Skill Practice 1

Numbers Practice

Name: _____

Date: _____

Hour: _____

For problems 1-3, please use these conversion factors:

1 pallet = 45 bundles   1 bundle = 32 cases   1 case = 12 cans   1 can = 218.4 mL

1. How many mL of apple juice does the company need to make to fulfill an order for 2.5 pallets?

2. If 46,680 mL of juice are produced, how many cases of juice can be made?

3. A certain store ordered 480 cases of juice. How many pallets were required to ship the order?

4. Please perform the following conversions.

   a) 15.60 cm = _____ m

   b) 41.0 kg = _____ µg

   c) 9.2 cL = _____ µL

   d) 9.16×10^{-5} m = _____ nm

5. Solve the following problems. Write answers in scientific notation.

   a) $(7.430 \times 10^{4})(3.0 \times 10^{2})$ = _____

   b) $8.03 \times 10^{6} + 4.0 \times 10^{4}$ = _____

   c) $(2.22 \times 10^{-12}) / (4.10 \times 10^{-33})$ = _____

   d) $(35,020)(321.0)$ = _____

6. Convert the following numbers to scientific notation:

   a) 23,000,210,000 = _____

   b) 0.00000000351 = _____

7. Convert the following numbers to "regular" notation:

   a) 2.354×10^{5} = _____

   b) 3.400×10^{-9} = _____

Skill Practice 2

Significant Figures Practice

Name: _____

Date: _____

Hour: _____

Perform the following operations and give the answers in the correct number of significant figures. If the question is in scientific notation, then please use scientific notation in your answer.

1. $200.00 + 125.2 =$ _____

2. $12,020 + 6000 =$ _____

3. $0.003450 + 0.0140 =$ _____

4. $0.820 - 0.030 =$ _____

5. $(240,900)(120.0) =$ _____

6. $340/12.5 =$ _____

7. $(2.450 \times 10^{6})(2.0 \times 10^{6}) =$ _____

8. $(5.369 \times 10^{12})/2.89 \times 10^{7}) =$ _____

Skill Practice 3

Matter Practice

Name: _____

Date: _____

Hour: _____

1. Explain why compounds are always homogeneous, but mixtures can be either homogeneous or heterogeneous.

2. A white powder is in a beaker. Which statement(s) can be said <u>for sure</u> about the powder?
    I.   It is homogeneous
    II.   It is heterogeneous
    III.   It is a mixture.
    IV.   It is a compound.

    A) I only   B) I and IV only   C) I and III only   D) III only   E) none of these

3. Classify the following as chemical changes (C) or physical changes (P). Place a C or P in the blanks as appropriate.

    _____ a) a dead fish rotting

    _____ b) dissolving salt in water

    _____ c) boiling salt water until just salt remains

    _____ d) melting steel

    _____ e) bending steel

    _____ f) cracking ice

4. Identify the following as an element (E), compound (C), or mixture (M).

    _____ a) calcium   _____ d) water

    _____ b) calcium and oxygen in the same container   _____ e) sodium

    _____ c) calcium and oxygen atoms bonded   _____ f) sand

5. How many phases and how many states are in a mixture made out of sand, saltwater, oil and ice.
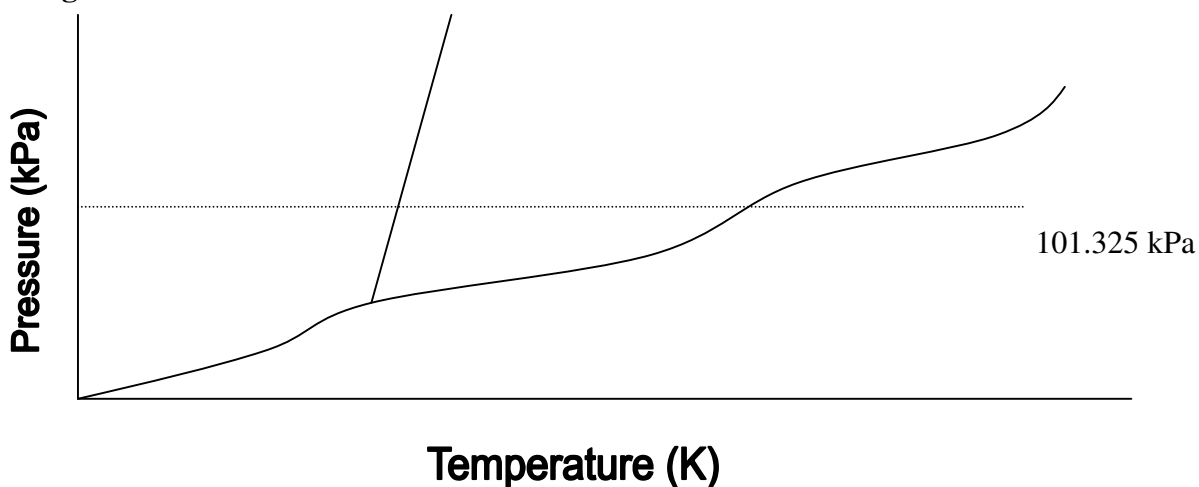
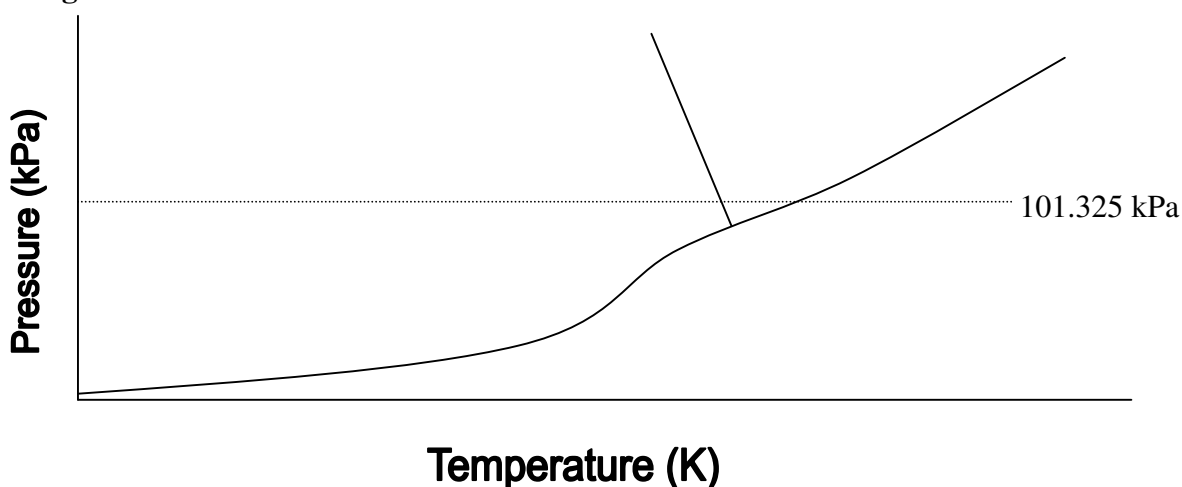Skill Practice 4

Phase Diagrams Practice

Name: _____

Date: _____

Hour: _____

Phase diagram for substance A:

Pressure (kPa)

101.325 kPa

Temperature (K)

Phase diagram for substance B:

Pressure (kPa)

101.325 kPa

Temperature (K)

1. On each of the phase diagrams label the triple point (TP) and the solid, liquid and vapor states.
2. For which substance, A or B, does the freezing point decrease as the pressure is increased?

3. One of the substances behaves more like most other substances. Which substance and what property allows you to tell?

4. Assuming that the temperature scales for both phase diagrams are the same, which can be sublimed at the highest temperature—substance A or B? Show on the phase diagram of this substance where sublimation will take place.

Skill Practice 5

Specific Heat Practice

Name: _____

Date: _____

Hour: _____

1. Heated blocks of iron used to be used to warm beds. A 1600 g brick of iron heated to 155°C would release how many joules of heat energy as it cooled to 25°C? Note: the specific heat of iron is 0.4494 J/g^{o}C.

2. How many joules of heat are required to heat 100.0 g of room temperature water (22°C) to the boiling point?

3. How many joules of heat are required to heat 20.5 g of tin from 30°C to 230°C? The specific heat of tin is 0.2274 J/g^{o}C.

4. If it takes 24,500 J to heat 1.05 g of a substance from 25°C to 49°C, what is the specific heat of the substance?

5. If 24,500 J is applied to 125 g of water at 35°C, what will the final temperature of the water be?

6. A reactor core needs to stay at or below 95°C to remain in good condition. Cool water at a temperature of 10°C is used to cool the reactor. If the reactor emits 210,000 kJ of energy each hour, how many grams of water need to be circulating each hour in order to keep the reactor at or below 95°C?

Energy Calculations Practice

Name: _____

Date: _____

Hour: _____

1. How much energy is required to change the temperature of 210 g of H_2O from -40^oC to 155^oC?

2. How much energy is required to heat up 45g of water at 55^oC to steam at 140^oC?

3. Consider a cup of coffee that has a temperature of 93^oC. Assume the mass of the coffee is 550 g and that the specific heat of coffee is about the same as the specific heat of water. Is a 230 g ice cube (at 0^oC) a large enough ice cube to bring the temperature of the coffee to 23^oC? Note: the final temperature of the ice cube and of the coffee is 23^oC.

4. Consider a pot of water at 100^oC. If it took 1,048,815 J of energy to vaporize the water and heat it to 135^oC, how many grams of water were in the pot?

Skill Practice 7

Density Practice

1. What is the density of a rock that has a mass of 234 g and a volume of 7.9 cm^3?

2. A piece of metal that has a density of 5.2 g/cm^3 and a mass of 100 g was placed in a full jar of water. How many mL of water spilled out of the jar? Note: one cm^3 = one mL.

3. A huge meteor had a mass of 3.2×10^{12} g. If the density of the meteor was 4.2 g/cm^3, what was the volume of the meteor?

4. Gold was mined in California and divided into 1.5 kg pieces. Each piece of gold was a perfect cube 8.1 cm tall. What was the density of the gold?

5. A very large boulder with a volume of 1200 L has a mass of 1.4×10^9 g. What is the density of the boulder?

6. What is the density of a piece of wood that has a mass of 2.74 g and a volume of 3.10 cm^3?

7. Find the volume of a liquid if 32.5 g of the liquid has a density of 0.852 g/mL.

Skill Practice 8

Atomic Structure

Name: _____

Date: _____

Hour: _____

1. An atom has a mass number of 43 and it also has 21 electrons.
   a) How many protons does this atom have?

   b) What is the identity of this atom?

   c) How many neutrons does this atom have?

2. What is an isotope? Give an example.

3. A certain *ion* has an atomic number of 16, a mass number of 33, and 18 electrons.
   a) What is the charge on the ion?

   b) What is the identity of this ion?

   c) How many neutrons does the nucleus of this ion have?

4. Tritium (an isotope of hydrogen) has 2 neutrons. How many protons does it have? What is its mass number?

5. What is the charge on a magnesium ion that has 10 electrons?

6. How many neutrons are there in a chromium atom with a mass number of 54?

7. Substance E has 29 protons, 28 electrons, and 34 neutrons. Substance F has 29 protons, 27 electrons, and 34 neutrons. Substances E and F can be categorized as…
   A) different elements   B) ions   C) isotopes   D) nuclides   E) nucleons

8. The element with 38 protons and 45 neutrons could correctly be identified as which element?

9. Complete the following table:

Symbol	# of neutrons	# of protons	# of electrons	Atomic #	Mass #
$^{136}_{56}\text{Ba}^{+2}$					
		25	25		56
	120		79	79	
	21	20	18		

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Practice Problems
Average Atomic Mass

Name: _____

Date: _____

Hour: _____

1. A certain element exists as three different isotopes. 24.1% of all the isotopes have a mass of 75.23 amu, 48.7% have a mass of 74.61 amu, and 27.2% have a mass of 75.20 amu.
    a. What is the average atomic mass of this element?

    b. Use your periodic table to determine which element this is.

2. An element exists as 4 different isotopes. 4.35% have a mass of 49.9461 amu, 83.79% have a mass of 51.9405 amu, 9.50% have a mass of 52.9407 amu, and 2.36% have a mass of 53.9389 amu.
    a. What is the average atomic mass of this element?

    b. What is the identity of this element?

3. Calcium has three different isotopes. One has a mass of 35.00 amu; another has a mass of 41.00 amu; and another has a mass of 40.00 amu. Which isotope is the most abundant of the three? (HINT: Look at the periodic table at calcium's average atomic mass.)

4. Several isotopes of a certain atom "X" exist. 4.35% of all X atoms have a mass of 49.946 amu. 83.79% have a mass of 51.941 amu, 9.50% have a mass of 52.941 amu, and 2.36% have a mass of 53.939 amu. What is the average atomic mass of atom X?

Skill Practice 10

Bohr Problems

Name: _____

Date: _____

Hour: _____

1. Define the terms "ground state" and "excited state".

2. What is the wavelength of light that has a frequency of 4.22×10^{15} Hz?

3. What is the energy of light that has a frequency of 1.30×10^{14} Hz?

4. A certain atom has a green spectrum line of about 540 nm. What is the difference in energy between the two energy levels responsible for producing the line?

5. The wavelength of a certain beam o flight was 3.52×10^{-7} m.
   a) Find the frequency of this light.

   b) Calculate how much energy this light has.

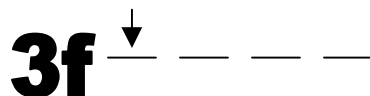6. What is the frequency and wavelength of light that has energy of 5.09×10^{-19} J?

Electron Practice

Name: _____

Date: _____

Hour: _____

1. What is wrong with the following notation?

   $$3f \overset{\downarrow}{\underline{}} \ \underline{} \ \underline{} \ \underline{}$$

2. How many sublevels would you expect in the 8th energy level?

3. What is the maximum number of electrons that can fit in the 3d sublevel?

4. How many electrons can fit in a 2p orbital?

5. In the 5th energy level, there is a fifth sublevel called the "g sublevel". Considering the trend in number of orbitals and electrons in the s, p, d, and f sublevels, predict how many orbitals and how many electrons can fit in a g sublevel.

6. Considering your answer to question 5, how many electrons can fit in the entire 5th energy level?

7. Write the notation for an electron spinning clockwise in a p sublevel in the 4th energy level.

Skill Practice 12

Quantum Practice

Name: _____

Date: _____

Hour: _____

1. Given the quantum numbers (n, l, m_l, m_s), which of the following combinations are NOT possible. Explain. (There may be more than one.)

   a) (3, 3, 2, -1/2)   b) (4, 1, -1, +1/2)   c) (0, 0, 0, -1/2)   d) (2, 1, -1, +1/2)

2. An electron is in a certain energy level where the maximum value of the quantum number l is 4. What energy level is the electron in?

3. How many m_l values are possible when l equals 5?

4. What are the 4 quantum numbers for the following electron notation?

   3p $\overset{\downarrow}{\underline{}}$ $\underline{}$ $\underline{}$

5. Draw an orbital diagram for an electron whose quantum numbers are (6, 3, -2, +½).

6. Draw an orbital diagram for an electron whose quantum numbers are (3, 2, +1, -½).
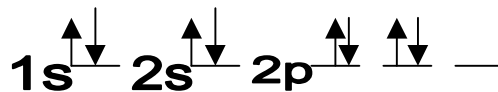
Configuration Practice

Name: _____

Date: _____

Hour: _____

1. Using arrows, write complete orbital diagrams for…

    a) Scandium

    b) Molybdenum

    c) Selenium

2. Write the complete electron configuration (no arrows) for…

    a) Chromium

    b) Antimony

    c) Calcium

3. What is wrong with the following electron orbital diagram? What is the name of the rule that allows you to identify the error?

$$1s\ \uparrow\downarrow \quad 2s\ \uparrow\downarrow \quad 2p\ \uparrow\downarrow\ \uparrow\downarrow\ \underline{\quad}$$

4. How many unpaired electrons does cobalt have?

Skill Practice 14

Lewis Practice

Name: _____

Date: _____

Hour: _____

1. How many valence electrons does each of the following atoms have?

   A) phosphorus   B) barium   c) selenium   d) argon   e) chlorine

2. Draw Bohr diagrams for each of the following atoms.

   A) aluminu   B) oxygen   C) sulfur

3. Which column of the periodic table contains elements whose Lewis dot structure will have four dots?

4. Draw Lewis dot structures for each of the following elements:

   A) antimony   B) magnesium   C) silicon   D) iodine

Skill Practice 15

Periodic Table
Configurations

Name: _____

Date: _____

Hour: _____

1. Use the noble gases to write abbreviated electron configurations for…

   a) Germanium

   b) Barium

   c) Bromine

   d) Bismuth

   e) Manganese

   f) Gold

2. What column of the periodic table contains elements whose electron configurations end with d^4?

3. What row of the periodic table contains elements with 4d electrons?

4. What row of the periodic table contains elements with 3p electrons?

5. In each row of the "d block" there are only 10 elements. Why is this?

6. In each row of the "p block" there are only 6 elements. Why is this?

Skill Practice 16

Atomic Size Practice

Name: _____

Date: _____

Hour: _____

1. What force of attraction does the second energy level of a phosphorus atom "feel" from the nucleus? Draw a Bohr diagram and use it to explain your answer.

2. Using the concepts of shielding and attraction, explain why sulfur is smaller in radius than silicon.

3. Why can't you tell by looking at the periodic table whether chlorine or lithium is larger?

4. Order the following elements from smallest to largest.

A) Al, Na, S, Mg   B) C, Sn, Pb, Si

C) K, Se, Ca, Br   D) Be, Ca, C, B, Mg

E) Ga, Al, Cl, P   F) O, Se, S, Ne

Skill Practice 17

Ionization Practice

Name: _____

Date: _____

Hour: _____

1. If an atom has a "high first ionization energy" does this mean that it is relatively easy or relatively hard to remove an electron from the atom?

2. Arrange the following atoms in order from lowest to highest 1st ionization energy.

A) Ca, Se, As, Br

B) As, N, P, Bi

C) Ga, Al, S, Si

D) Li, K, O, C

E) Te, O, S, Po

F) In, Te, Sn, I

3. A certain atom in the 2nd period has an unusually high 3rd ionization energy. Name this element. Draw a Bohr diagram and use it to illustrate why you were able to identify this atom.

4. Compare the trends for size and for ionization energy. As the size of an atom increases, what happens to the ionization energy? Explain *why* the ionization energy seems to depend on the size.

Skill Practice 18

Ion Practice

1. Draw two Bohr diagrams—one for a fluorine atom and one for the ion that the fluorine atom will form.

2. What is the charge on a calcium atom?

3. What is the charge on a calcium ion?

4. Give the charge for each of the ions formed by the following atoms. Your answers should include the magnitude of the charge with a positive or negative sign (i.e., +1, +2, or -1, etc.).

A) S   B) F   C) Br   D) Sr   E) K   F) Be

G) Al   H) P   I) O   J) Cl   K) Ba   L) Li

Skill Practice 19

Ionic Bonding Practice

Name: _____

Date: _____

Hour: _____

1. Write the symbol and charges for the following ions:
   Example: calcium = Ca^{2+}

   A) phosphide = _____   B) magnesium = _____   C) rubidium = _____

   D) fluoride = _____   E) aluminum = _____   F) sulfide = _____

2. Each of the following formulas is written incorrectly. Please rewrite them correctly.
   Example: $Ca_2Cl = CaCl_2$

   A) Ba_2S = _____   B) Rb_2N = _____   C) Li_2Cl = _____

   D) Al_3N_3 = _____   E) Mg_3Br_2 = _____   F) O_3Al_2 = _____

3. Write the formulas for the compound formed by the combination of the following pairs of atoms.
   Example: nitrogen and magnesium = Mg_3N_2

   A) sodium and sulfur = _____   B) aluminum and chlorine = _____

   C) phosphorus and calcium = _____   D) barium and oxygen = _____

4. For each of the formulas you wrote in question 3 above, give the names for the compounds.
   Example: Mg_3N_2 = magnesium nitride

   A) _____   B) _____

   C) _____   D) _____

5. In the blanks above each column, write the charge of the ions formed by atoms in that column.
   Note: group IA is done for you.

   <u>+1</u> __

   __ __ __ __ __ __

Skill Practice 20

Advanced Ionic Practice

Name: _____

Date: _____

Hour: _____

Write the formulas for the following compounds.

1. Lithium acetate _____

2. Sodium phosphate _____

3. Magnesium hydroxide _____

4. Sulfuric acid _____

5. Ammonium sulfide _____

6. Potassium oxide _____

7. Aluminum Phosphate _____

8. Sodium hydroxide _____

9. Acetic Acid _____

10. Carbonic Acid _____

Write the names for the following formulas.

11. CaO_2 _____

12. $BaCl_2$ _____

13. K_3PO_4 _____

14. $Mg(OH)_2$ _____

15. HNO_3 _____

16. $NaC_2H_3O_2$ _____

17. Li_2SO_4 _____

18. $(NH_4)_2SO_4$ _____

19. $Al(CN)_3$ _____

20. $Be(ClO_3)_2$ _____

Skill Practice 21

Practice with Transition Metals

Name: _____

Date: _____

Hour: _____

Write the formulas for each of the following compounds:

1. manganese(IV) fluoride _____

2. ammonium phosphate _____

3. nickel(II) nitrate _____

4. sodium nitride _____

5. aluminum sulfate _____

6. chromium(III) hydroxide _____

7. iron(II) phosphate _____

8. copper(II) chloride _____

Write the names for each of the following compounds:

9. CuO _____

10. $FeSO_4$ _____

11. $(NH_4)_2S$ _____

12. $Ni_3(PO_4)_2$ _____

13. $Cr(OH)_3$ _____

14. $Ba(ClO_3)_2$ _____

15. Mn_3N_4 _____

16. Cu_2CO_3 _____

How many oxygen atoms are contained in each of the following compounds?

17. $Ca(NO_3)_2$ 18. Al_2O_3 19. $MgSO_4$ 20. $Ca_3(PO_4)_2$

Skill Practice 22

Covalent Formulas
Practice

Name: _____

Date: _____

Hour: _____

Write the names of the following compounds.

1. N_2O_5 _____

2. P_3O_7 _____

3. S_3F_4 _____

4. CO_2 _____

5. N_2O_6 _____

6. $CuSO_4$ _____

7. $(NH_4)_2CO_3$ _____

8. SF_6 _____

Write the formulas for the following compounds.

9. dihydrogen tetraoxide _____

10. trinitrogen pentasulfide _____

11. carbon dioxide _____

12. dinitrogen monoxide _____

13. iron(II) nitrate _____

14. carbon tetrachloride _____

Write the empirical formula for each of the following molecular formulas.

15. C_6H_{14} _____

16. H_3PO_4 _____

17. N_2O_4 _____

18. C_4H_8 _____

19. $C_{12}H_{18}O_2$ _____

20. $N_4H_6O_4$ _____

21. S_2O_7 _____

22. $C_4H_3O_4$ _____

Structure Practice

Name: _____

Date: _____

Hour: _____

Draw Lewis structures for each of the following.

1. NO_3^{1-}

2. CH_4

3. NF_3

4. SiO_3^{2-}

5. HCN (carbon is the central atom)

6. H_2O (oxygen is the central atom)

7. NH_4^+

8. CCl_4
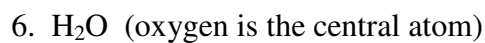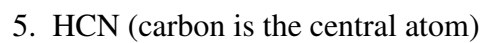
Skill Practice 24

More Lewis Practice

Name: _____
Date: _____
Hour: _____

1. Draw all of the resonance structures for CO_3^{2-}.

2. Concerning the structures you drew in question one, what is the bond order for the C—O bonds?

3. Draw the structure for CO_2.

4. Comparing the structures you drew for questions 1 and 3, which C—O bonds are the longest: those in CO_3^{2-} or those in CO_2? Which are the strongest (hardest to break)? Explain your answers.

5. Fill in the blanks:
    A) In general, the stronger the bonds, the _____ the bonds.
        longer or shorter

    B) In general, double bonds are _____ than triple bonds.
        longer or shorter

    C) Bonds with a low bond energy are _____ than bonds with high bond energy.
        weaker or stronger

Formal Charge Practice

Name: _____

Date: _____

Hour: _____

1. Examine the structure for the cyanide ion, CN^{1-} below. Label the formal charge of each of the atoms.
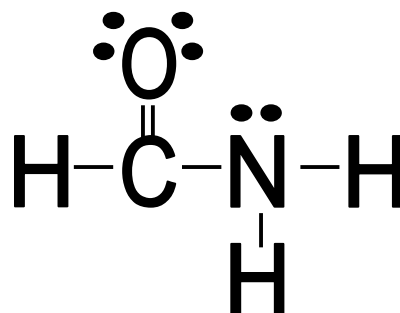
$$:C{\equiv}N:$$

2. Consider the following two structures for $CHNH_2O$?

Structure A

$$:\overset{..}{O}:$$
$$H-C=N-H$$
$$\qquad\;\; |$$
$$\qquad\;\; H$$

Structure B

$$\cdot\overset{..}{O}\cdot$$
$$\qquad ||$$
$$H-C-\overset{..}{N}-H$$
$$\qquad\quad |$$
$$\qquad\quad H$$
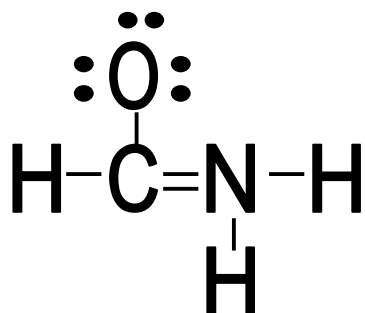
  A) Are both of the structures legitimate structures? I.e. Do all atoms have eight electrons? Are the right number of electrons used?

  B) Label each of the atoms in both structures with their appropriate formal charges.

  C) Which structure—A or B—is the best structure for $CHNH_2O$? Explain.

3. Draw a structure for ClO_3^{1-}. Label the formal charge of each atom.
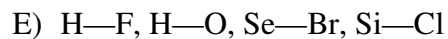
Skill Practice 26

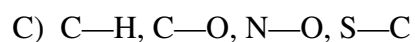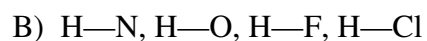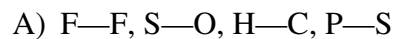# Polar Practice

Name: _____

Date: _____

Hour: _____

1. What does it mean to say that a bond is polar?

2. Label each of the following bonds as ionic (I), polar covalent (PC) or nonpolar covalent (NC).

    _____ Na—Cl   _____ N—O   _____ F—F

    _____ S—O   _____ H—C   _____ P—S

    _____ Mg—F   _____ P—O   _____ Br—N
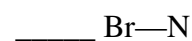
3. For each of the sets of bonds, rank them in order from most polar to least polar.

A) F—F, S—O, H—C, P—S

B) H—N, H—O, H—F, H—Cl

C) C—H, C—O, N—O, S—C

D) As—S, P—N, N—N, Cl—C

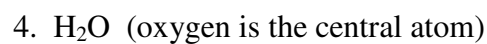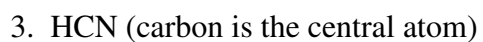E) H—F, H—O, Se—Br, Si—Cl

Skill Practice 27

Shape Practice

Name: _____

Date: _____

Hour: _____

Draw a structure for each of the following. On each structure label the approximate bond angle. Also name the geometry (i.e. "tetrahedral", "bent", etc.).

1. NO_3^{1-}

2. CH_4

3. HCN (carbon is the central atom)

4. H_2O (oxygen is the central atom)

4. NF_3

5. SiO_3^{2-}

6. A certain molecule is bent and has a bond angle of about 109°. Is the molecule SeS_2 or $SeCl_2$?

Skill Practice 28

Reactions Practice

I. Single Replacement Reactions

1. Write the reaction for each of the following reactions:
    a) Sodium sulfate reacts with magnesium to produce magnesium sulfate and sodium

    b) Copper(I) carbonate reacts with aluminum to form copper metal and aluminum carbonate.

2. Complete the following reactions:
    a) $Ca(NO_3)_2 + Al \rightarrow$

    b) $Zn + K_3PO_4 \rightarrow$

II. Double Replacement Reactions

3. Write the reaction for each of the following reactions:
    a) Iron(II) phosphate reacts with sodium chloride to produce iron(II) chloride and sodium phosphate.

    b) Calcium carbonate reacts with lithium hydroxide to produce calcium hydroxide and lithium carbonate.

4. Complete the following reactions:
    a) $Mg(NO_3)_2 + Al(C_2H_3O_2)_3 \rightarrow$

    b) $Ba(OH)_2 + Na_3PO_4 \rightarrow$

III. Combustion Reactions

5. Write the combustion reactions for the following compounds.
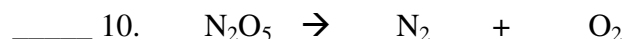   a) C_2H_4

    b) C_8H_{16}
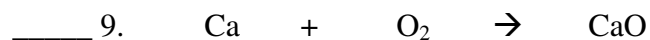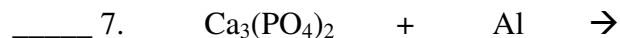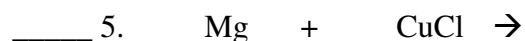
Skill Practice 29

Balancing Practice

Name: _____

Date: _____

Hour: _____

Directions: Complete the following equations. (Some reactions will already be complete.) After they are complete, <u>balance them</u>. Indicate in the blank to the left of each question whether the reaction is a single replacement (SR), double replacement (DR), synthesis (S), decomposition (D), or combustion (C).

_____ 1. C_4H_8 + O_2 →

_____ 2. $Al_2(CO_3)_3$ + _____ → $Al(NO_3)_3$ + Na_2CO_3

_____ 3. Li + _____ → $LiBr$

_____ 4. Na_2CO_3 → Na + C + O_2

_____ 5. Mg + $CuCl$ →

_____ 6. $CaCl_2$ + $Al(NO_3)_3$ →

_____ 7. $Ca_3(PO_4)_2$ + Al →

_____ 8. C_3H_8 + O_2 →

_____ 9. Ca + O_2 → CaO

_____ 10. N_2O_5 → N_2 + O_2

Skill Practice 30

Mole Conversion Practice

Name: _____

Date: _____

Hour: _____

1. Calculate the number of molecules in 210 grams of water.

2. If you have 6.25×10^{24} molecules of sulfur tetrafluoride, how many grams do you have?

3. Define what a mole is. Don't give a number, give a definition in words.

4. What is the mass of 3.45 moles of aluminum sulfate?

5. Consider zinc acetate and find its "formula mass" and its "molar mass". Include <u>units</u> for each.

6. If you have 245 grams of lithium carbonate, how many moles do you have?

7. How many gold atoms do you have if you have 400 grams of gold?

8. 68.5 grams of a certain compound contains 5.25×10^{23} molecules. What is the molar mass of the compound?

9. How many grams are there in a container of 2.26×10^{25} molecules of dinitrogen trisulfide?

10. How many molecules are in 325 g of N_2O_5?

Skill Practice 31

Moles and Formulas Practice

Name: _____

Date: _____

Hour: _____

1. What is the percent by mass of carbon in $Al_2(CO_3)_3$?

2. Find the percent composition of oxygen in each of the following compounds:
   a) Na_2O b) $Mg(NO_3)_2$

3. Find the percent composition of nitrogen in each of the following compounds.
   a) $(NH_4)_2O$ b) N_3O_5

4. What is the empirical formula of a compound that contains 25.9% nitrogen (N) and 74.1% oxygen (O) by mass?

5. What is the molecular formula of a compound that has an empirical formula of NO_2 and a molar mass of 138 g/mol?

6. A compound contains 64.3% carbon, 7.14% hydrogen and 28.6% oxygen. The molecular formula has a molecular mass of 448 amu.
   a) What is the empirical formula for this compound?

   b) What is the molecular formula for this compound?

7. A certain compound contains 26.35% C, 3.30% H and 70.35% O. If the molecular mass of this compound is 819 amu, what is the <u>molecular</u> formulas of the compound?

Skill Practice 32

Practice
Moles and Reactions

Name: _____

Date: _____

Hour: _____

1. Consider the reaction in which 410 g of $Ca(NO_3)_2$ react with just the right amount of lithium metal in a single replacement reaction.
   a) How many grams of lithium are required?

   b) How many grams of each product can be produced?

2. When 250 g of Na_2SO_4 reacts with plenty of Ca_3P_2 according to the following balanced equation, how many grams of Na_3P will be produced?
$$3\ Na_2SO_4\ +\ Ca_3P_2\ \rightarrow\ 2\ Na_3P\ +\ 3\ CaSO_4$$

3. Consider the following combustion reaction: $2\ C_4H_{10} + 13\ O_2 \rightarrow 8\ CO_2 + 10\ H_2O$. If 75.3 g of C_4H_{10} react with plenty of O_2, what mass of CO_2 and H_2O can be produced?

4. Consider the following balanced equation: $3Ca(NO_3)_2 + 2AlCl_3 \rightarrow 2Al(NO_3)_3 + 3CaCl_2$. If 210.5g of calcium nitrate react, what is the mass of each product that can be produced?

5. When 53.6 g of calcium carbonate react with plenty of aluminum fluoride, how many grams of each product can be produced?

Skill Practice 33

Limiting Reactants Practice

Name: _____

Date: _____

Hour: _____

1. Consider the following combustion reaction: $2 C_4H_{10} + 13 O_2 \rightarrow 8 CO_2 + 10 H_2O$. 125 g of C_4H_{10} react with 415 g of O_2.
   a) Which substance is the limiting reactant?

   b) What mass of CO_2 and H_2O can be produced?

2. When 412.5 g of calcium carbonate react with 521.9 g of aluminum fluoride, how many grams of each product can be produced?

3. When 277 g of Na_2SO_4 reacts with 137 g of Ca_3P_2 according to the following balanced equation… $3 Na_2SO_4 + Ca_3P_2 \rightarrow 2 Na_3P + 3 CaSO_4$
   a) How many grams of the excess reactant are left over?

   b) How many grams of Na_3P are produced?

4. If 312 g of potassium sulfide reacts with 410 g of aluminum phosphide, how many grams of each product can be produced?

Skill Practice 34

Practice Percent Yield

Name: _____

Date: _____

Hour: _____

1. In a certain chemical reaction, 297 g of zinc chloride was produced from the single replacement reaction of excess zinc and 202.7 g of lithium chloride. What is the percent yield of zinc chloride?

2. When 24.5 g of $CaCl_2$ reacted with plenty of $AgNO_3$, 21.5 grams of $Ca(NO_3)_2$ were produced. What was the percent yield of $Ca(NO_3)_2$?

3. When 312.7 g of $Al_2(SO_4)_3$ react with plenty of magnesium, what is the percent yield when 38.5 g of aluminum are formed?

4. Consider the reaction in which 370 g of $Ca(NO_3)_2$ react with just the right amount of lithium metal in a single replacement reaction. If the percent yield of $LiNO_3$ is 74.3%, what mass of $LiNO_3$ will be produced?

5. If 42.4g of Al react with excess O_2 and 67.3g of Al_2O_3 are produced, what was the percent yield of Al_2O_3? Note: the balanced equation is: $4\ Al\ +\ 3\ O_2\ \rightarrow\ 2\ Al_2O_3$

Skill Practice 35

Gas Laws Practice

Name: _____

Date: _____

Hour: _____

IMPORTANT: whenever you use temperature, it must be in degree Kelvin (K), so remember the equation: $K = {}^oC + 273$

1. a) convert 39 ^oC to K.   b) convert 127 K to ^oC.

2. A gas has an initial volume of 2.75 L at a temperature of 285 K. If the temperature changes to 380 K, what is the new volume of the gas if the pressure is unchanged?

3. Gas can often be cooled by compressing it while keeping the pressure constant. If I have 45.0 L of gas at room temperature (22^oC) and I compress it so that the final volume is 0.50 L, what is the final temperature of the gas if the pressure is constant?

4. The volume of a gas is 2.5 L when the pressure is at standard pressure (101.325 kPa). What is the volume of the gas if the pressure decreases to 85 kPa and the temperature remains unchanged?

5. A 5.0 L container of gas experiences a temperature change so that the final temperature is 4 times the initial temperature. What is the size of the container after the temperature change? (Assume constant pressure.)

6. At 45^oC the volume of a certain gas is 27.5 L and the pressure is 210 kPa. What is the volume of the gas at standard temperature (273 K) and 310 kPa of pressure?

7. The pressure of a sample of gas was 97.8 kPa and the volume of the gas was 3.75 L. If the gas occupied a container with a volume of 8.00 L, what would the pressure in the container be?

8. Isothermal expansion refers to allowing a gas to expand while keeping the temperature constant. This is one means to simulate a vacuum. If a gas originally at 97 kPa is allowed to expand from 0.25 L to 182 L, what is the pressure of the gas?

9. A gas is initially at a pressure of 225 kPa and a temperature of 245 K in a container that is 4.5 L. If the gas is compressed to a volume of 2.1 L and the temperature changes to 275 K, what is the new pressure?

Gases and Moles Practice

Name: _____

Date: _____

Hour: _____

1. Under water where the temperature is 17°C and the pressure is 394 kPa, a diver inhales 2.1 L of air from his SCUBA tank.

    a) How many moles of gas are in his lungs?

    b) If the diver swims to the surface without exhaling where the temperature is 32°C and the pressure changes to 100.2 kPa, what will the volume of the air in his lungs be?

3. On planet X, 2.78 moles of a gas takes up 1.85 L under a pressure of 74.1 kPa and a temperature of 201°C. What is the value of the ideal gas constant (R) on planet X? (include units)

4. At a pressure of 103 kPa and a temperature of 22°C, 52.9 g of a certain gas has a volume of 31.5 L. What is the identity of this gas? (Hint: find the molar mass of the gas and match it with the periodic table.)

5. Some oxygen gas has a volume of 41.0 L under a pressure of 245 kPa and a temperature of 279 K. What is the mass of the gas?

6. 17.5 mL of oxygen gas were collected at room temperature (22°C) and 100.2 kPa of atmospheric pressure.

    a) How many moles of oxygen gas were produced?

    b) What is the molar volume of the oxygen gas at the conditions in the laboratory?

7. What is the molar volume of a gas at 135 kPa and 45°C?

Skill Practice 37

Gas Stoichiometry Practice

Name: _____

Date: _____

Hour: _____

1. In a reaction, 24.9 L of N_2 reacts with excess H_2 to produce NH_3. How many liters of NH_3 were produced? How many grams of NH_3 is this? The pressure in the lab is 97.8 kPa and the temperature was 23.7^{o}C.

2. If 22.5 L of oxygen reacted with excess hydrogen, how many liters of water vapor (gaseous water) could be produced?

3. The combustion of a certain wax can be represented by the following balanced equation:
    $$C_{22}H_{44} + 33\,O_2 \rightarrow 22\,CO_2 + 22\,H_2O$$
    If 185g of wax ($C_{22}H_{44}$) burns, how many liters of oxygen gas were used up? Assume the conditions in the lab are 101 kPa and 25°C.

4. Zinc metal reacts with hydrochloric acid to produce hydrogen gas. How many liters of hydrogen can be produced at STP if 13.5g of zinc are reacted with excess HCl?
    $$Zn + 2\,HCl \rightarrow H_2 + ZnCl_2$$

5. If 210g of hydrogen gas react in an atmosphere of excess nitrogen, how many liters of NH_3 can be produced? Assume condtions are at STP.

Partial Pressures Practice

Name: _____

Date: _____

Hour: _____

1. During an experiment, 17.5 mL of oxygen gas were collected over water at room temperature (25^oC) and 100.2 kPa of atmospheric pressure. The vapor pressure of water at this temperature is 2.6 kPa.
   a) What is the pressure of the "dry" oxygen gas?

   b) How many moles of oxygen gas were produced?

   c) What is the molar volume of the oxygen gas at the conditions in the laboratory?

2. Zinc metal reacted with hydrochloric acid and 48.5 mL of hydrogen gas were collected over water at 35^oC and 95 kPa of pressure according to the balanced equation,
   $Zn + 2 HCl \rightarrow H_2 + ZnCl_2$. How many moles of HCl were used up in the reaction?

3. A gas was collected in a 2.0 L container over water at 40^oC and the pressure in the container was 105 kPa. What would be the volume of the gas at STP?

4. A certain container contains 3 moles of hydrogen gas and 2 moles of oxygen gas. The total pressure in the container is 100 kPa. What is the partial pressure of hydrogen and of oxygen in the container?

5. Oxygen gas was collected over water at 25^oC and 97 kPa by decomposing sodium chlorate:
   $$2 NaClO_3 \rightarrow 2 NaCl + 3 O_2$$
   If 1.45 L were collected, how many grams of $NaClO_3$ were decomposed?

Concentration Practice

Name: _____

Date: _____

Hour: _____

1. What is the mass percent of calcium chloride if 45 g of $CaCl_2$ is dissolved in 320 g of water?

2. A solution is prepared by dissolving 32 g of salt in 278 g of water.
   A) What is the mole fraction of salt in the solution?

   B) What is the mole fraction of water in the solution?

3. How many grams of calcium nitrate needs to be added to 400 g of water to make a solution that is 12.5% by mass of $Ca(NO_3)_2$?

4. A certain solution of salt water has a molality of 3.25 m.
   a) What is the mole fraction of salt in the solution?

   b) What is the mass percent of salt in the solution?

5. If 325 mL of a solution was prepared by dissolving 83.8g of Na_3PO_4 in 310 g of water…
   a) What is the molarity of the solution?

   b) What is the molality of the solution?

6. Describe how you could prepare 200 mL of a solution that is 1.2 M NaCl.

Skill Practice 40

Colligative Practice

Name: _____

Date: _____

Hour: _____

1. What is the molality of ammonium ions in a 1.75 m solution of $(NH_4)_3PO_4$?

2. What is the total molality of particles in the solution in question 1?

3. What is the total molality of particles in a 1.75 m solution of sugar (a covalent compound with the formula $C_6H_{12}O_6$)?

4. Calculate the freezing point of a 0.75 m solution of $Al_2(CO_3)_3$.

5. A solution is prepared by placing 72.8 g of calcium chloride in 120 g of water at 22^oC. The vapor pressure of water at 22^oC is 2.6 kPa.
   a) What is the boiling point of the solution?

   b) What is the freezing point of the solution?

   c) What is the vapor pressure of the solution?

6. A solution is prepared by placing 72.8 g of magnesium chloride in 120 g of water at 22^oC.
   a) What is the boiling point of the solution?

   b) What is the freezing point of the solution?

Skill Practice 41

Molar Mass Practice

Name: _____

Date: _____

Hour: _____

1. When 230 g of an unknown covalent compound is dissolved in 410 g of water, the freezing point of the solution is -3.51°C. Find the molar mass of the compound.

2. Find the molar mass of a covalent compound if 125 g dissolved in water changes the vapor pressure from 3.4 kPa to 1.8 kPa.

3. When 180 g of an unknown covalent compound is dissolved in 430 g of water, the boiling point changes to 101.52°C. What is the molar mass of the compound?

4. The boiling point of a 1.25m solution is 101.2°C. Find the molar mass of the covalent solute if the mass percent of solute in the solution is 15.2%.

5. Find the molar mass of a covalent compound that when dissolved in water to make a 2.1m solution the freezing point becomes -2.53°C. The mass percent of solute is 17.5%.

Skill Practice 42

Rates Practice

Name: _____

Date: _____

Hour: _____

Use the following information for questions 1 and 2: The following reaction proceeds slowly. It is possible to analyze the amount of iodide ion in the reaction container (which has a volume of 0.45 L) and so several measurements were made as shown in the table below.

$$3 \, HSO_3^- \; + \; IO_3^- \; \rightarrow \; 3 \, HSO_4^- \; + \; I^-$$
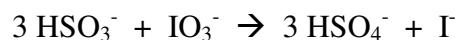
Time (s)	Moles HSO_3^-	Moles IO_3^-	Moles HSO_4^-	Moles I^-
0	0.0357	0.0105	0	0
200				0.0021
400				0.0032
600				0.0039

1. Recalling that the change in moles of iodide ions is related to the change in moles of the other substances, fill in the missing blanks in the table.

2. Calculate the average rate of formation of I^- during each of the following intervals of time. Your units should be M/s.
    a) Between 0 and 200 seconds

    b) Between 200 and 400 seconds

    c) Between 400 and 600 seconds

3. If the rate of disappearance of HSO_3^- was 0.0045 M/s, calculate the rate of appearance of I^-.
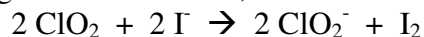
Skill Practice 43

Rate Law Practice

Name: _____

Date: _____

Hour: _____

1. Give the following reaction and data, answer the following questions.

$$2 ClO_2 + 2 I^- \rightarrow 2 ClO_2^- + I_2$$

Experiment	$[ClO_2]$	$[I^-]$	rate of disappearance of I^-
1	0.30	0.40	3.350×10^{-4} M/s
2	0.90	0.40	9.045×10^{-3} M/s
3	0.30	0.80	5.600×10^{-3} M/s

a) What is the order with respect to ClO_2 in this reaction?
b) What is the order with respect to I^- in this reaction?
c) What is the overall order in this reaction?
d) Write the rate law for this reaction.
e) Calculate the rate constant and include units.
f) How does the rate of disappearance of ClO_2 compare to the rate of appearance of I_2?

2. Consider the following reaction and the following experimental data.

$$H_2O_2 + 3 I^- + 2H^+ \rightarrow I_3^- + 2 H_2O$$

	$[H_2O_2]$	$[I^-]$	$[H^+]$	Rate
Expt. 1	0.010	0.010	0.00050	1.15×10^{-6} M/s
Expt. 2	0.020	0.010	0.00050	2.30×10^{-6} M/s
Expt. 3	0.010	0.020	0.00050	2.30×10^{-6} M/s
Expt. 4	0.010	0.010	0.00100	1.15×10^{-6} M/s

a) What is the order for each reactant?

b) Write the rate law.

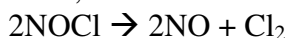c) Determine the rate constant including units.

Skill Practice 44

Concentration & Time Practice

Name: _____

Date: _____

Hour: _____

1. Given the following reaction and data, answer the following questions.
$$2NOCl \rightarrow 2NO + Cl_2$$

Time (s)	[NOCl] (M)
0	0.200
575	0.158
995	0.137
2080	0.102

a) How does the rate of disappearance of NOCl compare to the rate of appearance of Cl_2?

b) Is this reaction 1st order or 2nd order with respect to [NOCl]?

c) Calculate the rate constant, k, and include units.

d) What is the <u>average rate</u> of reaction between time 0 and 995 s?

e) Describe how you would find the instantaneous rate of reaction at 700 s using a plot of concentration verses time.

f) Write the rate law for this reaction.

g) Calculate the rate of disappearance of NOCl at time = 1550 s.

h) Calculate the rate of appearance of Cl_2 at time = 750 s.

2. Aspirin decomposes into acetic acid and salicylic acid. The following data was obtained during experimentation.

Time (min.)	[Aspirin], M
0	1.000
5	0.630
10	0.460
15	0.362

a) What is the order of the reaction with respect to aspirin?

b) What is the rate constant for this reaction?

c) How long will it take for the aspirin concentration to reach a value of 0.20 M?

Equilibrium Practice

Name: _____

Date: _____

Hour: _____

1. What is meant when we say that a reaction has reached "equilibrium"?

2. Consider the following chemical equation: $2 N_2O_5 \longleftrightarrow 2 N_2 + 5 O_2$. At equilibrium, the concentration of O_2 is 0.45 M, the concentration of N_2O_5 is 1.20 M, and the concentration of N_2 is 0.71 M. Calculate the equilibrium constant, K.

3. In an experiment, 0.100 mol of H_2 and 0.100 mol of I_2 are mixed in a 3.00-L container according to the following equation: $H_2 + I_2 \longleftrightarrow 2 HI$. If K = 50.0 for this reaction, what is the equilibrium concentration of I_2, H_2 and HI?

4. How many moles of each substance is in a 1.0 L vessel if you start with 0.500 mol of H_2 and 0.500 mol of I_2 to synthesize HI. K is 49.7.

5. Consider the following reaction: PCl_5 (g) $\longleftrightarrow$ PCl_3 (g) + Cl_2 (g). If the initial concentration of PCl_5 is 1.00 mol/L, what is the equilibrium composition (i.e. the concentration of each substance at equilibrium) of the gaseous mixture? K is 0.0211.

Skill Practice 46

More EQ Practice

Name: _____

Date: _____

Hour: _____

1. When 0.100 mol H_2S gas was put into a 10.0 L vessel and heated to 1132^oC, it gave an equilibrium mixture containing 0.0285 mol H_2 gas along with some S_2 gas.
    a) Calculate K_c at this temperature.

    b) Calculate K_p at this temperature.

2. If K_c for the following reaction is 4.58×10^{-4}, what is K_p at 420^oC?
$$SO_2Cl_2 \text{ (g)} \longleftrightarrow SO_2 \text{ (g)} + Cl_2 \text{ (g)}$$

3. Given the information in question 2 above, consider the following. a 2.5 L reaction vessel was filled with 0.84 mol of SO_2Cl_2. After the reaction comes to equilibrium, what is the concentration of SO_2Cl_2, SO_2 and Cl_2? (Hint: find K_c.)

4. Consider the following chemical equation: $2 N_2O_5 \longleftrightarrow 2 N_2 + 5 O_2$. If $K_c = 0.345$ at a temperature of 245 K, what is K_p at this temperature?

Quotient Practice

Name: _____

Date: _____

Hour: _____

1. The following reaction has an equilibrium constant K_c equal to 3.07×10^{-4}. At a given moment in time, the concentration of NOBr was 0.181 M, the concentration of NO was 0.0123 M and the concentration of Br_2 was 0.0201 M. Is the reaction at equilibrium? If not, indicate whether more products or more reactants will be formed. $2 NOBr\ (g) \longleftrightarrow 2 NO\ (g)\ + Br_2\ (g)$

2. Consider the reaction $2\ H_2S\ (g)\ +\ 3\ O_2\ (g)\ \longleftrightarrow\ 2\ H_2O\ (g)\ +\ 2\ SO_2\ (g)$ where $K_c = 2.38$. The reaction began and after a while, the sample was analyzed and the concentration of SO_2 was 0.085 M, the concentration of H_2O was 0.071 M, the concentration of O_2 was 0.162M and the concentration of H_2S was 0.059 M. As the reaction proceeds from this moment forward, do you expect more products to form or more reactants? Explain.

3. Given the reaction: $H_2\ +\ I_2\ \longleftrightarrow\ 2\ HI$. The equilibrium constant K_c is 0.481. The concentrations of H_2, I_2, and HI were measured at various times. For each of the following sets of data indicate whether the reaction is at equilibrium or not. If the reaction is not at equilibrium, then indicate whether more reactants will form or whether more products need to form to attain equilibrium.

    a) $[H_2] = 0.27$ M; $[I_2] = 0.40$ M; $[HI] = 0.31$ M

    b) $[H_2] = 0.46$ M; $[I_2] = 0.34$ M; $[HI] = 0.28$ M

    c) $[H_2] = 0.18$ M; $[I_2] = 0.29$ M; $[HI] = 0.48$ M

    d) $[H_2] = 0.257$ M; $[I_2] = 0.269$ M; $[HI] = 0.510$ M

Skill Practice 48

Acids Practice
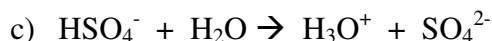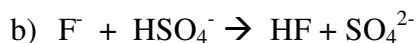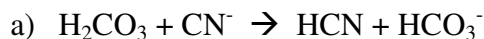
1. A certain substance in solution is known to increase the concentration of H_3O^+. Is this substance an acid or a base?

2. Given the following reaction, identify the Arrhenius acid and describe why the substance you chose is an Arrhenius acid.
$$H_2SO_4 \rightarrow HSO_4^- + H^+$$

3. How do the Bronsted-Lowry definitions and the Arrhenius definitions differ?

4. Describe the difference between a weak and a strong acid.

5. In each of the following reactions identify an acid (if there is one) and then specify whether it is an acid according to the Arrhenius definitions or the Bronsted-Lowry definitions or both.

   a) $H_2CO_3 + CN^- \rightarrow HCN + HCO_3^-$

   b) $F^- + HSO_4^- \rightarrow HF + SO_4^{2-}$

   c) $HSO_4^- + H_2O \rightarrow H_3O^+ + SO_4^{2-}$

6. What is the conjugate base of HCN?

pH Practice

Name: _____

Date: _____

Hour: _____

1. What is the pH of a 0.034 M solution of HNO_3?

3. Calculate the pH of a 0.0105 M solution of NaOH?

4. a) Calculate the pH of a 0.025 M solution of HNO_3.

   b) What is the pOH of this solution?

5. Calculate $[H^+]$, $[OH^-]$, pOH and the pH for a 0.0015 M solution of HCl.

6. Calculate $[H^+]$, $[OH^-]$, pOH and the pH for a 0.00024 M solution of sodium hydroxide, NaOH.

Skill Practice 50

Weak Acid Practice

Name: _____

Date: _____

Hour: _____

1. What is the pH of a 0.34 M solution of HNO_3?

2. What is the pH of a 0.34 M solution of benzoic acid ($K_a = 6.3 \times 10^{-5}$) ?

3. Compare the concentrations and pH of each solution in questions 1 and 2. Why are weak acids called weak? What is the relationship between a weak acid's K_a value and the pH?

4. Acetic acid ($HC_2H_3O_2$) has an ionization constant of 1.7×10^{-5}. What is the K_b for $C_2H_3O_2^-$?

5. What is the pH of a 0.16 M solution of acetic acid?

6. A 0.25 M solution of an unknown acid has a pH of 2.5. What is the K_a of the acid?

7. Ammonia is a weak base with $K_b = 1.8 \times 10^{-5}$. What is the pH of a 0.5 M solution of NH_3?

8. A 0.045 M solution of a certain unknown base has a pH of 9.7. What is the K_b for this base?

Skill Practice 51

Mixing Practice

Name: _____

Date: _____

Hour: _____

1. What is the pH of a solution formed by diluting 245 mL of 0.024 M HCl with 200 mL of water? (Assume volumes of liquids are additive.)

2. What is the pH of a solution made by mixing 1.5 L of 0.35 M HCl with 2.0 L of 0.10 M NaOH?

3. In titration, the <u>equivalence point</u> is when the moles of an acid equals the moles of a base. Consider 245 mL of 0.25 M NaOH being titrated with 0.40 M HCl.

   a) How many mL of HCl will need to be added to reach the equivalence point?

   b) What is the pH at the equivalence point?

4. What is the pH of a solution formed by mixing 1.27 L of 0.035 M NaOH with 1.65 L of 0.025 M HCl?

5. Find the pH of a solution that is formed by diluting 450 mL of 0.045 M NaOH with 300 mL of water. (Assume volumes of liquids are additive.)

Skill Practice 52

Acidic Salts Practice

Name: _____

Date: _____

Hour: _____

1. Indicate whether the following salts will result in an acidic (A), basic (B), or neutral (N) pH when dissolved in water.

   _____ a) NH_4Cl _____ b) NaCl   _____ c) $Mg(CN)_2$ _____ d) CaF_2

   _____ e) $Na_2C_2H_3O_2$ _____ f) NH_4Cl _____ g) $MgCl_2$ _____ h) $Ca(NO_3)_2$

2. What is the pH of a solution formed by dissolving 25.8 g of ammonium chloride (NH_4Cl) in 1.5 L of water?

3. A solution was made by adding acetic acid and a salt to water. The concentration of acetic acid in the solution was 0.5 M. The pH of the solution was found to be 3.3. Was the salt calcium chloride or sodium acetate? Explain.

4. Calculate the pH of a 0.045 M solution of sodium benzoate. (Benzoate is the anion formed from benzoic acid, which has a K_a of 6.3×10^{-5}.)

5. What effect on the pH does NH_4NO_3 have when it is added to a solution of ammonia in water?

6. Calculate the pH of a 0.035 M solution of sodium acetate.

7. Calculate the pH of a 0.00046 M solution of NH_4Cl.
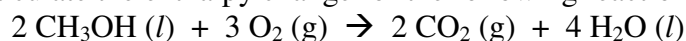
Skill Practice 53

First Law Practice

Name: _____

Date: _____

Hour: _____

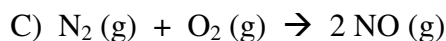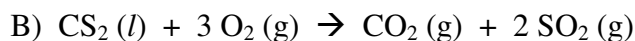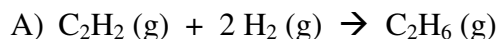For some of the following problems, you will need to use a table of ΔH_f values.

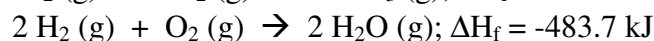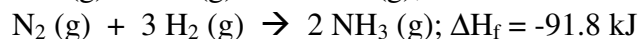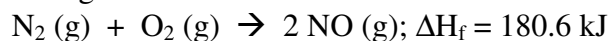1. Using ΔH_f values calculate the enthalpy change for the following reaction.
$$2\ CH_3OH\ (l)\ +\ 3\ O_2\ (g)\ \rightarrow\ 2\ CO_2\ (g)\ +\ 4\ H_2O\ (l)$$

2. Using ΔH_f values calculate the enthalpy change for the decomposition of <u>one mole</u> of SO_3 (g) into SO_2 (g) and O_2 (g).

3. Calculate the enthalpy change in kilojoules when 54.7g of $MgCO_3$ decomposes according to the following equation: $MgCO_3$ (s) $\rightarrow$ MgO (s) + CO_2 (g)

4. Which of the following reactions are exothermic?

   A) C_2H_2 (g) + 2 H_2 (g) $\rightarrow$ C_2H_6 (g)

   B) CS_2 (l) + 3 O_2 (g) $\rightarrow$ CO_2 (g) + 2 SO_2 (g)

   C) N_2 (g) + O_2 (g) $\rightarrow$ 2 NO (g)

5. Calculate the enthalpy for the following reaction: 4 NH_3 (g) + 5 O_2 (g) $\rightarrow$ 4 NO (g) + 6 H_2O (g).
   You may only use the following information:
$$N_2\ (g)\ +\ O_2\ (g)\ \rightarrow\ 2\ NO\ (g);\ \Delta H_f = 180.6\ kJ$$
$$N_2\ (g)\ +\ 3\ H_2\ (g)\ \rightarrow\ 2\ NH_3\ (g);\ \Delta H_f = -91.8\ kJ$$
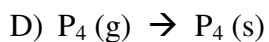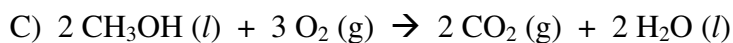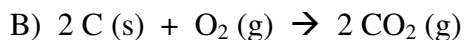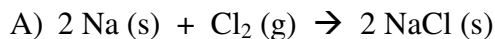$$2\ H_2\ (g)\ +\ O_2\ (g)\ \rightarrow\ 2\ H_2O\ (g);\ \Delta H_f = -483.7\ kJ$$
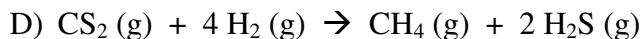
2nd Law Practice

Name: _____

Date: _____

Hour: _____

1. Predict whether ΔS is positive or negative for each of the following reactions.

    A) $2 \text{ Na (s)} + \text{Cl}_2 \text{ (g)} \rightarrow 2 \text{ NaCl (s)}$

    B) $2 \text{ C (s)} + \text{O}_2 \text{ (g)} \rightarrow 2 \text{ CO}_2 \text{ (g)}$

    C) $2 \text{ CH}_3\text{OH } (l) + 3 \text{ O}_2 \text{ (g)} \rightarrow 2 \text{ CO}_2 \text{ (g)} + 2 \text{ H}_2\text{O } (l)$

    D) $\text{P}_4 \text{ (g)} \rightarrow \text{P}_4 \text{ (s)}$

2. Calculate ΔS for the following reactions using standard entropy values.

    A) $2 \text{ SO}_3 \text{ (g)} \rightarrow 2 \text{ SO}_2 \text{ (g)} + \text{O}_2 \text{ (g)}$

    B) $\text{CS}_2 \text{ } (l) + 3 \text{ O}_2 \text{ (g)} \rightarrow \text{CO}_2 \text{ (g)} + 2 \text{ SO}_2 \text{ (g)}$

    C) $\text{CH}_4 \text{ (g)} + 2 \text{ O}_2 \text{ (g)} \rightarrow \text{CO}_2 \text{ (g)} + 2 \text{ H}_2\text{O } (l)$

    D) $\text{CS}_2 \text{ (g)} + 4 \text{ H}_2 \text{ (g)} \rightarrow \text{CH}_4 \text{ (g)} + 2 \text{ H}_2\text{S (g)}$
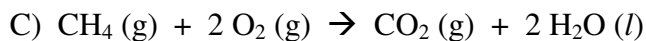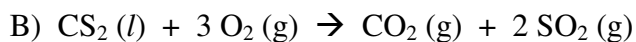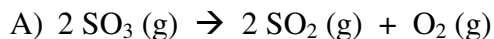
3. What does it mean for a reaction to be spontaneous?

Skill Practice 55

Name: _____

Date: _____

Hour: _____

Free Energy Practice

1. Given the following reaction, calculate ΔH and ΔS.

$$2\ CH_3OH\ (l)\ +\ 3\ O_2\ (g)\ \rightarrow\ 2\ CO_2\ (g)\ +\ 4\ H_2O\ (l)$$
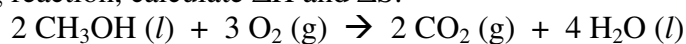
2. Given your answers to question 1 and the fact that this reaction takes place at 25°C, calculate ΔG.

3. A certain reaction is nonspontaneous at room temperature and spontaneous at high temperatures. What are the signs of ΔS and ΔH?

4. Calculate ΔG for each of the following reactions. Indicate whether each reaction is spontaneous or not.

A) $C_2H_2\ (g)\ +\ 2\ H_2\ (g)\ \rightarrow\ C_2H_6\ (g)$

B) $CS_2\ (l)\ +\ 3\ O_2\ (g)\ \rightarrow\ CO_2\ (g)\ +\ 2\ SO_2\ (g)$

C) $N_2\ (g)\ +\ O_2\ (g)\ \rightarrow\ 2\ NO\ (g)$