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 2.76 points.
- As before, exam grades will be posted on OWL once all exams have been graded.

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1. What is the molarity of a solution prepared by diluting 150mL of 0.53M NaOH to 0.5 L?

   a. 0.53 M
   b. 0.04 M
   c. 0.57 M
   d. 159.0 M
   e. 0.16 M

$150 \times 10^{-3} L \times \frac{0.53 mol}{L} = 0.0795 mol$

$\frac{0.0795 mol}{0.500 L} = 0.159 \frac{mol}{L} = 0.159\ M$

2. The number of wave crests that pass a fixed point each second is known as the _____ of the wave.

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

3. The oxidation number of Cr in $K_2Cr_2O_7$ is:

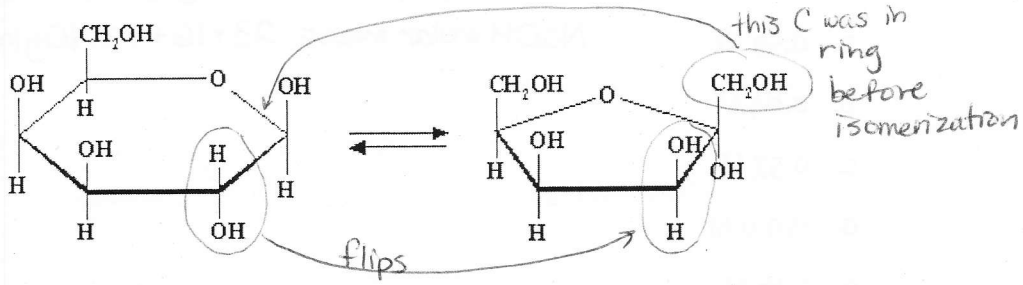
   a. +12
   b. +6
   c. +7
   d. +4
   e. none of these

dichromate ion
$Cr_2O_7^{2-}$ } O's are -2 → Total of -14
Net charge on ion = -2
Cr_2 must have O.N. of +12
+12 ÷ 2 = +6 for each Cr

4. Which of the following ionic compounds is considered *insoluble* in water?

   a. $(NH_4)_3PO_4$ Ammonium compounds are soluble, phosphates are not, but ammonium compounds are an exception.
   b. $Mg(OH)_2$ Hydroxides are insoluble, magnesium is not an exception
   c. Na_2SO_4 Sulfates are soluble, sodium is not an exception.
   d. $Pb(NO_3)_2$ nitrates are soluble
   e. $Mg(C_2H_3O_2)_2$ acetates are soluble

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



   a. Elimination
   b. Isomerization → same atoms, just rearranged
   c. Addition
   d. Substitution
   e. Combustion

6. What is the oxidation number of N in HNO_3?

   a. +2
   b. +3
   c. +4
   d. +5
   e. -1

HNO_3
H^+ NO_3^-
O = -2 x 3 = -6
Charge on ion = -1
Ox. # of N = +5

7. Exactly 7.5 mL of an NaOH solution is standardized by 12.5 mL of a 0.15 M HCl solution. Then, 58.56 mL is used to titrate 1.83 g of an unknown *monoprotic acid* (HA). What is the molar mass of HA (the unknown)?
   a. 0.228 g/mol
   b. 35.5 g/mol
   c. 347.2 g/mol
   d. 125.0 g /mol
   e. 555.6 g/mol

$12.5\times10^{-3}\,L \times \frac{0.15\,mol}{L} = 0.001875\,mol\,HCl \times \frac{1\,mol\,NaOH}{1\,mol\,HCl}$

$\frac{0.001875\,mol\,NaOH}{7.5\times10^{-3}\,L} = 0.25\,\frac{mol}{L}\,NaOH$

$0.25\,\frac{mol\,NaOH}{L} \times 58.56\times10^{-3}\,L = 0.01464\,mol\,NaOH$

8. A chemist places $(NH_4)_2SO_4$ in one flask and NaI 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 NH_4I precipitates when the contents of the flasks are mixed.
   b. Both of the compounds in the flasks dissolve when water is added and Na2SO4 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 $(NH_4)_2SO_4$ does not dissolve in water, but the NaI does dissolve. There is no change upon mixing the contents of flasks
   e. none of these

Reactants
$(NH_4)_2SO_4$
NaI
Both soluble

Possible Products
NH_4I
$Na_2(SO_4)$
Both soluble
∴ no precipitate

9. Which of the following has the least 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.

10. What is the wavelength of light with a frequency of 5.2×10^{14} Hz?
    a. 1.7×10^{6} m
    b. 1.9×10^{-7} m
    c. 5.8×10^{-7} m
    d. 5.8×10^{-7} nm
    e. 3.8×10^{-5} m

$Hz = s^{-1} = \frac{1}{s}$

$\lambda = \frac{c}{\nu} = \frac{3\times10^{8}\,m/s}{5.2\times10^{14}\,s^{-1}} = 5.77\times10^{-7}\,m$

$0.01464\,mol\,NaOH \times \frac{1\,mol\,HA}{1\,mol\,NaOH} = 0.01464\,mol\,HA$

$\frac{1.83\,g\,HA}{0.01464\,mol\,HA} = 125\,g/mol$

11. Which compound listed below is soluble in water?

a. $BaCl_2$ chlorides are soluble, barium is not an exception

b. AgBr

c. $PbSO_4$

d. $Be(OH)_2$

e. none of these

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

$CaCl_2\,(aq)$ and $Cs_3PO_4\,(aq)$

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

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

$CsCl$ is soluble

$Ca_3(PO_4)_2$ is not

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. $3\,Ca^{2+}\,(aq) + 2\,PO_4^{3-}\,(aq) \rightarrow Ca_3(PO_4)_2\,(s)$

Total Ionic Equation:

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

13. 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?

H_2SO_4: diprotic acid

a. 0.302 M

b. 0.745 M

c. 12.1 M

d. 0.604 M

e. none of these

$$30.2\times10^{-3}\,L \times \frac{2.0\,mol\,NaOH}{L} \times \frac{1\,mol\,H_2SO_4}{2\,mol\,NaOH} = 0.0302\,mol\,H_2SO_4$$

$$\frac{0.0302\,mol\,H_2SO_4}{50\times10^{-3}\,L} = 0.604\ M\ H_2SO_4$$

14. Consider mixing an aqueous solution of $FeCl_3$ with an aqueous solution of KOH.

$FeCl_3\,(aq) + KOH\,(aq) \rightarrow$??

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:

$Fe^{3+}(aq) + 3Cl^-(aq) + 3K^+(aq) + 3OH^-(aq) \rightarrow Fe(OH)_3(s) + 3K^+(aq) + 3Cl^-(aq)$

Same on both sides = "spectator" ions

15. What is the pH of a solution that has $[H3O^+] = 1.65 \times 10^{-4}$ M?

a. 8.71
b. 2.78
c. 3.78
d. 4.00
e. 0.217

$pH = -\log[H3O^+] = -\log[1.65 \times 10^{-4} M]$
$= 3.78$

16. In the oxidation-reduction equation (balanced)

$Br_2(aq) + 2\ I^-(aq) \rightarrow I_2(aq) + 2\ Br^-(aq)$

ox. #'s: 0 −1 0 −1

a. Br_2 is a reducing agent
b. I^- is oxidized
c. I_2 is an oxidizing agent
d. Br_2 loses electrons
e. none of these are correct

Br ox. # decreased = reduced, oxidizing agent
I ox. # increased = oxidized, reducing agent

17. What mass of $MgCl_2$ is needed to prepare 50.0 mL of 1.60 M solution?

a. 7.62 g
b. 4.78 g
c. 0.84 g
d. 76.1 g
e. 2.9 g

$MgCl_2$ molar mass $= (24.3 + 2 \cdot 35.45) = 95.2$ g/mol

$50 \times 10^{-3}\ L \times \frac{1.6\ mol}{L} = 0.08\ mol$ required

$0.08\ mol \times \frac{95.2\ g}{mol} = 7.6160\ g$

18. 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

19. 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. 2.4×10^{-2} M
c. 2.5×10^{-3} M
d. 3.4×10^{-4} M
e. 5×10^{-5} M

$pH = 2.6$
$[H3O^+] = 10^{(-pH)} = 10^{-2.6}$

20. What is the molarity of a solution prepared by dissolving 3.4 g of NH_3 in 500 mL of solution?

NH_3 molar mass $= (14 + (3 \cdot 1)) = 17\ g/mol$

a. 4.0×10^{-4} M

b. 6.8×10^{-3} M

c. 4.0×10^{-1} M

d. 6.8 M

e. none of these

$3.4\ g \times \frac{1\ mol}{17\ g} = 0.2\ mol$

$\frac{0.2\ mol}{0.5\ L} = 0.4\ \frac{mol}{L} = 0.4\ M$

21. What are the coefficients and products for the product side of balanced reaction equation when the iron(II) nitrate reacts with potassium phosphate?

$$Fe(NO_3)_2(aq) + K_3PO_4(aq) \rightarrow ??$$

a. $FePO_4(s) + K_3NO_3(aq)$

b. $Fe_2PO_4(s) + 3\ K(NO_3)_2$

c. $Fe_3PO_4(s) + 3\ KNO_3(aq)$

d. $Fe_3(PO_4)_2(s) + 6\ KNO_3(aq)$

e. $2\ Fe_3N(s) + 2\ K_3P + 11\ O_2$

$Fe(NO_3)_2(aq) + K_3PO_4(aq) \rightarrow$

Fe^{+2} $2NO_3^-$ $3K^+$ PO_4^{3-}

Possible Products

not soluble $\leftarrow Fe_3(PO_4)_2 \leftarrow$ need 3 Fe^{2+} ions and 2 PO_4^{3-} ions

soluble $\leftarrow KNO_3$

$$3Fe(NO_3)_2(aq) + 2K_3PO_4(aq) \rightarrow Fe_3(PO_4)_2(s) + 6KNO_3(aq)$$