

Flame Test

Type of Lesson:	<u>Content with Process:</u> Focus on constructing knowledge through active learning.	
IPC Content TEKS:	7C	Analyze constituents of various materials (fireworks displays, stars, light sources, metal salts) using spectral-analysis techniques.
Learning Goal/ Instructional Goal:	Given a data table with chemical compounds, formulas, and flame colors students will predict which metal emits the specific flame color.	
Key Question:	How do the chemicals used to make fireworks affect what you see in the sky as they burn?	
Related Process TEKS:		
	(1) Scientific processes. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices	The student is expected to: (A) demonstrate safe practices during field and laboratory investigations; and
	(2) Scientific processes. The student uses scientific methods during field and laboratory investigations.	The student is expected to: (A) plan and implement experimental procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology; (B) collect data and make measurements with precision; (C) organize, analyze, evaluate, make inferences, and predict trends from data; and (D) communicate valid conclusions.
	(3) Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions.	The student is expected to: (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information; (B) draw inferences based on data related to promotional materials for products and services; (C) evaluate the impact of research on scientific thought, society, and the environment; (D) describe connections between physics and chemistry and future careers
To the Teacher:	During this investigation, students observe that different chemicals produce different color flames when burned. Each element has a specific 'fingerprint' used in spectral analysis. The flames produced help identify the elements present in the chemicals.	



Astronomers to help identify the chemicals/gases of different stars in space using spectral analysis. The flame test can be related to the making of fireworks. There is an additional assignment/research if time is available.

The investigation takes time to prepare ahead of time but has nice results for the students to observe. Spend time talking with the students about safety and the importance of following instructions and being safe in lab. Be sure to point out the location of the fire blanket and fire extinguisher in case of an emergency. It is helpful if the students have a lid to a Petri dish near to place over the burning chemicals to carefully extinguish the flames after their observations are completed. Safety is very important and must be reviewed prior to conducting this investigation. Reference the MSDS sheets for each chemical and point out the proper safety precautions for handling and disposal. The directions ask the students to have 2 Petri dishes, one for pure ethanol and one for the substance. The ethanol by itself is used as a control so the students can compare the flame of the sawdust/chemical to the pure ethanol and determine any changes. Some chemicals are difficult to distinguish the difference between the orange of the ethanol and the orange of the chemical. The chemicals in the data table below are easily distinguished from ethanol.

*** CHEMICALS NEED TO BE PREPARED A FEW DAYS IN ADVANCE OF THE LAB FOR BEST RESULTS. The chemicals can be mixed in concentrated solutions or the solution mixed with sawdust and then allowed to dry or become semi dry. The sawdust absorbs the chemicals and when burned, release the desired color. Clean up is much easier with the sawdust compared to the solution.

Multiple Intelligences:	<i>Logical-Mathematical Intelligence—</i>	Consists of the ability to detect patterns, reason deductively and think logically. This intelligence is most often associated with scientific and mathematical thinking.
	<i>Linguistic Intelligence—</i>	Involves having a mastery of language. This intelligence includes the ability to effectively manipulate language to express oneself rhetorically or poetically. It also allows one to use language as a means to remember information.
	<i>Spatial Intelligence—</i>	Gives one the ability to manipulate and create mental images in order to solve problems. This intelligence is not limited to visual domains--Gardner notes that spatial intelligence is also formed in blind children.
	<i>Bodily-Kinesthetic Intelligence—</i>	Is the ability to use one's mental abilities to coordinate one's own bodily movements. This intelligence challenges the popular belief that mental and physical activities are unrelated.

Materials:

- Goggles
- Gloves
- Aprons
- 2 Glass Petri Dishes
- Ethanol
- Ignition source
- Wood shavings soaked in various chemical solutions (metal salts)
- Possible solutions could include:

Compound Name	Formula	Flame Color
sodium chloride	NaCl	Orange
copper (II) nitrate	$\text{Cu}(\text{NO}_3)_2$	Green
copper (II) sulfate	CuSO_4	Blue
iron (III) nitrate	$\text{Fe}(\text{NO}_3)_3$	Yellow
potassium chloride	KCl	Purple
strontium nitrate	$\text{Sr}(\text{NO}_3)_2$	Red





SAFETY NOTE: Point out the location of all fire safety materials such as fire extinguisher fire blanket. It is important to review the MSDS sheets with the students for the chemicals you use. If students are handling the chemicals, goggles and gloves should be worn. The use of a striker or long lighter is best so the fire source is as far from the ethanol as possible. Remind the students to keep the ethanol away from the flame to avoid an explosion. Always wash hands after lab clean up is complete. Remind students to follow safe lab procedures while conducting their investigation. See Texas Safety Manual online for safety during lab investigations: <http://www.tenet.edu/teks/science/safety/index.html>

Engagement:

Ask students about the fire works they have seen. Have them describe the colors produced. Ask how companies produce fireworks with different colors.

Explore:

1. Place a small amount of ethanol in a Petri dish and carefully ignite the liquid. *Be sure to keep the ethanol away from the flame and the ignition source. Observe the color of the flame and record your results.*
2. Place a small amount of the wood shavings soaked in solution on a flame resistance surface (Petri dish if necessary).
3. Add a small amount of ethanol to the wood shavings (about the size of a quarter). *Be sure to keep the ethanol away from the flame and the ignition source.*
4. Almost immediately after the ethanol is added, ignite the wood shavings.
5. After a few seconds observe the flame. In your data table, record the color that you see the flame turn as a result of the different chemical used.
6. After they stop burning let the Petri dishes cool for a minute. Then carefully wipe the surface/Petri dish with a paper towel and rinse out any residue. Dry the Petri dish and return to your station.
7. Repeat steps 2-6 with another chemical you have all 8 chemicals tested.

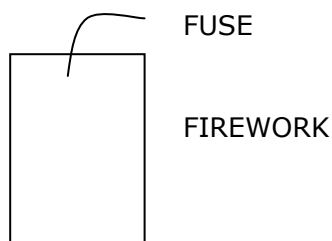
Explain:

COMPOUND NAME	CHEMICAL FORMULA	SOLUTION COLOR	FLAME COLOR

1. Why do we burn ethanol alone in a Petri dish? *To distinguish the orange of the ethanol burning and the color of the chemical burning.*
2. What is the control? *The control is ethanol because it is used in each experiment to distinguish from the chemical color.*
3. What makes the flames different colors? *The different chemicals in the solution. Each chemical has a particular chemical finger print called spectral analysis.*
4. Where have you seen different chemicals being burned and different colors produced? *Different flame colors are commonly found in burning fireworks and other fire displays that need to be different colors.*
5. What professions would use this type of information? *People that make fireworks or perhaps stunt directors to add additional color and richness to a scene.*



- Suppose you were a firefighter and you were called to a chemical plant fire. Upon arrival you see a bright violet/purple flame. What chemical would that tell you is burning? *The chemical potassium based on the data collected produces purple flames.*
- If you were watching a firework burn with a red color, what chemical is used in the fireworks? *Strontium produces red flames when burned.***
- If you observed another firework burn which started yellow and then turned blue, which two chemicals were used? *The fireworks started with iron and then ended with copper sulfate.*
- Using the information in your data table design a firework and then predict what it would look like as it burns.



Various answers would be appropriate. The order of the chemicals would have to match the order of burning. The chemical closest to the fuse would burn first.

Elaborate:

Using the topic of fireworks, research some information about the origin of fireworks, how they are made, what chemicals are used and what color they burn, and uses for fireworks. Write a brief summary paper and turn it in with this lab. You may use the Internet, books, magazines, etc. to collect your research.

Evaluate:

POINTS	Scientific Accuracy	Reasoning	Communication	Collaboration
4	I can accurately explain that different chemicals have particular chemical finger prints called spectral analysis and how this can be applied to the production of fireworks.	I answered the analysis questions accurately.	I communicated answers to the investigation questions completely and thoroughly using correct grammar. I shared my ideas about the investigation in the whole group discussion and with my team mates.	I worked extremely well with my group. Each person had a lot of input and participated in the investigation.
3	I can explain that different chemicals have particular chemical finger prints called spectral analysis and how this can be applied to the production of fireworks.	I answered the analysis questions somewhat accurately.	I communicated answers to the investigation questions and using correct grammar. I shared some of my ideas about the investigation in the whole group discussion and with my team mates.	I worked well with my group. Each person had input and participated in the investigation.

PROPERTIES OF MATTER

Extreme Games!

2	I can somewhat explain that different chemicals have particular chemical finger prints called spectral analysis and how this can be applied to the production of fireworks.	I answered the analysis questions with some errors.	I communicated answers to the investigation questions and with grammatical errors. I shared a few of my ideas about the investigation in the whole group discussion and with my team mates.	I worked somewhat well with my group. Each person had some input and participated in the investigation.	
1	I cannot explain that different chemicals have particular chemical finger prints called spectral analysis and how this can be applied to the production of fireworks.	I answered the analysis questions with many errors.	I communicated answers to the investigation questions and with many grammatical errors. I did not share my ideas about the investigation in the whole group discussion and with my team mates.	I did not work well with my group. A few people had input and participated in the investigation.	
	Subtotal: ____	Subtotal: ____	Subtotal: ____	Subtotal: ____	TOTAL: ____/16pts

Compound Name	Formula	Color
sodium chloride	NaCl	Orange
copper (II) nitrate	$\text{Cu}(\text{NO}_3)_2$	Green
copper (II) sulfate	CuSO_4	Blue
iron (III) nitrate	$\text{Fe}(\text{NO}_3)_3$	Yellow
potassium chloride	KCl	Purple
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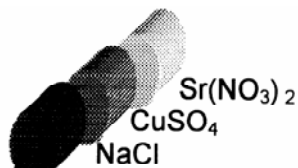
A fireworks employee works in a lab that designs fireworks. He wants to create a firework display that burns blue, red, and orange. If you were helping, what chemicals from the data above would you recommend?

- A. NaCl, CuSO_4 , and $\text{Fe}(\text{NO}_3)_3$
- B. CuSO_4 , KCl, and $\text{Fe}(\text{NO}_3)_3$
- C. KCl, CuSO_4 , and NaCl
- D. $\text{Sr}(\text{NO}_3)_2$, CuSO_4 , and NaCl



The display should start off with blue, then red, and then orange. In order to create the display with the chemicals you have chosen, which drawing represents the correct firing order? (Assume the first chemical to be fired should be placed nearest the fuse end of the cylinder.)

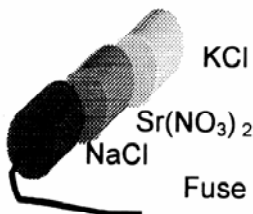
A.



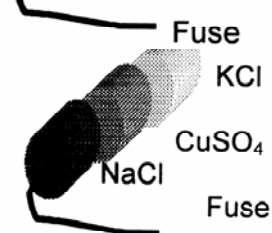
C.



B.



D.



The employee had an accident while working in the lab. The employee was seen running out of the building screaming while the flames on his lab coat gave off a beautiful purple color. What chemical had he spilled on himself?

- A. Sodium Chloride
- B. Strontium Nitrate
- C. Iron Nitrate
- D. Potassium Chloride

References/Resources/Websites:

- <http://chemistry.about.com/library/weekly/aa062701a.htm>
- <http://pubs.acs.org/cen/whatstuff/stuff/7927sci3.html>
- <http://chemistry.about.com/od/fireworkspyrotechnics/>
- <http://www.fireworks.com/safety/chemistry-fireworks.asp>
- http://www.teachersdomain.org/9-12/sci/phys/energy/lp_fireworks/
- <http://alchemy.chem.uwm.edu/amalgamator/NCW/ncw2001/fireworks.html>
- <http://chemistry.allinfoabout.com/features/fireworkcolors.html>

