Q1

$\Delta G = -RT \ln K$. $\therefore \ln\left(\frac{K_2}{K_1}\right) = -\left(\frac{\Delta G_2}{RT} - \frac{\Delta G_1}{RT}\right)$

$\ln K = -\frac{\Delta G}{RT}$

$= -\frac{1}{RT}(\Delta G_2 - \Delta G_1)$

$\ln\left(\frac{K_2}{K_1}\right) = \frac{-(-620\times10^3 - (-345\times10^3))\ J\ mol^{-1}}{(8.314\ JK^{-1}mol^{-1})(350K)}$

$= \frac{275\times10^3\ J\ mol^{-1}}{2909.9\ J\ mol^{-1}}$

3

$\ln\left(\frac{K_2}{K_1}\right) = 94.505$

$\frac{K_2}{K_1} = e^{94.505}$

or

$\frac{K_2}{K_1} = 1.104\times10^{41}$

$\frac{K_1}{K_2} = 9.058\times10^{-42}$

Q2

$\ln K = -1.04 - \frac{1088}{T} + \frac{1.51\times10^5}{T^2}$

@ 440k $\ln K_1 = -1.04 - \frac{1088}{440} + \frac{1.51\times10^5}{(440)^2}$

$= -2.733$

4

$K_1 = 0.065$

@ 460k $\ln K_2 = -1.04 - \frac{1088}{460} + \frac{1.51\times10^5}{(460)^2}$

$= -2.692$

$K_2 = 0.0677$

$\ln\left(\frac{K_2}{K_1}\right) = -\frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

$\ln\left(\frac{0.0677}{0.065}\right) = -\frac{\Delta H}{8.314\ JK^{-1}mol^{-1}}\left(\frac{1}{460K} - \frac{1}{440K}\right)$

$0.0407 = -\frac{\Delta H}{8.314\ JK^{-1}mol^{-1}}\ (-9.88\times10^{-5}\ K^{-1})$

$\Delta H = \frac{0.0407}{1.188\times10^{-5}\ mol\ J^{-1}}$

$\Delta H = 3424.4\ J\ mol$

K @ 450 = 0.0664

$\ln K = -\frac{\Delta H}{RT} + \frac{\Delta S}{R}$

$\left(\ln K + \frac{\Delta H}{RT}\right)R = \Delta S$

$\left(-2.712 + \frac{3424.4}{(8.314)450}\right)8.314 = \Delta S$

$\Delta S = -14.939\ J\ mol^{-1}$

Q3 a) $\Delta T_b = k_b B_b$

$= (0.51\ K\ kg\ mol^{-1}) \left(\frac{8.4g}{(92.09382g/mol)(0.475kg)} \right)$

$= 0.0979\ K$

$\therefore T_b = (373.15 + 0.0979)\ K$

$T_b = 373.25\ K$ (or $100.0979°C$)

/3.

b) $[sucrose] = \frac{\Pi}{RT} = \frac{270\ kPa}{(8.314 \frac{L\ kPa}{K\ mol})}$

$= 0.0999\ mol\ kg^{-1}$ (assuming $1\ mL = 1g$)

$\Delta T_f = K_f B_b = (1.86\ K\ kg\ mol^{-1})(0.0999\ mol\ kg^{-1})$

$= 0.0186\ K.$

$\therefore T_f = -0.0186°C$ or $272.96\ K$

Q4 a) method 1

$K' = \frac{[B][C]}{[A][H^+/10^{-7}]^2} = k[10^{-7}]^2$

$= 4.18 (10^{-14})$

$K' = 4.18 \times 10^{-14}$

method 2

$\Delta G^\circ = RT \ln k$

$= (8.314 \text{ J K}^{-1}\text{mol}^{-1})(310\text{K}) \ln (4.18)$

$= -3686 \text{ J mol}^{-1}$

$\ln K' = \frac{-\Delta G^\circ}{RT} = \frac{-79\,387 \text{ J mol}^{-1}}{(8.314 \frac{\text{J K}^{-1}}{\text{mol}})(310\text{K})}$

$= -30.805$

$K' = 4.18 \times 10^{-14}$

$\Delta G' = \Delta G^\circ + RT \ln Q$

$= -3686 \frac{\text{J}}{\text{mol}} + (8.314 \frac{\text{J K}^{-1}}{\text{mol}})(310) \ln (10^{14})$

$= 79\,387 \text{ J mol}^{-1}$

4

b) method 1

$\Delta G = \Delta G^\circ + RT \ln Q$

$= -3686 \text{ J mol}^{-1} + (8.314 \text{ J K}^{-1}\text{mol}^{-1})(310\text{K}) \ln (10^{12})$

$= -3686 \text{ J mol}^{-1} + 71215 \text{ J mol}^{-1}$

$\Delta G = 67529 \text{ J mol} = 67.5 \text{ kJ mol}^{-1}$

method 2

$\Delta G' = \Delta G^{\circ\prime} + RT \ln Q'$

$= 79\,387 \text{ J mol}^{-1} + (8.314 \text{ J K}^{-1}\text{mol}^{-1})(310\text{K}) \ln \left(\frac{10^{-6}}{10^{-7}}\right)^{12}$

$= 79\,387 \text{ J mol}^{-1} + 2577.34 \text{ J mol}^{-1} \ln (100)$

$\Delta G' = 67\,529 \text{ J mol} = 67.5 \text{ kJ mol}^{-1}$