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NCERT Class 11 Physics Solutions: Chapter 12 – Thermodynamics-Part 1

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Question 12.1:

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

Answer:

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

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

Initial temperature, $T_1 = 27°C$

Final temperature, $T_2 = 77°C$

$\therefore$ Rise in tempreture, $\Delta T = T_2 - T_1$

$= 77 - 27 = 50°C$

Heat of combustion $= 4 \times 104 J/g$

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

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

Total heat used, $\Delta Q = mc\,\Delta T$

$= 3000 \times 4.2 \times 50$

$= 6.3 \times 10^5 J/\text{ min}$

$\therefore$ Rate of consuption $= \dfrac{6.3 \times 10^5}{4 \times 10^4}$

$= 15.75g/\text{ min}$

Question 12.2:

What amount of heat must be supplied to $2.0 \times 10^{-2} kg$ of nitrogen (at room temperature) to raise its temperature by $45°C$ at constant pressure?

(Molecular mass of $N_2 = 28; R = 8.3 J\ mol^{-1} K^{-1}.$)

Answer:

Mass of nitrogen, $m = 2 \times 10^{-2} kg = 20g$

Rise in temperature, $\Delta T = 45°C$

Molecular mass of $N_2, M = 28$

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

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

$$C_p = \frac{7}{2}R$$

$$= \frac{7}{2} \times 8.3$$

$$= 29.05J\ mol^{-1}\ K^{-1}$$

The total amount of heat to be supplied is given by the relation:

$$\Delta Q = nC_p\ \Delta\ T$$

$$= 0.714$$

$$= 0.714 \times 29.05 \times 45$$

$$= 933.38J$$

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

Question 12.3:

Explain why

a) Two bodies at different temperatures $T_1 \text{and} T_2$ if brought in thermal contact do not necessarily settle to the mean temperature $(T_1 + T_2)/2.$

b) 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.

c) Air pressure in a car tyre increases during driving. d) The climate of a harbor town is more temperate than that of a town in a desert at the same latitude.

Answer:

(*a*)

Explanation:

When two bodies at different temperatures $T_1 \text{and} T_2$ 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.

(*b*)

Explanation:

The coolant in a chemical or nuclear plant should have a high specific heat. This is because higher the specific heat of the coolant, higher is its heat-absorbing capacity and vice versa. Hence, a liquid having a high specific heat is the best coolant to be used in a nuclear or chemical plant. This would prevent different parts of the plant from getting too hot.

(*c*)

Explanation:

When a car is in motion, the air temperature inside the car increases because of the motion of the air molecules. According to Charles' law, temperature is directly proportional to pressure. Hence, if the temperature inside a tyre increases, then the air pressure in it will also increase.

(*d*)

Explanation:

A harbor town has a more temperate climate (i.e.. , without the extremes of heat or cold) than a town located in a desert at the same latitude. This is because the relative humidity in a harbor town is more than it is in a desert town.