

## AP CHEMISTRY

# AP Pacing Guide for Flipped Classrooms: Jan.–April 2021

## Overview


Due to the challenges associated with hybrid and remote learning in 2020–21, a significant amount of the content and skills colleges are requiring for credit will likely need to be assigned to students as homework or independent learning. This guide allows students who are currently behind to complete all course topics from the course and exam description by May. This guide assumes students will complete approximately 30 minutes of AP Daily videos (~10 minutes each) and topic questions each day in lieu of, or addition to, assignments the teacher would ordinarily give.

## How to Implement




This guide assumes students covered only ~26% of the course content and skills in the fall of 2020. For classes that have been forced off schedule, there may not be time for teacher-led instruction of all remaining topics.

- Teachers should **assign the AP Daily videos and topic questions** listed below as student assignments each week.
- Using the reports generated by the topic questions, teachers should focus their limited, direct class time on the Learning Objectives where students need more help.
- If students are ahead of the pace indicated below, teachers will be able to incorporate additional days or weeks to spend more time on challenging topics, practicing course skills, or reviewing for the exam.

## Week 1: Jan. 4–8





Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
4.1 Introduction for Reactions	AP Daily Video 1	TRA-1.A: Identify evidence of chemical and physical changes in matter.	 Topic Questions

\*Prioritize the most challenging Learning Objectives for your students for direct, synchronous instruction.

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
4.2 Net Ionic Equations	AP Daily Video 1 AP Daily Video 2	TRA-1.B: Represent changes in matter with a balanced chemical or net ionic equation: a. For physical changes. b. For given information about the identity of the reactants and/or product. c. For ions in a given chemical reaction.	 Topic Questions
4.3 Representations of Reactions	AP Daily Video 1	TRA-1.C: Represent a given chemical reaction or physical process with a consistent particulate model.	 Topic Questions
4.4 Physical and Chemical Changes	AP Daily Video 1	TRA-1.D: Explain the relationship between macroscopic characteristics and bond interactions for: a. Chemical processes. b. Physical processes.	 Topic Questions



## Week 2: Jan. 11–15

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
4.5 Stoichiometry	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3	SPQ-4.A: Explain changes in the amounts of reactants and products based on the balanced reaction equation for a chemical process.	 Topic Questions
4.6 Introduction to Titration	AP Daily Video 1 AP Daily Video 2	SPQ-4.B: Identify the equivalence point in a titration based on the amounts of the titrant and analyte, assuming the titration reaction goes to completion.	 Topic Questions
4.7 Types of Chemical Reactions	AP Daily Video 1	TRA-2.A: Identify a reaction as acid-base, oxidation-reduction, or precipitation.	 Topic Questions
4.8 Introduction to Acid-Base Reactions	AP Daily Video 1	TRA-2.B: Identify species as Brønsted-Lowry acids, bases, and/or conjugate acid-base pairs, based on proton-transfer involving those species.	 Topic Questions

**Weeks 3: Jan. 18–22**

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
4.9 Oxidation-Reduction (Redox) Reactions	AP Daily Video 1	TRA-2.C: Represent a balanced redox reaction equation using half-reactions.	Topic Questions Personal Progress Check
5.1 Reaction Rates	AP Daily Video 1 AP Daily Video 2	TRA-3.A: Explain the relationship between the rate of a chemical reaction and experimental parameters.	Topic Questions
5.2 Introduction to Rate Law	AP Daily Video 1	TRA-3.B: Represent experimental data with a consistent rate law expression.	Topic Questions
5.3 Concentration Changes Over Time	AP Daily Video 1 AP Daily Video 2	TRA-3.C: Identify the rate law expression of a chemical reaction using data that show how the concentrations of reaction species change over time.	Topic Questions Personal Progress Check

**Week 4: Jan. 25–29**

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
5.4 Elementary Reactions	AP Daily Video 1	TRA-4.A: Represent an elementary reaction as a rate law expression using stoichiometry.	Topic Questions
5.5 Collision Model	AP Daily Video 1	TRA-4.B: Explain the relationship between the rate of an elementary reaction and the frequency, energy, and orientation of molecular collisions.	Topic Questions
5.6 Reaction Energy Profile	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3	TRA-4.C: Represent the activation energy and overall energy change in an elementary reaction using a reaction energy profile.	Topic Questions
5.7 Introduction to Reaction Mechanisms	AP Daily Video 1 AP Daily Video 2	TRA-5.A: Identify the components of a reaction mechanism.	Topic Questions

**Week 5: Feb. 1–5**

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
5.8 Reaction Mechanism and Rate Law	AP Daily Video 1	TRA-5.B: Identify the rate law for a reaction from a mechanism in which the first step is rate limiting.	Topic Questions
5.9 Steady-State Approximation	AP Daily Video 1 AP Daily Video 2	TRA-5.C: Identify the rate law for a reaction from a mechanism in which the first step is not rate limiting.	Topic Questions
5.10 Multistep Reaction Energy Profile	AP Daily Video 1	TRA-5.D: Represent the activation energy and overall energy change in a multistep reaction with a reaction energy profile.	Topic Questions
5.11 Catalysis	AP Daily Video 1	ENE-1.A: Explain the relationship between the effect of a catalyst on a reaction and changes in the reaction mechanism.	Topic Questions Personal Progress Check

**Week 6: Feb. 8–12**

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
6.1 Endothermic and Exothermic Processes	AP Daily Video 1 AP Daily Video 2 AP Daily Video 3	ENE-2.A: Explain the relationship between experimental observations and energy changes associated with a chemical or physical transformation.	Topic Questions
6.2 Energy Diagrams	AP Daily Video 1	ENE-2.B: Represent a chemical or physical transformation with an energy diagram.	Topic Questions
6.3 Heat Transfer and Thermal Equilibrium	AP Daily Video 1	ENE-2.C: Explain the relationship between the transfer of thermal energy and molecular collisions.	Topic Questions
6.4 Heat Capacity and Calorimetry	AP Daily Video 1 AP Daily Video 2	ENE-2.D: Calculate the heat $q$ absorbed or released by a system undergoing heating/cooling based on the amount of the substance, the heat capacity, and the change in temperature.	Topic Questions
6.5 Energy of Phase Changes	AP Daily Video 1 AP Daily Video 2	ENE-2.E: Explain changes in the heat $q$ absorbed or released by a system undergoing a phase transition based on the amount of the substance in moles and the molar enthalpy of the phase transition.	Topic Questions

**Week 7: Feb. 15–19**

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
6.6 Introduction to Enthalpy of Reaction	AP Daily Video 1	ENE-2.F: Calculate the heat $q$ absorbed or released by a system undergoing a chemical reaction in relationship to the amount of the reacting substance in moles and the molar enthalpy of reaction.	Topic Questions
6.7 Bond Enthalpies	AP Daily Video 1 AP Daily Video 2	ENE-3.A: Calculate the enthalpy change of a reaction based on the average bond energies of bonds broken and formed in the reaction.	Topic Questions
6.8 Enthalpy of Formation	AP Daily Video 1 AP Daily Video 2	ENE-3.B: Calculate the enthalpy change for a chemical or physical process based on the standard enthalpies of formation.	Topic Questions
6.9 Hess's Law	AP Daily Video 1 AP Daily Video 2	ENE-3.C: Represent a chemical or physical process as a sequence of steps.  ENE-3.D: Explain the relationship between the enthalpy of a chemical or physical process and the sum of the enthalpies of the individual steps.	Topic Questions Personal Progress Check

**Week 8: Feb. 22–26**

Topic		Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
7.1	Introduction to Equilibrium	AP Daily Video TBD	TRA-6.A: Explain the relationship between the occurrence of a reversible chemical or physical process, and the establishment of equilibrium, to experimental observations.	Topic Questions
7.2	Direction of Reversible Reactions	AP Daily Video TBD	TRA-6.B: Explain the relationship between the direction in which a reversible reaction proceeds and the relative rates of the forward and reverse reactions.	Topic Questions
7.3	Reaction Quotient and Equilibrium Constant	AP Daily Video TBD	TRA-7.A: Represent the reaction quotient $Q_c$ or $Q_p$ , for a reversible reaction, and the corresponding equilibrium expressions $K_c = Q_c$ or $K_p = Q_p$ .	Topic Questions
7.4	Calculating the Equilibrium Constant	AP Daily Video TBD	TRA-7.B: Calculate $K_c$ or $K_p$ based on experimental observations of concentrations or pressures at equilibrium.	Topic Questions
7.5	Magnitude of the Equilibrium Constant	AP Daily Video TBD	TRA-7.C: Explain the relationship between very large or very small values of $K$ and the relative concentrations of chemical species at equilibrium.	Topic Questions

**Week 9: Mar. 1–5**

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
7.6 Properties of the Equilibrium Constant	AP Daily Video TBD	TRA-7.D: Represent a multistep process with an overall equilibrium expression, using the constituent K expressions for each individual reaction.	Topic Questions
7.7 Calculating Equilibrium Concentrations	AP Daily Video TBD	TRA-7.E: Identify the concentrations or partial pressures of chemical species at equilibrium based on the initial conditions and the equilibrium constant.	Topic Questions
7.8 Representations of Equilibrium	AP Daily Video TBD	TRA-7.F: Represent a system undergoing a reversible reaction with a particulate model.	Topic Questions
7.9 introduction to Le Châtelier's Principle	AP Daily Video TBD	TRA-8.A: Identify the response of a system at equilibrium to an external stress, using Le Châtelier's principle.	Topic Questions
7.10 Reaction Quotient and Le Châtelier's Principle	AP Daily Video TBD	TRA-8.B: Explain the relationships between Q, K, and the direction in which a reversible reaction will proceed to reach equilibrium.	Topic Questions

**Week 10: Mar. 8–12**

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
7.11 Introduction to Solubility Equilibria	AP Daily Video TBD	SPQ-5.A: Calculate the solubility of a salt based on the value of $K_{sp}$ for the salt.	Topic Questions
7.12 Common-Ion Effect	AP Daily Video TBD	SPQ-5.B: Identify the solubility of a salt, and/or the value of $K_{sp}$ for the salt, based on the concentration of a common ion already present in solution.	Topic Questions
7.13 pH and Solubility	AP Daily Video TBD	SPQ-5.C: Identify the qualitative effect of changes in pH on the solubility of a salt.	Topic Questions
7.14 Free Energy of Dissolution	AP Daily Video TBD	SPQ-5.D: Explain the relationship between the solubility of a salt and changes in the enthalpy and entropy that occur in the dissolution process.	Topic Questions Personal Progress Check

**Week 11: Mar. 15–19**






Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
8.1 Introduction to Acids and Bases	AP Daily Video TBD	SAP-9.A: Calculate the values of pH and pOH, based on $K_w$ and the concentration of all species present in a neutral solution of water.	Topic Questions
8.2 pH and pOH of Strong Acids and Bases	AP Daily Video TBD	SAP-9.B: Calculate pH and pOH based on concentrations of all species in a solution of a strong acid or a strong base.	Topic Questions
8.3 Weak Acid and Base Equilibria	AP Daily Video TBD	SAP-9.C: Explain the relationship among pH, pOH, and concentrations of all species in a solution of a monoprotic weak acid or weak base.	Topic Questions
8.4 Acid-Base Reactions and Buffers	AP Daily Video TBD	SAP-9.D: Explain the relationship among the concentrations of major species in a mixture of weak and strong acids and bases.	Topic Questions

**Week 12: Mar. 22–26**





Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
8.5 Acid-Base Titrations	AP Daily Video TBD	SAP-9.E: Explain results from the titration of a mono- or polyprotic acid or base solution, in relation to the properties of the solution and its components.	Topic Questions
8.6 Molecular Structure of Acids and Bases	AP Daily Video TBD	SAP-9.F: Explain the relationship between the strength of an acid or base and the structure of the molecule or ion.	Topic Questions
8.7 pH and $pK_a$	AP Daily Video TBD	SAP-10.A: Explain the relationship between the predominant form of a weak acid or base in solution at a given pH and the $pK_a$ of the conjugate acid or the $pK_b$ of the conjugate base.	Topic Questions
8.8 Properties of Buffers	AP Daily Video TBD	SAP-10.B: Explain the relationship between the ability of a buffer to stabilize pH and the reactions that occur when an acid or a base is added to a buffered solution.	Topic Questions



 **Week 13: Mar. 29–Apr. 2**

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
8.9 Henderson-Hasselbalch Equation	AP Daily Video TBD	SAP-10.C: Identify the pH of a buffer solution based on the identity and concentrations of the conjugate acid-base pair used to create the buffer.	 Topic Questions
8.10 Buffer Capacity	AP Daily Video TBD	SAP-10.D: Explain the relationship between the buffer capacity of a solution and the relative concentrations of the conjugate acid and conjugate base components of the solution.	 Topic Questions  Personal Progress Check
9.1 Introduction to Entropy	AP Daily Video TBD	ENE-4.A: Identify the sign and relative magnitude of the entropy change associated with chemical or physical processes.	 Topic Questions
9.2 Absolute Entropy and Entropy Change	AP Daily Video TBD	ENE-4.B: Calculate the entropy change for a chemical or physical process based on the absolute entropies of the species involved in the process.	 Topic Questions

 **Week 14: Apr. 5–9**

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
9.3 Gibbs Free Energy and Thermodynamic Favorability	AP Daily Video TBD	ENE-4.C: Explain whether a physical or chemical process is thermodynamically favored based on an evaluation of $\Delta G^\circ$ .	 Topic Questions
9.4 Thermodynamic and Kinetic Control	AP Daily Video TBD	ENE-4.D: Explain, in terms of kinetics, why a thermodynamically favored reaction might not occur at a measurable rate.	 Topic Questions
9.5 Free Energy and Equilibrium	AP Daily Video TBD	ENE-5.A: Explain whether a process is thermodynamically favored using the relationships between $K$ , $\Delta G^\circ$ , and $T$ .	 Topic Questions
9.6 Coupled Reactions	AP Daily Video TBD	ENE-5.B: Explain the relationship between external sources of energy or coupled reactions and their ability to drive thermodynamically unfavorable processes.	 Topic Questions

**Week 15: Apr. 12–16**

Topic	Recommended Asynchronous Student Assignments	Options for Synchronous Instructional Focus*	Check for Understanding
9.7 Galvanic (Voltaic) and Electrolytic Cells	AP Daily Video TBD	ENE-6.A: Explain the relationship between the physical components of an electrochemical cell and the overall operational principles of the cell.	Topic Questions
9.8 Cell Potential and Free Energy	AP Daily Video TBD	ENE-6.B: Explain whether an electrochemical cell is thermodynamically favored, based on its standard cell potential and the constituent half-reactions within the cell.	Topic Questions
9.9 Cell Potential Under Nonstandard Conditions	AP Daily Video TBD	ENE-6.C: Explain the relationship between deviations from standard cell conditions and changes in the cell potential.	Topic Questions
9.10 Electrolysis and Faraday's Law	AP Daily Video TBD	ENE-6.D: Calculate the amount of charge flow based on changes in the amounts of reactants and products in an electrochemical cell.	Topic Questions Personal Progress Check