Problem 1.5.11

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Problem Statement

The point **R** divides the line segment AB, where **A**$(-4, 0)$ and **B**$(0, 6)$ such that AR $= \frac{3}{4}$AB. Find the coordinates of **R**.

Variable	**Description**	**Values**
A	Point	$(-5, 0)$
B	Point	$(0, 6)$
R	Coordinates of R	(x,y)

Table: Variables given

Section Formula

Formula:

$$\mathbf{P} = \frac{k(\mathbf{B}) + (\mathbf{A})}{k+1} = \begin{pmatrix} x \\ y \end{pmatrix} \tag{3.1}$$

Where:

'k' is the ratio in which the point divides the line segment

$$\mathbf{A} = \begin{pmatrix} -4 \\ 0 \end{pmatrix} \qquad \mathbf{B} = \begin{pmatrix} 0 \\ 6 \end{pmatrix} \tag{3.2}$$

Obtaining k Value

$$AR = \frac{3}{4}AB \tag{3.3}$$

$$AR = \frac{3}{4}(AR + RB) \tag{3.4}$$

$$4AR = 3AR + 3RB \tag{3.5}$$

$$AR = 3RB \tag{3.6}$$

$$\frac{AR}{RB} = 3 \tag{3.7}$$

Hence k=3

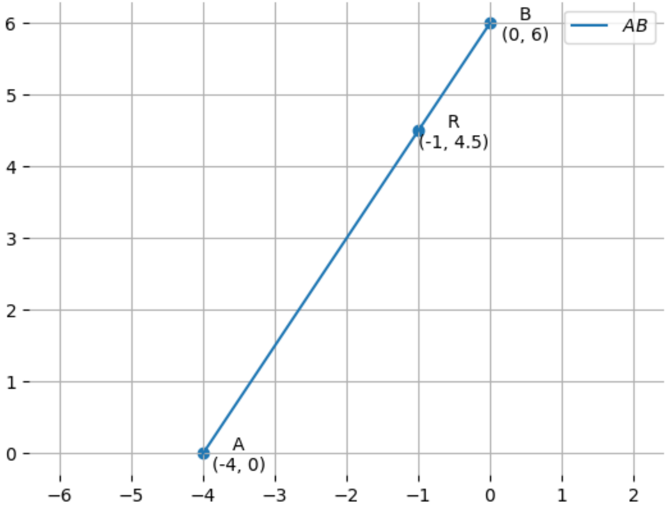
Obtaining Point

$$P = \frac{3B + A}{4} = \frac{3\begin{pmatrix}0\\6\end{pmatrix} + \begin{pmatrix}-4\\0\end{pmatrix}}{4} = \frac{\begin{pmatrix}-4\\18\end{pmatrix}}{4} \tag{3.8}$$

$$P = \begin{pmatrix}-1\\ \frac{9}{2}\end{pmatrix} \tag{3.9}$$

Hence the coordinates of **P** are $\left(-1, \frac{9}{2}\right)$

Plot



C Code for generating points on line

```c
#include <math.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>
#include <sys/socket.h>
#include <netinet/in.h>

#include "libs/matfun.h"
#include "libs/geofun.h"

int main() {
    double **k, **M, **C;
    int x1 = -4, x2 = 0, y1 = 0, y2 = 6;

    // Create matrices
    M = createMat(2, 2);
```

C Code for generating points on parabola

```
   k = createMat(2, 1);
    C = createMat(2, 1);

    M[0][1] = x1; // x1 = -4
    M[1][1] = y1; // y1 = 0

    M[0][0] = x2; // x2 = 0
    M[1][0] = y2; // y2 = 6

    k[0][0] = 3.0 / 4; // weight for B (column 0)
    k[1][0] = 1.0 / 4; // weight for A (column 1)

    C = Matmul(M, k, 2, 2, 1);

    // Write result to file
    FILE *file = fopen("values.dat", "w");
    if (file == NULL) {
```

C Code for generating points on parabola

```c
        printf("Error opening file!\n");
         return 1;
    }

    fprintf(file, "x\ty\t of C\n");
    fprintf(file, "%.02lf\t%.02lf\n", C[0][0], C[1][0]); // x and
         y of C

    fclose(file);
    printf("Results have been written to values.dat\n");

    // Free memory
    freeMat(M, 2);
    freeMat(k, 2);
    freeMat(C, 2);

    return 0;
}
```

Python Code for Plotting

```
# Code by /sdcard/github/matgeo/codes/CoordGeoVV Sharma
# September 12, 2023
# Revised July 21, 2024
# Released under GNU GPL
# Section Formula

import sys
sys.path.insert(0, '/workspaces/urban-potato/matgeo/codes/
    CoordGeo/') # path to my scripts
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
# Local imports
from line.funcs import *
from triangle.funcs import *
from conics.funcs import circ_gen
```

Python Code for Plotting

```
# Read data
data = np.loadtxt("values.dat", skiprows=1)

xc = data[0] # Extract x-coordinate (e.g., -1)
yc = data[1] # Extract y-coordinate (e.g., 4.5)

# Given points
A = np.array([-4, 0]).reshape(-1, 1)
B = np.array([0, 6]).reshape(-1, 1)
R = np.array([xc, yc]).reshape(-1, 1)

# Generating line AB
x_AB = line_gen(A, B)

# Plotting
plt.plot(x_AB[0, :], x_AB[1, :], label='$AB$')
```

Python Code for Plotting

```python
# Labeling the coordinates
tri_coords = np.block([[A, B, R]])
plt.scatter(tri_coords[0, :], tri_coords[1, :])

vert_labels = ['A', 'B', 'R']

# Helper function: format number with decimal only if needed
def fmt(val):
    return f"{val:.1f}" if abs(val - round(val)) > 1e-6 else f"{
        int(val)}"

for i, txt in enumerate(vert_labels):
    x = tri_coords[0, i]
    y = tri_coords[1, i]
    plt.annotate(f'{txt}\n({fmt(x)}, {fmt(y)})',
                 (x, y),
                 textcoords="offset points",
```

Python Code for Plotting

```
                xytext=(20, -10),
                ha='center')

# Styling
ax = plt.gca()
ax.spines['left'].set_visible(False)
ax.spines['right'].set_visible(False)
ax.spines['top'].set_visible(False)
ax.spines['bottom'].set_visible(False)

plt.legend(loc='best')
plt.grid()
plt.axis('equal')

plt.savefig('../figs/fig1.png')
plt.show()
```