In [16]:
```
# import required libraries
import pandas as pd
import numpy as np
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt
```

In [17]:
```
# load the dataset
url = 'https://archive.ics.uci.edu/ml/machine-learning-databases/wine/wine.data'
names = ['class', 'alcohol', 'malic_acid', 'ash', 'alcalinity_of_ash',
         'magnesium', 'total_phenols', 'flavanoids', 'nonflavanoid_phenols',
         'proanthocyanins', 'color_intensity', 'hue', 'od280/od315_of_diluted_wines', 'proline']
dataset = pd.read_csv(url, names=names)
```

In [25]:
```
dataset
```

Out[25]:

	class	alcohol	malic_acid	ash	alcalinity_of_ash	magnesium	total_phenols	flavanoids	nonflavanoid_phenols	proanthocyanins	color_intensity	hue	od280/od315_of_diluted_wines	proline
0	1	14.23	1.71	2.43	15.6	127	2.80	3.06	0.28	2.29	5.64	1.04	3.92	1065
1	1	13.20	1.78	2.14	11.2	100	2.65	2.76	0.26	1.28	4.38	1.05	3.40	1050
2	1	13.16	2.36	2.67	18.6	101	2.80	3.24	0.30	2.81	5.68	1.03	3.17	1185
3	1	14.37	1.95	2.50	16.8	113	3.85	3.49	0.24	2.18	7.80	0.86	3.45	1480
4	1	13.24	2.59	2.87	21.0	118	2.80	2.69	0.39	1.82	4.32	1.04	2.93	735
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
173	3	13.71	5.65	2.45	20.5	95	1.68	0.61	0.52	1.06	7.70	0.64	1.74	740
174	3	13.40	3.91	2.48	23.0	102	1.80	0.75	0.43	1.41	7.30	0.70	1.56	750
175	3	13.27	4.28	2.26	20.0	120	1.59	0.69	0.43	1.35	10.20	0.59	1.56	835
176	3	13.17	2.59	2.37	20.0	120	1.65	0.68	0.53	1.46	9.30	0.60	1.62	840
177	3	14.13	4.10	2.74	24.5	96	2.05	0.76	0.56	1.35	9.20	0.61	1.60	560

178 rows × 14 columns

In [26]:
```
eigenvalues = pca.explained_variance_
print("Eigenvalues of the retained principal components:\n", eigenvalues)
```

```
Eigenvalues of the retained principal components:
 [4.73243698 2.51108093 1.45424187 0.92416587 0.85804868 0.64528221
 0.55414147 0.35046627]
```

In [27]:
```
sum(eigenvalues)
```

Out[27]:
```
12.029864272097052
```

In [28]:
```
(eigenvalues[0]+eigenvalues[1]+eigenvalues[2]+eigenvalues[3]+eigenvalues[4])/sum(eigenvalues)
```

Out[28]:
```
0.8711631387849638
```

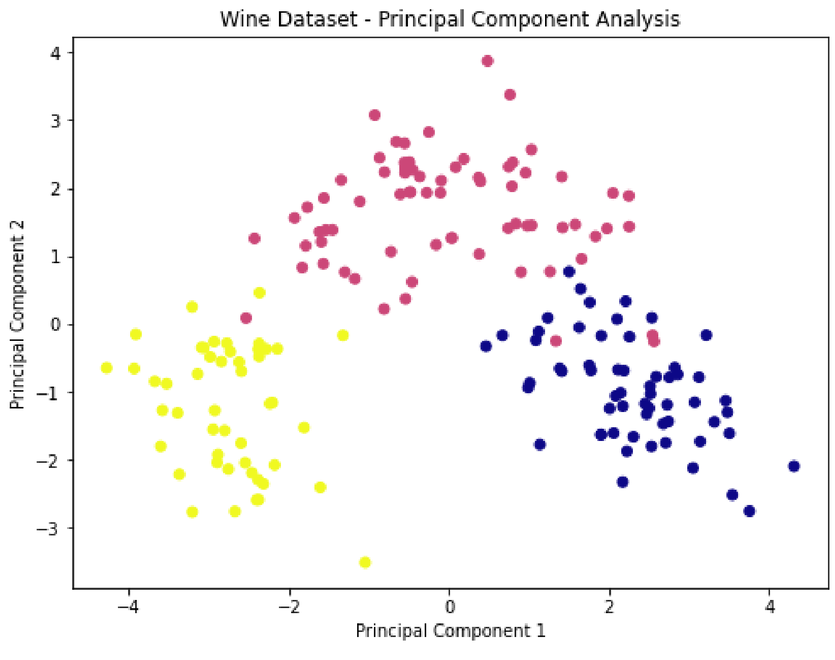
In [29]:
```
# apply PCA
pca = PCA(n_components=4)
principalComponents = pca.fit_transform(x)
principalDf = pd.DataFrame(data = principalComponents, columns = ['PC1', 'PC2', 'PC3', 'PC4'])

# combine the transformed data with class labels
finalDf = pd.concat([principalDf, dataset[['class']]], axis=1)

# print the transformed dataset
print("Transformed dataset with 4 principal components:\n", finalDf.head())
```

```
Transformed dataset with 4 principal components:
         PC1       PC2       PC3       PC4  class
0  3.316751 -1.443463 -0.165739 -0.215631      1
1  2.209465  0.333393 -2.026457 -0.291358      1
2  2.516740 -1.031151  0.982819  0.724902      1
3  3.757066 -2.756372 -0.176192  0.567983      1
4  1.008908 -0.869831  2.026688 -0.409766      1
```

In [30]:
```
# plot the principal components
plt.figure(figsize=(8,6))
plt.scatter(principalDf['PC1'], principalDf['PC2'], c=dataset['class'], cmap='plasma')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.title('Wine Dataset - Principal Component Analysis')
plt.show()
```



In [ ]: