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OZONE SNAPS!

Background Information

Ultraviolet (UV) radiation is electromagnetic energy at wavelengths shorter than that of the color violet, i.e., shorter than the shortest wavelengths that make up the spectrum of visible light. Like visible light, ultraviolet radiation reaches the earth from the sun.

UV radiation can degrade or chemically break down many common materials, such as wood, plastics, paper, textiles and nylon. Damage may include discoloration, blistering, brittleness or loss of strength, warping and cracking.

Ozone (O_3) in the upper atmosphere absorbs some UV radiation and keeps it from reaching the earth's surface. If this ozone layer is depleted by pollutants such as chlorofluorocarbons (CFC's), more ultraviolet radiation can penetrate to ground level.

Acid rain can also damage buildings and ecosystems on the earth's surface. Acid rain forms when sulfur and nitrogen oxides interact with sunlight and moisture. Over time, acid rain can damage copper, galvanized steel, mortar, granite, sandstone, marble and limestone. Many irreplaceable cultural artifacts, monuments, and historic buildings are made of these materials.

In this investigation, you will explore the effects of air pollution on rubber.

Problem: *(fill in problem):* _____

_____

Hypothesis:

If _____

Then _____

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OZONE SNAPS! INVESTIGATION CONT.

Materials

9 natural rubber bands per student
3 clean, wide-mouthed glass jars
2 wide-mouthed glass jar lids
3 smaller jar lids
magnifying glass
metric ruler

Procedure

1. Stretch the first rubber band out as far as you can without breaking it. Measure this distance and record on the data table.
2. While the rubber band is stretched, slide it around one of the smaller jar lids.
3. Use a magnifying glass to examine the rubber bands. Look for damage such as cracks or tears. Record notes about any blemishes you find, the color of the bands, and anything else you observe about their appearance. With your finger, push on each rubber band and note how it feels – the texture, how easily it snaps, etc. Record your observations on the data table.
4. Repeat steps 1-3 for two more rubber bands.
5. Repeat steps 1-4 using three more rubber bands on each of the remaining small jar lids.
6. Place a set of rubber bands (3) in each jar.
7. Tightly close two of the jars.
8. Place one closed and one open jar in a sunny location outside. This is your experimental group.
9. Place the other closed jar away from direct sunlight or bright artificial light inside. This is your control group.
10. After one week, use the magnifying glass to examine the rubber bands in each of the jars. Record any differences. Push on one of the rubber bands and note any changes on the data table.
11. If you do not notice any differences, continue the experiment. Check the rubber bands once a week and record their condition.
12. When you see or feel changes in the rubber bands, record your observations. Then carefully remove one of the bands from the lid. Stretch it as far as you did before first putting it on the lid. Record what happens. Do this with each rubber band.

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Observations

		Jar 1 *(sealed and stored outside)*	**Jar 2** *(left open and stored outside)*	**Jar 3** *(sealed and stored inside)*
	Rubber Band Length (cm)			
Beginning	#1			
	#2			
	#3			
Ending	#1			
	#2			
	#3			
	Other observations			
Beginning	#1			
	#2			
	#3			
Week 1	#1			
	#2			
	#3			
Week 2	#1			
	#2			
	#3			
Week 3	#1			
	#2			
	#3			
Ending	#1			
	#2			
	#3			

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Conclusion

1. What difference was found in the rubber bands that were exposed to UV, air pollution and UV, and those not exposed to outside air pollution or UV?

_____

_____

_____

2. Compare the results of the experiment with your hypothesis. _____

_____

3. What practical problems might the effects of air pollution on rubber imply? _____

_____

4. How could this experiment be improved? _____

_____

Application

5. Since materials such as rubber are affected by exposure to UV radiation and air pollutants, among other things, would you expect the cost associated with deteriorated materials to be felt unevenly across the globe? If so, what places would you expect to experience the most damage?

_____

_____

OZONE SNAPS! INVESTIGATION CONT.

6. Acid-rain damage to ancient buildings, statues and monuments has increased in the last 20 years. Historic structures damaged by acid rain include the Statue of Liberty, the Sphinx in Egypt, the Colosseum in Rome, and the Great Wall of China.

   Sandstone, limestone and marble are affected the most, because these minerals contain calcium. Acid rain reacts with calcium to form gypsum ($CaSO_4 \cdot 2H_2O$). Crystals of gypsum grow, damaging and crumbling the stone.

   What could or should be done about this situation? Give three reasons to support your opinion.

_____

_____

_____

_____

_____

Going Further

7. Acid rain is rain with a pH between 1 and 5.5. Vinegar can be used in simple experiments to simulate acid rain. Using three more rubber bands, compare the difference in elasticity before and after the rubber bands have soaked in vinegar for 10 minutes.

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