Name: __Answer Key__

Instructions:

- ° Fill in your name and student number on the scan sheet.
- ° Fill in the exam version number as listed above on the scan sheet.
- ° Write your lab section number on the "Instructor" line on the scan sheet.

Lab Sections

Sec. #	Day	Time	Instructor
7	M	12:00-2:50pm	N. Johnson
8	M	3:00-5:50pm	N. Johnson
9	W	12:00-2:50pm	S. Quick
10	W	3:00-5:50pm	S. Quick
11	M	12:00-2:50pm	S. Barsukoff
12	Th	12:00-2:50pm	S. Donadio

- Record your answers both here and on the scan sheet. Hand in the scan sheet; take this copy of the exam with you when you leave.
- The exam contains 21 multiple-choice questions. All questions are worth 4.76 points.
- As before, exam grades will be posted on OWL once all exams have been graded.

1. What is the molarity of a solution prepared by diluting 25mL of 1.2 KOH to 1.0L?

   a. 0.03 M
   b. 3.00 M
   c. 30.00 M
   d. 0.048 M
   e. 48.00 M

   $$25 \times 10^{-3} L \times \frac{1.2 \, mol}{L} \times \frac{}{1.0 L} = 0.03 \frac{mol}{L} = 0.03 M$$

2. What is the *balanced net ionic equation* for the result when the following two aqueous solutions are mixed?

   $$CaCl_2 \, (aq) \text{ and } Cs_3PO_4 \, (aq)$$

   a. $Ca^{2+} (aq) + 2 \, Cl^- (aq) \rightarrow CaCl_2 (s)$
   b. $Ca^{2+} (aq) + PO_4^{3-} (aq) \rightarrow CaPO_4 (s)$
   c. $Cs^+ (aq) + Cl^- (aq) \rightarrow CsCl (s)$
   d. $2 \, Ca^{2+} (aq) + 3 \, PO_4^{3-} (aq) \rightarrow Ca_2(PO_4)_3 (s)$
   e. $3 \, Ca^{2+} (aq) + 2 \, PO_4^{3-} (aq) \rightarrow Ca_3(PO_4)_2 (s)$

   Ions in solution:
   Ca^{2+} $3Cs^+$
   $2Cl^-$ PO_4^{3-}

   Possible Products:
   CsCl and $Ca_3(PO_4)_2$

   CsCl is soluble
   $Ca_3(PO_4)_2$ is not

   $Ca_3(PO_4)_2$ defines coefficients for reactants

3. The distance between two adjacent peaks of a wave is known as the _____ of the wave.

   a. frequency
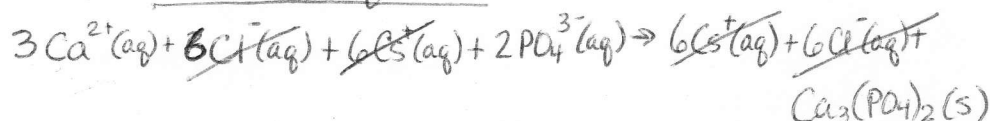   b. amplitude
   c. wavelength
   d. velocity
   e. none of the above

   Overall Equation:
   $$3CaCl_2(aq) + 2Cs_3PO_4(aq) \rightarrow$$
   $$6CsCl(aq) + Ca_3(PO_4)_2(s)$$
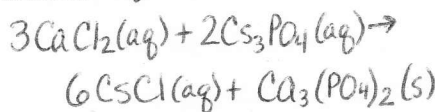
   Because you need 3 Ca^{2+} ions, you need 3 $CaCl_2$ molecules.
   Because you need 2 PO_4^{3-} ions, you need 2 Cs_3PO_4 molecules

   Total ionic equation:
   $$3Ca^{2+}(aq) + 6Cl^-(aq) + 6Cs^+(aq) + 2PO_4^{3-}(aq) \rightarrow 6Cs^+(aq) + 6Cl^-(aq) + Ca_3(PO_4)_2(s)$$

4. Which of the following compounds is soluble in water?
   a. Li_2O → O^{2-} oxides are insoluble
   b. $PbCl_2$ → chlorides are usually soluble, but Pb is an exception
   c. $AgNO_3$ nitrates are soluble
   d. $MgCO_3$ carbonates are not soluble, Mg is not an exception
   e. None of these are soluble

5. In the titration of a 50.0 mL solution of H_2SO_4 of unknown concentration, it takes 30.2 mL of a 2.00 molar solution of NaOH to reach the end point. What is the molarity of the H_2SO_4 solution?

diprotic acid

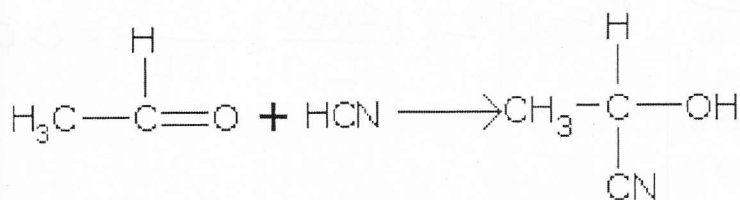$$30.2 \times 10^{-3} L \times \frac{2.0 \, mol \, NaOH}{L} \times \frac{1 \, mol \, H_2SO_4}{2 \, mol \, NaOH} = 0.0302 \, mol \, H_2SO_4$$

   a. 0.302 M
   b. 0.745 M
   c. 12.1 M

$$\frac{0.0302 \, mol \, H_2SO_4}{50 \times 10^{-3} L} = 0.604 \, M \, H_2SO_4$$

   d. 0.604 M
   e. none of these

6. What type of reaction is shown in the figure below?

   a. Elimination
   b. Isomerization
   c. Addition → Two molecules are combined into one.
   d. Substitution
   e. Combustion

7. Exactly 15.0 mL of an NaOH solution is standardized by 22.8 mL of a 0.15 M HCl solution. Then, 43.9 mL is used to titrate 1.25 g of an unknown *monoprotic acid* (HA). What is the molar mass of HA (the unknown)?
   a. 0.228 g/mol
   b. 5.48 g/mol
   c. 365.5 g/mol
   d. 125.0 g/mol
   e. 555.6 g/mol

$$22.8 \times 10^{-3} L \times \frac{0.15 \, mol}{L} = 0.00342 \, mol \, HCl$$

$$0.00342 \, mol \, HCl \times \frac{1 \, mol \, NaOH}{1 \, mol \, HCl} = 0.00342 \, mol \, NaOH$$

$$\frac{0.00342 \, mol \, NaOH}{15 \times 10^{-3} L} = 0.228 \frac{mol \, NaOH}{L}$$

$$43.9 \times 10^{-3} L \times \frac{0.228 \, mol \, NaOH}{L} \times \frac{1 \, mol \, HA}{1 \, mol \, NaOH} = 0.01 \, mol \, HA$$

$$\frac{1.25 g \, HA}{0.01 \, mol \, HA} = 125.0 \, g/mol$$

8. What is the oxidation number of C in $COCl_2$?

    a. 0

    b. -2

    c. +2

    d. +4

    e. -4

Total $\begin{cases} O = -2 \\ Cl = \text{Each } Cl \text{ is } -1 \ (Cl \text{ forms a } -1 \text{ ion}) \end{cases}$ -4

Total must add up to zero, so the oxidation number of C is $[(-1)2 + (-2)](-1) = (+4)$

9. Which compound listed below is not soluble in water?

    a. Na_2CO_3 Carbonates are not usually soluble, but Na^+ carbonates are

    b. $CuCl_2$ Chloride compounds are soluble, Cu is not an exception

    c. $Fe(NO_3)_3$ nitrates are soluble

D. →   d. $BaSO_4$ – sulfates are usually soluble, but Ba compounds are an exception

    e. NH_4OH – ammonium compounds are soluble hydroxides usually aren't, but ammonium hydroxide is an exception.

10. Which of the following has the most energy?

    a. A photon of infrared light

    b. A photon of ultraviolet light

    c. A photon of green light (550nm)

    d. A radio wave photon

    e. None because all photons have the same energy.

11. What is the frequency of light whose wavelength is 711 nm?

    a. $2.80 \times 10^{-19} s^{-1}$

    b. $4.22 \times 10^{14} s^{-1}$

    c. $4.22 \times 10^5 s^{-1}$
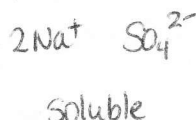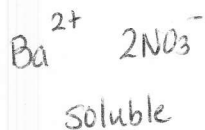
    d. $2.10 \times 10^8 s^{-1}$

    e. $2.37 \times 10^{-6} s^{-1}$

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8 m/s}{711 \times 10^{-9} m} = 4.22 \times 10^{14} s^{-1}$$

12. What mass of I_2 is needed to prepare 50.0 mL of 1.00 M solution?

    a. 1. 6.42 g

    b. 12.7 g

    c. 14.3 g

    d. 9.86 g

    e. none of these

$$50 \times 10^{-3} L \times \frac{1.0 \text{ mol}}{L} \times \frac{253.8g}{mol} = 12.7g$$

I_2 molar mass = 253.8 g/mol

$(2 \times 126.9 g/mol)$

$\overset{2+}{Ba}$ $\overset{-}{2NO_3}$ $2Na^+$ $\overset{2-}{SO_4}$ Possible Products

Soluble   Soluble   Ba SO$_4$ → insoluble, precipitates

Na NO$_3$ → soluble

13. A chemist places Ba(NO$_3$)$_2$ in one flask and Na$_2$SO$_4$ in another. Water is added to both flasks and the mixture in the first flask is added to the second. Which choice below describes correctly the results of this experiment?

   a. Both of the compounds in the flasks dissolve when water is added and NaNO$_3$ precipitates when the contents of the flasks are mixed.

   b. Both of the compounds in the flasks dissolve when water is added and BaSO$_4$ precipitates when the contents of the flasks are mixed.

   c. Both of the compounds in the flasks dissolve when water is added and there is no precipitate when the contents of the flasks are mixed.

   d. The Ba(NO$_3$)$_2$ does not dissolve in water, but the Na$_2$SO$_4$ does dissolve. There is no change upon mixing the contents of the flasks.

   e. none of these

14. Consider mixing an aqueous solution of FeCl$_3$ with an aqueous solution of KOH.

   FeCl$_3$ (aq) + KOH (aq) → ??

   What *spectator ions* are present in this precipitation reaction?

   a. Fe$^+$ (aq) and 3 Cl$^-$ (aq)

   b. K$^+$ (aq) and OH$^-$ (aq)

   c. Fe^{3+} (aq) and 3 OH$^-$ (aq)

   d. 3 K$^+$ and 3 Cl$^-$ (aq)

   e. K$_3^+$ (aq) and Cl$_3^-$ (aq)

Total Ionic Equation

Fe^{3+}(aq) + 3Cl$^-$(aq) + 3K$^+$(aq) + 3OH$^-$(aq) → Fe(OH)$_3$(s) + 3K$^+$(aq) + 3Cl$^-$(aq)
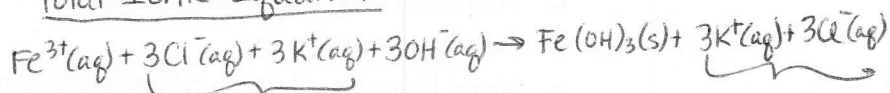
Same on both sides = "spectator" ions

15. Which aqueous solution(s) below is(are) considered *basic*?

   i. A solution with a pH = 6   Acidic

   ii. A solution with [OH$^-$] = 1 x 10^{-7}mm   pOH = 7   pH = 14-7 = 7 Neutral

   iii. A solution with [H$_3$O$^+$] = 1 x 10^{-9} pH = 9   Basic

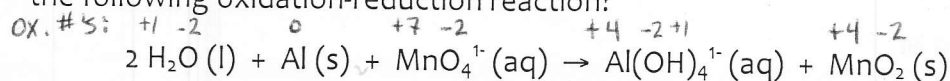   a. i only

   b. ii only

   c. iii only

   d. i and ii

   e. i and iii

16. A famous brand of sweet and sour barbecue sauce (consisting of tomato paste, water, vinegar, sugar, and secret spices) has a measured pH of 2.6. What is the hydrogen ion concentration in the sauce?

    a. 0.42 M

    b. 2.4 x 10⁻² M

    c. 2.5 X 10⁻³ M

    d. 3.4 X 10⁻⁴ M

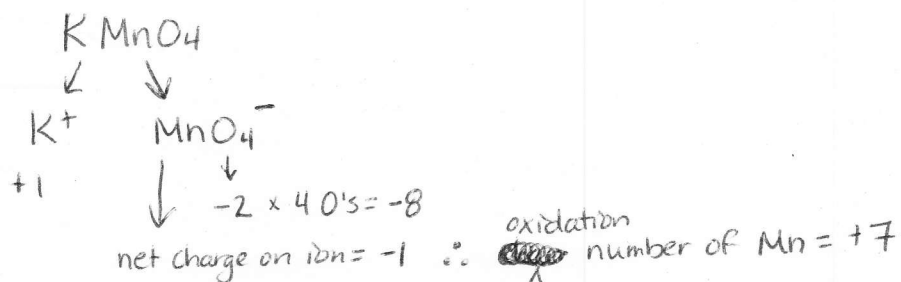   e. 5 X 10⁻⁵ M

$$[H_3O^+] = 10^{(-pH)} = 10^{-2.6}$$

$$= 0.0025$$

17. What species becomes *oxidized* and what species behaves as the *reducing agent* in the following oxidation-reduction reaction?

    OX. #5:   +1 -2   0   +7 -2   +4 -2 +1   +4 -2
    $$2 H_2O\ (l)\ +\ Al\ (s)\ +\ MnO_4^{1-}\ (aq)\ \rightarrow\ Al(OH)_4^{1-}\ (aq)\ +\ MnO_2\ (s)$$

    a. Al becomes oxidized and Al behaves as the reducing agent.

    Al oxidation # increases
    Mn oxidation # decreases.

    b. Al becomes oxidized and MnO_4^{1-} behaves as the reducing agent.

    c. MnO_4^{1-} becomes oxidized and MnO_4^{1-} behaves as the reducing agent.

    d. MnO_4^{1-} becomes oxidized and Al behaves as the reducing agent.

    e. MnO_4^{1-} becomes oxidized and H_2O behaves as the reducing agent.

18. What is the oxidation number of the manganese atom in the formula for the compound $KMnO_4$?

    a. -1

    b. +1

    c. +3

    d. +5

    e. +7

    K MnO4
    K^+ MnO_4^-
    +1   -2 × 4 O's = -8
    net charge on ion = -1   ∴ oxidation number of Mn = +7

19. What ions are the products when solid $Mg(ClO_4)_2$ is put into water?

    a. $2Mg^+(aq) + ClO_4^{2-}(aq)$

    b. $Mg^+(aq) + 2ClO_4^-(aq)$

    c. $Mg^{2+}(aq) + 2ClO_4^-(aq)$

    d. $Mg(ClO4)_2(s)$

    e. none of these

20. Which of the following is NOT a strong electrolyte?

    a. HCl

    b. Na_2SO_4

    c. (HCN) → On list of weak acids ∴ weak electrolyte

    d. KOH

    e. HNO_3

21. What is the molarity of a solution prepared by dissolving 41.0 g of NaCl in 250 mL of solution?

    a. 233.0 M

    b. 0.70 M

    c. 9.50 M

    d. 2.80 M

    e. 0.003 M

NaCl molar mass = $(23.0 + 35.5) = 58.5 g/mol$

$41.0 g \times \dfrac{1 mol}{58.5 g} = 0.70 mol$

$\dfrac{0.7 mol}{0.250 L} = 2.80 \dfrac{mol}{L} = 2.80 M$