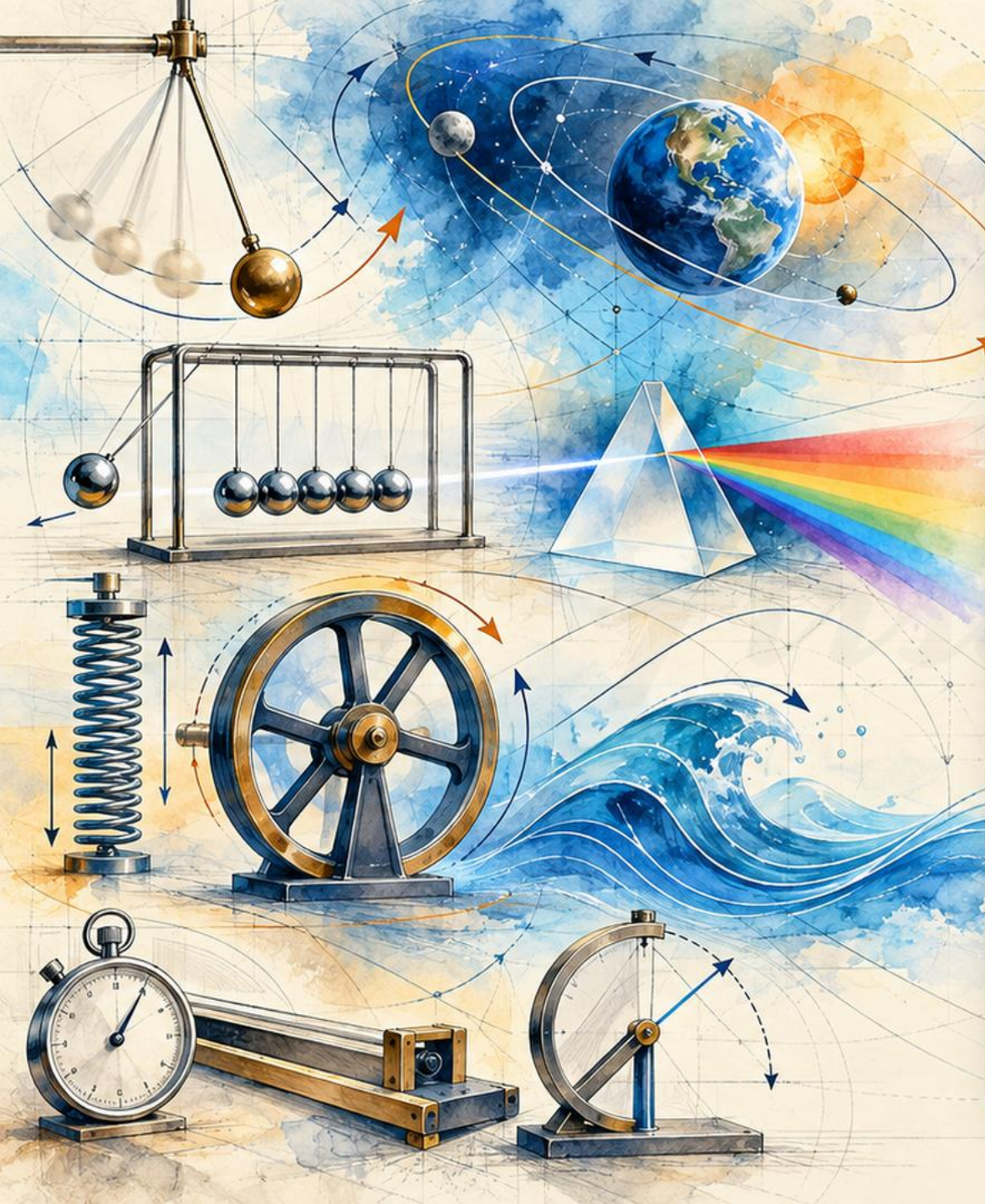




PHYSICS • CLASS 11

11

CHAPTER

Thermodynamics

NCERT SOLUTIONS

EXERCISE SOLUTION: QUESTION 11.1

A gas-fired geyser heats water flowing at 3.0 litres per minute from 27°C to 77°C. Find its fuel-consumption rate if the fuel's heat of combustion is $4.0 \times 10^4 \text{ J g}^{-1}$.

Solution:

Assume that all the fuel's released heat reaches the water. Use water density and specific heat to convert the flow into a heating rate.

$$\rho_{\text{water}} \approx 1.0 \text{ kg L}^{-1}$$

$$\dot{m}_{\text{water}} = 3.0 \text{ kg min}^{-1}$$

$$c_{\text{water}} = 4186 \text{ J kg}^{-1} \text{ K}^{-1}$$

$$\Delta T = 77 - 27 = 50 \text{ K}$$

$$\begin{aligned} Q_{\text{per min}} &= \dot{m}_{\text{water}} c_{\text{water}} \Delta T \\ &= (3.0)(4186)(50) \\ &= 6.279 \times 10^5 \text{ J min}^{-1} \end{aligned}$$

Divide the required heat per minute by the energy released per gram of fuel.

$$\dot{m}_{\text{fuel}} = \frac{6.279 \times 10^5}{4.0 \times 10^4} \approx 15.7 \text{ g min}^{-1}$$

$$\dot{m}_{\text{fuel}} = \frac{15.7}{60} \approx 0.262 \text{ g s}^{-1}$$

Final: Fuel consumption $\approx 16 \text{ g min}^{-1}$
(0.26 g s^{-1}).

Heat loss would require a higher fuel-consumption rate. The result is the ideal heat-transfer estimate.

EXERCISE SOLUTION: QUESTION 11.2

Q. How much 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: Nitrogen is diatomic. At room temperature, use its translational and rotational heat capacity, with vibration neglected. Constant-pressure heating requires the constant-pressure molar heat capacity.

$$C_V = \frac{5R}{2}$$

$$\begin{aligned} C_P &= C_V + R = \frac{7R}{2} \\ &= \frac{7}{2}(8.3) = 29.05 \text{ J mol}^{-1} \text{ K}^{-1} \end{aligned}$$

$$m = 20 \text{ g}$$

$$M = 28 \text{ g mol}^{-1}$$

$$n = \frac{m}{M} = \frac{20}{28} \approx 0.714 \text{ mol}$$

$$\Delta T = 45 \text{ K}$$

$$\begin{aligned} Q &= nC_P\Delta T = \left(\frac{20}{28}\right)(29.05)(45) \\ &= 933.75 \text{ J} \end{aligned}$$

Required heat $\approx 9.3 \times 10^2 \text{ J}$.

At constant pressure, some supplied energy increases internal energy and some is used in expansion work.

EXERCISE SOLUTION: QUESTION 11.3

- (a) Why do bodies initially at T_1 and T_2 not necessarily reach $(T_1 + T_2)/2$ after thermal contact?

Answer: The final temperature depends on their heat capacities, not just their temperatures. For an isolated pair with constant heat capacities and no phase change:

$$T_f = \frac{m_1 c_1 T_1 + m_2 c_2 T_2}{m_1 c_1 + m_2 c_2}$$

The arithmetic mean occurs when their total heat capacities are equal.

- (b) Why should the liquid coolant in a chemical or nuclear plant have high specific heat?

Answer: It can absorb a large amount of heat with only a small temperature rise, helping prevent overheating.

$$\Delta T = \frac{Q}{mc}$$

- (c) Why does air pressure in a car tyre rise during driving?

Answer: Tyre flexing and friction generate heat. The enclosed air warms; its volume changes relatively little, so its pressure rises.

Approximately: $\frac{P}{T} = \text{constant}$
with T in kelvin.

- (d) Why is a harbour town's climate more temperate than a desert town's at the same latitude?

Answer: Water's high specific heat makes the sea warm and cool slowly. Heat exchange with the sea moderates coastal temperatures. Desert land warms and cools much faster.

EXERCISE SOLUTION: QUESTION 11.4

An insulated cylinder with a movable piston contains 3 moles of hydrogen at standard temperature and pressure. The piston is insulated by a pile of sand. By what factor does the gas pressure increase when it is compressed to half its original volume?

Answer:

The insulation prevents heat exchange. Use the intended quasi-static adiabatic compression model for an ideal diatomic gas.

$$Q = 0$$

$$\gamma = \frac{C_P}{C_V} = \frac{(7R/2)}{(5R/2)} = \frac{7}{5} = 1.4$$

$$P_1 V_1^\gamma = P_2 V_2^\gamma$$

$$V_2 = \frac{V_1}{2}$$

$$\frac{P_2}{P_1} = \left(\frac{V_1}{V_2} \right)^\gamma = 2^{1.4} \approx 2.639$$

The final pressure is about 2.64 times the original pressure.

Compression raises the gas temperature, so the pressure factor is greater than the isothermal factor for the same volume change. The amount of gas cancels from this ratio.

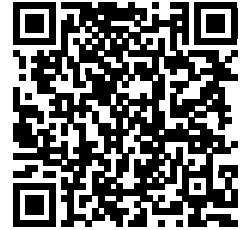


FREE PREVIEW

[Click here to visit our website](#)

SCHOOL NOTES & NCERT SOLUTIONS

Complete notes and
NCERT solutions are
available on
FirstHope app only.



[Scan or click here](#)

Click here to get the app



Available on Google Play

JOIN THE FIRSTHOPE COMMUNITY

Join our Telegram channel

Click here to join Telegram



[Scan or click here](#)

@FirstHope_CBSE_Notes

Instagram

@firsthope.school

[Click here to follow >](#)

YouTube channel

@firsthope.school

[Click here to watch >](#)

FirstHope website

firsthope.co.in

[Click here to visit our website >](#)

CBSE / Class 9 / Class 10 / Class 11 / Class 12

Preview notes and NCERT solutions. Full PDFs in the FirstHope app.