In [1]:
```
import pandas as pd
```

In [ ]:
```
#m² to sqft → multiply by 10.7639
#sqft to m² → multiply by 0.092903
```

In [2]:
```
url = "SquareFeet_Data.csv"
data = pd.read_csv(url)

data["SquareFeet"] = data["SquareFeet"] * 0.092903
data['price'] = data['price'] / 1000

x = data["SquareFeet"]
y = data["price"]
```

In [3]:
```
data
```

Out[3]:

	SquareFeet	StateA	StateB	StateC	price
0	78.967550	1	0	0	467.500
1	72.371437	0	1	0	363.014
2	91.973970	1	0	0	594.000
3	61.780495	0	0	1	266.000
4	51.096650	0	0	1	220.000
5	81.754640	0	1	0	478.720
6	52.676001	0	1	0	264.222
7	94.761060	0	1	0	497.760
8	192.030501	0	0	1	756.522
9	53.605031	1	0	0	375.050
10	91.881067	1	0	0	581.532
11	66.890160	0	0	1	165.600
12	54.348255	1	0	0	321.750
13	60.944368	0	0	1	196.800
14	73.207564	0	0	1	253.736
15	113.527466	0	1	0	596.336
16	52.490195	1	0	0	326.005
17	78.410132	0	0	1	196.652
18	69.119832	1	0	0	415.152
19	125.976468	0	1	0	737.664
20	144.464165	0	1	0	622.000
21	185.806000	0	0	1	560.000
22	60.108241	1	0	0	355.850
23	71.442407	0	0	1	196.095
24	79.432065	0	1	0	470.250
25	83.612700	1	0	0	509.400
26	42.363768	0	0	1	151.848
27	62.152107	0	1	0	347.880
28	176.422797	1	0	0	1044.450
29	58.807599	0	0	1	212.055

	SquareFeet	StateA	StateB	StateC	price
30	82.683670	0	1	0	400.500
31	87.886238	0	0	1	272.448
32	114.735205	1	0	0	679.250

In [4]:
```
w = 10
b = 10
n = len(x)

w_gradient = (2 * x * (w*x + b - y)).mean()
b_gradient = (2 * (w*x + b - y)).mean()
b_gradient
```

Out[4]: `np.float64(915.8337599999999)`

In [5]:
```
def compute_gradient(x,y,w,b):
    # w_gradient = 2*x*(w*x+b - y)
    # b_gradient = 2*(w*x+b - y)

    # w_gradient = (2*x*(w*x+b - y)).sum() / n
    # b_gradient = (2*(w*x+b - y)).sum() / n

    w_gradient = (2 * x * (w*x + b - y)).mean()
    b_gradient = (2 * (w*x + b - y)).mean()
    return w_gradient,b_gradient
```

In [6]:
```
compute_gradient(x,y,20,10)
```

Out[6]: `(np.float64(276380.7448477438), np.float64(2653.8518230303034))`

In [7]:
```
def compute_cost(x,y,w,b):
    y_pred = w*x + b
    cost = (y - y_pred)**2
    cost = cost.sum()/len(x)

    return cost
```

In [45]:
```
# w = 0
# b = 0
# learning_rate = 0.0000001
# for i in range(5000):
#     w_gradient,b_gradient = compute_gradient(x,y,w,b)

#     w = w - w_gradient * learning_rate
#     b = b - b_gradient * learning_rate
#     cost = compute_cost(x,y,w,b)
#     if i % 500 == 0:
#         print(f"Ieration {i:5}: Cost {cost:.2f}, w: {w:.2f}, b: {b:.2f}, w_gradie
```

In [11]:
```
w = 0
b = 0
```

```python
learning_rate = 0.0000001

def gradient_descent(x,y,w_init,b_init,learning_rate,cost_function,gradient_functio
    c_hist = []
    w_hist = []
    b_hist = []

    w = w_init
    b = b_init

    for i in range(run_ieration):
        w_gradient, b_gradient = gradient_function(x,y,w,b)

        w = w - w_gradient * learning_rate
        b = b - b_gradient * learning_rate
        cost = compute_cost(x,y,w,b)

        c_hist.append(cost)
        w_hist.append(w)
        b_hist.append(b)

        if i%p_ieration == 0:
            print(f"Ieration {i}:Cost {cost}, w: {w}, b: {b}, w_gradient: {w_gradie

    return w,b,c_hist,w_hist,b_hist
```

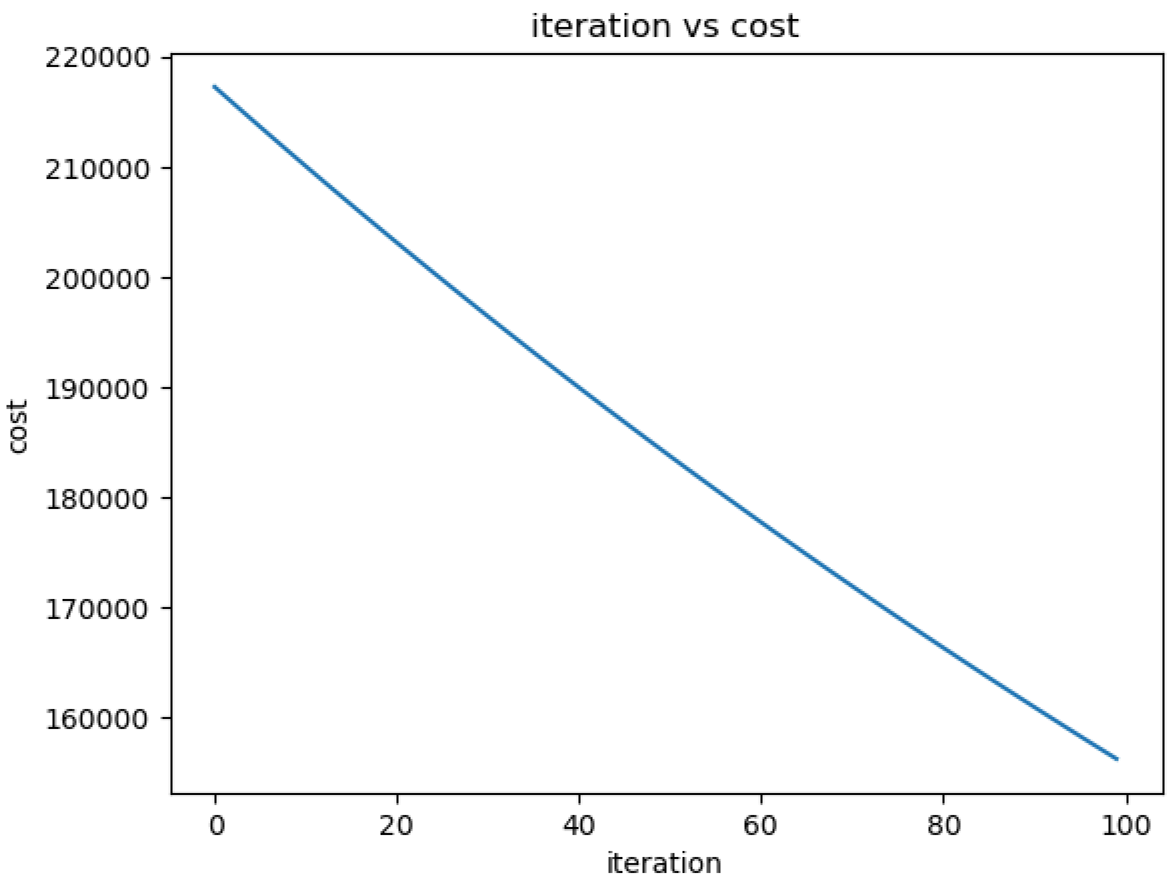
In [12]:
```python
w_init = 0
b_init = 0
learning_rate = 0.0000001
run_ieration = 5000

w_final,b_final,c_hist,w_hist,b_hist = gradient_descent(x,y,w_init,b_init,learning_
```

```
Ieration 0:Cost 217250.22210812083, w: 0.008573064816410297, b: 8.421843030303031e-0
5, w_gradient: -85730.64816410298, b_gradeint: -842.1843030303031
Ieration 500:Cost 47504.24490374939, w: 2.830220364785714, b: 0.028063401874277593,
w_gradient: -34791.66350239823, b_gradeint: -350.83552015438056
Ieration 1000:Cost 19547.92534215252, w: 3.9753146518471283, b: 0.03987083587353943,
w_gradient: -14119.28436505536, b_gradeint: -151.43312024388234
Ieration 1500:Cost 14943.650226408861, w: 4.440019650515202, b: 0.04511534147613646,
w_gradient: -5729.889444968543, b_gradeint: -70.51023768245204
Ieration 2000:Cost 14185.339540681342, w: 4.628604788894984, b: 0.04769643087507614,
w_gradient: -2325.2524343846135, b_gradeint: -37.669458036960606
Ieration 2500:Cost 14060.439879730118, w: 4.7051332289732875, b: 0.0491966286348241
1, w_gradient: -943.5612305239397, b_gradeint: -24.341659814020804
Ieration 3000:Cost 14039.85983343399, w: 4.73618611503119, b: 0.050258164827619224,
w_gradient: -382.83461736880713, b_gradeint: -18.932742442245157
Ieration 3500:Cost 14036.460704018262, w: 4.748783825806361, b: 0.05114167330083481,
w_gradient: -155.27701791240588, b_gradeint: -16.737515106063103
Ieration 4000:Cost 14035.891185631783, w: 4.753891941344171, b: 0.05195292612180027
5, w_gradient: -62.92816307863893, b_gradeint: -15.846487675161722
Ieration 4500:Cost 14035.7876902833, w: 4.75596058230721, b: 0.052734848376256346, w
_gradient: -25.45057138976953, b_gradeint: -15.484738855021291
```

In [13]:
```
import matplotlib.pyplot as plt
import numpy as np
```

In [20]:
```
plt.plot(np.arange(0,100),c_hist[:100])
plt.title("iteration vs cost")
plt.xlabel("iteration")
plt.ylabel("cost")
plt.show()
```



In [21]:
```
print(f"final w b = ({w_final:.2f} {b_final:.2f})")
```

```
final w b = (4.76 0.05)
```

You may try to type the square feet to predict the price below:

In [29]:
```
sqft = 733

print(f"if square feet is {sqft} (sqft), {sqft * 0.092903} (m^2), predict price is:
```

```
if square feet is 733 (sqft), 68.097899 (m^2), predict price is: 324.0K
```

In [30]:
```
ws = np.arange(-100,101)
bs = np.arange(-100,101)
costs = np.zeros((201,201))

i = 0
```

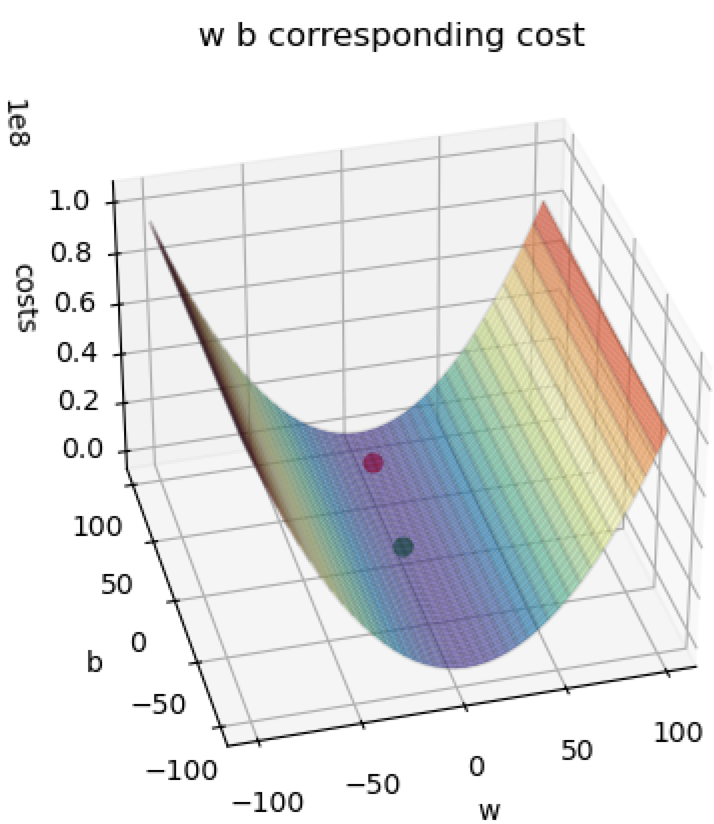
```
for w in ws:
    j = 0
    for b in bs:
        cost = compute_cost(x,y,w,b)
        costs[i,j] = cost
        j = j + 1
    i = i + 1
```

In [44]:
```
ax = plt.axes(projection="3d")
# ax.xaxis.set_pane_color((0,0,0))
# ax.yaxis.set_pane_color((0,0,0))
# ax.zaxis.set_pane_color((0,0,0))
ax.view_init(35,-105)
b_grid, w_grid = np.meshgrid(bs,ws)
ax.plot_surface(w_grid,b_grid,costs,cmap="Spectral_r",alpha=0.7)
ax.plot_wireframe(w_grid,b_grid,costs,color="black",alpha=0.1)

ax.set_title("w b corresponding cost")
ax.set_xlabel("w")
ax.set_ylabel("b")
ax.set_zlabel("costs")

w_index, b_index = np.where(costs == np.min(costs))
ax.scatter(ws[w_index],bs[b_index],costs[w_index,b_index],color="red",s=40)
ax.scatter(w_hist[0],b_hist[0],c_hist[0],color="green",s=40)
ax.plot(w_hist,b_hist,c_hist)

plt.show()
print(f"when w={ws[w_index]},b={bs[b_index]} will appear min cost:{costs[w_index,b_
```




```
when w=[4],b=[73] will appear min cost:[13811.0357929]
```

In [ ]: