

# Report: Homework 1

Date: 18.12.2023

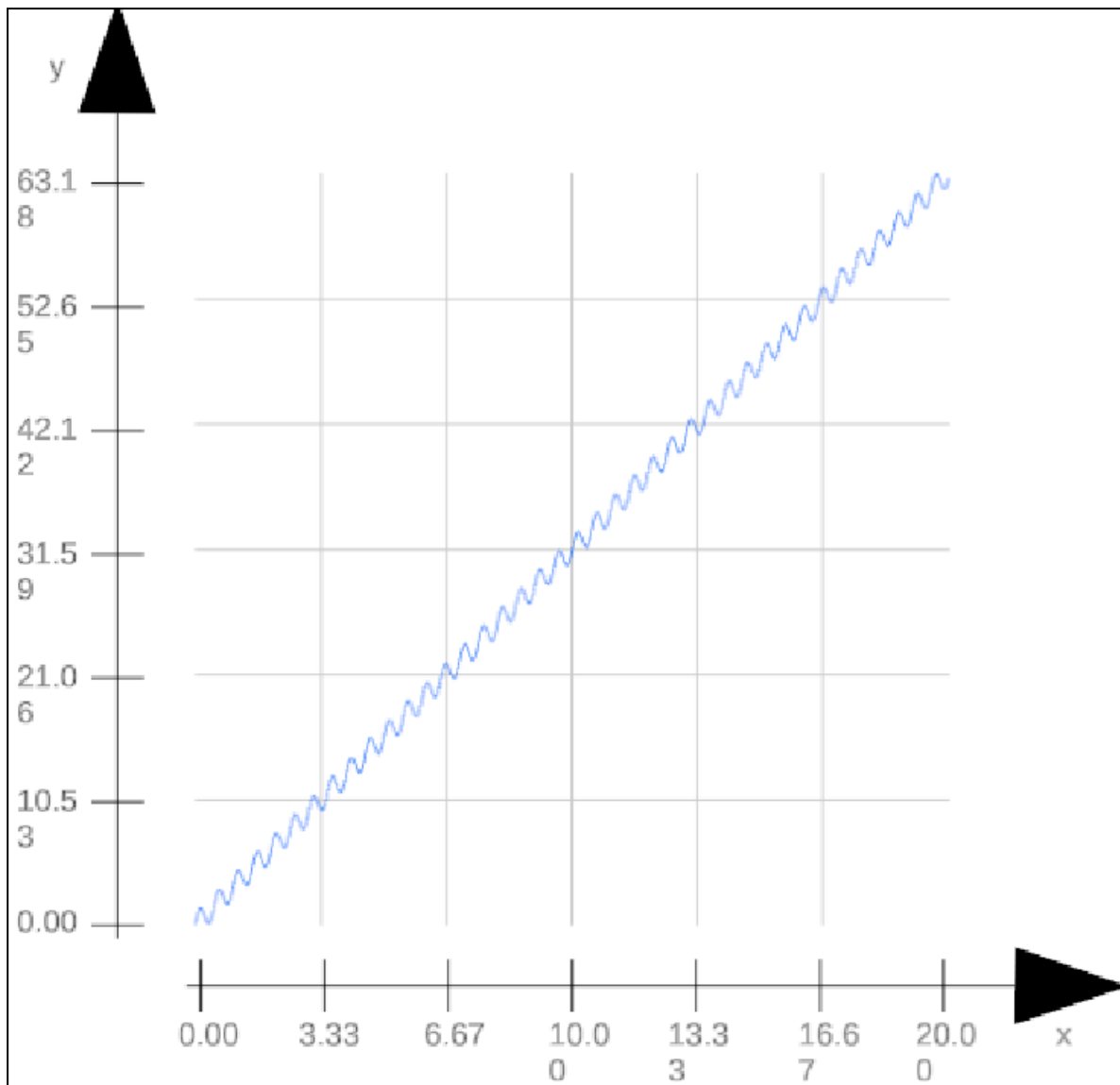
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[1] Exact result of the integration: 633.275

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[2] Plot of the function  $P(t)$ :



[3] Nassi-Schneiderman diagrams for all three algorithms:

Method1:

**Method1()**

Initialize constants

START

CalculateEnergyUsingRectangles(double start, double end, int numberOfIntervals)

Initialize totalEnergy = 0.0

for i <- 0 to intervals - 1

    Calculate t = startTime + i \* intervalWidth

    Calculate power = CalculatePowerAtTime(t)

    Calculate area = power \* intervalWidth

    Add area to totalEnergy

Return totalEnergy

[Log Total Energy to Console]

Output "Total Energy using Rectangle Method: [totalEnergy] Joules"

## Method2:

### Method2()

Initialize Constants

```
a1 = 126655.0 / 40000.0  
f1 = 2.0  
startTime = 0.0  
endTime = 20.0  
intervals = 200
```

//Calculate Total Energy using Midpoint Method

```
intervalWidth = (endTime - startTime) / intervals
```

```
totalArea = 0.0
```

```
for i <- 0 to intervals-1
```

```
    midpoint = startTime + (i + 0.5) * intervalWidth
```

```
    midpointHeight = CalculatePowerAtTime(midpoint)
```

```
    totalArea += midpointHeight * intervalWidth
```

```
Return totalArea
```

```
Log Total Energy to Console
```

```
Output "Total Energy using Midpoint Method: [totalEnergy] Joules"
```

### Method3:

#### Method3()

// Initialize Constants

```
a1 = 126655.0 / 40000.0  
f1 = 2.0  
startTime = 0.0  
endTime = 20.0  
intervals = 2000
```

// Calculate Total Energy using Trapezoidal Rule

```
h = (endTime - startTime) / intervals
```

```
totalArea = 0.5 * (CalculatePowerAtTime(startTime) + CalculatePowerAtTime(endTime))
```

```
for i <- 0 to intervals-1
```

```
    x = startTime + i * h
```

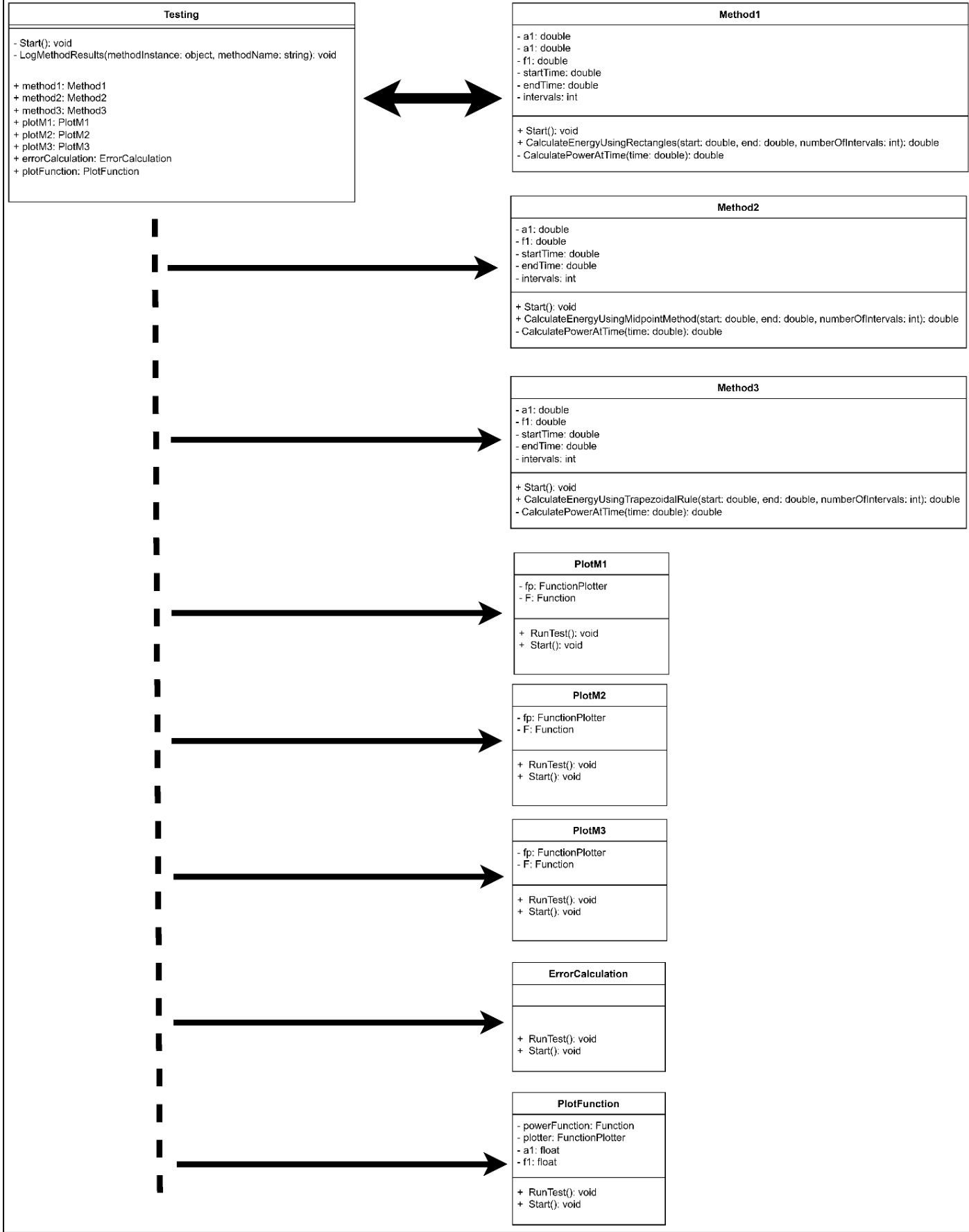
```
    totalArea += CalculatePowerAtTime(x)
```

```
Return totalArea * h (Total Energy)
```

Log Total Energy to Console

```
Output "Total Energy using Trapezoidal Rule: [totalEnergy] Joules"
```

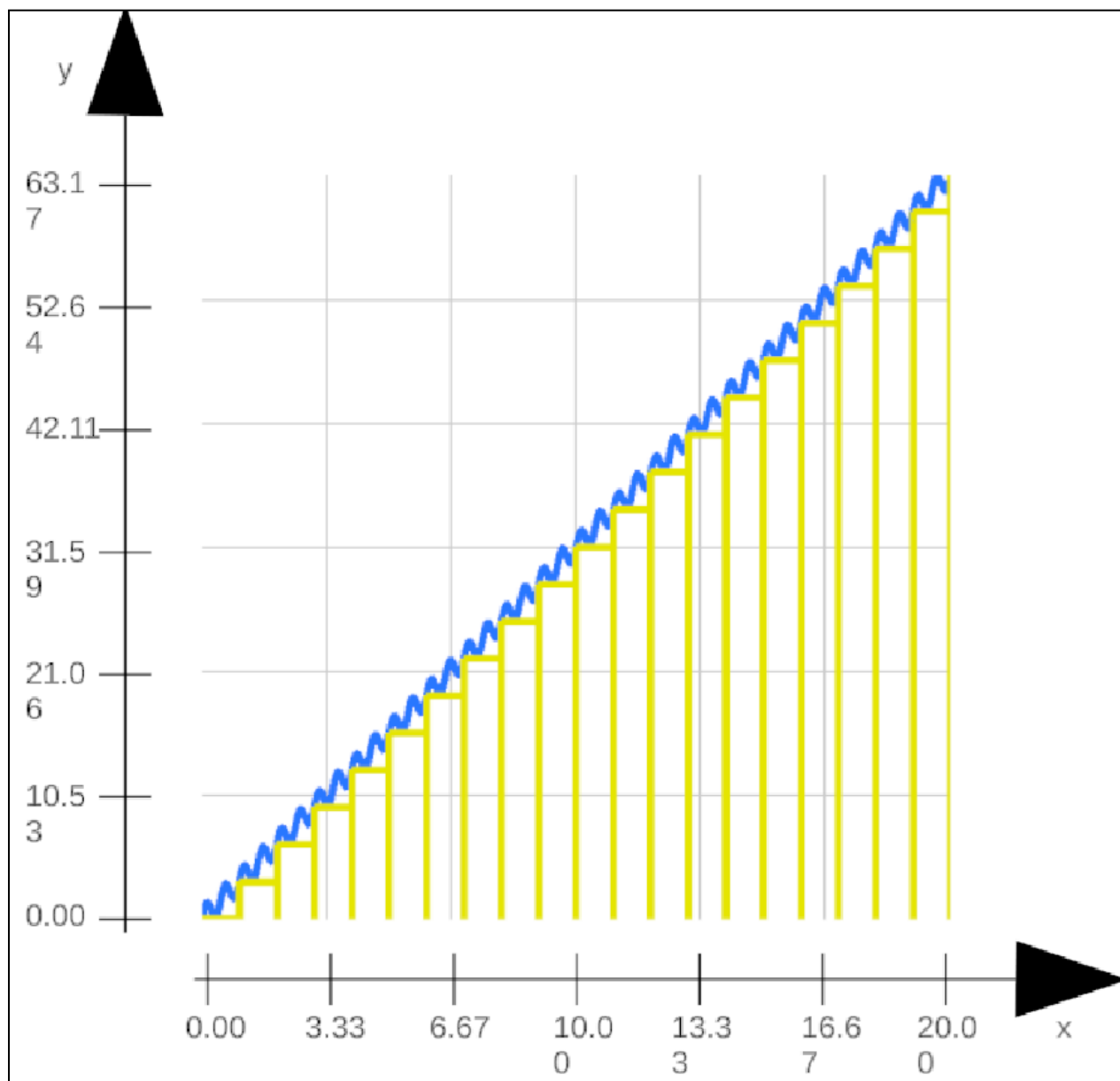
# UML Diagram



**[5] Results of the numerical integration:**

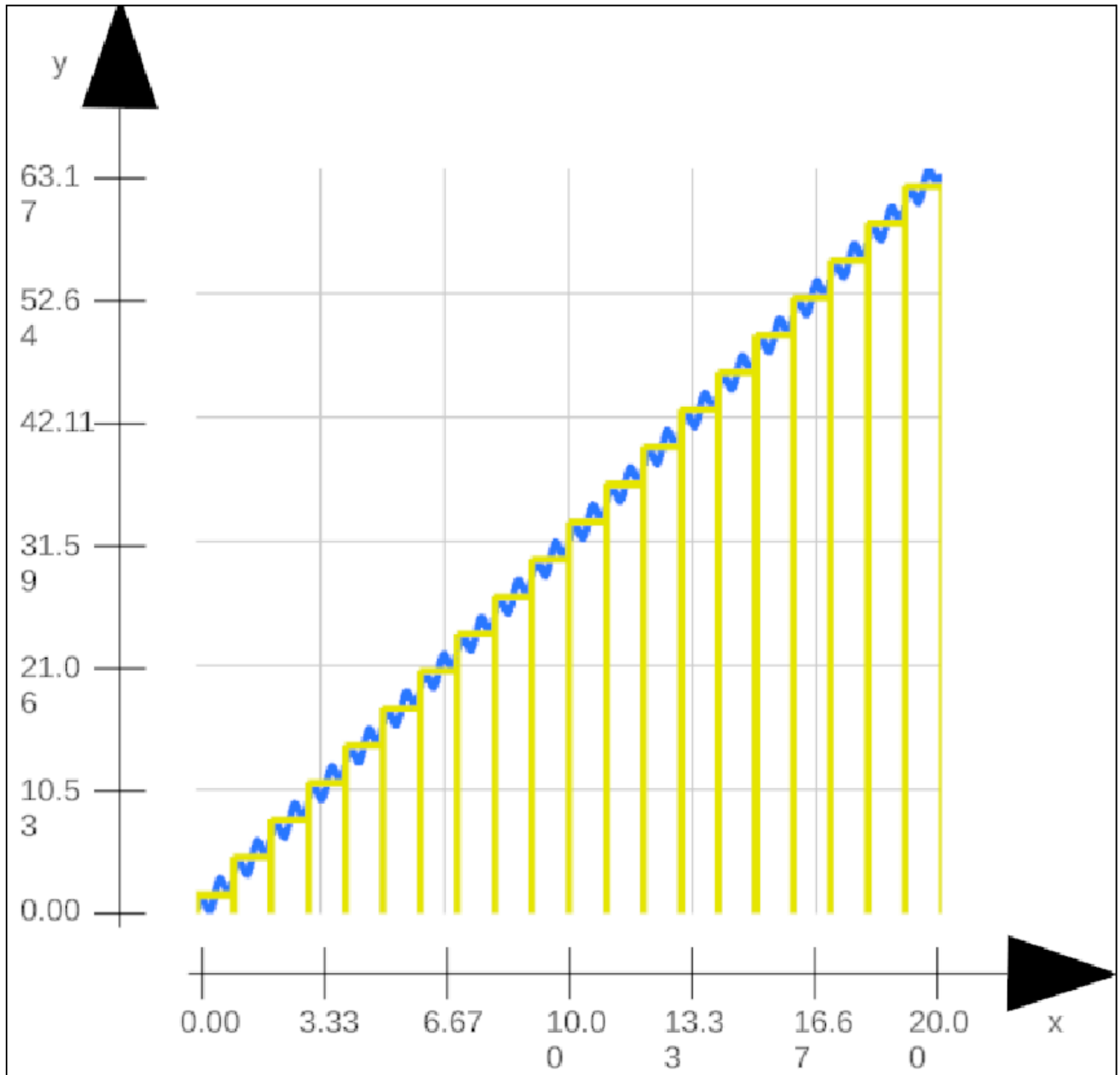
**Method 1:**

Total Energy using Rectangle Method: **630.108625** Joules



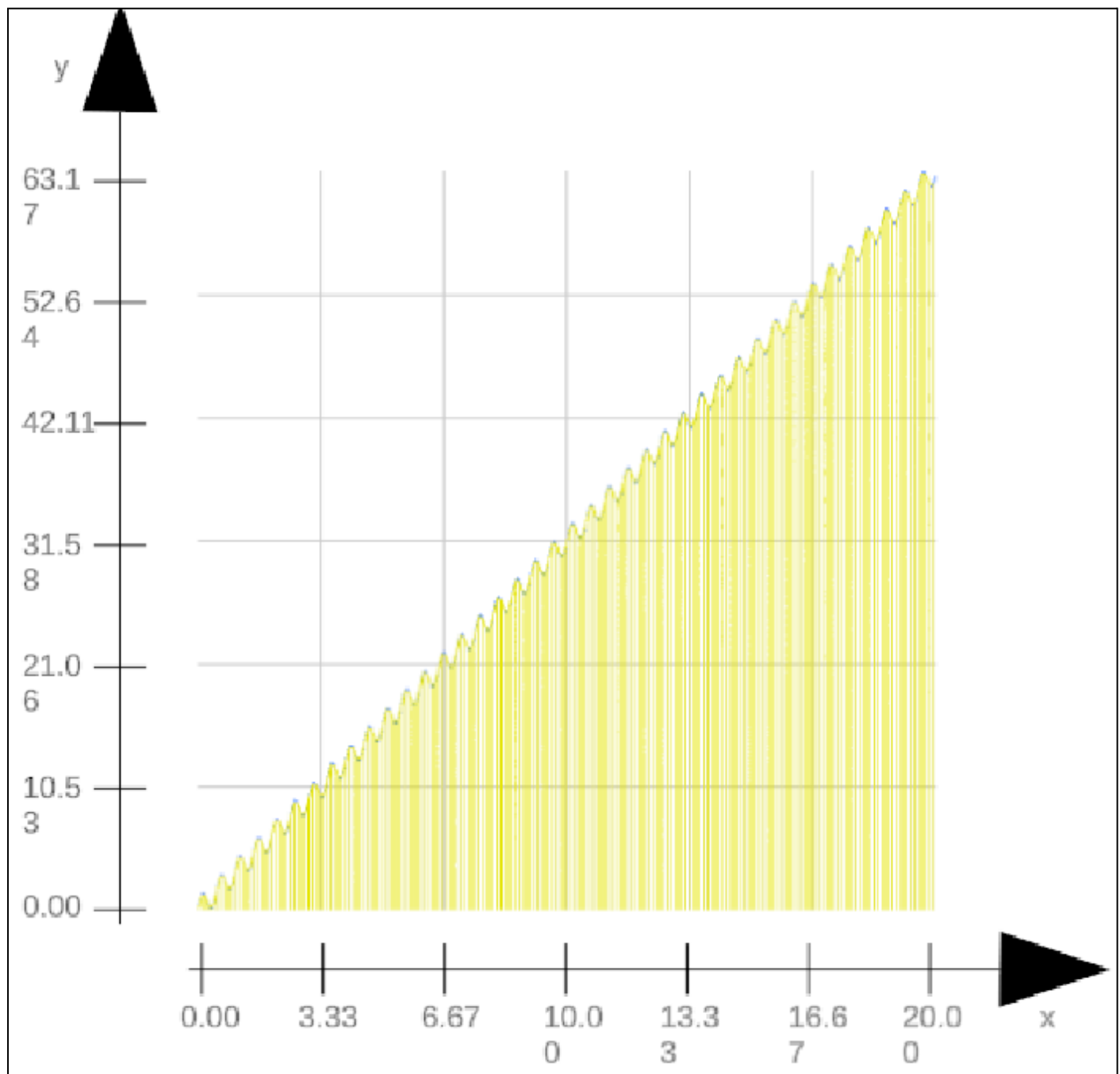
## Method 2:

Total Energy using Midpoint Method: **633.275** Joules



### Method 3:

Total Energy using Trapezoidal Rule: **633.2749** Joules



### [6] Absolut and relative error of the numerical results:

Absolute Error = (Approximate Value - Exact Value)

Relative Error = (Approximate Value - Exact Value) / (Exact Value)

Analytical Value = 633.275

Numerical Value of Method1 = 630.108625

Numerical Value of Method1 = 0

Numerical Value of Method1 = 633.2749

Absolute Error for Method 1 is: -3.166375000000002

Absolute Error for Method 2 is: 0

Absolute Error for Method 3 is: -9.99999999748979E-05



Relative Error for Method 1 is: -0.005000000000000003

Relative Error for Method 2 is: 0

Relative Error for Method 3 is: -1.57909281078359E-07

Relative Error Percentage for Method 1 is: -0.5000000000000003%

Relative Error Percentage for Method 2 is: 0%

Relative Error Percentage for Method 3 is: -1.57909281078359E-05%