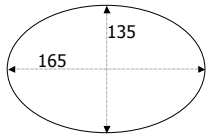
An Example

1

Problem

Using OCD, design and implement a program that computes the area and circumference of an Australian Rules Football field, which is an ellipse that is (ideally) 165m x 135m.



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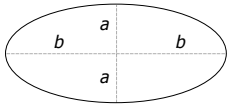
Problem Generalization

Using OCD, design and implement a program that computes the area and circumference of an *ellipse*.

$$area = \pi ab$$



$$circumference = 2\pi\sqrt{\frac{a^2 + b^2}{2}}$$

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Behavior

Our program should display on the screen a prompt for the major axis and minor axis. It should then read the major axis and the minor axis from the keyboard. It should then compute and display the ellipse's area and circumference along with a descriptive label.

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Objects

Our program should display on the screen a prompt for the major axis and minor axis. It should then read the major axis and the minor axis from the keyboard. It should then compute and display the ellipse's area and circumference along with a descriptive label.

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Operations

Our program should display on the screen a prompt for the major axis and minor axis. It should then read the major axis and the minor axis from the keyboard. It should then compute and display the ellipse's area and circumference along with a descriptive label.

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Representing Objects

Description	Java Type	Kind	Name
program	**new class**	**--**	***Ellipse***
screen	`Screen`	**variable**	***theScreen***
prompt	`String`	**constant**	**--none--**
major axis	`double`	**variable**	***majorAxis***
minor axis	`double`	**variable**	***minorAxis***
keyboard	`Keyboard`	**variable**	***theKeyboard***
area	`double`	**variable**	***area***
circumference	`double`	**variable**	***circumference***
label	`String`	**constant**	**--none--**

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Performing Operations

Description	Built-in/Class	Name
display strings	`Screen`	`print()`
read doubles	`Keyboard`	`readDouble()`
compute area		
compute circumference		
display doubles	`Screen`	`println()`

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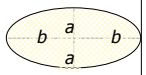
Algorithm

1. Ask *theScreen* to display a prompt for the length and width of an ellipse.
2. Ask *theKeyboard* to read *majorAxis*, *minorAxis*.
3. Compute *area*
4. Compute *circumference*.

$$area = \pi ab$$



$$circumference = 2\pi\sqrt{\frac{a^2 + b^2}{2}}$$

5. Display *area* and *circumference* with descriptive labels.

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Representing Objects

Description	Java Type	Kind	Name
program	**new class**	**--**	***Ellipse***
screen	`Screen`	**variable**	***theScreen***
prompt	`String`	**constant**	**--none--**
major axis	`double`	**variable**	***majorAxis***
minor axis	`double`	**variable**	***minorAxis***
keyboard	`Keyboard`	**variable**	***theKeyboard***
area	`double`	**variable**	***area***
circumference	`double`	**variable**	***circumference***
label	`String`	**constant**	**--none--**
π	`double`	**constant**	***PI***
half major axis	`double`	**variable**	***semiMajor***
half minor axis	`double`	**variable**	***semiMinor***

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Performing Operations

Description	Built-in/Class	Name
display strings	`Screen`	`print()`
read doubles	`Keyboard`	`readDouble()`
compute area		
– multiply doubles	**built-in**	`*`
compute circumference		
– multiply doubles	**built-in**	`*`
– add doubles	**built-in**	`+`
– divide doubles	**built-in**	`/`
– power	**Math**	`pow()`
– square root	**Math**	`sqrt()`
display doubles	`Screen`	`println()`

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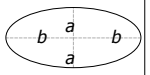
Algorithm

0. Ask *theScreen* to display a prompt for the length and width of an ellipse.
1. Ask *theKeyboard* to read *majorAxis*, *minorAxis*.
2. Check validity of data (both numbers are positive).
3. Compute *semiMajor* = *majorAxis* /2.0; *semiMinor* = *minorAxis* /2.0.
4. Compute *area* = *PI* * *semiMajor* * *semiMinor*

$$area = \pi ab$$



5. Compute *circumference* = 2.0 * *PI* * sqrt((*semiMajor*^{2} + *semiMinor*^{2}) / 2.0)

$$circumference = 2\pi\sqrt{\frac{a^2 + b^2}{2}}$$

6. Display *area* and *circumference* with descriptive labels.

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Coding

```
/* Ellipse.java computes an ellipse's area and circumference.
 * Input:  Ellipse's length and width
 * Output: Ellipse's area and circumference
 * Written by L. Nyhoff for CPSC 185 Project 99 on 9/23/2002
 */

import ann.easyio.*;     // Keyboard, Screen

class Ellipse
{
  public static void main(String [] args)
  {
    Screen theScreen = new Screen();
    Keyboard theKeyboard = new Keyboard();

    // Get the axes
    theScreen.print("To compute the area and circumference of an "
                  + "ellipse,\n\tenter its major & minor axes: ");
    double majorAxis = theKeyboard.readDouble();
    double minorAxis = theKeyboard.readDouble();
```



```
    // Check validity of the input values
    theScreen.println("Nonegative values? " +
                      (majorAxis > 0 && minorAxis > 0) );

    // Compute area and circimference
    double semiMajor = majorAxis / 2.0;
    double semiMinor = minorAxis / 2.0;

    double area = Math.PI * semiMajor * semiMinor;
    double circumference = 2.0 * Math.PI * Math.sqrt(
        ( Math.pow(semiMajor, 2) + Math.pow(semiMinor, 2) ) / 2.0 ) ;

    // Output area and circumference
    theScreen.println("\nThe area is " + area +
                      "\nand the circumference is " + circumference);
  }
}
```


Execution & Testing

First execute it with some values for which the results are easy to check by hand:

```
To compute the area and circumference of an ellipse,
        enter its major & minor axes: 2 2
Nonegative values? true

The area is 3.141592653589793
and the circumference is 6.283185307179586

To compute the area and circumference of an ellipse,
        enter its major & minor axes: 8 6
Nonegative values? true

The area is 37.69911184307752
and the circumference is 22.21441469079183
```



```
To compute the area and circumference of an ellipse,
        enter its major & minor axes: 0 0
Nonegative values? false

The area is 0.0
and the circumference is 0.0
```

When you are convinced of the program's correctness, execute it with the required inputs:

```
To compute the area and circumference of an ellipse,
        enter its major & minor axes: 165 135

The area is 17494.74408967816
and the circumference is 473.5892313120682
```