In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

In [2]:
```
plt.rcParams['font.size'] = 14
plt.rcParams['lines.linewidth'] = 2
plt.rcParams["figure.figsize"] = (8,5)
```

In [3]:
```
sample_heat = pd.read_excel( 'data.xlsx' , sheet_name=0)
room_temp = 17
```

In [4]:
```
sample_heat['T(*c) '] =  sample_heat['T(*c) '] + room_temp
```

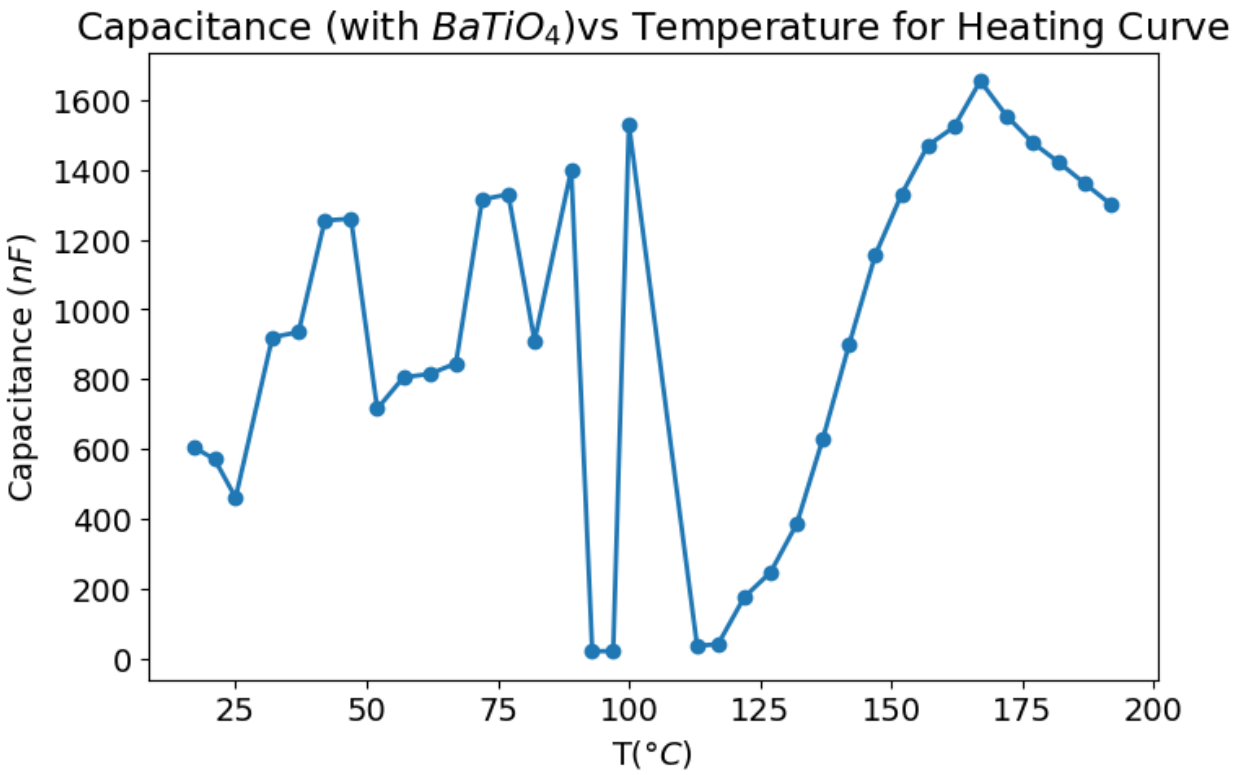
In [5]:
```
sample_heat
```

Out[5]:

	Voltage	Capacitance	D	T(*c)
0	0.00	605	0.615	17
1	0.15	570	0.640	21
2	0.31	460	0.760	25
3	0.59	920	0.600	32
4	0.79	935	0.580	37
5	1.00	1255	0.065	42
6	1.20	1260	0.058	47
7	1.40	715	0.790	52
8	1.61	805	0.725	57
9	1.81	815	0.730	62
10	2.02	845	0.705	67
11	2.23	1315	0.069	72
12	2.43	1330	0.070	77
13	2.64	910	0.705	82
14	2.93	1400	0.085	89
15	3.07	20	4.000	93
16	3.26	20	2.500	97
17	3.39	1530	0.085	100
18	3.95	35	3.000	113
19	4.09	40	3.500	117
20	4.30	175	3.000	122
21	4.50	246	3.000	127

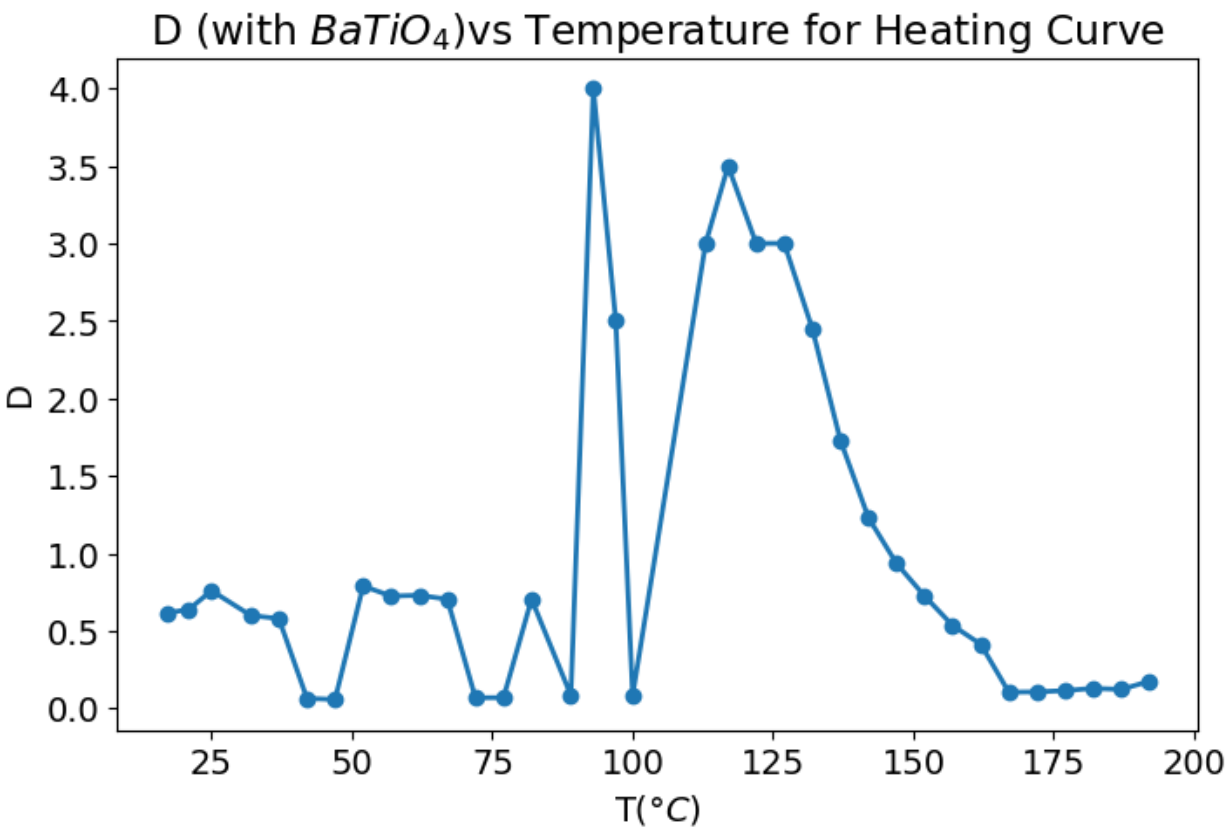
22	4.71	385	2.450	132
23	4.91	630	1.730	137
24	5.12	900	1.230	142
25	5.32	1157	0.935	147
26	5.53	1330	0.725	152
27	5.73	1470	0.535	157
28	5.93	1523	0.414	162
29	6.13	1655	0.105	167
30	6.33	1555	0.107	172
31	6.54	1478	0.115	177
32	6.74	1421	0.130	182
33	6.94	1360	0.123	187
34	7.14	1300	0.175	192

In [6]:
```
plt.plot(  sample_heat['T(*c) '] , sample_heat['Capacitance'] )
plt.scatter( sample_heat['T(*c) '] ,  sample_heat['Capacitance'])
plt.xlabel(r'T($\degree C$)')
plt.ylabel(r'Capacitance ($nF$)')
plt.title(r'Capacitance (with $BaTiO_4$)vs Temperature for Heating Curve'
plt.show()
```



In [7]:
```
plt.plot(  sample_heat['T(*c) '] , sample_heat['D '] )
plt.scatter( sample_heat['T(*c) '] ,  sample_heat['D '])
plt.xlabel(r'T($\degree C$)')
plt.ylabel(r'D')
```

```
plt.title(r'D (with $BaTiO_4$)vs Temperature for Heating Curve')
plt.show()
```



In [8]:
```
sample_cool = pd.read_excel( 'data.xlsx' , sheet_name=1)
room_temp = 17
```

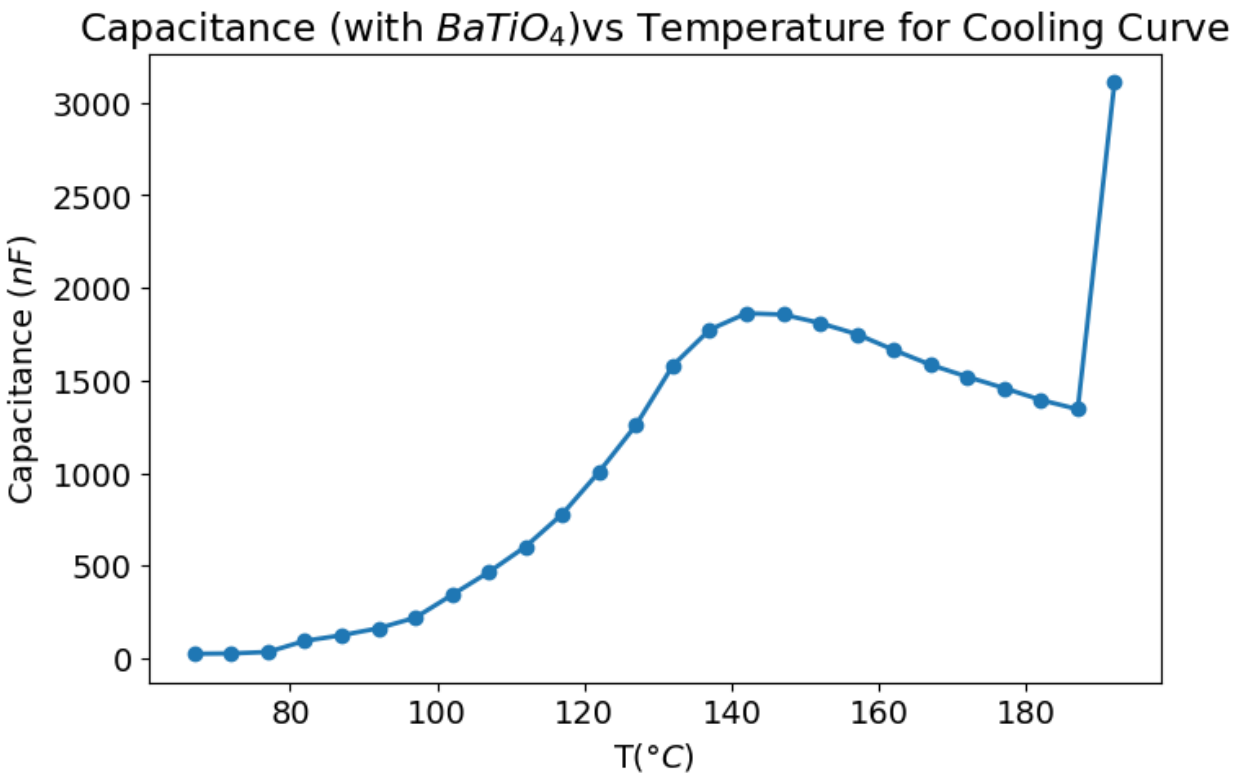
In [9]:
```
sample_cool['T(*c) '] = sample_cool['T(*c) '] + room_temp
sample_cool
```

Out[9]:

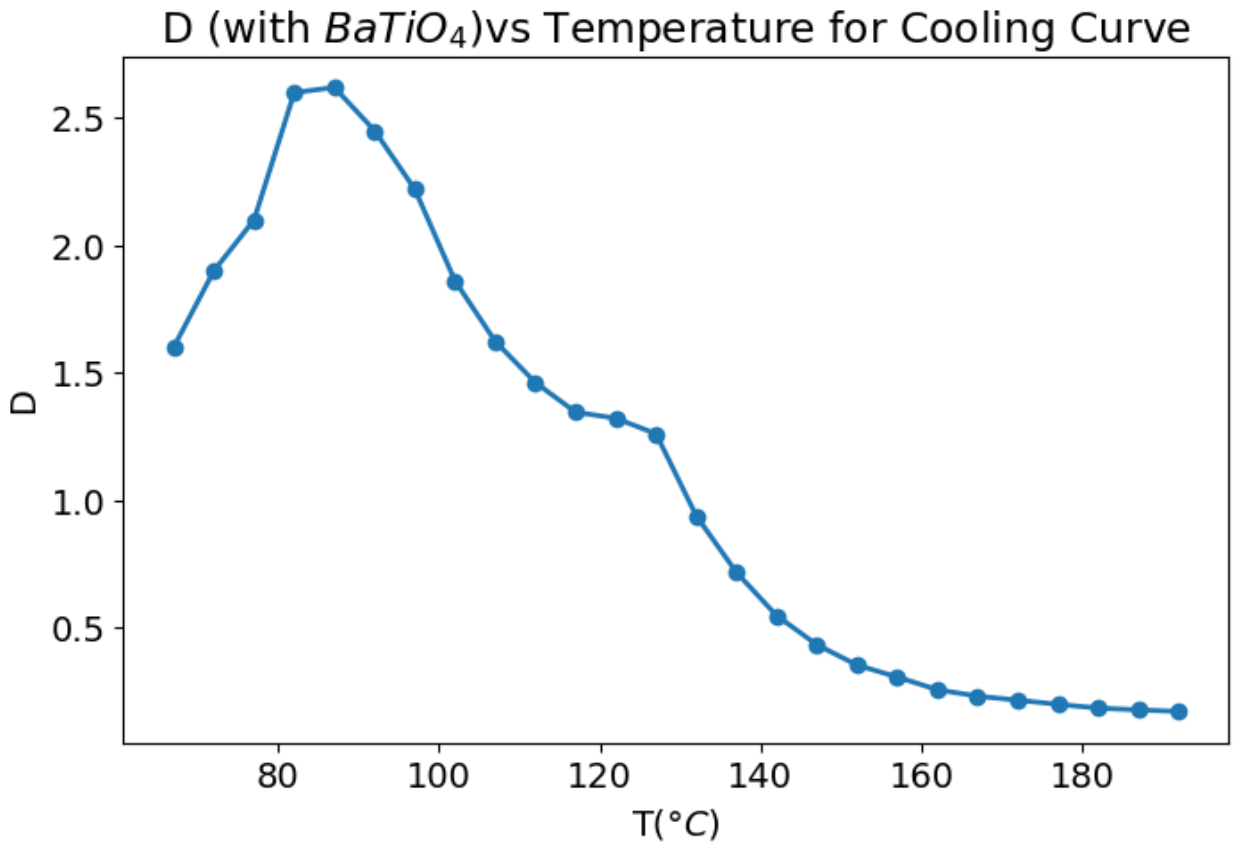
	Voltage	Capacitance	D	T(*c)
0	7.14	3110	0.170	192
1	6.94	1345	0.176	187
2	6.74	1395	0.183	182
3	6.54	1459	0.198	177
4	6.33	1520	0.214	172
5	6.13	1585	0.230	167
6	5.93	1665	0.255	162
7	5.70	1750	0.305	157
8	5.53	1810	0.352	152
9	5.32	1856	0.432	147
10	5.12	1863	0.546	142
11	4.91	1774	0.716	137
12	4.71	1581	0.938	132
13	4.50	1260	1.260	127
14	4.30	1008	1.321	122
15	4.09	780	1.345	117
16	3.89	604	1.461	112
17	3.68	466	1.623	107
18	3.47	343	1.860	102
19	3.26	220	2.220	97
20	3.06	163	2.450	92
21	2.85	125	2.620	87
22	2.64	95	2.600	82
23	2.43	35	2.100	77
24	2.22	27	1.900	72
25	2.02	25	1.600	67

In [10]:

```
plt.plot(  sample_cool['T(*c) '] , sample_cool['Capacitance'] )
plt.scatter( sample_cool['T(*c) '] ,  sample_cool['Capacitance'])
plt.xlabel(r'T($\degree C$)')
plt.ylabel(r'Capacitance ($nF$)')
plt.title(r'Capacitance (with $BaTiO_4$)vs Temperature for Cooling Curve'
plt.show()
```



In [11]:
```
plt.plot(  sample_cool['T(*c) '] , sample_cool['D '] )
plt.scatter( sample_cool['T(*c) '] ,  sample_cool['D '])
plt.xlabel(r'T($\degree C$)')
plt.ylabel(r'D')
plt.title(r'D (with $BaTiO_4$)vs Temperature for Cooling Curve')
plt.show()
```



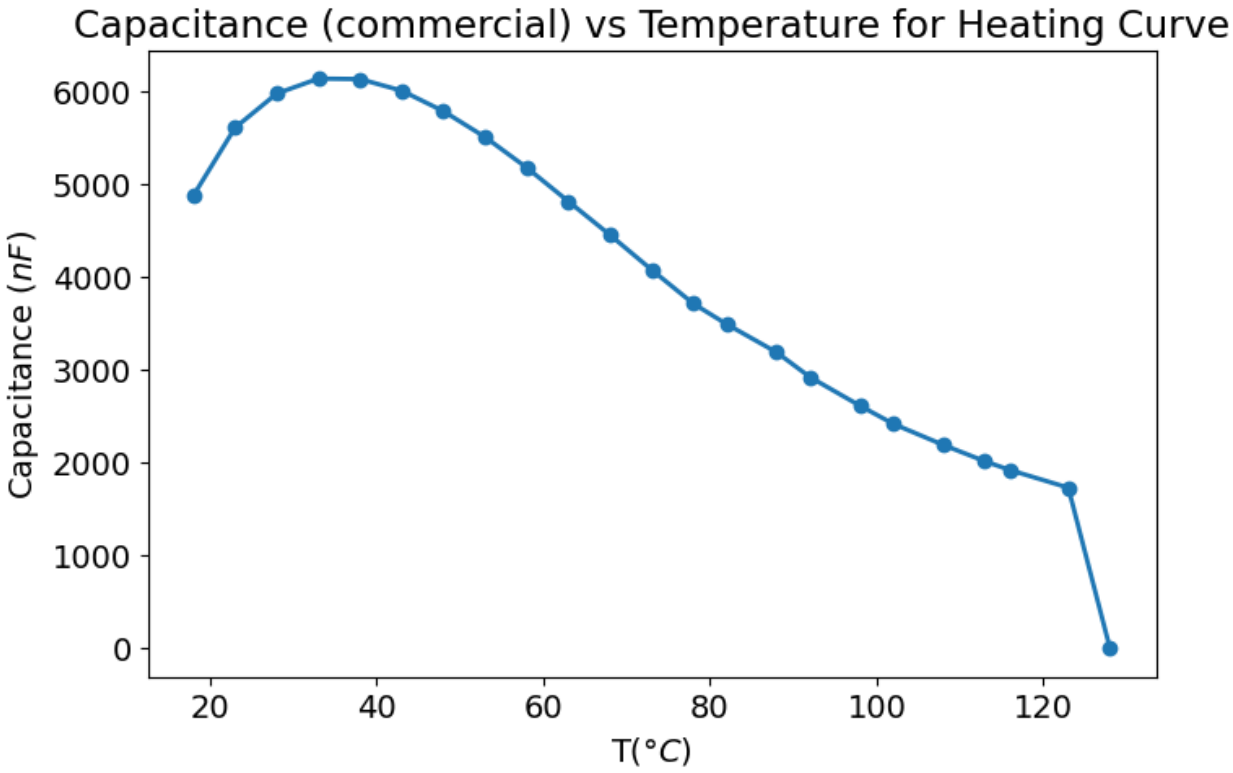
In [12]:
```
commercial_heat = pd.read_excel('data.xlsx' , sheet_name=2)
room_temp = 18
```

In [13]:
```
commercial_heat['T(*c) '] = commercial_heat['T(*c) '] + room_temp
commercial_heat
```

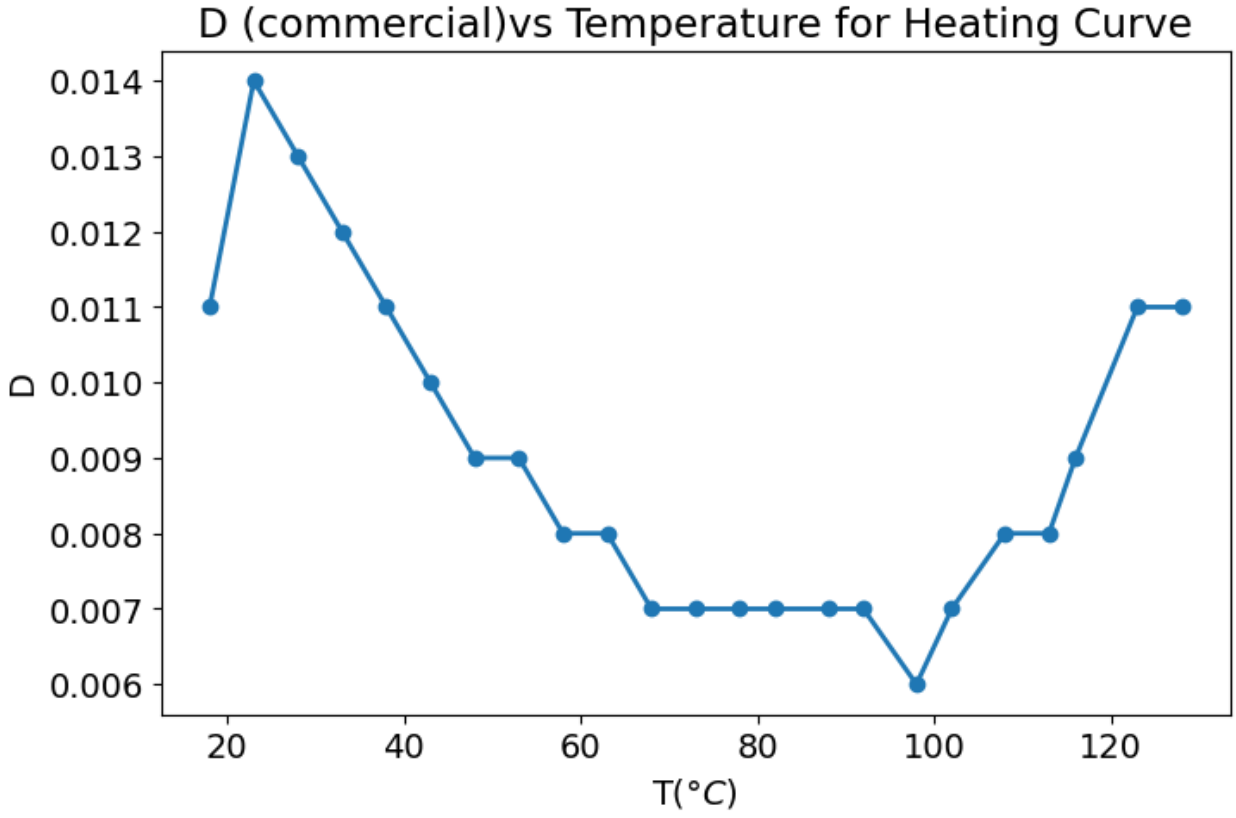
Out[13]:

	Voltage	Capacitance	D	T(*c)
0	0.00	4875.00	0.011	18
1	0.19	5605.00	0.014	23
2	0.39	5972.00	0.013	28
3	0.59	6133.00	0.012	33
4	0.80	6128.00	0.011	38
5	1.00	6003.00	0.010	43
6	1.20	5783.00	0.009	48
7	1.40	5504.00	0.009	53
8	1.61	5175.00	0.008	58
9	1.81	4812.00	0.008	63
10	2.02	4450.00	0.007	68
11	2.23	4075.00	0.007	73
12	2.44	3711.00	0.007	78
13	2.60	3490.00	0.007	82
14	2.85	3187.00	0.007	88
15	3.01	2920.00	0.007	92
16	3.26	2612.00	0.006	98
17	3.43	2417.00	0.007	102
18	3.68	2190.00	0.008	108
19	3.89	2014.00	0.008	113
20	4.01	1920.00	0.009	116
21	4.30	1730.00	0.011	123
22	4.50	1.61	0.011	128

In [14]:
```
plt.plot(  commercial_heat['T(*c) '] , commercial_heat['Capacitance'] )
plt.scatter( commercial_heat['T(*c) '] ,  commercial_heat['Capacitance'])
plt.xlabel(r'T($\degree C$)')
plt.ylabel(r'Capacitance ($nF$)')
plt.title(r'Capacitance (commercial) vs Temperature for Heating Curve')
plt.show()
```



In [15]:
```
plt.plot(  commercial_heat['T(*c) '] , commercial_heat['D '] )
plt.scatter( commercial_heat['T(*c) '] ,  commercial_heat['D '])
plt.xlabel(r'T($\degree C$)')
plt.ylabel(r'D')
plt.title(r'D (commercial)vs Temperature for Heating Curve')
plt.show()
```



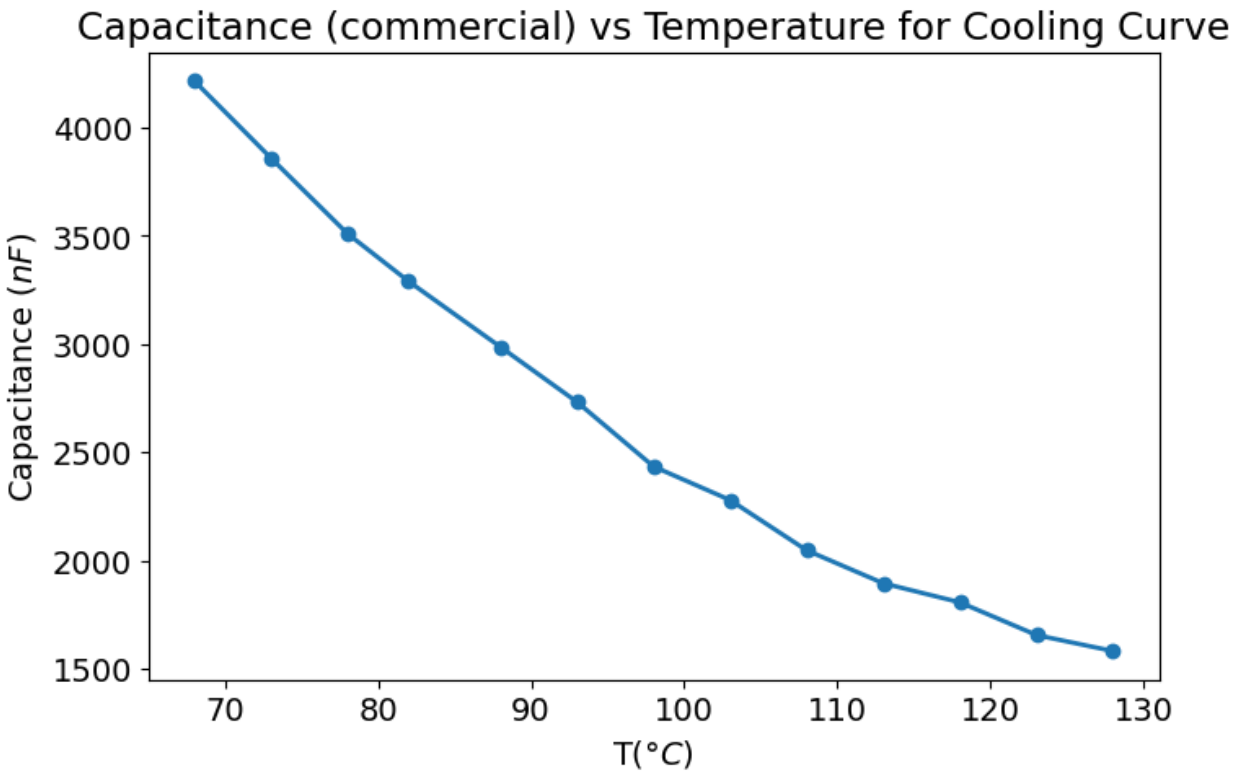
In [16]:
```
commercial_cool = pd.read_excel('data.xlsx' , sheet_name=3)
room_temp = 18
```

In [17]:
```
commercial_cool['T(*c) '] = commercial_cool['T(*c) '] + room_temp
commercial_cool
```

Out[17]:

	Voltage	Capacitance	D	T(*c)
0	4.50	1583	0.012	128
1	4.30	1657	0.011	123
2	4.01	1808	0.009	118
3	3.89	1896	0.008	113
4	3.68	2048	0.007	108
5	3.43	2280	0.006	103
6	3.26	2435	0.006	98
7	3.01	2733	0.006	93
8	2.85	2987	0.007	88
9	2.60	3290	0.007	82
10	2.44	3511	0.007	78
11	2.23	3860	0.007	73
12	2.02	4216	0.007	68

In [18]:
```
plt.plot(  commercial_cool['T(*c) '] , commercial_cool['Capacitance'] )
plt.scatter( commercial_cool['T(*c) '] ,  commercial_cool['Capacitance'])
plt.xlabel(r'T($\degree C$)')
plt.ylabel(r'Capacitance ($nF$)')
plt.title(r'Capacitance (commercial) vs Temperature for Cooling Curve')
plt.show()
```



In [19]:
```
plt.plot(  commercial_cool['T(*c) '] , commercial_cool['D '] )
plt.scatter( commercial_cool['T(*c) '] ,  commercial_cool['D '])
plt.xlabel(r'T($\degree C$)')
plt.ylabel(r'D')
plt.title(r'D (commercial)vs Temperature for Cooling Curve')
plt.show()
```