In [1]:

```
# Data manipulation
import pandas as pd

# Data visualization
import matplotlib.pyplot as plt

import seaborn as sns
```

IMPORTING THE DATASET

In [2]:

```
df = pd.read_csv('sales_data.csv')


# first five rows

df.head()
```

Out[2]:

	Product	Product id	Segmentation	Qty	Sales	Month
0	Peak Yoghurt Dr Plain Sweetened 24x100ml	1155370	ATOM-WS - Lockup Shop (Secondary Town)	30	39696.0	1
1	Peak Yoghurt Dr Plain Sweetened 24x100ml	1155370	GTOM-RT - Table Top	4	5292.8	1
2	Peak Yoghurt Dr Plain Sweetened 24x100ml	1155370	GTOM-RT - Table Top	2	2646.4	1
3	Peak Yoghurt Dr Plain Sweetened 24x100ml	1155370	GTOM-RT - Table Top	3	3969.6	1
4	Peak Yoghurt Dr Plain Sweetened 24x100ml	1155370	GTOM-RT - Table Top	10	13232.0	1

In [3]:

```
# last five rows of the dataset
df.tail()
```

Out[3]:

	Product	Product id	Segmentation	Qty	Sales	Month
62219	Peak 456 GUM Pwdr Pouch 12x360g	1178076	GTNOM-RT - Minimart	1	1348.25	11
62220	Peak 456 GUM Pwdr Pouch 12x360g	1178076	GTNOM-RT - Minimart	1	1348.25	11
62221	Peak 456 GUM Pwdr Pouch 12x360g	1178076	GTNOM-RT - Minimart	1	1348.25	11
62222	Peak 456 GUM Pwdr Pouch 12x360g	1178076	GTNOM-RT - Kiosk	1	1348.25	11
62223	Peak 456 GUM Pwdr Pouch 12x360g	1178076	GTNOM-RT - Minimart	1	1348.25	11

In [4]:

```
# shape of the dataset

df.shape
```

Out[4]:

```
(62224, 6)
```

In [5]:

```
# columns present in the dataset

df.columns
```

Out[5]:

```
Index(['Product', 'Product id', 'Segmentation', 'Qty', 'Sales', 'Month'], dtype='objec
t')
```

In [6]:

```
# A concise summary of the dataset

df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 62224 entries, 0 to 62223
Data columns (total 6 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   Product       62224 non-null  object 
 1   Product id    62224 non-null  int64  
 2   Segmentation  62224 non-null  object 
 3   Qty           62224 non-null  int64  
 4   Sales         62224 non-null  float64
 5   Month         62224 non-null  int64  
dtypes: float64(1), int64(3), object(2)
memory usage: 2.8+ MB
```

In [7]:

```
# checking for missing values

df.isnull().sum()
```

Out[7]:

```
Product         0
Product id      0
Segmentation    0
Qty             0
Sales           0
Month           0
dtype: int64
```

In [8]:

```
# Getting description statistics summary
df.describe()
```

Out[8]:

	Product id	Qty	Sales	Month
count	6.222400e+04	62224.000000	6.222400e+04	62224.000000
mean	2.592445e+06	7.893755	1.451961e+04	5.968437
std	2.587221e+06	19.651899	1.303623e+05	3.366869
min	4.034780e+05	1.000000	3.885000e+01	1.000000
25%	1.176870e+06	1.000000	2.242000e+02	3.000000
50%	1.182533e+06	2.000000	9.549500e+02	6.000000
75%	7.050005e+06	6.000000	3.009210e+03	9.000000
max	7.050593e+06	1200.000000	1.707606e+07	12.000000

EXPLORATORY DATA ANALYSIS

WHAT IS THE OVERALL SALES TRED ?

In [9]:

```
df['Month'].min()
```

Out[9]:

```
1
```

In [10]:

```
df['Month'].max()
```

Out[10]:

```
12
```

In [11]:

```
df['Month']
```

Out[11]:

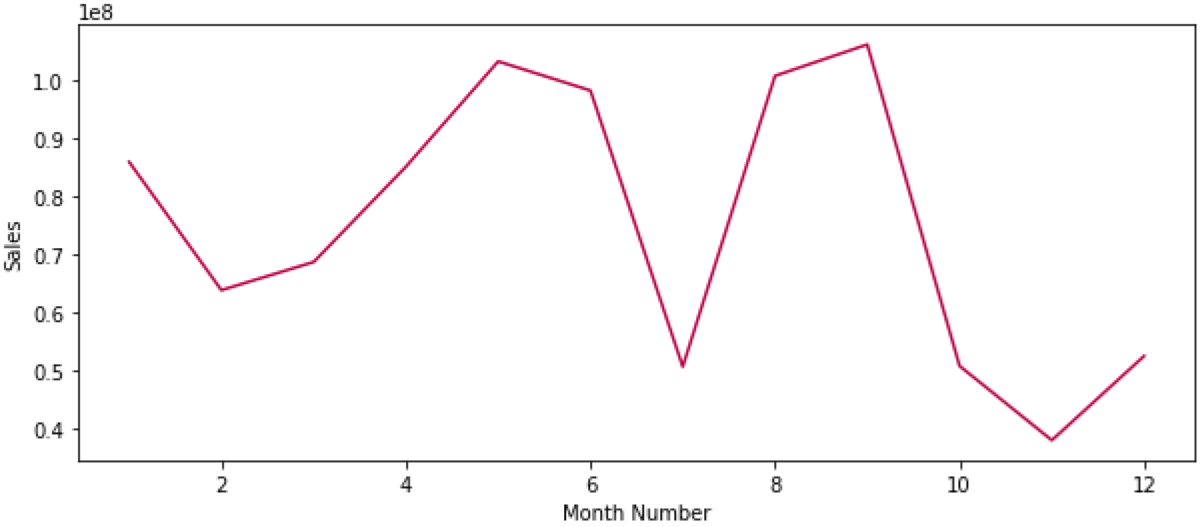
```
0         1
1         1
2         1
3         1
4         1
         ..
62219    11
62220    11
62221    11
62222    11
62223    11
Name: Month, Length: 62224, dtype: int64
```

In [12]:

```
df_trend = df.groupby('Month').sum()['Sales'].reset_index()
```

In [13]:

```
plt.figure(figsize=(10,4))
plt.plot(df_trend['Month'], df_trend['Sales'], color='#b80045')
plt.xlabel('Month Number')
plt.ylabel('Sales')
#plt.grid(True, which='both', color='grey', linewidth=1)
plt.savefig('graph.jpeg')
```



- WHICH ARE THE 1O PRODUCTS BY SALES ?

In [14]:

```
# Grouping product name column
#df['MONTH']=df['MONTH'].str[0:]
df['Month']=df['Month'].astype('int32')
df.head()
```

Out[14]:

	Product	Product id	Segmentation	Qty	Sales	Month
0	Peak Yoghurt Dr Plain Sweetened 24x100ml	1155370	ATOM-WS - Lockup Shop (Secondary Town)	30	39696.0	1
1	Peak Yoghurt Dr Plain Sweetened 24x100ml	1155370	GTOM-RT - Table Top	4	5292.8	1
2	Peak Yoghurt Dr Plain Sweetened 24x100ml	1155370	GTOM-RT - Table Top	2	2646.4	1
3	Peak Yoghurt Dr Plain Sweetened 24x100ml	1155370	GTOM-RT - Table Top	3	3969.6	1
4	Peak Yoghurt Dr Plain Sweetened 24x100ml	1155370	GTOM-RT - Table Top	10	13232.0	1

In [15]:

```
results = df.groupby('Month').sum()
results
```

Out[15]:

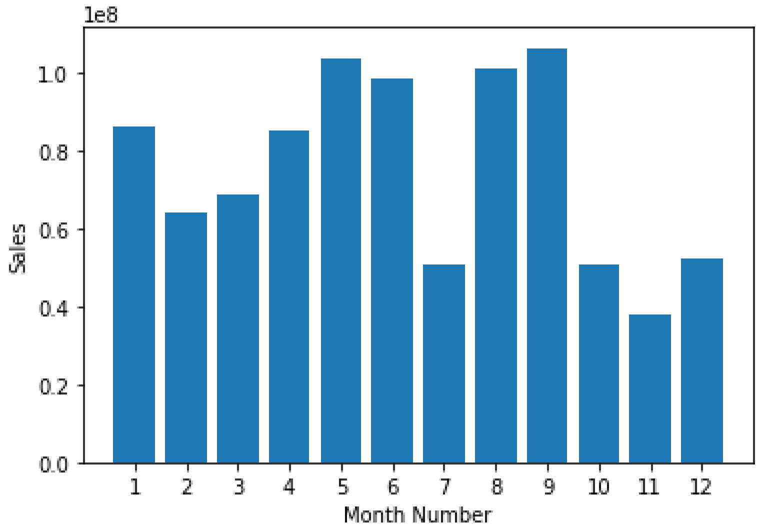
	Product id	Qty	Sales
Month			
1	17434476923	66458	8.592022e+07
2	18870873128	65275	6.377506e+07
3	19720424924	65514	6.863400e+07
4	16245843382	54461	8.511042e+07
5	19750583314	67731	1.032871e+08
6	14673011895	46113	9.825333e+07
7	10509499685	23464	5.056274e+07
8	14191488744	30865	1.007868e+08
9	3483897408	27867	1.062018e+08
10	9123758730	17394	5.068209e+07
11	6866372327	12361	3.785561e+07
12	10442042342	13678	5.239895e+07

In [16]:

```
months = range(1,13)
plt.bar(months, results['Sales'])

plt.xticks(months)
plt.xlabel('Month Number')

plt.ylabel('Sales')
plt.show()
```



In [17]:

```
#Top 10 Product
result = pd.DataFrame(df.groupby('Product').sum()['Sales'])
SORT = result.sort_values('Sales', ascending=False)  # Sorting in descending order
top_10 = SORT[:10]
top_10
```

Out[17]:

	Sales
Product	
Three Crowns Evm Reg Can 24x150g	2.363825e+08
Peak Pwdr Sac 210x14g	2.247596e+08
Peak Filled Evm Can 24x150g	1.223246e+08
Peak Pwdr Pouch 12x360g	6.868322e+07
Peak Filled Evm Can 48x150g	2.880818e+07
Three Crowns Pwdr Pouch 12x350g	2.633237e+07
Peak 123 GUM Pwdr Pouch 12x360g	2.288563e+07
Three Crowns Pwdr Sac 210x12g	2.213484e+07
My Boy Eldorin Box 12x400g	1.855955e+07
Peak Full Cream Pwdr Pouch 6x800g	1.582937e+07

In [18]:

```
# Plotting the top 10 products
'''plt.figure(figsize=(10, 6))
plt.bar(top_10.index, top_10['Sales'])
plt.xlabel('Product')
plt.ylabel('Total Sales')
plt.title('Top 10 Products by Total Sales')
plt.xticks(rotation=45)
plt.tight_layout()

plt.show()'''

plt.figure(figsize=(10, 6))
plt.barh(top_10.index, top_10['Sales'],color='#b80045')
plt.xlabel('Sales')
plt.ylabel('Product')
plt.title('Top 10 Products by Sales')
plt.gca().invert_yaxis()  # Invert y-axis for better readability
plt.show()
#plt.savefig('graph.png')
```

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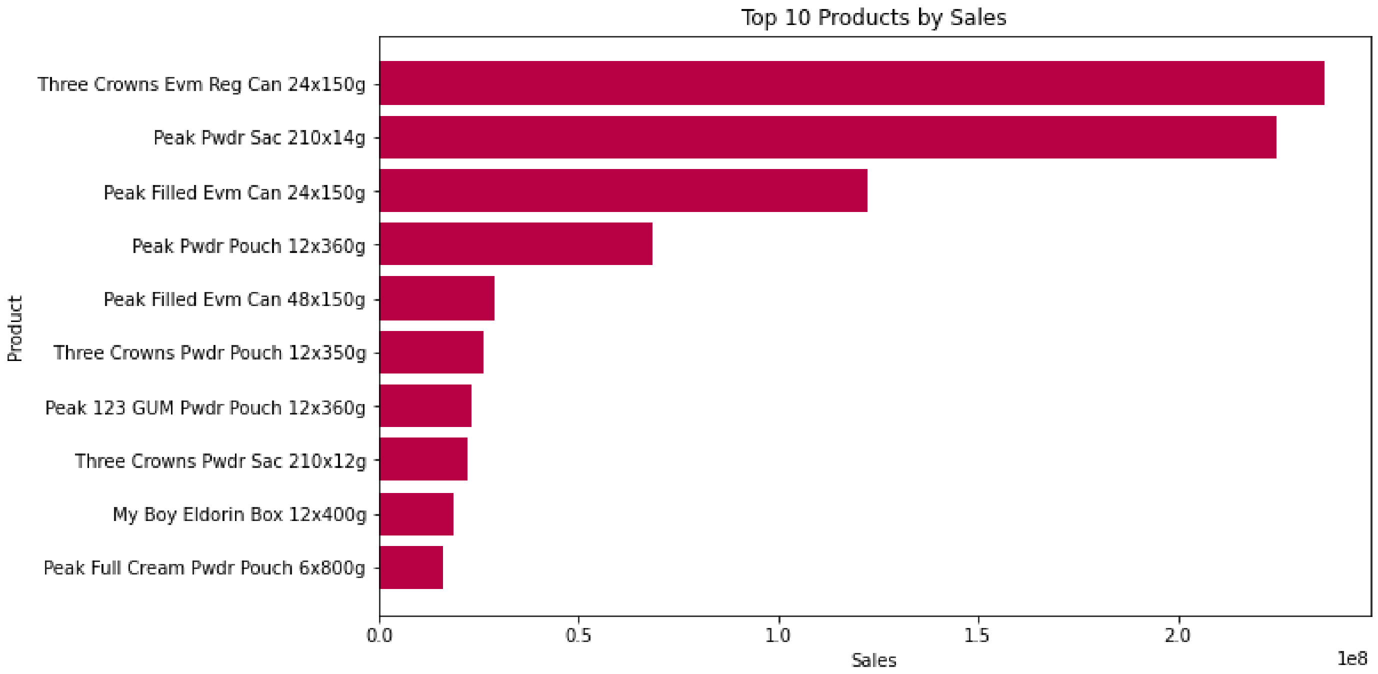


In [19]:

```
#least 10 Product
result = pd.DataFrame(df.groupby('Product').sum()['Sales'])
SORT = result.sort_values('Sales', ascending=True)
#result
least_10 = SORT[:10]
least_10
```

Out[19]:

	Sales
Product	
Frs Friso Gold Wheat Box 12x300g NG v19	2281.22
Frs Friso Gold Wheat Box 12x300g NG v18	2281.22
Frs Friso Gold Wheat Box 12x300g NG v37	2281.22
Frs Friso Gold Wheat Box 12x300g NG v20	2281.22
Frs Friso Gold Wheat Box 12x300g NG v21	2281.22
Frs Friso Gold Wheat Box 12x300g NG v22	2281.22
Frs Friso Gold Wheat Box 12x300g NG v23	2281.22
Frs Friso Gold Wheat Box 12x300g NG v38	2281.22
Frs Friso Gold Wheat Box 12x300g NG v24	2281.22
Frs Friso Gold Wheat Box 12x300g NG v26	2281.22

In [43]:

```
#Top 10 Segmentation
result = pd.DataFrame(df.groupby('Segmentation').sum()['Sales'])
SORT = result.sort_values('Sales', ascending=False)  # Sorting in descending order
tops_10 = SORT[:10]
tops_10
```

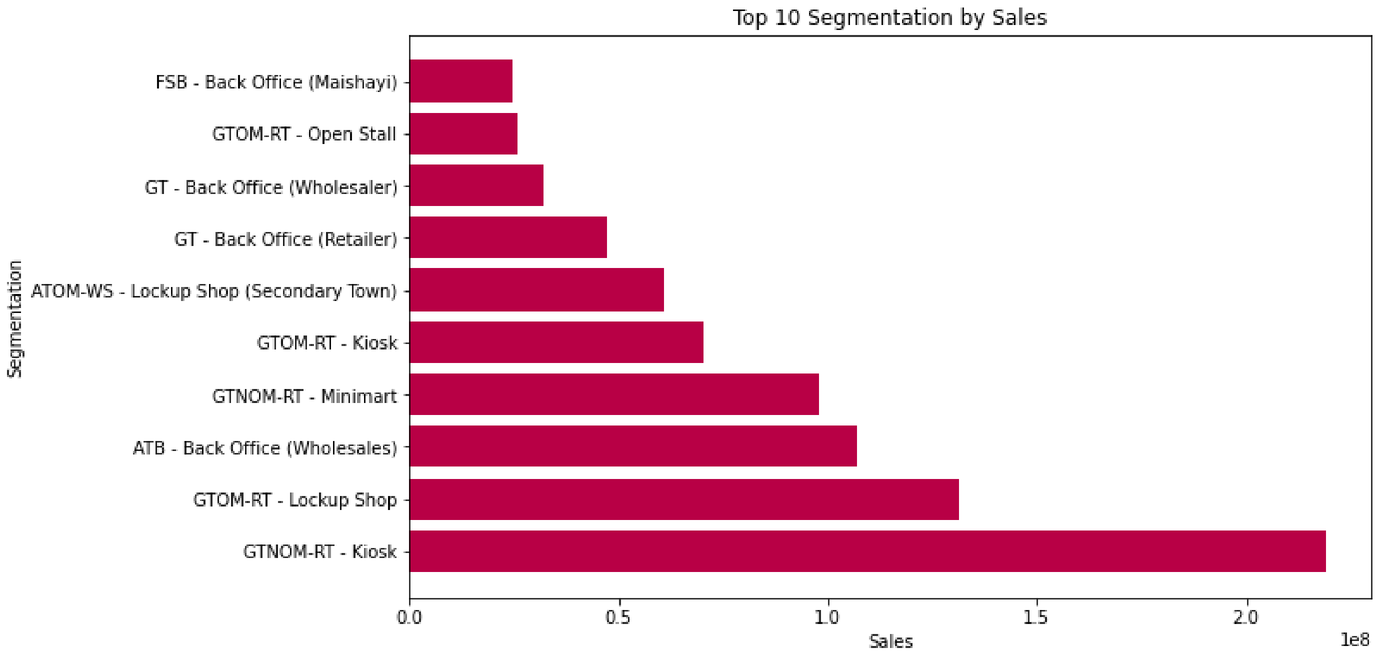
Out[43]:

	Sales
Segmentation	
GTNOM-RT - Kiosk	2.191089e+08
GTOM-RT - Lockup Shop	1.311520e+08
ATB - Back Office (Wholesales)	1.071934e+08
GTNOM-RT - Minimart	9.798699e+07
GTOM-RT - Kiosk	7.019244e+07
ATOM-WS - Lockup Shop (Secondary Town)	6.100492e+07
GT - Back Office (Retailer)	4.703843e+07
GT - Back Office (Wholesaler)	3.192763e+07
GTOM-RT - Open Stall	2.566857e+07
FSB - Back Office (Maishayi)	2.441633e+07

In [49]:

```python
import matplotlib.pyplot as plt

plt.figure(figsize=(10, 6))
plt.barh(tops_10.index, tops_10['Sales'],color='#b80045')
plt.xlabel('Sales')
plt.ylabel('Segmentation')
plt.title('Top 10 Segmentation by Sales')
#plt.gca().invert_yaxis()  # Invert y-axis for better readability
plt.show()
#plt.savefig('graph.png')
```



In [50]:

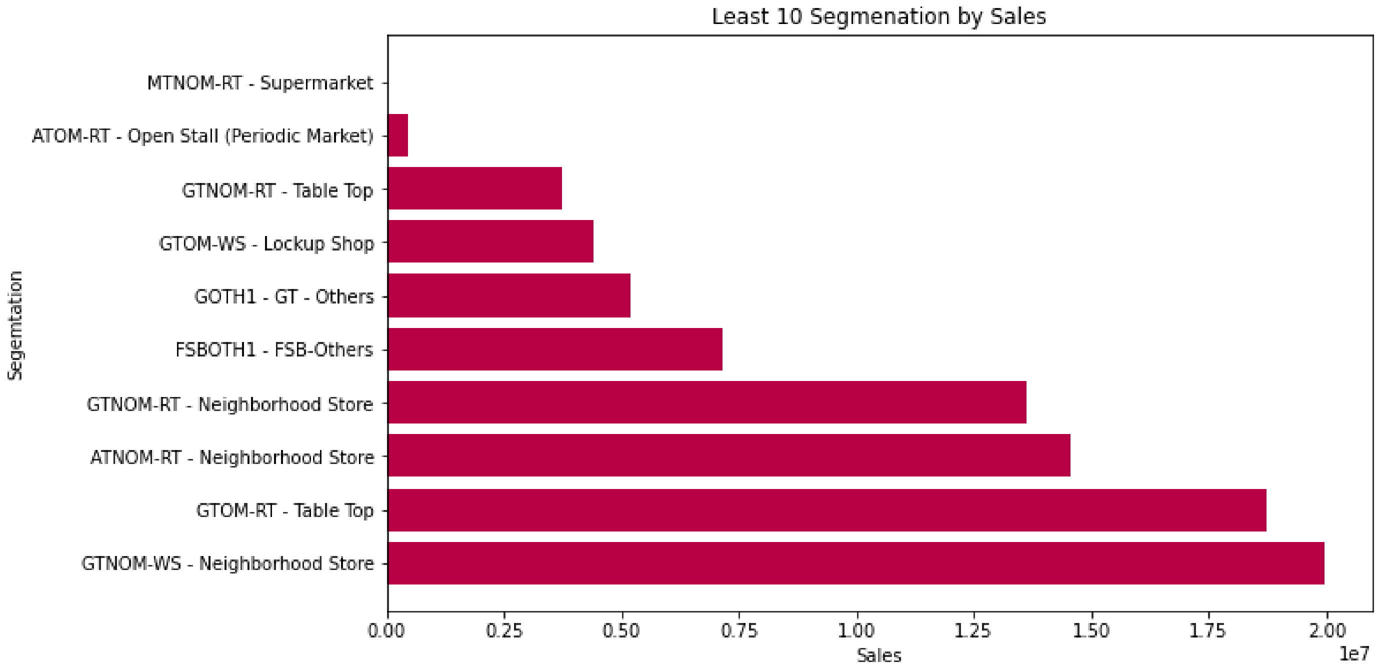
```python
#least 10 Segmentation
result = pd.DataFrame(df.groupby('Segmentation').sum()['Sales'])
SORT = result.sort_values('Sales', ascending=True)
#result
leasts_10 = SORT[:10]
leasts_10
```

Out[50]:

	Sales
Segmentation	
MTNOM-RT - Supermarket	490.72
ATOM-RT - Open Stall (Periodic Market)	449680.32
GTNOM-RT - Table Top	3722892.97
GTOM-WS - Lockup Shop	4425848.93
GOTH1 - GT - Others	5178256.13
FSBOTH1 - FSB-Others	7159604.93
GTNOM-RT - Neighborhood Store	13618957.28
ATNOM-RT - Neighborhood Store	14539125.48
GTOM-RT - Table Top	18717451.50
GTNOM-WS - Neighborhood Store	19966304.54

In [53]:

```
plt.figure(figsize=(10, 6))
plt.barh(leasts_10.index, leasts_10['Sales'],color='#b80045')
plt.xlabel('Sales')
plt.ylabel('Segemtation')
plt.title('Least 10 Segmenation by Sales')
plt.gca().invert_yaxis()  # Invert y-axis for better readability
#plt.show()
#plt.savefig('graph.png')
```



ARIMA and Seasonal ARIMA

Autoregressive Integrated Moving Averages

In [1]:

```
import numpy as np
import pandas as pd
from pmdarima import auto_arima
import matplotlib.pyplot as plt
%matplotlib inline
```

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```
C:\Users\JOBEN\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:7: FutureWa
rning: pandas.Int64Index is deprecated and will be removed from pandas in a future versi
on. Use pandas.Index with the appropriate dtype instead.
  from pandas import (to_datetime, Int64Index, DatetimeIndex, Period,
C:\Users\JOBEN\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:7: FutureWa
rning: pandas.Float64Index is deprecated and will be removed from pandas in a future ver
sion. Use pandas.Index with the appropriate dtype instead.
  from pandas import (to_datetime, Int64Index, DatetimeIndex, Period,
```

In [2]:

```
df=pd.read_csv('sales data.csv', parse_dates = True)
```

In [3]:

```
df.head()
```

Out[3]:

	Sales	MONTH
0	39696.0	JAN
1	5292.8	JAN
2	2646.4	JAN
3	3969.6	JAN
4	13232.0	JAN

In [4]:

```
df.tail()
```

Out[4]:

	Sales	MONTH
139	441.04	DEC
140	330.78	DEC
141	441.04	DEC
142	441.04	DEC
143	330.78	DEC

In [5]:

```
df.set_index('MONTH',inplace=True)
```

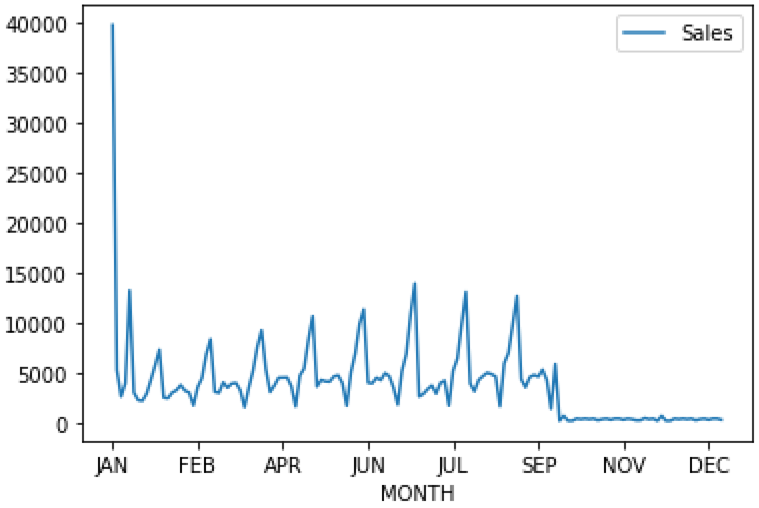
Visualize the Data

In [6]:

```
df.plot()
```

Out[6]:

```
<AxesSubplot:xlabel='MONTH'>
```



In [8]:

```
#training and test set
training = df.iloc[:-31,:]
test = df.iloc[-31:, :]
```

CREATING THE SARIMA MODEL

In [9]:

```
#SARIMA model
model = auto_arima(y = training.Sales,
                   m = 7)
```

In [10]:

```
#Predictions
predictions = pd.Series(model.predict(n_periods = len(test)))
predictions.index = test.index
#predictions[:4]
```

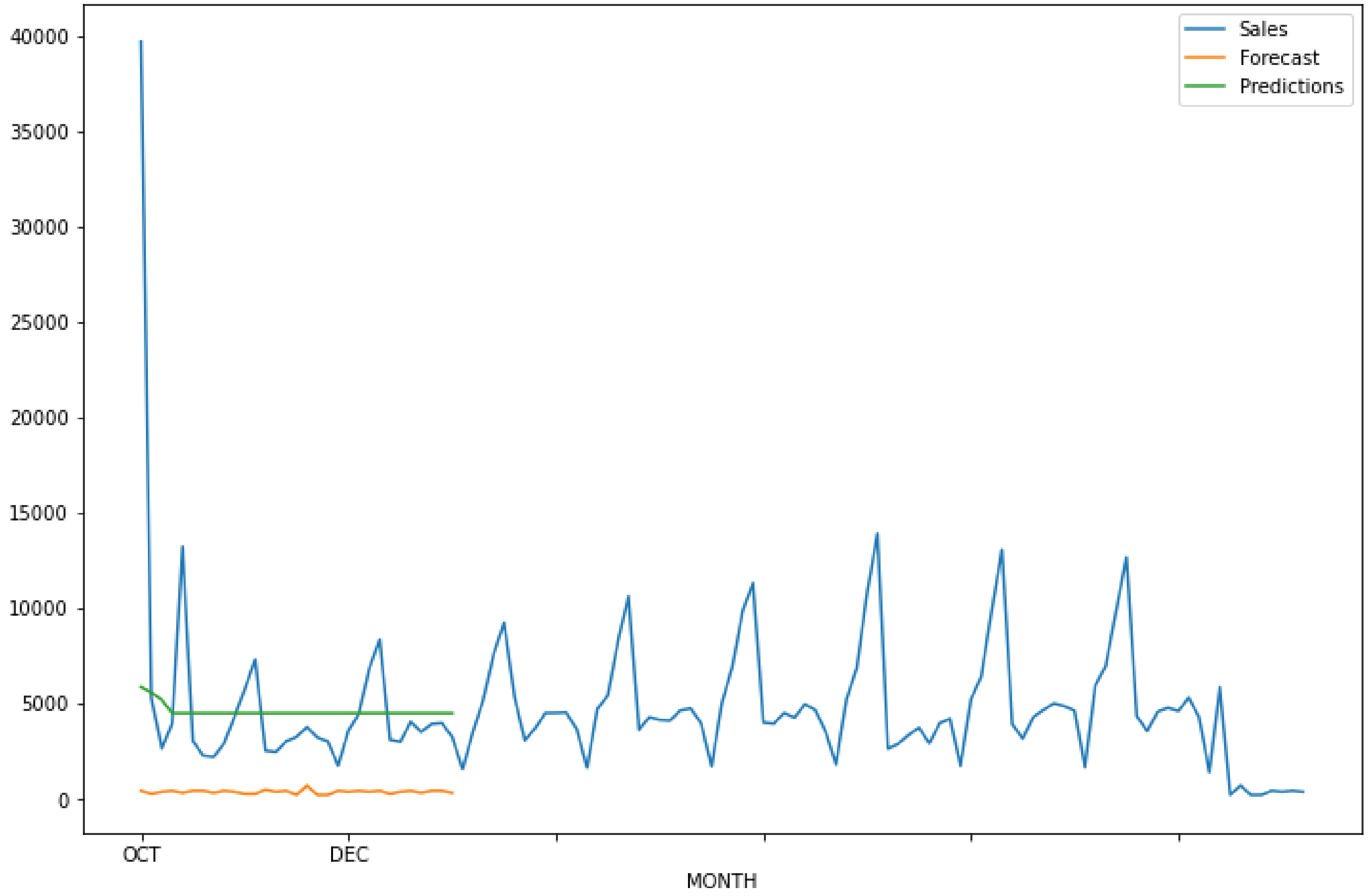
```
C:\Users\JOBEN\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:376: ValueW
arning: No supported index is available. Prediction results will be given with an intege
r index beginning at `start`.
  warnings.warn('No supported index is available.'
```

In [11]:

```
# Visualization
training['Sales'].plot(figsize=(12, 8), legend=True, label='Sales')
test['Sales'].plot(legend=True, label='Forecast')
predictions.plot(legend=True, label='Predictions')
```

Out[11]:

```
<AxesSubplot:xlabel='MONTH'>
```



ARIMA MODEL RESULTS

Loading [MathJax]/extensions/Safe.js

In [12]:

```
from statsmodels.tsa.arima_model import ARIMA
```

In [13]:

```
from statsmodels.tsa.arima.model import ARIMA

# Define the ARIMA model
model = ARIMA(df['Sales'], order=(1, 1, 1))

# Fit the model
model_fit = model.fit()

# Get summary information
print(model_fit.summary())
```

```
C:\Users\JOBEN\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:578: ValueW
arning: An unsupported index was provided and will be ignored when e.g. forecasting.
  warnings.warn('An unsupported index was provided and will be'
C:\Users\JOBEN\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:578: ValueW
arning: An unsupported index was provided and will be ignored when e.g. forecasting.
  warnings.warn('An unsupported index was provided and will be'
C:\Users\JOBEN\anaconda3\lib\site-packages\statsmodels\tsa\base\tsa_model.py:578: ValueW
arning: An unsupported index was provided and will be ignored when e.g. forecasting.
  warnings.warn('An unsupported index was provided and will be'
C:\Users\JOBEN\anaconda3\lib\site-packages\statsmodels\tsa\statespace\sarimax.py:966: Us
erWarning: Non-stationary starting autoregressive parameters found. Using zeros as start
ing parameters.
  warn('Non-stationary starting autoregressive parameters'
C:\Users\JOBEN\anaconda3\lib\site-packages\statsmodels\tsa\statespace\sarimax.py:978: Us
erWarning: Non-invertible starting MA parameters found. Using zeros as starting paramete
rs.
  warn('Non-invertible starting MA parameters found.'
```

```
                               SARIMAX Results
==============================================================================
Dep. Variable:                  Sales   No. Observations:                  144
Model:                 ARIMA(1, 1, 1)   Log Likelihood               -1345.105
Date:                Tue, 26 Sep 2023   AIC                           2696.211
Time:                        14:41:45   BIC                           2705.099
Sample:                             0   HQIC                          2699.823
                                - 144
Covariance Type:                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1          0.2346      0.042      5.605      0.000       0.153       0.317
ma.L1         -0.8768      0.065    -13.537      0.000      -1.004      -0.750
sigma2      8.946e+06   1.25e-09   7.13e+15      0.000    8.95e+06    8.95e+06
===================================================================================
Ljung-Box (L1) (Q):                  13.34   Jarque-Bera (JB):               622.90
Prob(Q):                              0.00   Prob(JB):                         0.00
Heteroskedasticity (H):               0.14   Skew:                            -1.41
Prob(H) (two-sided):                  0.00   Kurtosis:                        12.83
===================================================================================

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
```

In [ ]:

Loading [MathJax]/extensions/Safe.js