② $^{137}Ba$ : 56 protons + 81 neutrons

$56 \times 1.007885 = 56.44156$

$81 \times 1.008665 = 81.701865$

$138.143425$

$- \quad 136.905812$

$\Delta m = 1.237613$ amu

$$\Delta m\,(kg) = 1.237613\ amu \times \frac{1\ g}{6.0221 \times 10^{23}\ (g/amu)} \times \frac{1\ kg}{1000\ g}$$

$$= 2.0551186 \times 10^{-27}\ kg$$

$$E = (\Delta m)(c)^2 = (2.0551186 \times 10^{-27}\ kg)\left(3.0 \times 10^{8}\ m/s\right)^2$$

$$= 1.849 \times 10^{-10}\ J\ /\ nuclei$$

$$E = 1.849 \times 10^{-10}\ J\ /\ nuclei \times 6.0221 \times 10^{23}\ \frac{nucl}{mole}$$

$$= 1.114 \times 10^{14}\ J/mole = 1.114 \times 10^{11}\ KJ/mole$$

Short way:

$$E = \left(\Delta m\ (amu) \div \frac{1\ kg}{1000 g}\right) \times \left(3.0 \times 10^{8}\ m/sec\right)^2$$

$$= 1.114 \times 10^{14}\ J/mole = 1.114 \times 10^{11}\ KJ/mol$$

(4)

$t_{1/2}$ of $^{32}P$ = 14.3 days

since $\ln \frac{n_T}{n_0} = -\lambda t$ and $t_{1/2} = \frac{0.693}{\lambda}$

$\therefore \ln \frac{n_t}{n_0} = -0.693 \left(\frac{t_t}{t_{1/2}}\right)$

$n_0 = 10\ g$ ; $t_t = 28.6$ days, $t_{1/2} = 14.3$ days

$n_t = ?$

$$\ln \frac{n_t}{10} = -0.693 \left(\frac{28.6}{14.3}\right)$$

$$\ln \frac{n_t}{10} = -0.693\ (2) = -1.386$$

$$\frac{n_t}{10} = e^{-1.386} = 0.25$$

$$n_t = 2.5\ g$$

(5) $K_p = 9.1 \times 10^{14}$ for $\frac{1}{2} O_2 + Hg(l) \xrightarrow{\Delta} HgO(s)$

$2HgO \xrightarrow{\Delta} 2Hg + O_2(g)$ $K_p'$

$$K_p' = \left(\frac{1}{K_p}\right)^2 = \left(\frac{1}{9.1 \times 10^{14}}\right)^2 = 1.2 \times 10^{-30}$$

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(6) (c) $2NO_{2(g)} \xrightarrow{\Delta} N_{2(g)} + 2O_{2(g)}$ $K_c = ?$

given:

(a) $\frac{1}{2} N_{2(g)} + \frac{1}{2} O_2 \xrightarrow{\Delta} NO(g)$ $K_c^{(a)} = 4.8 \times 10^{-10}$

(b) $2NO_2 \longrightarrow 2NO + O_{2(g)}$ $K_c^{(b)} = 1.1 \times 10^{-5}$

(c) = $-2 \times$ (a) + (b)

$$\therefore K_c = \left(\frac{1}{K_c^{(a)}}\right)^2 \times K_c^{(b)} = \left(\frac{1}{4.8 \times 10^{-10}}\right)^2 \times 1.1 \times 10^{-5}$$

$$= 4.8 \times 10^{+13}$$

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(8) for $N_2 + 3H_2 \longrightarrow 2NH_3$ in 3.5 L @ 200°C, $K_c = 0.65$

initial conc $\left(\frac{0.249}{3.5}\right)$ $\left(\frac{3.21 \times 10^{-2}}{3.5}\right)$ $\left(\frac{6.42 \times 10^{-4}}{3.5}\right)$

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} \; ; \; Q_c = \frac{\left[\frac{6.42 \times 10^{-4}}{3.5}\right]^2}{\left[\frac{0.249}{3.5}\right]\left[\frac{3.21 \times 10^{-2}}{3.5}\right]^3}$$

$$Q_c = 0.613$$

$\therefore Q_c < K_c (0.65)$ $\therefore$ $\longrightarrow$ products

(9) $NH_4CO_2NH_{2(g)} \rightleftharpoons CO_{2(g)} + 2NH_{3(g)}$

$K_p = P_{CO_2} \times P_{NH_3}^2$ ; $P_{CO_2} + P_{NH_3} = 0.363$ atm

$\therefore$ $2P_{CO_2} = P_{NH_3}$ $\therefore$ $P_{CO_2} = 0.121$ atm

$P_{NH_3} = 0.242$ atm

$K_p = (0.121)(0.242)^2 = 7.09 \times 10^{-3}$

---

(10) $2NO_{(g)} + Cl_{2(g)} \longrightarrow 2NOCl_{(g)}$, $K_p = 6.5 \times 10^4$

at equilibrium:

$K_p = \dfrac{(P_{NOCl})^2}{(P_{Cl_2})(P_{NO})^2}$

$P_{NO} = 0.35$ atm

$P_{Cl} = 0.10$ atm $\quad P_{NOCl} = ?$

$\therefore$ $(P_{NOCl})^2 = P_{Cl_2} \times (P_{NO})^2 \times K_p$

$P_{NOCl} = \sqrt{P_{Cl_2} \times P_{NO}^2 \times K_p}$

$= \sqrt{(0.10) \times (0.35)^2 \times (6.5 \times 10^4)} = 28.2$ atm

$= 28$ atm

---

(11) $H_{2(g)} + F_{2(g)} \longrightarrow 2HF_{(g)}$ $\quad K_c = \dfrac{[HF]^2}{[H_2][F_2]}$

| | $H_2$ | $F_2$ | HF |
|---|---|---|---|
| I | 0.010 | 0.050 | 0 |
| C | $-x$ | $-x$ | $2x$ |
| E | $0.01-x$ | $0.05-x$ | $0.0125$ |
| | $\Downarrow$ | | $\downarrow$ |
| | $3.75 \times 10^{-3}$ | $4.375 \times 10^{-2}$ | $x = 0.00625$ |

$K_c = \dfrac{(0.0125)^2}{(3.75 \times 10^{-3})(4.375 \times 10^{-2})}$

$= 0.95 = 9.5 \times 10^{-1}$

(12) $2NO_{(g)} + Cl_{2(g)} \longrightarrow 2NOCl_{(g)}$

$$K_p = \frac{P_{NOCl}^2}{P_{NO}^2 \times P_{Cl_2}} = 6,5 \times 10^{-4} \text{ @ } 308\ K$$

$$K_p = K_c (RT)^{\Delta n\ (gas)} \qquad \Delta n = \#\ gas\ prod. - \#\ gas\ reac.$$
$$= 2 - 3 = -1$$

$$K_c = K_p / (RT)^{\Delta n}$$

$$= K_p / (RT)^{-1} = K_p (RT)$$

$$K_c = 6.5 \times 10^{-4} (R)(308) \qquad R = 0,08206$$

$$K_c = 1.64 \times 10^{-6} = \underline{1.6 \times 10^{-6}}$$

(14.) $[OH^-] = 0.50\ M \rightarrow pOH = 0.301 = 0,3$

$pH = 13,699 = 13,7$

(15) 0,25 M weak acid $pH = 3,5$

$[H^+] = 3,162 \times 10^{-4}$

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$= \frac{(3,162 \times 10^{-4})(3,162 \times 10^{-4})}{[0,25 - (3,162 \times 10^{-4})]} = \frac{1 \times 10^{-7}}{0,2496}$$

$K_a = 4 \times 10^{-7}$

(16)

$K_a$ $\quad HBrO_2 \rightleftharpoons H^+] + BrO_2^-$

$$K_a = \frac{[H^+][BrO_2^-]}{[HBrO_2]}$$

| | $HBrO_2$ | $H^+$ | $BrO_2^-$ |
|---|---|---|---|
| I | 0.35 | 0 | 0 |
| C | $-x$ | $+x$ | $+x$ |
| E | $0.35-x$ | $x$ | $x$ |

$$5.3\times10^{-5} = \frac{x^2}{0.35-x}$$

(0.3457) (98% ok)

$$= x = 4.3\times10^{-3}$$

$$pH = 2.366 = 2.37$$

(17)

$K_b = 1.80\times10^{-5}$ $\quad pH = ?$

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

| | $NH_3$ | $NH_4^+$ | $OH^-$ |
|---|---|---|---|
| I | .45 | 0 | 0 |
| C | $-x$ | $+x$ | $+x$ |
| E | $.45-x$ | $x$ | $x$ |

$$\frac{x^2}{.45-x} = 1.8\times10^{-5}$$

$$x = 2.846\times10^{-3} = [OH]$$

$$pOH = 2.546$$

$$pH = \underline{11.45}$$

(20) pH = ? 0.300 M RbF $K_a$ of HF = $7.20 \times 10^{-4}$

$RbF \longrightarrow Rb^+ + F^-$ conj base of weak acid

$Rb^+$: spectator

$F^-$: hydrolyses

$F^- + H_2O \longrightarrow HF + OH^-$

$$K_b = \frac{[HF][OH^-]}{[F^-]} = \frac{K_w}{K_a} = 1.389 \times 10^{-11}$$

| | $F^-$ | $[HF]$ | $OH^-$ |
|---|---|---|---|
| I | .300 | 0 | 0 |
| C | $-x$ | $+x$ | $+x$ |
| E | $.3-x$ | $x$ | $x$ |

$$1.389 \times 10^{-11} = \frac{x^2}{.3-x} =$$

$x = [OH^-] = [HF] = 2.041 \times 10^{-6}$

pOH = 5.69

pH = 8.31