Florida Teacher Certification Examinations

Test Information Guide

for

Chemistry 6–12

FLORIDA DEPARTMENT OF EDUCATION
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Third Edition

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Contents

Test and Test Information Guide Development

Teacher Certification Testing

Since 1980, Florida teacher certification candidates have been required to pass the Florida Teacher Certification Examinations (FTCE), which has consisted of tests in reading, writing, mathematics, and professional knowledge. The 1986 Florida Legislature modified the testing program by also requiring teacher candidates to pass a test in the subject area in which they wish to be certified. In addition, the Legislature substituted the Florida College-Level Academic Skills Test (CLAST) for the reading, writing, and mathematics portions of the FTCE. The 2000 Florida Legislature replaced the CLAST with the General Knowledge Test, effective July 1, 2002.

The subject area knowledge tested on the Chemistry 6–12 examination was identified and validated by committees of content specialists from within the state of Florida. Committee members included public school teachers, district supervisors, and college faculty with expertise in this field. Committee members were selected on the basis of recommendations by district superintendents, public school principals, deans of education, experts in the field, and other organizations. In developing the test, the committees used an extensive literature review, interviews with selected public school teachers, a large-scale survey of teachers, pilot tests, and their own professional judgment.

Role of the Test Information Guide

The purpose of this test information guide is to help candidates taking the subject area test in Chemistry 6–12 prepare effectively for the examination. The guide was designed to familiarize prospective test takers with various aspects of the examination, including the content that is covered and the way it is represented. The guide should enable candidates to direct their study and to focus on relevant material for review.

This test information guide is intended primarily for use by certification candidates, who may be students in a college or university teacher-preparation program, teachers with provisional certification, teachers seeking certification in an additional subject area, or persons making a career change to public school teaching. Candidates may have studied and worked in Florida or may be from out of state.

College or university faculty may also use the guide to prepare students for certification, and inservice trainers may find the guide useful for helping previously certified teachers prepare for recertification or multiple certification.

This test information guide is not intended as an all-inclusive source of subject area knowledge, nor is it a substitute for college course work in the subject area. The sample questions are representative of the content of the actual test; however, they are not actual test questions from an actual test form. Instead, the guide is intended to help candidates prepare for the subject area test by presenting an overview of the content and format of the examination.

2 Preparation for the Test

The following outline may help you to prepare for the examination. Adapt these suggestions to suit your own study habits and the time you have available for review.

Overview

- **Look over the organization of the test information guide.**

  Section 1 discusses the development of the test and test information guide.
  Section 2 (this section) outlines test preparation steps.
  Section 3 offers strategies for taking the test.
  Section 4 presents information about the content and structure of the test.
  Section 5 lists question formats and includes sample test questions.
  Section 6 provides an annotated bibliography of general references you may find useful in your review.
  Section 7 identifies a source of further information.

Self-Assessment

- **Decide which content areas you should review.**

  Section 4 includes the competencies and skills used to develop this subject area test and the approximate proportion of test questions from each competency area.

Review

- **Study according to your needs.**

  Review all of the competencies and concentrate on areas with which you are least familiar.

Practice

- **Acquaint yourself with the format of the examination.**

  Section 5 describes types of questions you may find on the examination.

- **Answer sample test questions.**

  Section 5 gives you an opportunity to test yourself with sample test questions and provides an answer key and information regarding the competency to which each question is linked.

Final preparation

- **Review test-taking advice.**

  Section 3 includes suggestions for improving your performance on the examination.

- **Refer to field-specific references.**

  Section 6 includes an annotated bibliography listing general references keyed to the competencies and skills used to develop this subject area test.

3 Test-Taking Advice

- Go into the examination prepared, alert, and well rested.
- Complete your travel arrangements prior to the examination date. Plan to arrive early so that you can locate the parking facilities and examination room without rushing.
- Dress comfortably and bring a sweater or jacket in case the room is too cool.
- Take the following with you to the test site:
  - — Admission ticket
  - — Proper identification as described in "Identification Policy"
  - — Watch
- There are many strategies for taking a test and different techniques for dealing with different types of questions. Nevertheless, you may find the following general suggestions useful.
  - — Read each question and all the response options carefully before selecting your answer. Pay attention to all of the details.
  - — Go through the entire test once and answer all the questions you are reasonably certain about. Then go back and tackle the questions that require more thought.
  - — When you are not certain of the right answer, eliminate as many options as you can and choose the response that seems best. It is to your advantage to answer all the questions on the test, even if you are uncertain about some of your choices.
  - — After completing the examination, go back and check every question. Verify that you have answered all of the questions and that your responses are correctly entered.

4 Competencies and Skills and Test Blueprint

The table on the following pages lists the competencies and skills used as the basis for the Chemistry 6–12 examination. These competencies and skills represent the knowledge that teams of teachers, subject area specialists, and district-level educators have determined to be important for beginning teachers. This table could serve as a checklist for assessing your familiarity with each of the areas covered by the test. The competencies and skills should help you organize your review. The test blueprint indicates the approximate percentage of test questions that will cover the specific competency on the exam.

Competencies are broad areas of content knowledge.

Skills identify specific behaviors that demonstrate the competencies.

Percentages indicate the approximate proportion of test questions that represent the competencies on the test.

The following excerpt illustrates the components of the table.

Competency

Approximate percentage of total test questions (test blueprint)

Competency/Skill		Approx. %
1	**Knowledge of the nature of matter**	**10%**
1	Differentiate between pure substances, homogeneous mixtures, and heterogeneous mixtures.	
2	Determine the effects of changes in temperature, volume, pressure, or quantity on an ideal gas.	
3	Apply units of mass, volume, and moles to determine concentrations and dilutions of solutions.	
4	Analyze the effects of physical variables (e.g., pressure, temperature) on solubility and the dissolving process.	
5	Analyze problems relating colligative properties to molar mass and solution concentrations.	
6	Analyze the effects of forces between chemical species on physical properties (e.g., melting point, boiling point, vapor pressure, solubility, conductivity) of matter.	
7	Solve problems involving an intensive property (e.g., density, specific heat) of matter.	
8	Differentiate between various physical methods (e.g., chromatography, distillation, filtration) for separating the components of mixtures.	
9	Identify the unique physical and chemical properties of water.	
10	Differentiate between physical and chemical properties and physical and chemical changes of matter.	

Skills (1-10)

Table of Competencies, Skills, and Approximate Percentages of Questions

Competency/Skill		Approx. %
1	**Knowledge of the nature of matter**	**10%**
1	Differentiate between pure substances, homogeneous mixtures, and heterogeneous mixtures.	
2	Determine the effects of changes in temperature, volume, pressure, or quantity on an ideal gas.	
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8	Differentiate between various physical methods (e.g., chromatography, distillation, filtration) for separating the components of mixtures.	
9	Identify the unique physical and chemical properties of water.	
10	Differentiate between physical and chemical properties and physical and chemical changes of matter.	
2	**Knowledge of energy and its interaction with matter**	**14%**
1	Distinguish between different forms of energy (e.g., thermal, electrical, nuclear).	
2	Relate temperature and heat to the motion of particles (e.g., atoms, molecules) using the kinetic molecular theory.	
3	Interpret a phase diagram of a pure substance.	
4	Interpret a heating and cooling curve of a substance.	
5	Calculate thermal changes associated with chemical reactions, such as heats of reaction, heats of formation, and heats of combustion, from thermochemical data.	
6	Analyze entropy changes during solution formation, phase changes, and chemical reactions.	

Competency/Skill		**Approx. %**
7	Predict spontaneity of a chemical process given either initial and final values of Gibbs free energy or temperature, enthalpy, and entropy.	
8	Relate regions of the electromagnetic spectrum to the energy, wavelength, and frequency of photons.	
9	Identify the effects of various types of electromagnetic radiation (e.g., ultraviolet, infrared) on the chemical or physical properties of matter.	
10	Recognize that energy can be transformed from one form to others and that the total energy in a closed system is conserved.	
11	Distinguish between the characteristics of endothermic and exothermic reactions.	
3	**Knowledge of bonding and molecular structure**	**18%**
1	Identify the basic theory and applications of spectroscopy (e.g., infrared, mass spectrometry, nuclear magnetic resonance, ultraviolet, x-ray).	
2	Identify types or examples of bonds (e.g., metallic, ionic, polar covalent, nonpolar covalent).	
3	Relate electronegativity differences to bond type.	
4	Identify properties of simple organic compounds.	
5	Given the structural formula for a simple covalent compound, identify the hybridization of the atoms.	
6	Identify sigma and pi bonds in a molecule.	
7	Interpret the information derived from the following models: Lewis electron dot structures, valence shell electron pair repulsion (VSEPR) theory, and molecular orbital (M/O) theory involving diatomic molecules.	
8	Select the most probable Lewis electron dot structure for an ionic or covalent formula (e.g., CO_2, Na_2CO_3) that follows the octet rule.	
9	Predict the geometry (e.g., bent, linear, tetrahedral, trigonal bipyramidal) of simple molecules.	
10	Predict the polarity of simple molecules.	
11	Predict physical or chemical properties based on the type of bonding involved.	
12	Identify the formula for an inorganic chemical compound (e.g., ionic, molecular, acid), given its name.	
13	Identify the name of an inorganic chemical compound (e.g., ionic, molecular, acid), given its formula.	

Competency/Skill		**Approx. %**
14	Identify proper names and formulas for simple organic compounds containing one functional group.	
15	Identify common functional groups in an organic molecule.	
16	Differentiate between the chemical structures of common biochemical compounds (e.g., lipids, amino acids, peptides, sugars, carbohydrates, nucleic acids).	
4	**Knowledge of chemical reactions and stoichiometry**	**21%**
1	Balance chemical equations.	
2	Given common chemical reactants and reaction conditions, predict probable products.	
3	Solve mass-mass stoichiometry problems.	
4	Solve mass-gas volume stoichiometry problems.	
5	Solve solution stoichiometry problems.	
6	Solve stoichiometry problems with limiting reactants.	
7	Determine empirical and molecular formulas from experimental data.	
8	Analyze the effects of concentration, temperature, pressure, surface area, and the presence or absence of catalysts on reaction rate.	
9	Predict the effect of a change in concentration, temperature, or pressure on the state of a system initially at equilibrium by applying Le Châtelier's principle.	
10	Determine rate laws from concentrations, rate data, or graphs.	
11	Determine either the equilibrium constant, *K*, or the concentration of a reaction species at equilibrium.	
12	Identify the characteristics of a chemical system in dynamic equilibrium.	
13	Identify major characteristics of strong and weak acids or bases.	
14	Evaluate the characteristics of buffer systems.	
15	Interpret graphical and numerical titration data.	
16	Identify oxidation-reduction processes.	
17	Balance redox equations in acidic or basic solutions.	
18	Determine the spontaneity of a chemical reaction using standard reduction potentials.	
19	Identify the characteristics of combustion reactions of simple organic compounds (e.g., sugars, alcohols, simple fossil fuels).	
20	Solve problems related to pH or pOH of strong acids or bases.	

Competency/Skill		Approx. %
21	Analyze electrolytic and voltaic cells.	
22	Given a balanced chemical equation, identify the common reaction type.	
5	**Knowledge of atomic theory and structure**	**12%**
1	Using the periodic table, determine the number of protons, neutrons, and electrons in an atom or ion of a specific isotope.	
2	Using the periodic table, analyze periodic trends in physical properties (e.g., ionic size, atomic size, boiling point, melting point) of the representative elements.	
3	Using the periodic table, analyze periodic trends in chemical properties (e.g., electron affinity, ionization energy, electronegativity) of the representative elements.	
4	Using the periodic table, determine electron configurations and orbital filling diagrams for elements with atomic numbers 1–56 and their ions.	
5	Relate an element's chemical reactivity to its valence-shell electron configuration.	
6	Identify the major characteristics of waves and particles, as well as the dual nature of matter.	
7	Identify characteristics of unstable nuclei, including the particles and electromagnetic radiation they emit.	
8	Given measurable quantities, solve problems involving radioactive decay.	
9	Balance simple nuclear equations.	
10	Identify the main characteristics of nuclear fission and fusion.	
11	Identify electron density distribution diagrams and characteristics for *s*, *p*, and *d* orbitals (e.g., nodes, shapes).	
12	Predict the effects of energy quantization at the atomic level.	
6	**Knowledge of the nature of science**	**10%**
1	Identify the characteristics and components of scientific inquiry and how it differs from other areas of learning.	
2	Analyze the characteristics (e.g., independent, dependent, and controlled variables; bias; control groups) of a given experimental design.	
3	Interpret empirical and graphical data to draw valid conclusions.	
4	Analyze the relationship of experimental observations to experimental design, including underlying assumptions, hypotheses, conclusions, models, or theories.	

Competency/Skill		Approx. %
5	Differentiate between the uses of qualitative and quantitative data.	
6	Identify how the progressive development of basic science affects applied science, technology, the economy, and society.	
7	Identify evidence of the progressive historical development of science.	
7	**Knowledge of measurement**	**10%**
1	Convert between units for one-, two-, and three-dimensional quantities.	
2	Determine the units of a given mathematical expression.	
3	Apply prefixes (e.g., *kilo-*, *milli-*, *nano-*) used in scientific measurements.	
4	Distinguish between accuracy and precision and between systematic and random error.	
5	Apply the correct number of significant figures in measurements or calculations.	
6	Relate the Celsius, Fahrenheit, and Kelvin temperature scales, including the boiling point and melting point of water.	
7	Use scientific notation (e.g., convert between decimal and scientific notation, perform mathematical calculations with numbers written in scientific notation).	
8	Solve a multistep problem involving dimensional analysis (e.g., kinetics, solution preparation, thermochemistry).	
8	**Knowledge of appropriate laboratory use and procedures**	**5%**
1	Identify appropriate chemistry laboratory procedures for the safe storage, use, and disposal of materials and equipment.	
2	Choose the correct laboratory equipment for a particular procedure.	
3	Identify emergency procedures and safety equipment needed in the chemistry laboratory and classroom.	
4	Identify the areas of teacher liability and responsibility in chemistry-related activities.	
5	Relate knowledge of pertinent guidelines (e.g., from American Chemical Society, Environmental Protection Agency, material safety data sheets, National Science Teachers Association, Americans with Disabilities Act) to laboratory safety, hazardous materials, experimentation, and accommodations for students with special needs.	

5 Test Format and Sample Questions

The Chemistry 6–12 subject area test consists of approximately 100 multiple-choice questions. You will have two and one-half hours to complete the test.

Each question will contain four response options, and you will indicate your answer by selecting **A**, **B**, **C**, or **D**.

Calculators are permitted on the Chemistry 6–12 test. The test center will provide scientific calculators. Candidates may not bring a calculator.

The table below presents types of questions on the examination and refers you to a sample question of each type.

Type of Question	Sample Question
Direct question Choose the response option that best answers the question.	Question 1, page 18
Graphics Examine a question involving a number line, a geometric figure, graphs of lines or curves, a table, or a chart, and select the best response option.	Question 6, page 19
Sentence completion Select the response option that best completes the sentence.	Question 19, page 22
Scenario Examine a situation, problem, or case study. Then answer a question, make a diagnosis, or recommend a course of action by selecting the best response option.	Question 23, page 23
Command Select the best response option.	Question 27, page 24

Sample Questions

The following questions represent both the form and content of questions on the examination. These questions will acquaint you with the general format of the examination; however, these sample questions do not cover all of the competencies and skills that are tested and will only approximate the degree of examination difficulty.

An answer key follows at the end of the sample questions. The answer key includes information regarding the competency to which each question is linked.

CHEMISTRY 6-12 REFERENCE SHEET

Periodic Table of the Elements

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12	Group 13	Group 14	Group 15	Group 16	Group 17	Group 18
1 **H** 1.01																	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.04											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
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** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.7	29 **Cu** 63.54	30 **Zn** 65.37	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.91	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** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	†57-71 **lanthanoids**	72 **Hf** 178.5	73 **Ta** 181.0	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (210)	85 **At** (218)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	††89-103 **actinoids**	104 **Rf** (261)	105 **Ha** (262)	106 **Sg** (266)	107 **Bh** (264)	108 **Hs** (277)	109 **Mt** (268)	110 **Ds** (271)	111 **Rg** (272)							

†57 **La** 138.9	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (147)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
††89 **Ac** (227)	90 **Th** (232)	91 **Pa** (231)	92 **U** (238)	93 **Np** (239)	94 **Pu** (239)	95 **Am** (243)	96 **Cm** (245)	97 **Bk** (247)	98 **Cf** (249)	99 **Es** (254)	100 **Fm** (253)	101 **Md** (255)	102 **No** (255)	103 **Lr** (257)

Atomic mass values given are averaged over isotopes in percentages that occur in nature.
For an unstable element, mass number of the most stable known isotope is given in parentheses.

CONSTANTS

Gas constant, $R = 0.0821\ L \cdot atm \cdot mol^{-1}\ K^{-1} = 8.314\ J \cdot mol^{-1} \cdot K^{-1}$

$= 8.31\ volt \cdot coulomb \cdot mol^{-1} \cdot K^{-1} = 62.4\ L \cdot torr \cdot mol^{-1} \cdot K^{-1}$

$= 8.31\ L \cdot kPa \cdot mol^{-1} \cdot K^{-1}$

Speed of light, $c = 3.00 \times 10^{8}\ m \cdot s^{-1}$

1 atm = 760 mm Hg = 760 torr = 101 kPa

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

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

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

1 faraday $= 9.65 \times 10^{4}$ coulomb $\cdot mol^{-1}$

1 calorie (cal) = 4.184 J (exact)
1 Cal = 1 kcal

CHEMISTRY 6–12 REFERENCE SHEET

Molal Freezing-Point and Boiling-Point Constants

Solvent	Normal f.p. (°C)	Molal f.p. Constant, K_f (°C/molal)	Normal b.p. (°C)	Molal b.p. Constant, Kb (°C/molal)
acetic acid	16.1	3.90	118.5	3.07
acetone	-94.8	--	56.00	1.71
aniline	-6.1	5.87	184.4	3.22
benzene	5.48	5.12	80.15	2.53
carbon disulfide	-111.5	3.80	46.3	2.34
carbon tetrachloride	-22.96	--	76.50	5.03
ethanol	-114.5	--	78.26	1.22
ether	-116.3	1.79	34.42	2.02
naphthalene	80.2	6.9	218.0	5.65
phenol	40.9	7.27	181.8	3.56
water	0.00	1.86	100.0	0.51

Heats of Formation (kJ/mol) at 25°C and 1 atm

$AgBr_{(s)}$	-99.5	$C_2H_{2(g)}$	+226.7	$H_2O_{(\ell)}$	-285.8	$NH_4Cl_{(s)}$	-315.4
$AgCl_{(s)}$	-127.0	$C_2H_{4(g)}$	+52.3	$H_2O_{2(\ell)}$	-187.6	$NH_4NO_{3(s)}$	-365.1
$AgI_{(s)}$	-62.4	$C_2H_{6(g)}$	-84.7	$H_2S_{(g)}$	-20.1	$NO_{(g)}$	+90.4
$Ag_2O_{(s)}$	-30.6	$C_3H_{8(g)}$	-103.8	$H_2SO_{4(\ell)}$	-811.3	$NO_{2(g)}$	+33.9
$Ag_2S_{(s)}$	-31.8	$n\text{-}C_4H_{10(g)}$	-124.7	$HgO_{(s)}$	-90.7	$NiO_{(s)}$	-244.3
$Al_2O_{3(s)}$	-1669.8	$n\text{-}C_5H_{12(\ell)}$	-173.1	$HgS_{(s)}$	-58.2	$PbBr_{2(s)}$	-277.0
$BaCl_{2(s)}$	-860.1	$C_2H_5OH_{(\ell)}$	-277.6	$KBr_{(s)}$	-392.2	$PbCl_{2(s)}$	-359.2
$BaCO_{3(s)}$	-1218.8	$CoO_{(s)}$	-239.3	$KCl_{(s)}$	-435.9	$PbO_{(s)}$	-217.9
$BaO_{(s)}$	-558.1	$Cr_2O_{3(s)}$	-1128.4	$KClO_{3(s)}$	-391.4	$PbO_{2(s)}$	-276.6
$BaSO_{4(s)}$	-1465.2	$CuO_{(s)}$	-155.2	$KF_{(s)}$	-562.6	$Pb_3O_{4(s)}$	-734.7
$CaCl_{2(s)}$	-795.0	$Cu_2O_{(s)}$	-166.7	$MgCl_{2(s)}$	-641.8	$PCl_{3(g)}$	-306.4
$CaCO_{3(s)}$	-1207.0	$CuS_{(s)}$	-48.5	$MgCO_{3(s)}$	-1113.0	$PCl_{5(g)}$	-398.9
$CaO_{(s)}$	-635.5	$CuSO_{4(s)}$	-769.9	$MgO_{(s)}$	-601.8	$SiO_{2(s)}$	-859.4
$Ca(OH)_{2(s)}$	-986.6	$Fe_2O_{3(s)}$	-822.2	$Mg(OH)_{2(s)}$	-924.7	$SnCl_{2(s)}$	-349.8
$CaSO_{4(s)}$	-1432.7	$Fe_3O_{4(s)}$	-1120.9	$MgSO_{4(s)}$	-1278.2	$SnCl_{4(\ell)}$	-545.2
$CCl_{4(\ell)}$	-139.5	$HBr_{(g)}$	-36.2	$MnO_{(s)}$	-384.9	$SnO_{(s)}$	-286.2
$CH_{4(g)}$	-74.8	$HCl_{(g)}$	-92.3	$MnO_{2(s)}$	-519.7	$SnO_{2(s)}$	-580.7
$CHCl_{3(\ell)}$	-131.8	$HF_{(g)}$	-268.6	$NaCl_{(s)}$	-411.0	$SO_{2(g)}$	-296.1
$CH_3OH_{(\ell)}$	-238.6	$HI_{(g)}$	+25.9	$NaF_{(s)}$	-569.0	$SO_{3(g)}$	-395.2
$CO_{(g)}$	-110.5	$HNO_{3(\ell)}$	-173.2	$NaOH_{(s)}$	-426.7	$ZnO_{(s)}$	-348.0
$CO_{2(g)}$	-393.5	$H_2O_{(g)}$	-241.8	$NH_{3(g)}$	-46.2	$ZnS_{(s)}$	-202.9

Vapor Pressure (mmHg) of Water at Various Temperatures (°C)

Temp	Pressure	Temp	Pressure	Temp	Pressure	Temp	Pressure
0	4.6	18	15.5	28	28.3	70	233.7
5	6.5	19	16.5	29	30.0	75	289.1
10	9.2	20	17.5	30	31.8	80	355.1
11	9.8	21	18.7	35	42.2	85	433.6
12	10.5	22	19.8	40	55.3	90	525.8
13	11.2	23	21.1	45	71.9	95	633.9
14	12.0	24	22.4	50	92.5	100	760.0
15	12.8	25	23.8	55	118.0	105	906.
16	13.6	26	25.2	60	149.4		
17	14.5	27	26.7	65	187.5		

CHEMISTRY 6–12 REFERENCE SHEET

Standard Reduction Potentials in Aqueous Solutions	Standard Potential, E°(V)
$F_{2(g)} + 2\ e^- \rightleftarrows 2\ F^-_{(aq)}$	2.87
$S_2O_8^{2-}{}_{(aq)} + 2\ e^- \rightleftarrows 2\ SO_4^{2-}{}_{(aq)}$	2.01
$H_2O_{2(aq)} + 2\ H^+_{(aq)} + 2\ e^- \rightleftarrows 2\ H_2O_{(l)}$	1.78
$MnO_4^-{}_{(aq)} + 8\ H^+_{(aq)} + 5\ e^- \rightleftarrows Mn^{2+}_{(aq)} + 4\ H_2O_{(l)}$	1.49
$Cl_{2(g)} + 2\ e^- \rightleftarrows 2\ Cl^-_{(aq)}$	1.36
$Cr_2O_7^{2-}{}_{(aq)} + 14\ H^+_{(aq)} + 6\ e^- \rightleftarrows 2\ Cr^{3+}_{(aq)} + 7\ H_2O_{(l)}$	1.33
$O_{2(g)} + 4\ H^+_{(aq)} + 4\ e^- \rightleftarrows 2\ H_2O_{(l)}$	1.23
$Br_{2(l)} + 2\ e^- \rightleftarrows 2\ Br^-_{(aq)}$	1.09
$NO_3^-{}_{(aq)} + 4\ H^+_{(aq)} + 3\ e^- \rightleftarrows NO_{(g)} + 2\ H_2O_{(l)}$	0.96
$2\ Hg^{2+}_{(aq)} + 2\ e^- \rightleftarrows Hg_2^{2+}{}_{(aq)}$	0.90
$ClO^-_{(aq)} + H_2O_{(l)} + 2\ e^- \rightleftarrows Cl^-_{(aq)} + 2\ OH^-_{(aq)}$	0.81
$Hg^{2+}_{(aq)} + 2\ e^- \rightleftarrows Hg_{(l)}$	0.85
$Ag^+_{(aq)} + e^- \rightleftarrows Ag_{(s)}$	0.80
$Hg_2^{2+}{}_{(aq)} + 2\ e^- \rightleftarrows 2\ Hg_{(l)}$	0.80
$Fe^{3+}_{(aq)} + e^- \rightleftarrows Fe^{2+}_{(aq)}$	0.77
$O_{2(g)} + 2\ H^+_{(aq)} + 2\ e^- \rightleftarrows H_2O_{2(aq)}$	0.70
$I_{2(s)} + 2\ e^- \rightleftarrows 2\ I^-_{(aq)}$	0.54
$Cu^+_{(aq)} + e^- \rightleftarrows Cu_{(s)}$	0.52
$IO^-_{(aq)} + H_2O_{(l)} + 2\ e^- \rightleftarrows I^-_{(aq)} + 2\ OH^-_{(aq)}$	0.49
$Cu^{2+}_{(aq)} + 2\ e^- \rightleftarrows Cu_{(s)}$	0.34
$Cu^{2+}_{(aq)} + e^- \rightleftarrows Cu^+_{(aq)}$	0.15
$Sn^{4+}_{(aq)} + 2\ e^- \rightleftarrows Sn^{2+}_{(aq)}$	0.15
$2\ H^+_{(aq)} + 2\ e^- \rightleftarrows H_{2(g)}$	0.00
$Fe^{3+}_{(aq)} + 3\ e^- \rightleftarrows Fe_{(s)}$	–0.04
$Pb^{2+}_{(aq)} + 2\ e^- \rightleftarrows Pb_{(s)}$	–0.13
$Sn^{2+}_{(aq)} + 2\ e^- \rightleftarrows Sn_{(s)}$	–0.14
$Ni^{2+}_{(aq)} + 2\ e^- \rightleftarrows Ni_{(s)}$	–0.26
$PbSO_{4(s)} + 2\ e^- \rightleftarrows Pb_{(s)} + SO_4^{2-}{}_{(aq)}$	–0.36
$Cd^{2+}_{(aq)} + 2\ e^- \rightleftarrows Cd_{(s)}$	–0.40
$Fe^{2+}_{(aq)} + 2\ e^- \rightleftarrows Fe_{(s)}$	–0.45
$Cr^{3+}_{(aq)} + 3\ e^- \rightleftarrows Cr_{(s)}$	–0.74
$Zn^{2+}_{(aq)} + 2\ e^- \rightleftarrows Zn_{(s)}$	–0.76
$2\ H_2O_{(l)} + 2\ e^- \rightleftarrows H_{2(g)} + 2\ OH^-_{(aq)}$	–0.83
$Mn^{2+}_{(aq)} + 2\ e^- \rightleftarrows Mn_{(s)}$	–1.19
$Al^{3+}_{(aq)} + 3\ e^- \rightleftarrows Al_{(s)}$	–1.66
$Mg^{2+}_{(aq)} + 2\ e^- \rightleftarrows Mg_{(s)}$	–2.37
$Na^+_{(aq)} + e^- \rightleftarrows Na_{(s)}$	–2.71
$Li^+_{(aq)} + e^- \rightleftarrows Li_{(s)}$	–3.04

DIRECTIONS: Read each question and select the best response.

1. Which of the following is an example of a pure substance?
   A. solid concrete
   B. ocean water
   C. liquid mercury
   D. Earth's atmosphere

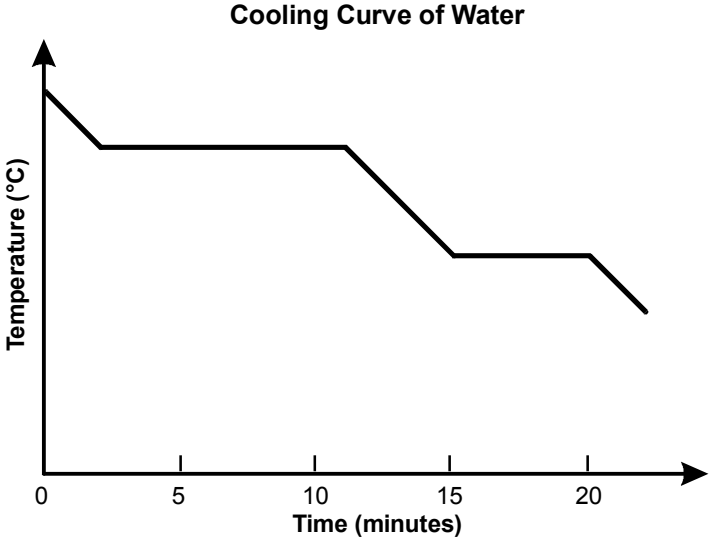
2. How many milliliters of 18 *M* sulfuric acid (H_2SO_4) must be added to water in order to make a total volume of 250 mL of 0.20 *M* H_2SO_4?
   A. 28.0 mL
   B. 5.6 mL
   C. 2.8 mL
   D. 1.4 mL

3. A teacher wishes to demonstrate crystallization of sodium acetate. Which of the following procedures would allow the teacher to accomplish this?
   A. Prepare a dilute solution of sodium acetate in cold water and then allow it to warm to room temperature. Adding more water will cause crystallization.
   B. Prepare a dilute sodium acetate solution at room temperature and then heat it. Crystallization will start when the solution begins to boil.
   C. Prepare a concentrated sodium acetate solution in hot water and then allow it to cool. Adding a grain of sodium acetate will initiate crystallization.
   D. Prepare a concentrated solution of sodium acetate at room temperature and then cool the solution. Crystallization will begin when the solution reaches 0°C.

4. The density of hydrogen sulfide gas (H_2S) at STP is
   A. 0.94 g/L.
   B. 1.52 g/L.
   C. 2.16 g/L.
   D. 2.79 g/L.

5. A sealed tube contains 1.0 mole of neon gas. When the temperature of the sample is increased, the pressure also increases. In terms of kinetic molecular theory, which of the following most appropriately explains this change?
   A. A chemical decomposition reaction has occurred.
   B. Ideal gas molecules exert no attraction to one another.
   C. The atoms of neon are considered to be point masses.
   D. Particles collide more frequently with the container walls.

6. Given the following cooling curve for a closed container of H_2O placed in a thermostated cooling bath, what is the most likely initial temperature of the H_2O?



A. 0°C
B. 25°C
C. 100°C
D. 105°C

7. What is the standard free-energy change (ΔG°_{rxn}) for the following reaction at 298K?

$[\Delta G^\circ_f(NH_3) = -16.66 \text{ kJ/mol}]$

$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$

A. –16.66 kJ
B. –17.89 kJ
C. –33.32 kJ
D. –49.65 kJ

8. The production of steam in a nuclear power plant is an example of a transformation from nuclear energy to
   A. chemical energy.
   B. electromagnetic energy.
   C. electrical energy.
   D. thermal energy.

9. An aqueous solution of which of the following is LEAST likely to conduct electricity?
   A. $MgBr_2$
   B. HCl
   C. SO_2
   D. CH_4

10. Molecular orbital theory describes the respective bond orders in H_2 , H_2^+, and H_2^- as
   A. 1, 0, and 0.
   B. 1, 0, and $\frac{1}{2}$.
   C. 1, $\frac{1}{2}$, and $\frac{1}{2}$.
   D. 1, $\frac{1}{2}$, and 0.

11. The correct IUPAC name for $CuSO_4$ is
   A. copper(II) sulfide.
   B. copper(II) sulfite.
   C. copper(II) sulfate.
   D. copper(II) persulfate.

12. Which of the following functional groups causes the greatest increase in the aqueous solubility of an organic compound?
   A. R-COOH
   B. R-OH
   C. R-CHO
   D. R-O-R

13. According to the following equation, what volume of oxygen gas, measured at STP, is theoretically required for the complete combustion of 28.05 g of ethylene (C_2H_4) to produce carbon dioxide and water?

$$C_2H_{4(g)} + 3\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 2\ H_2O_{(g)}$$

A. 11.2 L O_2
B. 22.4 L O_2
C. 33.6 L O_2
D. 67.2 L O_2

14. According to Le Châtelier's principle, what is the effect of a decrease in temperature on the following equilibrium reaction?

$$6\ CO_{2(g)} + 6\ H_2O_{(l)} \rightleftarrows C_6H_{12}O_{6(s)} + 6\ O_{2(g)}; \Delta H^\circ = 2801.69\ \text{kJ/mol}$$

A. The equilibrium shifts to the right.
B. The equilibrium shifts to the left.
C. The equilibrium remains unchanged.
D. The equilibrium shift is unpredictable.

15. What is the conjugate acid of NH_3 in the following reaction?

$$NH_{3(aq)} + H_2O_{(l)} \rightarrow {NH_4}^+_{(aq)} + {OH}^-_{(aq)}$$

A. H_2O
B. H_3O^+
C. NH_4^+
D. OH^-

16. Which half reaction indicates the oxidation process for the following reaction?

$$2\ Al_{(s)} + 3\ Pb(NO_3)_{2(aq)} \rightarrow 3\ Pb_{(s)} + 2\ Al(NO_3)_{3(aq)}$$

A. $Al_{(s)} + 3\ e^- \rightarrow Al^{3+}_{(aq)}$
B. $Al_{(s)} \rightarrow Al^{3+}_{(aq)} + 3\ e^-$
C. $Pb^{2+}_{(aq)} + 2\ e^- \rightarrow Pb_{(s)}$
D. $Pb_{(s)} \rightarrow Pb^{2+}_{(aq)} + 2\ e^-$

17. The given chemical reaction is an example of which class of chemical reactions?

$$Fe_{(s)} + Ni(NO_3)_{2(aq)} \rightarrow Fe(NO_3)_{2(aq)} + Ni_{(s)}$$

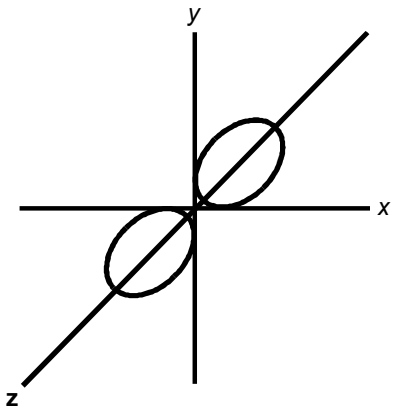
A. single displacement
B. combustion
C. decomposition
D. combination

18. An atom containing 50 protons, 50 electrons, and 69 neutrons has a mass number of
A. 50.
B. 69.
C. 119.
D. 169.

19. A complete octet of valence electrons usually leads to an element that has
A. high stability and high reactivity.
B. low stability and low reactivity.
C. high stability and low reactivity.
D. low stability and high reactivity.

20. The alpha emitter $^{226}_{88}Ra$ has a half-life of 1590 years. How much of a 12 g sample of $^{226}_{88}Ra$ would remain after 1.27×10^4 years?
A. 0.024 g
B. 0.047 g
C. 0.096 g
D. 0.190 g

21. The contour representation depicted in the diagram corresponds to which of the following orbitals?



A. 2s
B. p_z
C. d_{xz}
D. d_z^2

22. A team of researchers performs an experiment and obtains results they did not expect. Which of the following actions would be most appropriate for the researchers to do next?
A. alerting the media about the new discovery and holding a press conference
B. consulting other scientists regarding their opinions on the results
C. redesigning the experiment based on the assumption that it is flawed
D. repeating the experiment and comparing the second results with the first

23. In a solubility experiment, students add various solutes (e.g., salt, sugar) to the same amount of water. The students observe that equal amounts of water dissolve different amounts of solutes. Identify the independent variable in the experiment.
A. amount of solvent present
B. amount of dissolved solute
C. type of solute dissolved
D. type of solvent utilized

24. The discovery in the 1940s that the nuclei of many elements possess an inherent spin is the basis of what modern day technology?
    A. x-ray machine
    B. magnetic resonance imaging
    C. ultrasound device
    D. computerized axial tomography

25. Which of the following is equivalent to 550 nm?
    A. 5.5×10^{-9} m
    B. 5.5×10^{-7} m
    C. 5.5×10^{7} m
    D. 5.5×10^{9} m

26. The expected result from a laboratory activity is 3.50 grams of a substance. Which of the following sets of values shows high precision and low accuracy?
    A. 2.48 g, 2.49 g, 2.50 g
    B. 2.49 g, 1.49 g, 4.49 g
    C. 3.49 g, 3.50 g, 3.48 g
    D. 3.59 g, 2.49 g, 1.49 g

27. Find the density of an object with a mass of 1.50×10^{2} g and a volume of 3.0×10^{1} cm^3.
    A. $D = 5.0 \times 10^{0}$ g/cm^3

    B. $D = 5.0 \times 10^{3}$ g/cm^3

    C. $D = 4.5 \times 10^{1}$ $g \cdot cm^3$

    D. $D = 4.5 \times 10^{3}$ $g \cdot cm^3$

28. A student would like to observe the pigments that make up the ink in a water-soluble black marker. Which of the following techniques is most appropriate for conducting this experiment?
    A. filtration
    B. distillation
    C. chromatography
    D. spectrophotometry

29. School chemical waste disposal procedures are governed by the
    A. ACS Chemical Health and Safety Referral Service.
    B. Flinn Scientific Catalog/Reference Manual.
    C. CRC Handbook of Chemistry and Physics.
    D. U.S. Environmental Protection Agency.

30. Which of the following is a violation of chemistry laboratory safety procedures?
    A. rolling up long sleeves
    B. tying back long hair
    C. using goggles and aprons
    D. wearing open-toed shoes

Answer Key

Question Number	Correct Response	Competency
1.	C	1
2.	C	1
3.	C	1
4.	B	1
5.	D	2
6.	D	2
7.	C	2
8.	D	2
9.	D	3
10.	C	3
11.	C	3
12.	A	3
13.	D	4
14.	B	4
15.	C	4
16.	B	4
17.	A	4
18.	C	5
19.	C	5
20.	B	5
21.	B	5
22.	D	6
23.	C	6
24.	B	6
25.	B	7
26.	A	7
27.	A	7
28.	C	8
29.	D	8
30.	D	8

6 Annotated Bibliography

The annotated bibliography that follows includes basic references that you may find useful in preparing for the exam. Each resource is keyed to the competencies and skills found in Section 4 of this guide.

This bibliography is representative of the most important and most comprehensive texts as reflected in the competencies and skills. The Florida Department of Education does not endorse these references as the only appropriate sources for review; many comparable texts currently used in teacher preparation programs also cover the competencies and skills that are tested on the exam.

1. American Chemical Society. *Chemical safety for teachers and their supervisors grades 7–12*. (2001). Retrieved December 17, 2008, from http://www.portal.acs.org/portal/filefetch/C/CTP_005951/pdf/CTP_005951.pdf

   Provides practical information about safe handling of chemicals, teaching safety to students, and disposal information. Useful for review of competency 8.

2. American Chemical Society. *Chemistry in the community* (5th ed.). (2006). Gordonsville, VA: W. H. Freeman & Co.

   Highlights relevance of chemistry, including nuclear chemistry, to everyday life. Useful for review of competencies 1–8.

3. Brady, J. E., & Senese, F. (2004). *Chemistry: Matter and its changes* (4th ed.). New York: Wiley.

   Provides a mainstream, midlevel introduction to general chemistry. Focuses on problem-solving strategies with an emphasis on development of critical thinking and reasoning skills. Visual summaries provide step-by-step approaches to working out problems. Useful for review of competencies 1–5 and 7.

4. Brown, T. L., LeMay, H. E., Bursten, B. E., & Murphy, C. J. (2008). *Chemistry: The central science* (11th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

   Uses innovative pedagogy, functional problem solving, and visuals to teach concepts and skills. Provides comprehensive, accurate, and current examples and exercises. Useful for review of competencies 1–7.

5. Chang, R. (2009). *Chemistry* (10th ed.). Boston: McGraw-Hill Higher Education.

Balances theory and application by incorporating examples and helping students visualize three-dimensional atomic and molecular structures. Useful for review of competencies 1–7.

6. Davis, R. E., Metcalfe, H. C., Williams, J. E., & Castka, J. E. (2006). *Modern chemistry* (6th ed.). New York: Holt, Rinehart & Winston.

Emphasizes the fundamentals of chemistry and problem solving. Provides a bank of laboratory experiences to develop understanding of scientific inquiry, concepts, and experimentation. Useful for review of competencies 1–8.

7. Dingrando, L., Tallman, K., Hainen, N., & Wistrom, C. (2005). *Chemistry: Matter and change*. New York: Glencoe McGraw-Hill.

Considers multiple learning styles and differentiated instruction. Includes a variety of skill, knowledge, performance, and portfolio assessments correlated to the National Science Education Content Standards. Useful for review of competencies 1–8.

8. Florida Department of Education, Division of K–12 Public Schools, Bureau of Instruction and Innovation, Curriculum Support Section. (n.d.). *Science laboratory safety support information.* Retrieved April 30, 2008, from www.sunshineconnections.org/strategies/Strategies%20Paperwork%20Reduction/Lab%20Safety%20Prep.doc

Intended to help educators and students identify and examine science classrooms and chemical storage areas and make them as safe as possible. Based on State Board of Education Rules, Florida law, and criteria established by members of the Florida Association of Science Supervisors. Useful for review of competency 8.

9. Florida Department of Education, Office of Educational Facilities. (2006). *Chemical hygiene and laboratory safety plan*. Retrieved March 17, 2008, from http://www.fldoe.org/edfacil/sc3/safetyplan.asp

Contains information and policies on laboratory safety in schools. Useful for review of competency 8.

10. Kotz, J. C., Treichel, P. M., & Weaver, G. C. (2006). *Chemistry & chemical reactivity* (6th ed.). Belmont, CA: Thomson Brooks/Cole.

Provides a broad overview of the principles of chemistry and the reactivity of chemical elements and compounds. Emphasizes applications such as the chemical aspects of the world, materials important to the economy, contributions of chemistry to health care, and the role of chemists in protecting the environment. Useful for review of competencies 1–7.

11. National Committee on Science Education Standards and Assessment, National Research Council. (1996). *National Science Education Standards*. Washington, DC: National Academies Press.

Presents an overview of the standards for science content, professional development, assessment, and science teaching. Helpful review of science content standards for new teachers, change-of-career teachers, and practicing teachers. Available online at http://www.nap.edu/openbook.php?record_id=4962. Useful for review of competency 6.

12. National Science Teachers Association. (2007). *NSTA position statement: Liability of science educators for laboratory safety.* Retrieved March 17, 2008, from http://www.nsta.org/about/positions/liability.aspx

Identifies the responsibilities of science teachers, school administrators, district personnel, and school board members for ensuring safety in school science laboratories. Useful for review of competency 8.

13. National Science Teachers Association. (2004). *NSTA position statement: Students with disabilities.* Retrieved December 17, 2008, from http://www.nsta.org/about/positions/disabilities.aspx

Provides strategies to overcome barriers to science learning for students with disabilities. Useful for review of competency 8.

14. Olmsted, J., III, & Williams, G. M. (2006). *Chemistry* (4th ed.). Hoboken, NJ: Wiley.

Focuses on viewing and thinking about the world in terms of chemistry. Emphasizes considering how chemical phenomena are governed by what happens at the molecular level, applying critical thinking skills to chemical concepts and problems, and mastering basic mathematical techniques for quantitative reasoning. Useful for review of competencies 1–7.

15. Olson, S., & Loucks-Horsley, S. (Eds.) (2000). *Inquiry and the National Science Education Standards: A guide for teaching and learning*. Washington, DC: National Academies Press.

Focuses on an in-depth examination of the characteristics of scientific inquiry and inquiry teaching at all grades. Useful for review of competency 6.

16. Silberberg, M. (2008). *Chemistry: The molecular nature of matter and change* (3rd ed.). Boston: McGraw-Hill.

Contains macroscopic to microscopic molecular illustrations, step-by-step exercises, and sample problems that provide connections to disciplines such as engineering, medicine, materials, and environmental studies. Useful for review of competencies 1–7.

17. Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2004). *Fundamentals of analytical chemistry* (8th ed.). Belmont, CA: Thomson Brooks/Cole.

Introduces the principles and practices of quantitative chemistry. Assumes knowledge of general chemistry. Useful for in-depth review of competencies 1, 4, 6, and 7.

18. Texley, J., Terry, K., & Summers, J. (2004). *Investigating safely: A guide for high school teachers.* Arlington, VA: NSTA Press.

Examines the special safety requirements of specific disciplines such as physics, chemistry, Earth/space science, and biology. Topics include equipping labs, storing and disposing of chemicals and other hazardous materials, maintaining documentation, and organizing field trips. Discusses how to accommodate students with special needs as well as how to help students share responsibility for safety in science classes. Useful for review of competency 8.

19. Timberlake, K. (2008). *Chemistry: An introduction to general, organic and biological chemistry* (10th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Contains basic information covered in freshman general chemistry courses. Useful for review of competencies 1–7.

20. Wilbraham, A. C., Staley, D. D., Matta, M. S., & Waterman, E. L. (2006). *Chemistry*. Boston: Pearson Prentice Hall.

Includes problems that help learners interpret data and develop critical thinking skills. Useful for review of competencies 1–8.

21. Zumdahl, S. S., & Zumdahl, S. A. (2006). *Chemistry* (7th ed.). Belmont, CA: Brooks/Cole.

Provides a comprehensive overview of general chemistry. General college text. Useful for review of competencies 1–7.

7 Additional Information

Please visit the following Web site to review FTCE registration details and to find additional FTCE information, including test locations and passing scores.

http://www.fldoe.org/asp/ftce