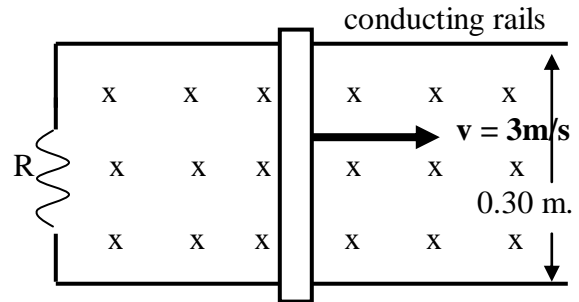


- II.** (5 points) During the past 30 years both the average surface temperature of the earth and the percentage of CO₂ in the atmosphere have increased. **Please explain a plausible mechanism for this correlation between temperature and CO₂ level.**
- III.** (10 points) On a clear day in summer in Bloomington the intensity of sunlight on a horizontal surface can reach 1000 W/m². **Taking as an approximation that an asphalt road is a “black body,” one that absorbs all electromagnetic radiation, please calculate its equilibrium temperature on such a day in summer.**
- IV.** (10 points) A lead acid cell contains a lead (Pb) anode and a lead-peroxide (PbO₂) cathode. **As the cell is discharged the lead electrode dissolves. How much energy can you extract from such a cell while dissolving 500 grams of lead from the lead electrode?** The voltage drop across the lead-acid cell is 2.2 volts, the valence of lead is +2, and the atomic weight of lead is 207.

V. A generator is constructed of two conducting rails in a 0.50 Tesla magnetic field pointing into the page, a $R = 6$ ohm resistor, and a 0.30 meter long conducting bar. (See diagram.) When you push the conducting bar to the right at $v = 3$ m/s, a magnetic force acts on the positive charges (+q) in the bar.



- (5 points) How much work is done on a charge $q = +0.1$ Coulomb by the magnetic field as it pushes the charge from one end of the bar to the other?
- (5 points) How much voltage is generated between the ends of the bar?
- (5 points) How much power is being dissipated in the 6 ohm resistor while the conducting bar is moving to the right at 3 m/s?

VI. (10 points) You decide to replace your gasoline engine with a PEM (proton exchange membrane) hydrogen/oxygen fuel cell, one that uses oxygen and hydrogen as input gases and develops a voltage of 1.229 volts across the cell. **If the fuel cell were 100% efficient at converting chemical energy to electric energy, how many kilograms of H_2 would you need to carry along in your automobile to equal a gallon of gasoline with an energy content of 1.32×10^8 Joules/gal?** Remember that the molecular weight of H_2 is 2 and that an H^+ ion has a charge of $+1.6 \times 10^{-19}$ C.

VII. (5 points) In class we rotated a circular coil of wire in the earth's magnetic field, about 1×10^{-4} Tesla. The coil has about 200 turns and an area of 0.05 m². We were able to rotate the coil at about 5 revolutions/second (i.e. an angular velocity $\omega = 2\pi f = 31.4$ radians/second). **What peak voltage did this rotating coil produce?**

Please use the next two pages to answer 5 of the following 13 questions from your presentations. Each answer is worth 8 points. Make sure to label your answers with the number of the question.

- 1.) **Chris Brinson** in his discussion of automobile engine emissions referred to six different pollutants measured by the Environmental Protection Agency. List three of these pollutants and explain the mechanisms for their reduction in current automobiles.
- 2.) **Mark Sadler** discusses ozone both in the troposphere and in the stratosphere, pointing out that ozone in the stratosphere protects us from ultraviolet radiation. What is the problem with ozone in the troposphere?
- 3.) **Richard Helfrich** identified environmental problems arising from mining coal, drilling for oil, and drilling for natural gas. At the moment we get roughly equal energy from each of these three sources. Which of the three, in your view, provide the greatest threat to the environment? Please explain your reasoning.
- 4.) **Brittney Galliher** calculated the sulfur dioxide expected from the old IGCC plant in Edwardsport, Indiana, one that generates 160MW of electricity at an efficiency of 40%. How many kilograms of coal does this plant use each second if a kilogram of coal supplies 28MJ/kg?
- 5.) **Adam Yowell** explained why “bouncing” back and fourth from rich to lean to rich fuel is useful when removing NO_x, HC, and CO from the exhaust of an internal combustion engine with a catalytic converter. Could you remind us of his argument?
- 6.) **Jim Cutright** listed stress-related consequences of noise for both human beings and animals. Please explain how ambient sound can create devastating consequences for whales, for example.
- 7.) **Brandon Govindarajoo** discussed the photo-catalysts (Ta₂O₅ + SiO₂) as potential water purifiers when exposed to ultraviolet light. He also described a method to shift the absorbance of these photo-catalysts into the visible. Why would this be an advantage?
- 8.) **Maria Beguelin** described the impact of nitrogen pollution on the growth of ocean dead zones. Give a brief explanation of the process by which oxygen is removed from these dead zones.
- 9.) **Winsor Tanner** explained that particulate matter with diameter greater than about 10 microns (10 x 10⁻⁶ meters) is usually not deposited in human lungs. Why are these particles less likely to be found in the atmosphere?
- 10.) **Damian Fricker** talked about ways to use waste energy from one process in the home to accomplish another process. Please explain one of his examples.
- 11.) **Peter Luntz**, in his discussions of life cycle analysis pointed out that the recycling of metals is considerably more energy efficient than the recycling of glass. Please explain why this is the case.
- 12.) **Trevor Corcoran** described the idea of harvesting solar energy by geosynchronous satellite and transmitting it to the ground via microwaves. Please make an estimate of the required area of a 10% efficient photovoltaic array in space needed to equal the output electric power of a 1GWe plant. The insolation above the earth’s atmosphere is about 1350 W/m².
- 13.) **Shodo Spring** evaluated David Blume’s “Alcohol Can Be A Gas.” A question raised during her discussion was whether or not ethanol production increases world hunger. Informed by her presentation, please give a discussion exploring both sides of this question.

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Your 5 Answers:

Your Name \_\_\_\_\_

Continuation of your answers...