Lab: Auto Emissions

Background Information

Emissions from an individual car are generally low relative to the smokestack image many people associate with air pollution. But in numerous cities across the country, the personal automobile is the single greatest polluter, as emissions from millions of vehicles on the road add up. Driving a private car is probably a typical citizen's most "polluting" daily activity. Pollution from cars comes from by-products of the combustion process (exhaust) and from evaporation of the fuel itself. The major exhaust pollutants are:

• HYDROCARBONS result when fuel molecules in the engine do not burn or burn only partially. Hydrocarbons react in the presence of nitrogen oxides and sunlight to form ground-level ozone, a major component of smog. Ozone irritates the eyes, damages the lungs, and aggravates respiratory problems. A number of exhaust hydrocarbons are also toxic, with the potential to cause cancer.
• NITROGEN OXIDES (NO_x) like hydrocarbons, are precursors to the formation of ozone. They also contribute to acid rain.
• CARBON MONOXIDE (CO) occurs when carbon in the fuel is partially oxidized rather than fully oxidized to carbon dioxide. Carbon monoxide reduces the flow of oxygen in the bloodstream and is particularly dangerous to persons with heart disease.
• CARBON DIOXIDE (CO_2) is a "greenhouse gas" that traps the earth's heat and contributes to the potential for global warming.
• PARTICULATE MATTER (PM) is made up of a number of components, including acids, organic chemicals, metals, and soil or dust particles. Particles that are 10 micrometers in diameter or smaller generally pass through the throat and nose and enter the lungs. Once inhaled, these particles can affect the heart and lungs and cause serious health effects.

The Clean Air Act of 1970 gave EPA broad authority to regulate motor vehicle pollution, and the Agency's emission control policies have become progressively more stringent since the early 1970's. EPA standards dictate how much pollution autos may emit but automakers decide how to achieve the pollution limits. The emission reductions of the 1970's came about because of fundamental improvements in engine design, plus the addition of charcoal canisters to collect hydrocarbon vapors and exhaust gas recirculation valves to reduce nitrogen oxides. The advent of "first generation" catalytic converters in 1975 significantly reduced hydrocarbon and carbon monoxide emissions. The use of converters provided a huge indirect benefit as well. Because lead inactivates the catalyst, 1975 saw the widespread introduction of unleaded gasoline. This resulted in dramatic reductions in ambient lead levels and alleviated many serious environmental and human health concerns associated with lead pollution. The next major milestone in vehicle emission control technology came in 1980-81. In response to tighter standards, manufacturers equipped new cars with even more sophisticated emission control systems. These systems generally include a "three-way" catalyst (which converts carbon monoxide and hydrocarbons to carbon dioxide and water, and also helps reduce nitrogen oxides to elemental nitrogen and oxygen), plus an on-board computer and oxygen sensor.

Efforts by government and industry since 1970 have greatly reduced typical vehicle emissions. In those same years, however, the number of miles we drive has more than doubled. The increase in travel has offset much of the emission control progress. The net result is a modest reduction in each automotive pollutant except lead, for which aggregate emissions have dropped by more than 95 percent. With ozone continuing to present a persistent urban air pollution problem, future vehicle emission control programs will emphasize hydrocarbon and nitrogen oxide reductions. Carbon monoxide control will remain critical in many cities, and limits on vehicle-generated carbon dioxide may become important in the future. (source: EPA)

Prelab Questions:

1. Name the five major pollutants from vehicle emissions.
2. Summarize efforts by the EPA to limit vehicle emissions.
3. Why would different vehicles have different levels of emissions?
4. Read the part one procedure below. What type of pollutant will be measured in this lab?
5. How does the pollution from question four affect human health?

PART ONE Procedure:

For safety reasons, you must start with a "cold" engine. Place two pieces of filter paper together and attach them to the exhaust pipe using rubber bands. Start the engine and let the vehicle run at idle for two minutes. After two minutes, carefully remove the filter paper (be careful not to touch the exhaust pipe directly – it may be hot) and record the car information below.

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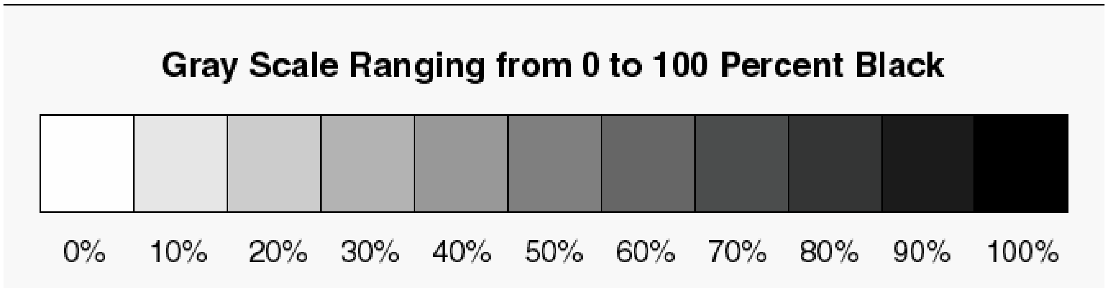

PART ONE Data:

Vehicle Make: ______________________

Vehicle Model: ______________________

Vehicle Year: ______________________ diesel? Y / N

Odometer Reading: ______________________
(to nearest 1,000)

Percent Gray Scale: ______________________

CLASS DATA	Vehicle	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Odometer															
	% Gray															

PART TWO Procedure:

Visit the website www.fueleconomy.gov, then click on "find and compare cars". Choose the year, make and model of the vehicle tested and enter the data below. Next, click "compare up to four vehicles" and add three vehicles that your family or friends own. Lastly, record the vehicle with the highest and lowest percent gray scale from part one of our lab.

PART TWO Data:

	Year	**Make**	**Model**	**Fuel Economy combined MPG** (fuel economy tab)	**Petroleum Consumption** (energy & environment tab)	**Greenhouse Gas Emissions** (energy & environment tab)	**EPA Smog Rating** (energy & environment tab)
Tested vehicle							
Family/friend vehicle							
Family/friend vehicle							
Family/friend vehicle							
Best tested vehicle @GH							
Worst tested vehicle @GH							

(continued)

Analysis:

Combine your data from part one with other vehicles in the class to create a graph with Odometer Reading on the x-axis and Percent Gray Scale on the y-axis. Draw a best-fit curve through the points.

6. What does percent gray scale represent in this lab?
7. Describe the relationship between odometer reading and percent gray scale (if any).
8. Which GH vehicle performed the best (least emissions)? Which performed the worst (most emissions)?
9. Relate emissions, odometer reading and mpg.
10. Rank the categories from above in terms of importance to you in the purchase of a car (make, model, mpg, petroleum consumption, emissions and smog rating)
11. At what gasoline price would you change your driving habits? (drive less, carpool, use mass transit)
12. At what gasoline price would you change the vehicle you drive? (sell your car and buy a more efficient one)

(done!)