In [88]:
```
import pandas as pd
from scipy.stats import linregress
import seaborn as sns
import matplotlib.pyplot as plt

df = pd.read_csv('activity7.csv').set_index('Country')
```

1. Use Excel to find the summation of x, y, xy, x^2, and y^2.

In [89]:
```
sumX= df['Birth Rate'].sum()
sumY = df['Life Expectancy'].sum()
print("Sum of x: " + str(sumX) + '\nSum of y: '+ str(sumY))
sumXY = 0
sumX2 = 0
sumY2 = 0
for _,row in df.iterrows():
    sumXY += row.iloc[0]*row.iloc[1]
    sumX2 += row.iloc[0] ** 2
    sumY2 += row.iloc[1] ** 2

print("Sum of xy: "+str(sumXY) + "\nSum of x^2: " + str(sumX2) + "\nSum of y
```

```
Sum of x: 466
Sum of y: 1788
Sum of xy: 34382
Sum of x^2: 9736
Sum of y^2: 133512
```

2. Use Excel to find the covariance S_{xy} .

In [90]:
```
cov = df.cov()['Birth Rate'].iloc[1]
print(cov)
```

```
-14.565217391304348
```

Covariance of xy is -14.562

3. Use Excel to calculate S_x , S_y , and the correlation coefficient.

In [91]:
```
sx = df['Birth Rate'].std()
sy = df['Life Expectancy'].std()
print('x devation: '+str(sx))
print("y deviation: "+str(sy))
corrCoef = df.corr()['Birth Rate'].iloc[1]
print("Correlation coeffecient: " + str(corrCoef))
```

```
x devation: 5.468619304856508
y deviation: 3.647512553245973
Correlation coeffecient: -0.7302011028563675
```

4. Use Excel to calculate the coefficient of determination.

In [92]:
```
print("Coefficient of determination: " + str(corrCoef**2))
```

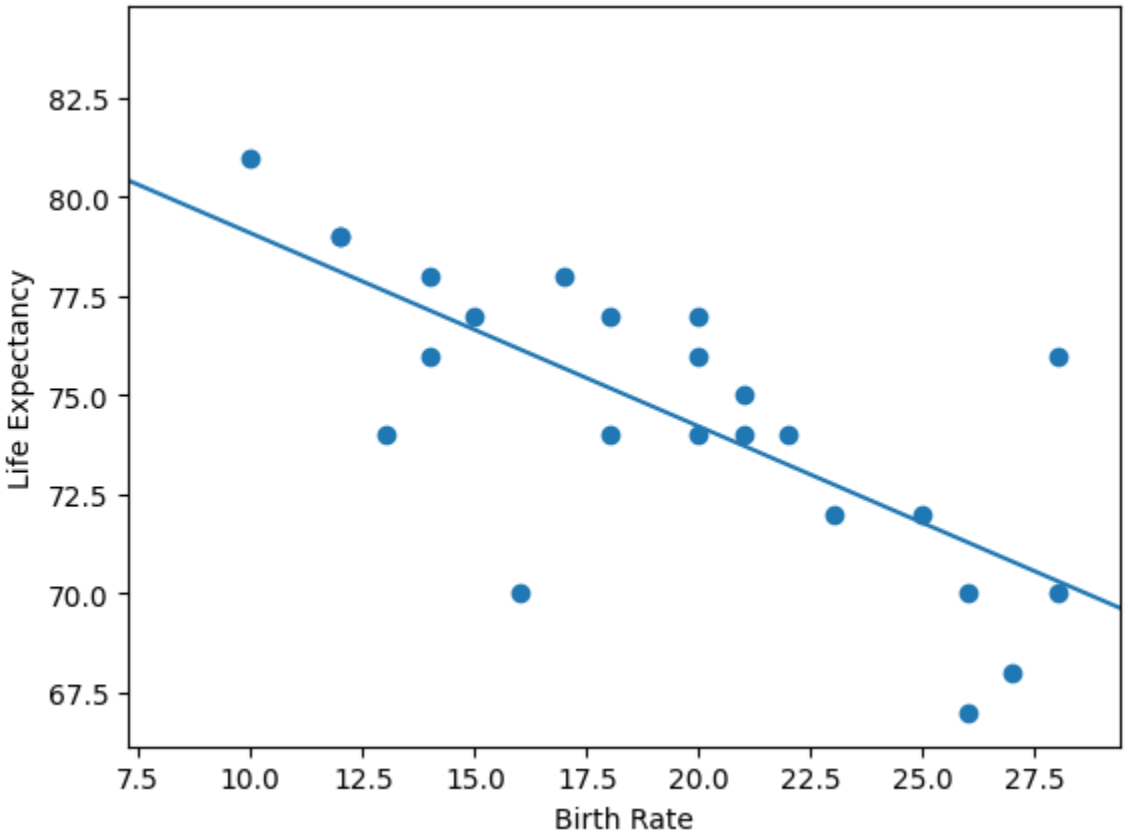
```
Coefficient of determination: 0.5331936506126554
```

5. Use Excel to calculate b_1 , x, y, and b_0 .

In [93]:
```
b1 = cov / sx**2
b0 = df['Life Expectancy'].mean() - (b1*df['Birth Rate'].mean())
print('slope: ' + str(b1) + ' intercept: ' + str(b0))
print(f"Model: ŷ={b0:.3f}+({b1:.3f})x")

fig, ax= plt.subplots()
ax.set_xlabel('Birth Rate')
ax.set_ylabel('Life Expectancy')
ax.axline((0,b0), slope = b1)
scatter = plt.scatter(df['Birth Rate'], df['Life Expectancy'])
ax.set_xlim(df['Birth Rate'].min()-df['Birth Rate'].std()/2)
plt.show()
```

```
slope: -0.48703658832081403 intercept: 83.9566270898958
Model: ŷ=83.957+(-0.487)x
```



6. Given the scatterplot and regression equation you created in Excel and the information you have found up to this point, do you think there is a linear relationship between birthrate and life expectancy?

ANSWER: Yes, it seems linear

7. Given the regression equation above, what is the general trend for life expectancy given a country's birthrate? Is this a positive or negative association?

ANSWER: There seems to be a negative relationship

8. Notice that Paraguay had a birth rate of 28 per 1000 and a life expectancy of 76 years. Find Paraguay's expected life expectancy and the residual. Do you think the model accurately predicted the life expectancy for Paraguay?

In [94]:
```
predParaguay = b0 + b1*28
print(f"predicted expectancy: {predParaguay: .3f}, Life expectency standard
```

```
predicted expectancy:  70.320, Life expectency standard devation: 3.64751255
3245973
```

ANSWER: The model predicts 70 years of life expentency vs. 76 measured, that is not within a standard devation of what has been measured. Not a good prediction

9. Find another country that the model poorly predicted the life expectancy of. Find the expected life expectancy of the country and the residual

In [95]:
```
yStd = df['Life Expectancy'].std()
print("Bad predictions (outside 1 standard deviation), life expectency, and
for index,row in df.iterrows():
    y = row.iloc[1]
    pred = b0 + b1*row.iloc[0]
    lowStd = y - yStd
    highStd = y + yStd
    if pred < lowStd or pred > highStd:
        print(f"{index}: predicted life expectency: {round(pred,3)}, residua
```

```
Bad predictions (outside 1 standard deviation), life expectency, and residua
l:

Bahamas: predicted life expectency: 76.164, residual: -6.164
Bolivia: predicted life expectency: 71.294, residual: -4.294
Paraguay: predicted life expectency: 70.32, residual: 5.68
```

10. Notice that Nicaragua had a birth rate of 23 per 1000 and a life expectancy of 72 years (23, 72). Find Nicaragua's expected life expectancy and the residual. Do you think the model accurately predicted the life expectancy for Nicaragua?

In [96]:
```
pred = pred = b0 + b1*23
y= 72
lowStd = pred - yStd
highStd = pred + yStd
print(f"Predicted life expectency: {pred:.3f}.\nStandard devation interval f
```

```
Predicted life expectency: 72.755.
Standard devation interval from prediction: (76.4,69.1)
```

ANSWER: Yes, measured expected life expectency is within 1 standard devation of predicted.

11. Find another country that the model accurately predicted the life expectancy of. Find the expected life expectancy of the country and the residual.

In [97]:
```
print("Good predictions (within 1 standard devation of prediction): \n")
for index,row in df.iterrows():
    y = row.iloc[1]
    pred = b0 + b1*row.iloc[0]
    lowStd = y - yStd
    highStd = y + yStd
    if pred > lowStd and pred < highStd:
        print(f"{index}: predicted life expectency: {round(pred,3)}, residua
```

```
Good predictions (within 1 standard devation of prediction):

Argentina: predicted life expectency: 75.19, residual: 1.81
Barbados: predicted life expectency: 77.625, residual: -3.625
Belize: predicted life expectency: 70.807, residual: -2.807
Canada : predicted life expectency: 79.086, residual: 1.914
Chile: predicted life expectency: 76.651, residual: 0.349
Colombia: predicted life expectency: 75.19, residual: -1.19
Costa Rica: predicted life expectency: 75.677, residual: 2.323
Dominican Republic: predicted life expectency: 73.242, residual: 0.758
Ecuador: predicted life expectency: 73.729, residual: 1.271
El Salvador: predicted life expectency: 71.781, residual: 0.219
Guatemala: predicted life expectency: 70.32, residual: -0.32
Honduras: predicted life expectency: 71.294, residual: -1.294
Jamaica: predicted life expectency: 74.216, residual: -0.216
Mexico: predicted life expectency: 74.216, residual: 1.784
Nicaragua: predicted life expectency: 72.755, residual: -0.755
Panama: predicted life expectency: 74.216, residual: 2.784
Puerto Rico: predicted life expectency: 78.112, residual: 0.888
United States: predicted life expectency: 77.138, residual: 0.862
Uruguay: predicted life expectency: 77.138, residual: -1.138
Venezuela : predicted life expectency: 73.729, residual: 0.271
Virgin Islands: predicted life expectency: 78.112, residual: 0.888
```