Lab: Auto Emissions

(MAKEUP VERSION)

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 do different vehicles have different levels of emissions?

4. What pollutants will future vehicle emission control programs target?

5. How do vehicle emissions affect human health? (not given, check your notes if needed)

(continued on back)

What we did in class:
Students tested their cars in the GH parking lot by placing filter paper over the tailpipe. This method yields results only for particulate pollution, as gaseous pollutants will pass freely through the filter paper. They then analyzed data and researched efficiency data at www.fueleconomy.gov.

Procedure: Watch this video (https://vimeo.com/195479547) and answer the following questions.

6. What choices you make have an impact on energy use and air pollution?

7. How does pollution vary between gas, hybrid and electric cars?

8. Describe how you can ensure the maximum efficiency with a gas car.

9. How can a driver maximize efficiency when driving?

10. What are some viable alternatives to driving in your own car? Are these available in Cary, NC?

Visit the website www.fueleconomy.gov, then click on "find and compare cars". Choose the year, make and model of vehicles owned by your family or friends. If you do not have three cars, you may choose your "dream car" to add to the list.

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)
Family/friend vehicle							
Family/friend vehicle							
Family/friend vehicle							

Postlab Questions:

11. 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)

12. Relate mpg, gas emissions and smog rating.

13. At what gasoline price would you change your driving habits? (drive less, carpool, use mass transit)

14. At what gasoline price would you change the vehicle you drive? (sell your car and buy a more efficient one)

15. What did you learn in this makeup lab?