

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

AP CHEMISTRY
FULL-LENGTH PRACTICE EXAMINATION
PRACTICE FORM #10

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 element X.

Only two isotope peaks are observed. The mass and relative abundance of each isotope are shown below.

Isotopic mass (amu)	Relative abundance (%)
63.0	69.2
65.0	30.8

- What average atomic mass is calculated from the spectrum?
(A) 63.0 amu
(B) 64.0 amu
(C) 63.6 amu
(D) 64.4 amu
- Which element is most consistent with the calculated average mass?
(A) Cu
(B) Ni
(C) Zn
(D) Ga
- A processed sample of X has an average atomic mass of 64.0 amu. How does its isotopic composition compare with the natural sample?
(A) The processed sample has a greater fraction of the 63.0 amu isotope.
(B) Both isotopes have equal abundance in the processed sample.
(C) The abundance change cannot affect average atomic mass.
(D) The processed sample has a greater fraction of the 65.0 amu isotope.
- An iron(III) ion is formed from a neutral ground-state Fe atom. Which configuration represents the ion?
(A) $[\text{Ar}] 3d^3 4s^2$
(B) $[\text{Ar}] 3d^5$
(C) $[\text{Ar}] 3d^6 4s^1$
(D) $[\text{Ar}] 3d^8$

5. Which ordering gives the ionic radii from largest to smallest for the isoelectronic ions S^{2-} , Cl^- , and K^+ ?

- (A) $\text{K}^+ > \text{Cl}^- > \text{S}^{2-}$
(B) $\text{S}^{2-} > \text{Cl}^- > \text{K}^+$
(C) $\text{Cl}^- > \text{S}^{2-} > \text{K}^+$
(D) $\text{S}^{2-} > \text{K}^+ > \text{Cl}^-$

6. Why does atomic radius generally decrease from Na to Cl across period 3?

- (A) The number of occupied principal shells decreases.
(B) Electron-electron repulsion disappears across the period.
(C) The nuclear charge decreases while shielding increases.
(D) The effective nuclear charge increases while the valence electrons remain in the same principal shell.

7. A spectral line has wavelength 486 nm. What is its frequency?

- (A) $6.17 \times 10^{14} \text{ s}^{-1}$
(B) $1.62 \times 10^{15} \text{ s}^{-1}$
(C) $2.06 \times 10^{-6} \text{ s}^{-1}$
(D) $1.46 \times 10^{17} \text{ s}^{-1}$

8. NF_3 has three N-F bonds and one lone pair on N. Which shape-polarity combination follows from this model?

- (A) Trigonal planar and nonpolar
(B) Tetrahedral and nonpolar
(C) Trigonal pyramidal and polar
(D) Bent and polar

9. Ozone, O_3 , is represented by two equivalent resonance contributors. What average O-O bond order follows from the model?

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

10. What is the hybridization of the central carbon atom in CO_2 ?

- (A) sp^2
(B) sp^3
(C) sp
(D) dsp^3

11. Which solid is expected to have the greatest lattice energy?

- (A) NaF
(B) MgO
(C) KCl
(D) CsI

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) Use K_{sp} and the excess $[Ag^+]$ from part (d) to estimate the equilibrium $[Cl^-]$ remaining in the filtrate.
- (f) Explain why the precipitate is washed with a small amount of cold deionized water. Also state how failing to wash it would affect the calculated chloride concentration.
- (g) Some AgCl is lost while the solid is transferred to the filter. Determine the direction of error in the reported chloride concentration and justify.
- (h) Describe a test using the filtrate that would indicate whether precipitation of chloride was complete.

Question 2 (Long, 10 points)

Peroxydisulfate reacts with iodide according to $\text{S}_2\text{O}_8^{2-}(\text{aq}) + 2 \text{I}^-(\text{aq}) \rightarrow 2 \text{SO}_4^{2-}(\text{aq}) + \text{I}_2(\text{aq})$. Initial-rate data at 298 K are shown below.

Trial	Initial $[\text{S}_2\text{O}_8^{2-}]$ (M)	Initial $[\text{I}^-]$ (M)	Initial rate (M s^{-1})
1	0.0200	0.0400	1.92×10^{-5}
2	0.0400	0.0400	3.84×10^{-5}
3	0.0200	0.0800	3.84×10^{-5}
4	0.0400	0.0800	7.68×10^{-5}

- (a) Identify the species oxidized and the species reduced in the overall reaction.
- (b) Use pairs of trials to determine the reaction order with respect to each reactant.
- (c) Write the rate law and calculate the rate constant at 298 K, including units.
- (d) A proposed mechanism begins with $\text{S}_2\text{O}_8^{2-} + \text{I}^- \rightarrow \text{SO}_4^{2-} + \text{SO}_4^- + \text{I}$ as the slow elementary step, followed by fast steps. Explain whether the mechanism is consistent with the experimental rate law.

Question 7 (Short, 4 points)

An acidic hydrogen-oxygen fuel cell operates according to $2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{l})$. The standard cell potential is 1.23 V at 25 degrees C. Use $F = 96,500 \text{ C mol}^{-1}$.

- (a) Write the balanced oxidation half-reaction for the reaction as written.

- (b) Write the balanced reduction half-reaction for the reaction as written.

- (c) State the number of moles of electrons transferred when the overall reaction occurs once as written.

- (d) Calculate delta G degrees for the reaction as written.

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

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

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. C 63.6 amu

The weighted average is $(63.0)(0.692) + (65.0)(0.308) = 63.616$ amu, which rounds to 63.6 amu.

2. A Cu

The weighted average is close to the periodic-table atomic mass of copper, about 63.55 amu.

3. D The processed sample has a greater fraction of the 65.0 amu isotope.

An average shifted toward 65.0 amu requires a greater relative contribution from the heavier isotope.

4. B [Ar] 3d⁵

Neutral Fe is [Ar] 3d⁶ 4s². The two 4s electrons and one 3d electron are removed to form Fe³⁺, giving [Ar] 3d⁵.

5. B S²⁻ > Cl⁻ > K⁺

All three ions have 18 electrons. Within an isoelectronic series, greater nuclear charge pulls the same electron cloud inward more strongly, so K⁺ is smallest.

6. D The effective nuclear charge increases while the valence electrons remain in the same principal shell.

Additional protons increase nuclear attraction, while added electrons enter the same $n = 3$ shell and do not fully shield one another.

7. A $6.17 \times 10^{14} \text{ s}^{-1}$

Frequency is $c/\lambda = (2.998 \times 10^8 \text{ m s}^{-1})/(4.86 \times 10^{-7} \text{ m}) = 6.17 \times 10^{14} \text{ s}^{-1}$.

8. C Trigonal pyramidal and polar

Three N-F bonds and one lone pair give a tetrahedral electron-domain geometry and trigonal-pyramidal molecular shape. The bond dipoles do not cancel.

9. A 3/2

Each contributor contains one O-O double bond and one O-O single bond. Delocalization makes the two bonds equivalent with average order $(2 + 1)/2 = 3/2$.

10. C sp

The central carbon has two electron domains and a linear arrangement, corresponding to sp hybridization.

11. B MgO

Lattice energy increases with ionic charge magnitude and decreases with ion size. MgO contains 2+ and 2- ions, giving the strongest electrostatic attraction among the choices.

12. D Bond P is shorter because its energy minimum occurs at a smaller internuclear distance.

Equilibrium bond length is the internuclear distance at the minimum of a potential-energy curve. Curve P reaches its minimum at the smaller distance.

13. D Bond P, because its potential well is deeper

The dissociation energy is the energy difference between the minimum and the zero-energy separated-atom limit. The deeper well for P corresponds to the larger bond energy.

14. B Repulsion, causing the potential energy to rise steeply

At very short distance, nucleus-nucleus and electron-electron repulsions dominate, producing the steep rise on the left side of the curve.

15. C Solid

The point at 25 degrees C and 1.0 atm lies in the solid region, to the left of the solid-liquid boundary and above the sublimation curve.

Question 2 - Scoring Guidelines (10 points)

Part	Points	Criteria
(a)	1	Identifies I^- as oxidized and $\text{S}_2\text{O}_8^{2-}$ as reduced.
(b)	2	Uses the data to establish first order in $\text{S}_2\text{O}_8^{2-}$ and first order in I^- .
(c)	2	Writes $\text{rate} = k[\text{S}_2\text{O}_8^{2-}][\text{I}^-]$ and calculates $k = 0.0240 \text{ M}^{-1} \text{ s}^{-1}$.
(d)	1	States that the slow-step molecularity predicts the observed first-order dependence on each reactant.
(e)	2	Correctly applies the Arrhenius relation and obtains E_a approximately 36.1 kJ mol^{-1} .
(f)	1	Relates higher temperature to a larger fraction of collisions with energy at least E_a .
(g)	1	Predicts the rate becomes one-fourth as large.

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

(a) Iodide changes from -1 in I^- to 0 in I_2 and is oxidized. Peroxydisulfate accepts electrons and is reduced to sulfate.

(b) Trials 1 and 2 double $[\text{S}_2\text{O}_8^{2-}]$ at constant $[\text{I}^-]$ and double the rate, so the order in $\text{S}_2\text{O}_8^{2-}$ is one. Trials 1 and 3 double $[\text{I}^-]$ at constant $[\text{S}_2\text{O}_8^{2-}]$ and double the rate, so the order in I^- is one.

(c) $\text{rate} = k[\text{S}_2\text{O}_8^{2-}][\text{I}^-]$. From Trial 1, $k = (1.92 \times 10^{-5} \text{ M s}^{-1})/[(0.0200 \text{ M})(0.0400 \text{ M})] = 0.0240 \text{ M}^{-1} \text{ s}^{-1}$.

(d) An elementary slow step containing one $\text{S}_2\text{O}_8^{2-}$ ion and one I^- ion predicts rate proportional to $[\text{S}_2\text{O}_8^{2-}][\text{I}^-]$. This matches the experimental rate law, so the proposal is kinetically consistent.

(e) $\ln(k_2/k_1) = (E_a/R)(1/T_1 - 1/T_2)$. $E_a = (8.314 \text{ J mol}^{-1} \text{ K}^{-1})\ln(0.0600/0.0240)/(1/298 - 1/318) = 3.61 \times 10^4 \text{ J mol}^{-1} = 36.1 \text{ kJ mol}^{-1}$.

(f) At higher temperature, the kinetic-energy distribution shifts so a larger fraction of collisions has energy equal to or greater than E_a . More collisions can therefore reach the transition state.

(g) The rate is first order in each reactant. Halving both concentrations multiplies the rate by $(1/2)(1/2) = 1/4$.

Final Examination Blueprint

Question	Section	Unit(s)	Principal topic	Science practice	Type	Difficulty	Answer / points
1	I	1	Isotopic abundance and average mass	Mathematical routines	quantitative	typical AP	C
2	I	1	Element identification from isotopes	Argumentation	conceptual	foundational AP	A
3	I	1	Isotopic enrichment	Model analysis	conceptual	typical AP	D
4	I	1	Electron configurations of transition-metal ions	Models and representations	conceptual	typical AP	B
5	I	1	Isoelectronic ionic radii	Argumentation	conceptual	typical AP	B
6	I	1	Periodic trends	Argumentation	conceptual	foundational AP	D
7	I	1	Electromagnetic radiation	Mathematical routines	quantitative	typical AP	A
8	I	2	Molecular geometry and polarity	Models and representations	conceptual	typical AP	C
9	I	2	Resonance and bond order	Mathematical routines	quantitative	typical AP	A
10	I	2	Hybridization	Models and representations	conceptual	foundational AP	C
11	I	2	Ionic lattice energy	Argumentation	conceptual	typical AP	B
12	I	2	Bond length from potential energy	Representing data	conceptual	typical AP	D
13	I	2	Bond energy	Model analysis	conceptual	typical AP	D
14	I	2	Interatomic forces	Argumentation	conceptual	challenging AP	B
15	I	3	Phase diagrams	Representing data	conceptual	typical AP	C
16	I	3	Phase changes and pressure	Model analysis	conceptual	typical AP	A
17	I	3	Critical point	Argumentation	conceptual	foundational AP	C
18	I	3	Kinetic molecular theory	Models and representations	conceptual	typical AP	D
19	I	3	Molecular speed and temperature	Argumentation	conceptual	challenging AP	B
20	I	3	Chromatography	Mathematical routines	quantitative	foundational AP	A
21	I	3	Chromatographic identification	Model analysis	conceptual	typical AP	A
22	I	3	Chromatography error analysis	Question and method	conceptual	typical AP	B
23	I	3	Dalton's law	Mathematical routines	quantitative	foundational AP	D
24	I	4	Net ionic equations	Models and representations	conceptual	typical AP	C
25	I	4	Solution stoichiometry	Mathematical routines	quantitative	typical AP	D
26	I	4	Limiting reactant	Mathematical routines	quantitative	typical AP	A
27	I	4	Hydrate composition	Mathematical routines	quantitative	typical AP	C
28	I	4	Balancing redox reactions	Models and representations	quantitative	challenging AP	B
29	I	4	Acid-base stoichiometry	Mathematical routines	quantitative	typical AP	B
30	I	5	Initial rates	Mathematical routines	quantitative	typical AP	C

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	9	15.0%
4. Chemical Reactions	6	10.0%
5. Kinetics	7	11.7%
6. Thermochemistry	6	10.0%
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.