

Test Course

Properties of Gases

Final Report - Answer Guide

Institution	SI Curriculum Development University
Session	Test Course
Course	Test Course
Instructor	Corinne Brown

Test Your Knowledge

Match each term to the best description.

Flame tests	Apparatus that contains starting reactants and gases that are produced in a chemical reaction	1
Gas generation tube	Substances that do not react to flame	2
Inert gases	Substances that facilitate combustion of other materials	3
Oxidizers	Formed by a reaction of CO ₂ with limewater	4
Precipitate	Methodology used to identify gases	5

Correct answers:

- 1 Gas generation tube 2 Inert gases 3 Oxidizers 4 Precipitate
5 Flame tests

Classify each statement as describing a gas, liquid, or solid phase.

⌘ Has molecules in a fixed arrangement, closely packed ⌘ Has molecules in a fixed volume and a fluid shape ⌘ Has rapidly moving molecules with no definite shape or volume		
Gas	Liquid	Solid
1	2	3

Correct answers:

- 1 Has rapidly moving molecules with no definite shape or volume
- 2 Has molecules in a fixed volume and a fluid shape
- 3 Has molecules in a fixed arrangement, closely packed

Classify each gas as flammable, an oxidizer, or inert.

⌘ Hydrogen ⌘ Nitrogen ⌘ Oxygen	<table border="1"><tr><td>Flammable</td><td>Oxidizer</td><td>Inert</td></tr><tr><td>1</td><td>2</td><td>3</td></tr></table>	Flammable	Oxidizer	Inert	1	2	3
Flammable	Oxidizer	Inert					
1	2	3					

Correct answers:

- 1 Hydrogen
- 2 Oxygen
- 3 Nitrogen

Exploration

The gas phase of matter has no fixed volume or shape.

- ☒ True
- ☐ False

✓

Properties of gases are dependent upon the ____ of the container they are in.

- ☐ pressure
- ☐ temperature
- ☐ volume
- ☒ All of the above

✓

Examples of inert gases include ____.

- ☒ nitrogen and noble gases
- ☐ oxygen and chlorine
- ☐ hydrogen and butane
- ☐ All of the above

✓

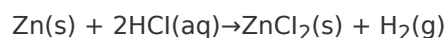
Gas generation tubes mix gases from the experimental reaction with gases from the environment.

- ☐ True
- ☒ False

✓

Exercise 1

Write a balanced chemical equation describing the reaction of zinc and hydrochloric acid.



What gas was produced by the reaction of zinc and hydrochloric acid? How did this gas behave in the presence of fire?

Hydrogen gas was produced. When exposed to the flame, there was a small pop, almost like a little explosion.

What gas was produced by the decomposition of hydrogen peroxide? What happened when the smoldering toothpick came in contact with the gas?

Oxygen was produced. When the smoldering toothpick was placed in the pipet bulb, it reignited or burned more brightly.

Compare the behavior of the mixture of gases with each solitary gas in the presence of flame.

The mixed gases produced a greater explosion. The popping noise created by the mixture of gases was much louder than of the hydrogen alone.

Outline the procedures you would use to determine whether a gas sample was composed of hydrogen or oxygen.

I would expose a flame to each gas sample, if the flame exposed to the gas grows brighter, the gas is oxygen. If the flame exposed to the gas "explodes", the gas is hydrogen.

Data Table 1: Gas Observations
(SAMPLE ANSWER BELOW)

Chemicals	Observations
HCl + Zinc	Reaction produces numerous clear bubbles.
Hydrogen Gas + Flame	Popping sound occurs and the flame extinguishes. Sounds like a small explosion. The tip of the match flew off of the matchstick.
Mn + H ₂ O ₂	The mixture produces numerous clear bubbles, the solution becomes warm and rust colored.
Oxygen Gas + Smoldering toothpick	The smoldering toothpick flares, or reignites when exposed to the oxygen gas.
Gas Mixture + Flame	The mixture of gases produces a loud pop and extinguishes the flame. The "explosion sound" is louder than for the hydrogen gas alone. The oxygen helps to fuel the explosion.

Exercise 2

The chemical equation for the reaction of baking soda (sodium bicarbonate, NaHCO₃) and vinegar (acetic acid, CH₃COOH) may be written as two steps. Fill in the missing information for the chemical equation.

Step 1: _____ + _____ → CH₃COONa(aq) + H₂CO₃(l)

Step 2: H₂CO₃(l) → H₂O(l) + _____

[NaHCO₃, CH₃COOH]
[CO₂]

Write a chemical equation for the reaction of CO₂ and limewater (Ca(OH)₂). Write a physical description of the products formed.

CO₂(g) + Ca(OH)₂(aq) → CaCO₃(aq) + H₂O(l)
Water is a clear liquid and calcium carbonate is a solid white precipitate.

When the bromothymol blue (BTB) was exposed to the CO₂ gas, what color was the solution? Did the BTB indicate presence of an acid or base? Explain your answer.

Upon exposure, the BTB turned yellow, indicating the presence of an acid.

Did the reaction between the antacid tablet and the tap water produce hydrogen, oxygen, or carbon dioxide gas? Support your answer with results from your work in both Exercise 1 and Exercise 2.

The antacid tablet and tap water produced carbon dioxide, as it produced a precipitate in limewater and extinguished a flame. If the antacid had produced hydrogen or oxygen, the flame would have exploded or become brighter.

Based on your observation of the reaction that occurred when limewater was exposed to your breath, what gas did you exhale? Support your answer with your observations in Data Table 2.

As is common knowledge, humans exhale CO₂. This was evidenced by formation of a white precipitate in the limewater solution.

Data Table 2: Carbon Dioxide Reaction Observations
(SAMPLE ANSWER BELOW)

Reaction	Observations
Ca(OH) ₂ + CO ₂	A slight white, chalky precipitate was formed and settled to the bottom of the well plate
CO ₂ + BTB	The solution changes to a yellow color
CO ₂ + Flame	The flame is immediately extinguished
Ca(OH) ₂ + Antacid/water gas	A slight white, chalky precipitate was formed and settled to the bottom of the well plate

Antacid/water gas + Smoldering toothpick	The flame/smoldering is immediately extinguished
Ca(OH) ₂ + Breath	A slight white, chalky precipitate was formed and settled to the bottom of the test tube

Competency Review

A ____ phase of matter has no fixed volume or shape.

- ☐ solid
- ☐ liquid
- ☒ gas
- ☐ All of the above

Gas molecules are in a constant state of random motion.

- ☒ True
- ☐ False

Gases that are produced by a chemical reaction are commonly observed as ____.

- ☐ precipitates
- ☒ bubbles
- ☐ suspensions
- ☐ light emissions

Gases are categorized as ____ based on their behavior in the presence of fire.

- ☐ flammable
- ☐ oxidizers
- ☐ inert
- ☒ All of the above

Oxidizers ____ the combustion of other materials.

☐ fully stop

☒ facilitate

☐ do not affect

☐ inhibit

✓

A gas generation tube contains both the reactants involved in a chemical reaction and the gases that are produced.

☒ True

☐ False

✓

Placing a smoldering object within a gas sample is an example of a gas flame test technique.

☒ True

☐ False

✓

Both chemical and flame tests are used to positively identify carbon dioxide gas.

☒ True

☐ False

✓

A gas sample that causes a smoldering object to ignite and burn intensely would be categorized as a(n) ____

☐ flammable gas

☒ oxidizer

☐ inert gas

☐ All of the above

✓

A sample of an unknown gas is found to be non-reactive to flame tests and chemically reactive with limewater and bromothymol blue. The gas present in the sample is ____.

- ☐ hydrogen
- ☒ carbon dioxide
- ☐ oxygen
- ☐ All of the above



Extension Questions

Natural gas is used as a cooking fuel in many restaurants and homes. The primary chemical components of natural gas are hydrocarbons known as alkanes. Alkanes are flammable gases. Explain based on your knowledge of categories of gases why this is a superior choice compared to, for example, nitrogen or oxygen gas. (SAMPLE ANSWER BELOW)

A flammable gas is a better choice than an inert gas because an inert gas like nitrogen won't burn and thus can't be used as cooking fuel. Because oxidizers like oxygen make burning things much more combustible, they are also not a good choice for cooking fuel, as their presence as a fuel makes the likelihood of fire getting out of control much more likely to happen, and accidents that do happen much more damaging.