CHAPTER 6 ANSWER KEY	Investigation 6.E: The Effect of Dilution on the $[H_3O^+(aq)]$ and pH of an Acid Answer Key	BLM 6.3.9A

Answers to Prediction Questions

(a) $[H_3O^+(aq)] = [HCl(aq)] = 0.10$ mol/L

$pH = -\log[H_3O^+(aq)] = -\log(0.10) = 1.00$

(b) $[H_3O^+(aq)] = 0.010$ mol/L

$pH = -\log[H_3O^+(aq)] = -\log(0.010) = 2.00$

(c) Based on similar calculations, you may predict pH = 3.00, 4.00, 5.00, 6.00, 7.00, 8.00 for the next six dilutions. You will not, however, observe a pH of 8.00. With continued dilutions, the pH remains at 7.00, the pH of water.

Answers to Procedure Questions

[HCl(aq)] (mol/L)	Calculated $[H_3O^+(aq)]$ (mol/L)	Predicted pH	pH measured with universal indicator (accuracy may vary by paper)	pH measured with pH meter
1.0×10^{-1}	1.0×10^{-1}	1.00	1-2 (red)	1.0
1.0×10^{-2}	1.0×10^{-2}	2.00	1-2 (red)	2.0
1.0×10^{-3}	1.0×10^{-3}	3.00	3-4 (orange)	3.0
1.0×10^{-4}	1.0×10^{-4}	4.00	3-4 (orange)	4.0
1.0×10^{-5}	1.0×10^{-5}	5.00	5-6 (yellow)	5.0
1.0×10^{-6}	1.0×10^{-6}	6.00	5-6 (yellow)	6.0
1.0×10^{-7}	1.0×10^{-7}	7.00	7 (yellow-green)	7.0
1.0×10^{-8}	1.0×10^{-8} (actually 1.0×10^{-7})	8.00 (actually 7.00)	7 (yellow-green)	7.0
1.0×10^{-9}	1.0×10^{-9} (actually 1.0×10^{-7})	9.00 (actually 7.00)	7 (yellow-green)	7.0

Answers to Analysis Questions

1. Provided that it is calibrated properly and well maintained, the pH meter is more precise and possibly more accurate. The pH meter allows for determining pH with several significant digits. Determining the colour of pH paper is subjective and can be affected by lighting and other factors such as colour blindness.

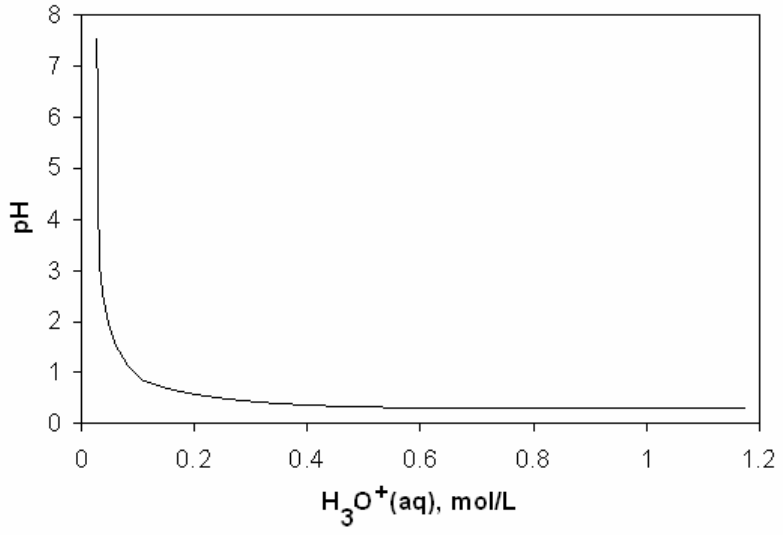
2. Most pH paper has a scale with only whole numbers, which means the pH value reported is only approximate. Digital pH meters read to the precision listed by the manufacturer. If you have values that are significantly different, it may indicate problems following the calculations. Slight variations may be due to an improperly calibrated pH meter, poor dilution technique, or contamination of the acid or water.

Investigation 6.E: The Effect of Dilution on the $[H_3O^+(aq)]$ and pH of an Acid Answer Key (continued)

3. You might make the mistake of performing the calculations for $[H_3O^+(aq)]$ and predicting the pH without realizing you are predicting that by continuous dilution, an acid may be diluted to become basic and vice versa. These two solutions ought to have had a pH of around 7.00, since the hydrochloric acid is so dilute that the prime contributor of hydronium ions is the autoionization of the water itself.

4. A 10-fold dilution of hydrochloric acid results in the increase of pH by 1.0, until the pH reaches 7.0, at which point the pH does not change further by dilution because $[H_3O^+(aq)]$ remains constant.

5. The graph should resemble the one below.



Answer to Conclusions Question

6. When the $[H_3O^+(aq)]$ of a solution decreases by a factor of 10, pH increases by 1.0.