

## Q1 - 24 January - Shift 1

For independent process at 300 K.

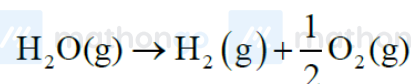
Process	$\Delta H/\text{kJ mol}^{-1}$	$\Delta S/\text{J K}^{-1}$
A	+25	+80
B	-22	40
C	25	-50
D	22	20

The number of non-spontaneous process from the following is \_\_\_\_\_.

Space for your notes:

## Q2 - 29 January - Shift 1

Water decomposes at 2300 K



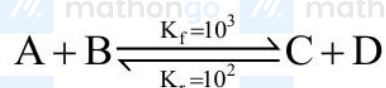
The percent of water decomposing at 2300 K and 1 bar is \_\_\_\_\_ (Nearest integer).

Equilibrium constant for the reaction is  $2 \times 10^{-3}$  at 2300 K

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## Q3 - 29 January - Shift 1

Consider the following reaction approaching equilibrium at 27°C and 1 atm pressure



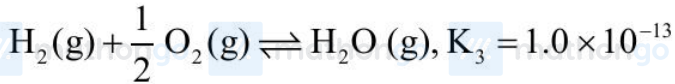
The standard Gibb's energy change ( $\Delta_r G^\circ$ ) at 27°C is (-) \_\_\_\_\_ kJ mol<sup>-1</sup>

(Nearest integer).

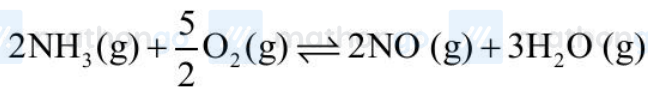
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## Q4 - 29 January - Shift 2

At 298 K



Based on above equilibria, the equilibrium constant of the reaction,

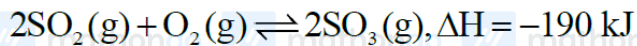


is  $\text{---} \times 10^{-33}$  (Nearest integer)

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## Q5 - 30 January - Shift 2

Consider the following equation :



The number of factors which will increase the yield of  $\text{SO}_3$  at equilibrium from the following is

- A. Increasing temperature
- B. Increasing pressure
- C. Adding more  $\text{SO}_2$
- D. Adding more  $\text{O}_2$
- E. Addition of catalyst

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## Q6 - 31 January - Shift 1

For reaction :  $\text{SO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightleftharpoons \text{SO}_3(\text{g})$

$K_p = 2 \times 10^{12}$  at  $27^\circ\text{C}$  and 1 atm pressure. The  $K_c$  for the same reaction is \_\_\_\_\_  $\times 10^{13}$ . (Nearest integer)

(Given  $R = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$ )

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**Q7 - 01 February - Shift 1**

At  $25^\circ\text{C}$ , the enthalpy of the following processes are given:

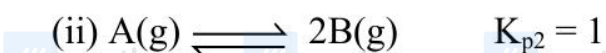


What would be the value of X for the following reaction? \_\_\_\_\_ (Nearest integer)



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**Q8 - 01 February - Shift 1**



If the degree of dissociation and initial concentration of both the reactants X(g) and A(g) are equal, then

the ratio of the total pressure at  $\left(\frac{p_1}{p_2}\right)$  is equilibrium

equal to x : 1. The value of x is \_\_\_\_\_

(Nearest integer)

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## Q9 - 01 February - Shift 2

The effect of addition of helium gas to the following reaction in equilibrium state, is :



(1) the equilibrium will shift in the forward direction and more of  $\text{Cl}_2$  and  $\text{PCl}_3$  gases will be produced.

(2) the equilibrium will go backward due to suppression of dissociation of  $\text{PCl}_5$ .

(3) helium will deactivate  $\text{PCl}_5$  and reaction will stop.

(4) addition of helium will not affect the equilibrium.

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## Answer Key

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(As per Official NTA Key released on 2 Feb)

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**Q1 (2)** // mathongo // **Q2 (2)** // mathongo // **Q3 (6)** // mathongo // **Q4 (4)** // mathongo // mathongo

**Q5 (3)** // mathongo // **Q6 (1)** // mathongo // **Q7 (499)** // mathongo // **Q8 (12)** // mathongo // mathongo

**Q9 (1)** // mathongo // mathongo // mathongo // mathongo // mathongo // mathongo

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Q1 (2)

$$\Delta G = \Delta H - T\Delta S$$

$$A : \Delta G (\text{J mol}^{-1}) = -25 \times 10^3 + 80 \times 300 : -\text{ve}$$

$$B : \Delta G (\text{J mol}^{-1}) = -22 \times 10^3 - 40 \times 300 : -\text{ve}$$

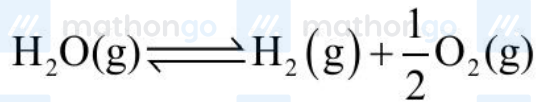
$$C : \Delta G (\text{J mol}^{-1}) = 25 \times 10^3 + 300 \times 50 : +\text{ve}$$

$$D : \Delta G (\text{J mol}^{-1}) = 22 \times 10^3 - 20 \times 300 : +\text{ve}$$

Processes C and D are non-spontaneous.

Q2 (2)

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$$P_0[1-\alpha] \quad P_0\alpha \quad \frac{P_0\alpha}{2} \quad \text{partial pr. at eq.}$$

$$P_0 \left[ 1 + \frac{\alpha}{2} \right] = 1 \quad \dots(i)$$

$$K_p = \frac{(P_{\text{H}_2})(P_{\text{O}_2})^{1/2}}{P_{\text{H}_2\text{O}}}$$

$$\frac{(P_0\alpha) \left( \frac{P_0\alpha}{2} \right)^{1/2}}{P_0[1-\alpha]} = 2 \times 10^{-3}$$

since  $\alpha$  is negligible w.r.t 1 so  $P_0 = 1$  and  $1 - \alpha \approx 1$

$$\frac{\alpha\sqrt{\alpha}}{\sqrt{2}} = 2 \times 10^{-3}$$

$$\alpha^{3/2} = 2^{3/2} \times 10^{-3}$$

$$\alpha = 2^{3/2 \times 2/3} \times 10^{-3 \times 2/3}$$

$$\alpha = 2 \times 10^{-2} \quad \% \alpha = 2\%$$

**Q3 (6)**

## Questions with Solutions

MathonGo

(Given :  $R = 8.3 \text{ J K}^{-1} \text{ mol}^{-1}$  and  $\ln 10 = 2.3$ )

$$\therefore \Delta G^\circ = -RT \ln K_{\text{eq}}$$

$$\text{and } K_{\text{eq}} = \frac{K_f}{K_b}$$

$$\therefore K_{\text{eq}} = \frac{10^3}{10^2} = 10$$

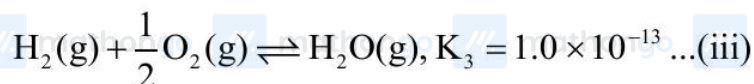
$$\therefore \Delta G = -RT \ln 10$$

$$\Rightarrow -(8.3 \times 300 \times 2.3) = -5.7 \text{ kJ mole}^{-1} \approx 6 \text{ kJ}$$

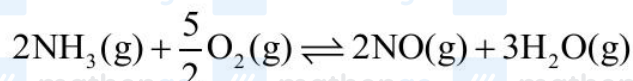
$\text{mole}^{-1}$  (nearest integer)

Ans = 6

## Q4 (4)



$$(\text{ii}) + 3 \times (\text{iii}) - (\text{i})$$



$$k_{\text{eq}} = \frac{k_2 \times k_3^3}{k_1} = \frac{1.6 \times 10^{12} \times (10^{-13})^3}{4 \times 10^5}$$

$$= \frac{1.6}{4} \times 10^{-32} = 4 \times 10^{-33}$$

## Q5 (3)

The yield of  $\text{SO}_3$  at equilibrium will be due to

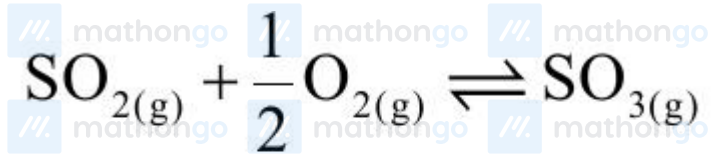
B. Increasing pressure

C. Adding more  $\text{SO}_2$

D. Adding more  $\text{O}_2$

## Q6 (1)

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$$K_p = 2 \times 10^{12} \text{ at } 300 \text{ K}$$

$$K_p = K_c \times (RT)^{\Delta n_g}$$

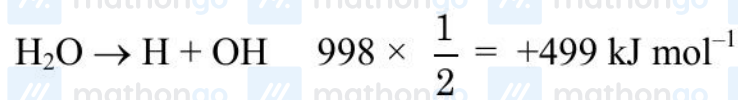
$$2 \times 10^{12} = K_c \times (0.082 \times 300)^{-1/2}$$

$$K_c = 9.92 \times 10^{12}$$

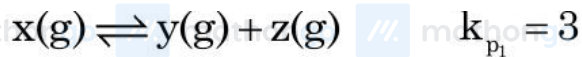
$$K_c = 0.992 \times 10^{13}$$

Ans. 1

Q7 (499)



Q8 (12)



Initial moles at equilibrium  $n$   
 $n - \alpha n$        $\alpha n$        $\alpha n$

$$k_{p_1} = \frac{\left( \frac{\alpha}{1 + \alpha} \times p_1 \right)^2}{\frac{1 - \alpha}{1 + \alpha} p_1}$$

$$3 = \frac{\alpha^2 \times p_1}{1 - \alpha^2}$$



Initial mole at equilibrium  $n$   
 $x - \alpha n$        $2\alpha n$        $p_{\text{total}} = p_2$

$$k_{p_2} = \frac{\left( \frac{2\alpha}{1 + \alpha} \times p_2 \right)^2}{\frac{1 - \alpha}{1 + \alpha} \times p_2}$$

$$1 = \frac{4\alpha^2 \times p_2}{1 - \alpha^2}$$

$$\frac{k_{p_1}}{k_{p_2}} = \frac{p_1}{4p_2}$$

$$\frac{3}{1} = \frac{p_1}{4p_2} \therefore p_1 : p_2 = 12 : 1$$

$$x = 12$$

Q9 (1)



(Case 1 : At constant P – volume will increase so reaction will shift in forward direction then answer

will be A

Case 2 : At constant volume no change in active mass so reaction will not shift in any direction then

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