

In [1]:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
```

In [2]:

```
amazon_data = pd.read_csv('amazon_stock_price.csv')
```

In [3]:

```
amazon_data
```

Out[3]:

	Date	Open	High	Low	Close	Adj Close	Volume
0	15-05-1997	2.437500	2.500000	1.927083	1.958333	1.958333	72156000
1	16-05-1997	1.968750	1.979167	1.708333	1.729167	1.729167	14700000
2	19-05-1997	1.760417	1.770833	1.625000	1.708333	1.708333	6106800
3	20-05-1997	1.729167	1.750000	1.635417	1.635417	1.635417	5467200
4	21-05-1997	1.635417	1.645833	1.375000	1.427083	1.427083	18853200
...	...	...	...	...	...	...	...
6120	09-09-2021	3526.020020	3549.989990	3480.370117	3484.159912	3484.159912	2719200
6121	10-09-2021	3501.830078	3508.449951	3462.909912	3469.149902	3469.149902	2393300
6122	13-09-2021	3482.800049	3497.959961	3438.000000	3457.169922	3457.169922	2569000
6123	14-09-2021	3475.550049	3486.810059	3437.709961	3450.000000	3450.000000	1936900
6124	15-09-2021	3442.520020	3485.149902	3402.010010	3475.790039	3475.790039	2921019

6125 rows × 7 columns

In [4]:



```
amazon_data.head()
```

Out[4]:

	Date	Open	High	Low	Close	Adj Close	Volume
0	15-05-1997	2.437500	2.500000	1.927083	1.958333	1.958333	72156000
1	16-05-1997	1.968750	1.979167	1.708333	1.729167	1.729167	14700000
2	19-05-1997	1.760417	1.770833	1.625000	1.708333	1.708333	6106800
3	20-05-1997	1.729167	1.750000	1.635417	1.635417	1.635417	5467200
4	21-05-1997	1.635417	1.645833	1.375000	1.427083	1.427083	18853200

In [5]:



```
amazon_data.tail()
```

Out[5]:

	Date	Open	High	Low	Close	Adj Close	Volume
6120	09-09-2021	3526.020020	3549.989990	3480.370117	3484.159912	3484.159912	2719200
6121	10-09-2021	3501.830078	3508.449951	3462.909912	3469.149902	3469.149902	2393300
6122	13-09-2021	3482.800049	3497.959961	3438.000000	3457.169922	3457.169922	2569000
6123	14-09-2021	3475.550049	3486.810059	3437.709961	3450.000000	3450.000000	1936900
6124	15-09-2021	3442.520020	3485.149902	3402.010010	3475.790039	3475.790039	2921019

In [6]:



```
amazon_data.shape
```

Out[6]:

```
(6125, 7)
```

In [7]:



amazon\_data.info()

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 6125 entries, 0 to 6124
Data columns (total 7 columns):
#   Column      Non-Null Count  Dtype
---  -
0   Date        6125 non-null   object
1   Open        6125 non-null   float64
2   High        6125 non-null   float64
3   Low         6125 non-null   float64
4   Close       6125 non-null   float64
5   Adj Close   6125 non-null   float64
6   Volume      6125 non-null   int64
dtypes: float64(5), int64(1), object(1)
memory usage: 335.1+ KB
```

In [8]:



amazon\_data.describe()

Out[8]:

	Open	High	Low	Close	Adj Close	Volume
<b>count</b>	6125.000000	6125.000000	6125.000000	6125.000000	6125.000000	6.125000e+03
<b>mean</b>	506.711946	512.263599	500.544531	506.589874	506.589874	7.351046e+06
<b>std</b>	836.045119	844.598987	826.233207	835.548822	835.548822	7.159739e+06
<b>min</b>	1.406250	1.447917	1.312500	1.395833	1.395833	4.872000e+05
<b>25%</b>	38.619999	39.439999	38.049999	38.720001	38.720001	3.600100e+06
<b>50%</b>	91.800003	93.400002	89.750000	91.300003	91.300003	5.483600e+06
<b>75%</b>	512.989990	519.409973	502.570007	511.890015	511.890015	8.310500e+06
<b>max</b>	3744.000000	3773.080078	3696.790039	3731.409912	3731.409912	1.043292e+08

In [9]:



amazon\_data.columns

Out[9]:

```
Index(['Date', 'Open', 'High', 'Low', 'Close', 'Adj Close', 'Volume'], dtype='object')
```

In [10]:



```
amazon_data.isnull().sum()
```

Out[10]:

```
Date          0
Open          0
High          0
Low           0
Close         0
Adj Close     0
Volume        0
dtype: int64
```

In [11]:



```
amazon_data = amazon_data.drop(columns=['Adj Close'])
```

In [12]:



```
amazon_data.head()
```

Out[12]:

	Date	Open	High	Low	Close	Volume
0	15-05-1997	2.437500	2.500000	1.927083	1.958333	72156000
1	16-05-1997	1.968750	1.979167	1.708333	1.729167	14700000
2	19-05-1997	1.760417	1.770833	1.625000	1.708333	6106800
3	20-05-1997	1.729167	1.750000	1.635417	1.635417	5467200
4	21-05-1997	1.635417	1.645833	1.375000	1.427083	18853200

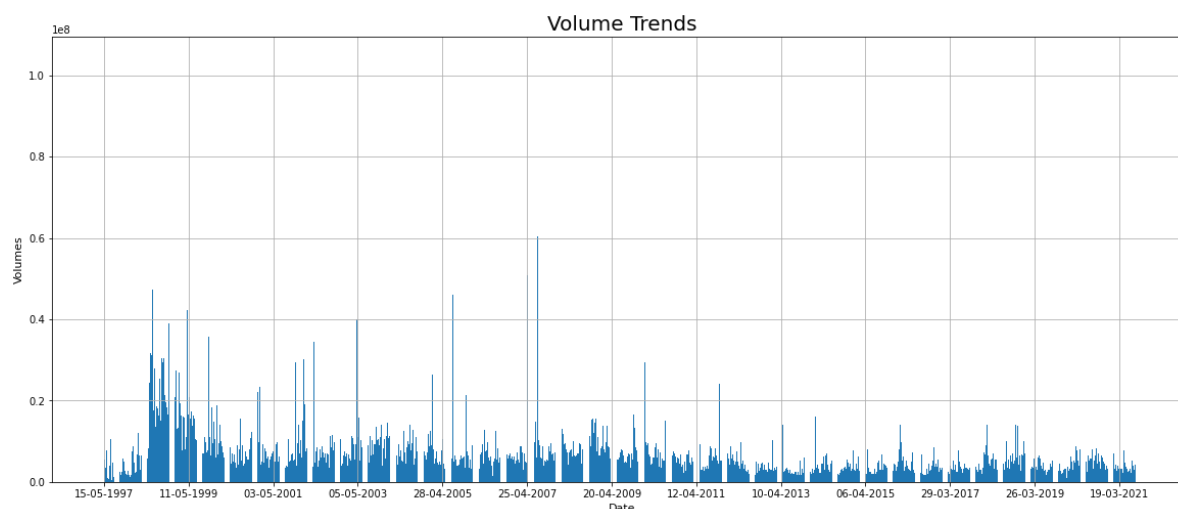
In [13]:

```
fig, ax = plt.subplots(figsize=(20,8))
ax.plot(amazon_data['Date'], amazon_data['Close'], color='Red')
ax.xaxis.set_major_locator(plt.MaxNLocator(15))
ax.set_xlabel('Date', fontsize='11')
ax.set_ylabel('Price in USD', fontsize='11')
plt.title('Amazon Stock Prices')
plt.grid()
plt.show()
```



In [14]:

```
fig, ax = plt.subplots(figsize=(20,8))
ax.bar(amazon_data['Date'], amazon_data['Volume'])
ax.xaxis.set_major_locator(plt.MaxNLocator(15))
ax.set_xlabel('Date', fontsize='11')
ax.set_ylabel('Volumes', fontsize='11')
plt.title('Volume Trends', fontsize='20')
plt.grid()
plt.show()
```



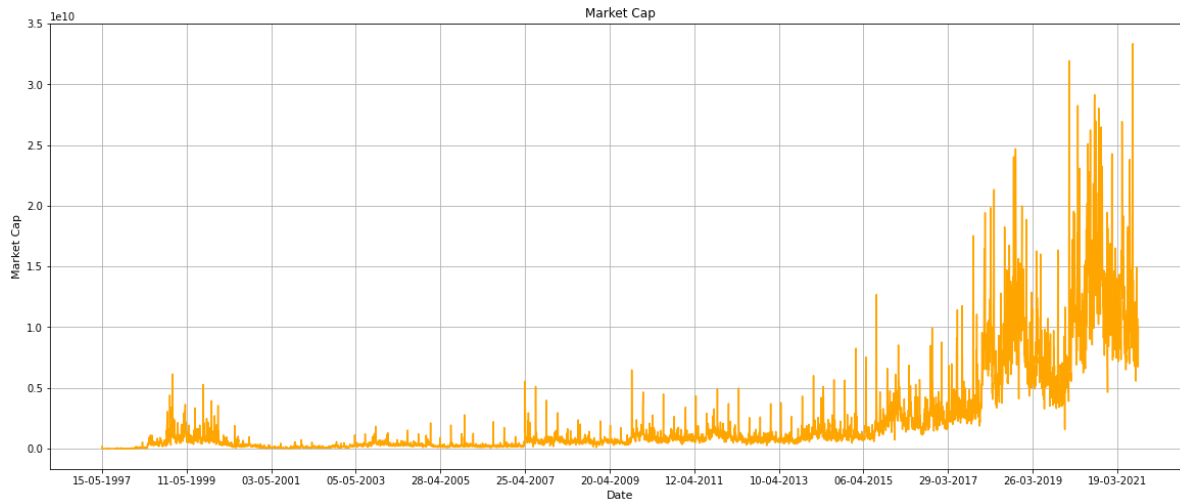
In [15]:

```
amazon_data['Market Cap'] = amazon_data['Open']*amazon_data['Volume']
```

In [16]:



```
fig, ax = plt.subplots(figsize=(20,8))
ax.plot(amazon_data['Date'], amazon_data['Market Cap'], color='orange')
ax.xaxis.set_major_locator(plt.MaxNLocator(15))
ax.set_xlabel('Date', fontsize='11')
ax.set_ylabel('Market Cap', fontsize='11')
plt.title('Market Cap')
plt.grid()
plt.show()
```



In [17]:



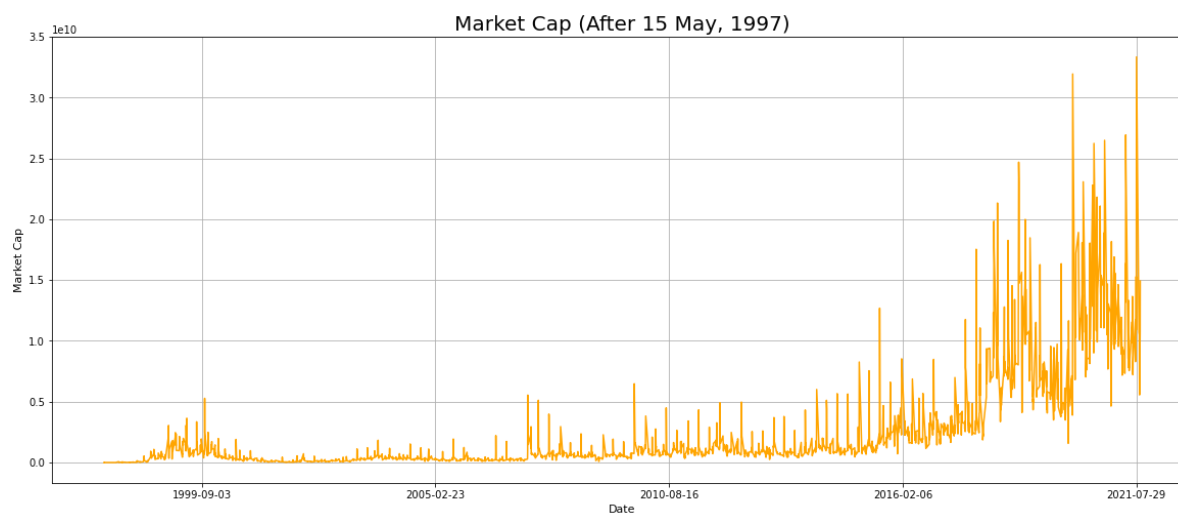
```
amazon_data.iloc[amazon_data['Market Cap'].argmax()]
```

Out[17]:

Date	30-07-2021
Open	3347.95
High	3368.14
Low	3306.98
Close	3327.59
Volume	9957100
Market Cap	3.33359e+10
Name: 6092, dtype: object	

In [19]:

```
ohlcv = amazon_data[(amazon_data['Date'] > '1997-05-15')]
ohlcv = ohlcv.loc[:, ['Date', 'Open', 'High', 'Low', 'Close', 'Volume',
                    'Market Cap']]
ohlcv['Date'] = pd.to_datetime(ohlcv['Date'], format='%d-%m-%Y')
fig, ax = plt.subplots(figsize=(20,8))
ax.plot(ohlcv['Date'], ohlcv['Market Cap'], color='orange')
ax.xaxis.set_major_locator(plt.MaxNLocator(5))
ax.set_xlabel('Date', fontsize='11')
ax.set_ylabel('Market Cap', fontsize='11')
plt.grid()
plt.title('Market Cap (After 15 May, 1997)', fontsize='20')
plt.show()
```

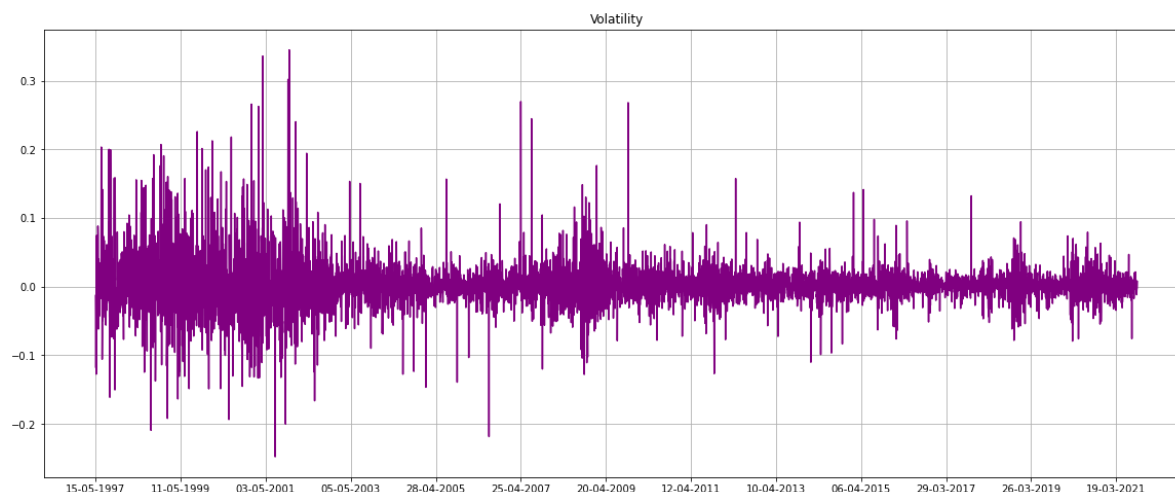


In [20]:

```
amazon_data['vol'] = (amazon_data['Close']/amazon_data['Close'].shift(1)) - 1
```

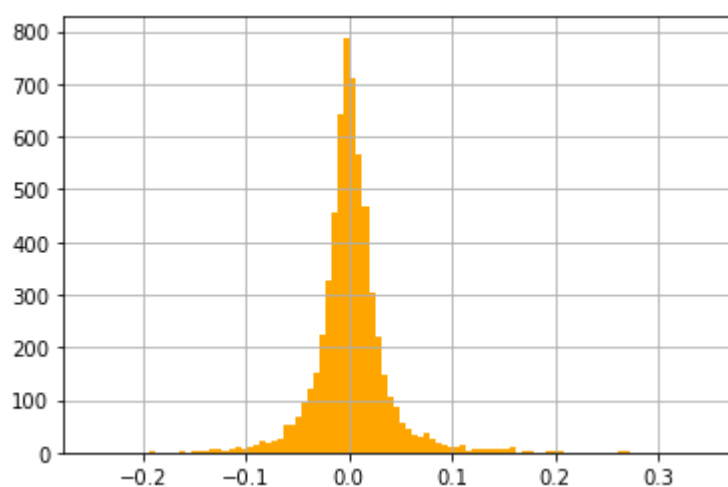
In [21]:

```
fig, ax = plt.subplots(figsize=(20,8))
ax.plot(amazon_data['Date'], amazon_data['vol'], color='purple')
ax.xaxis.set_major_locator(plt.MaxNLocator(15))
plt.title('Volatility')
plt.grid()
plt.show()
```



In [23]:

```
amazon_data['vol'].hist(bins=100, color='orange');
```



In [24]:

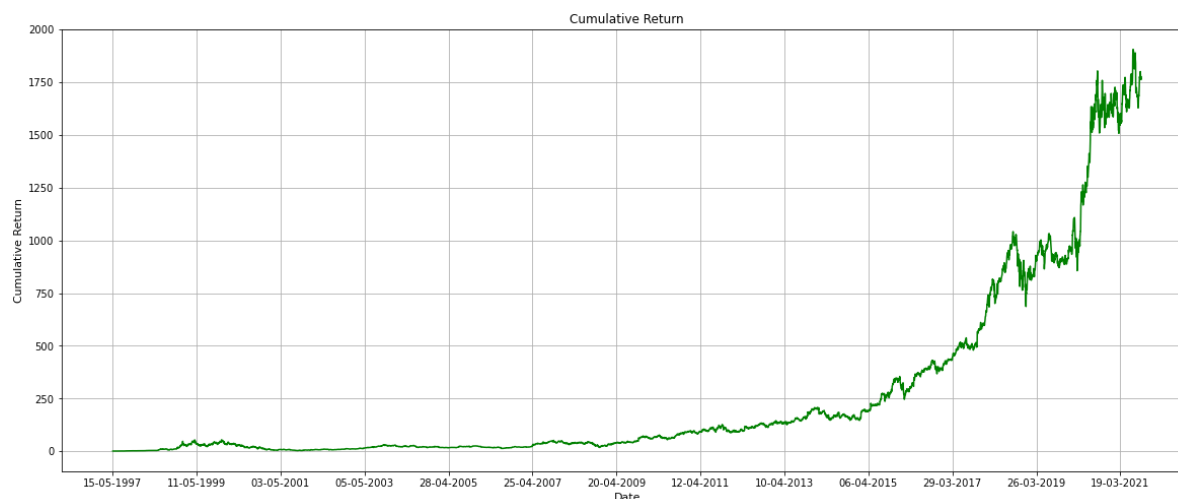
```
amazon_data['Cumulative Return'] = (1 + amazon_data['vol']).cumprod()
```



In [25]:



```
fig, ax = plt.subplots(figsize=(20,8))
ax.plot(amazon_data['Date'], amazon_data['Cumulative Return'], color='green')
ax.xaxis.set_major_locator(plt.MaxNLocator(15))
ax.set_xlabel('Date', fontsize='11')
ax.set_ylabel('Cumulative Return', fontsize='11')
plt.title('Cumulative Return')
plt.grid()
plt.show()
```

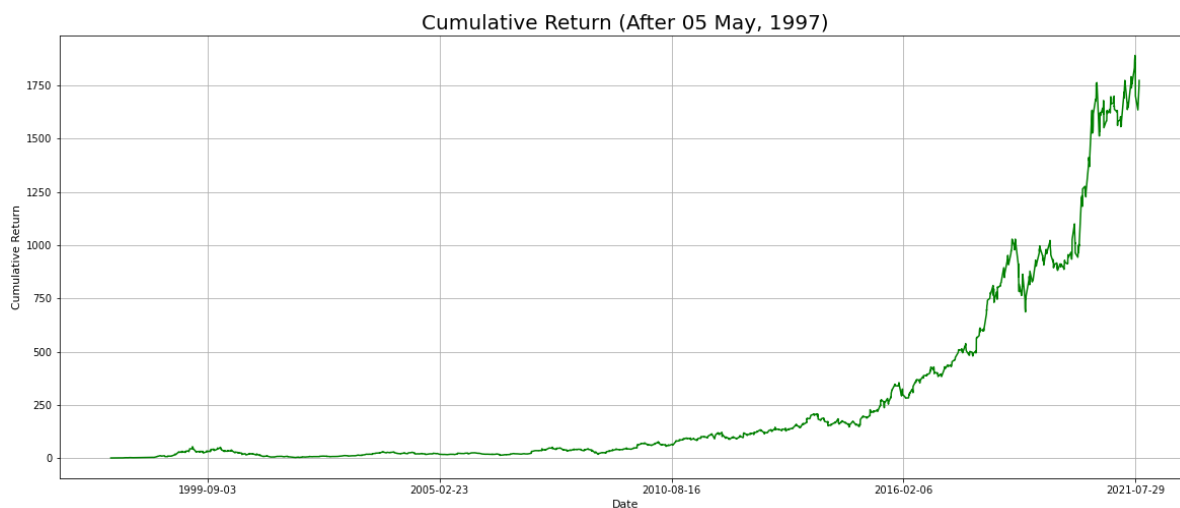


In [26]:

```

ohlcv = amazon_data[(amazon_data['Date'] > '1997-05-15')]
ohlcv = ohlcv.loc[:, ['Date', 'Open', 'High', 'Low', 'Close', 'Volume', 'Market Cap', 'Cumulative Return']]
ohlcv['Date'] = pd.to_datetime(ohlcv['Date'], format='%d-%m-%Y')
fig, ax = plt.subplots(figsize=(20,8))
ax.plot(ohlcv['Date'], ohlcv['Cumulative Return'], color='green')
ax.xaxis.set_major_locator(plt.MaxNLocator(5))
ax.set_xlabel('Date', fontsize='11')
ax.set_ylabel('Cumulative Return', fontsize='11')
plt.grid()
plt.title('Cumulative Return (After 05 May, 1997)', fontsize='20')
plt.show()

```



In [27]:

```
amazon_data.iloc[amazon_data['Cumulative Return'].argmax()]
```

Out[27]:

```

Date                08-07-2021
Open                3643.56
High                3759.99
Low                 3621.12
Close               3731.41
Volume              5180600
Market Cap          1.88758e+10
vol                 0.00942218
Cumulative Return    1905.4
Name: 6076, dtype: object

```

In [28]:

```

from sklearn.preprocessing import MinMaxScaler
from keras.models import Sequential
from keras.layers import Dense, LSTM
import math

```

In [29]:



```
amazon_data['Date'] = pd.to_datetime(amazon_data['Date'])
amazon_data.set_index('Date', inplace=True)
```

In [30]:



```
data = amazon_data.filter(['Close'])
dataset = data.values
training_data_len = math.ceil(len(dataset)*.8)
training_data_len
```

Out[30]:

4900

In [31]:



```
scaler = MinMaxScaler(feature_range=(0,1))
scaled_data = scaler.fit_transform(dataset)
scaled_data
```

Out[31]:

```
array([[1.50803720e-04],
       [8.93653463e-05],
       [8.37798446e-05],
       ...,
       [9.26477492e-01],
       [9.24555268e-01],
       [9.31469462e-01]])
```

In [32]:

```

train_data = scaled_data[0:training_data_len, :]
x_train = []
y_train = []
for i in range(60,len(train_data)):
    x_train.append(train_data[i-60:i, 0])
    y_train.append(train_data[i,0])
    if i<=60:
        print(x_train)
        print(y_train)
        print()

```

```

[array([1.50803720e-04, 8.93653463e-05, 8.37798446e-05, 6.42313929e-05,
        8.37798446e-06, 0.00000000e+00, 2.79267042e-05, 5.02679068e-05,
        3.63046887e-05, 2.93229456e-05, 2.79267042e-05, 3.07194551e-05,
        2.23414706e-05, 5.58550171e-06, 3.90974396e-05, 6.98166266e-05,
        7.81946110e-05, 5.02679068e-05, 3.90974396e-05, 5.58534085e-05,
        5.02679068e-05, 4.74754240e-05, 2.93229456e-05, 3.07194551e-05,
        3.07194551e-05, 3.49084473e-05, 2.79267042e-05, 3.07194551e-05,
        3.07194551e-05, 3.07194551e-05, 2.51339534e-05, 3.90974396e-05,
        3.21156965e-05, 5.16644163e-05, 1.38236744e-04, 1.61974456e-04,
        2.42961549e-04, 2.48547051e-04, 3.12778176e-04, 2.40169067e-04,
        1.98279144e-04, 2.79266238e-04, 2.51339534e-04, 2.20620347e-04,
        2.03864378e-04, 2.10846121e-04, 1.98279144e-04, 2.40169067e-04,
        2.31791082e-04, 2.23413098e-04, 2.48547051e-04, 2.90436973e-04,
        2.82058989e-04, 2.68095503e-04, 2.73681005e-04, 2.45754300e-04,
        2.17827596e-04, 2.28998331e-04, 2.09449612e-04, 2.40169067e-04])]
[0.0002499432925062694]

```

In [33]:

```

x_train,y_train = np.array(x_train), np.array(y_train)

```

In [34]:

```

x_train = np.reshape(x_train,(x_train.shape[0],x_train.shape[1],1))
x_train.shape

```

Out[34]:

```

(4840, 60, 1)

```

In [35]:

```

model =Sequential()
model.add(LSTM(64,return_sequences=True, input_shape=(x_train.shape[1],1)))
model.add(LSTM(64, return_sequences= False))
model.add(Dense(32))
model.add(Dense(1))

```

In [36]:

```

model.compile(optimizer='adam', loss='mean_squared_error')

```

In [37]:



```
model.fit(x_train,y_train, batch_size=1, epochs=10)
```

```
Epoch 1/10
4840/4840 [=====] - 117s 24ms/step - loss: 6.4671
e-05
Epoch 2/10
4840/4840 [=====] - 118s 24ms/step - loss: 2.8060
e-05
Epoch 3/10
4840/4840 [=====] - 118s 24ms/step - loss: 1.6807
e-05
Epoch 4/10
4840/4840 [=====] - 118s 24ms/step - loss: 1.3163
e-05
Epoch 5/10
4840/4840 [=====] - 119s 25ms/step - loss: 1.0469
e-05
Epoch 6/10
4840/4840 [=====] - 120s 25ms/step - loss: 1.0056
e-05
Epoch 7/10
4840/4840 [=====] - 121s 25ms/step - loss: 8.9571
e-06
Epoch 8/10
4840/4840 [=====] - 120s 25ms/step - loss: 8.9206
e-06
Epoch 9/10
4840/4840 [=====] - 119s 25ms/step - loss: 7.5139
e-06
Epoch 10/10
4840/4840 [=====] - 119s 25ms/step - loss: 6.4870
e-06
```

Out[37]:

```
<tensorflow.python.keras.callbacks.History at 0x4648fc8c40>
```

In [38]:



```
test_data= scaled_data[training_data_len-60:, :]
x_test = []
y_test = dataset[training_data_len:,:]
for i in range(60,len(test_data)):
    x_test.append(test_data[i-60:i,0])
```

In [39]:



```
x_test = np.array(x_test)
```

In [40]:



```
x_test = np.reshape(x_test, (x_test.shape[0], x_test.shape[1],1))  
x_test.shape
```

Out[40]:

```
(1225, 60, 1)
```

In [41]:



```
predictions = model.predict(x_test)  
predictions = scaler.inverse_transform(predictions)
```

In [42]:



```
rmse = np.sqrt(np.mean(predictions - y_test)**2)  
rmse
```

Out[42]:

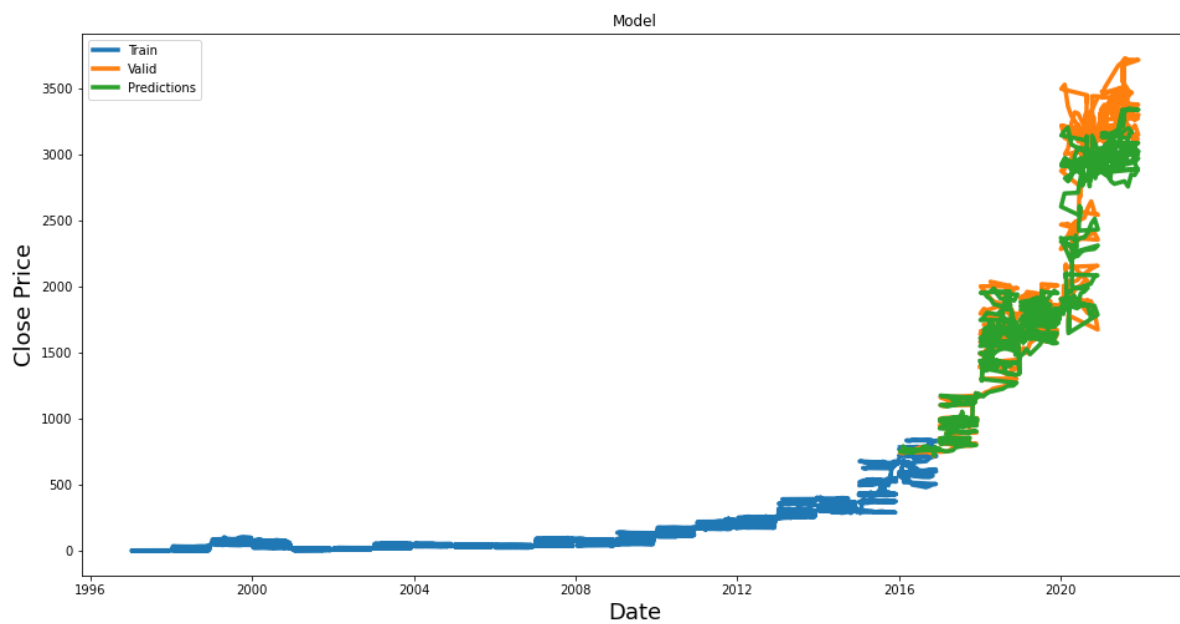
```
83.32420035000001
```

In [43]:

```
train = data[:training_data_len]
valid = data[training_data_len:]
valid['Predictions'] = predictions
plt.figure(figsize=(16,8))
plt.title('Model')
plt.xlabel('Date', fontsize=18)
plt.ylabel('Close Price', fontsize=18)
plt.plot(train['Close'],linewidth=3.5)
plt.plot(valid[['Close', 'Predictions']],linewidth=3.5)
plt.legend(['Train', 'Valid', 'Predictions'], loc='upper_center')
```

Out[43]:

&lt;matplotlib.legend.Legend at 0x465750fdf0&gt;



In [44]:



valid

Out[44]:

	Close	Predictions
Date		
2016-02-11	765.559998	789.824341
2016-03-11	767.030029	770.029297
2016-04-11	755.049988	772.032471
2016-07-11	784.929993	759.940369
2016-08-11	787.750000	790.500183
...	...	...
2021-09-09	3484.159912	3200.893311
2021-10-09	3469.149902	3168.460938
2021-09-13	3457.169922	3157.590820
2021-09-14	3450.000000	3149.124756
2021-09-15	3475.790039	3143.843994

1225 rows × 2 columns

In [46]:



```
amazon_quote = pd.read_csv('amazon_stock_price.csv')
new_amazon_data = amazon_quote.filter(['Close'])
last_60_days = new_amazon_data[-60:].values
last_60_days_scaled = scaler.transform(last_60_days)
X_test = []
X_test.append(last_60_days_scaled)
X_test = np.array(X_test)
X_test = np.reshape(X_test, (X_test.shape[0], X_test.shape[1], 1))
pred_price = model.predict(X_test)
pred_price = scaler.inverse_transform(pred_price)
pred_price
```

Out[46]:

array([[3163.9304]], dtype=float32)