# Vehicle Exhaust Environmental Impacts Explained

https://gemini.google.com/app/be91182772f83f8d

Response: Based on environmental chemistry principles, the correct option is **(1) exhaust gas released from fossil fuel burning vehicles**.

## Detailed Explanation

Exhaust gas from fossil fuel-burning vehicles contains a combination of gases, primary among them being **carbon dioxide ($\mathrm{CO_2}$)**, **nitrogen oxides ($\mathrm{NO}_x$, mainly $\mathrm{NO}$ and $\mathrm{NO_2}$)**, and **volatile organic compounds ($\mathrm{VOCs}$)** or unburnt hydrocarbons.

Here is how these components contribute to all three environmental issues:

1. **Global Warming:**
    - Vehicles emit large amounts of $\mathrm{CO_2}$ (a major greenhouse gas) along with trace amounts of $\mathrm{N_2O}$, which trap heat in the atmosphere.
2. **Acid Rain:**
    - High combustion temperatures inside vehicle engines cause atmospheric $\mathrm{N_2}$ and $\mathrm{O_2}$ to react, forming $\mathrm{NO}_x$.
    - These nitrogen oxides dissolve in atmospheric moisture to form nitric acid ($\mathrm{HNO_3}$), contributing significantly to acid rain.
3. **Photochemical Smog:**
    - Vehicle exhaust is the primary source of both $\mathrm{NO}_x$ and **unburnt hydrocarbons ( $\mathrm{VOCs}$)**.
    - Under sunlight, $\mathrm{NO}_x$ and VOCs undergo photochemical reactions to produce secondary pollutants such as ozone ($\mathrm{O_3}$) and peroxyacetyl nitrate (PAN), which are the main components of photochemical smog.

## Why Other Options Are Incorrect

- **(2) Exhaust gas from coal power plants:** Produces $\mathrm{SO_2}$ and $\mathrm{CO_2}$ (leading to acid rain and global warming), but emits significantly fewer volatile hydrocarbons necessary to trigger classical vehicle-driven **photochemical smog**.
- **(3) Refrigerant gases:** CFCs/HCFCs contribute mainly to ozone layer depletion and global warming, not acid rain or photochemical smog.

- **(4) Municipal solid waste emissions:** Primarily release methane ($\mathrm{CH_4}$) and $\mathrm{CO_2}$ (global warming), but do not directly cause photochemical smog or major acid rain.
- **(5) Biofuel burning vehicle emissions:** Biofuels are generally considered carbon-neutral regarding net global warming emissions over their lifecycle compared to fossil fuels.

**Correct Answer: (1)**

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Response: The **incorrect** statement is **(4) Among Group I elements, lithium has the weakest metallic bonding.**

## Detailed Analysis of Each Statement

- **(1) Among the Group I elements from Li – Cs, lithium has the most negative value for electron gain energy:**

  **Correct.** Electron gain enthalpy ($\Delta_{eg}H$) becomes less negative as you go down Group 1 due to increasing atomic radius and shielding effect. Lithium, being the smallest atom in Group 1, has the most negative (most exothermic) electron gain enthalpy.

- **(2) Lithium forms two products when heated in air:**

  **Correct.** Unlike other Group 1 metals which mainly react with oxygen, lithium reacts with both oxygen ($\mathrm{O_2}$) and nitrogen ($\mathrm{N_2}$) in the air to form **lithium oxide** ($\mathrm{Li_2O}$) and **lithium nitride** ($\mathrm{Li_3N}$).

- **(3) Considering the gases evolved, upon heating $\mathrm{LiNO_3(s)}$ produces two gases whereas $\mathrm{Li_2CO_3(s)}$ gives only one gas:**

  **Correct.** Due to the high charge density of the small $\mathrm{Li^+}$ ion, lithium nitrate thermally decomposes similarly to Group 2 nitrates, giving **two gases** ($\mathrm{NO_2}$ and $\mathrm{O_2}$):

  $$\mathrm{4LiNO_3(s) \xrightarrow{\Delta} 2Li_2O(s) + 4NO_2(g) + O_2(g)}$$

  In contrast, lithium carbonate decomposes to yield **only one gas** ($\mathrm{CO_2}$):

  $$\mathrm{Li_2CO_3(s) \xrightarrow{\Delta} Li_2O(s) + CO_2(g)}$$

- **(4) Among Group I elements, lithium has the weakest metallic bonding:**

  **Incorrect.** Metallic bonding strength increases with **smaller ionic radii** and **higher charge density**. Because $\mathrm{Li^+}$ has the smallest ionic radius in Group 1, its delocalized electrons are held most tightly to the nuclei. Thus, lithium actually has the **strongest** metallic bonding in Group 1 (which gives it the highest melting point and hardness among alkali metals).

- **(5) Lithium gives a red coloured flame in the flame test:**

**Correct.** Lithium salts impart a characteristic crimson/carmine red color to a non-luminous flame.

**Correct Answer: (4)**

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