

***** ANSWER KEY *******Student Name:****Grade: 09****Test Name:** November Chemistry for All: Unit 11 - Equilibrium Assessment**Version: 1**

1. The following describes the Haber Process for making fertilizer:

· nitrogen + hydrogen \rightleftharpoons ammonia

· $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightleftharpoons 2\text{NH}_{3(g)}$ ($\Delta H = -92 \text{ kJ mol}^{-1}$)

Describe the effect of lowering the temperature inside the reaction vessel on the equilibrium of the reaction.

- ✓ (a) The reaction is exothermic so the change favors the products.
(b) The reaction is exothermic so the change favors the reactants.
(c) The reaction is endothermic so the change favors the products.
(d) The change has no effect on the equilibrium position.

Explanation:

- (a) Lowering the temperature drives the reaction forward to replace the energy removed from the exothermic reaction.

Standard:

MI_CHEM_HS-0912-C5-3x-a

MI HSCEs Science - Chemistry

└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3a Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

2. The following describes the Haber Process for making fertilizer:

· nitrogen + hydrogen \rightleftharpoons ammonia



Describe the effect of decreasing the pressure inside the reaction vessel on the equilibrium of the reaction.

- (a) The change favors the products which has less gas molecules.
- ✓ (b) The change favors the reactants which has more gas molecules.
- (c) The change favors the products which has larger gas molecules.
- (d) The change has no effect on the equilibrium position.

Explanation:

- (b) Decreasing the pressure drives the reaction in the reverse direction because there are more particles

Standard:

MI_CHEM_HS-0912-C5-3x-a

MI HSCEs Science - Chemistry

└ 09-12

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└ Topic C5.3x Equilibrium

└ C5.3a Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

3. The following describes the Haber Process for making fertilizer:

• nitrogen + hydrogen \rightleftharpoons ammonia

• $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightleftharpoons 2\text{NH}_{3(g)}$ ($\Delta H = -92 \text{ kJ mol}^{-1}$)

Describe the effect of increasing the concentration of nitrogen gas or hydrogen gas inside the reaction vessel on the equilibrium of the reaction.

- (a) The change causes an increase in ammonia favoring the reactants.
- ✓ (b) The change causes an increase in ammonia favoring the products.
- (c) The change causes an decrease in ammonia favoring the reactants.
- (d) The change has no effect on the equilibrium of the reactants.

Explanation:

(a) forward

Standard:

MI_CHEM_HS-0912-C5-3x-a

MI HSCEs Science - Chemistry

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└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3a Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

4. The following describes the Haber Process for making fertilizer:

• nitrogen + hydrogen \rightleftharpoons ammonia

• $\text{N}_{2(\text{g})} + 3\text{H}_{2(\text{g})} \rightleftharpoons 2\text{NH}_{3(\text{g})}$ ($\Delta\text{H} = -92 \text{ kJ mol}^{-1}$)

Describe the effect of decreasing the concentration of ammonia on the equilibrium of the reaction.

- ✓ (a) Drives the reaction to the right which favors the products.
- (b) Drives the reaction to the left which favors the reactants.
- (c) Drives the reaction to the right which favors the reactants.
- (d) Has no effect on the equilibrium of the reaction.

Explanation:

- (a)
- (b) reverse

Standard:

MI_CHEM_HS-0912-C5-3x-a

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└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

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5. The following describes the Haber Process for making fertilizer:

• nitrogen + hydrogen \rightleftharpoons ammonia

• $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightleftharpoons 2\text{NH}_{3(g)}$ ($\Delta H = -92 \text{ kJ mol}^{-1}$)

Describe the effect of decreasing the volume of the reaction vessel on the equilibrium of the reaction.

- (a) The change causes an decrease in the pressure which favors the products.
- (b) The change causes an increase in pressure which favors the reactants.
- ✓ (c) The change causes an increase in pressure which favors the products.
- (d) The change has no effect on the equilibrium of the reaction.

Explanation:

(a) forward

Standard:

MI_CHEM_HS-0912-C5-3x-a

MI HSCEs Science - Chemistry

└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3a Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

6. The following describes the Haber Process for making fertilizer:

• nitrogen + hydrogen \rightleftharpoons ammonia

• $\text{N}_{2(g)} + 3\text{H}_{2(g)} \rightleftharpoons 2\text{NH}_{3(g)}$ ($\Delta H = -92 \text{ kJ mol}^{-1}$)

Describe the effect of the addition of a catalyst inside the reaction vessel on the equilibrium of the reaction.

- (a) The change increases the concentration of ammonia which favors the products.
- (b) The change increases the concentration of ammonia which favors the reactants.
- (c) The change decreases the concentration of the hydrogen gas which favors the reactants.
- ✓ (d) The change has no effect on the equilibrium of the reaction.

Explanation:

(c) Catalysts do not affect the equilibrium only the rate of reaction.

Standard:

MI_CHEM_HS-0912-C5-3x-a

MI HSCEs Science - Chemistry

└ 09-12

└ STANDARD C5: CHANGES IN MATTER

└ Topic C5.3x Equilibrium

└ C5.3a Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

7. The equilibrium is a state of dynamic molecular behavior, which statement below describes the change that occurs in a reaction to establish equilibrium?
- ✓ (a) The reactants turn into products and the products turn into reactants at equal rates.
 - (b) The reactants continually turn into products at a progressively slower rate until the reaction stops.
 - (c) The products continually turn into reactants at a progressively faster rate until the reaction stops.
 - (d) The reaction stops when the concentration of the products are equal to the concentration of the reactants.

Standard:

MI_CHEM_HS-0912-C5-3x-a

MI HSCEs Science - Chemistry

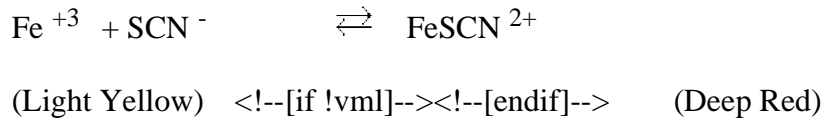
└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3a Describe equilibrium shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

8. Study the following aqueous reaction:



Adding $\text{Fe}(\text{NO}_3)_3$ produced the following change in the equilibrium:

- (a) The color in the test tube became a deeper red color because the equilibrium shifted to make more reactants.
- ✓ (b) The color in the test tube became a deeper red color because the equilibrium shifted to make more products.
- (c) The color in the test tube became a lighter color because the equilibrium shifted to make more reactants.
- (d) The color in the test tube became a lighter color because the equilibrium shifted to make more products.

Standard:

MI_CHEM_HS-0912-C5-3x-b

MI HSCEs Science - Chemistry

└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3b Predict shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

10. Study the following aqueous reaction:



(Light Yellow) <!--[if !vml]--><!--[endif]--> (Deep Red)

The reaction you studied is becoming a deeper red color when the tube is placed in an ice bath. Which statement best represents the observation?

- ✓ (a) The reaction is exothermic and has shifted to favor the products.
- (b) The reaction is endothermic and has shifted to favor the products.
- (c) The reaction is exothermic and has shifted to favor the reactants.
- (d) The reaction is endothermic and has shifted to favor the reactants.

Standard:

MI_CHEM_HS-0912-C5-3x-b

MI HSCEs Science - Chemistry

└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3b Predict shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

11. In the reaction $\text{N}_2\text{O}_{4(g)} \rightleftharpoons 2\text{NO}_{2(g)}$, an increase in pressure (by reducing the volume) would cause which of the following changes?
- (a) The reaction shift will be to the right and form more products.
 - ✓ (b) The reaction shift will be to the left and form more reactants.
 - (c) Increasing the pressure would have no effect on the equilibrium of the reaction.
 - (d) The concentrations of both the reactant and product would decrease.

Standard:

MI_CHEM_HS-0912-C5-3x-b

MI HSCEs Science - Chemistry

└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3b Predict shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

12. In the reaction, $\text{CO}_{(g)} + \text{NO}_{2(g)} \rightleftharpoons \text{CO}_{2(g)} + \text{NO}_{(g)}$, which of the following changes would result in the formation of more products to return to equilibrium?
- (a) increasing the pressure
 - (b) removing $\text{CO}_{(g)}$ from the reaction
 - ✓ (c) adding $\text{NO}_{2(g)}$ to the reaction
 - (d) adding CO_2 to the reaction

Standard:

MI_CHEM_HS-0912-C5-3x-b

MI HSCEs Science - Chemistry

└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3b Predict shifts in a chemical system caused by changing conditions (Le Chatelier's Principle).

13. Which of the following equilibrium constants indicates that its corresponding reaction goes nearly to completion?
- (a) $K_c = 1.0 \times 10^{-2}$
 - (b) $K_c = 1.0 \times 10^{-8}$
 - (c) $K_c = 1.0$
 - ✓ (d) $K_c = 1.0 \times 10^{+8}$

Explanation:

(a)
$$K_{eq} = \frac{[O_3]^2}{[O_2]^3}$$

Standard:

MI_CHEM_HS-0912-C5-3x-c

MI HSCEs Science - Chemistry

└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3c Predict the extent reactants are converted to products using the value of the equilibrium constant.

14. Which of the following equilibrium constants indicates that its corresponding reaction stays far to the left?

- ✓ (a) $K_c = 1.0 \times 10^{-8}$
- (b) $K_c = 9.0 \times 10^{-2}$
- (c) $K_c = 1.0$
- (d) $K_c = 5.0 \times 10^{+8}$

Explanation:

(a)
$$K_{eq} = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$$

Standard:

MI_CHEM_HS-0912-C5-3x-c

MI HSCEs Science - Chemistry

└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3c Predict the extent reactants are converted to products using the value of the equilibrium constant.

15. The K_c value for $\text{H}_2 + \text{I}_2 \rightleftharpoons 2 \text{HI}$ is 7.7×10^{-4} . If only hydrogen gas and iodine vapors are placed in the reaction vessel, what will be the result?
- (a) The reaction will move far to the right and equilibrium will favor the products.
 - ✓ (b) The reaction will stay far to the left and equilibrium will favor the reactants.
 - (c) The reaction will proceed until reactants equal products.
 - (d) The reaction will not start until some HI is introduced into the vessel.

Explanation:

(a)
$$K_{\text{eq}} = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]}$$

Standard:

MI_CHEM_HS-0912-C5-3x-c

MI HSCEs Science - Chemistry

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16. The K_2 for $\text{PCl}_3 + \text{Cl}_2 \rightleftharpoons \text{PCl}_5$ is 50. What statement best describes the result if only PCl_3 and Cl_2 is introduced into the reaction vessel?
- (a) The reaction will not begin until some PCl_5 is introduced into the reaction vessel.
 - (b) The reaction will shift to the right until 50 molecules of PCl_5 are produced and then stop.
 - ✓ (c) The reaction will shift to the right and favor the formation of the products.
 - (d) The reaction will stay to the left and favor the presence of the reactants.

Explanation:

(a)
$$K_{\text{eq}} = \frac{[\text{PCl}_3][\text{Cl}_2]}{[\text{PCl}_5]}$$

Standard:

MI_CHEM_HS-0912-C5-3x-c

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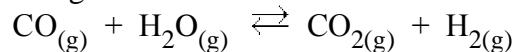
└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

└─ Topic C5.3x Equilibrium

└─ C5.3c Predict the extent reactants are converted to products using the value of the equilibrium constant.

17. CO and H₂O are added into a reaction vessel and allowed to reach equilibrium at constant temperature according to the reaction:



the equilibrium constant was determined to be 4.0. What would happen if the same reaction was performed but a catalyst was added to the vessel?

- (a) The reaction will shift further to the right and the K_c value will increase.
- (b) The reaction will stay further to the left and the K_c value will decrease
- ✓ (c) The addition of a catalyst has no effect on the equilibrium constant.
- (d) The reaction will shift further to the right and the K_c value will decrease.

Explanation:

(a) [CO₂ (g)] = 1.58 M

Standard:

MI_CHEM_HS-0912-C5-3x-c

MI HSCEs Science - Chemistry

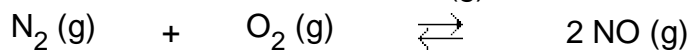
└─ 09-12

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└─ Topic C5.3x Equilibrium

└─ C5.3c Predict the extent reactants are converted to products using the value of the equilibrium constant.

18. Calculate the concentration of NO (g) in the following equilibrium



if at equilibrium the

$$[\text{N}_2(\text{g})] = 1.3 \text{ M}$$

$$[\text{O}_2(\text{g})] = 0.9 \text{ M}$$

and the Keq of the equilibrium is 4.5

- (a) 5.3 M
✓ (b) 2.3 M
(c) 3.9 M
(d) 2.0 M

Explanation:

(a) $[\text{NO}(\text{g})] = 2.3 \text{ M}$

Standard:

MI_CHEM_HS-0912-C5-3x-c

MI HSCEs Science - Chemistry

└─ 09-12

└─ STANDARD C5: CHANGES IN MATTER

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