

MATLAB Programming for Engineers | (5th Edition)

Step-by-step solution



Step 1 of 8

(a)

Consider the general ideal gas equation,

$$PV = nRT \dots\dots (1)$$

Here,

Pressure of the gas is represented as P ,

Volume of the gas is represented as V ,

Number of molecules of gas is represented as n ,

Universal gas constant is represented as R , and

Absolute temperature is represented as T .

Consider the following parameters.

$$n = 1 \text{ mole}$$

$$V = 30 \text{ L}$$

$$R = 8.314 \text{ kPa/mol} \cdot \text{K}$$

$$T = 273 \text{ K}$$

Substitute 30 L for V , 1 mole for n , 8.314 kPa/mol · K for R , and 273 K for T in equation (1).

$$P(30) = (1)(8.314)(273)$$

$$P = \frac{2,269.722}{30}$$

$$P = 75.66 \text{ kPa}$$

[Comment](#)

Step 2 of 8

Write the MATLAB code to calculate pressure using ideal gas equation.

$$n = 1;$$

$$R = 8.314;$$

$$\text{Temp} = 273;$$

$$\text{Vol} = 30;$$

$$P_ideal = (n * R * \text{Temp}) / \text{Vol}$$

[Comment](#)

Step 3 of 8

The output after executing the MATLAB code is,

$$P_ideal =$$

$$75.6574$$

Thus, the pressure of the gas according to the ideal gas law is **75.66 kPa**.

[Comment](#)

Step 4 of 8

(b)

The van der Waals equation is represented as,

$$P = \frac{nRT}{V - nb} - \frac{n^2 a}{V^2} \dots\dots (2)$$

Here,

Pressure of the gas is represented as P ,

Volume of the gas is represented as V ,

Number of molecules of gas is represented as n ,

Universal gas constant is represented as R ,

Absolute temperature is represented as T ,

Measure of attraction between molecules is represented as a , and

Volume of one mole of particles is represented as b .

Consider the following parameters.

$$n = 1 \text{ mole}$$

$$V = 30 \text{ L}$$

$$R = 8.314 \text{ kPa/mol} \cdot \text{K}$$

$$T = 273 \text{ K}$$

$$a = 0.369 \text{ kPa} \cdot \text{L}$$

$$b = 0.0427 \text{ L/mol}$$

[Comment](#)

Step 5 of 8

Substitute 30 L for V , 1 mole for n , 8.314 kPa/mol · K for R , 0.369 kPa · L for a , 0.0427 L/mol for b , and 273 K for T in equation (2).

$$P = \frac{1(8.314)(273)}{30 - (1)(0.0427)} - \frac{(1)^2(0.369)}{(30)^2}$$

$$= 75.76 - 0.0004$$

$$= 75.765$$

Type the following MATLAB code to calculate the pressure using Van der Waals equation.

$$n = 1;$$

$$R = 8.314;$$

$$\text{Temp} = 273;$$

$$\text{Vol} = 30;$$

$$a = 0.396;$$

$$b = 0.0427;$$

$$P_vander = ((n * R * \text{Temp}) / (\text{Vol} - n*b)) - (n^2*a./\text{Vol}.^2)$$

The output for the MATLAB code after execution is,

$$P_vander =$$

$$75.7648$$

Thus, pressure of the gas according to the van der Waals law is **75.765 kPa**.

[Comment](#)

Step 6 of 8

(c)

Type the following MATLAB code to plot pressure versus volume at constant temperature according to ideal gas law and van der Waals equation.

$$a = 0.396;$$

$$b = 0.0427;$$

$$n = 1;$$

$$R = 8.314;$$

$$\text{Temp} = 273;$$

$$\text{Vol1} = \text{logspace}(-1,2,100);$$

$$P_ideal = (n * R * \text{Temp}) / \text{Vol1};$$

$$P_vander = ((n * R * \text{Temp}) / (\text{Vol1} - n*b)) - (n^2*a./\text{Vol1}.^2);$$

$$\text{loglog}(P_ideal, \text{Vol1}, 'r--', 'LineWidth', 2);$$

hold on;

$$\text{loglog}(P_vander, \text{Vol1}, 'b', 'LineWidth', 2);$$

hold off;

$$\text{legend}('Ideal Gas','van der Waals');$$

$$\text{title}('Pressure vs Volume');$$

$$\text{xlabel}('Pressure in kilo pascals');$$

$$\text{ylabel}('Volume in liters');$$

grid on;

[Comment](#)

Step 7 of 8

The output for the MATLAB code after execution is shown in Figure 1.

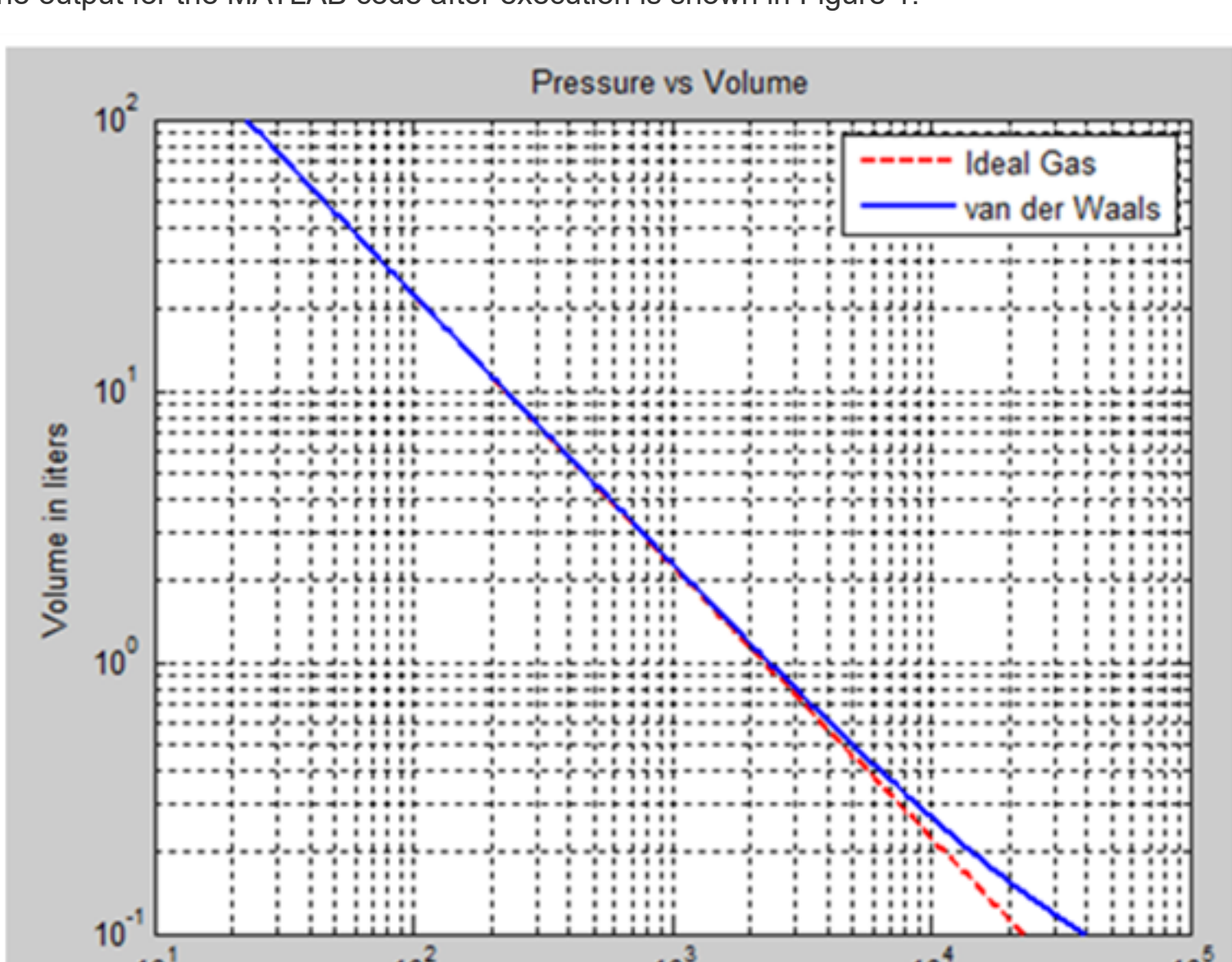


Figure 1

[Comment](#)

Step 8 of 8

From Figure 1, the pressure of real gas is higher than the pressure of ideal gas at same temperature.

Thus, the MATLAB code to plot pressure versus volume at constant temperature according to ideal gas law and van der Waals equation is written and verified.

[Comment](#)

Was this solution helpful? 0 0

Recommended solutions for you in Chapter 4

Chapter 4, Solution 17E

When a ray of light passes from a region with an index of refraction into a region with a different index of refraction, the...

[See solution](#)

n_1

Chapter 4, Solution 14E

Consider the gain G of a certain dish antenna. Where, θ is in radians

[See solution](#)

ABOUT CHEGG

Become a Tutor
Chegg For Good
College Marketing
Corporate Development
Investor Relations
Jobs

Join Our Affiliate Program
Media Center
Site Map

LEGAL

Advertising Choices
Cookie Notice
General Policies
Intellectual Property Rights
International Privacy Policy
Terms of Use
Chegg Tutors Terms of Service
US Privacy Policy
Your CA Privacy Rights

CHEGG PRODUCTS AND SERVICES

Cheap Textbooks
Chegg Coupon
Chegg Play
Chegg Study Help
College Textbooks
eTextbooks
Chegg Math Solver
Mobile Apps

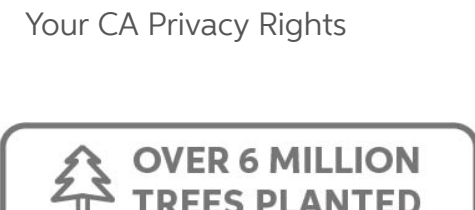
Online Tutoring
Sell Textbooks
Solutions Manual
Study 101
Test Prep
Textbook Rental
Used Textbooks
Digital Access Codes

CHEGG NETWORK

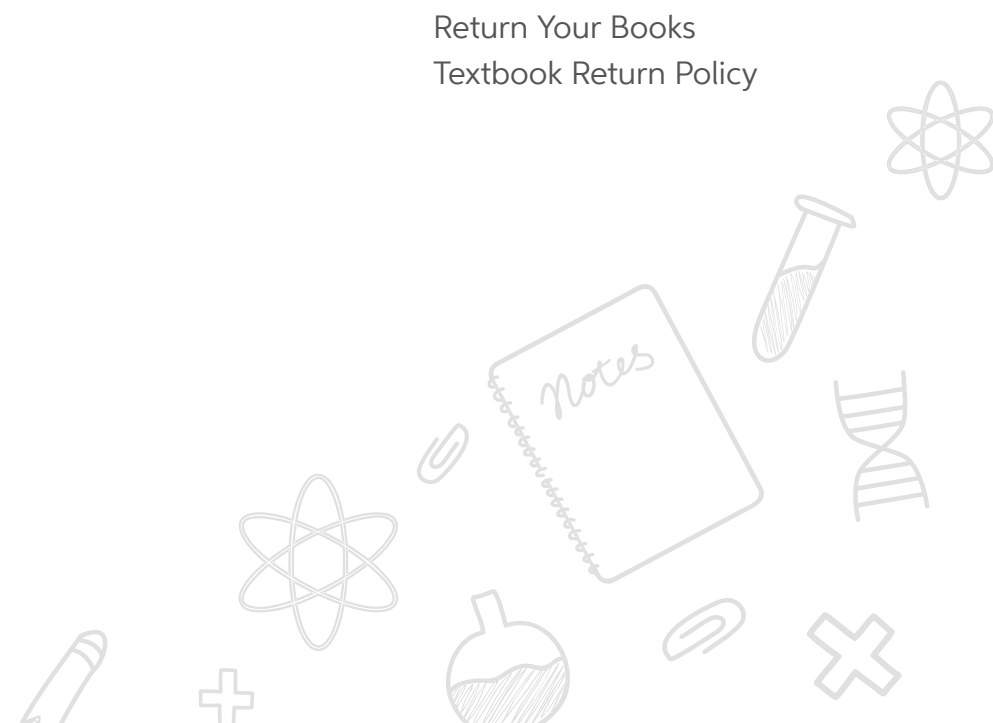
CareerMatch
Easybib
Internships.com
Studyblue

CUSTOMER SERVICE

Customer Service
Give Us Feedback
Help with Chegg Tutors
Help with eTextbooks
Help to use EasyBib Plus
Manage Chegg Study
Subscription
Return Your Books
Textbook Return Policy



© 2003-2018 Chegg Inc. All rights reserved.



feedback