Problem Sets must be postmarked by due date for credit.

AP CHEMISTRY
PROBLEM SETS UNIT 1: BASIC CONCEPTS

Set 1 : Sec 1.2, 1.3 Due July 6

1. Which tests would you perform on a substance to determine whether it is a liquid or a solid?

2. Classify the following observations about a substance as either physical or chemical properties: (a) color; (b) melting point; (c) reactivity with water; (d) boiling point (e) state of matter under ordinary conditions; (f) flammability; (g) density; (h) electrical conductivity; (i) decomposition products upon heating.

3. Classify each of the following as an element, compound, or mixture; if a mixture, indicate whether it is homogeneous or heterogeneous: (a) diamond; (b) ammonia water; (c) iodine crystals; (d) salad dressing; (e)magnesium chloride (the salt used to melt snow and ice).

4. Identify the chemical elements represented by the following symbols: (a) Si; (b) Be; (c) F; (d) Na; (e) Hg; (f) Au; (g) Ar; (h) As.

5. How many total elements are represented by the substances in Table 1. ? What fraction of all of the known elements is represented?

Set 2 : Sec. 1.5 Due July 13

6. Indicate which of the following are exact numbers: (a) the number of inches in a mile; (b) the value of π (c) the mass of a 12-oz bag of potato chips; (d) the number of ounces in a pound; (e) the number of micrometers in a kilometer; (f) the number of inches in a kilometer.

7. Indicate how many significant figures are in each of the following measured quantities: (a) 3.141 cm; (b)-1.200°C; (c) 0.002004; (d) 3,490,400 ps; (e) 6.000×10^{-3} km.

8. Round each of the following numbers to three significant figures: (a) 10.000; (b) 0.05000; (c) 23,000; (d) 1.565×10^{1}; (e) 9,834.05; (f) – 1235

9. Carry out the following operations and express the answers with the appropriate number of significant figures:(a) 1.23056 + 67.809; (b) 23.67 – 500.; (c) 890.05 x 12.3; (d) 88,132 / 22.500.

10. Carry out the following operations and express the answer with the appropriate number of significant figures:
    (a) 324.55 - (6104.5/22.3);
    (b) $[(285.3 \times 10^{6}) - (12.000 \times 10^{3})] \times 22.8954$;
    (c) $(0.0045 \times 30{,}000.0) + (283 \times 12)$;
    (d) $869 \times [1255 - (3.45 \times 10^{3})]$.

Set 3 Sec. 1.4 Due July 20

11. What basic SI units are appropriate for expressing the following quantities: (a) the diameter of the earth; (b) the surface area of a tennis ball; (c) the volume of a gasoline tank; (d) the mass of a brick; (e) the speed of light; (f) the temperature of the air?

12. Use the appropriate abbreviation to replace the power of ten in each of the following values: (a) 3.4×10^{-12} m; (b) 4.8 x 10-1 m; (c) 7.23×10^{3} g; (d) 2.35 x 10-6 m^3; (e) 5.8×10^{-9} s; (f) 3.45×10^{-3} mol.

13. Perform the following conversions: (a) 32.2 mm to µm; (b) 47.6 g/m to kg/d; (c) 32.4×10^{-12}m to pm (d) 4.5×10^{8} pm^3 to m^3.

14. (a) Water has a density of 1.00 g/mL or 1.00 g/cm3.What is the mass of 338d of water? (b) A cube of plastic 1.2×10^{-5} km on a side weighs 1.1 g. What is the density of this material? Will it float in water? (c) Table salt (sodium chloride) has a density of 2.16 g/cm^3. What volume would 36.2µg of this salt occupy?

15. (a) A certain sodium chloride solution has a density of 1.033 g/mℓ. What is the mass of 120 ℓ of this solution? (b) A piece of a pure unknown metal has a mass of 46.5 g and a volume of 5.3 cm^3. What is the density of this metal? Could this metal be gold? (see appendix 2D) (c) An iron bar has a density of 7.20 g/cm^3 and a mass of 431 g. What is the volume of this piece of iron?

16. Make the following conversions: (a) 9.2 K to °C; (b) 36.7 °C to °F; (c) – 102 °F to K; (d) 120 °F to °C; (e) 70 °C to K; (f) 1500 K to °F.

Set 4 Sec. 1.5, 1.6, 1.3 Due July 27

17. Perform the following conversions: (a) 5.0 ft to in; (b) 2.55 gal to mℓ; (c) 3.00 days to s; (d) 66.2 ft^3 to cm^3 e) 55 mi/hr to km/hr; (f) 25.2 mi/gal to km/ℓ.

18. The maximum allowable concentration of carbon monoxide in urban air is 10 mg/m^3 over an 8-hr period. At this level, what mass of carbon monoxide is present in a room measuring 8 x 12 x 20 ft?

19. A pound of coffee beans yields 50 cups of coffee. How many milliliters of coffee can be obtained from 1 g of coffee beans?

20. You aren't feeling well, so you go to the doctor. The nurse takes your temperature, and it is 312 K. Do you have a fever?

21. Which of the following are intensive properties: a) mass b) density c) temperature d) area e) color f) volume

22. A U.S. quarter has a mass of 5.67 g and is approximately 1.55 mm thick. (a) The Washington Monument is 575 ft tall. How many quarters would have to be stacked to reach this height? (b) How much would this stack weigh? (c) How much money would this stack contain? (d) At this writing, the national debt stands at $2.9 trillion. How many stacks like the one described would be necessary to pay off this debt?

23. A cylindrical glass tube 15.0 cm in length is filled with ethanol. The mass of ethanol needed to fill the tube is found to be 9.64 g. Calculate the inner diameter of the tube in centimeters. The density of ethanol is 0.789 g/mℓ.

AP CHEMISTRY
PROBLEM SETS UNIT 2: ATOMS, MOLECULES, AND IONS

Set 1 Sec. 2.1, 2.2 Due Aug 3

1. Using the atomic theory, explain the difference in the following two statements: (a) Nitrogen dioxide is a compound of nitrogen and oxygen (b) air is a mixture composed mostly of nitrogen and oxygen.

2. A chemist prepared a series of compounds containing only sulfur and fluorine and determined the amount of each element in each compound:

Compound	Mass of sulfur (g)	Mass of fluorine (g)
A	23.2	55.0
B	16.6	9.8
C	19.3	68.6

(a) Calculate the mass of fluorine per gram of sulfur in each compound. (b) do the numbers in part (a) follow the law of multiple proportions? Explain. (google it - see also Dalton's Law + Law of Constant Composition)

3. A negatively charged particle is directed between two electrically charged plates, as shown in Fig 2.3. (a) Why does the path of the charged particle bend? (b) As the charge on the plates is increased, would you expect the bending to increase, decrease, or stay the same? Explain. (c) As the mass of the particles is increased, would you expect the bending to increase, decrease, or stay the same? Explain.

4. Natural gas burns in the presence of oxygen to produce water, carbon dioxide, and heat. We know that 4.0g of natural gas requires 16.0g of oxygen for complete combustion and that 9.0g of water is produced in this reaction. Can the mass of carbon dioxide produced be determined from this information? Explain.

5. Static electricity, such as that given to a piece of amber by rubbing it with wool, is due to a buildup of electrons. A sample of amber is measured to have a static charge of 3.24×10^{-16}C. How many excess electrons are on the piece of amber? Be resourceful: find the charge (in Coulombs) for a single electron

6. Why is Rutherford's nuclear model of the atom more consistent with the results of the α-particle scattering experiment than Thompson's "plum pudding" model?

7. The diameter of the cesium atom is about 4.7Å. (a) Express this distance in nanometers and in picometers. (b) How many cesium atoms would have to be lined up to span 1.0cm? Å = angstrom

Set 2 Sec. 2.3, 2.5, 2.6 Due Aug 10

8. How many protons, neutrons, and electrons are in the following atoms; (a) ^{51}V, (b) ^{119}Sn, (c) ^{127}Te, (d) ^{165}Ho, (e) ^{16}O, (f) ^{234}Th, (g) ^{112}Cd, (h) ^{113}Cd?

9. Write the correct symbol, with both superscript and subscript, for each of the following (a) the isotope of sodium with mass 23, (b) the nuclide of vanadium that contains 28 neutrons, (c) an α-particle, (d) the isotope of chlorine with mass 37, (e) the nuclide of magnesium that has an equal number of protons and neutrons.

10. Fill in the gaps in the following table;

Symbol	${}^{11}_{5}B$	${}^{137}_{56}Ba$			
Protons			40		
Neutrons			51	29	126
Electrons					83
Mass #				53	

11. Locate each of the following elements in the periodic table, indicate whether it is a metal, semimetal, or nonmetal, and give the name of the element; (a) Se, (b) Be, (c) Hg, (d) Kr, (e) Te, (f) Ga, (g) Br, (h) Ba.

12. Write the empirical formula corresponding to each of the following molecular formulae: (a) C_4H_6, (b) H_2O_2, (c) P_2O_5, (d) $C_2H_4O_2$, (e) N_2H_4, (f) B_2H_6.

"The periodic table."

Set 3 Sec. 2.7 Due Aug 17

13. Each of the following elements is capable of forming an ion in chemical reactions. By referring to the periodic table, predict the charge found on the most stable ion formed by each: (a) Li, (b) Br, (c) Mg, (d) O, (e) Al, (f) Y

14. Which of the following ions would you not expect to form: (a) F^+, (b) S^{-2}, (c) Be^-, (d) P^{-3}, (e) Br^-, (f) K^{+2}

15. Predict the empirical formula for the ionic compound formed for each of the following pairs of ions: (a) Cu^{+2} and $C_2H_3O_2^-$, (b) NH_4^+ and HCO_3^-, (c) Al^{+3} and Br^-, (d) Ca^{+2} and ClO_4^-, (e) K^+ and SO_4^{-2}, (f) NH_4^+ and PO_4^{-3}

16. Predict the empirical formula for the ionic compound formed from each of the following pairs of elements: (a) Na and S, (b) Ca and F, (c) Mg and O, (d) Al and O, (e) Be and S, (f) Li and N

17. Predict whether each of the following compounds is molecular or ionic: (a) NO_2, (b) BF_3, (c) Li_2O, (d) Sc_2O_3, (e) CsBr, (f) PF_5, (g) NF_3, (h) LaP

Set 4 Sec. 2.8 Due Aug 24

18. Name the following ionic compounds: (a) $ZnCl_2$, (b) $PbCrO_4$, (c) $Hg(NO_3)_2$, (d) $Ca(CN)_2$, (e) FeF_3, (f) Na_2CO_3, (g) $KClO_4$, (h) $Cu(OH)_2$, (i) Cr_2O_3, (j) Ag_3PO_4

19. Give the chemical formula for each of the following ionic compounds: (a) chromium(III) nitrate, (b) manganese (III) fluoride, (c) calcium bicarbonate, (d) mercurous chloride, (e) potassium hydride, (f) sodium peroxide

20. Give the name or formula for each of the following: (a) SF_4, (b) nitrogen dioxide, (c) IF_7, (d) hydrogen selenide, (e) N_2O_5, (f) boron trifluoride

21. Provide chemical formulas or names for the following acids: (a) H_2CO_3, (b) nitrous acid, (c) $HClO_2$, (d) hydrocyanic acid, (e) H_2CrO_4, (f) periodic acid

22. Write the chemical formula for each substance mentioned in the following word descriptions: (a) zinc carbonate can be heated to form zinc oxide and carbon dioxide, (b) on treatment with hydrofluoric acid, silicon dioxide forms silicon tetrafluoride and water, (c) sulfur dioxide reacts with water to form sulfurous acid, (d) the substance hydrogen phosphide is commonly called phosphine, (e) perchloric acid reacts with cadmium to form cadmium(II) perchlorate, (f) vanadium(III) bromide is a colored solid

23. Many familiar substances have common, unsystematic names. For each of the following, give the correct systematic name: (a) saltpeter (KNO_3), (b) soda ash (cont.)

(Na_2CO_3), (c) lime (CaO), (d) muriatic acid (HCl), (e) Epsom salt ($MgSO_4$), (f) milk of magnesia (MOM) oops, sorry ($Mg(OH)_2$)

24. Iodic acid had the molecular formula HIO_3. Write the formulae for the following: (a) the iodate ion, (b) the periodate anion, (c) the hypoiodite anion, (d) hypoiodous acid, (e) periodic acid

- Clearly + neatly show all work,
- Circle or box numerical answers.
- Send problem sets to:

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Include a SASE!

[Self-addressed, Stamped envelope]

Must be postmarked by due-date for credit.

Ions sorted by NAME

Name	Formula	
Acetate	$C_2H_3O_2$	1-
Aluminum	Al	3+
Ammonia	NH_3	0
Ammonium	NH_4	1+
Arsenate	AsO_4	3-
Barium	Ba	2+
Bicarbonate	HCO_3	1-
Bismuth	Bi	3+
Bisulfate	HSO_4	1-
Boride	B	3-
Bromate	BrO_3	1-
Bromide	Br	1-
Cadmium	Cd	2+
Calcium	Ca	2+
Carbide	C	4-
Carbon	C	4+
Carbonate	CO_3	2-
Cerium	Ce	3+
Cesium	Cs	1+
Chlorate	ClO_3	1-
Chloride	Cl	1-
Chlorite	ClO_2	1-
Chromate	CrO_4	2-
Chromium 2	Cr	2+
Chromium 3	Cr	3+
Cobalt 2	Co	2+
Cobalt 3	Co	3+
Copper 1	Cu	1+
Copper 2	Cu	2+
Cyanide	CN	1-
Dichromate	Cr_2O_7	2-
Fluoride	F	1-
Fluorite	FO_2	1-
Hexaflorosilicate	SiF_6	2-
Hydride	H	1-
Hydroxide	OH	1-
Hypochlorite	ClO	1-
Iodate	IO_3	1-
Iodide	I	1-
Iron 2	Fe	2+
Iron 3	Fe	3+
Lead 2	Pb	2+
Lead 4	Pb	4+
Lithium	Li	1+
Magnesium	Mg	2+
Manganese 2	Mn	2+
Mercury 1	Hg_2	1+
Mercury 2	Hg	2+
Nickel 2	Ni	2+
Nitrate	NO_3	1-
Nitric Acid	HNO_3	0

Ions sorted by CHARGE

Name	Formula	
Ammonia	NH_3	0
Carbonic Acid	H_2CO_3	0
Nitric Acid	HNO_3	0
Acetate	$C_2H_3O_2$	1-
Bicarbonate	HCO_3	1-
Bisulfate	HSO_4	1-
Bromate	BrO_3	1-
Bromide	Br	1-
Chlorate	ClO_3	1-
Chloride	Cl	1-
Cyanide	CN	1-
Fluoride	F	1-
Hydride	H	1-
Hydroxide	OH	1-
Hypochlorite	ClO	1-
Iodate	IO_3	1-
Iodide	I	1-
Nitrate	NO_3	1-
Nitrite	NO_2	1-
Perchlorate	ClO_4	1-
Permanganate	MnO_4	1-
Fluorite	FO_2	1-
Ammonium	NH_4	1+
Cesium	Cs	1+
Copper 1	Cu	1+
Lithium	Li	1+
Potassium	K	1+
Rubidium	Rb	1+
Silver	Ag	1+
Sodium	Na	1+
Thallium 1	Tl	1+
Chlorite	ClO2	1+
Carbonate	CO_3	2-
Chromate	CrO_4	2-
Dichromate	Cr_2O_7	2-
Hexaflorosilicate	SiF_6	2-
Oxalate	C_2O_4	2-
Oxide	O	2-
Peroxide	O_2	2-
Selenide	Se	2-
Sulfate	SO_4	2-
Sulfide	S	2-
Sulfite	SO_3	2-
Tartrate	$C_4H_4O_6$	2-
Mercury 1	Hg_2	2+
Barium	Ba	2+
Cadmium	Cd	2+
Calcium	Ca	2+
Cobalt 2	Co	2+

Ions sorted by FORMULA

Name	Formula	
Silver	Ag	1+
Aluminum	Al	3+
Arsenate	AsO_4	3-
Boride	B	3-
Barium	Ba	2+
Bismuth	Bi	3+
Bromide	Br	1-
Bromate	BrO_3	1-
Carbon	C	4+
Carbide	C	4-
Acetate	$C_2H_3O_2$	1-
Oxalate	C_2O_4	2-
Tartrate	$C_4H_4O_6$	2-
Calcium	Ca	2+
Cadmium	Cd	2+
Cerium	Ce	3+
Chloride	Cl	1-
Hypochlorite	ClO	1-
Chlorite	ClO2	1+
Chlorate	ClO_3	1-
Perchlorate	ClO_4	1-
Cyanide	CN	1-
Cobalt 2	Co	2+
Cobalt 3	Co	3+
Carbonate	CO_3	2-
Chromium 2	Cr	2+
Chromium 3	Cr	3+
Dichromate	Cr_2O_7	2-
Chromate	CrO_4	2-
Cesium	Cs	1+
Copper 1	Cu	1+
Copper 2	Cu	2+
Fluoride	F	1-
Iron 2	Fe	2+
Iron 3	Fe	3+
Fluorite	FO_2	1-
Hydride	H	1-
Bicarbonate	HCO_3	1-
Mercury 2	Hg	2+
Mercury 1	Hg_2	2+
Bisulfate	HSO_4	1-
Iodide	I	1-
Iodate	IO_3	1-
Potassium	K	1+
Lithium	Li	1+
Magnesium	Mg	2+
Manganese 2	Mn	2+

Ions sorted by NAME

Nitride	N	3-
Nitrite	NO_2	1-
Oxalate	C_2O_4	2-
Oxide	O	2-
Perchlorate	ClO_4	1-
Permanganate	MnO_4	1-
Peroxide	O_2	2-
Phosphate	PO_4	3-
Phosphide	P	3-
Phosphite	PO_3	3-
Potassium	K	1+
Rubidium	Rb	1+
Selenide	Se	2-
Silicate	SiO_3	2-
Silicon	Si	4+
Silver	Ag	1+
Sodium	Na	1+
Strontium	Sr	2+
Sulfate	SO_4	2-
Sulfide	S	2-
Sulfite	SO_3	2-
Tartrate	$C_4H_4O_6$	2-
Thallium 1	Tl	1+
Tin 2	Sn	2+
Tin 4	Sn	4+
Zinc	Zn	2+

Ions sorted by CHARGE

Copper 2	Cu	2+
Iron 2	Fe	2+
Lead 2	Pb	2+
Magnesium	Mg	2+
Manganese 2	Mn	2+
Mercury 2	Hg	2+
Nickel 2	Ni	2+
Strontium	Sr	2+
Tin 2	Sn	2+
Zinc	Zn	2+
Silicate	SiO_3	2-
Chromium 2	Cr	2+
Arsenate	AsO_4	3-
Boride	B	3-
Nitride	N	3-
Phosphate	PO_4	3-
Phosphide	P	3-
Phosphite	PO_3	3-
Aluminum	Al	3+
Bismuth	Bi	3+
Cerium	Ce	3+
Cobalt 3	Co	3+
Iron 3	Fe	3+
Chromium 3	Cr	3+
Carbide	C	4-
Carbon	C	4+
Lead 4	Pb	4+
Silicon	Si	4+
Tin 4	Sn	4+

Ions sorted by FORMULA

Permanganate	MnO_4	1-
Nitride	N	3-
Sodium	Na	1+
Ammonia	NH_3	0
Ammonium	NH_4	1+
Nickel 2	Ni	2+
Nitrite	NO_2	1-
Nitrate	NO_3	1-
Oxide	O	2-
Peroxide	O_2	2-
Hydroxide	OH	1-
Phosphide	P	3-
Lead 2	Pb	2+
Lead 4	Pb	4+
Phosphite	PO_3	3-
Phosphate	PO_4	3-
Rubidium	Rb	1+
Sulfide	S	2-
Selenide	Se	2-
Silicon	Si	4+
Hexaflorosilicate	SiF_6	2-
Silicate	SiO_3	2-
Tin 2	Sn	2+
Tin 4	Sn	4+
Sulfite	SO_3	2-
Sulfate	SO_4	2-
Strontium	Sr	2+
Thallium 1	Tl	1+
Zinc	Zn	2+

Reactivity Series

Li
K
Ca
Na
Mg
Al
Zn
Fe
Pb
H*
Cu
Hg
Ag

Freely loses electrons

* Hydrogen only included for comparison

Strong hold on electrons

INFORMATION IN THE TABLE BELOW AND IN THE TABLES ON PAGES 3-5 MAY BE USEFUL IN ANSWERING THE QUESTIONS IN THIS SECTION OF THE EXAMINATION.

DO NOT DETACH FROM BOOK.

PERIODIC TABLE OF THE ELEMENTS

1 **H** 1.0079																	2 **He** 4.0026
3 **Li** 6.941	4 **Be** 9.012											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.179
11 **Na** 22.99	12 **Mg** 24.30											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.974	16 **S** 32.06	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.90	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.938	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.1	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.91	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 ***La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.21	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.02	89 **†Ac** 227.03	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 **§** (269)	111 **§** (272)	112 **§** (277)						

§Not yet named

*Lanthanide Series	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04	71 **Lu** 174.97
†Actinide Series	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

STANDARD REDUCTION POTENTIALS IN AQUEOUS SOLUTION AT 25°C

Half-reaction			$E°$(V)
$F_2(g) + 2e^-$	→	$2F^-$	2.87
$Co^{3+} + e^-$	→	Co^{2+}	1.82
$Au^{3+} + 3e^-$	→	$Au(s)$	1.50
$Cl_2(g) + 2e^-$	→	$2Cl^-$	1.36
$O_2(g) + 4H^+ + 4e^-$	→	$2H_2O(l)$	1.23
$Br_2(l) + 2e^-$	→	$2Br^-$	1.07
$2Hg^{2+} + 2e^-$	→	Hg_2^{2+}	0.92
$Hg^{2+} + 2e^-$	→	$Hg(l)$	0.85
$Ag^+ + e^-$	→	$Ag(s)$	0.80
$Hg_2^{2+} + 2e^-$	→	$2Hg(l)$	0.79
$Fe^{3+} + e^-$	→	Fe^{2+}	0.77
$I_2(s) + 2e^-$	→	$2I^-$	0.53
$Cu^+ + e^-$	→	$Cu(s)$	0.52
$Cu^{2+} + 2e^-$	→	$Cu(s)$	0.34
$Cu^{2+} + e^-$	→	Cu^+	0.15
$Sn^{4+} + 2e^-$	→	Sn^{2+}	0.15
$S(s) + 2H^+ + 2e^-$	→	$H_2S(g)$	0.14
$2H^+ + 2e^-$	→	$H_2(g)$	0.00
$Pb^{2+} + 2e^-$	→	$Pb(s)$	−0.13
$Sn^{2+} + 2e^-$	→	$Sn(s)$	−0.14
$Ni^{2+} + 2e^-$	→	$Ni(s)$	−0.25
$Co^{2+} + 2e^-$	→	$Co(s)$	−0.28
$Cd^{2+} + 2e^-$	→	$Cd(s)$	−0.40
$Cr^{3+} + e^-$	→	Cr^{2+}	−0.41
$Fe^{2+} + 2e^-$	→	$Fe(s)$	−0.44
$Cr^{3+} + 3e^-$	→	$Cr(s)$	−0.74
$Zn^{2+} + 2e^-$	→	$Zn(s)$	−0.76
$2H_2O(l) + 2e^-$	→	$H_2(g) + 2OH^-$	−0.83
$Mn^{2+} + 2e^-$	→	$Mn(s)$	−1.18
$Al^{3+} + 3e^-$	→	$Al(s)$	−1.66
$Be^{2+} + 2e^-$	→	$Be(s)$	−1.70
$Mg^{2+} + 2e^-$	→	$Mg(s)$	−2.37
$Na^+ + e^-$	→	$Na(s)$	−2.71
$Ca^{2+} + 2e^-$	→	$Ca(s)$	−2.87
$Sr^{2+} + 2e^-$	→	$Sr(s)$	−2.89
$Ba^{2+} + 2e^-$	→	$Ba(s)$	−2.90
$Rb^+ + e^-$	→	$Rb(s)$	−2.92
$K^+ + e^-$	→	$K(s)$	−2.92
$Cs^+ + e^-$	→	$Cs(s)$	−2.92
$Li^+ + e^-$	→	$Li(s)$	−3.05

GO ON TO THE NEXT PAGE.

ADVANCED PLACEMENT CHEMISTRY EQUATIONS AND CONSTANTS

ATOMIC STRUCTURE

$$E = h\nu \qquad c = \lambda\nu$$

$$\lambda = \frac{h}{m\upsilon} \qquad p = m\upsilon$$

$$E_n = \frac{-2.178 \times 10^{-18}}{n^2} \text{ joule}$$

EQUILIBRIUM

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$K_b = \frac{[OH^-][HB^+]}{[B]}$$

$$K_w = [OH^-][H^+] = 1.0 \times 10^{-14} \quad @ \ 25°C$$
$$= K_a \times K_b$$

$$pH = -\log [H^+], \quad pOH = -\log [OH^-]$$

$$14 = pH + pOH$$

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

$$pOH = pK_b + \log \frac{[HB^+]}{[B]}$$

$$pK_a = -\log K_a, \quad pK_b = -\log K_b$$

$$K_p = K_c(RT)^{\Delta n},$$

where Δn = moles product gas − moles reactant gas

THERMOCHEMISTRY/KINETICS

$$\Delta S° = \sum S° \text{ products} - \sum S° \text{ reactants}$$

$$\Delta H° = \sum \Delta H_f° \text{ products} - \sum \Delta H_f° \text{ reactants}$$

$$\Delta G° = \sum \Delta G_f° \text{ products} - \sum \Delta G_f° \text{ reactants}$$

$$\Delta G° = \Delta H° - T\Delta S°$$
$$= -RT \ln K = -2.303\, RT \log K$$
$$= -n\mathcal{F}E°$$

$$\Delta G = \Delta G° + RT \ln Q = \Delta G° + 2.303\, RT \log Q$$

$$q = mc\Delta T$$

$$C_p = \frac{\Delta H}{\Delta T}$$

$$\ln[A]_t - \ln[A]_0 = -kt$$

$$\frac{1}{[A]_t} - \frac{1}{[A]_0} = kt$$

$$\ln k = \frac{-E_a}{R}\left(\frac{1}{T}\right) + \ln A$$

E = energy $\quad \upsilon$ = velocity

ν = frequency $\quad n$ = principal quantum number

λ = wavelength $\quad m$ = mass

p = momentum

Speed of light, $c = 3.0 \times 10^8 \text{ m s}^{-1}$

Planck's constant, $h = 6.63 \times 10^{-34} \text{ J s}$

Boltzmann's constant, $k = 1.38 \times 10^{-23} \text{ J K}^{-1}$

Avogadro's number $= 6.022 \times 10^{23} \text{ mol}^{-1}$

Electron charge, $e = -1.602 \times 10^{-19}$ coulomb

1 electron volt per atom $= 96.5 \text{ kJ mol}^{-1}$

Equilibrium Constants

K_a (weak acid)

K_b (weak base)

K_w (water)

K_p (gas pressure)

K_c (molar concentrations)

$S°$ = standard entropy

$H°$ = standard enthalpy

$G°$ = standard free energy

$E°$ = standard reduction potential

T = temperature

n = moles

m = mass

q = heat

c = specific heat capacity

C_p = molar heat capacity at constant pressure

E_a = activation energy

k = rate constant

A = frequency factor

Faraday's constant, $\mathcal{F}$ = 96,500 coulombs per mole of electrons

Gas constant, $R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$
$= 0.0821 \text{ L atm mol}^{-1} \text{ K}^{-1}$
$= 8.31 \text{ volt coulomb mol}^{-1} \text{ K}^{-1}$

GO ON TO THE NEXT PAGE.

GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

$$P_A = P_{total} \times X_A, \text{ where } X_A = \frac{\text{moles A}}{\text{total moles}}$$

$$P_{total} = P_A + P_B + P_C + \ldots$$

$$n = \frac{m}{M}$$

$$\text{K} = {}^\circ\text{C} + 273$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$D = \frac{m}{V}$$

$$u_{rms} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}}$$

$$KE \text{ per molecule} = \frac{1}{2}mv^2$$

$$KE \text{ per mole} = \frac{3}{2}RT$$

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

molarity, M = moles solute per liter solution

molality = moles solute per kilogram solvent

$$\Delta T_f = iK_f \times \text{molality}$$

$$\Delta T_b = iK_b \times \text{molality}$$

$$\pi = iMRT$$

$$A = abc$$

P = pressure
V = volume
T = temperature
n = number of moles
D = density
m = mass
v = velocity

u_{rms} = root-mean-square speed
KE = kinetic energy
r = rate of effusion
M = molar mass
π = osmotic pressure
i = van't Hoff factor
K_f = molal freezing-point depression constant
K_b = molal boiling-point elevation constant
A = absorbance
a = molar absorptivity
b = path length
c = concentration
Q = reaction quotient
I = current (amperes)
q = charge (coulombs)
t = time (seconds)
E° = standard reduction potential
K = equilibrium constant

OXIDATION-REDUCTION; ELECTROCHEMISTRY

$$Q = \frac{[\text{C}]^c\,[\text{D}]^d}{[\text{A}]^a\,[\text{B}]^b}, \text{ where } a\text{ A} + b\text{ B} \rightarrow c\text{ C} + d\text{ D}$$

$$I = \frac{q}{t}$$

$$E_{cell} = E^\circ_{cell} - \frac{RT}{n\mathcal{F}} \ln Q = E^\circ_{cell} - \frac{0.0592}{n} \log Q \text{ @ } 25^\circ\text{C}$$

$$\log K = \frac{nE^\circ}{0.0592}$$

Gas constant, R = 8.31 J mol^{-1} K^{-1}
= 0.0821 L atm mol^{-1} K^{-1}
= 8.31 volt coulomb mol^{-1} K^{-1}

Boltzmann's constant, $k = 1.38 \times 10^{-23}$ J K^{-1}

K_f for H_2O = 1.86 K kg mol^{-1}

K_b for H_2O = 0.512 K kg mol^{-1}

1 atm = 760 mm Hg
= 760 torr

STP = 0.000°C and 1.000 atm

Faraday's constant, $\mathcal{F}$ = 96,500 coulombs per mole of electrons

GO ON TO THE NEXT PAGE

Sig Fig Review

(maybe the first time for some)

Note: this is a how-to, not an explanation (you should also know why all this is done. We can talk later: just ask).

The Rule That Always Applies:
All digits are significant.

Yes, all of them. Everyone. All the trailing zeros, all the leading zeros. All of them. Why is this hard? (See the following)

Except: trailing zeros (the ones after the last non-zero digit) in a whole number w/o a decimal point

And

Except: Leading zeros (the ones before the first non-zero digit) on a decimal less than one.

Multiplying and Dividing

Do the problem just like in math class (except get it right this time).
Round the answer to match the fewest sig figs in the original numbers.

Adding and Subtracting

Do the problem as usual.
Round to match the fewest decimal places in the original numbers.

Special Case

If a calculation involves both mult/div and add/sub, then since you're switching categories, round according to the first part's category, then round a second time at the end according to that part's rule.

Everyone of the problems I work out on the answer sheets follows all this. Make sure you do too.

These are for extra practice. Answers included. Do these until you get them correct w/o having to look at your ion-sheet.

Formulas and Nomenclature

I. Name the following compounds:

1. HCl
2. KOH
3. HgOH
4. KCl
5. $FeCl_3$
6. HNO_3
7. NH_4OH
8. Cu_2O
9. $Al_2(SO_4)_3$
10. N_2O_5
11. NaOH
12. CO_2
13. HF
14. $Pb(OH)_2$
15. NH_4NO_3
16. $NaHCO_3$
17. HgO
18. $Zn(NO_2)_2$
19. H_3PO_4
20. CsOH
21. Li_2O
22. $Ca(OH)_2$
23. $CaBr_2$
24. Fe_2O_3
25. H_2SO_4
26. $FeCO_3$
27. SO_3
28. $Ba(BrO_3)_2$
29. $Al(OH)_3$
30. $HClO_4$
31. $NaC_2H_3O_2$
32. Na_2SO_3
33. H_2CO_3
34. HFO_2
35. NH_4IO_3
36. LiH

(continued)

37. CO
38. $MgBr_2$
39. $SnBr_2$
40. N_2O
41. NH_4F
42. $AsCl_5$
43. $KHCO_3$
44. K_2O
45. Ba_3As_2
46. ZnO
47. $NaClO$
48. SrS
49. $Al(BrO_3)_3$
50. SbF_3
51. $Pd(CN)_2$
52. $ZnSiO_3$
53. $Mg(C_2H_3O_2)_2$
54. $Ca(MnO_4)_2$
55. $Be(NO_3)_2$
56. $NiSeO_4$
57. $RaBr_2$
58. $NaMnO_4$
59. PbI_2
60. CaS
61. Bi_2Te_3
62. $KClO_4$
63. $HgBr_2$
64. $CoSi$
65. P_3N_5
66. $CuSO_3$
67. $FePO_4$
68. $PbTe$
69. $HgNO_3$
70. K_2SiO_3
71. $AgC_2H_3O_2$
72. TeI_4
73. $Zn_3(PO_4)_2$
74. Ag_2S
75. $Cd(HCO_3)_2$
76. ZnF_2

(continued)

77. H_2SO_3
78. $Ba(OH)_2$
79. PbS
80. NaH_2PO_4
81. $NH_4C_2H_3O_2$
82. Ag_3N
83. SiL_4
84. $ZnCO_3$
85. H_3PO_3
86. SnL_4
87. $Pb(NO_3)_2$
88. NaF
89. $KAl(SO_4)_2$
90. KUO_4
91. $SmCl_3$
92. K_2S_5
93. $Fe_3[Fe(CN)_6]_2$
94. $PtCl_2$
95. PtL_4
96. NI_3
97. $MoCl_5$
98. $La(NO_3)_3$
99. Dy_2O_3
100. V_2O_5

II. Write the correct formula for each of the following compounds:

1. sulfuric acid
2. sodium hydroxide
3. sodium bromide
4. barium hydroxide
5. calcium oxide
6. hydrosulfuric acid
7. lithium sulfate
8. carbon monoxide

(continued)

9. manganese dioxide
10. sulfur dioxide
11. iron (II) sulfate
12. hypochlorous acid
13. potassium permanganate
14. silver chloride
15. copper (II) hydroxide
16. ammonium sulfide
17. nickel bromide
18. iron (II) oxide
19. bromic acid
20. ammonium bisulfate
21. mercury (I) sulfate
22. iron (III) oxide
23. magnesium phosphate
24. nickel bicarbonate
25. zinc hydroxide
26. hydriodic acid
27. diphosphorus pentoxide
28. aluminum phosphate
29. hydrogen acetate
30. copper (II) nitrite
31. nitrogen dioxide
32. phosphorus trichloride
33. sodium phosphate
34. potassium carbonate
35. phosphoric acid
36. lead (IV) chloride
37. tin (II) bromide
38. ammonium hydroxide
39. periodic acid
40. iron (II) hydroxide
41. carbon dioxide
42. dinitrogen pentoxide
43. silver oxide
44. aluminum nitride
45. manganese (II) hydroxide
46. ammonium carbonate
47. aluminum oxide
48. antimony pentasulfide

(continued)

49. barium carbonate
50. calcium phosphate
51. cesium carbonate
52. potassium silicate
53. silver chromate
54. magnesium sulfite
55. chromium (III) phosphide
56. cobalt (III) nitrate
57. zinc iodide
58. iron (II) fluoride
59. nickel (II) selenide
60. sodium bisulphate
61. lithium oxide
62. copper (I) carbonate
63. strontium carbonate
64. mercury (I) sulfate
65. potassium dichromate
66. manganese (II) oxide
67. nickel (II) chloride
68. lead (II) acetate
69. mercury (II) nitride
70. lead (II) hydroxide
71. tin (IV) chloride
72. selenium tetrafluoride
73. phosphorus pentabromide
74. mercury (I) iodate
75. iron (III) sulfate
76. nickel (II) sulfate
77. silicon dioxide
78. lithium phosphate
79. potassium antimonide
80. nitric acid
81. magnesium nitride
82. cadmium nitrite
83. zinc acetate
84. hydrogen nitrite
85. strontium hydroxide
86. lead (II) sulfate
87. aluminum bisulphate
88. disodium hydrogen phosphate

(continued)

89. ammonium aluminum sulphate
90. copper (II) sulfate pentahydrate
91. lead (II) nitrate
92. gold (III) chloride
93. tin (II) hydroxide
94. hydrogen carbonate
95. ammonium bromate
96. scandium bromide
97. bromine iodide
98. rubidium carbonate
99. potassium thiosulfate
100. potassium arsenate
101. silver potassium cyanide
102. sodium cyanate
103. permanganic acid
104. osmium tetrachloride
105. lanthanum oxide
106. germanium tetrachloride
107. erbium acetate
108. ytterbium oxide
109. calcium hydride
110. iron (II) ferricyanide

Formulas and Nomenclature: pp. 30–35

Group I.

1. hydrogen chloride or hydrochloric acid
2. potassium hydroxide
3. mercury(I) hydroxide or mercurous hydroxide
4. potassium chloride
5. iron(III) chloride or ferric chloride
6. nitric acid or hydrogen nitrate
7. ammonium hydroxide
8. copper(I) oxide or cuprous oxide
9. aluminum sulfate
10. dinitrogen pentoxide
11. sodium hydroxide
12. carbon dioxide
13. hydrofluoric acid or hydrogen fluoride
14. lead(II) hydroxide or plumbous hydroxide
15. ammonium nitrate
16. sodium bicarbonate or sodium hydrogen carbonate
17. mercury(II) oxide or mercuric oxide
18. zinc nitrite
19. phosphoric acid or hydrogen phosphate
20. cesium hydroxide
21. lithium oxide
22. calcium hydroxide
23. calcium bromide
24. iron(III) oxide or ferric oxide
25. sulfuric acid or hydrogen sulfate
26. iron(II) carbonate or ferrous carbonate
27. sulfur trioxide
28. barium bromate
29. aluminum hydroxide
30. perchloric acid or hydrogen perchlorate
31. sodium acetate
32. sodium sulfite
33. carbonic acid or hydrogen carbonate
34. fluorous acid or hydrogen fluorite
35. ammonium iodate
36. lithium hydride
37. carbon monoxide
38. magnesium bromide
39. tin (IV) bromide or stannic bromide
40. nitrous oxide
41. ammonium fluoride

(continued)

43. potassium bicarbonate
44. potassium oxide
45. barium arsenide
46. zinc oxide
47. sodium hypochlorite
48. strontium sulfide
49. aluminum bromate
50. antimony trifluoride
51. palladium cyanide
52. zinc silicate
53. magnesium acetate
54. calcium permanganate
55. beryllium nitrate
56. nickel selenate
57. radium bromide
58. sodium permanganate
59. lead(II) iodide or plumbous iodide
60. calcium sulfide
61. bismuth telluride
62. potassium perchlorate
63. mercury(II) bromide or mercuric bromide
64. cobalt silicide
65. triphosphorus pentanitride
66. copper(II) sulfite or cupric sulfite
67. iron(III) phosphate or ferric phosphate
68. lead(II) telluride or plumbous telluride
69. mercury(I) nitrate or mercurous nitrate
70. potassium silicate
71. silver acetate
72. tellurium tetraiodide
73. zinc phosphate
74. silver sulfide
75. cadmium bicarbonate
76. zinc fluoride
77. sulfurous acid or hydrogen sulfite
78. barium hydroxide
79. lead(II) sulfide or plumbous sulfide
80. sodium dihydrogen phosphate or monobasic sodium phosphate
81. ammonium acetate
82. silver nitride
83. silicon tetraiodide
84. zinc carbonate
85. phosphorus acid or hydrogen phosphite

(continued)

86. tin(IV) iodide or stannic iodide
87. lead(II) nitrate or plumbous nitrate
88. sodium fluoride
89. potassium aluminum sulfate
90. potassium uranate
91. samarium chloride
92. potassium pentasulfide
93. iron(II) ferricyanide or ferrous ferricyanide
94. platinum(II) chloride or platinous chloride
95. platinum (IV) iodide or platinic iodide
96. nitrogen triiodide
97. molybdenum pentachloride
98. lanthanum nitrate
99. dysprosium oxide
100. vanadium pentoxide

Group II.

1. H_2SO_4
2. NaOH
3. NaBr
4. $Ba(OH)_2$
5. CaO
6. H_2S
7. Li_2SO_4
8. CO
9. MnO_2
10. SO_2
11. $FeSO_4$
12. HClO
13. $KMnO_4$
14. AgCl
15. $Cu(OH)_2$
16. $(NH_4)_2S$
17. $NiBr_2$
18. FeO
19. $HBrO_3$
20. NH_4HSO_4
21. Hg_2SO_4
22. Fe_2O_3
23. $Mg_3(PO_4)_2$
24. $Ni(HCO_3)_2$
25. $Zn(OH)_2$
26. HI
27. P_2O_5
28. $AlPO_4$
29. $HC_2H_3O_2$
30. $Cu(NO_2)_2$
31. NO_2
32. PCl_5
33. Na_3PO_4
34. K_2CO_3
35. H_3PO_4
36. $PbCl_4$
37. $SnBr_2$
38. NH_4OH
39. HIO_4
40. $Fe(OH)_2$
41. CO_2
42. N_2O_5
43. Ag_2O
44. AlN
45. $Mn(OH)_2$
46. $(NH_4)_2CO_3$
47. Al_2O_3
48. Sb_2S_5
49. $BaCO_3$
50. $Ca_3(PO_4)_2$
51. Cs_2CO_3
52. K_2SiO_3
53. Ag_2CrO_4
54. $MgSO_3$
55. CrP
56. $Co(NO_3)_2$
57. ZnI_2
58. FeF_2
59. NiSe
60. $NaHSO_4$
61. Li_2O
62. Cu_2CO_3
63. $SrCO_3$
64. Hg_2SO_4
65. $K_2Cr_2O_7$
66. MnO
67. $NiCl_2$
68. $Pb(C_2H_3O_2)_2$
69. Hg_3N_2
70. $Pb(OH)_2$
71. $SnCl_4$
72. SeF_4
73. PBr_5
74. $HgIO_3$
75. $Fe_2(SO_4)_3$
76. $NiSO_4$
77. SiO_2
78. Li_3PO_4
79. K_3Sb
80. HNO_3
81. Mg_3N_2
82. $Cd(NO_2)_2$
83. $Zn(C_2H_3O_2)_2$
84. HNO_2
85. $Sr(OH)_2$
86. $PbSO_4$
87. $Al(HSO_4)_3$
88. Na_2HPO_4
89. $NH_4Al(SO_4)_2$
90. $CuSO_4 \cdot 5H_2O$
91. $Pb(NO_3)_2$
92. $AuCl_3$
93. $Sn(OH)_2$
94. H_2CO_3
95. NH_4BrO_3
96. $ScBr_3$
97. BrI
98. Rb_2CO_3
99. $K_2S_2O_3$
100. K_3AsO_4

(continued)

101. $KAg(CN)_2$
102. $NaCNO$
103. $HMnO_4$
104. $OsCl_4$
105. La_2O_3
106. $GeCl_4$
107. $Er(C_2H_3O_2)_3$
108. Yb_2O_3
109. CaH_2
110. $Fe_3[Fe(CN)_6]_2$

Equations: pp. 36–44

1. $Fe + S \rightarrow FeS$
2. $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
3. $AgNO_3 + NaBr \rightarrow NaNO_3 + AgBr$
4. $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2\uparrow$
5. $2H_2O \rightleftharpoons 2H_2 + O_2\uparrow$
6. $2HgO \xrightarrow{\Delta} 2Hg + O_2\uparrow$
7. $2KI + Pb(NO_3)_2 \rightarrow PbI_2 + 2KNO_3$
8. $4Al + 3O_2 \rightarrow 2Al_2O_3$
9. $MgCl_2 + 2NH_4NO_3 \rightarrow Mg(NO_3)_2 + 2NH_4Cl$
10. $FeCl_3 + 3NH_4OH \rightarrow Fe(OH)_3 + 3NH_4Cl$
11. $2Na_2O_2 + 2H_2O \rightarrow 4NaOH + O_2\uparrow$
12. $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO\uparrow$
13. $2Fe + 3H_2O \rightarrow 3H_2\uparrow + Fe_2O_3$
14. $FeCl_3 + 3KOH \rightarrow 3KCl + Fe(OH)_3$
15. $2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2\uparrow$
16. $Na_2CO_3 + Ca(OH)_2 \rightarrow 2NaOH + CaCO_3$
17. $CO_2 + H_2O \rightarrow H_2CO_3$
18. $4P + 5O_2 \rightarrow 2P_2O_5$
19. $2Na + 2HOH \rightarrow 2NaOH + H_2\uparrow$
20. $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2\uparrow$
21. $Al_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow 2Al(OH)_3 + 3CaSO_4$
22. $CaO + H_2O \rightarrow Ca(OH)_2$
23. $Fe + 2CuNO_3 \rightarrow Fe(NO_3)_2 + 2Cu$
24. $FeS + 2HCl \rightarrow H_2S\uparrow + FeCl_2$
25. $K_2O + H_2O \rightarrow 2KOH$
26. $(NH_4)_2S + Pb(NO_3)_2 \rightarrow 2NH_4NO_3 + PbS$
27. $3Hg(OH)_2 + 2H_3PO_4 \rightarrow Hg_3(PO_4)_2 + 6H_2O$
28. $3KOH + H_3PO_4 \rightarrow K_3PO_4 + 3H_2O$
29. $CaCl_2 + 2\,HNO_3 \rightarrow Ca(NO_3)_2 + 2\,HCl$
30. $K_2CO_3 + BaCl_2 \rightarrow 2KCl + BaCO_3$
31. $Mg(OH)_2 + H_2SO_4 \rightarrow MgSO_4 + 2H_2O$
32. $SO_2 + H_2O \rightarrow H_2SO_3$
33. $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2\uparrow$
34. $Mg + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2\uparrow$
35. $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$
36. $2K_3PO_4 + 3MgCl_2 \rightarrow Mg_3(PO_4)_2 + 6KCl$
37. $4NH_3 + 3O_2 \rightarrow 2N_2\uparrow + 6H_2O$

(continued)