

# CONTRAILS & CLOUDS

STUDENT WORKSHEET



## **What are the aircrafts contrails made of? Also, what are clouds made of?**

When aircrafts plough through the sky, it is very common to leave long white contrails. While some of these contrails dissipate in a short period of time, others persist in the sky for a long period of time. Moreover, sometimes these contrails get wider and wider.

*What are the aircrafts contrails made of? Also, what are the clouds made of?*



Designed with Canva

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English version revised by David Kerrigan



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## EXPERIMENT

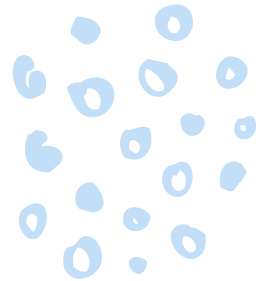
### MATERIALS

#### ACTIVITY 1:

- 1 glass jar with lid
- Water
- Microwave
- Ice cubes

#### ACTIVITY 2:

1 glass jar with lid  
Water  
Microwave  
Ice cubes



### EXPERIMENT DESIGN

#### ACTIVITY 1:

Fill half of the glass jar with water and place it into the microwave until the water is boiling (beware of hot glass materials and do not place a closed jar into the microwave). Remove the glass jar very carefully from the microwave. Add the lid to the glass jar. Place the ice cubes on the lid and wait for a few seconds.

#### ACTIVITY 2:

Pour some water on the plate and place the lit candle in the middle. Now, place the glass, facing down, over the candle.



**ACTIVITY 1**



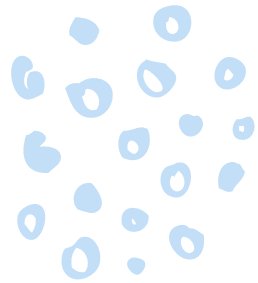
**ACTIVITY 2**

## RESEARCH

In both cases, take a long look to what is occurring. If you are required to do so, repeat the activities again (2 is easy to repeat).

Specifically, examine the inner surface (not in contact with water) of the glass closely.

Discuss your results with your classmates.



*Canva images*





# CONTRAILS & CLOUDS

TEACHER WORKSHEET



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## CONTEXT

STUDENTS: teacher could be able to addapt the theory to be accesible to Elementary, Middle or High School.

SUBJECTS: Physics and Chemistry

## OBJECTIVES

- Understand the physical phenomena underlying cloud formation.
- Comprehend the physicochemical phenomena underlying aircraft contrails formation.
- Describe the phase change from steam to water and vice versa.
- Illustrate a chemical combustion reaction.

## CONTENTS

- Atmosphere water steam
- Change of state
- Combustion reacctions

## SKILLS

- Knowledge construction.
- Scientific inquiry:
  - Questioning.
  - Hypothesis formulation.
  - Experimentation.
  - Data analysis.
  - Results conclusions.
- Collaboration.
- Communicative skills.
- Self-Assessment.
- Critical thinking and problem-solving skills.



Canva images

## EXPLANATION OF THE PHENOMENON

### ACTIVITY 1:

When we place the glass jar half-filled with water into the microwave, the water gets warmer and starts boiling. Once the jar is closed, the water-free inner area saturates with water steam (guide the student to understand that water steam is transparent). Placing the ice cubes on top of the lid, the temperature of the lid decreases.

Furthermore, the water steam temperature also drops and it condensates forming visible water droplets on the inner surface of the glass jar.

Guide the student to understand that water droplets instead of water steam form clouds.

### ACTIVITY 2:

Once we place the glass on top of the candle and the oxygen is depleted, the candle goes out. Two phenomena will immediately occur. The water level will increase and water droplets will form on the inner surface of the glass.

The explanation is as follows; the warm air inside the glass drops the temperature when the candle goes out; causing a decrease in pressure inside the glass due to the contracting gas, which causes a partial vacuum.

Thus, the water level rises as a result of the higher pressure outside the glass forcing the water to rise until the internal and external pressures are equal (guide the student to understand this phenomenon). In contrast, in a combustion reaction the products are always  $\text{CO}_2$  and  $\text{H}_2\text{O}$ ; which, in the first instance are in a gaseous state, but finally the water steam condensates on the inner surface of the jar to form water droplets.

## EXPLANATION OF THE PHENOMENON

### ACTIVITY 1:

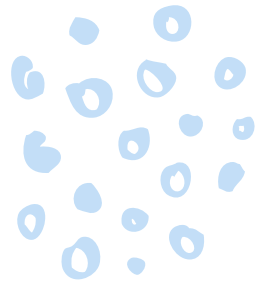


### ACTIVITY 2:



Air rushes out the airplane turbines at high temperature ( $1000\text{ }^{\circ}\text{C}$ ), while the surrounding air temperature is at  $0\text{ }^{\circ}\text{C}$ . This causes the water steam to condensate into small water droplets, forming the contrails (something similar occurs when we breath during the cold days of winter).

The surrounding air conditions are decisive for clouds formation or dissipation.





## GUIDANCE

### Teacher orientation to students

Some students will not be able to reach conclusions by themselves; thus, it is critical to guide them by asking key questions, e.g:

#### ACTIVITY 1:

- Which is the boiling temperature of water?
- What do we encounter inside the glass jar besides water?
- What is happening when we place the ice cubes on top of the lid?
- Which is the origin of the water droplets formed on the inner surface of the jar?

#### ACTIVITY 2:

- Why did the candle extinguish?
- Which are the products of a combustion reaction?
- When the candle is out, what happens to the gas located inside the glass?





## **EVALUATION**

Procedures:

- Inquiry Activity Report.
- Involvement on class discussions and debates.
- Self-evaluation report.
- Student self-evaluation report.

Design of suitable rubrics to evaluate each procedure.

## **BIBLIOGRAPHY**

Scientific American Why do jets leave a white trail in the sky?:

- <https://www.scientificamerican.com/article/why-do-jets-leave-a-white/>

Chemical reactions: combustion

- <https://cpanhd.sitehost.iu.edu/C101webnotes/chemical%20reactions/combustion.html>

## FURTHER ACTIVITIES

### Suggestion of further activities:

Activities based on:

**NASA resources:** <https://go.nasa.gov/2YhgYjb>

#### 1. [A reflexive experiment:](#)

Imagine you are sitting in classroom. Imagine you place an ice cube on a plate and wait until it is totally melted.

Will this event have an impact on the temperature or humidity of the air in that room?

2. Look for or take [your own photographs of aircraft contrails](#) and classify them according to what they indicate about the atmosphere at flight level: very dry (no contrail); dry (short-lived contrail); moist (persistent contrail); and very moist (persistent spreading contrail).

Activities based on:

**Education.com resource:** <https://bit.ly/2W9whaZ>

#### 3. [Making rain:](#)

##### Materials:

- 1 glass jar
- 1 tray
- 2 chairs
- Ice cubes
- 1 book
- Microwave
- 1 cup

##### Procedure:

Fill the glass jar half way with water. Place it in the microwave and boil the water. Place the two chairs one in front of the other. Locate the book in one of the chairs and connect both chairs with the tray. Place the boiling water under the tray (at the book corner) and the empty cup in the other side. Pour the ice cubes on the tray. Observe what is happening.