# CHE 105 Spring 2019 Exam 2

**Your Name:** _____          **Your ID:** _____

**Question #:** 1

What is the mass percent composition of lithium in $Li_3PO_4$?

    A. 26.75 %
    B. 17.98 %
    C. 30.72 %
    D. 55.27 %

---

**Question #:** 2

What is the empirical formula of a compound that contains 10.15 mg P and 34.85 mg Cl?

    A. $P_3Cl$
    B. $PCl_2$
    C. $P_2Cl_3$
    D. $PCl_3$

---

**Question #:** 3

What is the molecular formula of a compound that has a molar mass of 183.2 g/mol and an empirical formula of $C_2H_5O_2$?

    A. $C_2H_5O_2$
    B. $C_6H_{15}O_6$
    C. $C_4H_{10}O_4$
    D. $C_8H_{20}O_8$

---

**Question #:** 4

When salt, a __1__ [solvent, solute, concentrate], is added to water, the __2__ [solvent, solute, concentrate], the result is a(n) __3__ [dilute, concentrated, aqueous] solution.   Fill in the blanks with the correct choices of words.

1. _____
2. _____
3. _____

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**Question #:** 5

How many moles of NaCl are required to make 250. mL of a 3.00 $M$ solution?

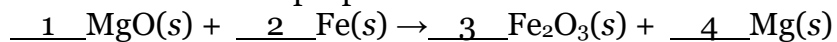A. 0.750 moles
B. 3.00 moles
C. 750. moles
D. 0.250 moles

---

**Question #:** 6

What is the concentration of a solution prepared by diluting 25.0 mL of a stock 0.188 $M$ $Ca(NO_3)_2$ solution to a total volume of 150.0 mL?
.

A. 1.13 $M$
B. 0.0887 $M$
C. 0.0313 $M$
D. 0.0199 $M$
E. 0.0501 $M$

---

**Question #:** 7

Balance the chemical equation below using the smallest possible **whole** numbers by filling in each blank with the proper coefficient.   If the coefficient is 1, fill in 1.
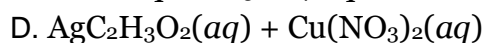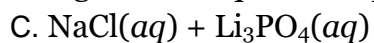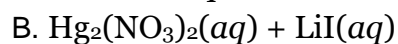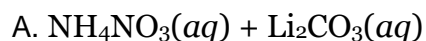
__1__ MgO($s$) + __2__ Fe($s$) → __3__ Fe₂O₃($s$) + __4__ Mg($s$)

1. _____
2. _____
3. _____
4. _____

---

**Question #:** 8

Which pair of aqueous solutions will form a precipitate when mixed?

A. $NH_4NO_3(aq)$ + $Li_2CO_3(aq)$
B. $Hg_2(NO_3)_2(aq)$ + $LiI(aq)$
C. $NaCl(aq)$ + $Li_3PO_4(aq)$
D. $AgC_2H_3O_2(aq)$ + $Cu(NO_3)_2(aq)$

---

**Question #:** 9

Which one is considered a strong electrolyte in an aqueous solution?

A. $NH_4NO_3$
B. $CH_3CO_2H$
C. $CH_3OH$
D. $C_6H_6O_6$

---

What precipitate is most likely formed from an aqueous solution containing $Ba^{2+}$, $Na^+$, $OH^-$, and $CO_3^{2-}$ ions?

    A. NaOH
    B. $BaCO_3$
    C. $Na_2CO_3$
    D. $Ba(OH)_2$

---

Which one is the **complete ionic equation** for the reaction (if any) that occurs when aqueous solutions of lithium sulfide and copper (II) nitrate are mixed?

    A. $Li^+(aq) + SO_4^{2-}(aq) + Cu^+(aq) + NO_3^-(aq) \rightarrow CuS(s) + Li^+(aq) + NO_3^-(aq)$
    B. $Li^+(aq) + S^-(aq) + Cu^+(aq) + NO_3^-(aq) \rightarrow CuS(s) + LiNO_3(s)$
    C. $2Li^+(aq) + S^{2-}(aq) + Cu^{2+}(aq) + 2NO_3^-(aq) \rightarrow Cu^{2+}(aq) + S^{2-}(aq) + 2LiNO_3(s)$
    D. $2Li^+(aq) + S^{2-}(aq) + Cu^{2+}(aq) + 2NO_3^-(aq) \rightarrow CuS(s) + 2Li^+(aq) + 2NO_3^-(aq)$

---

What is the **net ionic equation** for the reaction (if any) that occurs when aqueous solutions of $HNO_3$ and KOH are mixed?
.

    A. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
    B. $K^+(aq) + NO_3^-(aq) \rightarrow KNO_3(s)$
    C. $H^+(aq) + OH^-(aq) + K^+(aq) + NO_3^-(aq) \rightarrow H_2O(l) + KNO_3(s)$
    D. No reaction occurs.

Which one is a polyprotic acid in aqueous solution?

A. $Li(OH)_2$
B. $HClO_4$
C. $H_2O_2$
D. $H_2SO_4$

---

Strong bases

A. are the same as weak acids.
B. are able to ionize to produce hydronium ions in solution.
C. are soluble metal hydroxides.
D. react with water to produce precipitates.

---

Which reaction describes the ionization of a strong acid in aqueous solution?

A. $LiOH(aq) \rightarrow Li^+(aq) + OH^-(aq)$
B. $HBr(aq) + H_2O(l) \rightarrow H_2Br^+(aq) + OH^-(aq)$
C. $HSO_4^-(aq) + H_3O^+(aq) \rightarrow H_2O(l) + H_2SO_4(aq)$
D. $HI(aq) + H_2O(l) \rightarrow H_3O^+(aq) + I^-(aq)$

---

Which reaction is an oxidation-reduction reaction?

A. $HCl(aq) + Li(OH)(aq) \rightarrow LiCl(aq) + H_2O(l)$
B. $NaI(aq) + AgNO_3(aq) \rightarrow AgI(s) + NaNO_3(aq)$
C. $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
D. $Pb(C_2H_3O_2)_2(aq) + 2NaCl(aq) \rightarrow PbCl_2(s) + 2NaC_2H_3O_2(aq)$

---

**Question #:** 17

What element (if any) is undergoing **<u>reduction</u>** in the combustion reaction of methane in oxygen?

$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

    A. only oxygen
    B. only hydrogen
    C. only carbon
    D. both carbon and hydrogen
    E. None of the elements is undergoing reduction.
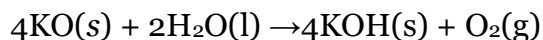
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**Question #:** 18

What is the oxidation number of phosphorus in the phosphite ion, $PO_3^{3-}$ ?

    A. +3
    B. +6
    C. +2
    D. −3

---

**Question #:** 19

How many moles of KOH will be formed from 5.44 moles of $H_2O$ according to the reaction below?  Assume an excess of KO.

$4KO(s) + 2H_2O(l) \rightarrow 4KOH(s) + O_2(g)$
.

    A. 2.72 moles KOH
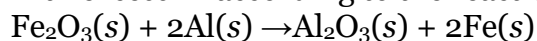    B. 16.7 moles KOH
    C. 10.9 moles KOH
    D. 8.33 moles KOH

---

A 12.39 g sample of phosphorus reacts with 42.54 g of chlorine to form phosphorus trichloride ($PCl_3$).  If $PCl_3$ is the only product, what mass of $PCl_3$ is formed? Hint: Write a balanced chemical equation.

    A. 30.15 g $PCl_3$
    B. 54.93 g $PCl_3$
    C. 40.1 g $PCl_3$
    D. 79.71 g $PCl_3$

---

What is the percent yield of a reaction that produces 28.65 g of Fe when 50.00 g of $Fe_2O_3$ reacts with excess Al according to the reaction equation given below?
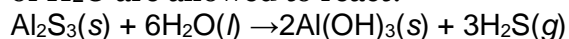$Fe_2O_3(s) + 2Al(s) \rightarrow Al_2O_3(s) + 2Fe(s)$
.

    A. 61.03%
    B. 57.30%
    C. 20.02%
    D. 81.93%

---

According to the reaction below, what amount of $Al_2S_3$ **remains** after 20.0 g of $Al_2S_3$ and 2.00 g of $H_2O$ are allowed to react?
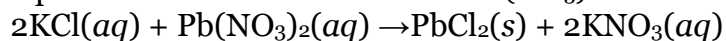$Al_2S_3(s) + 6H_2O(l) \rightarrow 2Al(OH)_3(s) + 3H_2S(g)$

.

| Substance | Molar Mass (g/mol) |
|---|---|
| $Al_2S_3$ | 150.14 |
| $H_2O$ | 18.02 |
| $Al(OH)_3$ | 78.00 |
| $H_2S$ | 34.08 |

A. 17.2 g $Al_2S_3$
B. 19.8 g $Al_2S_3$
C. 8.3 g $Al_2S_3$
D. 14.5 g $Al_2S_3$

---

What mass of $PbCl_2$ is formed from 235 mL of 0.110 $M$ KCl solution according to the following equation? Assume an excess of $Pb(NO_3)_2$.
$2KCl(aq) + Pb(NO_3)_2(aq) \rightarrow PbCl_2(s) + 2KNO_3(aq)$

.

A. 7.19 g $PbCl_2$
B. 1.30 g $PbCl_2$
C. 3.59 g $PbCl_2$
D. 5.94 g $PbCl_2$

---

The titration of 80.0 mL of a $H_3PO_4$ solution of unknown concentration requires 126 mL of 0.218 $M$ KOH solution.   What is the concentration of the $H_3PO_4$ solution? Hint: Write a balanced chemical equation.

    A. 1.03 $M$ $H_3PO_4$
    B. 0.138 $M$ $H_3PO_4$
    C. 0.448 $M$ $H_3PO_4$
    D. 0.114 $M$ $H_3PO_4$

---

Energy associated with the position or composition of an object is called

    A. kinetic energy.
    B. positional energy.
    C. compositional energy.
    D. potential energy.
    E. chemical energy.

---

If the change in the internal energy of a thermochemical system, $\Delta U$, is $-95$ J, which of the following is true?

    A. The system is gaining 95 J and the surroundings are losing 95 J.
    B. The system is losing 95 J and the surroundings are gaining 95 J.
    C. Both the system and the surroundings are gaining 95 J.
    D. Both the system and the surroundings are losing 95 J.
    E. It is impossible to tell is the system is gaining of losing energy.

---

The specific heat capacity is

    A. the quantity of heat required to raise the temperature of 1 liter of a substance by 1 °C.
    B. the quantity of heat required to raise the temperature of a mole of a substance by 1 °C.
    C. the quantity of heat required to raise the temperature of a gram of a substance by 1 °C.
    D. the quantity of heat required to raise the temperature of a substance by 1 °C.

---

What is the specific heat capacity of an alloy that requires 59.3 kJ to raise the temperature of 150.0 g of the alloy from 20 °C to 120 °C?

    A. 3.95 J/g·°C
    B. 4.38 J/g·°C
    C. 2.29 J/g·°C
    D. 1.87 J/g·°C

---

A 25.0 gram piece of iron at 398 K is placed in a Styrofoam coffee cup containing 25.0 mL of water at 298 K.   Assuming no heat is lost to the cup or surroundings, what will be the final temperature of the water?
.

| | |
|---|---|
| Specific heat capacity of iron | 0.449 J/g·K |
| Specific heat capacity of water | 4.18 J/g·K |
| Density of water | 1.00 g/mL |

    A. 325 K
    B. 348 K
    C. 308 K
    D. 388 K

Which statement is true?

    A. Endothermic processes result in the release of heat.
    B. The heat capacity is a measure of the amount of energy released in a chemical reaction.
    C. Joules cannot be numerically related to calories.
    D. A Joule is equivalent to one $kg \cdot m^2/s^2$.

# CHE 105 Spring 2019 Exam 2 - Confidential

**Your Name:** _____     **Your ID:** _____

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**Question #:** 1

What is the mass percent composition of lithium in $Li_3PO_4$?

.

    A. 26.75 %

✓B. 17.98 %

    C. 30.72 %

    D. 55.27 %

---

**Question #:** 2

What is the empirical formula of a compound that contains 10.15 mg P and 34.85 mg Cl?

    A. $P_3Cl$

B. $PCl_2$
C. $P_2Cl_3$
✓D. $PCl_3$

---

**Question #: 3**

What is the molecular formula of a compound that has a molar mass of 183.2 g/mol and an empirical formula of $C_2H_5O_2$?

.

A. $C_2H_5O_2$
✓B. $C_6H_{15}O_6$
C. $C_4H_{10}O_4$
D. $C_8H_{20}O_8$

---

**Question #: 4**

When salt, a __1__ [solvent, solute, concentrate], is added to water, the __2__ [solvent, solute, concentrate], the result is a(n) __3__ [dilute, concentrated, aqueous] solution. Fill in the blanks with the correct choices of words.

1. solute
2. solvent
3. aqueous

---

**Question #: 5**

How many moles of NaCl are required to make 250. mL of a 3.00 $M$ solution?

✓A. 0.750 moles
B. 3.00 moles
C. 750. moles
D. 0.250 moles

---

**Question #: 6**

What is the concentration of a solution prepared by diluting 25.0 mL of a stock 0.188 $M$ Ca(NO$_3$)$_2$ solution to a total volume of 150.0 mL?
.

    A. 1.13 $M$
    B. 0.0887 $M$
✓C. 0.0313 $M$
    D. 0.0199 $M$
    E. 0.0501 $M$

---

**Question #:** 7

Balance the chemical equation below using the smallest possible **whole** numbers by filling in each blank with the proper coefficient. If the coefficient is 1, fill in 1.

  _1_ MgO($s$) + _2_ Fe($s$) → _3_ Fe$_2$O$_3$($s$) + _4_ Mg($s$)
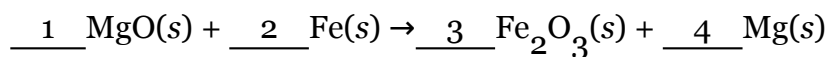
1. $\frac{3}{2}$
2. $\frac{2}{1}$
3. $\frac{1}{3}$
4. $\frac{3}{}$

---

**Question #:** 8

Which pair of aqueous solutions will form a precipitate when mixed?

    A. NH$_4$NO$_3$($aq$) + Li$_2$CO$_3$($aq$)
✓B. Hg$_2$(NO$_3$)$_2$($aq$) + LiI($aq$)
    C. NaCl($aq$) + Li$_3$PO$_4$($aq$)
    D. AgC$_2$H$_3$O$_2$($aq$) + Cu(NO$_3$)$_2$($aq$)

---

**Question #:** 9

Which one is considered a strong electrolyte in an aqueous solution?

✓A. NH$_4$NO$_3$
    B. CH$_3$CO$_2$H

C. $CH_3OH$
D. $C_6H_6O_6$

---

## Question #: 10

What precipitate is most likely formed from an aqueous solution containing $Ba^{2+}$, $Na^+$, $OH^-$, and $CO_3^{2-}$ ions?
.

  A. NaOH
✓B. $BaCO_3$
  C. $Na_2CO_3$
  D. $Ba(OH)_2$

---

## Question #: 11

Which one is the **complete ionic equation** for the reaction (if any) that occurs when aqueous solutions of lithium sulfide and copper (II) nitrate are mixed?

A. $Li^+(aq) + SO_4^{2-}(aq) + Cu^+(aq) + NO_3^-(aq) \rightarrow CuS(s) + Li^+(aq) + NO_3^-(aq)$
B. $Li^+(aq) + S^-(aq) + Cu^+(aq) + NO_3^-(aq) \rightarrow CuS(s) + LiNO_3(s)$
C. $2Li^+(aq) + S^{2-}(aq) + Cu^{2+}(aq) + 2NO_3^-(aq) \rightarrow Cu^{2+}(aq) + S^{2-}(aq) + 2LiNO_3(s)$
✓D. $2Li^+(aq) + S^{2-}(aq) + Cu^{2+}(aq) + 2NO_3^-(aq) \rightarrow CuS(s) + 2Li^+(aq) + 2NO_3^-(aq)$

---

## Question #: 12

What is the **net ionic equation** for the reaction (if any) that occurs when aqueous solutions of $HNO_3$ and KOH are mixed?
.

✓A. $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
  B. $K^+(aq) + NO_3^-(aq) \rightarrow KNO_3(s)$
  C. $H^+(aq) + OH^-(aq) + K^+(aq) + NO_3^-(aq) \rightarrow H_2O(l) + KNO_3(s)$
  D. No reaction occurs.

---

Which one is a polyprotic acid in aqueous solution?

    A. $Li(OH)_2$
    B. $HClO_4$
    C. $H_2O_2$
  ✓D. $H_2SO_4$

---

Strong bases

    A. are the same as weak acids.
    B. are able to ionize to produce hydronium ions in solution.
  ✓C. are soluble metal hydroxides.
    D. react with water to produce precipitates.

---

Which reaction describes the ionization of a strong acid in aqueous solution?

    A. $LiOH(aq) \rightarrow Li^+(aq) + OH^-(aq)$
    B. $HBr(aq) + H_2O(l) \rightarrow H_2Br^+(aq) + OH^-(aq)$
    C. $HSO_4^-(aq) + H_3O^+(aq) \rightarrow H_2O(l) + H_2SO_4(aq)$
  ✓D. $HI(aq) + H_2O(l) \rightarrow H_3O^+(aq) + I^-(aq)$

---

Which reaction is an oxidation-reduction reaction?

    A. $HCl(aq) + Li(OH)(aq) \rightarrow LiCl(aq) + H_2O(l)$
    B. $NaI(aq) + AgNO_3(aq) \rightarrow AgI(s) + NaNO_3(aq)$
  ✓C. $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
    D. $Pb(C_2H_3O_2)_2(aq) + 2NaCl(aq) \rightarrow PbCl_2(s) + 2NaC_2H_3O_2(aq)$

**Question #:** 17

What element (if any) is undergoing **reduction** in the combustion reaction of methane in oxygen?

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$
.

    ✓A. only oxygen
     B. only hydrogen
     C. only carbon
     D. both carbon and hydrogen
     E. None of the elements is undergoing reduction.

---

**Question #:** 18

What is the oxidation number of phosphorus in the phosphite ion, $PO_3^{3-}$ ?
.

    ✓A. +3
     B. +6
     C. +2
     D. −3

---

**Question #:** 19

How many moles of KOH will be formed from 5.44 moles of $H_2O$ according to the reaction below? Assume an excess of KO.

$$4KO(s) + 2H_2O(l) \rightarrow 4KOH(s) + O_2(g)$$
.

     A. 2.72 moles KOH
     B. 16.7 moles KOH
    ✓C. 10.9 moles KOH
     D. 8.33 moles KOH

---

**Question #:** 20

A 12.39 g sample of phosphorus reacts with 42.54 g of chlorine to form phosphorus trichloride $(PCl_3)$. If $PCl_3$ is the only product, what mass of $PCl_3$ is formed? Hint: Write a balanced chemical equation.

.

    A. 30.15 g $PCl_3$
   ✓B. 54.93 g $PCl_3$
    C. 40.1 g $PCl_3$
    D. 79.71 g $PCl_3$

---

**Question #: 21**

What is the percent yield of a reaction that produces 28.65 g of Fe when 50.00 g of $Fe_2O_3$ reacts with excess Al according to the reaction equation given below?

$Fe_2O_3(s) + 2Al(s) \rightarrow Al_2O_3(s) + 2Fe(s)$

.
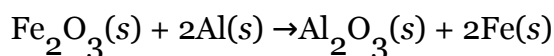
    A. 61.03%
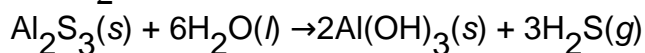    B. 57.30%
    C. 20.02%
   ✓D. 81.93%

---

**Question #: 22**

According to the reaction below, what amount of $Al_2S_3$ **remains** after 20.0 g of $Al_2S_3$ and 2.00 g of $H_2O$ are allowed to react?
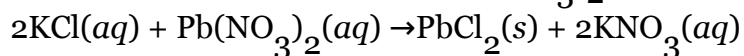
$Al_2S_3(s) + 6H_2O(l) \rightarrow 2Al(OH)_3(s) + 3H_2S(g)$

| Substance | Molar Mass (g/mol) |
|---|---|
| $Al_2S_3$ | 150.14 |
| $H_2O$ | 18.02 |
| $Al(OH)_3$ | 78.00 |
| $H_2S$ | 34.08 |

✓A. 17.2 g $Al_2S_3$
 B. 19.8 g $Al_2S_3$
 C. 8.3 g $Al_2S_3$
 D. 14.5 g $Al_2S_3$

---

**Question #:** 23

What mass of $PbCl_2$ is formed from 235 mL of 0.110 $M$ KCl solution according to the following equation?  Assume an excess of $Pb(NO_3)_2$.

$2KCl(aq) + Pb(NO_3)_2(aq) \rightarrow PbCl_2(s) + 2KNO_3(aq)$

.

 A. 7.19 g $PbCl_2$
 B. 1.30 g $PbCl_2$
✓C. 3.59 g $PbCl_2$
 D. 5.94 g $PbCl_2$

---

**Question #:** 24

The titration of 80.0 mL of a $H_3PO_4$ solution of unknown concentration requires 126 mL of 0.218 $M$ KOH solution.  What is the concentration of the $H_3PO_4$ solution? Hint: Write a balanced chemical equation.

.

 A. 1.03 $M$ $H_3PO_4$
 B. 0.138 $M$ $H_3PO_4$
 C. 0.448 $M$ $H_3PO_4$
✓D. 0.114 $M$ $H_3PO_4$

---

**Question #:** 25

Energy associated with the position or composition of an object is called

 A. kinetic energy.
 B. positional energy.

C. compositional energy.

✓D. potential energy.

E. chemical energy.

---

**Question #:** 26

If the change in the internal energy of a thermochemical system, ΔU, is −95 J, which of the following is true?

A. The system is gaining 95 J and the surroundings are losing 95 J.

✓B. The system is losing 95 J and the surroundings are gaining 95 J.

C. Both the system and the surroundings are gaining 95 J.

D. Both the system and the surroundings are losing 95 J.

E. It is impossible to tell is the system is gaining of losing energy.

---

**Question #:** 27

The specific heat capacity is

A. the quantity of heat required to raise the temperature of 1 liter of a substance by 1 °C.

B. the quantity of heat required to raise the temperature of a mole of a substance by 1 °C.

✓C. the quantity of heat required to raise the temperature of a gram of a substance by 1 °C.

D. the quantity of heat required to raise the temperature of a substance by 1 °C.

---

**Question #:** 28

What is the specific heat capacity of an alloy that requires 59.3 kJ to raise the temperature of 150.0 g of the alloy from 20 °C to 120 °C?

✓A. 3.95 J/g·°C

B. 4.38 J/g·°C

C. 2.29 J/g·°C

D. 1.87 J/g·°C

---

**Question #:** 29

A 25.0 gram piece of iron at 398 K is placed in a Styrofoam coffee cup containing 25.0 mL of water at 298 K. Assuming no heat is lost to the cup or surroundings, what will be the final temperature of the water?

| Specific heat capacity of iron | 0.449 J/g·K |
|---|---|
| Specific heat capacity of water | 4.18 J/g·K |
| Density of water | 1.00 g/mL |

A. 325 K
B. 348 K
✓C. 308 K
D. 388 K

---

**Question #:** 30

Which statement is true?

A. Endothermic processes result in the release of heat.
B. The heat capacity is a measure of the amount of energy released in a chemical reaction.
C. Joules cannot be numerically related to calories.
✓D. A Joule is equivalent to one $kg \cdot m^2/s^2$.