

DAILY PRACTICE PAPER

(DPP) – 1 For IIT

CHEMICAL EQUILIBRIUM – For Equilibrium Const.







DAILY PRACTICE Learnaf **DPP - 1** FOR - IIT PAPER Educational Revolution Level - 1 By - Arnav Girvan **Topic** - Equilibrium Constant Unit - Chemical Equilibrium Mob - 9470458687 09. Under what total pressure must an equimolar **Objective Problems** mixture of Cl₂ and PCl₃ be placed in order to obtain 1 atm of PCI at 250°C 01. When equimolar amounts of H₂ and I₂ are heated (A) 2.33 atm 🖖 (B) 1.33 atm in a closed vessel, at equilibrium 80% H₂ is (C) 3.66 atm (D) 1.78 atm converted to HI. $\rm K_{c}$ for the formation of HI is A \longrightarrow 2B K_p, C \rightarrow F; K'_p. If degree (D) 64.0 **10**. (A) 8.0 (B) 16.0 (C) 32.0 of dissociation of A & C are same and K_{p} 02. For the equilibrium $NH_4CI(s) \rightleftharpoons NH_3(g) + HCI(g)$ $2K'_{p}$, then the ratio of total pressure p/p' = ? the observed pressure of the mixture is 10atm. (A) 1/2 (B) 1/3 (C) 1/4 (D) 2 The equilibrium constant K_n is When a liquid is in equilibrium with its vapour 11. (A) 100 atm (B) 25 atm at its boiling point, on the average, the molecules (C) 50 atm (D) 30 atm in the two phases have equal 03. For an equilibrium reaction involving gases, the (A) pressure (B) potential energy forward reaction is 1st order while the reverse (C) kinetic energy (D) none of these reaction is 2nd order. The units of K_n for the forward equilibrium is (Assume stoichiometric | 12. If the equilibrium constants of the two reactions: $2NH_3 \iff N_2 + 3H_2$ and Coefficient = order) $N_2 + \frac{3}{2}H_2 \longrightarrow NH_3$ are K_1 and K_2 (A) atm (C) atm⁻¹ (B) atm² (D) atm⁻² 04. In a reversible reaction, two substances are in respectively at 25°C, then the relation between equilibrium. If the concentration of each one is K_1 and K_2 is doubled, the equilibrium constant will be (B) $K_2 = \frac{1}{K_1^2}$ (A) $K_1 = K_2$ (A) reduced to half its original value (B) reduced to one fourth of its original value (D) $K_1 = \frac{1}{K_2}$ (C) $K_1 = \frac{1}{K_2^2}$ (C) doubled (D) constant 13. A chemical reaction is catalyzed by a catalyst The vapour density of N_2O_4 at a certain tem-'X'. Hence the catalyst 'X' 05. perature is 30. The percentage dissociation of (A) does not affect the equilibrium constant of N_2O_4 at this temperature is the reaction (A) 62 (B) 50 (C) 100 (D) 46 (B) decreases the rate constant of the reaction (C) decreases the enthalpy For a reversible reaction, the rate constants for 06. (D) increases the activation energy the forward & reverse reactions are 2.38x10⁻⁴ and A mixture of SO₃, SO₂ & O₂ gases is maintained 8.15x10⁻⁵ respectively. The equilibrium constant **14**. in a 10 lit flask at a temp. at which the equifor the reaction is librium constant K_c for the reaction : (B) 2.92 (A) 0.342 (D) 3.42 (C) 0.292 $2SO_2 + O_2 = 2SO_3$ is 100. If the no. of moles 07. Phosgene is formed accordingly : of SO₂ & SO₂ in the flask are same, the no. $CO(g) + CI_{2}(g) \bigoplus COCI_{2}(g)$. When this reaction of moles of O₂ present is is carried out in a 2 litre flask at equilibrium 0.5 (A) 0.01 (B) 0.1 (C) 1.0 (D) 10 mole of phosgene, 0.2 mole of CO and 0.2 mole For the reaction: $A(g) + B(g) \implies 3C(g) + D(g)$ of Cl₂ are present. The equilibrium constant of **15**. If two moles each of A and B are taken initially, the reaction is then choose the true statement at equilibrium-(A) 25 (B) 12.5 [Volume of the vessel = 1 litre, degree of dis-(C) 4.0 x 10⁻² (D) 4 x 10² sociation = x

- (A) [A] [D] = 2 4x
- (B) [A] [B] = 1 x
- (C) Both the above
- (D) None of the above

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(B) K = 10^{-3}

(D) K = 1

In which of the following case, does the reaction

go farthest to completion?

(A) $K = 10^3$

(C) K = 10

08.

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| 16. | For the reaction $CaCO_3 \longrightarrow CaO(s) + CO_2(g)$, the pressure of CO_2 in equilibrium depends on (A) the mass of $CaCO_3(s)$ (B) the mass of $CaO(s)$ (C) the masses of both $CaCO_3(s)$ and $CaO(s)$ (D) temperature of the system | 24. | The partial pressure of CH ₃ OH, CO and H ₂ in the equilibrium mixture for the reaction CO + 2H ₂ \implies CH ₃ OH at 427° C are 2.0, 1.0 and 0.1 atm respectively. The value of K _p for the decomposition of CH ₃ OH of CO and H ₂ is |
| 17. | For a reaction A + B \longrightarrow C, equilibrium concentration of A, B and C are a, b & c respectively when volumes is doubled new equilibrium conc ⁿ . of C will be (A) c/2 (B) 2c (C) less than c/2 (D)greater than c/2 | 25. | (A) 1 x 10 ² atm (B) 2 x 10 ² atm ⁻¹ (C) 50 atm ² (D) 5 x 10 ⁻³ atm ² For the reversible reaction, $N_2(g) + 3H_2(g) =$ $2NH_3$ (g) at 500°C, the value of K_p is 1.44 x 10^{-5} when partial pressure is measured in at- mospheres. The corresponding value of $K_{c'}$ with |
| 18. | An example of reversible reaction is (A) $Pb(NO_3)_2(aq) + 2Nal(aq) \Rightarrow Pbl_2(s) + 2NaNO_3(aq)$ (B) $AgNO_3(aq) + NaCl(aq) \Rightarrow AgCl(s) + NaNO_3(aq)$ (C) $2Na(s) + H_2O(l) \Rightarrow 2NaOH(aq) + H_2(aq)$ (D) $KNO_3(aq) + NaCl(aq) \Rightarrow KCl(aq) + NaNO_3(aq)$ | 26. | concentration in mol L1 is (A) $\frac{1.44 \times 10^{-5}}{(0.082 \times 500)^{-2}}$ (B) $\frac{1.44 \times 10^{-5}}{(8.314 \times 773)^{-2}}$ (C) $\frac{1.44 \times 10^{-5}}{(0.082 \times 773)^2}$ (D) $\frac{1.44 \times 10^{-5}}{(0.082 \times 773)^{-2}}$ When two reactants A and B are mixed to give products C and D, the reaction quotient O at |
| 19. | In the study of the reaction $A + B \rightleftharpoons C + D$, A and B were mixed in a vessel at t ^o C. The initial concentration of A was thrice the initial concentration of B. At equilibrium the concen- tration of C was found to be equal to the equilibrium concentration of B. Calculate the equilibrium constant | 27. | the initial stages of the reaction (A) is zero (B) decreases with time (C) in independent of time (D) increases with time In the equilibrium : $2SO_{-}(q) + O_{-}(q) = 2SO_{-}(q)$ the partial |
| 20. | (A) 0.2 (B) 5 (C) 0.1 (D) 10 For the reaction : $2NO_2(g) \implies 2NO(g) + O_2(g),$ $K_c = 1.8 \times 10^{-6}$ at 185°C. At 185°C, the value of K_c for the reaction: $NO(g) + \frac{1}{2}O_2(g) \implies NO_2(g)$ is | | pressures of SO_2 , O_2 and SO_3 are 0.662, 0.101 and 0.331 atm respectively. What should be the partial pressure of oxygen so that the equilib- rium concentartions of SO_2 and SO_3 are equal? (A) 0.4 atm (B) 1.0 atm (C) 0.8 atm (D) 0.25 atm |
| 21. | (A) 0.9×10^{6} (B) 7.5×10^{2} (C) 1.95×10^{-3} (D) 1.95×10^{3} For a reaction N ₂ + 3H ₂ 2NH ₃ . If at any moment t ₁ the reaction mixture contains 1.5 mole of N ₂ , 3 mole of H ₂ & 2 moles of NH ₃ . | 28. | The equilibrium constant K_c of the reaction : $A_2(g) + B_2(g) \implies 2AB(g)$ is 50. If 1 mol of A_2 and 2 mol of B_2 are mixed, the amount of AB at equilibrium would be (A) 0.467 mol (B) 0.934 mol (C) 1.401 mol (D) 1.866 mol |
| 22. | If equilibrium is reached at $t = 2t_1$, then find the weight of the mixture at $t = 3t_1$ (A) 123gm (B) 54gm (C) 82gm (D) 47gm The vapour density of PCI ₅ is 104.25 but when heated to 230°C, its vapour density is reduced | 29. | A 10 litre box contains O_3 and O_2 at equilibrium at 2000K. $K_p = 4.17 \times 10^{14}$ for $2O_3 \implies 3O_2$. Assume that $P_{O_2} >> P_{O_3}$ and if total pressure is 7.33 atm, then partial pressure of O_3 will be (A) 9.71 x 10 ⁻⁵ atm (B) 9.71 x 10 ⁻⁷ atm. (C) 9.71 x 10 ⁻⁶ atm (D) 9.71 x 10 ⁻² atm |
| 23. | to 62. The degree of dessociation of PCI_5 at this temperature will be (A) 6.8% (B) 68% (C) 46% (D) 64% 28 g of N ₂ and 6g of H ₂ were mixed. At equilibrium 17 g of NH ₃ was produced. The weight of N ₂ & H ₂ at equilibrium are (A) 11g, 0g (B) 1g, 3g (C) 14g, 3g (D) 11g, 3g | 30. | In the system, LaCl ₃ (s) + H ₂ O(g) + heat \rightarrow LaClO(s) + 2HCl(g), equilibrium is established. More water vapour is added to reestablish the equilibrium. The pressure of water vapour is doubled. The factor by which pressure of HCl is changed is (A) 2 (B) $\sqrt{2}$ (C) $\sqrt{3}$ (D) $\sqrt{5}$ |

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| 31. | 10 moles of HI were produced of 5.2 moles of iodine vapour hydrogen gas at 444°C. The eq for the reaction : $H_2 + I_2 =$ (A) 20 (B) 30 (C) | by the interaction r and 15 moles of puilibrium constant \rightarrow 2HI is \rightarrow 2D 50 | 40. | For the reaction $A + B \longrightarrow C + D$, equi- librium concentration of $[C] = [D] = 0.5M$ if we start with 1 mol each of A and B. Percentage of A converted into C if we start with 2 mol of A and 1 mol of B, is |
| 32. | The reaction A + B \longrightarrow to right hand side upto 99.9% constant K of the reaction V (A) 10 ⁴ (B) 10 ⁵ (C | C + D proceeds 6. The equilibrium will be C) 10 ⁶ (D) 10 ⁸ | 41. | (A) 25% (B) 40% (C) 66.66% (D) 33.33% For the reaction : $NH_2COONH_4(s) = 2NH_3(g) + CO_2(g)$ the equilibrium constant $K_p = 2.92 \times 10^{-5}$ atm ³ . The |
| 33. | NaHCO ₃ decompose as : $2NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) +$ The equilibrium pressure is for the reaction is (A) 0.2704 | $CO_2(g) + H_2O(g)$ 1.04 atm. The K _p (B) 2.704 | 42. | total pressure of the gaseous products when 1 mol of reactant is heated, will be (A) 0.0194 atm (C) 0.0582 atm For the reaction |
| 34. | (C) 27.04 In the following reaction : 3A + B = 2C + D Initial of A. At equilibrium mol of A Hence % dissociation of B i | (D) 270.4 mol of B is double A and C are equal. | 43. | ShO ₂ (S) + 2H ₂ (G) = 2H ₂ O(G) + Sh(I). At 900K, under equilibrium, steam-hydrogen mixture was 45% H ₂ by volume. Hence K _p is (A) 1.22 (B) 1.49 (C) 0.45 (D) 0.55 The equilibrium constant for the reaction N(g) + O (g) = 2NO (g) |
| 35. | (A) 10% (B) 20% (C) The equilibrium constants for H ₃ BO ₃ + glycerine \rightleftharpoons (H 0.90. Glycerine present per lift to convert 60% of H ₃ BO ₃ into product is | by 40% (D) 5% by the reaction H_3BO_3 .glycerine) is tre of 0.1M H_3BO_3 by H_3BO_3 .glycerine | ç | is 4×10^{-4} at 2000K. In the presence of a catalyst, the equilibrium is attanined three times faster. The equilibrium constant in the presence of the catalyst at 2000K is (A) 4×10^{-1} (B) 1.2×10^{-3} (C) 4×10^{-3} (D) 4×10^{-4} |
| | (A) 0.167 M (C) 0.0167 M | (B) 1.73 M (D) 10.67 M | 44. | Which of the following statements is (are) correct? |
| 36. | $CH_3 - CO - CH_3(g) \longrightarrow CH_3$ Initial pressure of CH_3COCH_3 equilibrium is set up, mol fr $\frac{1}{3}$. Hence K_p is | $I_3 - CH_3(g) + CO(g)$ is 100 mm, When action of CO(g) is | | (A) The value of equilibrium constant for a particular reaction is constant under all conditions of temperature and pressure. (B) the units of K_c for the reaction $H_2O(I) = H_2O(g)$ are mol L ⁻¹ . (C) In the reaction |
| 37. | (A) 100mm (B) 50mm (C) 2 For the following equilibrium $N O \longrightarrow 2NO$ in gase | 5mm (D) 150mm n : | | $CaCO_3(s) \longrightarrow CaO_3(s) + CO_2(g),$ $[CaCO_3] = [CaO] = 1.$ |
| | $1N_2O_4$ 21NO ₂ iff gase 50% of the total volume wh set up. Hence percent disso (A) 50% (B) 25% (C) 66.6 | then equilibrium is ciation of N_2O_4 is 56% (D) 33.33% | 45. | (D) K_p is always greater than K_c for a particular reaction. In the system, CaF ₂ (s) \rightleftharpoons Ca ²⁺ + 2F ⁻ , increasing the concentration of Ca ²⁺ ions 4 times will cause |
| 38. | PCI ₅ is 40% dissociated when It will be 80% dissociated approximately (A) 0.2atm (B) 0.5atm (C) 0 | pressure is 2 atm. when pressure is 0.3atm (D) 0.6atm | | the equilibrium concentration of F⁻ ions to change to (A) 1/4 of the initial value (B) 1/2 of the initial value |
| 39. | Ammonium carbomate disso NH_2COONH_4 (s) \implies 2N The value of K _p for this real be equal to 2.92 x 10 ⁻⁵ atm ammonium carbamate is he container, the total pressure container is (A) 0.0194 atm (C) 0.0582atm | ciates as follows : NH_3 (g) + CO_2 (g) action is found to ³ . If one mole of eated in a sealed developed in the (B) 0.0388 atm (D) 0.0667 | 46. | (C) 2 times of the initial value (D) none One mole of N_2O_4 (g) at 300 K is left in a closed container under one atm. It is heated to 600 K when 20 % by mass of N_2O_4 (g) decomposes to NO_2 (g). The resultant pressure is (A) 1.2 atm (B) 2.4 atm (C) 2.0 atm (D) 1.0 atm |

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| | Subjective Problems | 04. | Among the solubility rules is the statement that all chlorides are soluble except Hg_2CI_2 , AgCI, PbCL and CuCl |
| <u>Rea</u> 01. | Example 1 The initial concentrations or pressure of reactants and products are given for each of the following systems. Calculate the reaction quotient and determine the directions in which each system will shift to reach equilibrium. (A) $2NH_3$ (g) $\rightleftharpoons N_2$ (g) + $3H_2$ (g) K = 17 $[NH_3] = 0.20$ M ; $[N_2] = 1.00$ M ; $[H_2] = 1.00$ M | (a) (b) | Write the expression for the equilibrium constant for the reaction represented by the equation. AgCl (s) \rightleftharpoons Ag ⁺ (aq) + Cl ⁻ (aq) Is K greater than 1, less than 1, or about equal to 1? Explain your answer Write the expression for the equilibrium constant for the reaction represented by the equation Pb ²⁺ (aq) + 2Cl ⁻ (aq) \rightleftharpoons PbCl ₂ (s) Is K greater than 1, less than 1, or about equal to 1? Explain |
| | (B) $2NH_3$ (g) $\rightleftharpoons N_2$ (g) + $3H_2$ (g) $K_p = 6.8 \times 10^4 \text{ atm}^2$ Initial pressure : $NH_3 = 3.0 \text{ atm}$; $N_2 = 2.0 \text{ atm}$; $H_2 = 1.0 \text{ atm}$ (C) $2SO_3$ (g) $\rightleftharpoons 2SO_2$ (g) + O_2 (g) K = 0.230 atm $[SO_3] = 0.00 \text{ M}$; $[SO_2] = 1.00 \text{ M}$; $[O_1] = 1.00 \text{ M}$ | Ans. | your answer. (A) $K = [Ag^+][Cl^-]$ is less than 1. AgCl is insoluble thus the concentration of ions are much less than 1 M (B) $K = 1/[Pb^{2+}][Cl^+]^2$ is greater than one because PbCl ₂ is insoluble and formation of the solid will reduce the concentration of ions to a low level |
| | (D) $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ $K_p = 16.5 \text{ atm}$ Initial pressure : $SO_3 = 1.0 \text{ atm}$; $SO_2 = 1.0 \text{ atm}$; $O_2 = 1.0 \text{ atm}$ (E) $2NO(g) + CI_2(g) \rightleftharpoons 2NOCI(g)$ $K = 4.6 \times 10^4$ $[NO] = 1.00 \text{ M}$; $[CI_2] = 1.00 \text{ M}$; [NOCI] = 0 M (F) $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ $K_p = 0.050$ | 05. | Using the equilibrium constant For which of the following reactions will the equilibrium mixture contain an appreciable concentration of both reactants and products? (A) $CI_2(g) \rightleftharpoons 2CI(g)$; $K_c = 6.4 \times 10^{-39}$ (B) $CI_2(g) + 2NO(g) \rightleftharpoons 2NOCI(g)$; $K_c = 3.7 \times 10^8$ |
| | Initial pressure : NO = 10.0 atm ; N ₂ = O ₂ = 5 atm | Ans. | $K_c = 1.8$ |
| Ans. | (A) 25, shifts left, (B) 0.22, shifts right, (C) ∞ , shifts left, (D) 1, shifts right, (E) 0, shift right, (F) 4, shifts left | 06. | The value of K_c for the reaction $3O_2$ (g) I $2O_3$ (g) is 1.7×10^{-56} at 25°C. Do you expect pure |
| 02. | When 0.5 mol of N_2O_4 is placed in a 4.00 L reaction vessel and heated at 400 K, 79.3 % of the N_2O_4 decomposes to NO_2 . Calculate K_c and K_p at 400 K for the reaction : N_2O_4 (g) \rightleftharpoons 2 NO_2 (g). | | air at 25°C to contain much O_3 (ozone) when O_2 and O_3 are in equilibrium? If the equilibrium concentration of O_2 in air at 25°C is 8×10^{-3} M, what is the equilibrium concentration of O_3 ? |
| Ans. | $K_{c} = 1.51$ | Ans. | $\sim 9 \times 10^{-32}$ mol/L |
| 03. | At 100 K, then value of K _c for the reaction $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$ is 3×10^{-2} . Calculate equilibrium concentrations of H ₂ O, CO ₂ and H ₂ in the reaction mixture obtained by heating 6.0 mole of steam and an excess of solid carbon in a 5.0 L container. What is the molar composition of the equilibrium mixture? | 07. | At 1400 K, $\kappa_c = 2.5 \times 10^{\circ}$ for the reaction CH_4 (g) + $2H_2S \implies CS_2(g) + 4H_2(g)$. A 10.0 L reaction vessel at 1400 K contains 2.0 mol of CH_4 , 3.0 mol of CS_2 , 3.0 mol of H_2 and 4.0 mol of H_2S . Is the reaction mixture at equilib- rium? If not, in which direction does the reaction proceed to reach equilibrium? The reaction is not an equilibrium because |
| Ans. | [CO] = [H ₂] = 0.18 M [H ₂ O] = 1.02 M | | $Q_c > K_c$. The reaction will proceed from right to left to reach equilibrium |

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| | Homogeneous equilibria degree of | 14. | Consider the gas-phase hydration of |
| diss | sociation, vapour density and equilibrium | | hexafluoroacetone, $(CF_3)_2CO$: |
| | <u>constant</u> | | k _f |
| 08. Ans. 09. | Solid Ammonium carbamate dissociates as: $NH_2 COONH_4$ (s) $\rightleftharpoons 2NH_3(g) + CO_2(g)$. In a closed vessel solid ammonium carbam- ate is in equilibrium with its dissociation prod- ucts. At equilibrium, ammonia is added such that the partial pressure of NH_3 at new equi- librium now equals the original total pressure. Calculate the ratio of total pressure at new equilibrium to that of original total pressure. 31/27 A sample of $CaCO_3(s)$ is introduced into a sealed container of volume 0.821 litre & heated to 1000K until equilibrium is reached. The equilibrium constant for the reaction : | Ans. 15. Ans. | $(CF_3)_2CO(g) + H_2O(g) \rightleftharpoons_{k_r} (CF_3)_2C(OH)_2(g)$ At 76°C, the forward and reverse rate constants are $k_f = 0.13 \text{ M}^{-1}\text{s}^{-1}$ and $k_r = 6.02 \times 10^{-4}\text{s}^{-1}$. What is the value of the equilibrium constant K_c ? 210 Consider the reaction of chloromethane with OH ⁻ in aqueous solution $CH_3CI(aq) + OH^-(aq) \rightleftharpoons CH_3OH(aq) + CI^-(aq)$ At 25°C, the rate constant for the forward reaction is $6 \times 10^{-6} \text{ M}^{-1}\text{s}^{-1}$, and the equilibrium constant K_c is 1×10^{16} . Calculate the rate constant for the reverse reaction at 25°C. |
| | $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ is 4×10^{-2} atm at this temperature. Calculate the mass of CaO present at equilibrium. | 10. | time, is presented in figure. |
| Ans. | 22.4 mg | | |
| 10. | Anhydrous calcium chloride is often used as a dessicant. In the presence of excess of $CaCl_{2'}$, the amount of the water taken up is governed by $K_p = 6.4 \times 10^{85}$ for the following reaction at room temperature, $CaCl_2(s) + 6H_2O(g) \rightleftharpoons$ $CaCl_2 .6H_2O(s)$. What is the equilibrium vapour pressure of water in a closed vessel that contains $CaCl_2(s)$? | | |
| Ans. | $P_{H_2O} = 5 \times 10^{-15} \text{ atm}$ | | Time / Hour |
| 11. | 20.0 grams of $CaCO_3(s)$ were placed in a closed vessel, heated & maintained at 727° C under equilibrium $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ and it is found that 75% of $CaCO_3$ was decomposed. What is the value of K_p ? The volume of the container was 15 litres. | Ans. | (A) the value of n. (B) the equilibrium constant k. (C) the initial rate of conversion of A. (A) 2; (B) 1.2 mol/L; (C) 0.1 moles/hr |
| Ans. | 0.821 atm | | |
| | Kinetics and equilibrium constant | | |
| 12. | Consider a general, single-step reaction of the type A + B \rightleftharpoons C. Show that the equilibrium constant is equal to the ratio of the rate constant for the forward and reverse reaction, $K_c = k_f / k_r$. k _f [C] | | |
| Ans. | $k_{f} [A][B] = k_{r} [C] ; \frac{1}{k_{r}} \frac{1}{[A][B]} = k_{c}$ | | |
| 13. Ans. | Which of the following relative values of k_f and k_r results in an equilibrium mixture that contains large amounts of reactants and small amounts of product? (A) $k_f > k_r$ (B) $k_f = k_r$ (C) $k_f < k_r$ (C) | | |

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