Monopoly Problems

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May 2024

Contents

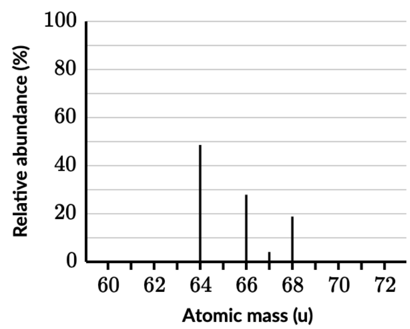
1 Unit 1: Atomic Structure and Properties

Problem 1

Calculate the number of moles in a $7.89 kg$ sample of $C_9H_8O_4$

Problem 2

Given this graph, what is true about the element depicted



(a) In an average sample of the element, less than 20% of the atoms have an atomic mass of $66u$.
(b) The most abundant isotope of the element has an atomic mass of $64u$.
(c) The element has an average atomic mass of $64u$.
(d) The element has an average atomic mass between 66 and $68u$.

Problem 3

What is the percent composition of Carbon in $C_{13}H_{18}O_2$?

Problem 4

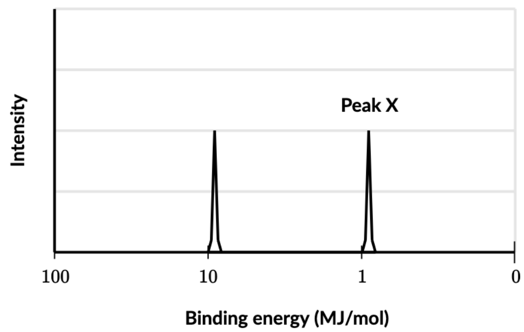
A compound contains 32.38% sodium, 22.65% sulfur, and 44.99% oxygen. What is the emperical forumula.

Problem 5

What is the full electron configuration of mercury?

Problem 6

Below, the photoelectron spectra of the $2s$ electrons of Be and Mg are shown.



Is peak X the peak associated with Be or Mg?

Problem 7

What are the periodic trends of ionization energy, atomic radius, and electronegativity? Why?

2 Unit 2: Molecular and Ionic Compound Structure and Properties

Problem 8

Which of the following bonds is likely to have the most ionic character?
(a) H — F
(b) C — O
(c) Na — F
(d) Mg — O

Problem 9

Based on the information in the table, which of the following arranges the bonds in order of decreasing polarity?

Element	Electronegativity
H	2.2
N	3.0
F	4.0
Cl	3.2
Se	2.6
I	2.7

(a) Se — N > H — I > Cl — F
(b) H — I > Se — N > Cl — F
(c) Cl — F > H — I > Se — N
(d) Cl — F > Se — N > H — I

Problem 10

Why is the lattice energy of CsF smaller than the lattice energy of KF?

Problem 11

What type of structure do metallic elements form and through what bonds?

Problem 12

What are the two types of metallic alloys and what are there differences?

Problem 13

Draw a Lewis Diagram for Acetic Acid CH_3COOH.

Problem 14

Draw the Lewis Diagram for CO_2

Problem 15

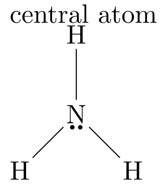
Draw the Lewis Diagram(s) for ozone, O_3

Problem 16

Write the formal charges for all three molecules above.

Problem 17

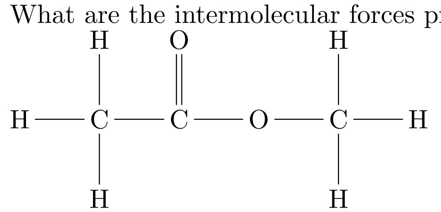
What is the electron geometry, molecular geometry, and hybridization of the central atom in this molecule.



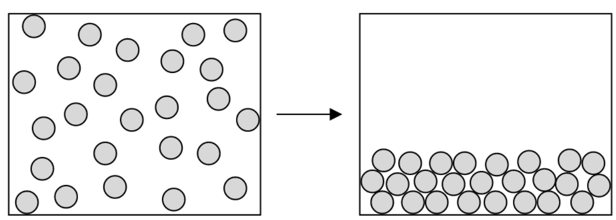
3 Unit 3: Intermolecular Forces and Properties

Problem 18

What are the intermolecular forces present among these molecules.



Problem 19



What phase transition is this?

Problem 20

Originally, a sample of gas is in a rigid container at $299K$ and $0.70atm$. The student increases the temperature of the CO_2(g) in the container to $425K$.
(a) What does raising the temperature do to the mostion of the molecules?
(b) What is the pressure at $425K$?
(c) In terms of Kinetic Molecular Theory, why does the pressure of gas change as it is heated?

Problem 21

A $60.3g$ of $Be(OH)_2$ is dissolved in enough water to produce $1.75L$ of solution. Calculate the concentration of OH^- ions.

Problem 22

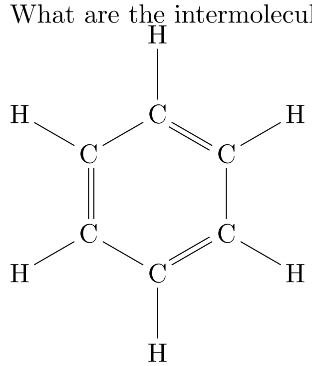
Describe the photoelectric effect.

Problem 23

List HCOOH, H_2S, and Ar in order of increasing intermolecular forces.

Problem 24

What are the intermolecular forces for this molecule:



Problem 25

Which of the following will require the greatest energy input to separate the ions?
(a) MgI_2
(b) MgF_2
(c) $MgCl_2$
(d) $MgBr_2$

Problem 26

Why does I_2 have a higher boiling point than Cl_2?

Problem 27

Is CO_2 polar? Why?

4 Unit 4: Chemical Reactions

Problem 28

Balance this reaction: $C_5H_{10} + O_2 \longrightarrow CO_2 + H_2O$

Problem 29

Balance this redox reaction: $MnO_4{}^- + I^- \longrightarrow I_2 + Mn^{2+}$

Problem 30

Aqueous $FeCl_3$ reacts with KOH to produce a solid precipitate of $Fe(OH)_3$ and aqueous KCl. What is the balanced net ionic equation?

Problem 31

What is the difference between physical changes and chemical changes?

Problem 32

H_2O and Fe are reacted according to the reaction below. There was initially $36.0g$ H_2O and $67.0g$ Fe. What is the limiting reactant, how much of the excess reactant will remain, and how much iron oxide is produced?
$3\,Fe(s) + 4\,H_2O(g) \longrightarrow Fe_3O_4(s)\,4\,H_2(g)$

Problem 33

A $56kg$ sample of CO and $6.0kg$ sample of H_2 are combined into a closed vessel.
$CO(g) + 2\,H_2(g) \longrightarrow CH_3OH(g)$
How many moles of $CH_3OH(g)$ have been produced?

Problem 34

Balance this reaction:
$Al(s) + O_2(g) \longrightarrow Al_2O_3$

Problem 35

Balance this reaction:
$V + O_2 \longrightarrow V_2O_5$

Problem 36

Balance this reaction:
$C_6H_{12}O_6 + O_2 \longrightarrow CO_2 + H_2O$

Problem 37

Balance this reaction:
$Mg + O_2 \longrightarrow MgO$

5 Unit 5: Kinetics

Problem 38

For this reaction:
$CH_4(g) + 2\,O_2(g) \longrightarrow CO_2(g) + 2\,H_2O\,(g)$
What would be rate be in terms of each reactant and product.
CH_4 rate =
O_2 rate =
CO_2 rate =
H_2O rate =

Problem 39

If the rate of dissapearance of CH_4 equals $5.0\frac{M}{s}$ for the above reaction, what is the rate of appearance of H_2O?

Problem 40

For the above reaction, what is the reaction rate if O_2 decreases from $0.1M$ to $0.04M$ in $125ms$?

Problem 41

$A\,(aq) + 2\,B\,(aq) \longrightarrow$ Products

Experiment	$[A]_0$	$[B]_0$	Initial Rate
1	$0.10M$	$0.10M$	$1.0 \times 10^{-2}\frac{M}{s}$
2	$0.3M$	$0.10M$	$9.0 \times 10^{-2}\frac{M}{s}$
3	$0.3M$	$0.15M$	$9.0 \times 10^{-2}\frac{M}{s}$

What is the rate law?

Problem 42

N_2O_5 decomposes by a 1st order reaction with $k = 4.80 \times 10^{-4}\frac{1}{s}$. What is the concentration of N_2O_5 after 825 seconds if the intial concentration is $0.0165M$? What is the half-life for this reaction?

Problem 43

This problem relates to problem 44 as well
The reaction $2\,C_4H_6(g) \longrightarrow C_8H_{12}(g)$ is a 2nd order reaction with $k = 4.0 \times 10^{-4}\frac{1}{Ms}$. If the initial concentration of C_4H_6 is $0.100M$ what is the concentration after 6 days?

Problem 44

How long does it take for the concentration to drop to $0.085M$?

Problem 45

What is the net chemical reaction and predict the experimental rate law for a chemical reaction with this chemical mechanism.

$$H_2O_2 + I^- \longrightarrow H_2O + IO^- \quad k_1\,(\text{slow})$$
$$IO^- + H_2O_2 \longrightarrow H_2O + O_2 + I^- \quad k_2\,(\text{fast})$$

Also identify catalysts and intermediates.

Problem 46

Predict the experimental rate law for a chemical reaction that proceeds by the following mechanism:

$$2\,NO \rightleftharpoons N_2O_2 \quad (\text{Fast equilibrium step})$$
$$N_2O_2 + H_2 \longrightarrow H_2O + N_2O \quad (\text{slow})$$
$$N_2O + H_2 \longrightarrow N_2 + H_2O \quad (\text{fast})$$

6 Unit 6: Thermodynamics

Problem 47

It takes 1.8×10^{-19} calories of energy to break an O—H bond in water. How much energy does it take to break all of the O—H bonds in 50.0 grams of water?

Problem 48

120. grams of an unknown metal at $100.°C$ is dropped in a styrofoam cup that contains $100.0mL$ of water that is at $20.0\deg C$. After some times, the final temperature of the equilibiated system is measured to be $27.3°C$. What is the specific heat capacity of the metal?

Problem 49

How much heat energy is required to vaporize 5.0 liters of $H_2O\,(l)$ where the heat of vaporization of water is $40.72\frac{kJ}{mol}$.

Problem 50

Given these chemical equations
$C_2H_2(g) + 2\,H_2(g) \longrightarrow C_2H_6(g) \qquad \Delta H = -311kJ$
$C_2H_4(g) + H_2(g) \longrightarrow C_2H_6(g) \qquad \Delta H = -136kJ$
Find the enthalpy change for
$C_2H_2(g) + H_2(g) \longrightarrow C_2H_6(g)$

Problem 51

For $C_2H_5OH(l) + 2\,O_2(g) \longrightarrow 2\,CO_2(g) + 2\,H_2O(l) \qquad \Delta H = -1371kJ$. If $1.5mol$ of oxygen is used, how much energy is released?

Problem 52

When temperature increases, does entropy increase or decrease?

Problem 53

If the standard entropies for $H_2O(g)$, $H_2(g)$, and O_2 are 188.83, 130.58, and 205.0 respectively, what is the entropy change for $2\,H_2O(g) \longrightarrow 2\,H_2(g) + O_2(g)$?

Problem 54

What is $\Delta S_{universe}$ for the equation $CH_4(g) + 2\,O_2(g) \rightleftharpoons CO_2(g) + 2\,H_2O(g)$ where $\Delta H = -802.2\frac{kJ}{mol}$. Use the standard entropy values above and note that $S^\circ = 213.7$ and 186.1 for $CO_2(g)$ and $CH_4(g)$ respectively.

Problem 55

For $N_2(g) + 2\,H_2(g) \rightleftharpoons 2\,NH_3(g)$ where $\Delta H = -91.8kJ$ and $\Delta S^\circ = -197.3\frac{J}{K}$. Calculate ΔG° at $1000K$

Problem 56

For $2\,H_2O(g) \rightleftharpoons 2\,H_2(g) + O_2(g) \qquad \Delta H^\circ = 483.6kJ$. Will the reaction form more or less product when temperature is increased.

7 Unit 7: Equilibrium

Problem 57

What is the concentration equilibrium constant for the reaction $CO(g) + 3\,H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$

Problem 58

If $K_c = 3.91$ at $1200K$, Will the reactants shift towards products, reactants, or stay the same if the reaction mixture contains $[CO] = 0.0200M$, $[H_2] = 0.0200M$, $[CH_4] = 0.00100M$, and $[H_2O] = 0.00100M$?

Problem 59

For this chemical reaction $2\,CH_4(g) \rightleftharpoons C_2H_2(g) + 3\,H_2(g)$, $K_p = 2.0 \times 10^{-6}$. $14atm$ of methane gas is put into the reaction vessel. What is the expected partial pressure of $C_2H_2(g)$ at equilibrium.

Problem 60

For this reaction $NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$, $K_c = 0.16$. What is the molar concentration of each product if $250g$ of ammonium hydrogen sulfide is introduced into a $2.0L$ flask and allowed to reach equilibrium.

Problem 61

What is the molar solubility of AgCl in water at $24°C$ where $K_{sp} = 1.8 \times 10^{-10}$ for AgCl at this temperature.

Problem 62

What is the solubility of $Ca_3(PO_4)_2$ in water at $25°C$ in where $K_{sp} = 1.2 \times 10^{-29}$.

Problem 63

$15mg$ of CaF_2 dissolves in $1.00L$ of water at $25°C$. What is K_{sp} for CaF_2 at this temperature?

Problem 64

What is the molar concentration of OH^- in an aqueous $1.3M$ HCl solution at $24°C$?

Problem 65

What is the pH of an aqueous solution of $0.050M$ HNO_3 solution at $25°C$?

Problem 66

What is the pH of a weak acid with a $K_a = 2.6 \times 10^{-5}$?

8 Unit 8: Acids and Bases

Problem 67

Calculate the pH of a solution that is $0.5M$ CH_3COOH and $0.10M$ KCH_3COO.

Problem 68

Calculate the pH of a solution that is $0.10M$ CH_3COOH and $0.50M$ KCH_3COO.

Problem 69

Which of the following buffer systems would be the best choice for preparing a $pH = 4.10$ buffer solution. (a) $HNO_2/NaNO_2$ $\quad K_a = 7.1 \times 10^{-4}$
(b) $HCOOH/KHCOO$ $\quad K_a = 1.8 \times 10^{-4}$
(b) C_6H_5COOH/NaC_6H_5COO $\quad K_a = 6.3 \times 10^{-5}$

Problem 70

Will $0.2 mol NH_3$ and $0.2 mol NH_4Cl$ be a buffer solution?

Problem 71

Will $0.2 mol CH_3COOH$ and $0.1 mol NaOH$ be a buffer solution?

Problem 72

A $0.10M$ weak acid solution has a $pH = 3.7$. What is the percent ionization of the acid in this solution?

Problem 73

Why is HF weak but HCl is a strong acid?

Problem 74

Why is $HClO_4$ a strong acid but $HClO_2$ a weak acid?

Problem 75

What is the conjugate base of $HSO_4{}^-$?

Problem 76

What is the concentration of the hydroxide ion in pure water at $25°C$?

9 Unit 9: Applications of Thermodynamics

Problem 77

For this reaction, which element is oxidized or reduced at the anode.
$2\,NaCl(l) \longrightarrow 2\,Na(l) + Cl_2(g)$

Problem 78

For the reaction $2\,Al^{3+}(aq) + 3\,Mg(s) \longrightarrow 2\,Al(s) + 3\,Mg^{2+}(aq)$. What are the half reactions?

Problem 79

Using the chemical reaction above:
If $E^{\circ} = 0.71V$ what is the cell potential if all the reactants are in their standard states except Al^{3+} which is present at $0.010M$?

Problem 80

Using the chemical reaction above:
What is the change in mass of the alumnimum electrode if this cell discharges for $100.0s$ with a current of $0.1A$?

10 Answers

10.1 Unit 1

Problem 1

The molar mass of $C_9H_8O_4$ is $1.008 * 8 + 12.01 * 9 + 16.00 * 4 = 180.2\frac{g}{mol}$

$$7.89kg \times \frac{1g}{10^{-3}kg} \times \frac{1mol}{180.2g} = 43.8mol \tag{1}$$

Problem 2

(b), the tallest peak of the graph is the one at $64u$.

Problem 3

In one mole of $C_{13}H_{18}O_2$ is $206.31g$.

$$1mol\,\mathrm{C_{13}H_{18}O_2} \times \frac{13mol\,\mathrm{C}}{1mol\mathrm{C_{13}H_{18}O_2}} \times \frac{12.01g}{1mol\,\mathrm{C}} = 156.31g \tag{2}$$

Thus, the percent composition by weight is $\frac{156.31}{206.31} = 75.764\%$

Problem 4

Take $100g$ of the substance such that there are $32.38g$ sodium, $22.65g$ sulfur, and $44.99g$ oxygen.

$$\begin{aligned} 32.38g\,\mathrm{Na} \times \frac{1mol\,\mathrm{Na}}{22.99g} &= 1.408mol\,\mathrm{Na} \\ 22.65\,g\mathrm{S} * \frac{1\,mol\mathrm{S}}{32.07g} &= 0.7063\,mol\mathrm{S} \\ 44.99\,g\mathrm{O} * \frac{1\,mol\mathrm{O}}{16g} &= 2.812\,mol\mathrm{O} \end{aligned} \tag{3}$$

Take the ratio of each compound with the smallest quantity.

$$\begin{aligned} S : \frac{0.7063}{0.7063} &= 1 \\ Na : \frac{1.408}{0.7063} &= 2 \\ O : \frac{2.812}{0.7063} &= 4 \end{aligned} \tag{4}$$

Therefore, the empirical formula is Na_2SO_4

Problem 5

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10}$

Problem 6

Be. The peak location of the peak on the x-axis means that there is less binding energy for the electrons in element X. Be has fewer protons and both electrons are in the same shell, so it peak must belong to Be.

Problem 7

- The electronegativity increases from left to right across a period. This is because if a valence shell of electrons is less than half full than it requires less energy to lose an electron than gain one. If if the valence shell of electrons is more than half full, it is easier to pull and electron into the valence shell. The electronegativity decreases from the top to the bottom of a group. This is beause there is a greater atomic radius lower on the group.
- The ionization energy increases from left to right in a period. This is because of greater valence shell stability also because of smaller atomic radius. The ionization energy also decreases from top to bottom of a group. This is because of greater electron shielding and greater atomic radius.
- Atomic radius decreases from left to right within a period. This is because there are more protons to the right of the period. Atomic radius increases from top to bottom within a group. This is because of electron shielding and there are more electron shells in the atom.

10.2 Unit 2

Problem 8

The ionic character increase the greater the electronegativity difference. In this case, Na and O had the greatest electronegativity difference.

Problem 9

(c) $\mathrm{Cl} — \mathrm{F} > \mathrm{H} — \mathrm{I} > \mathrm{Se} — \mathrm{N}$

Problem 10

Cs^+ has a larger atomic radius than K^+. So the distance between the cation and anion is greater than in CsF than in KF

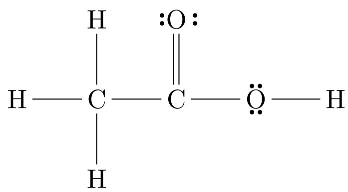
Problem 11

Most metallic elements form crystalline solids at room temperature. Their bonds are metallic bonds due to electrostatic attraction between metal cations and delocalized electrons.

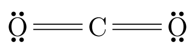
Problem 12

- Substitutional alloys. These alloys form when one atom of a similar size to the host metal replaces an atom of the host metal. The substitute atom must be of similar size. These alloys have good thermal and electrical conductivity.
- Interstitial alloys. These alloys are formed when smaller atoms fill in the gaps between the larger host atoms. This makes the metal harder and less malleable.

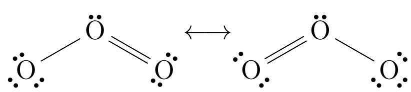
Problem 13



Problem 14

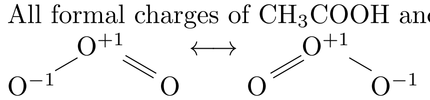


Problem 15



Problem 16

All formal charges of CH_3COOH and CO_2 are zero.



Problem 17

The electron geometry is tetrahedral. The molecular geometry is trigonal pyramidal. Hybridization of N atom is sp^3 since it has tetrahedral electron geometry.

10.3 Unit 3

Problem 18

Dipole-diple and london dispersion forces. The C — O bond is polar and the molecule is asymmetrical so it is polar. There are no H — F, H — O, or H — N bonds, so there is no hydrogen bonding.

Problem 19

Condensation. Both have no regular arrangement, the one on the left is separated by the one on the right is close together, so the molecules are transitioning from gas to liquid.

Problem 20

(a) As you increase the temperature, the average kinetic energy or speed increases as well.
(b) $n_1 = n_2$ and $V_1 = V_2$, so $P_1V_1 = n_1RT_1$ and $P_2V_2 = n_2RT_2$. $\frac{P_2V_2}{RT_2} = \frac{P_1V_1}{RT_1} \implies P_2 = \frac{P_1T_2}{T_1} = \frac{0.7*425}{299} = 0.99atm$
(c) As the temperature increases, the average kinetic energy increases, so the molecules undergo more collisions with the walls of the container.

Problem 21

$$60.3g \times \frac{1mol\,\mathrm{Ba(OH)_2}}{171.35g} \times \frac{2mol\,\mathrm{OH^-}}{1mol\,\mathrm{Ba(OH)_2}} * \frac{1}{1.75L} = 0.402M$$

Problem 22

The photoelectric effect occurs when light of a certain minimum frequency/energy hits the surface of a metal and electrons are ejected.

Problem 23

$\mathrm{Ar} < \mathrm{H_2S} < \mathrm{HCOOH}$

Problem 24

London dispersion forces. Benzene is symmetrical so there are no dipole dipole forces.

Problem 25

$\mathrm{MgF_2}$

Problem 26

Because $\mathrm{I_2}$ has a more polarizable electron cloud.

Problem 27

No, it is symmetrical.

10.4 Unit 4

Problem 28

$2\,C_5H_{10} + 15\,O_2 \longrightarrow 10\,CO_2 + 10\,H_2O$

Problem 29

The oxidation reaction:

$$\begin{aligned}
&I^- \longrightarrow I_2\\
&2\,I^- \longrightarrow I_2\\
&2\,I^- \longrightarrow I_2 + 2\,e^-\\
&10\,I^- \longrightarrow 5\,I_2 + 10\,e^-
\end{aligned}$$

The reduction reaction:

$$\begin{aligned}
&MnO_4{}^- \longrightarrow Mn^{2+}\\
&MnO_4{}^- \longrightarrow Mn^{2+} + 4\,H_2O\\
&MnO_4{}^- + 8\,H^+ \longrightarrow Mn^{2+} + 4\,H_2O\\
&5\,e^- + MnO_4{}^- + 8\,H^+ \longrightarrow Mn^{2+} + 4\,H_2O\\
&10\,e^- + 2\,MnO_4{}^- + 16\,H^+ \longrightarrow 2\,Mn^{2+} + 8\,H_2O
\end{aligned}$$

Add the reactions together:
$10\,I^- + 16\,H^+ + 2\,MnO_4{}^- \longrightarrow 5\,I_2 + 2\,Mn^{2+} + 8\,H_2O$

Problem 30

$Fe^{3+}(aq) + 3\,OH^-(aq) \longrightarrow Fe(OH)_3(s)$

Problem 31

Chemical processes are characterized by changes in intramolecular forces, while physical processes are characterized by changes only in intermolecular forces.

Problem 32

Find the limiting reactant:

$$\begin{aligned}
36.0\,gH_2O * \frac{1\,molH_2O}{18.02\,gH_2O} * \frac{1\,molFe_3O_4}{4\,molH_2O} &= 0.49945\,molFe_3O_4\\
67.0\,gFe * \frac{1\,molFe}{55.85\,gFe} * \frac{1\,molFe_3O_4}{3\,molFe} &= 0.39988\,molFe_3O_4
\end{aligned} \tag{5}$$

Therefore, the limiting reactant is Fe_3
Find how much iron oxide is produced: Use the limiting reactant

$$0.39988\,mol\mathrm{Fe}_3 * \frac{231.55\,gFe_3O_4}{1\,mol\mathrm{Fe}_3} = 92.6\,gFe_3O_4 \tag{6}$$

Find how much excess reactant is left over:

$$67.0\,gFe * \frac{1\,molFe}{55.85\,gFe} * \frac{4\,molH_2O}{3\,molFe} * \frac{18.02\,gH_2O}{1\,molH_2O} = 28.8\,gH_2O \tag{7}$$

28.8 grams of water is used out of 32.0 grams. So there is 7.2 grams left over of the excess reagent.

Problem 33

$4\,\mathrm{Al(s)} + 3\,\mathrm{O_2(g)} \longrightarrow 2\,\mathrm{Al_2O_3(s)}$

Problem 34

$4\,\mathrm{V} + 5\,\mathrm{O_2} \longrightarrow 2\,\mathrm{V_2O_5}$

Problem 35

$\mathrm{C_6H_{12}O_6} + 6\,\mathrm{O_2} \longrightarrow 6\,\mathrm{CO_2} + 6\,\mathrm{H_2O}$

Problem 36

$2\,\mathrm{Mg} + \mathrm{O_2} \longrightarrow 2\,\mathrm{MgO}$

10.5 Unit 5

Problem 37

$1.5 \times 10^3 mol$

Problem 38

$\mathrm{CH_4}$ rate $= \frac{-\Delta[\mathrm{CH_4}]}{\Delta t}$
$\mathrm{O_2}$ rate $= \frac{-1}{2}\frac{\Delta[\mathrm{O_2}]}{\Delta t}$
$\mathrm{CO_2}$ rate $= \frac{\Delta[\mathrm{CO_2}]}{\Delta t}$
$\mathrm{H_2O}$ rate $= \frac{1}{2}\frac{\Delta[\mathrm{H_2O}]}{\Delta t}$

Problem 39

$10\frac{M}{s}$

Problem 40

$\frac{(0.04-0.1)M}{125ms} \times \frac{1ms}{10^{-3}s} = -0.48\frac{M}{s}$
rate $= -\frac{1}{2} \times -0.48 = 0.24\frac{M}{s}$

Problem 41

When concentration of B is held constant and the concentration of A is tripled, the initial rate is multiplied by 9 so the order with respect to A is 2. The order with respect to B is 0 because nothing changes when the concetration is increased. Thus the rate law is

$$rate = k[A]^2[B]^0 = k[A]$$

$1.0 \times 10^{-2} = k \times 0.1^2 \implies k = 1.0\frac{1}{ms}$, thus $rate = [A]^2$

Problem 42

$$ln[A]_t = -kt + ln[A]_0$$
$$ln[A]_t = -(4.8 \times 10^{-4})(825) + ln(0.0165)$$
$$[A]_t = e^{-4.50} = 0.0111M$$

Half-life:

$$ln(\frac{1}{2}[A]_0) - ln[A]_0 = -kt$$
$$ln(\frac{1}{2}) = -kt$$
$$t = \frac{ln(2)}{k}$$

Problem 43

$k = 4.0 \times 10^{-4}\frac{1}{Ms} = 35\frac{1}{M \times days}$
$\frac{1}{[A]_t} = 35 * 6 + \frac{1}{0.1} \implies [A]_t = 4.5 \times 10^{-3}$

Problem 44

$\frac{1}{0.085M} = 35t + \frac{1}{0.1M} \implies t = 0.05days$

Problem 45

$2\,H_2O_2 \longrightarrow 2\,H_2O + O_2$ The rate determining step is the slow reaction, so $rate = k[H_2O_2][I^-]$
I^- is the catalyst. IO^- is the intermediate.

Problem 46

Overall: $2\,NO + 2\,H_2 \longrightarrow 2\,H_2O + N_2$
Rate determining step: $rate = k[N_2O_2][H_2]$
Fast equilbium: rate forward = rate back $\implies [N_2O_2] = \frac{k_f}{k_r}[NO]^2$
Thus, $rate = \frac{kk_f}{k_r}[NO]^2[H_2]$

10.6 Unit 6

Problem 47

$50g\mathrm{H_2O} \times \frac{1mol\mathrm{H_2O}}{18.01g\mathrm{H_2O}} \times \frac{6.022\times10^{23}\mathrm{H_2O}}{1mol\mathrm{H_2O}} \times \frac{2\mathrm{O{-}H}}{1\mathrm{H_2O}} \times \frac{1.8\times10^{-9}cal}{1\mathrm{O{-}H}} \times \frac{4.184J}{1cal} \times \frac{1kJ}{10^3J} = 2500kJ$

Problem 48

$q_{water} = 7.3 \times 100 \times 4.184$
$q_{water} = -q_{metal}$
$q_{metal} = C_{metal}(27.3 - 100) * 120 \implies C_{metal} = 0.350\frac{J}{g^\circ C}$

Problem 49

$5.0L\mathrm{H_2O} \times \frac{1mL\mathrm{H_2O}}{10^{-3}L\mathrm{H_2O}} \times \frac{1g\mathrm{H_2O}}{1mL} \times \frac{1mol}{18.01g} \times \frac{40.72kJ}{1mol} = 11302.32kJ$

Problem 50

$$\begin{aligned} &\mathrm{C_2H_2 + 2\,H_2 \longrightarrow C_2H_6} \\ &\mathrm{C_2H_6 \longrightarrow C_2H_4 + H_2} \qquad \implies \mathrm{C_2H_2 + H_2 \longrightarrow C_2H_4} \end{aligned}$$

Thus, $\Delta H = -175$

Problem 51

$1.5mol\mathrm{O_2} \times \frac{1mol_{rxn}}{3mol\mathrm{O_2}} \times \frac{-1371kJ}{mol_{rxn}} = -685.5kJ$

Problem 52

Increase

Problem 53

$\Delta S = 205.0 + 2 \times 130.58 - 2 \times 188.83 = 88.5\frac{J}{K}$

Problem 54

$\Delta S_{surr} = \frac{-\Delta H}{T} = -\frac{-802.2*1000}{298.15} = 2691\frac{J}{K}$
$\Delta S_{sys} = 2 \times 188.7 + 213.7 - (186.1 + 2 \times 205.0) = -5.0\frac{J}{K}$
$\Delta S_{universe} = -5 + 2691 = 2686\frac{J}{K}$.

Problem 55

$\Delta G = -19800J - (1000) * (-197.3\frac{J}{K}) = 106000J$

Problem 56

More product at high temperature

10.7 Unit 7

Problem 57

$K_c = \frac{[CH_4][H_2O]}{[H_2]^2[CO]}$

Problem 58

$Q_c = 6.25$. $Q_c > K_c$ so the reaction will shift towards reactants.

Problem 59

$K_p = \frac{(3x)^3 x}{(14-2x)^2} \implies 2.0 \times 10^{-6} \approx \frac{(3x)^3 x}{14^2} \implies x = 0.062atm$. The partial pressure is $0.062atm$.

Problem 60

$x^2 = 0.16 \implies x = 0.4M$. Note that $250g = 4.89mol$ which is clearly enough to produce the $0.4M$ predicted by the equilibrium constant.

Problem 61

$K_{sp} = [Ag^+][Cl^-] = 1.8 \times 10^{-10} \implies x^2 = 1.8 \times 10^{-10} \implies x = 1.3 \times 10^{-5}M$

Problem 62

$K_{sp} = [Ca^{2+}]^3[PO_4{}^{3-}]^2 \implies 108x^5 = 1.2 \times 10^{-29} \implies x = 6.4 \times 10^{-7}M$

Problem 63

$x = 15mg \times \frac{10^{-3}g}{1mg} \times \frac{1mol}{78.08g} = 1.9 \times 10^{-4}M$
$K_{sp} = [Ca^{2+}][F^-]^2 = x(2x)^2 = 2.7 \times 10^{-11}$

Problem 64

$1.0 \times 10^{-14} = 1.3[OH^-] \implies [OH^-] = 7.7 \times 10^{-15}M$

Problem 65

$pH = -log(0.05) = 1.30$

Problem 66

HA	H_2O	H_3O^+	A^-
0.2		~ 0	0
$-x$		x	x
$0.2 - x$		$\sim x$	x

$2.6 \times 10^{-5} = \frac{x^2}{0.2-x} \approx \frac{x^2}{0.2} \implies x = 0.00228 \implies pH = 2.64$

10.8 Unit 8

Problem 67

$pH = pK_a + log(\frac{[\text{CH}_3\text{COO}]}{[\text{CH}_3\text{COOH}]}) \implies pH = -log(1.8 \times 10^{-5} + log(\frac{0.1}{0.5}) \implies pH = 4.04$

Problem 68

$pH = -log(1.8 \times 10^{-5}) + log(\frac{0.5}{0.1}) = 5.44$

Problem 69

(c)

Problem 70

Yes

Problem 71

Yes, the strong base reacts with half of the weak acid to produce weak base.

Problem 72

$[\text{H}_3\text{O}^+] = 10^{-3.7} = 2.0 \times 10^{-4}$
Percent ionization $= \frac{2.0 \times 10^{-4}}{0.1} \times 100 = 0.2\%$

Problem 73

HF is weak even though F is highly electronegative because the bond between HF is stronger than the bond between HCl.

Problem 74

Because the highly electronegative O in the molecule of $HClO_4$ pulls away electrons more effectively than the $HClO_2$ because $HClO_2$ only has 2 electrons. Thus the H — O bond is more polar in $HClO_4$

Problem 75

$SO_4{}^{2-}$

Problem 76

1×10^{-7}

10.9 Unit 9

Problem 77

Chlorine is oxidized.

Problem 78

Reduction: $2\,Al^{3+} + 6\,e^- \longrightarrow 2\,Al$
Oxidation: $3\,Mg \longrightarrow 6\,e^- + 3\,Mg^{2+}$

Problem 79

$Q = \frac{[Mg^{2+}]^3}{[Al^{3+}]^2}$
So $E_{cell} = E_{cell}{}^\circ - \frac{RT}{nF} ln(Q) = 0.71 - \frac{8.314\times298}{6\times96485} \times ln(1\times10^4) = 0.67V.$

Problem 80

$Al^{3+} + 3\,e^- \longrightarrow Al$
$q = I \times t = 10C$
$n = \frac{q}{F} = \frac{10C}{96485\frac{C}{mol}} = 1.04\times10^{-4} mol\mathrm{e}^-$
$1.04\times10^{-4} mol\mathrm{e}^- \times \frac{1mol\mathrm{Al}^{3+}}{3mole^-} \times \frac{26.98g}{1mol} = 9.32\times10^{-4}g$