

1.1 Air Quality: More than Meets the Eye

Engage

Observe the images below of Denver.
Predict the air quality (AQ) of each photo:



Image 1: good air quality poor air quality



Image 2: good air quality poor air quality

Source: http://www.colorado.gov/airquality/live_image.aspx

Engage

Observe the images below of Denver.
Predict the air quality (AQ) of each photo:



Image 1: good air quality poor air quality

VSI: _____ O3: _____



Image 2: good air quality poor air quality

VSI: _____ O3: _____

Explore

Review the “Causes of Air Pollution” fact sheet and diagram

HOW GROUND-LEVEL OZONE FORMS



Source: Regional Air Quality Council [What Causes Air Pollution? | RAQC](https://raqc.org/what-causes-air-pollution/)

<https://cires.colorado.edu/outreach/>

Explore

Air Pollution 101 Demonstration Part 1

Materials & Equipment:

- Clear plastic cup filled $\frac{3}{4}$ full with water (one per student)
- “Pollutants” – shared set of 4 liquid food colors (labeled as CO, NOx, VOC, and O₃), cocoa mix (PM2.5), coffee grounds (PM10), (4-6 students per set)
- Large clear container filled $\frac{1}{2}$ full with water (shared with class)

Ingredient	Air Pollutant	Pollutant Sources
Green food color	Carbon Monoxide (CO) Primary pollutant	Fossil fuel powered vehicle combustion engines (e.g. cars, trucks, trains, planes), home/industrial heating sources, fires (natural, human-caused)
Red food color	Nitrogen Oxide (NOx) Primary pollutant	Fossil fuel powered vehicle emissions (e.g. cars, trucks, buses, off-road equipment), fuel combustion for generating electricity & heat (e.g. power plants, propane tanks, boilers), industrial processes (e.g. oil & gas production, petroleum refining, mining, cement and chemical manufacturing)
Blue food color	Volatile Organic Compounds (VOCs) Primary pollutant	Solvents (e.g. paints, stains, paint removers, nail polish remover, dry cleaning chemicals, degreasers, etc.)
Yellow food color	Ozone (O₃) Secondary pollutant	Formed in the atmosphere when NOx and VOCs combine in the presence of sunlight
Cocoa mix	Fine Particulate Matter – (PM2.5) Primary pollutant or Secondary pollutant	Inhalable fine particles 2.5 micrometers or less in diameter from wildfire smoke, haze formed from vehicle & power plant emissions, etc.
Coffee grounds	Coarse Particulate Matter –(PM10) Primary pollutant or Secondary pollutant	Inhalable coarse particles between 2.5 and 10 micrometers in diameter from dust (e.g. dirt/gravel roads, construction sites), fires (e.g. wildfires, agricultural & prescribed burns), etc.

Explore

Air Pollution 101 Demonstration Part 1

Discussion Questions:

- a. Compare and contrast how the “air” (water) looked before and after you added pollutants based on your actions that contribute to air pollution:
 - “Air” (water) before “pollutants” added:
 - “Air” (water) after “pollutants” added:
- b. Name another source of air pollution that you think affects air quality.

Explain

Air Pollution 101 Demonstration Part 2

1. Predict what you think will happen if each individual's cup of colored water (polluted air) is added to the jar of water (atmosphere).
2. When asked, pour your cup of "polluted air" (colored water) into the "atmosphere" (jar of water). After each individual has added their water to the jar, observe the jar and describe the effect individual contributions of air pollution have on the overall air quality of the atmosphere.

Explain

Air Pollution 101 Demonstration Part 2

3. As a class, view the [AirNow.gov](https://airnow.gov) website.

Discuss the following ways to reduce air pollution. Choose two or more ways you and your family can help to reduce air pollution and improve air quality:

- Drive less - walk, bike, carpool, or take public transportation when possible.
- Save energy – turn off lights, electronics (TVs, computers, etc.), and unplug chargers when not in use.
- On hot, sunny days, mow after 5pm and delay mowing on severe ozone level days.
- Tell adults to avoid car idling and combine errands into one trip.
- Ask adults to refuel vehicles after 5pm on hot, sunny days, stop filling the tank at the “click”, and tighten the gas cap to reduce ozone-forming pollutants.
- Ask adults to turn home thermostat temperatures down in winter (68 F, 10 degrees lower when not home) and up in summer (78 F, 10 degrees higher when not home).
- Let adults know that solvent-based products have air-polluting chemicals and to use water-based paints, stains, sealants, and cleaners instead.
- Avoid painting and staining projects in the heat of the day.
- Reduce, reuse & recycle!

Elaborate

Scientist Snapshot

Meet the scientists who conduct groundbreaking research to understand and find solutions to improve air quality for people, places, and all living things!



Roya Bahreini, University of California-Riverside
Assistant Professor of Atmospheric Science

Elaborate

Visibility and Air Quality Analysis

Have you noticed that on some days in the Front Range the views of the Rocky Mountains look crisp and clear and on other days the views look hazy and blurred?



Scale - Visibility Standard Index	
0 - 50	GOOD
51 - 100	MODERATE
101 - 200	POOR
201 - 300	EXTREMELY POOR
	WEATHER LIMITED
	NOT AVAILABLE

Source: <http://www.colorado.gov/airquality/brochure.aspx>

Elaborate

Kinesthetic Visibility & PM Activity

- A. Particulate Matter (PM) concentration
- B. Particulate Matter (PM) size
- C. Relative humidity (RH)
- D. Haze is the opposite of visibility

Elaborate

Visibility & PM Concept Application

Compare and contrast the images of Denver in terms of visibility (high vs. low), the haze level (the lower the value, the less haze) and the organic/inorganic particulate mass ratio (comparison of the amount of organic PM to the amount of inorganic PM).

View of Downtown Denver 08/02/2014 10:00 AM



Higher visibility Day (30% RH)
Haze Level= 8 Mm^{-1}
Organic/inorganic PM mass= 2

View of Downtown Denver 08/12/2014 10:00 AM



Lower visibility Day (30% RH)
Haze Level= 25 Mm^{-1}
Organic/inorganic PM mass = 4.5

Elaborate

Visibility & PM Concept Application

Compare and contrast the images of Denver in terms of visibility (high vs. low), the haze level (the lower the value, the less haze) and the organic/inorganic particulate mass ratio (comparison of the amount of organic PM to the amount of inorganic PM).

View of Downtown Denver 08/15/2014 10:00 AM



Higher visibility Day (34% RH)
Haze Level= 6 Mm^{-1}
Organic/inorganic PM mass= 1.7

View of Downtown Denver 08/03/2014 10:00 AM



Lower visibility Day (34% RH)
Haze Level= 10 Mm^{-1}
Organic/inorganic PM mass= 2.2

Elaborate

Visibility & PM Data Analysis

Match the following air quality measurements with their correct air quality image below.

1. Circle the image that has the higher visibility (lower haze):

Image 1 (top) 7/26/2014

Image 2 (bottom) 8/11/2014

2. Match and write the correct haze level value on the blanks below for Image 1 and Image 2:
 - a. 21 Mm⁻¹
 - b. 12 Mm⁻¹
3. Match and write the correct ratio of organic to inorganic PM mass on the blanks below for Image 1 and Image 2:
 - c. 3
 - d. 4

Image 1 (top) 7/26/2014

Relative Humidity: ~40%

Haze Level Value: _____

Ratio of Organic to Inorganic PM mass: _____

Image 2 (bottom) 8/11/2014

Relative Humidity: ~40%

Haze Level Value: _____

Ratio of Organic to Inorganic PM mass: _____

Elaborate

Visibility & PM Data Analysis

Image 1 (top)

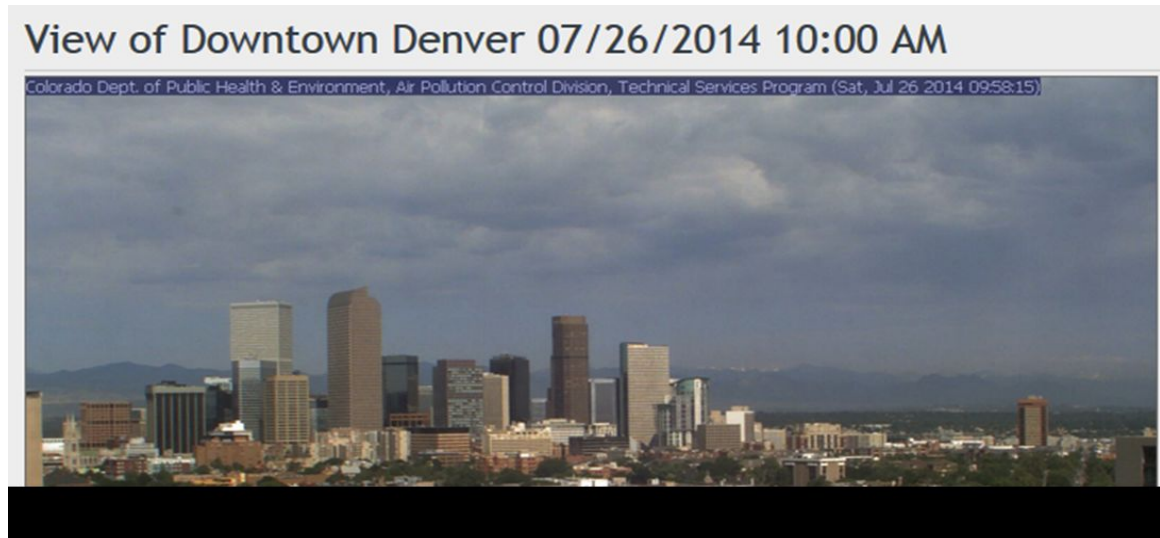


Image 2 (bottom)



Evaluate

Air Quality 3-2-1 Exit Ticket

Complete the exit ticket as you watch the two videos about the 2014 joint FRAPPÉ and DISCOVER-AQ air quality campaign:

- [“Summertime Air Quality with FRAPPÉ”](#) video
- [“The DISCOVER-AQ Mission”](#) video

List three main sources of air pollution that affects air quality.

- 1.
- 2.
- 3.

What are two methods that scientists use to study air quality?

- 1.
- 2.

Circle the one air pollutant that is of most concern for the air quality of Colorado’s Northern Front Range?

Particulate Matter (PM)

Nitrogen Oxides (NO_x)

Ozone (O₃)