21. **(b) Fourteen**

Explanation

At **25°C**, water ionizes as:

Kw = $[H^+] \times [OH^-] = 1 \times 10^{-14}$

Taking negative logarithm:

pH + pOH = 14

This is a **fixed relation at 25°C**.

22. (c) It is a strong acid and they lose proton in a solution.

23. (a) $[OH^-] = 10^{-2}M$; $pOH = 2$

$pH + pOH = 14; pH = 14 - pOH$

$\boldsymbol{pH = 14 - 2 = 12}$

24. (d) Order of acidic strength is $H_2Te > H_2Se > H_2S > H_2O$

$Na_2O$is a salt of NaOH+$H_2O$and $H_2O$is least acidic among given acids hence pHin this case will be max^m .

25. (b) pH of the solution A = 3

$[H^+]_A = 10^{-3}\ M.$

pH of the solution B = 2

$[H^+]_B = 10^{-2}\ M$

$[H^+] = 10^{-3} + 10^{-2} = 10^{-3} + 10 \times 10^{-3} = 11 \times 10^{-3}.$

$pH = -\log(11 \times 10^{-3}) = 3 - \log 11$

$= 3 - 1.04 = 1.95$

26. (a) $CN^- + H_2O \rightarrow HCN + OH^-$

Because OH^- concentration is increased.

27. (a) On dilution the pH of acid A increases while pH of base B decreases.

28. (d) CH_3COONa is a salt of weak acid, (CH_3COOH) and strong base $(NaOH)$.

29. (b) The equilibrium will shift in the backward direction.

30. (b) $K_a = 10^{-5}$; $pH = 6$

$pH = -\log K_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$;

$6 = -\log 10^{-5} + \log \frac{[\text{Salt}]}{[\text{Acid}]}$

$6 = 5\log 10 + \log \frac{[\text{Salt}]}{[\text{Acid}]}$; $6 = 5 + \log \frac{[\text{Salt}]}{[\text{Acid}]}$

$\log \frac{[\text{Salt}]}{[\text{Acid}]} = 6 - 5 = 1$; $\frac{[\text{Salt}]}{[\text{Acid}]} = \frac{10}{1}$

31. (d) All are true – (a) is true for acid buffer, (b) for basic buffer, (c) is called buffer solution.

32. (b) $\frac{N}{100} = 0.01 NHCl$; $[H^+] = 10^{-2} M$; $pH = 2$

$[OH] = 10^{-2} M$ for $NaOH$

$pH + pOH = 14$; $\boldsymbol{pH = 14 - 2; pH = 12}$

33. (a) Slightly lower than that of rainwater without thunderstorm

Explanation (Easy to Understand):
During a thunderstorm, large amounts of electric discharge occur.
This causes nitrogen and oxygen in the air to react and form oxides of nitrogen (e.g., NO and NO_2).
These oxides dissolve in rainwater and form nitric acid (HNO_3).
As a result, the rainwater becomes slightly more acidic, meaning pH decreases.
So, thunderstorm rain = more nitric acid formation → lower pH.

34. (a) It is a buffer solution of strong acid and its weak conjugate base.

35. (c) $HA \rightleftharpoons H^+ + A^-$

$[\boldsymbol{H^+}] = \boldsymbol{0.1M}$; $[\boldsymbol{H^+}]^2 = \boldsymbol{K_a \times C}$

$[\boldsymbol{H^+}] = \sqrt{\boldsymbol{K_a \times C}} = \sqrt{\boldsymbol{1 \times 10^{-5} \times 0.1}} = \sqrt{\boldsymbol{10^{-6}}}$

$[\boldsymbol{H^+}] = \boldsymbol{10^{-3}M}; \boldsymbol{pH = 3}$

36. (c) As the solution is acidic, $pH < 7$. This is because $[H^+]$ from H_2O cannot be neglected in comparison to 10^{-8}.

37. (c) Human body contain buffer solution. Its pH= 6.8

38. (a) It is a neutral solution and its pH= 7

39. (a) $pH = 5$, means $[H^+] = 10^{-5}M$.

After dilution $[H^+] = 10^{-5}/100 = 10^{-7}M$

$[H^+]$ from H_2O cannot be neglected.

Total $[H^+] = 10^{-7} + 10^{-7} = 2 \times 10^{-7}$

$pH = 7 - 0.3010 = 6.6990 = 7$ (neutral).

40. (d) $[H^+] = \alpha . C = \frac{2}{100} \times .02; [H^+] = 4 \times 10^{-4} M$

$pH = -log \quad [H^+] = 4 - log \quad 4; pH = 3.3979$