Name _____ Date _____ Period _____

Gas Ws #7: Airbags - Chemical Reactions that Save Lives

Show all your work and provide answers in the correct number of sig figs. Circle your final answer with units

The nitrogen gas for a standard airbag's inflation comes from a series of chemical reactions. The gas generator contains and electrical igniter and a precise mixture of sodium azide, NaN_3, potassium nitrate, KNO_3, and silicon dioxide, SiO_2. These chemicals are contained within a folded fabric pouch with tiny holes. When ignited, the sodium azide decomposes rapidly and produces sodium metal and nitrogen gas.

Reaction #1 **NaN_3 (s) → Na (s) + N_2 (g)**

The sodium that is set free combines with the potassium nitrate and releases even more nitrogen gas.

Reaction #2 **Na (s) + KNO_3 (s) → K_2O (s) + Na_2O (s) + N_2 (g)**

Finally, the heat released by these reactions melts the reaction products and silicon dioxide to form small pieces of an unreactive, safe glass.

Reaction #3 **K_2O (s) + Na_2O (s) + SiO_2 (s) → glass**

1. What chemicals are in a standard airbag?
   sodium azide, NaN_3, potassium nitrate, KNO_3, and silicon dioxide, SiO_2
2. What gas if formed that inflates the airbag?
3. Balance the equation for reaction #1 and #2 above.
   Reaction #1 **$2NaN_3$ (s) → $2Na$ (s) + $3N_2$ (g)**
   Reaction #2 **$10Na$ (s) + $2KNO_3$ (s) → K_2O (s) + $5Na_2O$ (s) + N_2 (g)**
4. Is more gas produced by the first reaction or the second reaction? How can you tell?

5. Why is it necessary to have the second reaction? (think about the chemical properties of Sodium)
   You wouldn't want sodium metal to react in a violent exothermic reaction with any water to produce a strong base. At least not while you are having a wreck.
6. A typical airbag contains 132.0 g of sodium azide. Use stochiometry to determine the number of moles of nitrogen gas and the number of moles of solid Na produced in the 1st decomposition reaction of NaN_3.

7. Assuming all of the Na from the 1st reaction goes on to react with excess KNO_3 in the second reaction, how many moles of nitrogen gas are produced in the second reaction? .203 mol **N_2 (g)**

8. What is the total number of moles of nitrogen gas produced by these two reactions?
9. What volume of nitrogen gas would be produced at STP? 79.0 L **N_2 (g)**
10. Weather conditions are rarely STP. So, suppose you are in Tahoe to snowboard and it is 17.0°C and the air pressure is 747 torr. What volume of gas would be produced at this temperature and pressure?
11. You decide to drive to Mexico for a vacation. Unfortunately, you get into an accident south of the border. It is 29.0°C and the air pressure is 0.80 atm. If your airbag inflates, what volume of gas will be produced? 101. L **N_2 (g)**

12. Why is it necessary to have tiny holes in an airbag material?
13. What would happen if a manufacturer accidentally doubled the amount of NaN_3it placed in the airbag?
    The volume of **N_2** gas produced would also double, given that the NaN_3 was the limiting reactant in Reaction#1 and Na was the limiting reactant in Reaction #2. This would likely cause the airbag to explode.
14. Calculate the number of moles of nitrogen produced in the first reaction if there were 264 g of NaN_3.
15. What volume of nitrogen gas would be produced by the 1st reaction if 264 g of sodium azide react completely and you were in the rare spot on earth where it was 0.00°C and 1.00 atm. 136. L **N_2 (g)**

16. What would happen if scientist did not account for variations in temperature and pressure in the development of airbags?
17. Isn't it nice to know that there is a practical application to all of this fun gas law stoichiometry stuff?
    Define "nice to know"