$FW_{NH_4NO_3} = 80.0434\ g/mol$

$$2\,NH_4NO_3(s) \longrightarrow 2\,N_2(g) + O_2(g) + 4\,H_2O(g)$$

At 300°C, ammonium nitrate violently decomposes to produce nitrogen gas, oxygen gas, and water vapor. What is the total volume of gas that would be produced at 1.00 atm by the decomposition of 15.0 grams of ammonium nitrate?

To simplify this problem, find the TOTAL MOLES of gas rather than using the individual substances!

1- Convert 15.0 g of ammonium nitrate to moles using formula weight
2 - Convert moles ammonium nitrate to moles gas using chemical equation
3 - Convert moles gas to volume using ideal gas equation

$80.0434\,g\ NH_4NO_3 = mol\ NH_4NO_3$ | $2\ mol\ NH_4NO_3 = 7\ mol\ gas$

$$15.0\,g\ NH_4NO_3 \times \underset{①}{\frac{mol\ NH_4NO_3}{80.0434\,g\ NH_4NO_3}} \times \underset{②}{\frac{7\ mol\ gas}{2\ mol\ NH_4NO_3}} = 0.655894\ mol\ gas$$

$$V = \frac{nRT}{P}$$

$n = 0.655894\ mol$ $\quad R = 0.08206\ \frac{L\cdot atm}{mol\cdot K}$ $\quad V = ???$

$T = 300\,°C = 573\,K$ $\quad P = 1.00\ atm$

$$V = \frac{(0.655894\ mol)\left(0.08206\ \frac{L\cdot atm}{mol\cdot K}\right)(573\,K)}{(1.00\ atm)} = \boxed{30.8\,L\ gas}$$

REAL GASES

- The empirical gas laws (including the ideal gas equation) do not always apply.

  - The gas laws don't apply in situations where the assumptions made by kinetic theory are not valid.

    - When would it be FALSE that the space between gas molecules is much larger than the molecules themselves?

      - at high pressure, molecules would be much closer together!

    - When would it be FALSE that attractive and repulsive forces would be negligible?

      - at high pressure, attractions and repulsions should be stronger!

      - at low temperature, attractions and repulsions have a more significant affect on the paths of molecules

-The gas laws are highly inaccurate near the point where a gas changes to liquid!

- In general, the lower the pressure and the higher the temperature, the more IDEAL a gas behaves.

van der Waals equation

- an attempt to modify PV = nRT to account for several facts.
  - gas molecules actually have SIZE (they take up space)
  - attractive and repulsive forces

$$PV = nRT$$ Ideal gas equation

$$\left(P + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$ van der Waals equation

$\frac{n^2 a}{V^2}$: attempts to account for attractive / repulsive forces

nb: attempts to account for molecular size

* "a" and "b" are experimentally determined parameters that are different for each gas. p211

He: $a = 0.0346$, $b = 0.0238$ tiny, no special attractive forces

H_2O: $a = 5.537$, $b = 0.03049$ small, but strong attractions between moleculres

CH_3CH_2OH: $a = 12.56$ $b = 0.08710$ larger, and strong attractions between molecules