

Experiment Answers

Acids and Bases

Experiment #1 – “Sour and Bitter”

What a satisfactory answer should mention

Prompt on card	Key idea(s) students should supply	Why it is acceptable
<i>Identify which samples are sour or bitter</i>	Vinegar and lemon juice are sour (acidic); baking-soda paste and unsweetened/bitter chocolate are bitter (basic).	Correctly links taste with pH: acids → sour, bases → bitter.
<i>Name other acidic foods</i>	Any common examples such as citrus fruits (orange, grapefruit, lime), tomato, yogurt, sour candy, pickles.	Each of these has a food-grade acid (citric, acetic, lactic).
<i>Why are there few basic foods?</i>	Strong bases are caustic/unpleasant; mild ones react with fats/proteins, so humans rarely eat them except in small doses (e.g., cocoa, tonic water, antacids).	Shows awareness of safety and culinary chemistry.
<i>Why not taste-testing in a laboratory?</i>	Unknown strength/toxicity, risk of burns or poisoning, contamination, subjective results.	Demonstrates understanding of safe lab practice.

A student need not list every example, but answers should connect acidity ⇔ sour, basicity ⇔ bitter, and emphasize safety.

Experiment #2 – “Litmus Red and Blue”

Expected observations and reasoning

1. Color changes to look for

- **Acidic solution:** blue litmus → **red**; red litmus **unchanged**.
- **Basic solution:** red litmus → **blue**; blue litmus **unchanged**.
- **Neutral solution:** neither strip changes color.

2. Typical results for the listed liquids

Substance	Likely pH	Expected litmus outcome
Vinegar, colorless soft drink, aspirin solution	Acidic	Blue → red; red stays red
Baking-soda solution, antacid solution, window cleaner (ammonia), liquid soap	Basic	Red → blue; blue stays blue

Tap-water, salt solution	≈ Neutral	No change on either strip
Baking powder	Often slightly acidic (contains cream of tartar)	Same as weak acid

3. "Ant-" meaning

- Because *antacid* means "opposite of acid," students should conclude it is **basic** (or at least weakly basic/alkaline).

A correct answer recognises the diagnostic colors and classifies most household samples plausibly. Minor pH deviations (e.g., slightly basic tap water) are acceptable if the color observation supports the claim.

Experiment #3 – "Shiny Pennies"

What teachers should see

Solution cup	Likely number of shiny pennies (out of 5)	Why
Vinegar	4–5	Acetic acid dissolves the copper-oxide tarnish quickly.
Lemon juice	4–5	Citric acid performs similarly to vinegar.
Baking-soda solution	0–2 (may stay dull or only partly brighten)	Basic solution does not dissolve oxide; any shine comes from gentle abrasion.
Window cleaner (ammonia)	1–3, usually slower	Ammonia can complex Cu^{2+} but is less effective than a weak acid in 10 min.

A student explanation should connect "acid removes oxide" to the best-performing liquid; acceptable if they notice both weak acids work better.

Experiment #4 – "Shinier Pennies"

Short-term (10 min) vs. overnight trends

Cup	After 10 min	After overnight soak	What that indicates
Vinegar only	Noticeable shine, some spots remain	Slightly brighter, stable	Moderate acidity cleans steadily.
Coca-Cola®	Little to moderate shine	Much brighter; carbonation/ phosphoric acid work slowly	Confirms cola is acidic (pH ≈ 2.5).

Vinegar + salt	Brightest, quickest clean	May develop green film (copper chloride) or stay shiny	Acid + chloride ions accelerate dissolution; the green shows continuing reaction.
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Interpretation cues for students

- The vinegar-salt mixture's aggressiveness shows that *both acidity and chloride ions* speed up oxide removal.
- Coke's delayed cleaning still signals strong acidity.
- Ranking liquids by relative acidity/reactivity: **Vinegar + salt > Coke \approx Vinegar** (initially), though long-term side reactions may alter appearance.

A complete answer highlights which solution cleaned best at each time point and ties that observation to stronger or more reactive acidity.

Experiment Answers

Chemical Changes

Experiment 1

Card prompt	Points a correct answer should include	Why it matters
Evidence of a chemical change	Brown surface on apple slices; oxidation of phenolic compounds to melanin-like pigments	New color indicates new substances formed, not just water loss
Best method for slowing change	Any treatment that kept oxygen away or reduced oxidation rate—e.g., vitamin C coating (antioxidant), plastic wrap (physical barrier), placement away from sun/heat	Shows understanding that oxidation needs O ₂ and is faster with light/heat
Other ways to slow browning	Lemon juice, pineapple juice, quick blanch, sugar syrup, refrigeration	All either lower pH, supply antioxidants, or limit oxygen

A full-credit student answer links browning to oxygen-driven chemical change and explains why the chosen method worked.

Experiment 2

Card prompt	Acceptable explanation	Key chemical idea
Why only part changed color	Exposed copper reacted with acetic-acid vapor to form blue-green copper acetate; clay-covered half had no contact with vapor	Reaction requires both acid vapor and copper surface
Why the jar needed to be closed	Traps vinegar fumes so reaction proceeds; prevents corrosive vapors escaping into room	Reaction involves gaseous component; safety/containment

*Correct responses highlight that **gas from the vinegar**, not liquid contact, drives the patina—demonstrating a chemical change.*

Experiment 3

What students should observe	Why that shows chemical change
Rapid effervescence around potato slice; foam rising	Catalase enzyme in potato decomposes $\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{O}_2$ (gas)
Possible warmth in beaker	Reaction is exothermic
Bubbles absent if peroxide is old or potato is boiled	Shows reaction depends on active biological catalyst

*A satisfactory answer mentions gas production **and** links bubbles to oxygen released by breaking down hydrogen peroxide.*

Experiment 4

Expected observation	Underlying chemistry students should note
Milk separates into white curds and yellowish whey within minutes	Acid in vinegar coagulates casein proteins; new solid phase forms
Curds can be lifted with spoon/filter	Precipitate formation = irreversible chemical change in protein structure

*A good explanation uses the language of **protein denaturation/precipitation** and contrasts chemical change (new substance/texture) with mere physical mixing.*

Experiment Answers

Physical Changes

Experiment 1 – “What Is an Ice Cube?”

Card prompt	What a correct answer should note	Key concept
Changes you see	Ice surface turns glossy, droplets form, puddle grows beneath cube	Melting (solid → liquid)
Where changes occur	First at edges and bottom touching towel (warmer)	Heat moves from surroundings into ice
Is energy involved?	Yes—ice absorbs ambient thermal energy (endothermic)	Energy drives a <i>phase change</i>
Is the process reversible?	Yes—meltwater can be refrozen to solid ice	No new substance created

Students earn full credit if they link melting to heat absorption, identify it as reversible, and emphasize that ice and water are the same substance (H₂O).

Experiment 2 – “Salt Crystals”

Card prompt	Acceptable student points	Why it matters
What happened to the solution?	Water level drops; cubic salt crystals grow on string/paper clip and jar walls; remaining liquid becomes less clear	Evaporation leaves ions behind, which re-form solid NaCl
Why did crystals form?	Water evaporated, solution became supersaturated, salt precipitated	A physical separation (evaporation) leads to solid returning
Is this reversible?	Yes—crystals will dissolve again in water, recreating a solution	Substance identity unchanged

A good explanation mentions evaporation, supersaturation, and that dissolving/precipitating is reversible and physical.

Experiment 3 – “Muddy Water”

Observation focus	What a solid answer should include	Underlying reasoning
Jar water appearance	Water collected is noticeably clearer/clean	Sequential filtering removed suspended soil
Why the layer order?	Bottom cotton plugs holes and catches coarse dirt; charcoal adsorbs fine particles & odors; sand strains smaller grains; pebbles keep layers from shifting and aid drainage	Larger particles stopped first; finer stages follow
Type of change?	Physical separation—no new substances	Filtration relies on size and adsorption, not reaction

Credit responses that recognize each layer’s role in trapping smaller and smaller impurities and emphasize that only physical properties (particle size, adsorption) are involved.

Experiment 4 – “Stuck on You”

Card prompt	Points students should provide	Key chemistry/physics
What is a mixture?	Two or more substances combined without chemical bonding—each keeps its own properties	Sand (silica) and steel (iron) remain unaltered
Why does the magnet work?	Steel wool is ferromagnetic; sand is not, so magnet pulls shavings away, leaving sand	Uses magnetic property to separate components
How is this a physical change?	Substances unchanged; only location/arrangement altered; separation is reversible	Demonstrates physical property, not reaction

Strong answers quantify the masses before and after and mention that magnetism is exploited, confirming no chemical change took place.

Experiment Answers

States of Matter

Experiment 1 – Matter Takes Up Space (Rice & Ping-Pong Ball)

Card prompt	What students should notice	Why it's correct
<i>Observation</i>	Ball slowly rises as rice packs tighter	Shaking lets small rice grains settle into gaps, forcing the larger ball upward (granular convection)
<i>Why did this happen?</i>	Both rice and ball occupy space; shaking rearranges particles without changing volume	Shows that matter can't occupy the same space, so objects shift to accommodate
<i>Other matter present?</i>	Air in spaces between grains	Recognizes that gases also take up space

Accept any clear explanation that mentions size, packing, and the fact that air and solids are all matter with volume.

Experiment 2 – Matter Takes Up Space (Marbles in Water)

Focus	Key points
Water level rises above tape mark when marbles are added	Marble volume displaces water because two forms of matter cannot share the same space
The rise matches the total volume of marbles submerged	Demonstrates Archimedes' principle qualitatively

Credit answers that link the extra height to displacement, even if they don't name Archimedes.

Experiment 3 – Identifying the Three States (Candle)

Prompt	Acceptable student responses	Concept checked
States observed	Solid: wax; Liquid: melted wax near wick; Gas: hot vapor/smoke	Recognizing simultaneous states
Why changes occur	Heat from flame melts solid wax and then vaporizes it; cooling after blow-out returns vapor/liquid to solid	Shows energy drives phase changes; changes are physical, reversible

Experiment 4 – How Much Space? (Salt + Water vs. Water Alone)

Observation	Correct reasoning
250 mL salt + 250 mL water < 500 mL total volume	Water fills spaces between salt grains; some salt dissolves, breaking into ions that nestle among water molecules

Experiment 5 – Is It Solid or Liquid? (Corn-starch “Goop” in Bag)

Evidence to list	Interpretation
Flows slowly when bag is tilted (liquid-like)	Particles slide past each other at low stress
Feels firm if squeezed quickly (solid-like)	Under sudden force, particles lock—non-Newtonian (shear-thickening) fluid
Conclusion	It behaves as both; best described as a “suspension” or “oobleck,” showing properties of liquids <i>and</i> solids

Experiment 6 – Viscosity of Liquids

Expected ranking (fast → slow)	Why	Temperature question
Water < cooking oil < mineral oil ≈ dish detergent < syrup	Greater internal friction = higher viscosity	Warming liquids lowers viscosity; cooling raises it because particle movement changes

Allow small swaps (e.g., oil types) if students justify with observed marble times.

Experiment 7 – Finding Holes in Water (Sugar in Brim-Full Mug)

Observation	Correct explanation
Several spoonfuls dissolve without overflow	Sugar crystals occupy gaps between water molecules until solution nears saturation; dissolution adds little bulk

Experiment 8 – How Heavy Is a Gas? (CO₂ “Poured” on Candle)

Question	What to hear	Underlying science
<i>Why didn't gas escape the bottle?</i>	CO ₂ is denser than air; it settled and stayed when thumb closed bottle	Density
<i>Why could you pour it?</i>	Gas flows downward like a heavy fluid when bottle tipped	CO ₂ acts like invisible liquid
<i>Why did candle go out?</i>	CO ₂ displaces O ₂ ; flame lacks oxygen	Combustion needs oxygen

Experiment 9 – Air Takes Up Space (Plastic Bag)

Observation	Expected reasoning
Bag resists being compressed	Trapped air molecules push back (air pressure); gas occupies volume

Experiment 10 – Inflating a Balloon Inside a Bottle

Key finding	Explanation
Balloon won't inflate	Bottle already full of air; blowing cannot add more without escape path, so internal pressure stops the balloon

Experiment 11 – Magic Paper (Dry Paper Underwater)

Observation	Why paper stays dry
Paper dry after inverted glass submerged	Air trapped in glass blocks water; water can't replace the air without a vent

Experiment 12 – Air Has Pressure (Paper Ball & Bottle)

Outcome	Reasoning
Blowing hard pushes paper <i>out</i> of bottle rather than in	Fast air over bottle mouth lowers pressure (Bernoulli); higher static pressure inside forces paper outward