
103	204	1045.622										
104	206	962.5722										
105	208	985.448										
106	210	1049.466										
107	212	973.3154										
108	214	972.6833										
109	216	1049.366										
110	218	986.1808										
111	220	962.0913										
112	222	1045.33										
113	224	1000.144										
114	226	954.5168										
115	228	1037.681										
116	230	1014.094										
117	232	950.5636										
118	234	1027.029										
119	236	1026.92										
120	238	950.5472										
121	240	1014.773										

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Alignment Merge & Center

Number General % % %

Conditional Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
121	240	1014.223										
122	242	1037.601										
123	244	954.4692										
124	246	1000.282										
125	248	1045.285										
126	250	962.0175										
127	252	986.3189										
128	254	1049.361										
129	256	972.5908										
130	258	973.4447										
131	260	1049.505										
132	262	985.3472										
133	264	962.6855										
134	266	1045.705										
135	268	999.2705										
136	270	954.8986										
137	272	1038.264										
138	274	1013.252										
139	276	950.7042										
140	278	1027.774										
141	280	1026.177										
142	282	950.4365										
143	284	1015.072										
144	286	1037.017										
145	288	954.1169										

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	A	B	C	D	E	F	G	H	I	J	K	L
145	288	954.1169										
146	290	1001.17										
147	292	1044.908										
148	294	961.4523										
149	296	987.1737										
150	298	1049.222										
151	300	971.8582										
152	302	974.1994										
153	304	1049.615										
154	306	984.506										
155	308	963.2803										
156	310	1046.055										
157	312	998.3879										
158	314	955.2862										
159	316	1038.827										
160	318	1012.398										
161	320	950.854										
162	322	1028.505										
163	324	1025.421										
164	326	950.3367										
165	328	1015.913										
166	330	1036.418										
167	332	953.7756										
168	334	1002.054										
169	336	1044.515										

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Font: Calibri, 11, Bold, Italic, Underline, Text Color, Background Color

Alignment: Left, Center, Right, Justify, Merge & Center, Wrap Text

Number: General, Percentage, Currency, Text, Date, Time, Fraction, Decimals

Conditional Formatting 

	A	B	C	D	E	F	G	H	I	J	K	L
169	336	1044.515										
170	338	960.8966										
171	340	988.0303										
172	342	1049.066										
173	344	971.1326										
174	346	974.9605										
175	348	1049.708										
176	350	983.6682										
177	352	963.8853										
178	354	1046.39										
179	356	997.5047										
180	358	955.687										
181	360	1039.377										
182	362	1011.54										
183	364	951.0186										
184	366	1029.227										
185	368	1024.656										
186	370	950.252										
187	372	1016.749										
188	374	1035.808										
189	376	953.4484										
190	378	1002.937										
191	380	1044.107										
192	382	960.353										
193	384	988.8905										

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Clipboard

Font: Calibri, 11, Bold, Italic, Underline, Text Color, Background Color, Font Color

Alignment:

Number: General, %,

Conditional Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
193	384	988.8905										
194	386	1048.893										
195	388	970.4158										
196	390	975.7293										
197	392	1049.785										
198	394	982.8354										
199	396	964.5015										
200	398	1046.71										
201	400	996.6222										
202	402	956.1015										
203	404	1039.914										
204	406	1010.678										
205	408	951.1984										
206	410	1029.939										
207	412	1023.883										
208	414	950.1829										
209	416	1017.579										
210	418	1035.186										
211	420	953.1357										
212	422	1003.819										
213	424	1043.686										
214	426	959.8217										
215	428	989.754										
216	430	1048.706										
217	432	969.7083										

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Alignment:

Number: General, Percentage (%), Currency (\$), Accounting (\$), Fraction (/), Decimals (0-2)

Conditions Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
217	432	969.7083										
218	434	976.5057										
219	436	1049.846										
220	438	982.0079										
221	440	965.1288										
222	442	1047.015										
223	444	995.7408										
224	446	956.5298										
225	448	1040.439										
226	450	1009.813										
227	452	951.3936										
228	454	1030.642										
229	456	1023.103										
230	458	950.1293										
231	460	1018.404										
232	462	1034.553										
233	464	952.8377										
234	466	1004.699										
235	468	1043.251										
236	470	959.303										
237	472	990.6208										
238	474	1048.503										
239	476	969.0103										
240	478	977.2894										
241	480	1049.897										

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Alignment:

Number: General, Percentage (%), Thousand Separator (k), Decimal Places (0)

Conditional Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
241	480	1049.892										
242	482	981.1861										
243	484	965.767										
244	486	1047.306										
245	488	994.8607										
246	490	956.9717										
247	492	1040.952										
248	494	1008.945										
249	496	951.6039										
250	498	1031.335										
251	500	1022.316										
252	1	276.1301										
253	3	345.0154										
254	5	407.3454										
255	7	463.744										
256	9	514.7755										
257	11	560.9507										
258	13	602.7318										
259	15	640.5368										
260	17	674.7443										
261	19	705.6964										
262	21	733.7031										
263	23	759.0446										
264	25	781.9746										
265	27	807.7774										

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Font: Calibri, 11, A A, B, I, U,

Alignment:

Number: General, %,

Condition Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
265	27	802.7224										
266	29	821.4959										
267	31	838.4828										
268	33	853.8532										
269	35	867.7609										
270	37	880.3451										
271	39	891.7318										
272	41	902.0349										
273	43	911.3575										
274	45	919.7929										
275	47	927.4256										
276	49	934.332										
277	51	940.5811										
278	53	946.2356										
279	55	951.3519										
280	57	955.9814										
281	59	960.1703										
282	61	963.9606										
283	63	967.3902										
284	65	970.4935										
285	67	973.3014										
286	69	975.8421										
287	71	978.141										
288	73	980.2212										
289	75	982.1034										

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Alignment:

Number: General, %,

Conditional Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
289	75	982.1034										
290	77	983.8065										
291	79	985.3475										
292	81	986.7419										
293	83	988.0035										
294	85	989.1452										
295	87	990.1781										
296	89	991.1128										
297	91	991.9585										
298	93	992.7238										
299	95	993.4162										
300	97	994.0427										
301	99	994.6096										
302	101	995.1226										
303	103	995.5867										
304	105	996.0067										
305	107	996.3867										
306	109	996.7306										
307	111	997.0417										
308	113	997.3232										
309	115	997.578										
310	117	997.8084										
311	119	998.017										
312	121	998.2057										
313	123	998.3765										

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Clipboard

Font: Calibri, 11, A A, B I U,

Alignment:

Number: General, %, %%, +%

Conditional Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
313	123	998.3765										
314	125	998.531										
315	127	998.6708										
316	129	998.7972										
317	131	998.9117										
318	133	999.0153										
319	135	999.109										
320	137	999.1938										
321	139	999.2705										
322	141	999.3399										
323	143	999.4027										
324	145	999.4596										
325	147	999.511										
326	149	999.5575										
327	151	999.5996										
328	153	999.6377										
329	155	999.6722										
330	157	999.7034										
331	159	999.7316										
332	161	999.7572										
333	163	999.7803										
334	165	999.8012										
335	167	999.8201										
336	169	999.8372										
337	171	999.8577										

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Paste

Clipboard

Calibri 11 A A

B I U

Font

Alignment

Wrap Text

Merge & Center

General

Number

Conditions Formatting

N5

	A	B	C	D	E	F	G	H	I	J	K	L
337	171	999.8527										
338	173	999.8667										
339	175	999.8794										
340	177	999.8909										
341	179	999.9013										
342	181	999.9107										
343	183	999.9192										
344	185	999.9269										
345	187	999.9338										
346	189	999.9401										
347	191	999.9458										
348	193	999.951										
349	195	999.9556										
350	197	999.9599										
351	199	999.9637										
352	201	999.9671										
353	203	999.9703										
354	205	999.9731										
355	207	999.9757										
356	209	999.978										
357	211	999.9801										
358	213	999.982										
359	215	999.9837										
360	217	999.9852										
361	219	999.9866										

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

Font: Calibri, 11, A[^] A[^], B, I, U,


Alignment: Merge & Center, Wrap Text




Number: General, %,


Conditional Formatting




	A	B	C	D	E	F	G	H	I	J	K	L
361	219	999,9866										
362	221	999,9879										
363	223	999,9891										
364	225	999,9901										
365	227	999,991										
366	229	999,9919										
367	231	999,9927										
368	233	999,9934										
369	235	999,994										
370	237	999,9946										
371	239	999,9951										
372	241	999,9956										
373	243	999,996										
374	245	999,9964										
375	247	999,9967										
376	249	999,997										
377	251	999,9973										
378	253	999,9976										
379	255	999,9978										
380	257	999,998										
381	259	999,9982										
382	261	999,9984										
383	263	999,9985										
384	265	999,9987										
385	267	999,9988										


Paste  





Clipboard  %


B *I* U **B**    %


Font  %

   Merge & Center

Alignment  Wrap Text

General  %  %   %

Number  %

Conditions  Formatting

NS

	A	B	C	D	E	F	G	H	I	J	K	L
385	267	999,9988										
386	269	999,9989										
387	271	999,999										
388	273	999,9991										
389	275	999,9992										
390	277	999,9993										
391	279	999,9993										
392	281	999,9994										
393	283	999,9995										
394	285	999,9995										
395	287	999,9996										
396	289	999,9996										
397	291	999,9996										
398	293	999,9997										
399	295	999,9997										
400	297	999,9997										
401	299	999,9998										
402	301	999,9998										
403	303	999,9998										
404	305	999,9998										
405	307	999,9998										
406	309	999,9999										
407	311	999,9999										
408	313	999,9999										
409	315	999,9999										

verlier

Clipboard Paste Font Alignment Conditional Formatting

Calibri 11 A A

B I U A

Font

Alignment

General

Number

Conditional Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
409	315	999,9999										
410	317	999,9999										
411	319	999,9999										
412	321	999,9999										
413	323	999,9999										
414	325	999,9999										
415	327	999,9999										
416	329	999,9999										
417	331	1000										
418	333	1000										
419	335	1000										
420	337	1000										
421	339	1000										
422	341	1000										
423	343	1000										
424	345	1000										
425	347	1000										
426	349	1000										
427	351	1000										
428	353	1000										
429	355	1000										
430	357	1000										
431	359	1000										
432	361	1000										
433	363	1000										

verifier

Clipboard

Font: Calibri, 11, A A A

Font: B I U

Alignment:

Number: General, %, %d, %e

Conditional Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
433	363	1000										
434	365	1000										
435	367	1000										
436	369	1000										
437	371	1000										
438	373	1000										
439	375	1000										
440	377	1000										
441	379	1000										
442	381	1000										
443	383	1000										
444	385	1000										
445	387	1000										
446	389	1000										
447	391	1000										
448	393	1000										
449	395	1000										
450	397	1000										
451	399	1000										
452	401	1000										
453	403	1000										
454	405	1000										
455	407	1000										
456	409	1000										
457	411	1000										

Clipboard

Font: Calibri, Size: 11, Bold (B), Italic (I), Underline (U), Text Color (A), Background Color (A)

Alignment: Left, Center, Right, Justify, Indent, Decrease Indent, Increase Indent, Merge & Center, Wrap Text

Number: General, Percentage (%), Decimals (0.00, 0.01, 0.02)

Conditions Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
457	411	1000										
458	413	1000										
459	415	1000										
460	417	1000										
461	419	1000										
462	421	1000										
463	423	1000										
464	425	1000										
465	427	1000										
466	429	1000										
467	431	1000										
468	433	1000										
469	435	1000										
470	437	1000										
471	439	1000										
472	441	1000										
473	443	1000										
474	445	1000										
475	447	1000										
476	449	1000										
477	451	1000										
478	453	1000										
479	455	1000										
480	457	1000										
481	459	1000										

Clipboard Paste Font Calibri 11 A A Bold Italic Underline Font Color Background Color Alignment Wrap Text Merge & Center Number General % +.00 -.00 Conditional Formatting

	A	B	C	D	E	F	G	H	I	J	K	L
481	459	1000										
482	461	1000										
483	463	1000										
484	465	1000										
485	467	1000										
486	469	1000										
487	471	1000										
488	473	1000										
489	475	1000										
490	477	1000										
491	479	1000										
492	481	1000										
493	483	1000										
494	485	1000										
495	487	1000										
496	489	1000										
497	491	1000										
498	493	1000										
499	495	1000										
500	497	1000										
501	499	1000										
502												
503												
504												
505												