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|   | Environmental Science Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Does human breathing contribute to global warming?Man would be bummed if by just breathing we contribute to global warming.  Yet it is a legitimate question to ask, and we can find the answer using simple chemistry.  We will apply dimensional analysis and reasonable assumptions to come up with a ball-park estimate.  Making estimates is an important part of science. Usually we make what is called an order of magnitude estimate, that is, an estimate of the quantity within a factor of ten.  Order of magnitude estimations are important tools, especially in cases like this investigation where determining an exact value for the amount of CO2 produced by the human population is very difficult (or impossible).The ProblemYou will have to determine the approximate volume of air a normal human exhales in a single breath (Choose a normal human from your group.  One of your lab partners may qualify).  Then use conversion factors and assumptions to estimate how much the entire world population exhales per day. The ApproachHow you accomplish this task is up to you and your group members. The following equipment is at your disposal: * A Zip-Closure bag
* A straw
* Water
* Graduated cylinder

 Remembering that about 78% of air is nitrogen, and assuming that all of the oxygen is converted to CO2, determine approximately how much CO2 is being exhaled. Once you have measured the volume of CO2 in a single breath, use conversion factors to calculate how many liters of CO2 are exhaled per person per day.  Finally, extend this result to the entire world population. **Table 1. CO2 level data.**

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| --- | --- | --- | --- | --- | --- |
| **Volume of breath** | **Respiration rate** | **CO2 = O2 in air assumption**  | **World population** | **Current CO2 levels** | **Volume of atmosphere** |
|  |  | 21% CO2 by volume | 7.2 x 109 | 402 ppm | 2 x 1022 L |

http://socrates.berkeley.edu/~chem1a/labmanual/Experiment1_files/image008.gifFrom the graph, you can determine how much of that is CO2 using conversion factors. The unit of parts per million (ppm) is used in the plots.  This unit is a conversion factor itself, indicating 1 part CO2 = 1 million parts atmosphere.   Volume CO2 per person per day: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Total volume CO2 exhaled per day by the world’s population: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ From the graph, you can determine how much of that is CO2. The unit of parts per million (ppm) is used in the plots.  This unit is a conversion factor itself, indicating 1 part CO2 = 1 million parts atmosphere.   Volume of CO2 in the atmosphere:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Does the breathing of the human population contribute significantly to the total volume of CO2 in the atmosphere (compare the order of magnitude volumes of CO2)? Explain your answer.   |

**Atmosphere**, mixture of gases surrounding any celestial object that has a gravitational field strong enough to prevent the gases from escaping; especially the gaseous envelope of Earth. The principal constituents of the atmosphere of Earth are nitrogen (78 percent) and oxygen (21 percent). The atmospheric gases in the remaining 1 percent are argon (0.9 percent), carbon dioxide (0.03 percent), varying amounts of water vapor, and trace amounts of hydrogen, ozone, methane, carbon monoxide, helium, neon, krypton, and xenon.

Causes of Global Warming

 **Carbon Dioxide from Power Plants**
In 2008 about **40% of U.S. carbon dioxide** emissions stem from the burning of fossil fuels for the purpose of electricity generation. Coal accounts for 93 percent of the emissions from the electric utility industry. [US Emissions Inventory 2004 Executive Summary p. 10](http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/RAMR5WNMK2/%24File/04executivesummary.pdf)

Coal emits around [1.7 times as much carbon per unit of energy](http://www.eia.doe.gov/emeu/cabs/carbonemiss/introduction.html) when burned as does natural gas and 1.25 times as much as oil. Natural gas gives off 50% of the carbon dioxide, the *principal greenhouse gas*, released by coal and 25% less carbon dioxide than oil, for the same amount of energy produced. Coal contains about 80 percent more carbon per unit of energy than gas does, and oil contains about 40 percent more. For the typical U.S. household, a metric ton of carbon equals about 10,000 miles of driving at 25 miles per gallon of gasoline or about one year of home heating using a natural gas-fired furnace or about four months of electricity from coal-fired generation.

**Carbon Dioxide Emitted from Cars**
About **20% of U.S carbon dioxide emissions** comes from the burning of gasoline in internal-combustion engines of cars and light trucks (minivans, sport utility vehicles, pick-up trucks, and jeeps).[US Emissions Inventory 2004](http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ResourceCenterPublicationsGHGEmissionsUSEmissionsInventory2004.html#toc) Vehicles with poor gas mileage contribute the most to global warming. For example, according to the E.P.A's 2000 Fuel Economy Guide, a new Dodge Durango sports utility vehicle (with a 5.9 liter engine) that gets 12 miles per gallon in the city will emit an estimated 800 pounds of carbon dioxide over a distance of 500 city miles. In other words for each gallon of gas a vehicle consumes, 19.6 pounds of carbon dioxide are emitted into the air.  [[21]](http://www.ecobridge.org/content/g_ref.htm#air)  A new Honda Insight that gets 61 miles to the gallon will only emit about 161 pounds of carbon dioxide over the same distance of 500 city miles. Sports utility vehicles were built for rough terrain, off road driving in mountains and deserts. When they are used for city driving, they are so much overkill to the environment. If one has to have a large vehicle for their family, station wagons are an intelligent choice for city driving, especially since their price is about half that of a sports utility. Inasmuch as SUV's have a narrow wheel base in respect to their higher silhouette, they are four times as likely as cars to rollover in an accident. [[33]](http://www.ecobridge.org/content/g_ref.htm#accident)

The United States is the largest consumer of oil, using 20.4 million barrels per day. In his debate with former Defense Secretary Dick Cheney, during the 2000 Presidential campaign, Senator Joseph Lieberman said, "[If we can get 3 miles more per gallon](http://www.debates.org/pages/trans2000d.html) from our cars, we'll save 1 million barrels of oil a day, which is exactly what the (Arctic National Wildlife) Refuge at its best in Alaska would produce."

 If car manufacturers were to increase their fleets' average gas mileage about 3 miles per gallon, this country could save a million barrels of oil every day, while US drivers would save $25 billion in fuel costs annually.

**Carbon Dioxide from Trucks**About another **13% of U.S carbon dioxide** emissions comes from trucks used mostly for commercial purposes.

**Carbon Dioxide from Airplanes**
The UN's Intergovernmental Panel on Climate Change estimates that aviation causes 3.5 percent of global warming, and that the figure could rise to 15 percent by 2050.

**Carbon Dioxide from Buildings**
Buildings structure account for about **12% of carbon dioxide** emissions.

**Table 1. Raw CO2 level data.**

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| --- | --- | --- | --- | --- | --- | --- |
| **Volume of breath** | **Respiration rate** | **CO2 = O2 in air assumption**  | **MeasuredCO2 content of breath** | **World population** | **Current CO2 levels** | **Volume of atmosphere** |
| 0.25 L | 10,000 breaths/day | 22% CO2 by volume | 20% CO2 by volume | 6 x 109 | 323 ppm | 2 x 1022 L |

|  |  |  |  |
| --- | --- | --- | --- |
|   | **Volume of a single breath assuming 100% O2 conversion to CO2** | **Volume corrected for CO2 in a single breath** | **Calculated volume from metabolism** |
| CO2 Volume (one person) | 550 L/day | 500 L/day | 408 L/day |
| CO2 volume exhaled (WP) | 3.0 x 1012 L/day | 3.0 x 1012 L/day | 2.0 x 1012 L/day |
| CO2 in atmosphere (ppm) (WP) | 3 x 10-5 | 3 x 10-5 | 2 x 10-5 |