Chemistry 30 – Equilibrium Unit QUEST

23/23

Name:
Partner:

Use the following information to answer the next four questions.

Prairie Chem Inc. in Edmonton is a bulk manufacturer of concentrated bleach ($NaOCl_{(aq)}$). The bleach reacts with water to form a solution with a pH of 10.87.

$$OCl^-_{(aq)} + H_2O_{(l)} \rightleftharpoons HOCl_{(aq)} + OH^-_{(aq)}$$

1. In this reaction, the substances that act as Brønsted-Lowry acids are
   A. $OCl^-_{(aq)}$ and $H_2O_{(l)}$
   B. $OCl^-_{(aq)}$ and $HOCl_{(aq)}$
   C. $OCl^-_{(aq)}$ and $OH^-_{(aq)}$
   D. $H_2O_{(l)}$ and $HOCl_{(aq)}$

2. The substance in the equation above that may act as an amphiprotic species is
   A. $OCl^-_{(aq)}$
   B. $H_2O_{(l)}$
   C. $HOCl_{(aq)}$
   D. $OH^-_{(aq)}$

3. The two species in equimolar amounts that could act as a buffer in this bleach solution are
   A. $OCl^-_{(aq)}$ and $HOCl_{(aq)}$
   B. $HOCl_{(aq)}$ and $OH^-_{(aq)}$
   C. $OCl^-_{(aq)}$ and $H_2O_{(l)}$
   D. $H_2O_{(l)}$ and $OH^-_{(aq)}$

4. In this bleach solution, the acid-base indicator
   A. phenolphthalein would be colourless
   B. alizarin yellow R would be orange
   C. indigo carmine would be green
   D. methyl orange would be red

Use the following information to answer the next question.

A source of hydrogen for the Haber process is "syngas", which is produced by a reaction of methane and water at 1 000°C.

$$CH_{4(g)} + H_2O_{(g)} \xrightleftharpoons{\text{nickel catalyst}} CO_{(g)} + 3\,H_{2(g)}$$

Numerical Response

1. If, at equilibrium, the $[CH_{4(g)}] = 2.97$ mol/L, $[H_2O_{(g)}] = 7.94$ mol/L, $[CO_{(g)}] = 5.45$ mol/L, and $[H_{2(g)}] = 2.10$ mol/L, then the K_{eq} is 2.14.

(Record your three-digit answer in the numerical-response section on the answer sheet)

5. In the equation $HNO_{3(aq)} + N_2H_{4(aq)} \rightleftharpoons NO_3^-{}_{(aq)} + N_2H_5^+{}_{(aq)}$, one conjugate acid-base pair is
   A. $HNO_{3(aq)}$ and $N_2H_5^+{}_{(aq)}$
   B. $HNO_{3(aq)}$ and $N_2H_{4(aq)}$
   C. $N_2H_{4(aq)}$ and $N_2H_5^+{}_{(aq)}$
   D. $N_2H_{4(aq)}$ and $NO_3^-{}_{(aq)}$

Use the following information to answer the next question.

Some of the $SO_{2(g)}$ produced from the burning of coal and natural gas can react with $NO_{2(g)}$ in the atmosphere according to the equation

$$SO_{2(g)} + NO_{2(g)} \rightleftharpoons NO_{(g)} + SO_{3(g)} \qquad \Delta H = -41.9\ kJ$$

6. The equilibrium concentration of $SO_{3(g)}$ in the reaction could be increased by
   A. raising the temperature
   B. adding a catalyst
   C. removing $SO_{2(g)}$
   D. adding $NO_{2(g)}$

Use the following information to answer the next question.

Rainwater is acidic because it contains dissolved atmospheric $CO_{2(g)}$ that occurs naturally. It may also contain air pollutants, $NO_{x(g)}$, and $SO_{x(g)}$ from industrial sources.

7. If each of the following components of acid rain is of equal concentration, then which of them would have the lowest pH?

A. $HNO_{3(aq)}$ **B.** $HNO_{2(aq)}$
C. $H_2SO_{3(aq)}$ **(D)** $H_2SO_{4(aq}$

Use the following information to answer the next two questions.

If $H_2S_{(g)}$ is released into the atmosphere, it dissolves in atmosphere water to form hydrosulphuric acid. The ionization of $H_2S_{(aq)}$ can be represented by the equilibrium

$$H_2S_{(aq)} + H_2O_{(l)} \rightleftharpoons HS^-_{(aq)} + H_3O^+_{(aq)}$$

8. The K_a expression for this ionization is

A. $K_a = \dfrac{[H_2S_{(aq)}]}{[HS^-_{(aq)}][H_3O^+_{(aq)}]}$ **B.** $K_a = \dfrac{[H_2S_{(aq)}][H_2O_{(l)}]}{[HS^-_{(aq)}][H_3O^+_{(aq)}]}$

C. $K_a = \dfrac{[HS^-_{(aq)}][H_3O^+_{(aq)}]}{[H_2S_{(aq)}][H_2O_{(l)}]}$ **(D)** $K_a = \dfrac{[HS^-_{(aq)}][H_3O^+_{(aq)}]}{[H_2S_{(aq)}]}$

9. The $[H_3O^+_{(aq)}]$ in a 0.050 mol/L $H_2S_{(aq)}$ solution is

A. 4.5×10^{-9} mol/L **(B)** 6.7×10^{-5} mol/L
C. 1.3×10^{-4} mol/L **D.** 0.10 mol/L

Numerical Response

2. The K_b for the conjugate base of the ammonium ion, expressed in scientific notation, is 1.79 $\times 10^{-5}$.

(Record your three-digit answer in the numerical-response section on the answer sheet)

Use the following information to answer the next question.

0.10 mol/L Solutions

1 $NaNO_{2(aq)}$ **3** $HNO_{3(aq)}$
2 $NaHCO_{3(aq)}$ **4** $Ba(OH)_{2(aq)}$

Numerical Response

3. When the solutions above are ordered from most basic to least basic, the order is 4, 2, 1, and 3.

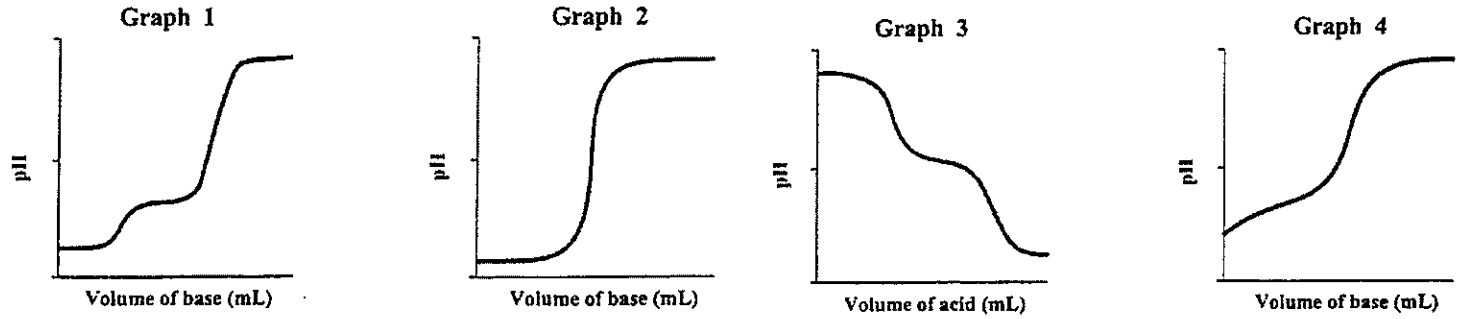
(Record your **four-digit answer** in the numerical-response section on the answer sheet)

10. Which of the following mixtures could act as a buffer solution?

A. $HF_{(aq)}$ and $H_2S_{(aq)}$ **B.** $NaOH_{(aq)}$ and $HCl_{(aq)}$
C. $Na_2CO_{3(aq)}$ and $NH_{3(aq)}$ **(D)** $NaH_2BO_{3(aq)}$ and $Na_2HBO_{3(aq)}$

Use the following information to answer the next question.

When equally concentrated solutions of $HNO_{3(aq)}$, $CH_3COOH_{(aq)}$, $HOOCCOOH_{(aq)}$, and $Na_2S_{(aq)}$ were titrated with either a strong acid or strong base, the following curves were obtained.



Numerical Response

4. Match each of the graphs, as numbered above, with the corresponding titration species listed below.

$HNO_{3(aq)}$	2	(Record in the **first** column)
$CH_3COOH_{(aq)}$	4	(Record in the **second** column)
$HOOCCOOH_{(aq)}$	1	(Record in the **third** column)
$Na_2S_{(aq)}$	3	(Record in the **fourth** column)

(Record your **four-digit answer** in the numerical-response section on the answer sheet)

Use the following information to answer the next question.

A 0.500 mol/L solution of hydrazine ($N_2H_{4(aq)}$) contains the following equilibrium concentrations.

$[N_2H_{4(aq)}] = 0.498$ mol/L
$[OH^-_{(aq)}] = 2.14 \times 10^{-3}$ mol/L
$[N_2H_5^+{}_{(aq)}] = 2.14 \times 10^{-3}$ mol/L

Numerical Response

5. The K_b for hydrazine, in scientific notation, is $a.bc \times 10^{-d}$. The values of a, b, c, and d are, respectively, 9, 2, 0, and 6.

(Record your four-digit answer in the numerical-response section on the answer sheet)

A) 2.55
B) 2.28
C) 1.59
D) 3.15

11. The $[H_3O^+_{(aq)}]$ in 0.20 mol/L $HC_3H_5O_{3(aq)}$ is
A. 2.8×10^{-3} mol/L
B. 5.3×10^{-3} mol/L
C. 2.6×10^{-2} mol/L
D. 7.0×10^{-4} mol/L

*Use your recorded answer from **Multiple choice 11** to answer **Numerical Response 6*.***

Numerical Response

6. The pH of the $HC_3H_5O_{3(aq)}$ is 2.28.

(Record your **three-digit answer** in the numerical-response section on the answer sheet)

***You can receive marks for this question even if the previous question was answered incorrectly.**

12. A drop of thymol blue indicator in its blue form added to 10.0 mL of 0.10 mol/L $H_2SO_{4(aq)}$ would become
A. yellow because the indicator would gain one proton
B. yellow because the indicator would lose one proton
C. red because the indicator would gain two protons
D. red because the indicator would lose two protons

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13. Kelly tested portions of a solution with three indicators to determine the approximate pH.

Indicator	Colour
Bromocresol green	blue
Indigo carmine	blue
Thymophthalein	blue

The approximate pH of the solution is:

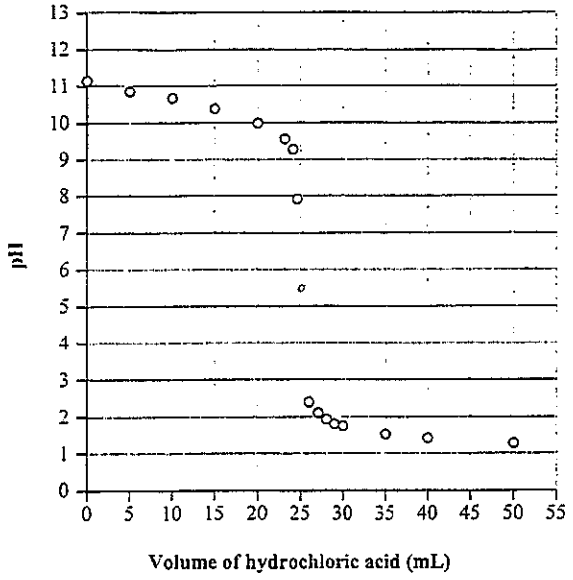
A. 5.0 **B.** 9.0
C. 10.8 **D.** 11.6

14. A solution was tested and found to have a pOH of 3.2. This solution would most likely

A. be a proton donor **B.** react violently with zinc
C. cause thymolphthalein to be blue **D.** cause bromocresol green to be yellow

Use the following information to answer the next question.

Titration Plot for 25.0 mL of 0.100 mol/L $NH_{3(aq)}$ with 0.100 mol/L $HCl_{(aq)}$



15. The most suitable indicator for the titration is

A. Phenolphthalein **B.** methyl violet
C. chlorophenol red **D.** methyl orange

16. A glass of orange juice contains enough hydronium ions to kill you if your blood is not buffered to a pH of about 7.35. One of the several buffer systems that your blood contains is $H_2PO_4^-{}_{(aq)} - HPO_4^{2-}{}_{(aq)}$. This system initially buffers the addition of hydronium ions from orange juice by the reaction

A. $H_3O^+_{(aq)} + H_2PO_4^-{}_{(aq)} \rightleftharpoons H_3PO_{4(aq)} + H_2O_{(l)}$
B. $H_3O^+_{(aq)} + HPO_4^{2-}{}_{(aq)} \rightleftharpoons H_2PO_4^-{}_{(aq)} + H_2O_{(l)}$
C. $2\,H_3O^+_{(aq)} + PO_4^{3-}{}_{(aq)} \rightleftharpoons H_2PO_4^-{}_{(aq)} + H_2O_{(l)}$
D. $2\,H_3O^+_{(aq)} + 2\,H_2PO_4^-{}_{(aq)} \rightleftharpoons PO_4^{3-}{}_{(aq)} + 2\,H_2O_{(l)}$

17. Phenol red in its acid form was placed in a solution of sodium hydroxide. Write a net ionic equation to show the likely reaction.

HPr , $Na^+_{(aq)}$, $OH^-_{(aq)}$

Equation:

$HPr_{(aq)} + OH^-_{(aq)} \rightleftharpoons H_2O_{(l)} + Pr^-_{(aq)}$

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