Assignment - 01

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Answer to the Q. No. - 01

Given Linear system,

$$2x_1 - x_2 + 3x_3 + 4x_4 = 9$$
$$x_1 - 2x_3 + 7x_4 = 11$$
$$3x_1 - 3x_2 + x_3 + 5x_4 = 8$$
$$2x_1 + x_2 + 4x_3 + 4x_4 = 10$$

The corresponding augmented matrix $\Rightarrow$

$$\left(\begin{array}{cccc|c} 2 & -1 & 3 & 4 & 9 \\ 1 & 0 & -2 & 7 & 11 \\ 3 & -3 & 1 & 5 & 8 \\ 2 & 1 & 4 & 4 & 10 \end{array}\right)$$

$$\sim \left(\begin{array}{cccc|c} 2 & -1 & 3 & 4 & 9 \\ 0 & 1 & -7 & 10 & 13 \\ 0 & -3 & -7 & -2 & -11 \\ 0 & 2 & 1 & 0 & 1 \end{array}\right) ; \quad \begin{array}{l} R_2' = 2R_2 - R_1 \\ R_3' = 2R_3 - 3R_1 \\ R_4' = R_4 - R_1 \end{array}$$

$$\sim \left(\begin{array}{cccc|c} 2 & -1 & 3 & 4 & 9 \\ 0 & 1 & -7 & 10 & 13 \\ 0 & 0 & -28 & 28 & 28 \\ 0 & 0 & 15 & -20 & -25 \end{array}\right) ; \quad \begin{array}{l} R_3' = R_3 + 3R_2 \\ R_4' = R_4 - 2R_2 \end{array}$$

$$\sim \left(\begin{array}{cccc|c} 2 & -1 & 3 & 4 & 9 \\ 0 & 1 & -7 & 10 & 13 \\ 0 & 0 & -28 & 28 & 28 \\ 0 & 0 & 0 & -140 & -280 \end{array}\right) ; \quad R_4' = 28R_4 + 15R_3$$

[P.T.O.]

$$\sim \left(\begin{array}{cccc|c} 1 & -\frac{1}{2} & \frac{3}{2} & 2 & \frac{9}{2} \\ 0 & 1 & -7 & 10 & 13 \\ 0 & 0 & 1 & -1 & -1 \\ 0 & 0 & 0 & 1 & 2 \end{array}\right) ; \quad \begin{array}{l} R_1' = \frac{1}{2} R_1 \\ R_3' = -\frac{1}{28} R_3 \\ R_4' = -\frac{1}{140} R_4 \end{array}$$

Here, this is in the row echelon form.

Now,

The corresponding system $\Rightarrow$

$$x_1 - \frac{1}{2} x_2 + \frac{3}{2} x_3 + 2x_4 = \frac{9}{2} \quad \text{--- (I)}$$

$$x_2 - 7x_3 + 10x_4 = 13 \quad \text{--- (II)}$$

$$x_3 - x_4 = -1 \quad \text{--- (III)}$$

$$x_4 = 2 \quad \text{--- (IV)}$$

$\because x_4 = 2.$

$\therefore$ from (III) $\Rightarrow x_3 = 1$

from (II) $\Rightarrow x_2 = 13 + 7\cdot(1) - 10\cdot(2) = 0$

from (I) $\Rightarrow x_1 = 9/2 + 1/2(0) - 3/2(1) - 2(2)$

$= -1.$

$\therefore (x_1, x_2, x_3, x_4) = (-1, 0, 1, 2)$

(Ans:)

Answer to the Q. NO - 02

Given Linear System,

$$-2q + 3r = 1$$
$$3p + 6q - 3r = -2$$
$$6p + 6q + 3r = 5$$

using Gauss- Jordan elimination method:-

The augmented matrix is ⇒

$$\left(\begin{array}{ccc|c} 0 & -2 & 3 & 1 \\ 3 & 6 & -3 & -2 \\ 6 & 6 & 3 & 5 \end{array}\right)$$

$$\sim \left(\begin{array}{ccc|c} 3 & 6 & -3 & -2 \\ 0 & -2 & 3 & 1 \\ 6 & 6 & 3 & 5 \end{array}\right) \quad ; \quad R_2 \longleftrightarrow R_1$$

$$\sim \left(\begin{array}{ccc|c} 3 & 6 & -3 & -2 \\ 0 & -2 & 3 & 1 \\ 0 & -6 & 9 & 9 \end{array}\right) \quad ; \quad R_3' = R_3 - 2R_1$$

$$\sim \left(\begin{array}{ccc|c} 3 & 6 & -3 & -2 \\ 0 & -2 & 3 & 1 \\ 0 & 0 & 0 & 6 \end{array}\right) \quad ; \quad R_3' = R_3 - 3R_2$$

$$\sim \left(\begin{array}{ccc|c} 3 & 0 & 6 & 1 \\ 0 & -2 & 3 & 1 \\ 0 & 0 & 0 & 6 \end{array}\right) \quad ; \quad R_1' = R_1 + 3R_2$$

$$\sim \left(\begin{array}{ccc|c} 1 & 0 & 2 & \frac{1}{3} \\ 0 & 1 & -\frac{3}{2} & -\frac{1}{2} \\ 0 & 0 & 0 & 6 \end{array}\right) \quad ; \quad \begin{array}{l} R_1' = \frac{1}{3} R_1 \\ R_2' = -\frac{1}{2} R_2 \end{array}$$

[P.T.O.]

Now,

The corresponding system $\Rightarrow$

$$p + 2r = \frac{1}{3}$$

$$q - \frac{3}{2} r = -\frac{1}{2}$$

$$0 \cdot p + 0 \cdot q + 0 \cdot r = 6$$ [Got from the last row]

$$\Rightarrow 0 = 6$$

$\because$ $0 = 6$ is not possible.

$\therefore$ the given system has no solution.

$\therefore$ the system is inconsistent.

(Ans:)

Ans. to the Q. NO - 3(a) (i)

Given system,

$$x+y+\lambda z = 1$$
$$x+\lambda y+z = \lambda$$
$$\lambda x+y+z = \lambda^2$$

The corresponding augmented system $\Rightarrow$

$$\left(\begin{array}{ccc|c} 1 & 1 & \lambda & 1 \\ 1 & \lambda & 1 & \lambda \\ \lambda & 1 & 1 & \lambda^2 \end{array}\right)$$

$$\sim \left(\begin{array}{ccc|c} 1 & 1 & \lambda & 1 \\ 0 & \lambda-1 & 1-\lambda & \lambda-1 \\ 0 & 1-\lambda & 1-\lambda^2 & \lambda^2-\lambda \end{array}\right) ; \quad \begin{array}{l} R_2' = R_2 - R_1 \\ R_3' = R_3 - \lambda R_1 \end{array}$$

$$\sim \left(\begin{array}{ccc|c} 1 & 1 & \lambda & 1 \\ 0 & \lambda-1 & 1-\lambda & \lambda-1 \\ 0 & 0 & -\lambda^2-\lambda+2 & \lambda^2-1 \end{array}\right) ; \quad R_3' = R_3 + R_2$$

$$\sim \left(\begin{array}{ccc|c} 1 & 1 & \lambda & 1 \\ 0 & \lambda-1 & 1-\lambda & \lambda-1 \\ 0 & 0 & -(\lambda+2)(\lambda-1) & (\lambda+1)(\lambda-1) \end{array}\right) \text{ ——— } (1)$$

[P.T.O.]

(i) unique solution :-

Here, if $\lambda \neq 1$ and
$\lambda \neq -2$

then it can be defined as eqn — (1) as :-

$$\left(\begin{array}{ccc|c} 1 & 1 & \lambda & 1 \\ 0 & 1 & -1 & 1 \\ 0 & 0 & 1 & \frac{-1-\lambda}{\lambda+2} \end{array}\right); \quad R_2' = \frac{1}{\lambda-1} \cdot R_2 \quad R_3' = \frac{1}{-(\lambda+2)(\lambda-1)} \cdot R_3$$

as it is in row echelon form and all three columns has a leading 1.

$\therefore$ the given system has a unique solution.

(ii) No Solution :-

Here, if $\lambda = -2$,

then eqn ---- (1) $\Rightarrow$

$$\left(\begin{array}{ccc|c} 1 & 1 & -2 & 1 \\ 0 & -3 & 3 & -3 \\ 0 & 0 & 0 & 3 \end{array}\right)$$

from the last row, $0 \cdot x + 0 \cdot y + 0 \cdot z = 3$
$\Rightarrow 0 = 3$

This is not possible.

$\therefore$ It means the system has no solution.
and the system is inconsistent.

(iii) Many solution :

when $\lambda = 1$,

the eqn ----- (1) $\Rightarrow$

$$\left(\begin{array}{ccc|c} 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{array}\right)$$

when $\lambda = 1$;
all the values of 2nd and 3rd row becomes zero and there will be infinite amount of many solutions.

Answer :- (i) Unique solution $\Rightarrow$ when $\lambda \neq 1$ & $\lambda \neq -2$ for all the values

(ii) No Solution $\Rightarrow$ when $\lambda = -2$

(iii) Many solution $\Rightarrow$ infinitely many solution when $\lambda = 1$.

Answer to the Q. NO- 03(b)

Given Linear System,

$$x+2y-3z=\alpha$$
$$3x-y+2z=\beta$$
$$2x-10y+16z=2\gamma$$

The corresponding augmented matrix $\Rightarrow$

$$\left(\begin{array}{ccc|c} 1 & 2 & -3 & \alpha \\ 3 & -1 & 2 & \beta \\ 2 & -10 & 16 & 2\gamma \end{array}\right)$$

$$\sim \left(\begin{array}{ccc|c} 1 & 2 & -3 & \alpha \\ 0 & -7 & 11 & \beta-3\alpha \\ 0 & -14 & 22 & 2\gamma-2\alpha \end{array}\right) ; \quad R_2' = R_2 - 3R_1, \quad R_3' = R_3 - 2R_1$$

$$\sim \left(\begin{array}{ccc|c} 1 & 2 & -3 & \alpha \\ 0 & -7 & 11 & \beta-3\alpha \\ 0 & 0 & 0 & 4\alpha+2\gamma-2\beta \end{array}\right) ; \quad R_3' = R_3 - 2R_2$$

Here, the given system will be consistent if $\Rightarrow$

$$4\alpha+2\gamma-2\beta=0.$$
$$\Rightarrow 2(2\alpha+\gamma-\beta)=0$$
$$\Rightarrow 2\alpha+\gamma-\beta=0$$

$\therefore$ $2\alpha+\gamma-\beta$ is the solution.

(Ans:)

Answer to the Q. NO - 04(a)

Given system,

$$x_1 + x_2 + x_3 = 1$$
$$2x_1 + 2x_2 + 2x_3 = 1$$
$$3x_1 + 3x_2 + 3x_3 = 2$$

The augmented matrix $\Rightarrow$

$$\left(\begin{array}{ccc|c} 1 & 1 & 1 & 1 \\ 2 & 2 & 2 & 1 \\ 3 & 3 & 3 & 2 \end{array}\right)$$

$$\sim \left(\begin{array}{ccc|c} 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & -1 \end{array}\right) ; \quad \begin{array}{l} R_2' = R_2 - 2R_1 \\ R_3' = R_3 - 3R_1 \end{array}$$

Now,

$$x_1 + x_2 + x_3 = 1$$

$\Rightarrow 0 \cdot x_1 + 0 \cdot x_2 + 0 \cdot x_3 = -1$ [from 2nd & 3rd row]

$\Rightarrow 0 = -1$.

which is not possible.

$\therefore$ The system has no solution.

$\therefore$ The system is inconsistent.

(Ans.)

Answer to the Q. NO - 04 (b)

Given system,

$$x_1 + 2x_2 + x_3 + x_4 = 6$$

$$x_1 - x_2 - x_4 = -2$$

$$x_1 + 8x_2 + x_3 + 5x_4 = 22$$

$$2x_1 + 7x_2 + 2x_3 + 4x_4 = 20$$

The augmented corresponding matrix $\Rightarrow$

$$\left(\begin{array}{cccc|c} 1 & 2 & 1 & 1 & 6 \\ 1 & -1 & 1 & -1 & -2 \\ 1 & 8 & 1 & 5 & 22 \\ 2 & 7 & 2 & 4 & 20 \end{array}\right)$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 1 & 1 & 6 \\ 0 & -3 & 0 & -2 & -8 \\ 1 & 8 & 1 & 5 & 22 \\ 2 & 7 & 2 & 4 & 20 \end{array}\right) ; R_2' = R_2 - R_1$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 1 & 1 & 6 \\ 0 & -3 & 0 & -2 & -8 \\ 0 & 6 & 0 & 4 & 16 \\ 2 & 7 & 2 & 4 & 20 \end{array}\right) ; R_3' = R_3 - R_1$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 1 & 1 & 6 \\ 0 & -3 & 0 & -2 & -8 \\ 0 & 6 & 0 & 4 & 16 \\ 0 & 3 & 0 & 2 & 8 \end{array}\right) ; R_4' = R_4 - 2R_1$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 1 & 1 & 6 \\ 0 & 1 & 0 & \frac{2}{3} & \frac{8}{3} \\ 0 & 6 & 0 & 4 & 16 \\ 0 & 3 & 0 & 2 & 8 \end{array}\right) ; R_2' = -\frac{1}{3} R_2$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 1 & 1 & 6 \\ 0 & 1 & 0 & \frac{2}{3} & \frac{8}{3} \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{array}\right) ; \begin{array}{l} R_3' = R_3 - 6R_2 \\ R_4' = R_4 - 3R_2 \end{array}$$

$$\sim \left(\begin{array}{cccc|c} 1 & 0 & 1 & -\frac{1}{3} & \frac{2}{3} \\ 0 & 1 & 0 & \frac{2}{3} & \frac{8}{3} \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{array}\right) ; R_1' = R_1 - 2R_2$$

[It is Reduced Row Echelon form]

Here,

The system is consistent.

The corresponding system $\Rightarrow$

$$x_1 + x_3 - \frac{1}{3} x_4 = \frac{2}{3}$$

$$x_2 + \frac{2}{3} x_4 = \frac{8}{3}$$

There are 2 equations, 4 unknowns.

$\therefore$ we have $(4-2) = 2$ free variables.

3rd & 4th column have no leading 1.

$\therefore$ x_3 and x_4 are free variables. [P.T.O.]

let,

$$x_3 = t_1 \quad ; \quad x_4 = t_2$$

$$\therefore x_1 = \frac{2}{3} + \frac{1}{3}t_2 - t_1$$

$$x_2 = \frac{8}{3} - \frac{2}{3}t_2$$

$$\therefore (x_1, x_2, x_3, x_4) = \left(\frac{2}{3} + \frac{1}{3}t_2 - t_1, \frac{8}{3} - \frac{2}{3}t_2, t_1, t_2\right)$$

[where $t_1, t_2 \in \mathbb{R}$]

Now,

putting values to t_1 & t_2, $\Rightarrow$

$t_1 = 1$ and $t_2 = 1$, we get $\Rightarrow$

$x_1 = 0$,

$x_2 = 2$,

$x_3 = 1$,

$x_4 = 1$

Again, $t_1 = 10$ and $t_2 = 10$, we get $\Rightarrow$

$x_1 = -6$,

$x_2 = -4$,

$x_3 = 10$,

$x_4 = 10$

(Ans:)

Answer to the Q. NO- 04(c)

Given system;

$$x_1 + 2x_2 + 3x_3 + 4x_4 = 0$$
$$2x_1 + 3x_2 + 4x_3 = 1$$
$$3x_1 + 4x_2 + x_4 = 2$$
$$4x_1 + x_3 + 2x_4 = 3$$

The corresponding augmented matrix $\Rightarrow$

$$\left(\begin{array}{cccc|c} 1 & 2 & 3 & 4 & 0 \\ 2 & 3 & 4 & 0 & 1 \\ 3 & 4 & 0 & 1 & 2 \\ 4 & 0 & 1 & 2 & 3 \end{array}\right)$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 3 & 4 & 0 \\ 0 & -1 & -2 & -8 & 1 \\ 0 & -2 & -9 & -11 & 2 \\ 0 & -8 & -11 & -14 & 3 \end{array}\right) ; \begin{array}{l} R_2' = R_2 - 2R_1 \\ R_3' = R_3 - 3R_1 \\ R_4' = R_4 - 4R_1 \end{array}$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 3 & 4 & 0 \\ 0 & 1 & 2 & 8 & -1 \\ 0 & -2 & -9 & -11 & 2 \\ 0 & -8 & -11 & -14 & 3 \end{array}\right) ; R_2' = (-1) \cdot R_2$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 3 & 4 & 0 \\ 0 & 1 & 2 & 8 & -1 \\ 0 & 0 & -5 & 5 & 0 \\ 0 & 8 & -11 & -14 & 3 \end{array}\right) ; R_3' = R_3 + 2R_2$$

[P.T.O.]

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 3 & 4 & 0 \\ 0 & 1 & 2 & 8 & -1 \\ 0 & 0 & -5 & 5 & 0 \\ 0 & 0 & 5 & 50 & -5 \end{array}\right) ; \quad R_4' = R_4 + 8R_2$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 3 & 4 & 0 \\ 0 & 1 & 2 & 8 & -1 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 5 & 50 & -5 \end{array}\right) ; \quad R_3' = -\frac{1}{5} R_3$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 3 & 4 & 0 \\ 0 & 1 & 2 & 8 & -1 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 0 & 55 & -5 \end{array}\right) ; \quad R_4' = R_4 - 5R_3$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 3 & 4 & 0 \\ 0 & 1 & 2 & 8 & -1 \\ 0 & 0 & 1 & -1 & 0 \\ 0 & 0 & 0 & 1 & -1/11 \end{array}\right) ; \quad R_4' = \frac{1}{55} R_4$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 3 & 0 & \frac{4}{11} \\ 0 & 1 & 2 & 0 & -\frac{3}{11} \\ 0 & 0 & 1 & 0 & -\frac{1}{11} \\ 0 & 0 & 0 & 1 & -\frac{1}{11} \end{array}\right) ; \quad \begin{array}{l} R_3' = R_3 + R_4 \\ R_2' = R_2 - 8R_4 \\ R_1' = R_1 - 4R_4 \end{array}$$

$$\sim \left(\begin{array}{cccc|c} 1 & 2 & 0 & 0 & \frac{7}{11} \\ 0 & 1 & 0 & 0 & -\frac{1}{11} \\ 0 & 0 & 1 & 0 & -\frac{1}{11} \\ 0 & 0 & 0 & 1 & -\frac{1}{11} \end{array}\right) ; \quad \begin{array}{l} R_2' = R_2 - 2R_3 \\ R_1' = R_1 - 3R_3 \end{array}$$

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$$\sim \left(\begin{array}{cccc|c} 1 & 0 & 0 & 0 & \frac{9}{11} \\ 0 & 1 & 0 & 0 & -\frac{1}{11} \\ 0 & 0 & 1 & 0 & -\frac{1}{11} \\ 0 & 0 & 0 & 1 & -\frac{1}{11} \end{array}\right) ;\ R_1' = R_1 - 2R_2$$

This is in Reduced Row echelon form. and the system is consistent.

$$\therefore\ x_1 = \frac{9}{11}$$

$$x_2 = -\frac{1}{11}$$

$$x_3 = -\frac{1}{11}$$

$$x_4 = -\frac{1}{11}$$

$$\therefore\ (x_1, x_2, x_3, x_4) = \left(\frac{9}{11}, -\frac{1}{11}, -\frac{1}{11}, -\frac{1}{11}\right)$$

(Ans:)

Ans. to the Q. NO - 05

Given chemical reaction,

$$CO_2 + H_2O \longrightarrow C_6H_{12}O_6 + O_2$$

Let,

$$x_1 (CO_2) + x_2 (H_2O) \longrightarrow x_3 (C_6H_{12}O_6) + x_4 (O_2)$$

where $x_1, x_2, x_3, x_4 \Rightarrow$ integers.

To balance the given equation,

the number of atoms on both sides of the equation must be equal.

Now,

	left side		right side
Number of Carbon (C) :	x_1	$=$	$6x_3$
Number of Hydrogen (H) :	$2x_2$	$=$	$12x_3$
Number of Oxygen (O) :	$2x_1 + x_2$	$=$	$6x_3 + 2x_4$

Now, the corresponding homogenous linear system $\Rightarrow$

$$\begin{aligned} x_1 \qquad\qquad - 6x_3 &= 0 \\ 2x_2 - 12x_3 &= 0 \\ 2x_1 + x_2 - 6x_3 - 2x_4 &= 0 \end{aligned}$$

The corresponding augmented matrix $\Rightarrow$

$$\left(\begin{array}{cccc|c} 1 & 0 & -6 & 0 & 0 \\ 0 & 2 & -12 & 0 & 0 \\ 2 & 1 & -6 & -2 & 0 \end{array}\right)$$

$$\sim \left(\begin{array}{cccc|c} 1 & 0 & -6 & 0 & 0 \\ 0 & 2 & -12 & 0 & 0 \\ 0 & 1 & 6 & -2 & 0 \end{array}\right) ; \quad R_3' = R_3 - 2R_1$$

$$\sim \left(\begin{array}{cccc|c} 1 & 0 & -6 & 0 & 0 \\ 0 & 2 & -12 & 0 & 0 \\ 0 & 0 & 12 & -2 & 0 \end{array}\right) ; \quad R_3' = R_3 - \frac{1}{2} R_2$$

$$\sim \left(\begin{array}{cccc|c} 1 & 0 & 0 & -1 & 0 \\ 0 & 2 & 0 & -2 & 0 \\ 0 & 0 & 12 & -2 & 0 \end{array}\right) ; \quad \begin{array}{l} R_2' = R_2 + R_3 \\ R_1' = R_1 + \frac{1}{2} R_3 \end{array}$$

$$\sim \left(\begin{array}{cccc|c} 1 & 0 & 0 & -1 & 0 \\ 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & 1 & -\frac{1}{6} & 0 \end{array}\right) \quad \begin{array}{l} R_2' = \frac{1}{2} R_2 \\ R_3' = \frac{1}{12} R_3 \end{array}$$

Now, The corresponding system $\Rightarrow$

$$x_1 - x_4 = 0 \quad \text{—— (I)}$$

$$x_2 - x_4 = 0 \quad \text{—— (II)}$$

$$x_3 - \frac{1}{6} x_4 = 0 \quad \text{—— (III)}$$

There are 3 equations and 4 unknowns;

$\therefore$ we have $(4-3) = 1$ free variable.

Here,

4th column has no leading 1.

$\therefore$ x_4 is free variable.

let,

$x_4 = t \quad ; \quad t \in \mathbb{R}$

$\therefore$ $x_1 = t,$

$x_2 = t,$

$x_3 = \frac{1}{6} t$

$\therefore (x_1, x_2, x_3, x_4) = (t, t, \frac{1}{6} t; t)$

[where $t \in \mathbb{R}$]

The smallest value of t for which, all the values of x_i are positive integers is $t = 6$.

$t = 6 \Rightarrow$

$x_1 = 6,$

$x_2 = 6,$

$x_3 = 1,$

$x_4 = 6$

$\therefore$ The balanced equation $\Rightarrow$

$$6\, CO_2 + 6\, H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

(Ans:)

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