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.head()
```

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

In [4]:

```
amazon_data.tail()
```

Out[4]:

	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 [5]:

```
amazon_data.shape
```

Out[5]:

```
(6125, 7)
```

In [6]:

```
amazon_data.columns
```

Out[6]:

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

In [7]:

```
amazon_data.duplicated().sum()
```

Out[7]:

```
0
```

In [8]:

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

Out[8]:

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

In [9]:

```
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 [10]:

```
amazon_data.describe()
```

Out[10]:

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

In [11]:

```
amazon_data.nunique()
```

Out[11]:

```
Date         6125
Open         5432
High         5376
Low          5382
Close        5513
Adj Close    5513
Volume       5949
dtype: int64
```

In [12]:

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

In [13]:

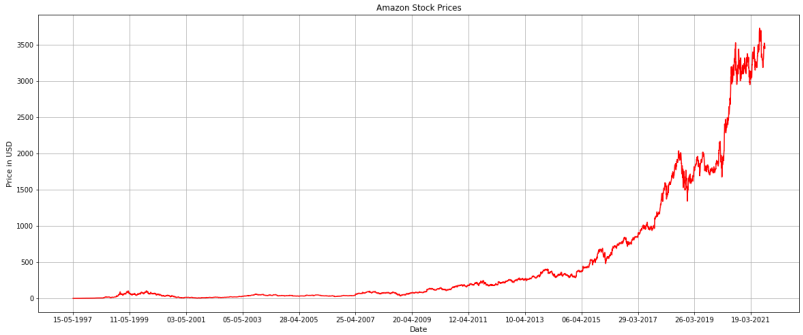
```
amazon_data.head()
```

Out[13]:

	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

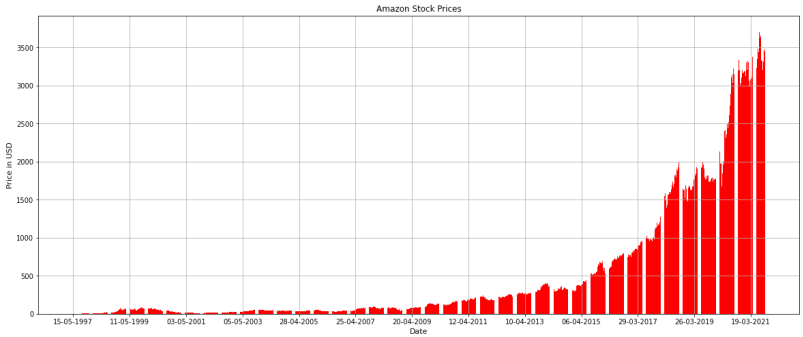
In [14]:

```
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()
```



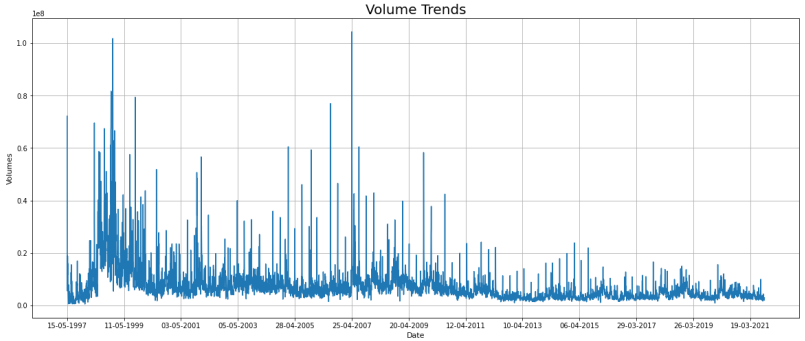
In [18]:

```
fig, ax = plt.subplots(figsize=(20,8))
ax.bar(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()
```



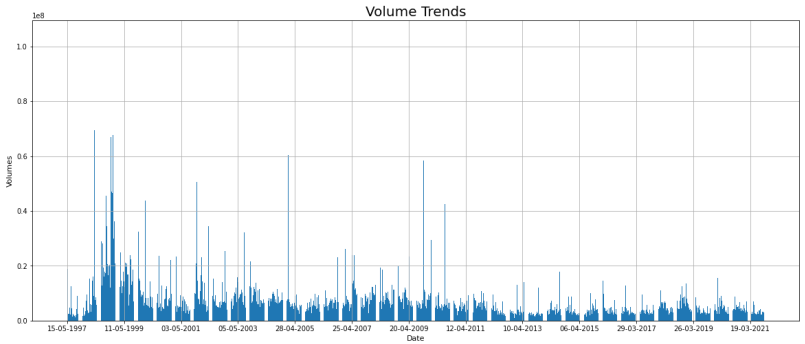
In [17]:

```
fig, ax = plt.subplots(figsize=(20,8))
ax.plot(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]:

```
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()
```

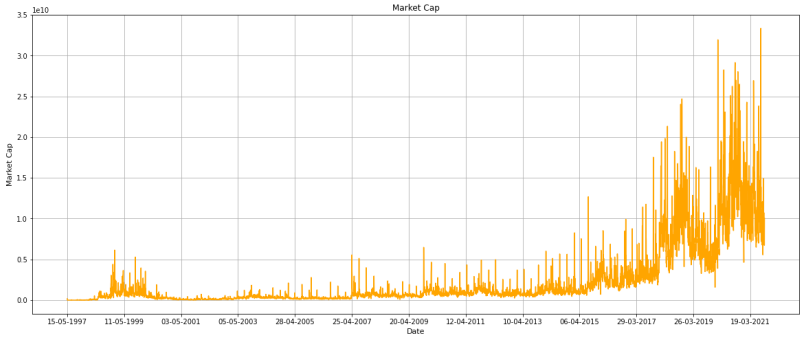


In [19]:

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

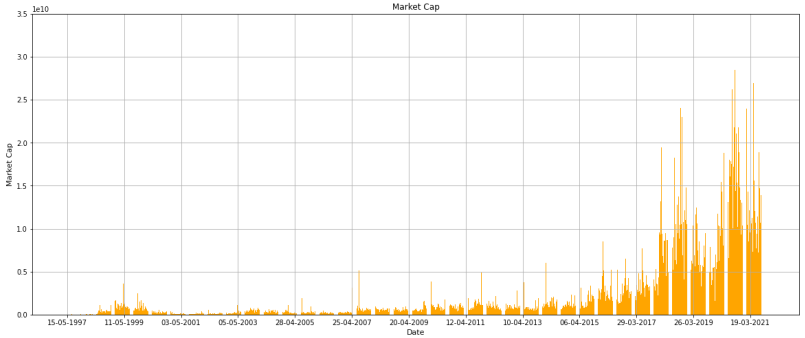
In [20]:

```
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 [21]:

```
fig, ax = plt.subplots(figsize=(20,8))
ax.bar(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 [22]:

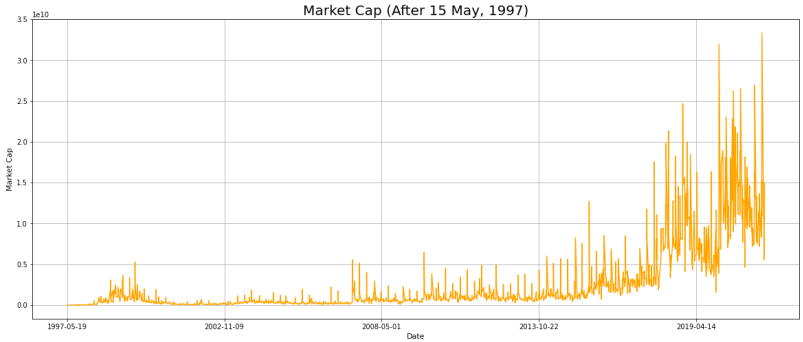
```
amazon_data.iloc[amazon_data['Market Cap'].argmax()]
```

Out[22]:

```
Date                 30-07-2021
Open               3347.949951
High               3368.139893
Low                 3306.97998
Close              3327.590088
Volume                 9957100
Market Cap    33335872457.1021
Name: 6092, dtype: object
```

In [23]:

```
ohlc = amazon_data[(amazon_data['Date'] > '1997-05-15')]
ohlc = ohlc.loc[:, ['Date', 'Open', 'High', 'Low', 'Close', 'Volume',
                    'Market Cap']]
ohlc['Date'] = pd.to_datetime(ohlc['Date'], format='%d-%m-%Y')
fig, ax = plt.subplots(figsize=(20,8))
ax.plot(ohlc['Date'], ohlc['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()
```

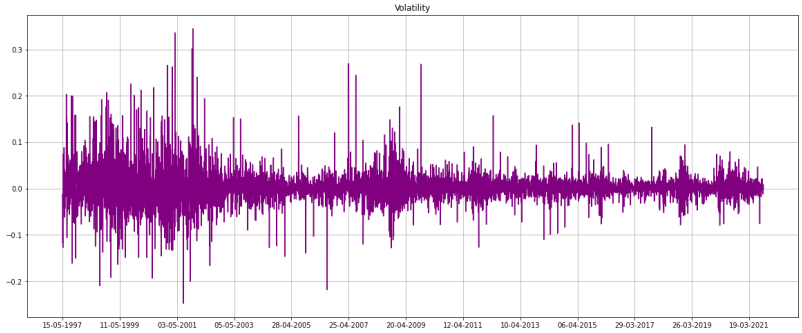


In [24]:

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

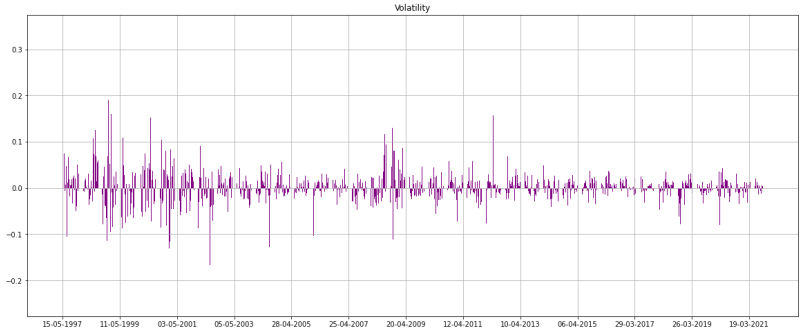
In [25]:

```
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()
```



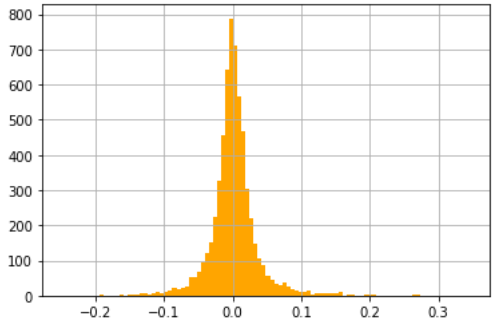
In [26]:

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



In [27]:

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

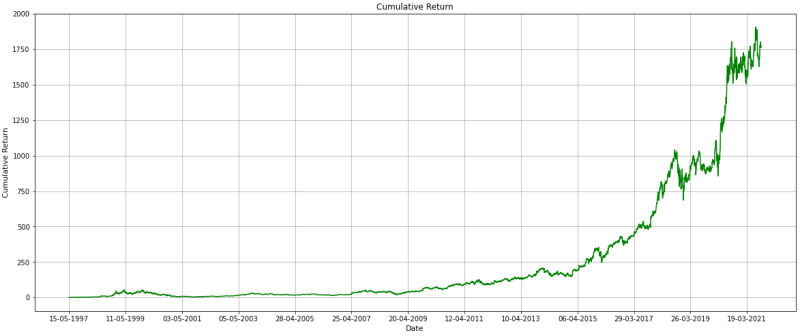


In [28]:

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

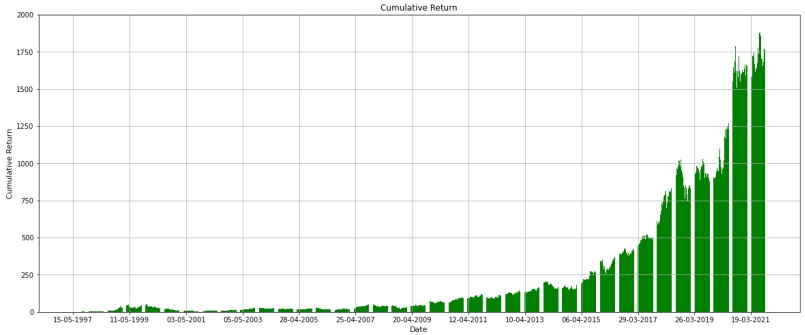
In [29]:

```
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()
```



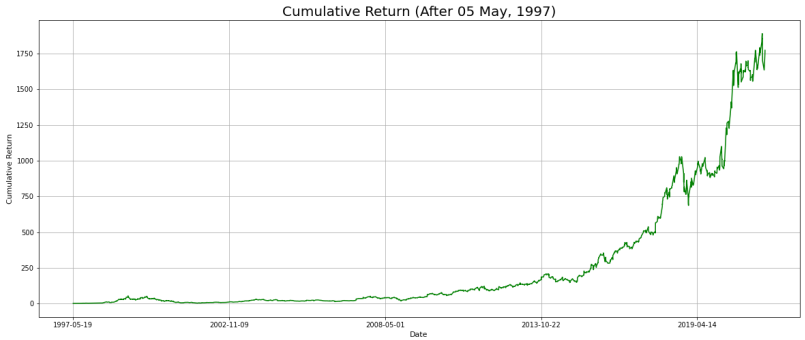
In [30]:

```
fig, ax = plt.subplots(figsize=(20,8))
ax.bar(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 [31]:

```
ohlc = amazon_data[(amazon_data['Date'] > '1997-05-15')]
ohlc = ohlc.loc[:, ['Date', 'Open', 'High', 'Low', 'Close', 'Volume', 'Market Cap', 'Cumulat
ohlc['Date'] = pd.to_datetime(ohlc['Date'], format='%d-%m-%Y')
fig, ax = plt.subplots(figsize=(20,8))
ax.plot(ohlc['Date'], ohlc['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 [32]:

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

Out[32]:

```
Date                        08-07-2021
Open                       3643.560059
High                        3759.98999
Low                        3621.120117
Close                      3731.409912
Volume                         5180600
Market Cap          18875827241.655399
vol                          0.009422
Cumulative Return           1905.40113
Name: 6076, dtype: object
```

In [33]:

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

In [34]:

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

In [35]:

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

Out[35]:

```
4900
```

In [36]:

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

Out[36]:

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

In [37]:

```
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])]
[0.00024994329250626934]
```

In [38]:

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

In [39]:

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

Out[39]:

```
(4840, 60, 1)
```

In [40]:

```
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 [41]:

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

In [42]:

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

```
Epoch 1/10
4840/4840 [==============================] - 57s 11ms/step - loss: 6.2420e-05
Epoch 2/10
4840/4840 [==============================] - 55s 11ms/step - loss: 3.1873e-05
Epoch 3/10
4840/4840 [==============================] - 55s 11ms/step - loss: 1.4562e-05
Epoch 4/10
4840/4840 [==============================] - 55s 11ms/step - loss: 1.6858e-05
Epoch 5/10
4840/4840 [==============================] - 55s 11ms/step - loss: 1.2109e-05
Epoch 6/10
4840/4840 [==============================] - 56s 12ms/step - loss: 1.0253e-05
Epoch 7/10
4840/4840 [==============================] - 56s 12ms/step - loss: 9.5520e-06
Epoch 8/10
4840/4840 [==============================] - 57s 12ms/step - loss: 9.1521e-06
Epoch 9/10
4840/4840 [==============================] - 56s 12ms/step - loss: 7.2142e-06
Epoch 10/10
4840/4840 [==============================] - 61s 13ms/step - loss: 8.8516e-06
```

Out[42]:

```
<keras.callbacks.History at 0x21b71bda9d0>
```

In [43]:

```
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 [44]:

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

In [45]:

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

Out[45]:

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

In [46]:

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

```
39/39 [==============================] - 2s 11ms/step
```

In [50]:

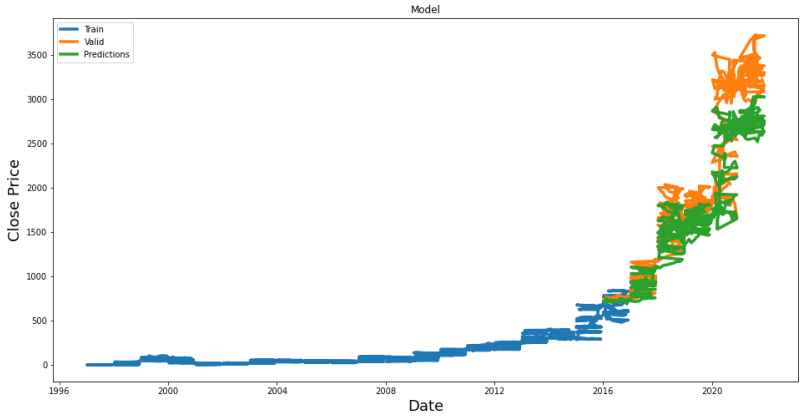
```
rmse = np.sqrt(np.mean(predictions - y_test)**2)
rmse
```

Out[50]:

```
227.69713950417733
```

In [53]:

```
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 left')
plt.show()
```



In [54]:

```
valid
```

Out[54]:

Date	Close	Predictions
2016-02-11	765.559998	749.395874
2016-03-11	767.030029	730.665222
2016-04-11	755.049988	734.175049
2016-07-11	784.929993	721.294922
2016-08-11	787.750000	750.772522
...	...	...
2021-09-09	3484.159912	2909.845947
2021-10-09	3469.149902	2878.983643
2021-09-13	3457.169922	2873.817139
2021-09-14	3450.000000	2867.034912
2021-09-15	3475.790039	2862.620361

1225 rows × 2 columns

In [55]:

```
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
```

```
1/1 [==============================] - 0s 24ms/step
```

Out[55]:

```
array([[2881.3567]], dtype=float32)
```