1.	<ul> <li>A student tested a 0.1 M aqueous solution and made the following observations:</li> <li>conducts electricity</li> <li>turns blue litmus to red</li> <li>reacts with Zn(s) to produce gas bubbles</li> </ul>		5. The only positive ion found in H <sub>2</sub> SO <sub>4</sub> (aq) is the			
			A C	<ul><li>A) ammonium ion</li><li>C) hydroxide ion</li></ul>	<ul><li>B) hydronium ion</li><li>D) sulfate ion</li></ul>	
			6. Which compound is a strong Arrhenius base?			
	Which compound could	be the solute in this solution?	A C	А) С2Н5ОН С) НОН	<ul><li>B) CH<sub>3</sub>OH</li><li>D) NaOH</li></ul>	
	<ul><li>A) CH<sub>3</sub>OH</li><li>C) HBr</li></ul>	<ul><li>B) LiBr</li><li>D) LiOH</li></ul>	7. A c t	A 0.1 M solution of ace of ammonium hydroxid he acetic acid solution	tic acid and a 0.1 M solution e, both at 25°C, <i>differ</i> in that has a larger	
2.	Which is a characteristic of an aqueous solution of HNO <sub>3</sub> ?		<ul> <li>A) ionization constant</li> <li>B) pH</li> <li>C) H<sub>3</sub>O<sup>+</sup> concentration</li> <li>D) OH<sup>-</sup> concentration</li> </ul>			
	<ul> <li>A) It conducts electricity.</li> <li>B) It forms OH<sup>-</sup> ions.</li> <li>C) It turns litmus blue.</li> <li>D) It turns phenolphthalein pink</li> </ul>					
			8. An Arrhenius acid has			
3.	Beakers $A$ , $B$ , $C$ , and $D$ shown below each contain a different solution. Bulb Conductivity apparatus		<ul> <li>A) only hydroxide ions in solution</li> <li>B) only hydrogen ions in solution</li> <li>C) hydrogen ions as the only positive ions in solution</li> <li>D) hydrogen ions as the only negative ions in solution</li> </ul>			
			9. A hydrogen ion, H <sup>+</sup> , in aqueous solution may also be written as			
	NaCl(aq) C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> (aq) CH <sub>3</sub> OH(aq) CH <sub>3</sub> COOH(aq)		A) H <sub>2</sub> O B) H <sub>2</sub> O <sub>2</sub> C) H <sub>3</sub> O <sup>+</sup> D) OH <sup>-</sup>			
			10. Which relationship is present in a solution that has a pH of 7?			
	A B	C D		A) $[H^+] = [OH^-]$	B) $[H^+] > [OH^-]$	
	The bulb will glow when the conductivity apparatus is placed into which beakers? (A) $A$ and $B$ (B) $B$ and $C$		<ul> <li>11. Which pH change represents a hundredfold increase in the concentration of H<sub>3</sub>O<sup>+</sup>?</li> </ul>			
	C) $A$ and $D$	D) $C$ and $D$		A) pH 5 to pH 7	B) pH 13 to pH 14	
4.	As water is added to a 0.10 M NaCl aqueous solution, the conductivity of the resulting solution		C) pH 3 to pH 1		D) pH 4 to pH 3	
			12. Which pH value indicates the most basic solution?			
	<ul> <li>A) decreases because the concentration of ions decreases</li> <li>B) decreases, but the concentration of ions remains the same</li> <li>C) increases because the concentration of ions decreases</li> </ul>		A) 7 B) 8 C) 3 D) 11			
			solution			
			A) decreasesB) increasesC) remains the same			
	D) increases, but the co the same	oncentration of ions remains				

14. Both HNO <sub>3</sub> (aq) and CH <sub>3</sub> COOH(aq) can be	22. Which equation represents a neutralization reaction?			
<ul> <li>Arrhenius acids that turn blue litmus red</li> <li>Arrhenius bases that turn blue litmus red</li> <li>Arrhenius acids that turn red litmus blue</li> <li>Arrhenius bases that turn red litmus blue</li> </ul>	A) $Na_2CO_3 + CaCl_2 \rightarrow 2 NaCl + CaCO_3$ B) $Ni(NO_3)_2 + H_2S \rightarrow NiS + 2 HNO_3$ C) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$ D) $H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + 2 H_2O$ 23 A 25 0-milliliter sample of HNO_3(aq) is neutralized			
<ul> <li>15. In which 0.01 M solution is phenolphthalein pink?</li> <li>A) CH<sub>3</sub>OH(aq) B) Ca(OH)<sub>2</sub>(aq)</li> <li>C) CH<sub>3</sub>COOH(aq) D) HNO<sub>3</sub>(aq)</li> <li>16. Three samples of the same solution are tested, each with a different indicator. All three indicators, bromthymol blue, bromcresol green and thymol blue, appear blue if the pH of the solution is</li> <li>A) 4.7 B) 6.0 C) 7.8 D) 9.9</li> <li>17. In the reaction:</li> </ul>	<ul> <li>by 32.1 milliliters of 0.150 M KOH(aq). What is the molarity of the HNO<sub>3</sub>(aq)?</li> <li>A) 0.117 M B) 0.150 M</li> <li>C) 0.193 M D) 0.300 M</li> <li>24. How many milliliters of 0.2 M NaOH are required to exactly neutralize 40 milliliters of 0.1 M HCl?</li> <li>A) 10 B) 20 C) 40 D) 80</li> <li>25. During which process can 10.0 milliliters of a 0.05 M HCl(aq) solution be used to determine the unknown concentration of a given volume of NaOH(aq) solution?</li> </ul>			
<ul> <li>The two acids are</li> <li>A) H<sub>2</sub>O and HNO<sub>3</sub> B) H<sub>2</sub>O and NO<sub>3</sub><sup>-</sup></li> <li>C) H<sub>2</sub>O and H<sub>3</sub>O<sup>+</sup> D) HNO<sub>3</sub> and H<sub>3</sub>O<sup>+</sup></li> <li>18. Which products are formed when an acid reacts with a base?</li> <li>A) an alcohol and carbon dioxide</li> <li>B) an ester and water</li> <li>C) a soap and glycerine</li> <li>D) a salt and water</li> </ul>	<ul> <li>A) evaporation B) distillation</li> <li>C) filtration D) titration</li> <li>26. What is the pH of the solution formed by completely neutralizing 50 milliliters of 0.1 M HNO3 with 50 milliliters of 0.1 M NaOH at 298 K?</li> <li>A) 1 B) 7 C) 10 D) 4</li> <li>27. When additional solid NaCl dissolves in a solution of NaCl in water, the pH of the solution</li> <li>A) decreases B) increases</li> </ul>			
<ul> <li>19. Equal volumes of 0.1 M NaOH and 0.1 M HCl are thoroughly mixed. The resulting solution has a pH closest to</li> <li>A) 5 B) 7 C) 3 D) 9</li> </ul>	C) remains the same			
<ul> <li>20. Which element reacts spontaneously with 1.0 M HCl(aq) at room temperature?</li> <li>A) copper</li> <li>B) gold</li> <li>C) silver</li> <li>D) zinc</li> </ul>				
21. Which compound is a salt?				
A) CH3OHB) C6H12O6C) H2C2O4D) KC2H3O2				

28. Base your answer to the following question on the information below and on your knowledge of chemistry.

A company produces a colorless vinegar that is 5.0% HC<sub>2</sub>H<sub>3</sub>O<sub>2</sub> in water. Using thymol blue as an indicator, a student titrates a 15.0-milliliter sample of the vinegar with 43.1 milliliters of a 0.30 M NaOH (aq) solution until the acid is neutralized.

Identify the negative ion in the NaOH(aq) used in this titration.

29. Base your answer to the following question on information below and on your knowledge of chemistry.

A sample of nitric acid contains both  $\rm H_3O^+$  ions and  $\rm NO_3$  ions. This sample has a pH value of 1.

Write a name of the positive ion present in this sample.

- 30. Identify two indicators from Reference Table M that are yellow in solutions with a pH of 5.5.
- 31. Base your answer to the following question on the information below.

Using burets, a student titrated a sodium hydroxide solution of unknown concentration with a standard solution of 0.10 M hydrochloric acid. The data are recorded in the table below.

## **Titration Data**

Solution	HCI(aq)	NaOH(aq)	
Initial Buret Reading (mL)	<b>15.5</b> 0	5.00	
Final Buret Reading (mL)	25.00	8.80	

Show a correct numerical setup for calculating the molarity of the sodium hydroxide solution.

32. Base your answer to the following question on the information below.

A 20.0-milliliter sample of HCl(aq) is completely neutralized by 32.0 milliliters of 0.50 M KOH(aq). Calculate the molarity of the HCl(aq). Your response must include *both* a numerical setup and the calculated result.

33. Base your answer to the following question on the information below.

The health of fish depends on the amount of oxygen dissolved in the water. A dissolved oxygen (DO) concentration between 6 parts per million and 8 parts per million is best for fish health. A DO concentration greater than 1 part per million is necessary for fish survival.

Fish health is also affected by water temperature and concentrations of dissolved ammonia, hydrogen sulfide, chloride compounds, and nitrate compounds. Most freshwater fish thrive in water with a pH between 6.5 and 8.5.

A student's fish tank contains fish, green plants, and 3800 grams of fish-tank water with 2.7 x 10-2 gram of dissolved oxygen. Phenolphthalein tests colorless and bromthymol blue tests blue in samples of the fish-tank water.

Based on the test results for the indicators phenolphthalein and bromthymol blue, what is the pH range of the fish-tank water?

34. Base your answers to the following questions on the information below.

The relative amount of acid or base in the soil can affect the flowers and plants that grow there. Hydrangeas, commonly called "snow ball" bushes, will have blue flowers if the soil is acidic and pink blossoms if the soil is basic.

*a* AHydrangea plant is producing blue flowers. Is the pH of the soil above, below, or at the pH of 7? Explain your answer.

*b* An indicator, bromthymol blue was used to test the soil. What color would you expect the indicator to be?

35. Base your answer to the following question on the information below and on your knowledge of chemistry.

 $\label{eq:ANaOH(aq)} \begin{array}{l} \text{ANaOH(aq)} \text{ solution and an acid-base indicator are used to determine the molarity of an} \\ \mathrm{HCl(aq)} \text{ solution. A 25.0-milliliter sample of the} \mathrm{HCl(aq)} \text{ is exactly neutralized by 15.0 milliliters of } 0.20 \ M \ \mathrm{NaOH(aq)}. \end{array}$ 

Based on the data, the calculated molarity of the  ${\rm HCl}({\rm aq})$  should be expressed to what number of significant figures?

36. Base your answer to the following question on the information below.

Three bottles of liquids labeled 1, 2, and 3 were found in a storeroom. One of the liquids is known to be drain cleaner. Drain cleaners commonly contain KOH or NaOH. The pH of each liquid at 25°C was determined with a pH meter. The table below shows the test results.

Bottle	pH of Liquid		
1	3.8		
2	7.0		
3	12.8		

pH Test Results

Explain, in terms of the pH values, why thymol blue is *not* a suitable indicator to distinguish between the contents of bottle 1 and bottle 2.

Base your answers to questions **37** and **38** on the graph below.

The graph shows the relationship between pH value and hydronium ion concentration for common aqueous solutions and mixtures.



## pH Versus Hydronium Ion Concentration

Hydronium Ion Concentration (M)

37. According to this graph, which mixture is approximately 100 times more acidic that milk of magnesia?

38. What is the hydronium ion concentration of tomato juice?

## Answer Key Acids and Bases 2017

1. 2. 3	$\frac{C}{A}$	31.	Examples: $(0.10 \text{ M})(9.50 \text{ mL}) = \text{M}_{\text{B}}$ (3.80 mL) or (0.1)(0.5)/2.8	36.	Examples: – The liquids in bottle 1 and bottle 2 both
4.	Ā	32	(0.1)(9.3)/3.8		but thymol blue does
5.	В	52.	setup. Acceptable		not change color
6	 D		responses include,		until the pH value
0. 7			but are not limited		– The pH range for
7. Q			$(M_A)(20.0 \text{ mL}) =$		the thymol blue
0. 0			(32.0  mL)(0.50  M)		color change is too
9. 10			$\frac{32(0.5)}{20}$	27	nign.
10.	A		• 0.80 M <i>or</i> for a	37.	seawater
11.	<u> </u>		with the student's	38.	0.0001 M
12.	D		numerical setup.		
13.	A		Significant figures		
14.	A		do <i>not</i> need to be shown		
15.	В		Note: Do <i>not</i> allow		
16.	D		credit for a		
17.	D		numerical setup and		
18.	D		are not related to the		
19.	В		concept assessed by		
20.	D		the question.		
21.	D	33.	<i>Examples</i> : $-7.6$ and $8.2 - 8.1$ and $7.7$		
22.	D	31	a The pH is below 7		
23.	_ <u>C</u>	54.	because blue flowers		
24.	В		are expressed in		
25.	D		acidic soil.		
26.	В		answer for a above		
27.	C		is below 7; Blue, if		
28	$-0H^{-}or$		the answer above is		
20.	hydroxide		basic.		
29.	— hydronium ion —	35.	2 or two		
	hydronium —				
	hydrogen ion —				
20	nydrogen				
30.	<i>Examples:</i> —methyl				
	bromthymol blue —				
	thymol blue				