Name: ______________________ date: ______________ period: _____

Ch. 14.3 equilibrium test 45 points ngss chemistry

In problems involving any calculation, show your work in an organized manner, include (i) any relevant equation (or formula), (ii) conversion factor(s), (iii) put the proper units in your calculations and answer, and (iv) proper number of significant figures in your answer.

1. In regards to the reaction: $N_{2(g)} + 3\ H_{2(g)} \rightleftarrows 2\ NH_{3(g)}$, there is initially 4.0 mM and 9.0 mM N_2 and H_2, respectively. At equilibrium, there is 2.0 mM N_2; what is . . . [10 points]

   a. the equilibrium concentration of H_2 and NH_3 ? basis / rationale ?

   $N_2 + 3H_2 \rightleftarrows 2NH_3$

I	4 mM	9 mM	0
C	-2	-6	+4
E	2 mM	3 mM	4 mM

3+3+3+5

   b. the numeric value of the equilibrium constant ? basis / rationale ?

   1+3+1

   $K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{(4\cdot10^{-3})^2}{(2\cdot10^{-3})(3\cdot10^{-3})^3} = \frac{16\cdot10^{-6}}{54\cdot10^{-12}} = 0.296\cdot10^{6}$ or equivalent

2. Write the algebraic expression of the equilibrium constant for the reaction . . . [15 poitns]

4p a. $N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)}$

3

   $Kc = \frac{[NH_3]^2}{[N_2][H_2]^3}$

2 b. $N_{2(g)} + 3H_{2(g)} \rightleftarrows 2NH_{3(g)}$

3

   $Kp = \frac{P_{NH_3}^2}{P_{N_2} P_{H_2}^3}$

2 c. $3Ca(NO_3)_{2(aq)} + 2Na_3PO_{4(aq)} \rightleftarrows 6NaNO_{3(aq)} + Ca_3(PO_4)_{2(s)}$

3

   $Kc = \frac{[NaNO_3]^6}{[Ca(NO_3)_2]^3[Na_3PO_4]^2}$

3. The chemical reaction: 2 $NH_{3(g)} \rightleftharpoons N_{2(g)} + 3H_{2(g)}$ is at equilibrium and is an endothermic reaction. What is the effect on the number of moles of N_2 by a disturbance of the reaction at equilibrium due to . . . ? basis / rationale ? [20 points] 20

a. addition of an inert gas, helium, at constant volume and temperature

2 pt

$$Q = \frac{[N_2][H_2]^3}{[NH_3]^2} = \frac{n_{N_2} n_{H_2} \left(\frac{1}{V}\right)^{4}}{n_{NH_3} \left(\frac{1}{V}\right)^2} = \frac{n_{N_2} n_{H_2}}{n_{NH_3} V^2}$$

2 ≠ n_{N_2} b/c Rx still @ equilibrium

b. addition of an inert gas, neon, at constant pressure and temperature

2 i) $PV = nRT \rightarrow P = \frac{nRT}{V}$

2 ii) $\uparrow n_{Ne} \rightarrow \uparrow n_{total} \rightarrow \uparrow P \rightarrow \uparrow V$ to maintain P $\rightarrow \downarrow Q \rightarrow \uparrow Q$ to establish equilibrium $\rightarrow \uparrow n_{N_2}$

2 iii) ... $Q = \frac{n_{N_2} n_{H_2}}{n_{NH_3} V^2}$

c. removal of NH_3

2 i) $\downarrow NH_3 \rightarrow \uparrow Q \rightarrow \downarrow Q$ to establish equilibrium $\rightarrow \downarrow n_{N_2}$

2 ii) $Q = \frac{n_{N_2} n_{H_2}}{n_{NH_3} V^2}$

d. cooling the reaction

3 $q + NH_3 \rightleftharpoons N_2 + H_2$

3 $\downarrow T \rightarrow$ "want" $\uparrow T$ = generate $q \rightarrow \uparrow r_b \rightarrow \downarrow n_{N_2}$