Exercise 9 Code

```python
#!/usr/bin/env python

import numpy as np
import matplotlib.pyplot as plot

# Calculate the result of a matrix vector multiplication
def matrix_vector_multiplication():
    mat = np.array([[1, 2, 3], [4, 5, 6], [7, 8, 9]])
    vec = np.array([1, 2, 3])
    print("Result: {}".format(np.matmul(mat, vec)))


# Plot sine from -pi to pi with 1,000 data points
def plot_sine():
    x = np.linspace(-np.pi, np.pi, 1000)
    y = [np.sin(x_i) for x_i in x]
    plot.plot(x, y)
    plot.show()


# Plot 10,000 uniformly distributed random numbers on [0, 1)
def generate_histogram():
    x = np.random.uniform(0, 1, 10000)
    plot.hist(x)
    plot.show()


if __name__ == "__main__":
    matrix_vector_multiplication()
    plot_sine()
    generate_histogram()
```
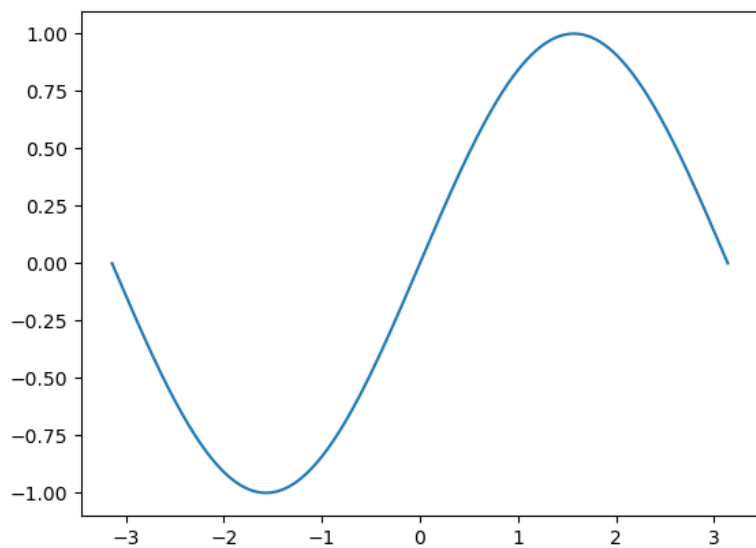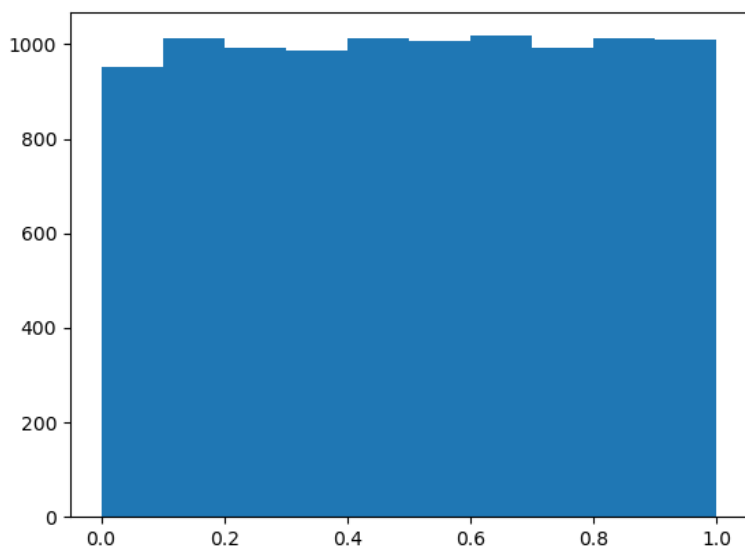
Exercise 9 Result

(a) Result: $[14, 32, 50]$

(b) sin(x) on [-π, π] for 1000 data points of x

(c) 10,000 uniformly distributed random numbers on [0, 1)

Exercise 10 Code

```python
#!/usr/bin/env python

import numpy as np

# Do n random draws of letters without replacement and compute fraction
#     that included one vowel and one consonant
def random_draw(n = 10000):
    matches = 0
    for _ in range(0, n):
        # Make list of all letters and of vowels
        letters = ['a', 'b', 'c', 'd', 'e', 'f', 'g', 'h', 'i',
                   'j', 'k', 'l', 'm', 'n', 'o', 'p', 'q', 'r',
                   's', 't', 'u', 'v', 'w', 'x', 'y', 'z']
        vowels = ['a', 'e', 'i', 'o', 'u']
        # Draw and remove first letter
        draw1 = letters[np.random.randint(0, 25)]
        letters.remove(draw1)
        # Draw second letter
        draw2 = letters[np.random.randint(0, 24)]
        # Return True if one is a vowel and one is a consonant
        if (draw1 in vowels and draw2 not in vowels) or (draw1 not in
            vowels and draw2 in vowels):
            matches += 1
    print("Fraction of draws with one vowel and one consonant: {}".
        format(matches / n))


if __name__ == "__main__":
    random_draw()
```

Exercise 10 Result

(a) Fraction of draws with one vowel and one consonant: 0.3366

Exercise 11 Code

```python
#!/usr/bin/env python

import numpy as np

# Do m runs of n students with random birthdays to determine
#    probability of collision
def birthday_problem(m = 10000, n = 50):
    matches = 0
    for _ in range(0, m):
        # Assign each student a random birthday between 0 and 364
        students = np.random.randint(0, 365, n)
        # Checks for birthday matches since set doesn't contain
        #    duplicates
        if len(students) != len(set(students)):
            matches += 1
    print("Fraction of simulations with at least one matching birthday:
        {}".format(matches / m))


if __name__ == "__main__":
    birthday_problem()
```

Exercise 11 Result

(a) Fraction of simulations with at least one matching birthday: 0.9676