CSE1341 - Lab 3 Programming Assignment

Algorithms with multiple methods

Assignment Due Saturday, March 9th, 2019 at 6:00 AM

This assignment will require a Pre-Lab and a Lab.

Pre-Lab (10 POINTS): Create a Java program called **Density** which prompts the user to enter values for the mass and volume, stores the values in two double variables, calculates the density, and displays it to the user.
Hint: density = mass / volume. A sample output is provided below where user input is highlighted in yellow.

Sample output

```
Enter the mass in grams and volume in milliliters separated by spaces: 3 250
The density of mass = 3.0000 g and volume = 250.0000 ml is: 0.0120 g/ml
```

(Bonus +5 points) Modify the above program and create a method called **getDensity** which accepts two parameters of type double called **mass** and **volume**, calculates the density, and returns it. Use this method in a Java program called **DensityUsingMethods**. In the main method, ask the user to enter the mass and volume, store the values in two double variables, call the **getDensity** method passing the mass and volume, and display the returned density value to the user.

Grading: Comment your program to explain your steps. Each program should compile without errors and should run to produce outputs described for each exercise. The following points will be discounted if the related element is missing or incorrect:

- Output formatting [2 points each]
- Proper names for classes, variables, and methods [1 point each]
- No Comments [5 points]
- Program doesn't compile [5 points for each minor error up to 5 errors provided that after fixing the errors the program compiles. If the program does not compiler after the 5 errors are fixed, partial credit will be given not to exceed 50 points]
- Source code (java file) missing [15 points]
- Executable (class file) missing [15 points]
- Both java file and class file missing [100 points]
- Missing method where required [5 points each]

Part I (30 POINTS)

- Create a Java program called **IdealGasLawCalculator**. The program will consist of two methods in addition to the **main** method as follows:

public static double applyIdealGasLaw()

public static double getNumberOfMoles(double pressure, double volume, double temperature)

- In the **main** method, call the **applyIdealGasLaw** method which will return the number of moles, and then display the returned number of moles to the user with 5 digits after the decimal point.

- In the **applyIdealGasLaw** method, display information to the user as shown in the sample output below, then get the pressure value from the user storing it in a double variable. Repeat this step for the volume and the temperature. Display to the user the values they entered. Finally, call the **getNumberOfMoles** method passing it the pressure, volume, and temperature values and return the number of moles to the **main** method.

- In the **getNumberOfMoles** method, apply the formula PV = nRT using the pressure (P), volume (V), and temperature (T) values and return the number of moles to the **applyIdealGasLaw** method. Hint: n = (pressure x volume) / (r x temperature).

- Before the **main** method and inside the class, create a static Scanner object and a static double variable called r as follows:

  static double r = 0.08205;
  static Scanner scan = new Scanner(System.in);

  Note: A variable declared within a class but outside any method is called a *class member variable* or ***field***, in contrast to a local variable defined inside a method. A field's scope extends from the class's opening brace to the class's closing brace and reaches into methods regardless of where the field is declared within the class.

Sample output (user input is highlighted in yellow)

```
In Ideal Gas Law, the relationship between pressure (P), volume (V), number of moles (n), and
temperature (T) is expressed as PV = nRT.
Enter the following values for P (atm), V (L), and T (K), and let's find n(moles).
The units of the values are provided inside the parentheses.

2 3 283

You entered: 2.0 for P
You entered: 3.0 for V
You entered: 283.0 for T
The number of moles is 0.25840 moles
```

Part II (60 POINTS)

Create a Java program called **GasLawCalculator** which allows the user to select from a menu of options where each option represents a gas law formula. The following instructions describes the program.

- Outside the main method created the following static variables and Scanner object:

```
static double r = 0.08205;
static int mmHgToAtm = 760;
static int mlToL = 1000;
static int cToK = 273;
static Scanner scan = new Scanner(System.in);
```

- In the main method, create a loop. Inside the loop call the **displayMenu** method to print the menu of options to the user as follows:

```
Welcome to the Gas Laws Calculator
Choose from the following options:
1) Boyle's Law
2) Charles' Law
3) Gay-Lussac's Law
4) Ideal Gas Law
9) Exit
option:
```

- The header of the **displayMenu** method looks like this:

  public static int displayMenu()

  where the method returns an integer representing the option the user has entered.

- If the user enters an option that is **not** 1, 2, 3, 4 or 9, the loop should redisplay the menu. Continue in this manner until a correct option is input.

- If option 1 is selected, call the **displayTableOfUnitsAndConversions** method, then call the **applyBoylesLaw** method, and display the returned value from the **applyBoylesLaw** method using a **printf** with 5 digits after the decimal point.

- The header of the **displayTableOfUnitsAndConversions** is as follows:

  public static void displayTableOfUnitsAndConversions()

  The **displayTableOfUnitsAndConversions** method will print the following table to the screen:

```
|----------------------------TABLE OF UNITS AND CONVERSIONS-----------------------------------|
|V = volume in liters (L)      | P = pressure in atmosphere (atm) | R = ideal gas constant      |
|T = temperature in Kelvin (K) | n = number of moles              |                             |
|---------------------------------------------------------------------------------------------|
|1 liter = 1000 milliliters | 1 Celsius = 273 Kelvin | 1 atm = 760 millimeter of mercury (mmHg) |
|R = 0.08205                |                                                                 |
|---------------------------------------------------------------------------------------------|
```

- The header of the **applyBoylesLaw method** is as follows:

  public static double applyBoylesLaw()

  In the **applyBoylesLaw** method, display information to the user as shown in the sample output below when option 1 is entered. Then get the pressure (pressure1) value from the user storing it in a double. Repeat this step for the volume (volume1) and the second pressure (pressure2) values. Display to the user the values they entered. Finally, call the **getVolumeInLiters** method passing in pressure1, volume1, and pressure2, and return volume2 to the **main** method. **Note:** methods can be called from other methods besides main.

- The header of the **getVolumeInLiters** method is as follows:

  public static double getVolumeInLiters(double pressure1, double volume1, double pressure2)

  In the method, use the formula pressure1 X volume1 = pressure2 x volume2 to get volume2. Return volume2 to the **applyIdealGasLaw** method. **Hint:** volume2 = (pressure1 x volume1) / pressure2.

  Note: You will need to convert some of the values the user enters by multiplying or dividing by, or adding the static variables created at the beginning of the program. For example:

  - To convert the volume from ml to L, divide the volume by mlToL (1000)

- To convert the pressure from mmHg to atm, divide the pressure by mmHgToAtm (760)
- To convert the temperature from Celsius to Kelvin, add cToK (273) to the temperature

- Repeat the above for option 2, 3, and 4 (details of option 4 were listed in Part I). The sample output below demonstrates what information to show the user and which formula to apply for each gas law.

- The method headers for option 2 are as follows:

public static double applyCharlesLaw()
public static double getTemperatureInKelvin(double temperature1, double volume1, double volume 2)

- The method headers for option 3 are as follows:

public static double applyGayLussacsLaw()
public static double getPressureInATM(double pressure1, double temperature 1, double temperature 2)

- If the user enters option 9, break out of the loop and print Good-bye! to the user.

A sample output is provided below. User input is highlighted in yellow.

Sample output

```
Welcome to the Gas Laws Calculator
Choose from the following options:
1) Boyle's Law
2) Charles' Law
3) Gay-Lussac's Law
4) Ideal Gas Law
9) Exit
option: 1

 |----------------------------TABLE OF UNITS AND CONVERSIONS------------------------------------|
 |V = volume in liters (L)      | P = pressure in atmosphere (atm) | R = ideal gas constant      |
 |T = temperature in Kelvin (K) | n = number of moles              |                             |
 |---------------------------------------------------------------------------------------------|
 |1 liter = 1000 milliliters | 1 Celsius = 273 Kelvin | 1 atm = 760 millimeter of mercury (mmHg) |
 |R = 0.08205                |                                                                 |
 |---------------------------------------------------------------------------------------------|


In Boyle's Law, the relationship between pressure (P1 and P2) and volume (V1 and V2) is expressed
as P1V1 = P2V2.
Enter the following values for P1 (mmHg), V1 (ml), and P2 (atm), and let's find V2 (L).
The units of the values are provided inside the parentheses.

805 2000 3

You entered: 805.0 for P1
You entered: 2000.0 for V1
You entered: 3.0 for P2

V2 is 0.70614 L

Welcome to the Gas Laws Calculator
Choose from the following options:
1) Boyle's Law
2) Charles' Law
```

```
3) Gay-Lussac's Law
4) Ideal Gas Law
9) Exit
option: 2

 |----------------------------TABLE OF UNITS AND CONVERSIONS-----------------------------------|
 |V = volume in liters (L)      | P = pressure in atmosphere (atm) | R = ideal gas constant      |
 |T = temperature in Kelvin (K) | n = number of moles              |                             |
 |---------------------------------------------------------------------------------------------|
 |1 liter = 1000 milliliters | 1 Celsius = 273 Kelvin | 1 atm = 760 millimeter of mercury (mmHg) |
 |R = 0.08205                |                                                                 |
 |---------------------------------------------------------------------------------------------|


In Charles' Law, the relationship between temperature (T1 and T2) and volume (V1 and V2) is
expressed as V1/T1 = V2/T2.
Enter the following values for T1 (C), V1 (ml), and V2 (L), and let's find T2 (K).
The units of the values are provided inside the parentheses.

25 3 2000

You entered: 25.0 for T1
You entered: 3.0 for V1
You entered: 2000.0 for V2

T2 is 198.66667 K

Welcome to the Gas Laws Calculator
Choose from the following options:
1) Boyle's Law
2) Charles' Law
3) Gay-Lussac's Law
4) Ideal Gas Law
9) Exit
option: 3

 |----------------------------TABLE OF UNITS AND CONVERSIONS-----------------------------------|
 |V = volume in liters (L)      | P = pressure in atmosphere (atm) | R = ideal gas constant      |
 |T = temperature in Kelvin (K) | n = number of moles              |                             |
 |---------------------------------------------------------------------------------------------|
 |1 liter = 1000 milliliters | 1 Celsius = 273 Kelvin | 1 atm = 760 millimeter of mercury (mmHg) |
 |R = 0.08205                |                                                                 |
 |---------------------------------------------------------------------------------------------|


In Gay-Lussac's Law, the relationship between pressure (P1 and P2) and temperature (T1 and T2) is
expressed as P1/T1 = P2/T2.
Enter the following values for P1 (mmHg), T1 (C), and T2 (C), and let's find P2 (atm).
The units of the values are provided inside the parentheses.

805 25 35

You entered: 805.0 for P1
You entered: 25.0 for T1
You entered: 35.0 for T2

P2 is 1.09475 atm

Welcome to the Gas Laws Calculator
Choose from the following options:
1) Boyle's Law
2) Charles' Law
3) Gay-Lussac's Law
4) Ideal Gas Law
```

```
9) Exit
option: 4

 |-----------------------------TABLE OF UNITS AND CONVERSIONS-----------------------------------|
 |V = volume in liters (L)      | P = pressure in atmosphere (atm) | R = ideal gas constant      |
 |T = temperature in Kelvin (K) | n = number of moles              |                             |
 |-----------------------------------------------------------------------------------------------|
 |1 liter = 1000 milliliters | 1 Celsius = 273 Kelvin | 1 atm = 760 millimeter of mercury (mmHg) |
 |R = 0.08205                |                                                                   |
 |-----------------------------------------------------------------------------------------------|


In Ideal Gas Law, the relationship between pressure (P), volume (V), number of moles (n), and
temperature (T) is expressed as PV = nRT.
Enter the following values for P (atm), V (L), and T (K), and let's find n (moles).
The units of the values are provided inside the parentheses.

2 2 298

You entered: 2.0 for P
You entered: 2.0 for V
You entered: 298.0 for T
The number of moles is 0.16359 moles

Welcome to the Gas Laws Calculator
Choose from the following options:
1) Boyle's Law
2) Charles' Law
3) Gay-Lussac's Law
4) Ideal Gas Law
9) Exit
option: 5
Welcome to the Gas Laws Calculator
Choose from the following options:
1) Boyle's Law
2) Charles' Law
3) Gay-Lussac's Law
4) Ideal Gas Law
9) Exit
option: 9
Good-bye!
```