Chemistry Review
Unit 9 – Acids, Bases, and Salts
Acids & Bases, Acid-Base Reactions, Salts, Normality

Acids, Bases and Salts
1. Behavior of many acids and bases can be explained by the Arrhenius theory. Arrhenius acids and bases are electrolytes.

2. An electrolyte is a substance which, when dissolved in water, forms a solution capable of conducting electricity. The ability to conduct electricity depends on the concentration of ions.

3. Arrhenius acids yield H+(aq) ions as the only positive ion in solution.
✓ H^+(aq) ions may also be written as H_3O^+(aq) ions (hydronium ions).

4. Arrhenius bases yield OH⁻(aq) ions as the only negative ion in solution.
✓ Organic compounds with OH^- are not bases.
✓ Ammonia (NH_3) is a base.

5. In neutralization reactions an Arrhenius acid and an Arrhenius base react to form salt and water.
✓ The <u>net ionic equation</u> for all neutralization reactions is the same: H^+(aq) + OH^- (aq) → H_2O (l)

6. Titration is a lab process in which a volume of a solution of known concentration is used to determine the concentration of another solution. Titration is a practical application of a neutralization reaction.

7. There are other acid-base theories besides the Arrhenius theory. One states that an acid is an H^+ donor and a base an H^+ acceptor.

8. The acidity or alkalinity of a solution can be measured by pH.
✓ A low pH indicates a higher concentration of H^+ ions than OH^- ions.
✓ A high pH indicates a lower concentration of H^+ ions than OH^- ions.
✓ A neutral pH (7) indicates an equal concentration of H^+ ions than OH^- ions.
✓ Pure water has a neutral pH.

9. On the pH scale, each decrease of one pH unit represents a <u>tenfold</u> increase in H^+ ion concentration.

August 2007

26 Which formula represents a hydronium ion?

(1) H_3O^+ (3) OH^-

(2) NH_4^+ (4) HCO_3^-

27 Which compound is an Arrhenius acid?

(1) H_2SO_4 (3) NaOH

(2) KCl   (4) NH_3

47 The table below shows the color of the indica-tors methyl orange and litmus in two samples of the same solution.

Results of Acid-Base Indicator Tests

Indicator	Color Result from the Indicator Test
methyl orange	yellow
litmus	red

Which pH value is consistent with the indicator results?

(1) 1   (3) 3

(2) 5   (4) 10

53 What color is bromcresol green after it is added to a sample of NaOH(aq)? [1]

53 _____

June 2007

25 An Arrhenius base yields which ion as the only negative ion in an aqueous solution?

(1) hydride ion   (3) hydronium ion
(2) hydrogen ion   (4) hydroxide ion

26 According to one acid-base theory, a water molecule acts as an acid when the water molecule

(1) accepts an H^+ (3) donates an H^+
(2) accepts an OH^- (4) donates an OH^-

48 Which two formulas represent Arrhenius acids?

(1) CH_3COOH and CH_3CH_2OH

(2) $HC_2H_3O_2$ and H_3PO_4

(3) $KHCO_3$ and $KHSO_4$

(4) NaSCN and $Na_2S_2O_3$

48 What is the pH of a solution that has a hydronium ion concentration 100 times greater than a solution with a pH of 4?

(1) 5   (3) 3
(2) 2   (4) 6

49 Information related to a titration experiment is given in the balanced equation and table below.

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(\ell)$$
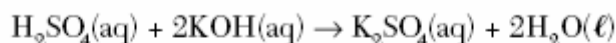
Titration Experiment Results

volume of H_2SO_4(aq) used	12.0 mL
concentration of H_2SO_4(aq)	?
volume of KOH(aq) used	36.0 mL
concentration of KOH(aq)	0.16 M

Based on the equation and the titration results, what is the concentration of the H_2SO_4(aq)?

(1) 0.12 M   (3) 0.24 M
(2) 0.16 M   (4) 0.96 M

Unit 9 – Acids, Bases, and Salts

Base your answers to questions 67 and 68 on the information below.

Sulfur dioxide, SO_2, is one gas produced when fossil fuels are burned. When this gas reacts with water in the atmosphere, an acid is produced forming acid rain. The pH of the water in a lake changes when acid rain collects in the lake.

Two samples of the same rainwater are tested using two indicators. Methyl orange is yellow in one sample of this rainwater. Litmus is red in the other sample of this rainwater.

67 Identify a possible pH value for the rainwater that was tested. [1]

68 Write the formula for *one* substance that can neutralize the lake water affected by acid rain. [1]

67 _____

68 _____

January 2007

30 Which ion is the only negative ion produced by an Arrhenius base in water?

(1) NO_3^- (3) OH^-

(2) Cl^- (4) H^-

47 In which 0.01 M solution is phenolphthalein pink?

(1) $CH_3OH(aq)$ (3) $CH_3COOH(aq)$

(2) $Ca(OH)_2(aq)$ (4) $HNO_3(aq)$

48 As the pH of a solution is changed from 3 to 6, the concentration of hydronium ions

(1) increases by a factor of 3
(2) increases by a factor of 1000
(3) decreases by a factor of 3
(4) decreases by a factor of 1000

64 Identify *two* indicators from Reference Table *M* that are yellow in solutions with a pH of 5.5. [1]

64 Indicator 1: _____

Indicator 2: _____

Unit 9 – Acids, Bases, and Salts

Base your answers to questions 78 through 81 on the information below.

In preparing to titrate an acid with a base, a student puts on goggles and an apron. The student uses burets to dispense and measure the acid and the base in the titration. In each of two trials, a 0.500 M NaOH(aq) solution is added to a flask containing a volume of HCl(aq) solution of unknown concentration. Phenolphthalein is the indicator used in the titration. The calculated volumes used for the two trials are recorded in the table below.

Volumes of Base and Acid Used in Titration Trials

Solution (aq)	Molarity (M)	Trial 1 Volume Used (mL)	Trial 2 Volume Used (mL)
NaOH	0.500	17.03	16.87
HCl	?	10.22	10.12

78 Write a chemical name for the acid used in the titration. [1]

79 Using the volumes from trial 1, determine the molarity of the HCl(aq) solution. [1]

80 Based on the information given in the table, how many significant figures should be shown in the calculated molarity of the HCl(aq) solution used in trial 2? [1]

81 Identify *one* additional safety precaution the student should have taken before performing the titration. [1]

78 _____

79 _____ M

80 _____

81 _____

_____

21 A substance is classified as an electrolyte because

(1) it has a high melting point
(2) it contains covalent bonds
(3) its aqueous solution conducts an electric current
(4) its aqueous solution has a pH value of 7

26 The compound NaOH(s) dissolves in water to yield

(1) hydroxide ions as the only negative ions
(2) hydroxide ions as the only positive ions
(3) hydronium ions as the only negative ions
(4) hydronium ions as the only positive ions

27 Which equation represents a neutralization reaction?

(1) $4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$
(2) $2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell)$
(3) $HNO_3(aq) + KOH(aq) \rightarrow$
$\quad KNO_3(aq) + H_2O(\ell)$
(4) $AgNO_3(aq) + KCl(aq) \rightarrow$
$\quad KNO_3(aq) + AgCl(s)$

50 Solution A has a pH of 3 and solution Z has a pH of 6. How many times greater is the hydronium ion concentration in solution A than the hydronium ion concentration in solution Z?

(1) 100   (3) 3
(2) 2   (4) 1000

Base your answers to questions 76 and 77 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	HCl(aq)	NaOH(aq)
Initial Buret Reading (mL)	15.50	5.00
Final Buret Reading (mL)	25.00	8.80

76 Determine *both* the total volume of HCl(aq) and the total volume of NaOH(aq) used in the titration.   [1]

77 In the space *in your answer booklet*, show a correct numerical setup for calculating the molarity of the sodium hydroxide solution.   [1]

76 _____ mL HCl(aq) and _____ mL NaOH(aq)

77

Unit 9 – Acids, Bases, and Salts

Base your answers to questions 80 and 81 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.

pH Test Results

Bottle	pH of Liquid
1	3.8
2	7.0
3	12.8

80 Explain how the pH results in this table enable a student to correctly conclude that bottle 3 contains the drain cleaner. [1]

81 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. [1]

80 _____

_____

_____

81 _____

_____

_____

June 2006

25 Which substance is an electrolyte?

(1) CH_3OH (3) H_2O
(2) $C_6H_{12}O_6$ (4) KOH

26 Which ion is the only negative ion present in an aqueous solution of an Arrhenius base?

(1) hydride ion   (3) hydronium ion
(2) hydrogen ion   (4) hydroxide ion

44 What volume of 0.500 M HNO_3(aq) must completely react to neutralize 100.0 milliliters of 0.100 M KOH(aq)?

(1) 10.0 mL   (3) 50.0 mL
(2) 20.0 mL   (4) 500. mL

47 Which reactants form the salt $CaSO_4$(s) in a neutralization reaction?

(1) H_2S(g) and $Ca(ClO_4)_2$(s)
(2) H_2SO_3(aq) and $Ca(NO_3)_2$(aq)
(3) H_2SO_4(aq) and $Ca(OH)_2$(aq)
(4) SO_2(g) and CaO(s)

48 A student tested a 0.1 M aqueous solution and made the following observations:

• conducts electricity
• turns blue litmus to red
• reacts with Zn(s) to produce gas bubbles

Which compound could be the solute in this solution?

(1) CH_3OH (3) HBr
(2) LiBr   (4) LiOH

Unit 9 – Acids, Bases, and Salts

Base your answers to questions 73 through 75 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
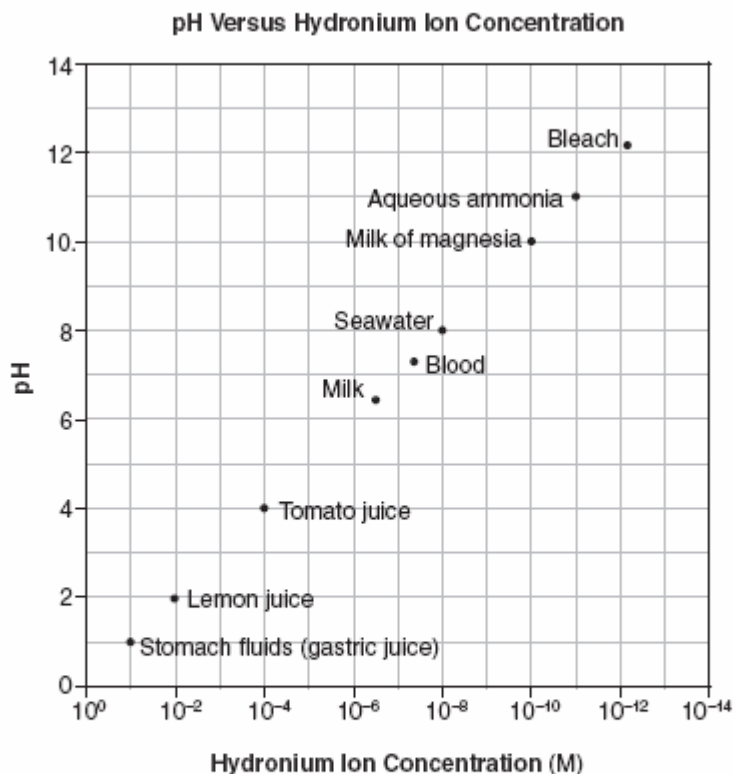
73 What is the hydronium ion concentration of tomato juice? [1]

74 What color is thymol blue when added to milk of magnesia? [1]

75 According to this graph, which mixture is approximately 100 times more acidic than milk of magnesia? [1]

73 _____ M

74 _____

75 _____

January 2006

17 Which substance is an Arrhenius base?

(1) KCl   (3) KOH
(2) CH_3Cl (4) CH_3OH

22 Which of the following aqueous solutions is the best conductor of electricity?

(1) 0.10 M CH_3OH (3) 0.10 M NaOH
(2) 1.0 M CH_3OH (4) 1.0 M NaOH

23 One acid-base theory states that an acid is

(1) an H^- donor   (3) an H^+ donor
(2) an H^- acceptor   (4) an H^+ acceptor

47 Which indicator is yellow in a solution with a pH of 9.8?

    (1) methyl orange   (3) bromcresol green
    (2) bromthymol blue   (4) thymol blue

48 How many milliliters of 0.100 M $NaOH(aq)$ would be needed to completely neutralize 50.0 milliliters of 0.300 M $HCl(aq)$?

    (1) 16.7 mL   (3) 150. mL
    (2) 50.0 mL   (4) 300. mL

Base your answers to questions 71 through 74 on the passage below.

      Acid rain lowers the pH in ponds and lakes and over time can cause the death of some aquatic life. Acid rain is caused in large part by the burning of fossil fuels in power plants and by gasoline-powered vehicles. The acids commonly associated with acid rain are sulfurous acid, sulfuric acid, and nitric acid.

      In general, fish can tolerate a pH range between 5 and 9. However, even small changes in pH can significantly affect the solubility and toxicity of common pollutants. Increased concentrations of these pollutants can adversely affect the behavior and normal life processes of fish and cause deformity, lower egg production, and less egg hatching.

71 Acid rain caused the pH of a body of water to decrease. Explain this pH decrease in terms of the change in concentration of hydronium ions. [1]

72 Write the chemical formula of a *negative* polyatomic ion present in an aqueous nitric acid solution. [1]

73 Using information in the passage, describe *one* effect of acid rain on future generations of fish species in ponds and lakes. [1]

74 Sulfur dioxide, SO_2, is one of the gases that reacts with water to produce acid rain. According to Reference Table G, describe how the solubility of sulfur dioxide in water is affected by an increase in water temperature. [1]

71 _____

   _____

   _____

72 _____

73 _____

   _____

74 _____

   _____

25 Which aqueous solution is the best conductor of an electrical current?

(1) 0.01 M CH$_3$OH   (3) 0.1 M CH$_3$OH

(2) 0.01 M KOH   (4) 0.1 M KOH

26 A hydrogen ion, H$^+$, in aqueous solution may also be written as

(1) H$_2$O   (3) H$_3$O$^+$

(2) H$_2$O$_2$ (4) OH$^-$

27 One acid-base theory states that an acid is

(1) an electron donor   (3) an H$^+$ donor

(2) a neutron donor   (4) an OH$^-$ donor

49 How are HNO$_3$(aq) and CH$_3$COOH(aq) similar?

(1) They are Arrhenius acids and they turn blue litmus red.

(2) They are Arrhenius acids and they turn red litmus blue.

(3) They are Arrhenius bases and they turn blue litmus red.

(4) They are Arrhenius bases and they turn red litmus blue.

Base your answers to questions 77 through 79 on the information below.

In a titration, 3.00 M NaOH(aq) was added to an Erlenmeyer flask containing 25.00 milliliters of HCl(aq) and three drops of phenolphthalein until one drop of the NaOH(aq) turned the solution a light-pink color. The following data were collected by a student performing this titration.

Initial NaOH(aq) buret reading: 14.45 milliliters

Final NaOH(aq) buret reading: 32.66 milliliters

77 What is the total volume of NaOH(aq) that was used in this titration? [1]

78 In the space *in your answer booklet*, show a correct numerical setup for calculating the molarity of the HCl(aq). [1]

79 Based on the data given, what is the correct number of significant figures that should be shown in the molarity of the HCl(aq)? [1]

77 _____ mL

78

79 _____

Base your answers to questions 80 through 82 on the information below.

A student was studying the pH differences in samples from two Adirondack streams. The student measured a pH of 4 in stream A and a pH of 6 in stream B.

80 Compare the hydronium ion concentration in stream A to the hydronium ion concentration in stream B. [1]

81 What is the color of bromthymol blue in the sample from stream A? [1]

82 Identify *one* compound that could be used to neutralize the sample from stream A. [1]

80 _____

_____

81 _____

82 _____

June 2005

27 Which formula represents an electrolyte?

(1) CH_3OCH_3 (3) CH_3COOH

(2) CH_3OH (4) C_2H_5CHO

28 When an Arrhenius acid dissolves in water, the only positive ion in the solution is

(1) H^+ (3) Na^+

(2) Li^+ (4) K^+

48 Sulfuric acid, H_2SO_4(aq), can be used to neutralize barium hydroxide, $Ba(OH)_2$(aq). What is the formula for the salt produced by this neutralization?

(1) BaS   (3) $BaSO_3$

(2) $BaSO_2$ (4) $BaSO_4$

50 In which solution will thymol blue indicator appear blue?

(1) 0.1 M CH_3COOH (3) 0.1 M HCl

(2) 0.1 M KOH   (4) 0.1 M H_2SO_4

Base your answers to questions 74 through 76 on the passage below.

     Acid rain is a problem in industrialized countries around the world. Oxides of sulfur and nitrogen are formed when various fuels are burned. These oxides dissolve in atmospheric water droplets that fall to earth as acid rain or acid snow.

     While normal rain has a pH between 5.0 and 6.0 due to the presence of dissolved carbon dioxide, acid rain often has a pH of 4.0 or lower. This level of acidity can damage trees and plants, leach minerals from the soil, and cause the death of aquatic animals and plants.

     If the pH of the soil is too low, then quicklime, CaO, can be added to the soil to increase the pH. Quicklime produces calcium hydroxide when it dissolves in water.

74 Balance the neutralization equation *in your answer booklet*, using the smallest whole-number coefficients. [1]

75 A sample of wet soil has a pH of 4.0. After the addition of quicklime, the H^+ ion concentration of the soil is $\frac{1}{100}$ of the original H^+ ion concentration of the soil. What is the new pH of the soil sample? [1]

76 Samples of acid rain are brought to a laboratory for analysis. Several titrations are performed and it is determined that a 20.0-milliliter sample of acid rain is neutralized with 6.50 milliliters of 0.010 M NaOH. What is the molarity of the H^+ ions in the acid rain? [1]

74 _____ HNO_3 + _____ $Ca(OH)_2$ → _____ $Ca(NO_3)_2$ + _____ H_2O
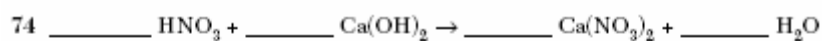
75 _____

76 _____ M

January 2005

25 The compound HNO_3 can be described as an

(1) Arrhenius acid and an electrolyte

(2) Arrhenius acid and a nonelectrolyte

(3) Arrhenius base and an electrolyte

(4) Arrhenius base and a nonelectrolyte

26 According to Reference Table *M*, what is the color of the indicator methyl orange in a solution that has a pH of 2?

(1) blue   (3) orange

(2) yellow   (4) red

27 Given the reaction:

$$NH_3 + HCl \rightarrow NH_4Cl$$

In this reaction, ammonia molecules (NH_3) act as a base because they

(1) accept hydrogen ions (H^+)

(2) accept hydroxide ions (OH^-)

(3) donate hydrogen ions (H^+)

(4) donate hydroxide ions (OH^-)

47 Which chemical equation represents the reaction of an Arrhenius acid and an Arrhenius base?

(1) $HC_2H_3O_2(aq) + NaOH(aq) \rightarrow$
    $NaC_2H_3O_2(aq) + H_2O(\ell)$
(2) $C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(\ell)$
(3) $Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
(4) $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow$
    $BaSO_4(s) + 2\ NaCl(aq)$

48 Based on Reference Table F, which of these saturated solutions has the *lowest* concentration of dissolved ions?

(1) $NaCl(aq)$ (3) $NiCl_2(aq)$
(2) $MgCl_2(aq)$ (4) $AgCl(aq)$

Base your answers to questions 63 through 65 on the information below.

In a titration experiment, a student uses a 1.4 M HBr(aq) solution and the indicator phenolphthalein to determine the concentration of a KOH(aq) solution. The data for trial 1 is recorded in the table below.

Trial 1

Buret Readings	HBr(aq)	KOH(aq)
Initial volume (mL)	7.50	11.00
Final volume (mL)	22.90	33.10
Volume used (mL)	15.40	22.10

63 In the space provided *in your answer booklet*, show a correct numerical setup for calculating the molarity of the KOH(aq) solution for trial 1. [1]

64 Why is it better to use several trials of a titration rather than one trial to determine the molarity of a solution of an unknown concentration? [1]

65 In a second trial of this experiment, the molarity of KOH(aq) was determined to be 0.95 M. The actual molarity was 0.83 M. What is the percent error in the second trial? [1]

63

64 _____

   _____

   _____

65 _____ %

27 Which compound is an Arrhenius base?

(1) CH_3OH (3) LiOH

(2) CO_2 (4) NO_2

28 The only positive ion found in an aqueous solution of sulfuric acid is the

(1) hydroxide ion   (3) sulfite ion
(2) hydronium ion   (4) sulfate ion

30 Which pH change represents a hundredfold increase in the concentration of H_3O^+?

(1) pH 5 to pH 7   (3) pH 3 to pH 1
(2) pH 13 to pH 14   (4) pH 4 to pH 3

48 Which statement correctly describes a solution with a pH of 9?

(1) It has a higher concentration of H_3O^+ than OH^- and causes litmus to turn blue.
(2) It has a higher concentration of OH^- than H_3O^+ and causes litmus to turn blue.
(3) It has a higher concentration of H_3O^+ than OH^- and causes methyl orange to turn yellow.
(4) It has a higher concentration of OH^- than H_3O^+ and causes methyl orange to turn red.

Base your answers to questions 79 through 81 on the information and data table below.

    Indigestion may be caused by excess stomach acid (hydrochloric acid). Some products used to treat indigestion contain magnesium hydroxide. The magnesium hydroxide neutralizes some of the stomach acid.
    The amount of acid that can be neutralized by three different brands of antacids is shown in the data table below.

Antacid Brand	Mass of Antacid Tablet (g)	Volume of HCl(aq) Neutralized (mL)
X	2.00	25.20
Y	1.20	18.65
Z	1.75	22.50

79 Based on Reference Table F, describe the solubility of magnesium hydroxide in water. [1]

80 In the space provided in your answer booklet, show a correct numerical setup for calculating the milliliters of HCl(aq) neutralized per gram of antacid tablet for each brand of antacid. [1]

81 Which antacid brand neutralizes the most acid per gram of antacid tablet? [1]

79 _____

80   X   Y   Z

81 _____

June 2004

14 Recovering the salt from a mixture of salt and water could best be accomplished by

(1) evaporation
(2) filtration
(3) paper chromatography
(4) density determination

28 Which pair of formulas represents two compounds that are electrolytes?

(1) HCl and CH_3OH
(2) HCl and NaOH
(3) C_5H_{12} and CH_3OH
(4) C_5H_{12} and NaOH

29 Hydrogen chloride, HCl, is classified as an Arrhenius acid because it produces

(1) H^+ ions in aqueous solution
(2) Cl^- ions in aqueous solution
(3) OH^- ions in aqueous solution
(4) NH_4^+ ions in aqueous solution

30 Which compound could serve as a reactant in a neutralization reaction?

(1) NaCl
(2) KOH
(3) CH_3OH
(4) CH_3CHO

45 Which pH indicates a basic solution?

(1) 1
(2) 5
(3) 7
(4) 12

Base your answers to questions 56 through 58 on the information below.

A student titrates 60.0 mL of HNO_3(aq) with 0.30 M NaOH(aq). Phenolphthalein is used as the indicator. After adding 42.2 mL of NaOH(aq), a color change remains for 25 seconds, and the student stops the titration.

56 What color change does phenolphthalein undergo during this titration?   [1]

57 In the space provided *in your answer booklet*, show a correct numerical setup for calculating the molarity of the HNO_3(aq).   [1]

58 According to the data, how many significant figures should be present in the calculated molarity of the HNO_3(aq)?   [1]

56 _____ to _____

57

58 _____

Unit 9 – Acids, Bases, and Salts

Base your answers to questions 65 through 67 on the information and equation below.

Antacids can be used to neutralize excess stomach acid. Brand A antacid contains the acid-neutralizing agent magnesium hydroxide, $Mg(OH)_2$. It reacts with $HCl(aq)$ in the stomach, according to the following balanced equation:

$$2\ HCl(aq) + Mg(OH)_2(s) \rightarrow MgCl_2(aq) + 2\ H_2O(\ell)$$

65 In the space provided *in your answer booklet*, show a correct numerical setup for calculating the number of moles of $Mg(OH)_2$ (gram-formula mass = 58.3 grams/mole) in an 8.40-gram sample. [1]

66 If a person produces 0.050 mole of excess HCl in the stomach, how many moles of $Mg(OH)_2$ are needed to neutralize this excess hydrochloric acid? [1]

67 Brand B antacid contains the acid-neutralizing agent sodium hydrogen carbonate. Write the chemical formula for sodium hydrogen carbonate. [1]

65

66 _____ mol

67 _____

85 A plan is being developed for an experiment to test the effect of concentrated strong acids on a metal surface protected by various coatings. Some safety precautions would be the wearing of chemical safety goggles, an apron, and gloves. State one additional safety precaution that should be included in the plan. [1]

85 _____

_____

January 2004

25 Which of these pH numbers indicates the highest level of acidity?

(1) 5   (3) 10
(2) 8   (4) 12

26 According to the Arrhenius theory, when a base dissolves in water it produces

(1) CO_3^{2-} as the only negative ion in solution

(2) OH^- as the only negative ion in solution

(3) NH_4^+ as the only positive ion in solution

(4) H^+ as the only positive ion in solution

27 Which compound is an electrolyte?

(1) $C_6H_{12}O_6$ (3) $CaCl_2$
(2) CH_3OH (4) CCl_4

Unit 9 – Acids, Bases, and Salts

32 The data table below represents the properties determined by the analysis of substances A, B, C, and D.

Substance	Melting Point (°C)	Boiling Point (°C)	Conductivity
A	−80	−20	none
B	20	190	none
C	320	770	as solid
D	800	1250	in solution

Which substance is an ionic compound?

(1) A

(2) B

(3) C

(4) D

35 Which solution when mixed with a drop of bromthymol blue will cause the indicator to change from blue to yellow?

(1) 0.1 M HCl

(2) 0.1 M NH_3

(3) 0.1 M CH_3OH

(4) 0.1 M NaOH

45 A student neutralized 16.4 milliliters of HCl by adding 12.7 milliliters of 0.620 M KOH. What was the molarity of the HCl acid?

(1) 0.168 M

(2) 0.480 M

(3) 0.620 M

(4) 0.801 M

Base your answers to questions 80 and 81 on the information below.

Calcium hydroxide is commonly known as agricultural lime and is used to adjust the soil pH. Before the lime was added to a field, the soil pH was 5. After the lime was added, the soil underwent a 100-fold decrease in hydronium ion concentration.

80 What is the new pH of the soil in the field? [1]

81 According to Reference Table F, calcium hydroxide is soluble in water. Identify another hydroxide compound that contains a Group 2 element and is also soluble in water. [1]

80 _____

81 _____

August 2003

9 Based on Reference Table F, which of these salts is the best electrolyte?

(1) sodium nitrate

(2) magnesium carbonate

(3) silver chloride

(4) barium sulfate

28 When the pH of a solution changes from a pH of 5 to a pH of 3, the hydronium ion concentration is

(1) 0.01 of the original content

(2) 0.1 of the original content

(3) 10 times the original content

(4) 100 times the original content

29 A sample of $Ca(OH)_2$ is considered to be an Arrhenius base because it dissolves in water to yield

(1) Ca^{2+} ions as the only positive ions in solution

(2) H_3O^+ ions as the only positive ions in solution

(3) OH^- ions as the only negative ions in solution

(4) H^- ions as the only negative ions in solution

30 Which reaction occurs when hydrogen ions react with hydroxide ions to form water?

(1) substitution

(2) saponification

(3) ionization

(4) neutralization

Unit 9 – Acids, Bases, and Salts

Base your answers to questions 75 through 78 on the article below and on your knowledge of chemistry.

Fizzies — A Splash from the Past

They're baaack . . . a splash from the past! Fizzies instant sparkling drink tablets, popular in the 1950s and 1960s, are now back on the market. What sets them apart from other powdered drinks is that they bubble and fizz when placed in water, forming an instant carbonated beverage.

The fizz in Fizzies is caused by bubbles of carbon dioxide (CO_2) gas that are released when the tablet is dropped into water. Careful observation reveals that these bubbles rise to the surface because CO_2 gas is much less dense than water. However, not all of the CO_2 gas rises to the surface; some of it dissolves in the water. The dissolved CO_2 can react with water to form carbonic acid, H_2CO_3.

$$H_2O(\ell) + CO_2(aq) \rightleftharpoons H_2CO_3(aq)$$
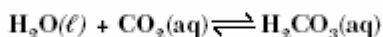
The pH of the Fizzies drink registers between 5 and 6, showing that the resulting solution is clearly acidic. Carbonic acid is found in other carbonated beverages as well. One of the ingredients on any soft drink label is carbonated water, which is another name for carbonic acid. However, in the production of soft drinks, the CO_2 is pumped into the solution under high pressure at the bottling plant.

— Brian Rohrig
Excerpted from "Fizzies—A Splash from the Past,"
Chem Matters, February 1998

75 What is the only positive ion in an aqueous solution of carbonic acid?   [1]

76 CO_2 is pumped into the soft drink solution under high pressure. Why is high pressure necessary?   [1]

77 Describe the solubility of CO_2 gas in water.   [1]

78 Explain your response to question 77 in terms of the *molecular polarities* of $CO_2(g)$ and $H_2O(\ell)$.   [1]

75 _____

76 _____

_____

77 _____

78 CO_2: _____

H_2O: _____

14 According to Table F, which of these salts is *least* soluble in water?

(1) LiCl   (3) $FeCl_2$
(2) RbCl   (4) $PbCl_2$

23 At standard pressure when NaCl is added to water, the solution will have a

(1) higher freezing point and a lower boiling point than water
(2) higher freezing point and a higher boiling point than water
(3) lower freezing point and a higher boiling point than water
(4) lower freezing point and a lower boiling point than water

29 Which 0.1 M solution contains an electrolyte?

(1) $C_6H_{12}O_6$(aq)   (3) CH_3OH(aq)
(2) CH_3COOH(aq)   (4) CH_3OCH_3(aq)

30 Which equation represents a neutralization reaction?

(1) $Na_2CO_3 + CaCl_2 \rightarrow 2\ NaCl + CaCO_3$
(2) $Ni(NO_3)_2 + H_2S \rightarrow NiS + 2\ HNO_3$
(3) $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$
(4) $H_2SO_4 + Mg(OH)_2 \rightarrow MgSO_4 + 2\ H_2O$

31 An Arrhenius acid has

(1) only hydroxide ions in solution
(2) only hydrogen ions in solution
(3) hydrogen ions as the only positive ions in solution
(4) hydrogen ions as the only negative ions in solution

48 A student was given four unknown solutions. Each solution was checked for conductivity and tested with phenolphthalein. The results are shown in the data table below.

Solution	Conductivity	Color with Phenolphthalein
A	Good	Colorless
B	Poor	Colorless
C	Good	Pink
D	Poor	Pink

Based on the data table, which unknown solution could be 0.1 M NaOH?

(1) A   (3) C
(2) B   (4) D

66 A student recorded the following buret readings during a titration of a base with an acid:

	Standard 0.100 M HCl	Unknown KOH
Initial reading	9.08 mL	0.55 mL
Final reading	19.09 mL	5.56 mL

a In the space provided *in your answer booklet*, calculate the molarity of the KOH. Show all work. [1]

b Record your answer to the correct number of significant figures. [1]

66 a

b _____ M

Unit 9 – Acids, Bases, and Salts

Base your answers to questions 77 through 79 on the information below.

A truck carrying concentrated nitric acid overturns and spills its contents. The acid drains into a nearby pond. The pH of the pond water was 8.0 before the spill. After the spill, the pond water is 1,000 times more acidic.

77 Name an ion in the pond water that has increased in concentration due to this spill. [1]

78 What is the new pH of the pond water after the spill? [1]

79 What color would bromthymol blue be at this new pH? [1]

77 _____

78 _____

79 _____

January 2003

19 What occurs when NaCl(s) is added to water?

 (1) The boiling point of the solution increases, and the freezing point of the solution decreases.
 (2) The boiling point of the solution increases, and the freezing point of the solution increases.
 (3) The boiling point of the solution decreases, and the freezing point of the solution decreases.
 (4) The boiling point of the solution decreases, and the freezing point of the solution increases.

23 Which of these 1 M solutions will have the highest pH?

 (1) NaOH   (3) HCl
 (2) CH_3OH (4) NaCl

30 Which species can conduct an electric current?

 (1) NaOH(s)   (3) H_2O(s)
 (2) CH_3OH(aq)   (4) HCl(aq)

32 Given the following solutions:

 Solution A: pH of 10
 Solution B: pH of 7
 Solution C: pH of 5

Which list has the solutions placed in order of increasing H^+ concentration?

 (1) A, B, C   (3) C, A, B
 (2) B, A, C   (4) C, B, A

34 A compound whose water solution conducts electricity and turns phenolphthalein pink is

 (1) HCl   (3) NaOH
 (2) $HC_2H_3O_2$ (4) CH_3OH

46 According to Reference Table J, which of these metals will react most readily with 1.0 M HCl to produce H_2(g)?

 (1) Ca   (3) Mg
 (2) K   (4) Zn

Unit 9 – Acids, Bases, and Salts

Base your answers to question 71 through 74 on the information and data table below.

A titration setup was used to determine the unknown molar concentration of a solution of NaOH. A 1.2 M HCl solution was used as the titration standard. The following data were collected.

	Trial 1	Trial 2	Trial 3	Trial 4
Amount of HCl Standard Used	10.0 mL	10.0 mL	10.0 mL	10.0 mL
Initial NaOH Buret Reading	0.0 mL	12.2 mL	23.2 mL	35.2 mL
Final NaOH Buret Reading	12.2 mL	23.2 mL	35.2 mL	47.7 mL

71 Calculate the volume of NaOH solution used to neutralize 10.0 mL of the standard HCl solution in trial 3. Show your work.   [2]

72 According to Reference Table M, what indicator would be most appropriate in determining the end point of this titration? Give one reason for choosing this indicator.   [2]

73 Calculate the average molarity of the unknown NaOH solution for all four trials. Your answer must include the correct number of significant figures and correct units.   [3]

74 Explain why it is better to use the average data from multiple trials rather than the data from a single trial to calculate the results of the titration.   [1]

71

_____ mL

72 Indicator: _____

Reason: _____

_____

_____

73

_____

74 _____

_____

_____