

Buffers Evaluation Information Page

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Broad definition of what we are considering

We are considering primarily the conceptual understanding of buffer systems. This includes how buffers are formed, how buffers work, what limits the capacity of buffers, why buffers are useful. We are not focused on videos that exclusively solve mathematical problems involving buffers without addressing the conceptual aspects. **Note, videos that only use HH equation to solve buffer problem CANNOT meet concept of interest.**

Johnstone's Triangle Elements

Element	Examples
Macroscopic	Examples of buffer solutions in everyday life (e.g., blood, ocean water). <i>Needs to actually include what the buffer system is.</i> Demonstrations of how buffers resist changes in pH when acids or bases are added. Acid base indicator and color changes. Note: many physiological examples (e.g., blood maintaining pH are verbal only as it is really hard to show this visually)
Symbolic	Chemical equations showing the components of a buffer (e.g., weak acid and its conjugate base). Graphs or diagrams illustrating buffer capacity and pH changes. Equations involving buffer systems (e.g., Henderson-Hasselbalch equation).
Particulate	Particle diagrams showing the interactions between buffer components and added acids or bases. Illustrations of how buffer components neutralize added H^+ or OH^- ions at the particulate level, though this must show more than one H^+ or OH^- ion reacting.
Connection between levels	Videos should make explicit connections between two or more levels for this to be coded as present. For example, they could show a macroscopic example of a buffer solution resisting pH changes and connect it to particle diagrams showing neutralization and symbolic representations of buffer equations.

Core Ideas

Core Idea Elements	
Change and Stability in Chemical Systems	Particulate Nature of Matter
Energy and entropy changes, the rates of competing processes, and the balance between opposing forces govern the fate of chemical systems. Video needs to include: Buffers are equilibrium systems comprised of a weak acid and its conjugate base (or weak base and its conjugate acid). They resist changes in pH when small amounts of strong acids or bases are added through a chemical reaction that shifts the equilibrium position slightly. OR Buffers are equilibrium systems comprised of a weak acid and its conjugate base (or weak base and its conjugate acid). They keep the H^+ ion concentration constant by shifting the equilibrium system to adjust for added or lost H^+.	Matter is comprised of individual particles and it is through interactions of these individual particles that materials exhibit their properties and undergo chemical reactions Video needs to include: Buffers work through reactions between components of the buffer equilibrium system (acid or base) and the added H^+ or OH^-. If either buffer component is used up, the buffer will no longer work (buffer capacity will be exceeded).
Atomic/Molecular Structure & Properties	
The macroscopic physical and chemical properties of a substance are determined by the three-dimensional structure, the distribution of electron density, and the nature and extent of noncovalent interactions between the particles. Video needs to include: A buffer requires both the acid and the base to have significant ability to react. Further, because the components must not react together to neutralize each other, only weak conjugate acid/base pairs form buffers. Alternately, videos may address at the molecular structure level why strong acids/bases and their conjugate can not form buffers. The idea must be linked to the structural features of the compounds, not simply stated as a definition.	

Scientific Practices

Scientific Practices Criteria (must satisfy all criteria)
SP 1: Asking Questions ☐ Instruction presents an event, observation, phenomenon, data, scenario, or model. ☐ Instruction has instructor/students <i>generate</i> an empirically testable question about the given event, observation, phenomenon, data, scenario, or model. (Question cannot be rhetorical or simply a part of instruction; rather it must be a <i>process of generating</i> a testable question.)
SP 2: Developing and Using Models ☐ Instruction presents an event, observation, or phenomenon for instructor/students to explain or make a prediction about. ☐ Instruction presents a representation or asks instructor/students to construct a representation. ☐ Instruction has instructor/students explain or make a prediction about the event, observation, or phenomenon. ☐ Instruction has instructor/students provide the reasoning that links the representation to their explanation or prediction.
SP 3: Planning Investigations ☐ Instruction poses a scientific question, claim, or hypothesis to be investigated. ☐ Instruction has instructor/students describe or design an investigation, or identify the observations required to answer the question or test the claim or hypothesis. ☐ Instruction has instructor/students justify how their description, design, or observations can be used to answer the question or test the claim or hypothesis.
SP 4: Analyzing and Interpreting Data ☐ Instruction presents a scientific question, claim, or hypothesis to be investigated. ☐ Instruction provides a representation of data (table, graph, or list of observations) used to answer the question or test the claim or hypothesis. ☐ Instruction provides an analysis of the data or asks instructor/students to analyze the data. ☐ Instruction has instructor/students interpret the results or assess the validity of the conclusions in the context of the scientific question, claim, or hypothesis.
SP 5: Using Mathematics and Computational Thinking ☐ Instruction presents an event, observation, or phenomenon. Instruction has instructor/students perform a calculation or statistical test, generate a mathematical representation, or demonstrate a relationship between parameters. ☐ Instruction has instructor/students give a consequence or an interpretation in words, diagrams, symbols, or graphs of their mathematical results while demonstrating reasoning in the context of the given event, observation, or phenomenon.
SP 6: Constructing Explanations and Engaging in Argument from Evidence ☐ Instruction presents an event, observation, or phenomenon. ☐ Instruction presents or asks instructor/students to make a claim based on the given event, observation, or phenomenon. ☐ Instruction has instructor/students provide scientific principles or evidence (data or observations) to support the claim. ☐ Instruction has instructor/students provide reasoning about why the scientific principles or evidence support the claim.

SP 7: Evaluating Information

- ❑ Instruction provides an excerpt from a conversation, article, student solution, or other communication that makes one or more assertions.
- ❑ Instruction presents a conclusion about the validity of the assertion(s) made or asks instructor/students to make a conclusion about the validity of the assertion(s), or reconcile multiple assertions with each other.
- ❑ Instruction has instructor/students provide reasoning to support their conclusion(s) about the validity of the assertion(s) or reconciliation with data, observations, or scientific principles.

Causal Mechanistic Reasoning - Must have Both How and Why!

Option 1: What causes a buffer to resist changes in pH?

- **How:** Buffers resist changes in pH (or keeping H^+ concentration constant) through neutralization reactions between the buffer components (weak acid and conjugate base or weak base and conjugate acid) and added acids or bases.
- **Why:** The conjugate acid/base pair are in equilibrium with each other in the buffer system. Any added H^+ or OH^- will **react** with components of that equilibrium system and cause a shift in the equilibrium position rather than having significant changes in the concentration of H^+ or OH^- ions in the solution. This maintains the pH within a narrow range. *(Note: If the video only addresses this from one side - e.g., only talks about adding strong acid, but includes both the How and Why for that direction we are saying that is OK. Make note if it addresses this for adding acid OR base.)*

Option 2: What makes a good or poor buffer?

- **How:** An acid/conjugate base system that is in equilibrium is required for a buffer.
- **Why:** This dynamic equilibrium between the weak acid and its conjugate base allows the buffer to neutralize added acids or bases, maintaining a stable pH. A system of a strong acid and its conjugate base will neutralize added base; however, the conjugate base of a strong acid is stable and thus will not react appreciably with added acid to neutralize it. (And the analogous case for a strong base and conjugate acid).

Option 3: What causes a buffer to break down?

- **How:** Buffer capacity is influenced by the concentration of the weak acid and its conjugate base (or weak base and conjugate acid). Higher concentrations of buffer components result in greater capacity to neutralize added acids or bases.
- **Why:** With higher concentrations, there are more base/acid molecules available to react with added H^+ or OH^- ions, enhancing the buffer's ability to resist pH changes. If there are no more base/acid molecules to react with the added H^+ or OH^- ions, the buffer will no longer work.

Must address both aspects of the why.

Multimedia Principles

Multimedia learning as knowledge construction: The goal of multimedia presentations is not only to present information but also to provide guidance for how to process the presented information – that is, for determining what to pay attention to, how to mentally organize it, and how to relate it to prior knowledge. We will categorize the videos along each of the following criteria (High and Low should be mutually exclusive.)

High	Low
• Video almost exclusively involves <u>meaningful and relevant</u> images and verbal components <u>AND images are explained for a novice learner</u> • Text on screen is minimal (ex. Only brief bullet points or keywords if text is used) • Content is all relevant to the topic and learning (no music, unhelpful animations, graphics, etc.) • Contains elements that meaningfully support student organizing content or identify key ideas (introductory organizer, section heading, summary, guiding questions/topic (for short, focused video only) Key Question: Could a novice learner clearly understand what they should take away from the video? Yes=high.	• Large segments of video are presented just verbally and not pictorially (ex. just the instructor talking, or just written words) OR images presented are not relevant to learning or explained • Contains full sentences of written text that are also narrated (<i>e.g., several bullet points or sentences on one screen OR full sentences of text on many screens includes forced closed captioning</i>) • Contains extraneous content, music, graphics, animations, background changes, sounds, or just too much stuff on the screen at one time - anything that detracts attention from core content • Does not contain any elements that meaningfully help learners organize content or identify key ideas (e.g., no introductory organizer, section headings, video segments, summary, guiding question/topic (for short focused videos only)

Misleading vs. Inaccuracies

- Several minor spelling issues is misleading, not inaccurate

Captions

- Videos with full on-screen captions (that can not be removed) are considered “low” for multimedia when considering text usage.