

COOLING IT WITH R-12 vs. R-22 vs. R-134

Performance Standards 12B/12C/11A/13A/13B.J

Students will apply the concepts, principles and processes of issue investigation and scientific inquiries to research the sustainability of global air resources.

- *Knowledge*: understand the physical, biological and chemical properties of ozone as it relates to global air composition, environmental impact and industrial applications.
- *Application*: assess costs for technological progress on personal, governmental, economic and ecosystem impact of the use or non-use of refrigerants.
- *Communication*: evaluate the advantages and disadvantages of refrigerants (and its chemical ozone-production) in industrial settings.

Procedures

1. ***In order to know and apply concepts that describe how living things interact with each other and with their environment (12B); concepts that describe properties of matter and energy and the interactions between them (12C); the concepts, principles and processes of scientific inquiry (11A); the accepted practices of science (13A); and concepts that describe the interaction between science, technology and society (13B)***, students should experience sufficient learning opportunities to develop the following:
 - Formulate an issue hypothesis associated with the sustainability of global air resources associated with the effects of refrigerants containing ozone-producers.
 - Review scientific and industrial literature resources which explain the physical, chemical and biological properties and effects of ozone, including its production, decomposition and industrial applications.
 - Differentiate subjective and objective data and their usefulness to the issue.
 - Examine applicable existent surveys, impact studies or models from industrial and environmental resources about different refrigerants that are regulated and the regulatory changes in the recent past.
 - Design and conduct a modified issue investigation to compare the industrial applications and regulations for the use of refrigerants around the world and the possible costs to individuals, governments, local/national/global economics and ecosystems.
 - Interview scientific and industrial experts about the ozone issue, including how the understandings about its impact have changed over time and distinguishing opinion from supported theory.
 - Test simulation models that can provide data about the ozone-refrigerant issue.
 - Interpret and analyze results of findings from varying sources of resource information.
 - Question information sources for bias, validity and reliability and correlation of similar and dissimilar information.
 - Report, display and defend the process and findings of issue investigation.
 - Generalize information from investigation for possible resolution or responses for action.

Note to teacher: This activity relates to knowledge associated with Standards 12B and 12C, while addressing the Performance Descriptors for Stage J within Standards 11A, 13A and 13B. This activity could be incorporated directly in a curricular study of air conditioning or refrigeration. This activity will be beneficial to the student's understanding of the costs of technologies and the environment.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. Introduce students to the basic scientific principles associated with ozone-related refrigeration or air conditioning (other applications to consider: fire extinguishers, banned aerosol propellants, automotive fuels, some cleaning solvents, etc.) processes. Internet research may be a good option for most current resources. Question students about their current understanding about the use of ozone industrially and the regulations that pertain to its use. Students should formulate an issue hypothesis and its counter statement relating to the cost of the impact of refrigerants on the sustainability of global air resources (i.e., world use of refrigerants needs to be reduced vs. world use of refrigerants does not need to be reduced). Students should brainstorm ways to find out about the cost of the impact of refrigerants and how this cost can be estimated. They will also need to consider how various resources may incorporate bias into informational statements. They may suggest outside speakers to present information or suggest industrial/scientific/ commercial resources of information, environmental model software programs, etc. Interviews may be appropriate. The class may divide research about industrial HVAC fields which use regulated refrigerants, governmental policies and union compliance, personal (health,

comfort, disease, safety, etc.) or environmental (sea level, atmospheric), changes over time, etc. Provide sufficient time to collect information, display findings and discuss explanations. They should present their findings by adding to a classroom chart which supports or refutes their issue investigation hypothesis or counter-statement. Students should record their final evaluations about the impact of refrigerants on global air resources.

4. Evaluate each student's work using the Science Rubric as follows, and add the scores to determine the performance level:
 - *Knowledge:* The explanations of the physical, biological and chemical properties of ozone and correlations to industrial applications were complete and unbiased.
 - *Application:* The costs associated with refrigerants impact on personal, governmental, economic and ecosystems were assessed objectively and factually.
 - *Communication:* The individual evaluation of the advantages and disadvantages of refrigerant use showed factual insight and accurate understandings of the issue.

Examples of Student Work

- [Meets](#)
- [Exceeds](#)

Time Requirements

- Portions of 5-7 class periods

Resources

- Access to industrial, scientific and engineering research
- Internet websites such as:
 - http://daac.gsfc.nasa.gov/CAMPAIGN_DOCS/ATM_CHEM/ozone_cycle.html
 - <http://www.atmos.umd.edu/~owen/CHPI/IMAGES/ozonedes.html>
 - <http://www.valdosta.edu/~tmanning/research/ozone/>
 - <http://www.eurobc.net/index.htm>
- Industrial materials
- Governmental regulatory materials
- Science Rubric

SCIENCE RUBRIC

Exceeds - must receive no more than one 3 and the rest 4s in the other areas of the rubric.

Meets - may receive no more than one 2 and a combination of 3s and 4s in the other areas of the rubric.

Approaches - may receive no more than one 1 and a combination of 2s, 3s or 4s, in the other areas of the rubric.

Begins - must receive at least a 1 in all 3 areas of the rubric.

	KNOWLEDGE	APPLICATION	COMMUNICATION
	Knows and understands scientific terms, facts, concepts, principles, theories and methods.	Applies scientific knowledge, skills and methods to manipulate, analyze, synthesize, create and evaluate.	Communicates scientific knowledge and applications through writing, speech and visual displays.
4	<ul style="list-style-type: none"> • Descriptions of scientific terms, facts, concepts, principles, theories and methods are complete and correct. 	<ul style="list-style-type: none"> • Applications are thorough, appropriate and accurate. 	<ul style="list-style-type: none"> • Written, oral and/or visual communication is well organized and effective.
3	<ul style="list-style-type: none"> • Descriptions of scientific terms, facts, concepts, principles, theories and methods are mostly complete and correct. 	<ul style="list-style-type: none"> • Applications are mostly thorough, appropriate and accurate. 	<ul style="list-style-type: none"> • Most of the written, oral and/or visual communication is well organized and effective.
2	<ul style="list-style-type: none"> • Descriptions of scientific terms, facts, concepts, principles, theories and methods are somewhat complete and correct. 	<ul style="list-style-type: none"> • Applications are somewhat appropriate and accurate. 	<ul style="list-style-type: none"> • Some of the written, oral and/or visual communication is organized and effective.
1	<ul style="list-style-type: none"> • Descriptions of scientific terms, facts, concepts, principles, theories and methods are minimally present or correct. 	<ul style="list-style-type: none"> • Applications are minimally appropriate and accurate. 	<ul style="list-style-type: none"> • Little of the written, oral and/or visual communication is organized and effective.
0	<ul style="list-style-type: none"> • All descriptions of scientific terms, facts, concepts, principles, theories and methods are missing and/or incorrect. 	<ul style="list-style-type: none"> • All applications are missing and/or incorrect. 	<ul style="list-style-type: none"> • All of the written, oral or visual communication is missing and/or lacks organization.
Score			