Supplementary Resource Document for Bego et al. (2024) “Single-Paper Meta-Analyses of the Effects of Spaced Retrieval Practice in Nine Introductory STEM Courses: Is the Glass Half Full or Half Empty?”

Assessment Items for General Chemistry, exported from Blackboard

1. Classify each element appropriately, using the options in the dropdown menu.

Cs _____

Sc _____

H _____

Sb _____

Pb _____

*e. main group metal
*a. transition metal
*c. main group nonmetal
*b. main group nonmetal
*d. main group metal
f. transition nonmetal

2. Classify each element appropriately, using the options in the dropdown menu.

As _____

Ag _____

Ar _____

H _____

Hg _____

*c. main group nonmetal
*f. transition metal
*b. main group nonmetal
*a. main group nonmetal
*e. transition metal
g. main group metal
d. transition nonmetal

3. Classify each element appropriately, using the options in the dropdown menu.

Ni _____

In _____

I _____

N _____

Na _____

*f. transition metal
*d. main group metal
*a. main group nonmetal
*c. main group nonmetal
*b. main group metal
e. transition nonmetal

4. Classify each element appropriately, using the options in the dropdown menu.

H _____

Pb _____

Sb _____

Cs _____

Sc _____

*e. main group nonmetal
*a. main group metal
*f. main group nonmetal
*d. main group metal
*c. transition metal
b. transition nonmetal

5. Classify each substance appropriately, using the options in the dropdown menu.

CO _____

Co _____

CoS _____

COS _____

CsO _____

O_2 _____

*b. molecular/covalent compound
*e. element
*a. ionic compound
*d. molecular/covalent compound
*f. ionic compound
*c. element

6. Classify each substance appropriately, using the options in the dropdown menu.

CO _____

Co _____

CoS _____

COS _____

CsO _____

O_2 _____

*c. molecular/covalent compound
*e. element
*d. ionic compound
*b. molecular/covalent compound
*f. ionic compound
*a. element

7. Write the names, with correct spellings, of the elements with the following symbols:

Ag _____

Au _____

Hg _____

Fe _____

Answers:
a. silver
b. gold
c. mercury
d. iron

8. Give the chemical symbol for each element:

Mercury _____

Gold _____

Silver _____

Iron _____

Answers:
a. Hg
b. Au
c. Ag
d. Fe

9. Match each element name with the correct symbol.

[d] 1. Iron

[c] 2. Silver

[g] 3. Gold

[f] 4. Mercury

a. H

b. Mg

c. Ag

d. Fe

e. Si

f. Hg

g. Au

h. Ir

10. Write the names, with correct spellings, of the elements with the following symbols:

Ag _____

Au _____

Hg _____

Fe _____

Answers:
a. silver
b. gold
c. mercury
d. iron

11. Complete the formula for each ion by choosing the appropriate charge from the dropdown menu.

magnesium ion: Mg_____

copper(I) ion: Cu_____

oxide ion: O_____

*b. 2+
*i. +
*d. 2-
h. 4-
a. 3-
e. -
c. 0
g. 3+
f. 4+

12. Complete the formula for each ion by choosing the appropriate charge from the dropdown menu.

sulfide ion: S_____

copper(II) ion: Cu_____

sodium ion: Na_____

*h. 2-
*e. 2+
*a. +
c. 4-
g. 3-
d. -
f. 0
i. 3+
b. 4+

13. Complete the formula for each ion by choosing the appropriate charge from the dropdown menu.

chloride ion: Cl_____

iron(II) ion: Fe_____

aluminum ion: Al_____

*c. -
*e. 2+
*g. 3+
f. 4-
h. 3-
i. 2-
d. 0
b. +
a. 4+

14. Complete the formula for each ion by choosing the appropriate charge from the dropdown menu.

magnesium ion: Mg_____
copper(I) ion: Cu_____

oxide ion: O_____

*f. 2+
*d. +
*h. 2-
i. 4-
g. 3-
a. -
c. 0
b. 3+
e. 4+

15. Give the correct formulas for these compounds. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

sodium sulfide _____

mercury(II) chloride _____

ammonium carbonate _____

Answers:
a. Na2S
b. HgCl2
c. (NH4)2CO3

16. Give the correct formulas for these compounds. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

potassium carbonate _____

iron(III) sulfide _____

ammonium chloride _____

Answers:
a. K2CO3
b. Fe2S3
c. NH4Cl

17. Give the correct formulas for these compounds. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

sodium sulfate _____

lead(IV) oxide _____

aluminum chloride _____

Answers:
a. Na2SO4
b. PbO2
c. AlCl3

18. Give the correct formulas for these compounds. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

sodium sulfide _____

mercury(II) chloride _____

ammonium carbonate _____

Answers:
a. Na2S
b. HgCl2
c. (NH4)2CO3

19. Give the correct formulas for these compounds. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

disilicon hexachloride _____

phosphorus pentachloride _____

nitrogen monoxide _____

Answers:
a. Si2Cl6
b. PCl5
c. NO

20. Give the correct formulas for these compounds. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

hydrogen iodide _____

disilicon hexahydride _____

sulfur tetrachloride _____

Answers:
a. HI
b. Si2H6
c. SCl4

21. Give the correct formulas for these compounds. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

sulfur trioxide _____

diphosphorus tetrachloride _____

carbon disulfide _____

Answers:
a. SO3
b. P2Cl4
c. CS2

23.

26		7		8
Fe		N		O
		14.0		16.0
55.9				

Calculate the formula mass of $Fe(NO_3)_2$, using any information needed from the periodic table cells provided above.

Correct Answer Range:
179.9 +/- 0.

24.

1		7		16
H		N		S
1.0		14.0		
				32.1

Calculate the formula mass of $(NH_4)_2S$, using any information needed from the periodic table cells provided above.

Correct Answer Range:
68.1 +/- 0.

25.

13		17		8
Al		Cl		O
27.0		35.5		16.0

Calculate the formula mass of $Al(ClO_3)_3$, using any information needed from the periodic table cells provided above.

Correct Answer Range:
277.5 +/- 0.

26.

12		7		8
Mg		N		O
24.3		14.0		16.0

Calculate the formula mass of $Mg(NO_3)_2$, using any information needed from the periodic table cells provided above.

Correct Answer Range:
148.3 +/- 0.

27. Balance the following reaction equation with smallest whole-number coefficients. (Choose the appropriate values from the dropdown menus. Note: even though we don't normally show coefficients of "1," please include them if needed in this reaction.)

_____ C_3H_8 + _____ O_2 → _____ CO_2 + _____ H_2O

*b. 1
*a. 5
*c. 3
*e. 4
h. 0
i. 2
k. 6
j. 7
d. 8
f. 9
g. 10

28. Balance the following reaction equation with smallest whole-number coefficients. (Choose the appropriate values from the dropdown menus. Note: even though we don't normally show coefficients of "1," please include them if needed in this reaction.)

_____ Ag_2SO_4 → _____ SO_3 + _____ Ag + _____ O_2

*a. 2
*e. 2
*f. 4
*h. 1
k. 0
l. 3
i. 5
c. 6
d. 7
g. 8
b. 9
j. 10

29. Balance the following reaction equation with smallest whole-number coefficients. (Choose the appropriate values from the dropdown menus. Note: even though we don't normally show coefficients of "1," please include them if needed in this reaction.)

_____ Cl_2CO + _____ SbF_5 → _____ $SbCl_5$ + _____ F_2CO

*d. 5
*f. 2
*k. 2
*i. 5
h. 0
j. 1

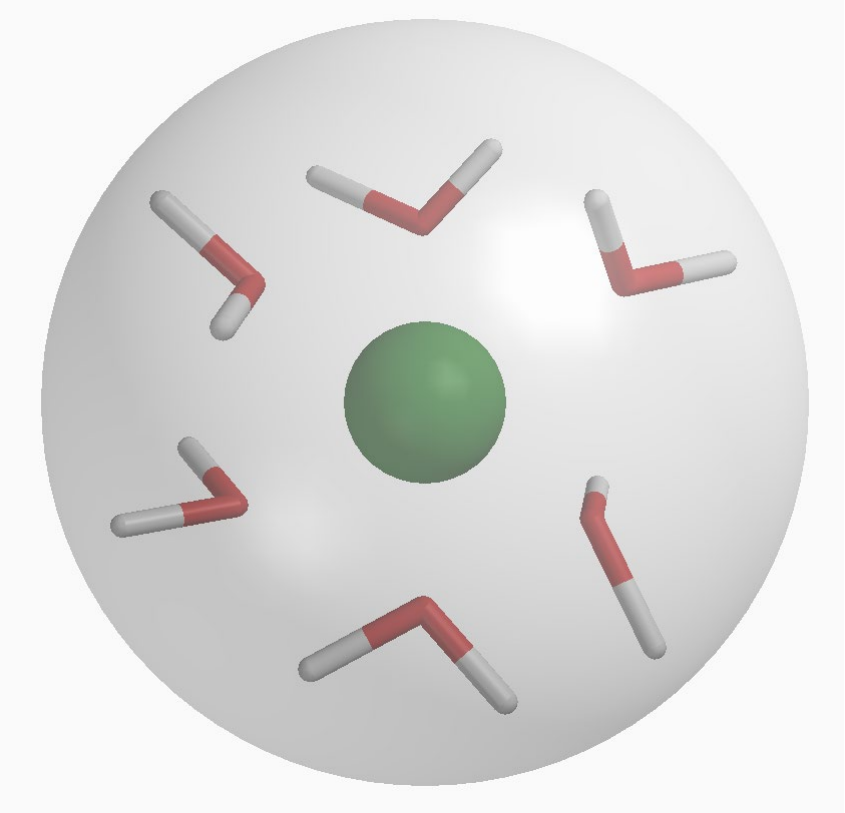
g. 3
c. 4
m. 6
e. 7
l. 8
a. 9
b. 10

30. Balance the following reaction equation with smallest whole-number coefficients. (Choose the appropriate values from the dropdown menus. Note: even though we don't normally show coefficients of "1," please include them if needed in this reaction.)

_____ C_3H_6 + _____ O_2 → _____ CO_2 + _____ H_2O

*e. 2
*l. 9
*j. 6
*g. 6
k. 0
a. 1
h. 3
c. 4
f. 5
d. 7
i. 8
b. 10

31. Which of these could be the identity of the ion in aqueous solution, represented in the graphic?



a. Cl^-

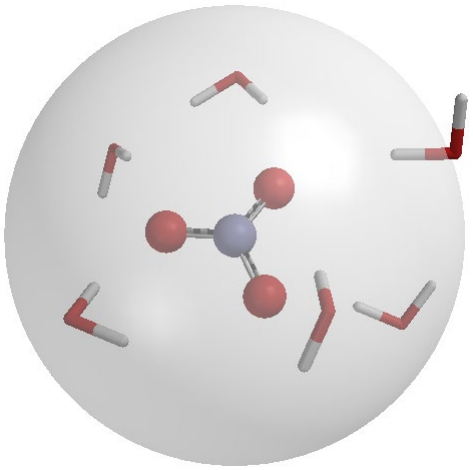
b. NH_4^+

*c. Mg^{2+}

d. NO_3^-

e. SO_4^{2-}

32. Which of these could be the identity of the ion in aqueous solution, represented in the graphic?



a. Cl^-

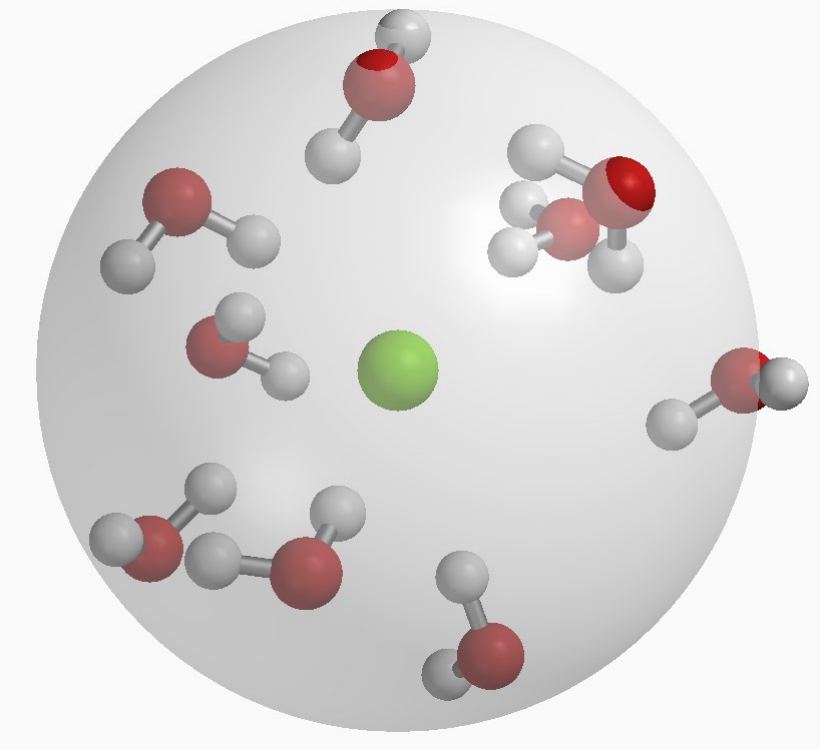
b. NH_4^+

c. Mg^{2+}

*d. NO_3^-

e. SO_4^{2-}

33. Which of these could be the identity of the ion in aqueous solution, represented in the graphic?



*a. Cl^-

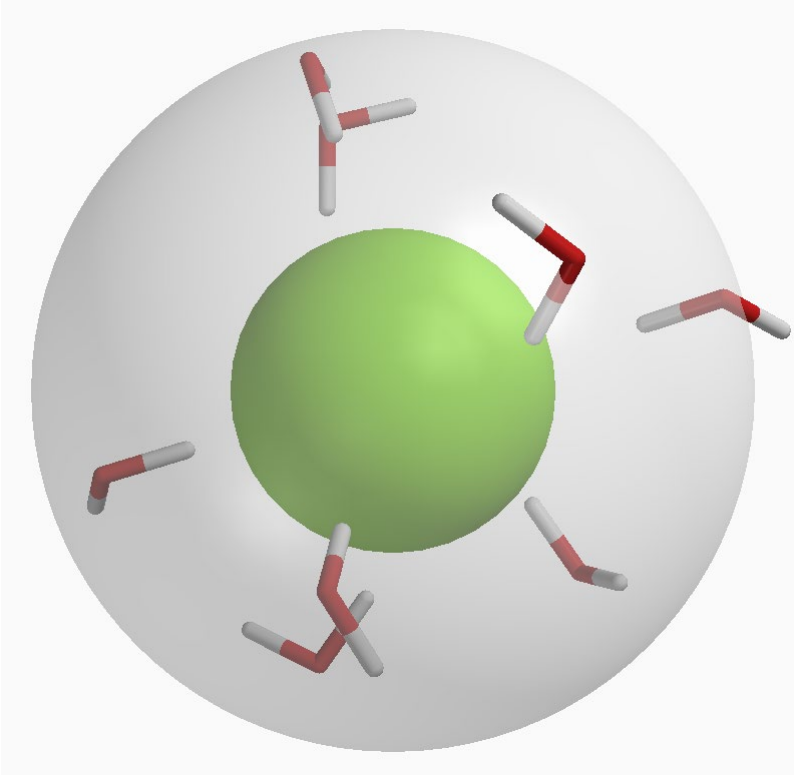
b. NH_4^+

c. Mg^{2+}

d. NO_3^-

e. SO_4^{2-}

34. Which of these could be the identity of the ion in aqueous solution, represented in the graphic?



*a. Cl^-

b. NH_4^+

c. Mg^{2+}

d. NO_3^-

e. SO_4^{2-}

35. Use the solubility trends to identify each of these compounds as soluble or insoluble in water.

Solubility trends:

1. Group 1 compounds and ammonium compounds tend to be soluble.
2. Nitrates, acetates, chlorates, and perchlorates tend to be soluble.
3. Silver, lead, mercury(I) and copper(I) compounds tend to be INSOLUBLE.
4. Chlorides, bromides, and iodides tend to be soluble.
5. Sulfates tend to be soluble except calcium sulfate, strontium

sulfate and barium sulfate.
6. Compounds with anions of 2- or 3- charge tend to be INSOLUBLE.
7. Hydroxides tend to be INSOLUBLE except calcium hydroxide, strontium hydroxide and barium hydroxide.

_____ AgCl

_____ $NaNO_3$

_____ $FeCO_3$

*a. insoluble
*b. soluble
*c. insoluble

36. Use the solubility trends to identify each of these compounds as soluble or insoluble in water.

Solubility trends:

1. Group 1 compounds and ammonium compounds tend to be soluble.
2. Nitrates, acetates, chlorates, and perchlorates tend to be soluble.
3. Silver, lead, mercury(I) and copper(I) compounds tend to be INSOLUBLE.
4. Chlorides, bromides, and iodides tend to be soluble.
5. Sulfates tend to be soluble except calcium sulfate, strontium sulfate and barium sulfate.
6. Compounds with anions of 2- or 3- charge tend to be INSOLUBLE.
7. Hydroxides tend to be INSOLUBLE except calcium hydroxide, strontium hydroxide and barium hydroxide.

_____ $AgNO_3$

_____ $PbCO_3$

_____ CsCl

*a. soluble
*c. insoluble
*b. soluble

37.

Use the solubility trends to identify each of these compounds as soluble or insoluble in water.

Solubility trends:

1. Group 1 compounds and ammonium compounds tend to be soluble.
2. Nitrates, acetates, chlorates, and perchlorates tend to be

soluble.
3. Silver, lead, mercury(I) and copper(I) compounds tend to be INSOLUBLE.
4. Chlorides, bromides, and iodides tend to be soluble.
5. Sulfates tend to be soluble except calcium sulfate, strontium sulfate and barium sulfate.
6. Compounds with anions of 2– or 3– charge tend to be INSOLUBLE.
7. Hydroxides tend to be INSOLUBLE except calcium hydroxide, strontium hydroxide and barium hydroxide.

_____ $NiBr_2$

_____ $(NH_4)_3PO_3$

_____ $PbSO_4$

*c. soluble
*b. soluble
*a. insoluble

38. Use the solubility trends to identify each of these compounds as soluble or insoluble in water.

Solubility trends:

1. Group 1 compounds and ammonium compounds tend to be soluble.
2. Nitrates, acetates, chlorates, and perchlorates tend to be soluble.
3. Silver, lead, mercury(I) and copper(I) compounds tend to be INSOLUBLE.
4. Chlorides, bromides, and iodides tend to be soluble.
5. Sulfates tend to be soluble except calcium sulfate, strontium sulfate and barium sulfate.
6. Compounds with anions of 2– or 3– charge tend to be INSOLUBLE.
7. Hydroxides tend to be INSOLUBLE except calcium hydroxide, strontium hydroxide and barium hydroxide.

_____ $BaCl_2$

_____ $CuClO_3$

_____ $MgCO_3$

*b. soluble
*c. soluble
*a. insoluble

39. Choose appropriate phase labels for each species in the reaction below, which takes place in water.

CO_2 _____ + H_2O _____ → H_2CO_3 _____

*c. aqueous
*b. liquid
*a. aqueous
d. solid
e. gas

40. Choose appropriate phase labels for each species in the reaction below, which takes place in water.

H_2CO_3_____ → H^+ _____ + HCO_3^- _____

*b. aqueous
*e. aqueous
*d. aqueous
f. solid
c. liquid
a. gas

41. Choose appropriate phase labels for each species in the reaction below, which takes place in water.

Ag^+ _____ + Cl^- _____ → AgCl _____

*e. aqueous
*d. aqueous
*b. solid
a. liquid
c. gas

42. Choose appropriate phase labels for each species in the reaction below, which takes place in water.

CO_2 _____ + H_2O _____ → H_2CO_3 _____

*b. aqueous
*a. liquid
*d. aqueous
e. solid
c. gas

43. In writing the ionic or net ionic equation for a reaction occurring in aqueous solution, which of the species below should be shown as dissociated into the component ions? Check all that apply.

*a. NaBr (aq)

b. H_2O (l)

c. AgCl (s)

44. In writing the ionic or net ionic equation for a reaction occurring in aqueous solution, which of the species below should be shown as dissociated into the component ions? Check all that apply.

*a. KNO_3 (aq)

*b. $FeCl_3$ (aq)

c. CO_2 (aq)

45. In writing the ionic or net ionic equation for a reaction occurring in aqueous solution, which of the species below should be shown as dissociated into the component ions? Check all that apply.

*a. $AgNO_3$ (aq)

b. SO_2 (aq)

c. $PbCl_2$ (s)

46. In writing the ionic or net ionic equation for a reaction occurring in aqueous solution, which of the species below should be shown as dissociated into the component ions? Check all that apply.

*a. NaBr (aq)

b. H_2O (l)

c. AgCl (s)

47. Give the correct formulas for these acids. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

hydriodic acid _____ perchloric acid _____ sulfurous acid _____

Answers:
a. HI
b. HClO4
c. H2SO3

48. Give the correct formulas for these acids. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

bromic acid _____

sulfuric acid _____

hydrofluoric acid _____

Answers:
a. HBrO3
b. H2SO4
c. HF

49. Give the correct formulas for these acids. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

hydrobromic acid _____

chlorous acid _____

nitric acid _____

Answers:
a. HBr
b. HClO2
c. HNO3

50. Give the correct formulas for these acids. (Capitalization must be correct. For this question only, you do not need to give atom numbers as subscripts; for example, you would give the formula of water as H2O rather than H_2O).

phosphoric acid _____

hypochlorous acid _____

hydrochloric acid _____

Answers:
a. H_3PO_4
b. HClO
c. HCl

51. Identify each acid as strong or weak.

$HClO_4$:_____

H_3PO_4 :_____

H_2S :_____

HBr :_____

HCN :_____

*d. Strong
*e. Weak
*a. Weak
*b. Strong
*c. Weak

52. Identify each acid as strong or weak.

$HClO_2$:_____

H_2SO_4 :_____

HI :_____

HIO :_____

H_2CO_3 :_____

*b. Weak
*c. Strong
*e. Strong
*a. Weak
*d. Weak

53. Identify each acid as strong or weak.

HF :_____

H_2SO_3 :_____

H_2S :_____

HNO_2 :_____

HCl :_____

*c. Weak
*d. Weak
*e. Weak
*a. Weak
*b. Strong

54. Identify each acid as strong or weak.

HClO :_____

H_3AsO_3 :_____

H_2SO_4 :_____

HBr :_____

HCN :_____

*d. Weak
*c. Weak
*a. Strong
*b. Strong
*e. Weak

55. Identify each substance as an acid or a base in aqueous solution.

NH_3: _____

H_2CO_3: _____

NaOH: _____

*a. Base
*b. Acid
*c. Base

56. Identify each substance as an acid or a base in aqueous solution.

H_2S: _____

K_2O: _____

OH^-: _____

*a. Acid
*b. Base
*c. Base

57. Identify each substance as an acid or a base in aqueous solution.

HCN: _____

H_2SO_3: _____

$Ca(OH)_2$: _____

*c. Acid
*b. Acid
*a. Base

58. Identify each substance as an acid or a base in aqueous solution.

HF: _____

NH_3: _____

NaOH: _____

*b. Acid
*c. Base
*a. Base

59. Identify each substance as a strong electrolyte, weak electrolyte, or nonelectrolyte in aqueous solution.

NH_3 _____

H_2CO_3 _____

NaOH _____

*c. weak electrolyte
*a. weak electrolyte
*d. strong electrolyte
b. nonelectrolyte

60. Identify each substance as a strong electrolyte, weak electrolyte, or nonelectrolyte in aqueous solution.

KBr _____

NH_3 _____

$AgNO_3$ _____

*b. strong electrolyte
*a. weak electrolyte
*d. strong electrolyte
c. nonelectrolyte

61. Identify each substance as a strong electrolyte, weak electrolyte, or nonelectrolyte in aqueous solution.

HCN _____

H_2SO_3 _____

$CaCl_2$ _____

*b. weak electrolyte
*a. weak electrolyte
*d. strong electrolyte
c. nonelectrolyte

62. Identify each substance as a strong electrolyte, weak electrolyte, or nonelectrolyte in aqueous solution.

HF _____

NH_3 _____

NaOH _____

*c. weak electrolyte
*a. weak electrolyte
*d. strong electrolyte
b. nonelectrolyte

63. Which of the reactions below is a **combustion** reaction?

*a. $C\,(s) + O_2\,(g) \rightarrow CO_2\,(g)$

b. $HCO_3^-\,(aq) + NH_3\,(aq) \rightleftharpoons CO_3^{2-}\,(aq) + NH_4^+\,(aq)$

c. $H_2\,(g) + Li\,(s) \rightarrow LiH\,(s)$

d. $CO_3^{2-}\,(aq) + Ag^+\,(aq) \rightleftharpoons Ag_2CO_3\,(s)$

64. Which of the reactions below is an **acid-base** reaction?

a. $C\,(s) + O_2\,(g) \rightarrow CO_2\,(g)$

*b. $HCO_3^-\,(aq) + NH_3\,(aq) \rightleftharpoons CO_3^{2-}\,(aq) + NH_4^+\,(aq)$

c. $H_2\,(g) + Li\,(s) \rightarrow LiH\,(s)$

d. $CO_3^{2-}\,(aq) + Ag^+\,(aq) \rightleftharpoons Ag_2CO_3\,(s)$

65. Which of the reactions below is a **precipitation** reaction?

a. $C\,(s) + O_2\,(g) \rightarrow CO_2\,(g)$

b. $HCO_3^-\,(aq) + NH_3\,(aq) \rightleftharpoons CO_3^{2-}\,(aq) + NH_4^+\,(aq)$

c. $H_2\,(g) + Li\,(s) \rightarrow LiH\,(s)$

*d. $CO_3^{2-}\,(aq) + Ag^+\,(aq) \rightleftharpoons Ag_2CO_3\,(s)$

66. Which of the reactions below is a **redox** reaction, but not as a combustion reaction?

a. $C\,(s) + O_2\,(g) \rightarrow CO_2\,(g)$

b. $HCO_3^-\,(aq) + NH_3\,(aq) \rightleftharpoons CO_3^{2-}\,(aq) + NH_4^+\,(aq)$

*c. $H_2\,(g) + Li\,(s) \rightarrow LiH\,(s)$

d. $CO_3^{2-}\,(aq) + Ag^+\,(aq) \rightleftharpoons Ag_2CO_3\,(s)$

67. Give the oxidation number of iron in each of these species:

$Fe^{3+}\,(aq)$ _____

iron(II) ion _____

Fe (s) _____

*k. +3
*g. +2
*l. 0
e. -6
c. -5
d. -4
h. -3
f. -2
a. -1

b. +1
j. +4
m. +5
i. +6

68. Give the oxidation number of lead in each of these species:

Pb (s) _____

Pb^{2+} (aq) _____

lead(IV) ion _____

*a. 0
*m. +2
*g. +4
k. -6
h. -5
j. -4
l. -3
f. -2
c. -1
i. +1
e. +3
d. +5
b. +6

69. Give the oxidation number of chromium in each of these species:

Cr^{2+} (aq) _____

Chromium metal _____

chromium(II) ion _____

*d. +2
*n. 0
*i. +2
c. -6
e. -5
h. -4
a. -3
j. -2
m. -1
g. +1
b. +3
f. +4
k. +5
l. +6

70. Give the oxidation number of iron in each of these species:

Fe^{3+} (aq) _____

iron(II) ion _____

Fe (s) _____

*m. +3
*b. +2
*c. 0
j. -6
f. -5
h. -4
g. -3
d. -2
i. -1
k. +1
a. +4
l. +5
e. +6

71. Give the oxidation number of the underlined atom in each formula:

$\underline{Cr}O_4^{2-}$ (aq) _____

$\underline{Na_2}SO_4$ _____

$Fe_2\underline{O_3}$ _____

*j. +6
*m. +1
*a. -2
i. -6
b. -5
e. -4
c. -3
h. -1
f. 0
g. +2
l. +3
k. +4
d. +5

72. Give the oxidation number of the underlined atom in each formula:

CrO_4^{2-} (aq) _____

$Na_2\underline{S}O_4$ _____

$\underline{Fe_2}O_3$ _____

*j. -2
*d. +6
*l. +3
k. -6

h. -5
g. -4
b. -3
a. -1
m. 0
c. +1
f. +2
i. +4
e. +5

73. Give the oxidation number of the underlined atom in each formula:

$\underline{N}O_3^-$ (aq) _____

$Na_2\underline{C}O_3$ _____

$\underline{Pb}O_2$ _____

*d. +5
*e. +4
*g. +4
l. -6
i. -5
k. -4
h. -3
c. -2
b. -1
a. 0
n. +1
j. +2
m. +3
f. +6

74. Give the oxidation number of the underlined atom in each formula:

$\underline{Cr}O_4^{2+}$ (aq) _____

$\underline{Na_2}SO_4$ _____

$Fe_2\underline{O_3}$ _____

*d. +6
*c. +1
*e. -2
k. -6
l. -5
a. -4
f. -3
i. -1
m. 0
b. +2
j. +3
h. +4

g. +5

75. Identify each of the changes below as an oxidation or a reduction.

O_2 to 2 O^{2-} _____

Fe^{3+} to Fe^{2+} _____

*c. reduction
*a. reduction
b. oxidation

76. Identify each of the changes below as an oxidation or a reduction.

N_2 to 2 N^{3-} _____

Na to Na^{+} _____

*b. reduction
*a. oxidation

77. Identify each of the changes below as an oxidation or a reduction.

Cu^{+} to Cu^{2+} _____

Al^{3+} to Al _____

*b. oxidation
*a. reduction

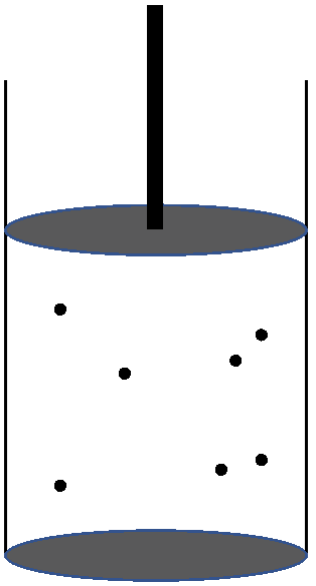
78. Identify each of the changes below as an oxidation or a reduction.

Mn^{2+} to Mn^{4+} _____

2 O^{2-} to O_2 _____

*a. oxidation
*b. oxidation
c. reduction

79. A gas sample contains 1.0 moles of N_2 at 3.0 atm and 300 K, in an apparatus with a piston that allows changes to the volume of the sample. Which of these changes will cause the pressure of the sample to <u>decrease</u>? Select all that apply.



a. Increasing the temperature of the sample at constant volume.

*b. Removing some of the N_2 gas at constant volume.

c. Moving the piston to decrease the volume of the sample at constant temperature.

d. Adding another gas to the sample at constant volume.

80. A gas sample contains 1.0 moles of N_2 at 3.0 atm and 300 K, in an apparatus with a piston that allows changes to the volume of the sample. Which of these changes will cause the volume of the sample to increase? Select all that apply.

*a. Increasing the temperature of the sample at constant pressure.

b. Removing some of the N_2 gas at constant pressure.

c. Increasing the pressure on the sample at constant temperature.

*d. Adding another gas to the sample at constant pressure.

81. A gas sample contains 1.0 moles of N_2 at 3.0 atm and 300 K, in an apparatus with a piston that allows changes to the volume of the sample. Which of these changes will cause the pressure of the sample to increase? Select all that apply.

*a. Increasing the temperature of the sample at constant volume.

b. Removing some of the N_2 gas at constant volume.

*c. Moving the piston to decrease the volume of the sample at constant temperature.

*d. Adding another gas to the sample at constant volume.

82. A gas sample contains 1.0 moles of N_2 at 3.0 atm and 300 K, in an apparatus with a piston that allows changes to the volume of the sample. Which of these changes will cause the volume of the sample to decrease? Select all that apply.

a. Increasing the temperature of the sample at constant pressure.

*b. Removing some of the N_2 gas at constant pressure.

*c. Increasing the pressure on the sample at constant temperature.

d. Adding another gas to the sample at constant pressure.

83. Sample A contains He (g) and sample B contains O_2 (g). Both samples are at the same pressure and temperature. Use the options in the dropdown menu to answer the following questions.

Which sample has the greater average particle speed? _____

Which sample's particles have the greater average kinetic energy? _____

Which sample's gas particles will escape more quickly through a small hole? _____

*b. Sample A
*a. Both samples have the same value
*c. Sample A
d. Sample B

84. Sample C contains He (g) at 150 K and sample D contains He (g) at 300 K. Both samples are at the same volume and the same number of moles. Use the options in the dropdown menu to answer the following questions.

Which sample has the greater average particle speed? _____

Which sample's particles have the greater average kinetic energy? _____

Which sample's gas particles will escape more quickly through a small hole? _____

*e. Sample D
*b. Sample D
*a. Sample D
d. Sample C
c. Both samples have the same value

85. Sample E contains He (g) at 600 K and sample F contains He (g) at 300 K. Both samples are at the same volume and the same number of moles. Use the options in the dropdown menu to answer the following questions.

Which sample has the greater average kinetic energy? _____

Which sample's particles have the greater average particle speed? _____

Which sample's gas particles will escape more quickly through a small hole? _____

*e. Sample E
*d. Sample E
*c. Sample E
a. Sample F
b. Both samples have the same value

86. Sample G contains O_2 (g) and sample H contains He (g). Both samples are at the same pressure and temperature. Use the options in the dropdown menu to answer the following questions.

Which sample has the greater average particle speed? _____

Which sample's particles have the greater average kinetic energy? _____

Which sample's gas particles will escape more quickly through a small hole? _____

*b. Sample H
*a. Both samples have the same value
*c. Sample H
d. Sample G

87. Sample A contains 1.0 L of He (g) and sample B contains 1.0 L of O2 (g). Both samples are at the same pressure and temperature. Use the options in the dropdown menu to answer the following questions.

Which sample has the greater density? _____

Which sample contains the same number of gas particles? _____

Which sample contains the greatest number of atoms? _____

*c. Sample B
*a. Both samples have the same value
*b. Sample B
d. Sample A

88. Sample C contains He (g) at 150 K and sample D contains He (g) at 300 K. Both samples are at the same volume and the same number of moles. Use the options in the dropdown menu to answer the following questions.

Which sample has the greater density? _____

Which sample has the greater pressure? _____

Which sample contains the greater number of atoms? _____

*d. Both samples have the same value
*c. Sample D
*a. Both samples have the same value
b. Sample C

89. Sample E contains He (g) at 600 K and sample F contains He (g) at 300 K. Both samples are at the same volume and have the same number of moles. Use the options in the dropdown menu to answer the following questions.

Which sample contains the greater number of atoms? _____

Which sample has the greater density? _____

Which sample has the greater pressure? _____

*b. Sample E
*d. Both samples have the same value
*a. Sample E
c. Sample F

90. Sample G contains 1.0 L of O2 (g) and sample H contains 1.0 L of He (g). Both samples are at the same pressure and temperature. Use the options in the dropdown menu to answer the following questions.

Which sample has the greater density? _____

Which sample contains the greater number of gas particles? _____

Which sample contains the greater number of atoms? _____

*c. Sample G
*b. Both samples have the same value

*a. Sample G
d. Sample H

91. Based on the principles of kinetic molecular theory, decide whether each of these statements is TRUE or FALSE.

_____ At the same temperature, two gas samples with particles of different masses will have the same average kinetic energy.

_____ If two gas samples have the same temperature, the one with the lighter gas particles will have the greater average particle speed.

_____ In a gas sample at constant temperature, all gas particles have the same kinetic energy.

*b. TRUE
*c. TRUE
*a. FALSE

92. Based on the principles of kinetic molecular theory, decide whether each of these statements is TRUE or FALSE.

_____ If two samples of different gases have the same temperature, they will have the same particle speed.

_____ In a gas sample at constant temperature, the gas particles have a range of kinetic energy values.

_____ If two gas samples have the same temperature, the one with the lighter gas particles will have the greater average kinetic energy.

*c. FALSE
*a. TRUE
*b. FALSE

93. Based on the principles of kinetic molecular theory, decide whether each of these statements is TRUE or FALSE.

_____ In a sample containing a mixture of gases, both gases will have the same average kinetic energy.

_____ If two gas samples have the same temperature, the one with the heavier particles will have a slower average particle speed.

_____ If two gas samples have the same temperature, they have the same average particle mass.

*b. TRUE
*a. TRUE
*c. FALSE

94. Based on the principles of kinetic molecular theory, decide whether each of these statements is TRUE or FALSE.

_____ At the same temperature, two gas samples with particles of different masses will have the same average kinetic energy.

_____ If two gas samples have the same temperature, the one with the lighter gas particles will have the greater average particle speed.

_____ In a gas sample at constant temperature, all gas particles have the same kinetic energy.

*b. TRUE
*a. TRUE
*c. FALSE