CH 2

KEY

Multiple Choice Questions

1. *Fluorine gas is bubbled through an aqueous solution of calcium bromate. Besides water, this statement refers to which chemical formulas?*

   A) F_2 and $CaBr_2$

   B) F and $CaBr_2$

   C) F_2 and $Ca(BrO_3)_2$

   D) F_2 and $CaBrO_3$

   E) F and $CaBrO_3$

2. *Magnesium nitride reacts with water to form ammonia and magnesium hydroxide. Besides water, this statement refers to which chemical formulas?*

   A) Mg_3N_2, NH_3 and $Mg(OH)_2$

   B) $Mg(NO_3)_2$, NH_4^+ and MgH_2

   C) $Mg(NO_3)_2$, NH_3 and MgH_2

   D) $Mg(NO_2)_2$, NH_4^+ and $Mg(OH)_2$

   E) Mg_3N_2, NH_3 and $MgOH$

3. *The mineral spinel is an ionic compound containing only the elements magnesium, aluminum, and oxygen. Its simplest formula is probably:*

   A) $MgAlO_3$

   B) Mg_2AlO_4

   C) $MgAl_2O_4$

   D) $Mg_2Al_2O_3$

   E) Mg_2AlO_3

4. *The mineral chromite, $FeCr_2O_4$, consists of a mixture of iron(II) oxide and chromium(III) oxide. What is the most likely ratio of iron(II) oxide to chromium(III) oxide in chromite?*

   A) 1:1

   B) 1:2

   C) 2:3

   D) 3:2

   E) 2:1

5. *Which formula represents a peroxide?*

   A) K_2O

   B) K_2O_2

   C) KO_2

   D) CaO

   E) Ca_2O_2

6. *What is the general formula for an alkaline earth metal hydride?*

   A) MH

   B) MOH

   C) MH_2

   D) $M(OH)_2$

   E) M_2H

7. *Which of the following compounds contains four carbon atoms?*

   A) *propane*

   B) *butanoic acid*

   C) *ethyl methyl ether*

   D) *2-pentanol*

   E) *heptanal*

8. *Bromine has just two major isotopes giving it an atomic mass of 79.904 amu. Based on this information, which of the following statements can explain the atomic mass value?*

   A) *The isotope, Br-81, is more common than Br-79.*

   B) *Br-79 and Br-81 exist in about equal proportions.*

   C) *Br-78 is about twice as abundant as Br-81.*

   D) *Br-82 is more abundant than Br-79.*

   E) *The two major isotopes of Br have 45 and 46 neutrons.*

9. *Which is a collection of only molecular compounds?*

   A) NO, CS_2, PCl_3, HBr

   B) $NaNO_3, CCl_4, CuS$

   C) Ar, NH_3, SF_4, PCl_5

D) Cl_2, CCl_4, NO_2, SF_6

E) H_2O, CaO, CO, CO_2

10. *Which is true of the* $^{243}Am^{3+}$ *ion?*

	Protons	*Electrons*	*Neutrons*
A)	*95*	*92*	*243*
B)	*95*	*98*	*243*
C)	*95*	*95*	*148*
D)	*95*	*92*	*148*
E)	*92*	*95*	*148*

Free Response Questions

1. *The two stable isotopes of chlorine have masses of 34.969 amu and 36.966 amu.*
   a. *What are the mass numbers of the two isotopes of chlorine?*
   b. *Calculate the % abundance of the lighter isotope.*
   c. *How many types of molecules with different masses exist in a sample of chlorine gas if the sample exists entirely as diatomic molecules? Explain your answer.*
   d. *Calculate the mass of the chlorine molecule having the largest molecular mass.*
   e. *What is the mass of the most abundant molecule? Calculate its % abundance.*

2. *Like chlorine, iodine is a halogen and forms similar compounds. Write the names and formulas of the four oxyanions and the four oxyacids of iodine.*

Additional Practice in *Chemistry the Central Science*

For more practice answering questions in preparation for the Advanced Placement examination try these problems in Chapter 2 of Chemistry the Central Science*:*

Additional Exercises: 2.79, 2.91, 2.95, 2.97, 2.98, 2.99, 2.100, 2.102, 2.103, 2.104.

CH 3

Multiple Choice Questions

1. *Ammonia forms when hydrogen gas reacts with nitrogen gas. If equal number of moles of nitrogen and hydrogen are combined, the maximum number of moles of ammonia that could be formed will be equal to:*

   A) the number of moles of hydrogen.

   B) the number of moles of nitrogen.

   C) twice the number of moles of hydrogen.

   D) twice the number of moles of nitrogen.

   E) two thirds the number of moles of hydrogen.

2. *If $C_4H_{10}O$ undergoes complete combustion, what is the sum of the coefficients when the equation is completed and balanced using smallest whole numbers?*

   A) 8

   B) 16

   C) 22

   D) 25

   E) 32

3. *What are the products when lithium carbonate is heated?*

   A) $LiOH + CO_2$

   B) $Li_2O + CO_2$

   C) $LiO + CO_2$

   D) $LiC + O_2$

   E) $LiO + CO$

4. *Beginning with 48 moles of H_2, how many moles of $Cu(NH_3)_4Cl_2(aq)$ can be obtained if the synthesis of $Cu(NH_3)_4Cl_2(aq)$ is carried out through the following sequential reactions? Assume that a 50% yield of product(s) is(are) obtained in each reaction.*

   I. $3H_2(g) + N_2(g) \dashrightarrow 2NH_3(g)$

   II. $4NH_3(g) + CuSO_4(aq) \dashrightarrow Cu(NH_3)_4SO_4(aq)$

   III. $Cu(NH_3)_4SO_4 + 2NaCl \dashrightarrow Cu(NH_3)_4Cl_2(aq) + Na_2SO_4(aq)$

A) 1

B) 2

C) 4

D) 8

E) 12

5. *What mass of water can be obtained from 4.0 g of H_2 and 16 g of O_2?*

$2H_2(g) + O_2(g) \rightarrow 2H_2O$

A) 9 g

B) 18 g

C) 36g

D) 54 g

E) 72 g

6. *The empirical formula of pyrogallol is C_2H_2O and its molar mass is 126. Its molecular formula is:*

A) C_2H_2O

B) $C_4H_4O_2$

C) $C_2H_6O_3$

D) $C_6H_6O_3$

E) $C_2H_6O_6$

7. *What is the maximum amount of water that can be prepared from the reaction of 20.0 g of HBr with 20.0 g of $Ca(OH)_2$?*

$2HBr + Ca(OH)_2 \rightarrow CaBr_2 + 2H_2O$

A) (20/81)(2/2)(18) g

B) (20/74)(2/2)(18) g

C) (20/81)(2/1)(18) g

D) (20/74)(2/1)(18) g

E) (20/74)(1/2)(18) g

8. *How many moles of ozone, O_3, could be formed from 96.0 g of oxygen gas, O_2?*

A) 0.500 mol

B) 1.00 mol

C) 2.00 mol

D) 3.00 mol

E) 1/16 mol

9. The percentage of oxygen in $C_8H_{12}O_2$ is:

A) (16/140)(100)

B) (32/140)(100)

C) (16/124)(100)

D) (140/32)(100)

E) (32/124)(100)

10. A compound contains 48% O, 40.0% Ca, and the remainder is C. What is its empirical formula?

A) $O_3C_2Ca_2$

B) O_3CCa_2

C) O_3CCa

D) O_3CCa_2

E) O_2CCa

Free Response Question

1. Combustion of 8.652 grams of a compound containing C, H, O, and N yields 11.088 g of CO_2, 3.780 grams of H_2O and 3.864 grams of NO_2.

a. How many moles of C, H, and N are contained in the sample?

b. How many grams of oxygen are contained in the sample?

c. What is the simplest formula of the compound?

d. If the molar mass of the compound lies between 200 and 300, what is its molecular formula?

e. Write and balance a chemical equation for the combustion of the compound.

Additional Practice in *Chemistry the Central Science*

For more practice answering questions in preparation for the Advanced Placement examination try these problems in Chapter 3 of Chemistry the Central Science:

Additional Exercises: 3.81, 3.84, 3.86, 3.88, 3.89, 3.90, 3.91, 3.96, 3.98, 3.99, 3.100.

Integrative Exercises: 3.103, 3.104, 3.105, 3.107.

CH4

Multiple Choice Questions

1. *Which of the following elements should react most readily with water?*

   A) *potassium*

   B) *calcium*

   C) *sulfur*

   D) *oxygen*

   E) *magnesium*

2. *The collection of ions, all of whose members do not commonly form precipitates is*

   A) $Hg_2^{2+}, Ag^+, Pb^{2+}, Ba^{2+}$

   B) $PO_4^{3-}, OH^-, S^{2-}, CO_3^{2-}$

   C) $NO_3^-, Na^+, K^+, NH_4^+$

   D) $SO_4^{2-}, Cl^-, Br^-, I^-$

   E) $CrO_4^{2-}, Cu^{2+}, Fe^{2+}, SO_4^{2-}$

3. *Which substance will* **not** *form a gas upon mixing with an aqueous acid?*

   A) $NaHCO_3(s)$

   B) $CaS(s)$

   C) $Ca(s)$

   D) $K_2SO_3(s)$

   E) $Al_2O_3(s)$

4. *Which metal will* **not** *react with aqueous hydrochloric acid?*

   A) *Fe*

   B) *Al*

   C) *Cu*

   D) *K*

   E) *Ni*

5. *How many milliliters of 0.40 M $FeBr_3$ solution would be necessary to precipitate all of the Ag^+ from 30 mL of a 0.40 M $AgNO_3$ solution?*

   $FeBr_3(aq) + 3AgNO_3(aq) \dashrightarrow Fe(NO_3)_3(aq) + 3AgBr(s)$

CH 4

A) 10 mL

B) 20 mL

C) 30 mL

D) 60 mL

E) 90 mL

6. *How many grams of baking soda, sodium hydrogen carbonate, are required to completely neutralize 1.00 L of 6.00 M sulfuric acid that has been spilled on the floor?*

A) (1/6.00)(2/1)(84.0)

B) (6.00)(84.0)

C) (6.00)(2/1)/(84.0)

D) (6.00)(2/1)(84.0)

E) (6.00)(1/2)(84.0)

7. *It takes 37.50 mL of 0.152 M sodium chromate to titrate 25.00 mL of silver nitrate. What is the molarity of the silver nitrate solution?*

A) (2)(37.50)(0.152)(25.00)

B) (25.00)/(37.50)(0.152)(2)

C) (0.152)(25.00)/(37.50)

D) (37.50)(0.152)/(25.00)

E) (2)(37.50)(0.152)/(25.00)

8. *Which substance will react with water, at room temperature and pressure, to produce hydrogen?*

A) Mg

B) NaH

C) HN_3

D) $NaOH$

E) NH_3

9. *What is the net-ionic equation for the reaction of aqueous solutions of* $CaCl_2$ *and* Na_2CO_3?

A) $Ca^{2+}(aq) + 2Cl^-(aq) + 2Na^+(aq) + CO_3^{2-}(aq) \dashrightarrow CaCO_3(s) + 2Na^+(aq) + 2Cl^-(aq)$

B) $Cl^-(aq) + Na^+(aq) \dashrightarrow NaCl(s)$

C) $CaCl_2(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3(s) + 2Cl^-(aq)$

D) $Ca^{2+}(aq) + Na_2CO_3^{2-}(aq) \rightarrow CaCO_3(s) + 2Na^+(aq)$

E) $Ca^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3(s)$

10. *Magnesium burns in carbon dioxide to produce carbon and magnesium oxide. What is the ratio of carbon to magnesium oxide in the products?*

A) 1:1

B) 2:1

C) 1:2

D) 2:3

E) 3:2

Free Response Questions

1. *A student accidentally spills a 1.00 L bottle of concentrated 18.0 M sulfuric acid on the floor of the laboratory. She attempts to neutralize the spill by pouring a 5.00 kg box baking soda, sodium hydrogen carbonate, onto the acid.*

   a. *Write a balanced net ionic equation for the reaction. Assume the concentrated sulfuric acid is 100% pure and not in aqueous solution.*

   b. *What is the limiting reactant?*

   c. *How many grams of sodium hydrogen carbonate are required to neutralize all the acid?*

   d. *How many moles of excess reactant remain after all the limiting reactant has been consumed?*

   e. *Would a floor consisting of bare concrete require more, less, or the same amount of baking soda to neutralize the spill? Explain.*

2. *Three unknown acid solutions are labeled A, B, and C. One is sulfuric acid, one is hydrochloric acid, and the other is nitric acid. Each has a concentration of approximately one molar. Using only aqueous reagents of 0.20 M lead(II) nitrate and 0.50 M calcium nitrate write a short, concise experimental procedure, the results of which will be sufficient to identify each of the unknown acids. Tell what you would expect to see and what it means. Write net ionic equations to illustrate your answers.*

CH5

Multiple Choice Questions

1. *The standard enthalpy of formation ($\Delta H°_f$) for potassium chloride is the enthalpy change for the reaction:*

   A) $K(g) + \frac{1}{2}\,Cl_2(g) \rightarrow KCl(g)$

   B) $K^+(g) + Cl^-(g) \rightarrow KCl(s)$

   C) $2K(s) + Cl_2(g) \rightarrow 2KCl(s)$

   D) $K(s) + \frac{1}{2}\,Cl_2(g) \rightarrow KCl(s)$

   E) $K^+(g) + Cl^-(g) \rightarrow KCl(s)$

2. *For which of these processes is the value of ΔH expected to be negative?*

   I. *The temperature increases when calcium chloride dissolves in water.*

   II. *Steam condenses to liquid water.*

   III. *Water freezes.*

   IV. *Dry ice sublimes.*

   A) *IV only*

   B) *I, II and III*

   C) *I only*

   D) *II and III only*

   E) *I and II only*

3. *Which is expected to not have a $\Delta H°_f$ value of zero?*

   A) $F_2(g)$

   B) $Br_2(g)$

   C) $I_2(s)$

   D) *C(s, graphite)*

   E) $N_2(g)$

4. *For which of the following equations is the change in enthalpy at 25°C and 1 atm equal to $\Delta H°_f$ of $CH_3OH(l)$?*

   A) $CH_3OH(l) + 3/2\,O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$

   B) $CH_3OH(l) + 3/2\,O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

   C) $2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)$

   D) $CH_3OH(l) \rightarrow C(s) + 2H_2O(l)$

   E) $C(s) + 2H_2(g) + \frac{1}{2}\,O_2(g) \rightarrow CH_3OH(l)$

Ch 5

5. *Which change will result in an increase in enthalpy of the system?*

   A) *burning a candle*

   B) *freezing water*

   C) *evaporating alcohol*

   D) *dropping a ball*

   E) *condensing steam*

6. *The standard enthalpy of formation of Cl(g) is +242 kJ/mol. What is the dissociation energy of a Cl-Cl bond?*

   A) +242 *kJ/mol*

   B) −242 *kJ/mol*

   C) +484 *kJ/mol*

   D) +121 *kJ/mol*

   E) −121 *kJ/mol*

7. *For which process is the sign of ΔH negative?*

   A) *Photosynthesis*

   B) $CO_2(g) \dashrightarrow C(s) + O_2(g)$

   C) $N_2(g) \dashrightarrow 2N(g)$

   D) $NaOH(s) \dashrightarrow Na^+(aq) + OH^-(aq) + heat$

   E) $H_2O + electricity \dashrightarrow \frac{1}{2} H_2(g) + O_2(g)$

8. *Given the following data, what is the heat of formation of methane gas?*

   I. $CH_4(g) + 2O_2(g) \dashrightarrow CO_2(g) + 2H_2O(g)$ $\quad \Delta H = -803\ kJ$

   II. $H_2(g) + \frac{1}{2} O_2(g) \dashrightarrow H_2O(g)$ $\quad \Delta H = -242\ kJ$

   III. $C(s) + O_2(g) \dashrightarrow CO_2(g)$ $\quad \Delta H = -394\ kJ$

   IV. $C(s) + \frac{1}{2} O_2(g) \dashrightarrow CO(g)$ $\quad \Delta H = -111\ kJ$

   A) −803 *kJ/mol*

   B) −75 *kJ/mol*

   C) +167 *kJ/mol*

   D) +208 *kJ/mol*

   E) −1439 *kJ/mol*

9. *The standard heat of formation of gaseous sulfur trioxide is −396 kJ/mol. What is the enthalpy of reaction represented by the following balanced equation?*

   $2SO_3(g) \dashrightarrow 2S(s) + 3O_2(g)$

A) −396 kJ

B) +396 kJ

C) +792 kJ

D) −792 kJ

E) +198 kJ

10. *Given only the following data, what can be said about the following reaction?*

$3H_2(g) + N_2(g) \dashrightarrow 2NH_3(g) \qquad \Delta H = -92\ kJ$

A) *The enthalpy of products is greater than the enthalpy of reactants.*

B) *The total bond energies of products are greater than the total bond energies of reactants.*

C) *The reaction is very fast.*

D). *Nitrogen and hydrogen have very stable bonds compared to the bonds of ammonia.*

E. *The reaction is endothermic.*

Free Response Questions

1. *The heat of combustion of gaseous butane is −2658 kJ/mol and the heat of combustion of liquid butane is −2635 kJ/mol when, in both cases, all products are gases.*

   a. *Write a balanced chemical equation for the combustion of gaseous butane.*

   b. *How many grams of gaseous butane combust when 1550 kJ of heat are produced?*

   c. *What is the magnitude and sign of the molar heat of vaporization of butane? Explain your reasoning using Hess's law. Is your sign for the heat of vaporization realistic? Explain.*

2. *When 15.00 g of propane are burned in air to produce all gaseous products, 730.0 kJ of heat are produced.*

   a. *Calculate the molar heat of combustion of propane.*

   b. *When 15.00 g of propane are combusted in air to produce gaseous carbon dioxide and liquid water, 790.0 kJ of heat are produced. Explain why the amount of heat available from the combustion of propane depends on the phase of the products.*

   c. *Calculate the heat of vaporization of water in units of kJ/g.*