In[1]:= dipole moment of SF4

Input interpretation:

sulfur tetrafluoride	dipole moment

Result:

0.632 D (debyes)

Unit conversions:

2.108×10^{-18} pC m (picocoulomb meters)

2.108×10^{-21} nC m (nanocoulomb meters)

2.108×10^{-30} C m (coulomb meters)

0.2486 au's of electric dipole moment

WolframAlpha

In[2]:= CH3OH + O2 = CO2 + H2O

Input interpretation:

CH_3OH (methanol) + O_2 (oxygen) ⟶ CO_2 (carbon dioxide) + H_2O (water)

Balanced equation: Start over

Balance the chemical equation:

$$CH_3OH + O_2 \longrightarrow CO_2 + H_2O$$

Add coefficients to all the molecules:

$$c_1\, CH_3OH + c_2\, O_2 \longrightarrow c_3\, CO_2 + c_4\, H_2O$$

The number of C, H, and O atoms on both sides of the reaction must be equal:

C: $c_1 = c_3$

H: $4\,c_1 = 2\,c_4$

O: $c_1 + 2\,c_2 = 2\,c_3 + c_4$

Since the coefficients are only determined up to a multiplicative constant, set $c_1 = 1$ and solve for the coefficients:

$c_1 = 1$

$c_2 = \frac{3}{2}$

$c_3 = 1$

$c_4 = 2$

Since one of the coefficients is a fraction, set $c_1 = 2$ and repeat the step above to obtain integer coefficients:

$c_1 = 2$
$c_2 = 3$
$c_3 = 2$
$c_4 = 4$

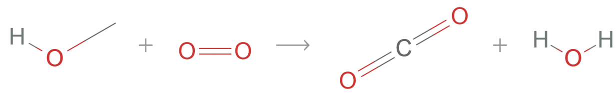
Since the coefficients are all integers with a greatest common denominator equal to 1, substitute the coefficients into the chemical reaction to obtain the balanced equation:

Answer:

$$2\ CH_3OH + 3\ O_2 \longrightarrow 2\ CO_2 + 4\ H_2O$$

Structures:

Skeletal structure



Names:

methanol + oxygen ⟶ carbon dioxide + water

Reaction thermodynamics:

More

Enthalpy:

ΔH^0_{rxn}	−1930 kJ/mol − −477.3 kJ/mol = −1453 kJ/mol (exothermic)

Gibbs free energy:

ΔG^0_{rxn}	−1737 kJ/mol − 362.6 kJ/mol = −2100 kJ/mol (exergonic)

Entropy:

ΔS^0_{rxn}	707.6 J/(mol K) − 868.6 J/(mol K) = −161 J/(mol K) (exoentropic)

+ Units

Equilibrium constant:

$$K_c = \frac{[CO_2]^2\ [H_2O]^4}{[CH_3OH]^2\ [O_2]^3}$$

Chemical names and formulas:

	methanol	oxygen	carbon dioxide	water

formula	CH_3OH	O_2	CO_2	H_2O
Hill formula	CH_4O	O_2	CO_2	H_2O
name	methanol	oxygen	carbon dioxide	water
IUPAC name	methanol	molecular oxygen	carbon dioxide	water

Substance properties:

	methanol	oxygen	carbon dioxide	water
molar mass	32.0419 g/mol	31.9988 g/mol	44.0095 g/mol	18.0153 g/mol
phase	liquid (at STP)	gas (at STP)	gas (at STP)	liquid (at STP)
melting point	−98 °C	−218 °C	−56.56 °C (at triple point)	0 °C
boiling point	64.7 °C	−183 °C	−78.5 °C (at sublimation point)	99.9839 °C
density	0.791 g/cm^3	0.001429 g/cm^3 (at 0 °C)	0.00184212 g/cm^3 (at 20 °C)	1 g/cm^3
solubility in water	miscible			
surface tension		0.01347 N/m		0.0728 N/m
dynamic viscosity	5.44×10^{-4} Pa s (at 25 °C)	2.055×10^{-5} Pa s (at 25 °C)	1.491×10^{-5} Pa s (at 25 °C)	8.9×10^{-4} Pa s (at 25 °C)
odor	pungent	odorless	odorless	odorless

+ Units

WolframAlpha

In[3]:= **5 grams N2 + 2 grams H2 = NH3**

Assuming “H2” is a chemical compound | Use as an isotope instead

Input interpretation:

5 g of N_2 (nitrogen) + 2 g of H_2 (hydrogen) ⟶ NH_3 (ammonia)

Balanced equation:

Step-by-step

$$N_2 + 3\,H_2 \longrightarrow 2\,NH_3$$

Stoichiometry:

Start over

Find the theoretical yield of the following reaction given 5 g N_2 and 2 g H_2:

5 g of N_2 (nitrogen) + 2 g of H_2 (hydrogen) $\longrightarrow$ NH_3 (ammonia)

Convert the specified mass of N_2 into moles using the molar mass (28.0134 g/mol). Convert the specified mass of H_2 into moles using the molar mass (2.01588 g/mol):

$$5\text{ g}\left(\frac{1}{28.0134\text{ g/mol}}\right) = 0.178486\text{ mol } N_2$$

$$2\text{ g}\left(\frac{1}{2.01588\text{ g/mol}}\right) = 0.992123\text{ mol } H_2$$

In order to identify the limiting reactant, make a table of the molar quantities of the reagents corresponding to 0.178486 mol N_2 and 0.992123 mol H_2 (one row for each). Begin by filling in these molar quantities:

	N_2	H_2	NH_3
0.178486 mol N_2	0.178486 mol		
0.992123 mol H_2		0.992123 mol	

Write the balanced equation for the reaction:

$$N_2 + 3\,H_2 \longrightarrow 2\,NH_3$$

Use the ratios of coefficients in the balanced equation to compute the molar quantities of the remaining reagents corresponding to 0.178486 mol N_2:

$$(0.178486\text{ mol } N_2)\left(\frac{3\text{ mol } H_2}{1\text{ mol } N_2}\right) = 0.535458\text{ mol } H_2$$

$$(0.178486\text{ mol } N_2)\left(\frac{2\text{ mol } NH_3}{1\text{ mol } N_2}\right) = 0.356972\text{ mol } NH_3$$

Summarize the results of the previous step in the table:

	N_2	H_2	NH_3
0.178486 mol N_2	0.178486 mol	0.535458 mol	0.356972 mol
0.992123 mol H_2		0.992123 mol	

Use the ratios of coefficients in the balanced equation to compute the molar quantities of the remaining reagents corresponding to 0.992123 mol H_2:

$$(0.992123\text{ mol } H_2)\left(\frac{1\text{ mol } N_2}{3\text{ mol } H_2}\right) = 0.330708\text{ mol } N_2$$

$$(0.992123 \text{ mol } H_2)\left(\frac{2 \text{ mol } NH_3}{3 \text{ mol } H_2}\right) = 0.661415 \text{ mol } NH_3$$

Summarize the results of the previous step in the table:

	N_2	H_2	NH_3
0.178486 mol N_2	0.178486 mol	0.535458 mol	0.356972 mol
0.992123 mol H_2	0.330708 mol	0.992123 mol	0.661415 mol

The limiting reactant (the row with the smallest values) is 0.178486 mol N_2:

	N_2	H_2	NH_3
0.178486 mol N_2	0.178486 mol	0.535458 mol	0.356972 mol
0.992123 mol H_2	0.330708 mol	0.992123 mol	0.661415 mol

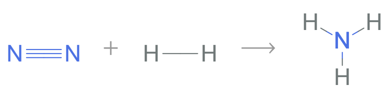
The theoretical yield of the products will be:

Answer:

0.356972 mol NH_3

Structures:

Skeletal structure



Names:

nitrogen + hydrogen ⟶ ammonia

Reaction thermodynamics:

More

Enthalpy:

ΔH^0_{rxn}	−91.8 kJ/mol − 0 kJ/mol = **−91.8 kJ/mol** (exothermic)

Gibbs free energy:

ΔG^0_{rxn}	−32.8 kJ/mol − 0 kJ/mol = **−32.8 kJ/mol** (exergonic)

Entropy:

ΔS^0_{rxn}	386 J/(mol K) − 537 J/(mol K) = **−151 J/(mol K)** (exoentropic)

+ Units

Equilibrium constant:

$$K_c = \frac{[NH_3]^2}{[N_2]\,[H_2]^3}$$

Chemical names and formulas:

	nitrogen	hydrogen	ammonia
formula	N_2	H_2	NH_3
Hill formula	N_2	H_2	H_3N
name	nitrogen	hydrogen	ammonia
IUPAC name	molecular nitrogen	molecular hydrogen	ammonia

Substance properties:

	nitrogen	hydrogen	ammonia
molar mass	28.0134 g/mol	2.01588 g/mol	17.0305 g/mol
phase	gas (at STP)	gas (at STP)	gas (at STP)
melting point	−210 °C	−259.2 °C	−77.73 °C
boiling point	−195.79 °C	−252.8 °C	−33.33 °C
density	0.001251 g/cm^3 (at 0 °C)	8.99×10^{-5} g/cm^3 (at 0 °C)	6.96×10^{-4} g/cm^3 (at 25 °C)
solubility in water	insoluble		
surface tension	0.0066 N/m		0.0234 N/m
dynamic viscosity	1.78×10^{-5} Pa s (at 25 °C)	8.915×10^{-6} Pa s (at 25 °C)	1.009×10^{-5} Pa s (at 25 °C)
odor	odorless	odorless	

+ Units

WolframAlpha

WolframAlpha::nopst : The StoichiometryPod:ChemicalReactionData pod is not reporting any additional information for the StoichiometryPod:ChemicalReactionData__Show all steps pod state. >>

In[4]:= **5 grams N2 + 2 grams H2 = 4 grams NH3**

Assuming “H2” is a chemical compound | Use as an isotope instead

Input interpretation:

5 g of N_2 (nitrogen) + 2 g of H_2 (hydrogen) ⟶ 4 g of NH_3 (ammonia)

Balanced equation: Step-by-step

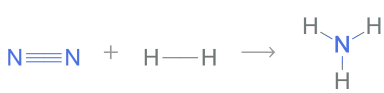
$N_2 + 3\ H_2 \longrightarrow 2\ NH_3$

Stoichiometry: Show volume Step-by-step

reagent	N_2	H_2	NH_3
name	nitrogen	hydrogen	ammonia
amount	0.178486 mol (5 g)	0.992123 mol (2 g)	0.234872 mol (4 g)
equivalents	1 eq (limiting reactant)	1.85285 eq	
theoretical yield			0.356972 mol (6.0794 g)
% yield			65.796%
amount remaining	(none)	0.45666 mol (0.92058 g)	

+ Units

Structures: Skeletal structure



Names:

nitrogen + hydrogen ⟶ ammonia

Reaction thermodynamics: More

Enthalpy:

ΔH^0_{rxn}	−91.8 kJ/mol − 0 kJ/mol = −91.8 kJ/mol (exothermic)

Gibbs free energy:

ΔG^0_{rxn}	−32.8 kJ/mol − 0 kJ/mol = −32.8 kJ/mol (exergonic)

Entropy:

ΔS^0_{rxn}	386 J/(mol K) − 537 J/(mol K) = −151 J/(mol K) (exoentropic)

+ Units

Equilibrium constant:

$[NH_3]^2$

$$K_c = \frac{[NH_3]}{[N_2]\,[H_2]^3}$$

Chemical names and formulas:

	nitrogen	hydrogen	ammonia
formula	N_2	H_2	NH_3
Hill formula	N_2	H_2	H_3N
name	nitrogen	hydrogen	ammonia
IUPAC name	molecular nitrogen	molecular hydrogen	ammonia

Substance properties:

	nitrogen	hydrogen	ammonia
molar mass	28.0134 g/mol	2.01588 g/mol	17.0305 g/mol
phase	gas (at STP)	gas (at STP)	gas (at STP)
melting point	−210 °C	−259.2 °C	−77.73 °C
boiling point	−195.79 °C	−252.8 °C	−33.33 °C
density	0.001251 g/cm^3 (at 0 °C)	8.99×10^{-5} g/cm^3 (at 0 °C)	6.96×10^{-4} g/cm^3 (at 25 °C)
solubility in water	insoluble		
surface tension	0.0066 N/m		0.0234 N/m
dynamic viscosity	1.78×10^{-5} Pa s (at 25 °C)	8.915×10^{-6} Pa s (at 25 °C)	1.009×10^{-5} Pa s (at 25 °C)
odor	odorless	odorless	

+ Units

WolframAlpha

In[5]:= **SF4**

Assuming "SF4" is a chemical compound | Use as a gene or a protein or more instead | Use "SF" as a unit instead

Input interpretation:

sulfur tetrafluoride

Chemical names and formulas:

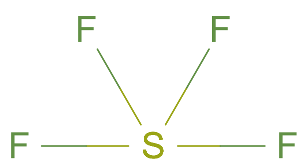
More

formula	SF_4
name	sulfur tetrafluoride

Lewis structure:

Start over

Draw the Lewis structure of sulfur tetrafluoride. Start by drawing the overall structure of the molecule:



Count the total valence electrons of the fluorine $(n_{F,val} = 7)$ and sulfur $(n_{S,val} = 6)$ atoms:

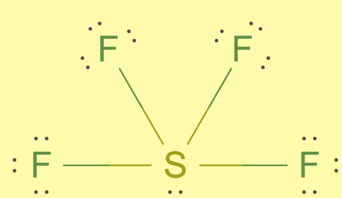
$4\, n_{F,val} + n_{S,val} = 34$

Calculate the number of electrons needed to completely fill the valence shells for fluorine $(n_{F,full} = 8)$ and sulfur $(n_{S,full} = 8)$:

$4\, n_{F,full} + n_{S,full} = 40$

Subtracting these two numbers shows that $40 - 34 = 6$ bonding electrons are needed, which are already accounted for in the structure. Note that the valence shell of sulfur has been expanded. After accounting for the expanded valence, there are 4 bonds and hence 8 bonding electrons in the diagram. Lastly, fill in the remaining unbonded electrons on each atom. In total, there remain $34 - 8 = 26$ electrons left to draw:

Answer:



Basic properties:

molar mass	108.059 g/mol
phase	gas (at STP)

melting point	−123.9 °C
boiling point	4.84 °C
density	0.004417 g/cm^3 (at 25 °C)
solubility in water	decomposes

+ Units

Gas properties (at STP):

density	0.004417 g/cm^3 (at 25 °C)
vapor density	3.78 (relative to air)
molar volume	24 460 cm^3/mol

+ Units

Thermodynamic properties: More

specific free energy of formation $\Delta_f G°$	gas	−6.682 kJ/g
specific heat of formation $\Delta_f H°$	gas	−7.063 kJ/g
critical temperature	364 K	

(at STP)

+ Units

Chemical identifiers: More

CAS number	7783−60−0
PubChem CID number	24555

Toxicity properties: More

short- term exposure limit	1 mg/m^3

+ Units

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link = information about chemistry features;
link = how to access via mathematica