

FREE PREVIEW
contains 12 random pages from the full-length exam

AP CHEMISTRY
FULL-LENGTH PRACTICE EXAMINATION
PRACTICE FORM #15

Printable simulation of the current examination content

Original questions designed to closely reflect the format, style, complexity, data presentation, and reasoning demands of current AP Chemistry examinations

60 Multiple-Choice Questions • 7 Free-Response Questions
Complete Answer Key, Scoring Guidelines, and Detailed Solutions

Section I	60 multiple-choice questions	90 minutes	50%
Section II	7 free-response questions	105 minutes	50%

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Calculator permitted in both sections. Equations, constants, and a periodic table are provided.

Section I: Multiple Choice

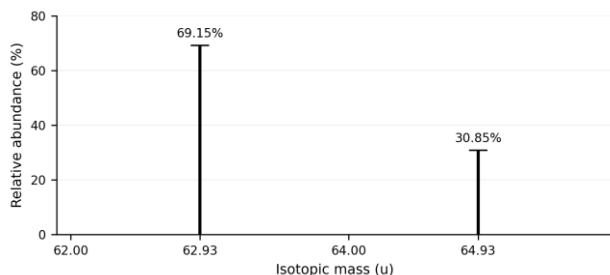
Time—1 hour and 30 minutes

60 Questions • Calculator Permitted • 50% of Examination Score

Select the one best answer for each question. Record all answers on the grid following Question 60.

Questions 1-3 refer to the mass spectrum of a naturally occurring sample of copper.

Only the two stable isotopes are shown. Peak intensity is proportional to isotopic abundance.



1. Which isotope produces the more intense peak?

- (A) Cu-65
- (B) Cu-63
- (C) Both peaks have equal intensity.
- (D) The spectrum does not show isotope abundance.

2. Using the peak positions and relative abundances, which value is closest to the average atomic mass of the sample?

- (A) 63.00 u
- (B) 64.00 u
- (C) 65.00 u
- (D) 63.55 u

3. A Cu-63 atom becomes Cu^{2+} without changing its nucleus. Which pair gives the numbers of protons and electrons in the ion?

- (A) 29 protons and 27 electrons
- (B) 27 protons and 29 electrons
- (C) 29 protons and 31 electrons
- (D) 34 protons and 29 electrons

4. Two electrons are removed from a ground-state Fe atom. Which configuration describes the resulting ion?

- (A) $[\text{Ar}] 3d^4 4s^2$
- (B) $[\text{Ar}] 3d^5 4s^1$
- (C) $[\text{Ar}] 3d^6$
- (D) $[\text{Ar}] 3d^8$

5. Among Na, Mg, Al, and Si, which atom has the greatest first ionization energy?

- (A) Na
- (B) Mg
- (C) Si
- (D) Al

6. In a photoelectron experiment, 250 nm radiation ejects an electron with 1.20×10^{-19} J of kinetic energy. What was the electron's binding energy? Use $h = 6.626 \times 10^{-34}$ J s and $c = 2.998 \times 10^8$ m s^{-1} .

- (A) 1.20×10^{-19} J
- (B) 6.75×10^{-19} J
- (C) 7.95×10^{-19} J
- (D) 9.15×10^{-19} J

7. Measured first ionization energies are 1012 kJ mol^{-1} for P and 1000 kJ mol^{-1} for S. Which orbital feature accounts for the lower value for S?

- (A) S has fewer occupied energy levels than P.
- (B) The valence electrons of P are in a higher principal shell.
- (C) S has a smaller nuclear charge than P.
- (D) One 3p orbital in S contains a paired set of electrons, increasing electron-electron repulsion.

8. A valid resonance form of ClO_3^- contains one $\text{Cl}=\text{O}$ bond and two $\text{Cl}-\text{O}$ single bonds. How many equivalent positions can the double bond occupy?

- (A) 3
- (B) 1
- (C) 2
- (D) 4

9. XeOF_4 has five bonding domains and one lone pair on Xe. Which molecular geometry and polarity are predicted?

- (A) Square pyramidal and polar
- (B) Trigonal bipyramidal and nonpolar
- (C) Square planar and nonpolar
- (D) Octahedral and nonpolar

10. In the carbonate ion, CO_3^{2-} , the three C-O bonds are equivalent. What is their average bond order?

- (A) 1
- (B) $3/2$
- (C) $4/3$
- (D) 2

11. Why can a piece of copper conduct electricity without undergoing a chemical reaction?

- (A) Copper atoms exchange protons through the solid.
- (B) Delocalized valence electrons can move through the metallic lattice.
- (C) Cu^{2+} ions migrate between fixed electron sites.
- (D) Covalent bonds break and reform continuously.

12. Ionic crystals such as CaF_2 are brittle. Which particle-level explanation is most appropriate?

- (A) Heating converts the ions into neutral atoms.
- (B) The mobile electrons suddenly leave the crystal.
- (C) Weak London forces between formula units are easily overcome.
- (D) A shifted layer can place ions of like charge next to one another, producing strong repulsion.

Section I Answer Grid

Fill one response for each question.

1	☐ A ☐ B ☐ C ☐ D	21	☐ A ☐ B ☐ C ☐ D	41	☐ A ☐ B ☐ C ☐ D
2	☐ A ☐ B ☐ C ☐ D	22	☐ A ☐ B ☐ C ☐ D	42	☐ A ☐ B ☐ C ☐ D
3	☐ A ☐ B ☐ C ☐ D	23	☐ A ☐ B ☐ C ☐ D	43	☐ A ☐ B ☐ C ☐ D
4	☐ A ☐ B ☐ C ☐ D	24	☐ A ☐ B ☐ C ☐ D	44	☐ A ☐ B ☐ C ☐ D
5	☐ A ☐ B ☐ C ☐ D	25	☐ A ☐ B ☐ C ☐ D	45	☐ A ☐ B ☐ C ☐ D
6	☐ A ☐ B ☐ C ☐ D	26	☐ A ☐ B ☐ C ☐ D	46	☐ A ☐ B ☐ C ☐ D
7	☐ A ☐ B ☐ C ☐ D	27	☐ A ☐ B ☐ C ☐ D	47	☐ A ☐ B ☐ C ☐ D
8	☐ A ☐ B ☐ C ☐ D	28	☐ A ☐ B ☐ C ☐ D	48	☐ A ☐ B ☐ C ☐ D
9	☐ A ☐ B ☐ C ☐ D	29	☐ A ☐ B ☐ C ☐ D	49	☐ A ☐ B ☐ C ☐ D
10	☐ A ☐ B ☐ C ☐ D	30	☐ A ☐ B ☐ C ☐ D	50	☐ A ☐ B ☐ C ☐ D
11	☐ A ☐ B ☐ C ☐ D	31	☐ A ☐ B ☐ C ☐ D	51	☐ A ☐ B ☐ C ☐ D
12	☐ A ☐ B ☐ C ☐ D	32	☐ A ☐ B ☐ C ☐ D	52	☐ A ☐ B ☐ C ☐ D
13	☐ A ☐ B ☐ C ☐ D	33	☐ A ☐ B ☐ C ☐ D	53	☐ A ☐ B ☐ C ☐ D
14	☐ A ☐ B ☐ C ☐ D	34	☐ A ☐ B ☐ C ☐ D	54	☐ A ☐ B ☐ C ☐ D
15	☐ A ☐ B ☐ C ☐ D	35	☐ A ☐ B ☐ C ☐ D	55	☐ A ☐ B ☐ C ☐ D
16	☐ A ☐ B ☐ C ☐ D	36	☐ A ☐ B ☐ C ☐ D	56	☐ A ☐ B ☐ C ☐ D
17	☐ A ☐ B ☐ C ☐ D	37	☐ A ☐ B ☐ C ☐ D	57	☐ A ☐ B ☐ C ☐ D
18	☐ A ☐ B ☐ C ☐ D	38	☐ A ☐ B ☐ C ☐ D	58	☐ A ☐ B ☐ C ☐ D
19	☐ A ☐ B ☐ C ☐ D	39	☐ A ☐ B ☐ C ☐ D	59	☐ A ☐ B ☐ C ☐ D
20	☐ A ☐ B ☐ C ☐ D	40	☐ A ☐ B ☐ C ☐ D	60	☐ A ☐ B ☐ C ☐ D

Continue your response to Question 1 on this page.

(e) Calculate k at 318 K from the best-fit slope.

(f) Calculate the half-life at 318 K.

(g) Predict $P_{\text{N}_2\text{O}_5}$ after 600 s at 318 K.

(h) Calculate the activation energy using the two rate constants.

(i) A proposed mechanism contains an NO_3 intermediate. State the defining feature that makes a species an intermediate.

(j) A slow leak causes $P_{\text{N}_2\text{O}_5}$ to decrease for a reason other than reaction. State the direction of error in the calculated k and justify.

Question 2 (Long, 10 points)

A student determines the amount of Co^{2+} in a solution using visible-light spectrophotometry and a 1.00 cm cuvette. Calibration standards give the data shown. A 10.00 mL aliquot of the unknown is diluted to 50.00 mL. The diluted unknown has absorbance 0.300 at the calibration wavelength. The total volume of the original unknown solution is 250.0 mL. Use $M(\text{Co}) = 58.93 \text{ g mol}^{-1}$.

$[\text{Co}^{2+}] \text{ (mol L}^{-1}\text{)}$	Absorbance
0	0.000
2.00×10^{-5}	0.120
4.00×10^{-5}	0.240
6.00×10^{-5}	0.360
8.00×10^{-5}	0.480

- (a) State the purpose of using a reagent blank to set zero absorbance.
- (b) Plot absorbance versus $[\text{Co}^{2+}]$ and draw a best-fit line.
- (c) Determine the slope of the calibration line and identify its relationship to molar absorptivity.
- (d) Determine $[\text{Co}^{2+}]$ in the diluted unknown.

Question 7 (Short, 4 points)

A metal object is plated with Ni(s) from an aqueous NiSO₄ solution. A current of 1.50 A passes for 32.2 min. The cathode reaction is $\text{Ni}^{2+}(\text{aq}) + 2 \text{e}^- \rightarrow \text{Ni}(\text{s})$. Use $F = 96,500 \text{ C mol}^{-1}$ and $M(\text{Ni}) = 58.69 \text{ g mol}^{-1}$.

- (a) Identify whether the object being plated is the anode or cathode and justify.

- (b) Calculate the total charge passed.

- (c) Calculate the theoretical mass of Ni deposited.

- (d) The measured mass gain is smaller than the theoretical value. Give one chemically reasonable explanation.

TEACHER MATERIALS

DO NOT REVIEW UNTIL THE EXAMINATION IS COMPLETE

Section I Answer Key and Explanations

Section II Scoring Guidelines and Worked Solutions

Examination Blueprint and Quality-Control Summary

Section I Answer Key

No.	Key	No.	Key	No.	Key	No.	Key
1	B	16	B	31	C	46	C
2	D	17	B	32	A	47	D
3	A	18	C	33	D	48	A
4	C	19	A	34	B	49	A
5	C	20	D	35	C	50	D
6	B	21	C	36	B	51	C
7	D	22	D	37	A	52	B
8	A	23	B	38	D	53	D
9	A	24	A	39	C	54	C
10	C	25	D	40	B	55	A
11	B	26	B	41	C	56	B
12	D	27	A	42	A	57	C
13	D	28	C	43	B	58	B
14	A	29	A	44	D	59	D
15	C	30	D	45	B	60	A

Answer-position audit: A = 15, B = 15, C = 15, D = 15. The sequence is intentionally irregular.

Section I Explanations

Each explanation identifies the controlling chemical principle and the principal misconception represented by the distractors.

1. B Cu-63

The Cu-63 peak is about 69 percent of the total intensity, so Cu-63 is the more abundant isotope.

2. D 63.55 u

The weighted mean is $(0.6915)(62.93 \text{ u}) + (0.3085)(64.93 \text{ u}) = 63.55 \text{ u}$, approximately 63.6 u.

3. A 29 protons and 27 electrons

Copper's atomic number fixes the proton count at 29. Forming Cu^{2+} removes two electrons from the neutral atom, leaving 27 electrons.

4. C [Ar] 3d⁶

Neutral Fe is [Ar] 3d⁶ 4s². The two 4s electrons are removed first, leaving [Ar] 3d⁶.

5. C Si

Across period 3, effective nuclear charge generally increases. Of the listed atoms, Si holds its valence electrons most strongly.

6. B $6.75 \times 10^{-19} \text{ J}$

The photon energy is $hc/\lambda = 7.95 \times 10^{-19} \text{ J}$. Energy conservation gives binding energy = photon energy - kinetic energy = $6.75 \times 10^{-19} \text{ J}$.

7. D One 3p orbital in S contains a paired set of electrons, increasing electron-electron repulsion.

P has a half-filled 3p subshell. In S, pairing in one 3p orbital adds repulsion, making one electron easier to remove.

8. A 3

Any one of the three equivalent oxygen atoms can be double-bonded to Cl, giving three resonance forms.

9. A Square pyramidal and polar

Six electron domains give an octahedral electron-domain arrangement. With one lone pair, the molecular geometry is square pyramidal, and its bond dipoles do not cancel.

10. C 4/3

Each resonance form has one double bond and two single bonds, for four bond-order units distributed among three C-O bonds.

11. B Delocalized valence electrons can move through the metallic lattice.

Metallic bonding includes mobile, delocalized electrons that carry charge through the lattice.

12. D A shifted layer can place ions of like charge next to one another, producing strong repulsion.

When an ionic layer is displaced, like charges can become adjacent. Their repulsion cleaves the crystal.

13. D In spaces between iron atoms in the metallic lattice

Carbon atoms are much smaller than iron atoms and occupy interstitial holes in the iron lattice.

14. A 180 degrees

NO_2^+ has two bonding domains and no lone pair on N, so it is linear with a 180 degree bond angle.

15. C Ethane-1,2-diol

The smallest vapor pressure indicates the strongest attractions. Ethane-1,2-diol can form an extensive hydrogen-bonding network.

16. B Diethyl ether

The liquid with the largest vapor pressure has the greatest escape tendency and evaporates most rapidly.

17. B Each ethane-1,2-diol molecule has two O-H groups and can participate in more hydrogen bonding.

Two hydroxyl groups allow stronger and more extensive intermolecular hydrogen bonding, reducing the escaping tendency.

Question 2 — Scoring Guidelines (10 points)

Part	Points	Criteria
(a)	1	States that the blank corrects for absorbance by the solvent, reagents, and cuvette.
(b)	1	Plots the calibration data with labeled axes and a straight best-fit line through or near the origin.
(c)	1	Calculates slope = $6.00 \times 10^3 \text{ L mol}^{-1}$ and identifies slope = epsilon b, so epsilon = $6.00 \times 10^3 \text{ L mol}^{-1} \text{ cm}^{-1}$ for b = 1.00 cm.
(d)	1	Calculates $[\text{Co}^{2+}]_{\text{diluted}} = 5.00 \times 10^{-5} \text{ M}$.
(e)	1	Calculates $[\text{Co}^{2+}]_{\text{original}} = 2.50 \times 10^{-4} \text{ M}$.
(f)	1	Calculates $6.25 \times 10^{-5} \text{ mol Co}^{2+}$ in the original solution.
(g)	1	Calculates $3.68 \times 10^{-3} \text{ g Co}$.
(h)	1	Concludes concentration is calculated too high because added light attenuation raises absorbance.
(i)	1	Explains that 1.20 is outside the calibrated absorbance range and would require unsupported extrapolation or may violate linearity.
(j)	1	Gives a valid control such as using the same wavelength and cuvette orientation, rinsing with each solution, or wiping the cuvette clean.

Verified total: 10 points**Question 2 — Worked Solution**

(a) The blank subtracts absorbance caused by the solvent, dissolved reagents other than Co^{2+} , and the cuvette, so the remaining signal is attributed to Co^{2+} .

(b) The points form a straight line from (0, 0.000) to ($8.00 \times 10^{-5} \text{ M}$, 0.480).

(c) Slope = $0.480 / (8.00 \times 10^{-5} \text{ M}) = 6.00 \times 10^3 \text{ L mol}^{-1}$. From $A = \text{epsilon } bc$, the slope of A versus c is epsilon b. With b = 1.00 cm, epsilon = $6.00 \times 10^3 \text{ L mol}^{-1} \text{ cm}^{-1}$.

(d) $c = A/\text{slope} = 0.300 / (6.00 \times 10^3) = 5.00 \times 10^{-5} \text{ M}$.

(e) $M_1V_1 = M_2V_2$ gives $M_1 = (5.00 \times 10^{-5} \text{ M})(50.00 \text{ mL}) / (10.00 \text{ mL}) = 2.50 \times 10^{-4} \text{ M}$.

(f) $n = MV = (2.50 \times 10^{-4} \text{ mol L}^{-1})(0.2500 \text{ L}) = 6.25 \times 10^{-5} \text{ mol}$.

(g) $m = nM = (6.25 \times 10^{-5} \text{ mol})(58.93 \text{ g mol}^{-1}) = 3.68 \times 10^{-3} \text{ g Co}$.

(h) A fingerprint absorbs or scatters additional light, making the absorbance too large. Reading that value from the calibration line gives a concentration that is too high.

(i) $A = 1.20$ lies well above the highest standard, 0.480. Dilution brings the sample into the demonstrated linear calibration range and avoids uncertain extrapolation.

(j) Examples include measuring every solution at the same wavelength with the same clean cuvette orientation, rinsing the cuvette with the solution before filling, and wiping the optical faces before measurement.

Final Examination Blueprint

Question	Section	Unit(s)	Principal topic	Science practice	Type	Difficulty	Answer / points
1	I	1	Mass spectrometry and isotopic abundance	Model analysis	conceptual	typical AP	B
2	I	1	Average atomic mass	Mathematical routines	quantitative	foundational AP	D
3	I	1	Isotopes and ionic composition	Models and representations	quantitative	typical AP	A
4	I	1	Transition-metal ions	Models and representations	conceptual	typical AP	C
5	I	1	Periodic trends in ionization energy	Argumentation	conceptual	typical AP	C
6	I	1	Photoelectron energy balance	Mathematical routines	quantitative	challenging AP	B
7	I	1	Ionization-energy exceptions	Argumentation	conceptual	challenging AP	D
8	I	2	Resonance structures	Models and representations	conceptual	foundational AP	A
9	I	2	VSEPR and molecular polarity	Models and representations	conceptual	typical AP	A
10	I	2	Resonance and bond order	Mathematical routines	quantitative	challenging AP	C
11	I	2	Metallic bonding	Models and representations	conceptual	foundational AP	B
12	I	2	Properties of ionic solids	Argumentation	conceptual	typical AP	D
13	I	2	Alloy particle models	Models and representations	conceptual	typical AP	D
14	I	2	VSEPR geometry	Model analysis	quantitative	challenging AP	A
15	I	3	Intermolecular forces and vapor pressure	Representing data and phenomena	conceptual	foundational AP	C
16	I	3	Evaporation and vapor pressure	Argumentation	conceptual	typical AP	B
17	I	3	Hydrogen-bonding networks	Argumentation	conceptual	challenging AP	B
18	I	3	Dalton's law	Mathematical routines	quantitative	foundational AP	C
19	I	3	Graham's law	Mathematical routines	quantitative	typical AP	A
20	I	3	Electrolyte concentrations	Mathematical routines	quantitative	challenging AP	D
21	I	3	Beer-Lambert law	Mathematical routines	quantitative	typical AP	C
22	I	3	Dilution with ion stoichiometry	Mathematical routines	quantitative	typical AP	D
23	I	4	Precipitation reactions	Models and representations	conceptual	foundational AP	B
24	I	4	Spectator ions	Model analysis	conceptual	challenging AP	A
25	I	4	Solution stoichiometry	Mathematical routines	quantitative	typical AP	D
26	I	4	Reaction stoichiometry and gas volume	Mathematical routines	quantitative	typical AP	B
27	I	4	Balancing redox equations	Mathematical routines	quantitative	challenging AP	A
28	I	4	Limiting reactants	Mathematical routines	quantitative	typical AP	C
29	I	4	Combustion analysis	Mathematical routines	quantitative	typical AP	A
30	I	5	Initial-rate analysis	Representing data and phenomena	quantitative	typical AP	D

Quality-Control Summary

Unit	Primary MCQs	Share of 60
1. Atomic Structure and Properties	7	11.7%
2. Compound Structure and Properties	7	11.7%
3. Properties of Substances and Mixtures	8	13.3%
4. Chemical Reactions	7	11.7%
5. Kinetics	8	13.3%
6. Thermochemistry	5	8.3%
7. Equilibrium	7	11.7%
8. Acids and Bases	6	10.0%
9. Thermodynamics and Electrochemistry	5	8.3%

- Exactly 60 MCQs; every item has four choices and one keyed best answer.
- Answer positions are balanced at 15 each for A, B, C, and D, with no mechanical repeating pattern.
- Exactly seven FRQs: three 10-point long questions and four 4-point short questions; total = 46 points.
- All nine units and all six AP Chemistry science practices are represented across the examination.
- The student portion contains no answer key, scoring criteria, unit labels, or learning-objective labels.
- The examination includes stimulus sets, tables, graphs, particulate and ionic representations, experimental design, error analysis, calculations, net ionic equations, and qualitative justification.
- All questions are original and were written to reproduce general AP assessment characteristics without copying or closely paraphrasing published questions.
- Chemical equations, numerical results, units, signs, scoring totals, and answer distribution were checked programmatically and editorially.