Chem 1A

Sample Final Exam

Name: ____________________________  Last Name  First Name

Perm Number: _______________________

First Letter of your last name: ________

Instructions: No hats or hoods allowed. No books or notes allowed. No sharing of calculators. Cell phones, iPods, headsets/headphones, and any other electronic devices must be turned off and put away. If you are using a cell phone or any unauthorized electronic device during the exam, your score for the exam will be a zero.

There are a total of 16 pages (40 questions) on the exam. Not every question is worth the same number of points--point values are indicated for each question.

Carefully bubble in your Perm number, form letter, and answers on your ParSCORE form. Fill in all bubbles completely.

You must show photo ID (preferably your Access Card) when you turn in your exam and ParSCORE form.

1. Which of the following statements is/are incorrect?

   I. MgCl₂ is called magnesium chloride
   II. ZnO is called zinc(II) oxide
   III. CoS₂ is called cobalt(III) sulfide

   a) I only
   b) II only
   c) III only
   d) II and III
   e) I, II, and III

2. How many chlorine atoms are there in 64.3 grams of chlorine gas?

   a) 2.73x10²³
   b) 5.46x10²³
   c) 6.02x10²³
   d) 1.09x10²⁴
   e) none of these
3. One mole of a compound is added to a liter of water, producing 3 moles of ions in solution. What is the identity of the compound?

a) $\text{AgNO}_3$

b) $\text{MgF}_2$

c) $\text{CaBr}_2$

d) $\text{FeCl}_3$

e) more than one of these

4. Which pair of symbols corresponds to species with the same number of electrons?

a) $\frac{32}{16}_S$ and $\frac{27}{13}_Al$

b) $\frac{7}{3}_Li$ and $\frac{23}{11}_Na$

c) $\frac{40}{20}_{Ca}^{2+}$ and $\frac{51}{23}_{V}^{5+}$

d) $\frac{56}{23}_{Fe}^{3+}$ and $\frac{52}{24}_{Cr}^{6+}$

e) more than one of these answers is correct.

5. When hydrocyanic acid (HCN) is added to sodium hydroxide (NaOH), what is the net ionic equation for the reaction that occurs?

a) $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$

b) $\text{HCN} + \text{OH}^- \rightarrow \text{CN}^- + \text{H}_2\text{O}$

c) $\text{HCN} + \text{Na}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{CN}^- + \text{Na}^+$

d) $\text{HCN} + \text{NaOH} \rightarrow \text{NaCN} + \text{H}_2\text{O}$

e) $\text{H}^+ + \text{CN}^- + \text{Na}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{NaCN}$

6. A monoprotic weak acid (HA) is titrated with sodium hydroxide. In the middle of the buffer region, will the resulting solution be acidic, basic, or neutral?

a) acidic

b) basic

c) neutral

d) more information is needed
7. Consider the following reactions at equilibrium:

\[ \text{H}_2 (g) + \text{N}_2 (g) \rightleftharpoons \text{NH}_3 (g) \]

\[ \text{NH}_3 (g) + \text{H}_2\text{O} (l) \rightleftharpoons \text{NH}_4^+ (aq) + \text{OH}^- (aq) \]

What will happen if HCl (aq) is added to the reaction?

a) The partial pressure of N\(_2\) (g) will decrease
b) The partial pressure of H\(_2\) (g) will increase
c) The base dissociation constant (K_b) for NH\(_3\) will decrease
d) The concentration of NH\(_4^+\) (aq) will decrease
e) There will be no change

Questions 8 & 9. Consider the following unbalanced oxidation/reduction reaction that takes place in a basic solution.

\[ \text{MnO}_4^- + \text{C}_2\text{O}_4^{2-} \rightarrow \text{MnO}_2 + \text{CO}_2 \]

8. What is the reducing agent in this reaction?

a) MnO\(_4^-\)
b) MnO\(_2\)
c) C\(_2\)O\(_4^{2-}\)
d) CO\(_2\)
e) none of these

9. What is the coefficient in front of H\(_2\)O when this equation is balanced with lowest whole number coefficients?

a) 4
b) 8
c) 6
d) 2
e) none of these
Questions 10-11. Consider the dissociation of the salt barium phosphate in water.

10. If $K_{sp} = 3.8 \times 10^{-35}$, then what is the solubility for barium phosphate in water?

a) 0.0 mol/L.
b) $9.1 \times 10^{-9}$ mol/L
c) $6.2 \times 10^{-18}$ mol/L
d) $5.1 \times 10^{-9}$ mol/L
e) none of these

11. If solid $(NH_4)_3PO_4$ is added to the barium phosphate solution at a constant temperature, what will happen? Assume that the volume of added $(NH_4)_3PO_4$ is negligible.

a) Solubility increases, $K_{sp}$ increases
b) Solubility increases, $K_{sp}$ does not change
c) Solubility decreases, $K_{sp}$ does not change
d) Solubility decreases, $K_{sp}$ decreases
e) none of these

12. Which of the following compounds is/are strong electrolytes?

I. HNO$_3$
II. HCN
III. P$_2$O$_5$

a) I. only
b) II. only
c) I. and III. only
d) I. and II. only
e) I., II., and III.

13. Consider the following reaction at equilibrium:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + heat$$

$K_p = 5.3 \times 10^5$ at 298K

Which of the following will cause the reaction to shift to the right?

a) Decrease the volume of the container at constant temperature
b) Increase temperature at a constant volume
c) Increase the partial pressure of $H_2$
d) (a) and (c) will cause the reaction to shift to the right
e) (a), (b), and (c) will cause the reaction to shift to the right
14. Which of the following mixtures results in the formation of a buffer?

I. 10 mL of 1.0 M HNO₃ mixed with 10 mL of 1.0 M NaNO₃
II. 10 mL of 1.0 M NaHCO₃ mixed with 12 mL of 1.0 M Na₂CO₃
III. 10 mL of 1.0 M HCN mixed with 8 mL of 1.0 M NaOH

a) I. only
b) II. only
c) I. and II.
d) II. and III.
e) I., II., and III.

15. Which of the following solutions will be the best buffer at a pH of 4.74?

(\(K_a\) for HCHO₂ is \(1.8 \times 10^{-5}\); \(K_b\) for \(\text{NH}_3\) is \(1.8 \times 10^{-5}\))

a) 0.10 M \(\text{NH}_3\) and 0.10 M \(\text{NH}_4\)Cl
b) 3.0 M HCHO₂ and 3.0 M \(\text{NH}_4\)Cl
c) 0.10 M HCHO₂ and 0.10 M NaC₂H₃O₂
d) 3.0 M HCHO₂ and 3.0 M NaC₂H₃O₂
e) 3.0 M HCHO₂ and 3.0 M \(\text{NH}_3\)

16. 115.3 mL of a 4.40 M potassium bromide solution is diluted to 1.5 L. What is the molarity of the diluted solution?

a) 0.338 M
b) 0.507 M
c) 338 M
d) 5.07 M
e) none of these
17. 35.0 grams of sodium reacts with 163.0 grams of iodine to form 53.8 grams of sodium iodide. The molar mass of sodium iodide is 149.89 g/mol. What is the percent yield for this reaction?

a) 27.9%
b) 23.9%
c) 35.9%
d) 100.0%
e) none of these

18. Calculate the pH of a solution made by mixing 15 mL of 1.0 M HF with 12 mL of 1.0 M NaF at 25°C. Assume that the volumes are additive.

a) 9.0
b) 3.2
c) 3.0
d) 7.0
e) none of these

19. How many milliliters of 0.5 M calcium hydroxide are required to neutralize 25 mL of 0.8 M hydrochloric acid?

a) 40.0 mL
b) 25 mL
c) 20.0 mL
d) 10.0 mL
e) none of these
20. Elemental analysis of a compound shows that it is 63.2% carbon, 8.76% hydrogen, and 28.1% oxygen by mass. What is the empirical formula of the compound?

a) $\text{C}_{0.632}\text{H}_{0.0876}\text{O}_{0.281}$
b) $\text{C}_3\text{H}_2\text{O}$
c) $\text{C}_2\text{H}_6\text{O}$
d) $\text{CH}_2\text{O}$
e) none of these

21. 125 mL of a 0.50 M solution of lead(II) nitrate is mixed with 50 mL of a 0.90 M solution of potassium sulfate. What is $[\text{Pb}^{2+}]$ in solution after the reaction has gone to completion?

a) 0.0 M
b) 0.10 M
c) 0.14 M
d) 0.36 M
e) none of these
22. Which compound has the greatest number of oxygen atoms in a 100 gram sample?

a) MgO  
b) HCH₂COO  
c) CO₂  
d) C₆H₁₂O₆  
e) more than one of these

23. Sodium metal is reacted with excess aqueous HCl to form aqueous NaCl and H₂ gas. If 432 mL of H₂ is collected over water at 25°C and a total pressure of 763 torr, how much sodium reacted? Assume ideal gas behavior. The vapor pressure of water at 25°C is 23.8 torr. The molar mass of Na = 23 g/mol.

a) 9.4 g  
b) 0.82 g  
c) 0.79 g  
d) 0.40 g  
e) none of these

24. A sample of an unknown gas diffuses at half the rate of helium. What is the density of the unknown gas at STP? Assume ideal gas behavior.

a) 16 g/L  
b) 0.83 g/L  
c) 0.045 g/L  
d) 0.71 g/L  
e) none of these
25. A mixture of gas contains 20 grams of oxygen gas and 83 grams of methane (CH₄) gas. If the total pressure is 850 torr, what is the partial pressure of oxygen gas?

a) 91.5 torr  

b) 165 torr  
c) 102 torr  
d) 531 torr  
e) none of these

26. Consider the following reactions:

\[ \text{SO}_2 (g) + \frac{1}{2} \text{O}_2 (g) \rightleftharpoons \text{SO}_3 (g) \quad K_p = 3.2 \]
\[ \text{NO} (g) + \frac{1}{2} \text{O}_2 (g) \rightleftharpoons \text{NO}_2 (g) \quad K_p = 0.6 \]

What is the equilibrium constant \( K_p \) for the reaction:

\[ \text{SO}_2 (g) + \text{NO}_2 (g) \rightleftharpoons \text{NO} (g) + \text{SO}_3 (g) \quad K_p = ? \]

a) 5.3  
b) 3.8  
c) 1.9  
d) 2.6  
e) none of these

27. At what temperature is the average speed of O₂ equal to half the average speed of Ne at 25°C?

a) -154°C  
b) -124°C  
c) 119°C  
d) 12.5°C  
e) none of these
28. Calculate the percent dissociation for a 4.0 M hydrocyanic acid solution.

a) 0.0050%
b) 100%
c) 4.0%
d) 0.0012%
e) none of these

29. Calculate the pH of a $1 \times 10^{-10}$ M solution of HNO$_3$

a) 1
b) 10
c) 5
d) 7
e) none of these.

30. Calculate the pH of a 1.0 M solution of NaF

a) 1.6
b) 7.0
c) 12
d) 14
e) none of these
31. Consider the following reaction:

\[ \text{CaCO}_3 (s) \rightleftharpoons \text{CaO} (s) + \text{CO}_2 (g) \quad K = 0.16 \]

200. grams of CaCO\(_3\) (molar mass = 100. g/mol) was introduced into an otherwise empty 4.0 L rigid container. At equilibrium, how many grams of CaCO\(_3\) remain?

- a) 136 g
- b) 184 g
- c) 114 g
- d) 200. g
- e) none of these

32. How many mmoles of HCl must be added to 140.0 mL of a 0.20 M solution of CH\(_3\)NH\(_2\) (a weak base with pK\(_b\) = 3.36) to give a buffer having a pH of 11.30?

- a) 28 mmol
- b) 0.22 mmol
- c) 5.0 mmol
- d) 4.8 mmol
- e) 0.44 mmol
33. A 50.0 mL sample of buffer solution was prepared in which [NaCN] = 1.6 M and [HCN] = 1.2 M. To this buffer solution, 12.0 mL of 1.0 M NaOH was added. What is the pH of the solution after adding the NaOH?

a) 9.5  
b) 9.2  
c) 4.5  
d) 7.0  
e) none of these

34. How many grams of NaCH₃COO must be added to 3.2 L of water at 25°C to prepare a solution with a pH of 9.1? Assume that the volume of the NaCH₃COO is negligible.

a) 0.89 g  
b) 73 g  
c) 2.9x10⁻⁷ g  
d) 23 g  
e) none of these
35. Consider the following reaction: \( S_8 (s) + 24 \text{F}_2 (g) \rightarrow 8 \text{SF}_6 (g) \)
How many grams of \( \text{F}_2 \) are left over if you react 36.0 grams of \( S_8 \) with 400.0 grams of \( \text{F}_2? \) The reaction has a 73.8% yield.

a) 8.04 g 
b) 104 g 
c) 305 g 
d) 358 g 
e) none of these

36. Silver has two stable isotopes, \(^{107}\text{Ag} \) (mass = 106.907 amu) and \(^{109}\text{Ag} \) (mass = 108.910 amu). What is the abundance of \(^{107}\text{Ag}? \) Note: you must use 107.868 amu as the average molar mass of silver.

a) 52.0% 
b) 37.6% 
c) 48.2% 
d) 0.00% 
e) 62.4%
37. A 50 mL sample of 1.9 M hydrocyanic acid (HCN) is titrated with 1.9 M NaOH. What is the pH at the equivalence point in the titration?

a) 7.0  
b) 9.2  
c) 11.1  
d) 2.9  
e) 11.6

38. The pH of a 1.4 M solution of weak acid HA is 2.5. Calculate $K_b$ for the conjugate base $A^-$. 

a) 4.46  
b) 3.16x10^{-3}  
c) 6.42x10^{-8}  
d) 7.14x10^{-6}  
e) 1.40x10^{-9}
39. Consider the following apparatus consisting of two chambers (A and B) separated by a closed valve.

\[ A \quad H_2 \quad \rightarrow \quad B \quad O_2 \]

Chamber A has a volume of 3.0 L and is filled with 2.0 atm of hydrogen gas at 400K. Chamber B has a volume of 2.0 L and is filled with 3.0 atm of oxygen gas at 400K. The valve between the two chambers is opened, and the hydrogen and oxygen gas react to form water. What is the total pressure in the apparatus? Assume ideal gas behavior and that the reaction goes to completion.

a) 1.2 atm  
b) 1.8 atm  
c) 5.0 atm  
d) 2.4 atm  
e) none of these
40. Consider the following reaction: \( \text{N}_2\text{O}_4 \rightleftharpoons 2 \text{NO}_2 \) \( K_p = 70.9 \)

A certain pressure of \( \text{N}_2\text{O}_4 \) is initially added to an otherwise empty rigid vessel. At equilibrium, 25.8% of the \( \text{N}_2\text{O}_4 \) remains. What is the partial pressure of \( \text{NO}_2 \) at equilibrium?

a) 102 atm  
b) 6.2 atm  
c) 51.0 atm  
d) 12.3 atm  
e) 24.7 atm

Answers:
Chem. 1A Final Exam

December 13, 2007

Name: 

Last Name First Name

Perm #

There are a total of nine pages (32 questions) on the exam. Each question is worth 5 points. You must show your work on the exam. We can evaluate your exam only if you have shown work.

You must show your picture ID when you turn in your exam.

SCANTRON FORM: Use a PENCIL
1) Write your name
2) Bubble in FORM A
3) Bubble in your PERM number (7 digits only, no extra numbers)

INFORMATION PAGE: An information page is provided separately. You are also allowed one 8.5 by 11" page of your own notes. No other notes or books are allowed.

INSTRUCTIONS: No hats allowed. No sharing of calculators. Cell Phones, iPods, headsets, etc. must be turned off and put away. ANSWERS are given on the last page.

1. Which of the following compounds does not have the correct chemical formula or does not have the correct name?
   a) Li₂O lithium oxide
   b) FePO₄ iron(III) phosphate
   c) HF hydrogen fluoride
   d) N₂O nitrogen dioxide
   e) Mg₃N₂ magnesium nitride

2. Which of the following is true?
   a) 
   b) 
   c) 
   d) 
   e) 

3. A metal oxide contains 83.0% metal by mass. Determine the identity of the metal.
   a) Na
   b) Ca
   c) K
   d) Rb
   e) Sr
4. How many atoms of nitrogen are present in 3.52 g of calcium nitrate?
   a) $1.29 \times 10^{22}$
   b) $2.58 \times 10^{22}$
   c) $1.02 \times 10^{24}$
   d) $6.02 \times 10^{23}$
   e) $2.08 \times 10^{22}$

5. A solution is prepared by dissolving 0.115 moles of ammonium sulfate, $(NH_4)_2SO_4$, in enough water to make 100.0 mL of stock solution. A 11.00 mL sample of this stock solution is added to 50.00 mL of water. Calculate the concentration of ammonium ions in the final solution.
   a) 1.15 M
   b) 0.51 M
   c) 0.41 M
   d) 0.21 M
   e) 1.53 M

6. Silver chloride can be prepared by the reaction of 100.0 mL of 0.20 M silver nitrate with 100.0 mL of 0.15 M calcium chloride. After the reaction goes to completion, what concentration of which ion remains in solution?
   a) 0.05 M Cl$^-$
   b) 0.025 M Ca$^{2+}$
   c) 0.05 M Ag$^+$
   d) 0.025 M Cl$^-$
   e) 0.025 M Ag$^+$

7. Consider the following reaction: $2\text{NOBr}(g) \rightleftharpoons 2\text{NO}(g) + \text{Br}_2(g)$

   A 1.0-liter vessel was initially filled with pure NOBr, at a pressure of 4.0 atm, at 300 K. After equilibrium was established, the partial pressure of NOBr was 2.5 atm. What is $K_p$ for the reaction?
   a) 0.45
   b) 0.27
   c) 0.18
   d) 0.75
   e) 0.14
8. Nitric oxide, an important pollutant in air, is formed from the elements nitrogen and oxygen at high temperatures, such as those obtained when gasoline burns in an automobile engine.

\[ \text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) \]

For this reaction the equilibrium constant, \( K = 0.01 \) at 2000 °C. Predict the direction in which the system will move to reach equilibrium at 2000 °C if 0.4 moles of \( \text{N}_2 \), 0.1 moles of \( \text{O}_2 \), and 0.08 moles of \( \text{NO} \) are placed in a 1.0-liter container.

a) The system remains unchanged.
b) The concentration of \( \text{NO} \) will decrease; the concentrations of \( \text{N}_2 \) and \( \text{O}_2 \) will increase.
c) The concentration of \( \text{NO} \) will increase; the concentrations of \( \text{N}_2 \) and \( \text{O}_2 \) will decrease.
d) The concentration of \( \text{NO} \) will decrease; the concentrations of \( \text{N}_2 \) and \( \text{O}_2 \) will remain unchanged.
e) More information is necessary.

9. Consider the following three equilibria occurring simultaneously in solution.

\[ \text{Ca}^{2+} \text{(aq)} + \text{CO}_3^{2-} \text{(aq)} \rightleftharpoons \text{CaCO}_3 \text{(s)} \]  
\[ \text{HCO}_3^- \text{(aq)} \rightleftharpoons \text{H}^+ \text{(aq)} + \text{CO}_3^{2-} \text{(aq)} \]  
\[ \text{HCO}_3^- \text{(aq)} + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 \text{(aq)} + \text{OH}^- \text{(aq)} \]

If \( \text{NaOH} \) is added to the solution, will the amount of \( \text{CaCO}_3 \text{(s)} \) precipitate increase or decrease or stay the same?

a) Increase
b) Decrease
c) Stay the same

d) The same

e) The same

10. When the equation below is balanced using integer coefficients, what is the coefficient in front of \( \text{K}_2\text{CrO}_4 \)?

\[ \text{FeCr}_2\text{O}_4 + \text{K}_2\text{CO}_3 + \text{O}_2 \rightarrow \text{K}_2\text{CrO}_4 + \text{Fe}_2\text{O}_3 + \text{CO}_2 \]

a) 8
b) 4
c) 1
d) 2
e) 6

11. How many moles of sodium phosphate are required to react completely with 6.0 moles of calcium nitrate to form sodium nitrate and calcium phosphate?

a) 1.0 mol
b) 2.0 mol
c) 4.0 mol
d) 6.0 mol
e) 8.0 mol
12. 10.0 g of Al and 10.0 g Br₂ react according to the equation \[ 2 \text{Al} + 3 \text{Br}_2 \rightarrow 2 \text{AlBr}_3 \] What mass of AlBr₃ is formed, assuming 100% yield?

a) 10.0 g  
b) 11.1 g  
c) 25.0 g  
d) 98.8 g  
e) 110 g

13. A 4.40-g piece of solid CO₂ (dry ice) is allowed to sublime in a balloon. The final volume of the balloon is 1.00 L at 300 K. What is the pressure of the gas?

a) 2.46 atm  
b) 246 atm  
c) 0.122 atm  
d) 122 atm  
e) none of these

14. Which of the following relationships is not true?

a) PV = constant when temperature and moles of gas are held constant.  
b) V/T = constant when pressure and moles of gas are held constant.  
c) nT = constant when pressure and volume are held constant.  
d) P/n = constant when volume and temperature are held constant.  
e) All of the above are true.

15. Consider a sample of neon gas in a container fitted with a moveable piston (assume the piston is massless and frictionless). The temperature of the gas is increased from 20.0 °C to 40.0 °C. The density of neon _________.

a) increases less than 10%.  
b) decreases less than 10%.  
c) increases more than 10%.  
d) decreases more than 10%.  
e) does not change.
16. A sample of nitrogen gas has a volume of 160.0 mL at STP. What volume does the gas occupy if the absolute temperature and pressure are each doubled?
   a) 40.00 mL  
   b) 80.00 mL  
   c) 160.0 mL  
   d) 320.0 mL  
   e) 640.0 mL

17. Body temperature is about 308 K. On a cold day, what volume of air at 273 K must a person with a lung capacity of 2.00 L breathe in to fill the lungs?
   a) 2.26 L  
   b) 1.77 L  
   c) 1.13 L  
   d) 3.54 L  
   e) none of these

18. Given a cylinder of fixed volume filled with 1 mol of argon gas, which of the following is correct? (Assume all gases obey the ideal gas law.)
   a) If the temperature of the cylinder is changed from 25 °C to 50 °C, the pressure inside the cylinder will double.  
   b) If a second mole of argon is added to the cylinder, the ratio T/P would remain constant.  
   c) A cylinder of identical volume filled with the same pressure of helium must contain more atoms of He gas because He has a smaller atomic radius than argon.  
   d) (a) and (b) are both correct.  
   c) None of the above statements are correct.

19. The two main components in air are nitrogen and oxygen gas. Air is 79% N₂ and 21% O₂ by volume. Considering only N₂ and O₂ in air, calculate the density of air at 1.0 atm, 25 °C.
   a) 0.590 g/L  
   b) 1.18 g/L  
   c) 2.46 g/L  
   d) 14.1 g/L  
   e) None of the above.
20. Consider a solution of 2.0 M HCN and 1.0 M NaCN. Which of the following statements is true?
   a) The solution is not a buffer because [HCN] is not equal to [CN⁻].
   b) The pH will be below 7.00 because the concentration of the acid is greater than that of the base.
   c) [OH⁻] > [H⁺]
   d) The buffer will be more resistant to pH changes from addition of strong acid than of strong base.
   e) All of the above are false.

21. If 25 mL of 0.75 M HCl are added to 100 mL of 0.25 M NaOH, what is the final pH?
   a) 12.7
   b) 12.8
   c) 1.30
   d) 1.20
   e) 7.00

22. A 50.0-mL sample of 0.10 M HNO₂ is titrated with 0.10 M NaOH. What is the pH after 25.0 mL of NaOH have been added?
   a) 7.00
   b) 1.00
   c) 12.50
   d) 3.34
   e) 2.48

23. Which of the following solutions has the lowest pH?
   a) 1.0 M NaNO₃
   b) 1.0 M KOH
   c) 1.0 M KCN
   d) 1.0 M NH₃
24. Which of the following is the net ionic equation for the reaction that occurs during the titration of nitrous acid, HNO₂, with potassium hydroxide, KOH?

a) \( \text{HNO}_2 + \text{K}^+ + \text{OH}^- \rightleftharpoons \text{KNO}_2 + \text{H}_2\text{O} \)

b) \( \text{HNO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{NO}_2^- + \text{H}_3\text{O}^+ \)

c) \( \text{HNO}_2 + \text{KOH} \rightleftharpoons \text{K}^+ + \text{NO}_2^- + \text{H}_2\text{O} \)

d) \( \text{HNO}_2 + \text{OH}^- \rightleftharpoons \text{NO}_2^- + \text{H}_2\text{O} \)

e) \( \text{H}^+ + \text{OH}^- \rightleftharpoons \text{H}_2\text{O} \)

25. Is a 1.0 M NaHCO₃(aq) solution acidic, basic or neutral?

a) acidic

b) basic

c) neutral

d) can not be determined from the information given

26. When 20 mL of 0.1 M Ba(OH)₂ is added to 40 mL of 0.1 M weak acid (HA) what is the pH of the solution?

a) \( \text{pH} < 7 \)

b) \( \text{pH} = 7 \)

c) \( \text{pH} > 7 \)

d) \( \text{pH} = \text{pK}_a \)

e) None of these

27. Balance the following reaction in basic solution. \( \text{NO}_2^- (aq) + \text{Al} (s) \rightarrow \text{NH}_3 (g) + \text{AlO}_2^- (aq) \)

In the balanced equation what is the coefficient in front of Al?

a) 4

b) 2

c) 3

d) 1

e) 6
28. A 0.240 M solution of the salt NaA has pH = 8.40. Calculate $K_a$ for the acid HA.
   a) $6.60 \times 10^{-17}$
   b) $1.05 \times 10^{-5}$
   c) $3.80 \times 10^{-4}$
   d) $2.63 \times 10^{-11}$
   e) none of these

29. Consider a 100.0 mL of buffer solution that is 0.50 M CH₂COOH and 0.50 M NaCH₂COO. What is the pH of the solution after 10.0 mL of 1.0 M NaOH is added.
   a) 4.75
   b) 4.93
   c) 4.57
   d) 4.67
   c) 7.0

30. A 100 mL sample of 0.10 M HCl is mixed with 50 mL of 0.10 M NH₃. What is the resulting pH?
   a) 12.52
   b) 3.87
   c) 1.30
   d) 7.85
   e) 1.48
31. The following plot show the pH curves for the titrations of various acids, HA, by 0.10 M NaOH. At the start of the titration, all of the acids were 50.0 mL of 0.10 M HA.

![pH curves plot]

Which pH curve corresponds to an acid with $K_a = 2 \times 10^{-6}$?

a) a  b) b  c) c  d) d  e) e

32. A 0.4647-g sample of a compound known to contain only carbon, hydrogen, and oxygen was burned in oxygen to yield 0.8635 g of CO$_2$ and 0.1767 g of H$_2$O. What is the empirical formula of the compound?

a) CHO  
b) C$_3$H$_2$O  
c) C$_3$H$_3$O$_2$  
d) C$_6$H$_3$O$_2$  
e) C$_3$H$_6$O$_2$

**ANSWERS:** 1. d  2. e  3. c  4. b  5. c  6. a  7. b  8. b  9. a  10. a  11. c  12. b  
26. c  27. b  28. c  29. b  30. e  31. d  32. c