

Physics

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(Chapter 11) (Thermodynamics) (Exercises) (Class 11)

Question 11.1:

A geyser heats water flowing at the rate of 3.0 litres per minute from 27 °C to 77 °C. If the geyser operates on a gas burner, what is the rate of consumption of the fuel if its heat of combustion is 4.0×10^4 J/g?

Answer 11.1:

Water is flowing at a rate of 3.0 litre/min.

The geyser heats the water, raising the temperature from 27°C to 77°C.

Initial temperature, $T_1 = 27^\circ\text{C}$ and Final temperature, $T_2 = 77^\circ\text{C}$

Rise in temperature, $\Delta T = T_2 - T_1 = 77 - 27 = 50^\circ\text{C}$

Heat of combustion = 4×10^4 J/g

Specific heat of water, $c = 4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$

Mass of flowing water, $m = 3.0 \text{ litre/min} = 3000 \text{ g/min}$

Total heat used, $\Delta Q = mc \Delta T = 3000 \times 4.2 \times 50 = 6.3 \times 10^5 \text{ J/min}$

∴ Rate of consumption = $\frac{6.3 \times 10^5}{4 \times 10^4} = 15.75 \text{ g/min}$

Question 11.2:

What amount of heat must be supplied to 2.0×10^{-2} kg of nitrogen (at room temperature) to raise its temperature by 45 °C at constant pressure? (Molecular mass of $\text{N}_2 = 28$; $R = 8.3 \text{ J mol}^{-1} \text{ K}^{-1}$.)

Answer 11.2:

Mass of nitrogen, $m = 2.0 \times 10^{-2} \text{ kg} = 20 \text{ g}$ and Rise in temperature, $\Delta T = 45^\circ\text{C}$

Molecular mass of N_2 , $M = 28$

Universal gas constant, $R = 8.3 \text{ J mol}^{-1} \text{ K}^{-1}$

Number of moles, $n = \frac{m}{M} = \frac{2.0 \times 10^{-2} \times 10^3}{28} = 0.714$

Molar specific heat at constant pressure for nitrogen $C_p = \frac{7}{2}R = \frac{7}{2} \times 8.3 = 29.05 \text{ J mol}^{-1} \text{ K}^{-1}$

The total amount of heat to be supplied is given by the relation: $\Delta Q = nC_p \Delta T$

$= 0.714 \times 29.05 \times 45 = 933.38 \text{ J}$

Therefore, the amount of heat to be supplied is 933.38 J.

Question 11.3:

Explain why

- Two bodies at different temperatures T_1 and T_2 if brought in thermal contact do not necessarily settle to the mean temperature $(T_1 + T_2)/2$.
- The coolant in a chemical or a nuclear plant (i.e., the liquid used to prevent the different parts of a plant from getting too hot) should have high specific heat.
- Air pressure in a car tyre increases during driving.
- The climate of a harbour town is more temperate than that of a town in a desert at the same latitude.

Answer 11.3:

- When two bodies at different temperatures T_1 and T_2 are brought in thermal contact, heat flows from the body at the higher temperature to the body at the lower temperature till equilibrium is achieved, i.e., the temperatures of both the bodies become equal. The equilibrium temperature is equal to the mean temperature $(T_1 + T_2)/2$ only when the thermal capacities of both the bodies are equal.

Chapter 11 Solutions Thermodynamics An Engineering Approach

Sabine Zange



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Table of Contents Chapter 11 Solutions Thermodynamics An Engineering Approach

1. Understanding the eBook Chapter 11 Solutions Thermodynamics An Engineering Approach
 - The Rise of Digital Reading Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Advantages of eBooks Over Traditional Books
2. Identifying Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Chapter 11 Solutions Thermodynamics An Engineering Approach
 - User-Friendly Interface
4. Exploring eBook Recommendations from Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Personalized Recommendations
 - Chapter 11 Solutions Thermodynamics An Engineering Approach User Reviews and Ratings
 - Chapter 11 Solutions Thermodynamics An Engineering Approach and Bestseller Lists

5. Accessing Chapter 11 Solutions Thermodynamics An Engineering Approach Free and Paid eBooks
 - Chapter 11 Solutions Thermodynamics An Engineering Approach Public Domain eBooks
 - Chapter 11 Solutions Thermodynamics An Engineering Approach eBook Subscription Services
 - Chapter 11 Solutions Thermodynamics An Engineering Approach Budget-Friendly Options
6. Navigating Chapter 11 Solutions Thermodynamics An Engineering Approach eBook Formats
 - ePub, PDF, MOBI, and More
 - Chapter 11 Solutions Thermodynamics An Engineering Approach Compatibility with Devices
 - Chapter 11 Solutions Thermodynamics An Engineering Approach Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Highlighting and Note-Taking Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Interactive Elements Chapter 11 Solutions Thermodynamics An Engineering Approach
8. Staying Engaged with Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Chapter 11 Solutions Thermodynamics An Engineering Approach
9. Balancing eBooks and Physical Books Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Chapter 11 Solutions Thermodynamics An Engineering Approach
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Setting Reading Goals Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Fact-Checking eBook Content of Chapter 11 Solutions Thermodynamics An Engineering Approach
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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