Q #21 - 30 pg 305

#21. $KOH(s) \longrightarrow K^+(aq) + OH^-(aq)$ $\Delta H_{sol}^\circ = ?$

system

$m = 0.648\,g$

$M = 56.105\,\frac{g}{mol}$

$n = 0.648\,g \times \frac{1\,mol}{56.105\,g}$

$= 0.011550\,mol$

surroundings

$Q = mc\Delta T$

$= (40\,g)(4.19\,J/g°C)(27.8 - 22.6°C)$

$= (40\,g)(4.19\,J/g°C)(5.2°C)$

$= 871.52\,J$

$= 0.87152\,kJ$

$\Delta H_{syst} = -\Delta H_{surr}$

$\Delta H_{syst} = -0.87152\,kJ$

$n\Delta H_{sol} = -0.87152\,kJ$

$\Delta H_{sol} = \frac{-0.87152\,kJ}{0.011550\,mol}$

$= -75.5\,kJ/mol$

∴ the molar enthalpy of solution is $-75.5\,kJ/mol$

#22. $CH_3COOH(aq) + NaHCO_3(s) \rightarrow CH_3COONa(aq) + CO_2(g) + H_2O(l)$

$V = 80.00\,mL$

$\Delta T = 28.4 - 18.6$

$= 9.8°C$

$m = 5.022\,g$

$M = 84.006\,\frac{g}{mol}$

$n = 5.022\,g \times \frac{1\,mol}{84.006\,g}$

$= 0.05978\,mol$

$Q = mc\Delta T$

$= (80\,g)(4.19\,J/g°C)(9.8°C)$

$= 3284.96\,J$

$= 3.28496\,kJ$

$n\Delta H_r = -\Delta H_{surr}$

$\Delta H_r = \frac{-3.28496\,kJ}{0.05978\,mol}$

$= -55.0\,kJ/mol$

∴ the molar enthalpy of reaction is $-55.0\,kJ/mol$

23. $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$

$\Delta T = 25.70 - 19.30 = 6.4°C$

$m = 0.37 g$

$M = 22.990 \frac{g}{mol}$

$n = 0.37 g \times \frac{1 mol}{22.990 g}$
$= 0.0160940 mol$

$Q = mc\Delta T$
$= (175 g)(4.19 J/g°C)(6.4°C)$
$= 4692.8 J$
$= 4.6928 kJ$

$n\Delta H_r = -\Delta H_{surr}$

$\Delta H_r = \frac{-4.6928 kJ}{0.0160940 mol}$
$= -290 kJ/mol$ OR $-2.9 \times 10^2 kJ/mol$

∴ the molar enthalpy of reaction is $-2.9 \times 10^2 kJ/mol$.

* 24. $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow 2NaCl(aq) + BaSO_4(s)$

$V = 0.250 L$
$c = 0.120 mol/L$

$V = 0.150 L$
$c = 0.200 \frac{mol}{L}$

$n = V \times C$
$= 0.250 L \times 0.120 \frac{mol}{L}$
$n = \frac{\boxed{0.03 mol}}{1}$
$= 0.03$

$n = V \times C$
$= 0.150 L \times \frac{0.200 mol}{L}$
$= \frac{\boxed{0.03 mol}}{1}$
0.03

no LR

$\Delta T = 20.49°C - 20.00°C = 0.49°C$

m = total V
$= 250 mL + 150 mL = 400 mL$
$= 400 g$

$Q = mc\Delta T$
$= (400 g)(4.19 J/g°C)(0.49°C)$
$= 821.24 J$
$= 0.82124 kJ$

$\Delta H_r = \frac{-\Delta H_{sur}}{n}$
$= \frac{-0.82124 kJ}{0.03 mol} = -27.4 kJ/mol$

∴ the molar enthalpy of rxn is $-27.4 kJ/mol$

* 25. $NH_3(aq) + HCl(aq) \longrightarrow NH_4Cl(aq) + 53.6\ kJ$

NH_3: $V = 0.1\ L$, $c = 0.2\ \frac{mol}{L}$

HCl: $V = 0.2\ L$, $c = 0.2\ \frac{mol}{L}$

$\downarrow$

$\Delta H_r = -53.6\ \frac{kJ}{mol}$

$= -53600\ \frac{J}{mol}$

$n = 0.1\,L \times 0.2\ \frac{mol}{L} = \boxed{0.02\ mol}$

$n = 0.2\,L \times 0.2\ \frac{mol}{L} = 0.04\ mol$

$\frac{0.02}{1}$ $\frac{0.04}{1}$

0.02
↑ smaller #
LR

$n\Delta H_r = -\Delta H_{surr}$

$\Delta H_{sur} = -(0.02\ mol)(-53600\ J/mol)$

$= 1072\ J$

$= mc\Delta T$

$m = 100\ mL + 200\ mL$
$= 300\ mL$
$= 300\ g$

$1072\ J = mc\Delta T$

$\Delta T = \frac{1072\ J}{mc}$

$= \frac{1072\ J}{(300g)(4.19\ J/g°C)}$

$= 0.853\ °C$

∴ the temperature change is 0.853 °C

26. $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$

$NaOH$: $v = 0.15\ L$, $c = 1.\ mol/L$, $n = 0.15\ mol$

HCl: $v = 0.15$, $c = 1\ mol/L$, $n = 0.15\ mol$

$\Delta T = 30 - 25 = 5°C$

$m = 150 + 150 = 300\ mL$
$= 300\ g$

$Q = mc\Delta T$
$= (300g)(4.19\ J/g°C)(5°C)$
$= 6285\ J$
$= 6.285\ kJ$

$\Delta H_r = \frac{-\Delta H_{sur}}{n}$

$= \frac{-6.285\ kJ}{0.15\ mol}$

$= -41.9\ kJ/mol$

∴ the molar enthalpy of reaction [illegible]

27. $NaOH_{(s)} \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$ $\Delta H = -55.0\ kJ/mol$

$V = 0.25\ L$

$c = 0.1\ mol/L$

$Q = mc\Delta T$

$n = 0.25\ L \times 0.1\ \frac{mol}{L}$

$= 0.025\ mol$

$\Delta H_{system} = -\Delta H_{surr}\ (q_{surr})$

$n\Delta H_{sol} = -q_{surr}$

$(0.025\ mol)(-55.0\ kJ/mol) = -mc\Delta T$

in J

$\Delta T = \frac{(0.025\ mol)(55.0\ kJ/mol) \times 1000}{(250g)(4.19\ J/g\cdot c)}$

$= 1.31°c$

∴ the temperature increases by 1.31 °C

*28. $LiOH_{(aq)} + HNO_{3\,(aq)} \rightarrow LiNO_{3\,(aq)} + H_2O_{(l)} + 53.1\ kJ$

$V = 0.12\ L$ $V = 0.16\ L$ $\Delta H_r = -53.1\ kJ/mol$

$c = 0.5\ \frac{mol}{L}$ $c = 0.375\ \frac{mol}{L}$ $= -53\ 100\ J/mol$

$n = 0.12\ L \times 0.5\ \frac{mol}{L}$ $n = \boxed{0.06\ mol}$

$= \boxed{0.06\ mol}$

1 1

0.06 0.06

$m = 120\ mL + 160\ mL$

$= 280\ mL$

$= 280g$

$\Delta H_{system} = (0.06\ mol)(-53100\ J/mol)$

$= -3186\ J$

$-3186\ J = -mc\Delta T$

$\Delta T = \frac{3186\ J}{mc}$

$T_f - T_i = \frac{3186\ J}{mc}$

$T_i = T_f - \frac{3186\ J}{(280g)(4.19\ J/g°c)}$

$= 24.5°c - 2.7156\ °c$ $= 21.8\ °C$

∴ the initial temperature of the solution is 21.8 °C

29. $2Na_2O_{2\,(s)} + 2H_2O_{(l)} \rightarrow 4\,NaOH_{(aq)} + O_{2\,(g)}$

$m = 7.800\,g$ $\Delta H° = -285.0\,kJ$

$M = 77.978\,\frac{g}{mol}$

$\Delta H_{syst} = 7.800g \times \frac{1mol}{77.978g} \times \frac{-285.0\,kJ}{2\,mol}$ ← from balanced chem equ.

$= -14.2540\,kJ$

$= -14254\,J$

$\Delta H_{syst} = -\Delta H_{surr}$

$-14254J = -\Delta H_{surr} = -Q$

$-14254J = -mc\Delta T$

$\Delta T = \frac{14254\,J}{mc}$

$= \frac{14254\,J}{(110g)(4.19J/g°c)}$

$= 30.9°C$

∴ the temperature change is 30.9°C

30. $H_2SO_{4\,(aq)} + 2KOH_{(aq)} \rightarrow K_2SO_{4\,(aq)} + 2H_2O_{(l)}$

H_2SO_4	KOH
$v = 0.2L$	$v = 0.2L$
$c = 1\,mol/L$	$c = 1\,mol/L$
$n = \frac{0.2\,mol}{1}$	$n = \frac{0.2\,mol}{2}$
0.2	0.1 ↑ LR

$Q = mc\Delta T$

$= (400g)(4.19\,J/g°c)(6.50°C)$

$= 10894\,J$

$= 10.894\,kJ$

$\Delta H = \frac{-10.894\,kJ}{0.2\,mol}$

$= -54.5\,kJ/mol$

∴ the molar enthalpy is $-54.5\,kJ/mol$.