In [10]:

```
# -*- coding: utf-8 -*-
"""
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"""
import numpy as np
from requiredFunctions.trainMLP import trainMLP
from requiredFunctions.MLP import MLP
from requiredFunctions.doubleMoon import doubleMoon
import matplotlib as mpl
import matplotlib.pyplot as plt
import matplotlib.ticker as mtick

height = 10
width = 10

mpl.rcParams['figure.figsize'] = (width, height)
mpl.rcParams['font.size'] = 20
mpl.rcParams['figure.titlesize'] = 'small'
mpl.rcParams['legend.fontsize'] = 'small'
mpl.rcParams['xtick.major.size'] = 12
mpl.rcParams['xtick.minor.size'] = 8
mpl.rcParams['xtick.labelsize'] = 18
mpl.rcParams['ytick.major.size'] = 12
mpl.rcParams['ytick.minor.size'] = 8
mpl.rcParams['ytick.labelsize'] = 18

# Data parameters
N_train = 300
N_val = 3000
r = 1
w = 0.6
d = -0.5

# Model parameters
learning_rate = 1.25e-3
alpha = 0
epochs = 1000*125

# Init train data
train_data = doubleMoon(N_train, w, r, d, seed=0)
x_train, y_train = train_data[:,:2], train_data[:,2]
x_train, y_train = x_train.T, y_train.reshape(1, len(y_train))

# Init validation data
val_data = doubleMoon(N_val, w, r, d, seed=100)
x_val, y_val = val_data[:,:2], val_data[:,2]
x_val, y_val = x_val.T, y_val.reshape(1, len(y_val))

wh, wo, mse, mse_val = trainMLP(x_train, y_train, [5], learning_rate, alpha,
                                epochs, verbose=False, X_val=x_val, D_val=y_val)

train_pred = MLP(x_train, wh, wo).flatten()
train_pred[train_pred > 0] = 1
train_pred[train_pred < 0] = -1
val_pred = MLP(x_val, wh, wo).flatten()
val_pred[val_pred > 0] = 1
val_pred[val_pred < 0] = -1

train_acc = (train_pred == y_train).sum() / N_train
val_acc = (val_pred == y_val).sum() / N_val
```

In [11]:
```
epoch_grid = np.arange(0, epochs) + 1
print('Early Stopping Point at', epoch_grid[np.argmin(mse_val)], 'epochs')
print('Final Accuracies')
print('Training: {}%'.format(train_acc*100))
print('Testing: {}%'.format(val_acc*100))
fig, ax = plt.subplots()
ax.plot(epoch_grid, np.log10(mse.flatten()), color='blue', markeredgewidth=2, label='Trainin
g')
ax.plot(epoch_grid, np.log10(mse_val.flatten()), '--', color='crimson', markeredgewidth=2, l
abel='Testing')
ax.set_xlabel('Epochs')
ax.set_ylabel(r'$\log_{10}$MSE')
ax.xaxis.set_major_locator(mtick.MultipleLocator(25000))
ax.xaxis.set_minor_locator(mtick.MultipleLocator(5000))
ax.yaxis.set_major_locator(mtick.MultipleLocator(0.5))
ax.yaxis.set_minor_locator(mtick.MultipleLocator(0.1))
ax.ticklabel_format(axis='x', style='sci', scilimits=(3,3), useMathText=True)
ax.set_xlim(-5000,epochs+5000)
ax.set_ylim(-1.5,0.2)
ax.legend()
fig.tight_layout(pad=0.5)
#fig.savefig('../prob3a.eps', dpi=500)
```

```
Early Stopping Point at 47864 epochs
Final Accuracies
Training: 100.0%
Testing: 98.8%
```