

C - S - N in Air Pollution - and the ozone chain ($N_2 \xrightarrow{hit} NO \xrightarrow{NO} NO_2 \xrightarrow{O} O_3 \xrightarrow{O_3} O_2$) where each is formed [rxns often use ∞] & then reacts

	natural sources	human sources	reaction(s) to FORM it	reaction with H ₂ O	biological effects	properties: senses, lab
CO	CO if NOT enough O ₂ FOREST photosynthesis ↓ ↓ ↓ CO ₂	C-fuel → GLOBAL WARMING due to CO ₂ CAR, PLANE, TRAIN engine exhausts outdoor grill, camp stove in LAB, HCl + NaHCO ₃ → CO ₂ + H ₂ O	$C + O_2 \rightarrow CO$ more O ₂ → CO ₂ $2C + 1O_2 \rightarrow 2CO$ (A) INCOMPLETE combustion COMPLETE combustion $2C + 2O_2 \rightarrow 2CO_2$ (A) SEQUENTIAL * (A)(B) $CO + \frac{1}{2}O_2 \rightarrow CO_2$	$CO + H_2O \rightleftharpoons H_2CO_3$ below H ⁺ + HCO ₃ ⁻ H ₂ O-solubility? med-LOW	hemoglobin (in blood) carries O ₂ CO binds to hg more strongly than dec. O ₂ cells don't get enough O ₂ → suffocation	on QUIZ / EXAM, cannot do BIO-experiment! is SENSELESS (colorless, odorless) (2 meanings) tasteless
CO ₂	FIRES ANIMAL RESPIRATION only CO ₂ CO ₂ if enough O ₂	in LAB, HCl + NaHCO ₃ → CO ₂ + H ₂ O	(A) $2C + 2O_2 \rightarrow 2CO_2$ (B) $CO + \frac{1}{2}O_2 \rightarrow CO_2$	$H_2O + CO_2 \rightarrow H_2CO_3$ below H ⁺ + HCO ₃ ⁻ H ₂ O-solubility? med-LOW	HEALTH (at level of cells) CO ₂ can "smother" as in FIRE EXTINGUISHER, or Lake Nyos CO ₂ -disastr	CO ₂ also colorless, odorless in lab, CO ₂ - (H ₂ O) → ACID LIME WATER TEST Ca(OH) ₂ + CO ₂ → CaCO ₃ (s) + H ₂ O and "Fire Extinguisher" (?)
SO ₂	volcanoes! (and some bacteria?)	combustion of S-containing coal (1-3%) O ₂ → SO ₂ more O ₂	$S + O_2 \rightarrow SO_2$ (A) COMBUSTION $S + O_2 \rightarrow SO_2$ (A)	$H_2O + SO_2 \rightarrow H_2SO_3$ (makes solution acidic) → H ⁺ + HSO ₃ ⁻ H ₂ O-solubility? HIGH	(NATURAL ACID RAIN) (weak) with H ₂ CO ₃ pollutant ACID RAIN (strong) w/ H ₂ SO ₃ , H ₂ SO ₄ similarly, "ACID LUNGS" w/ H ₂ SO ₃ , H ₂ SO ₄ gen + H ₂ O HCl, HNO ₃ → H ⁺ in	SO ₂ has ODOR (pungent, burning) in lab, SO ₂ - (H ₂ O) → ACID in lab, SO ₃ - (H ₂ O) → ACID (as A-B indicator changes color) SO ₃ odor (sharp, → irritate)
SO ₃		SO ₃ indirect, secondary rxn	$SO_2 + \frac{1}{2}O_2 \rightarrow SO_3$ (B) CO + CO ₂ produced simultaneously SO ₃ only produced sequentially	$H_2O + SO_3 \rightarrow H_2SO_4$ H ⁺ + HSO ₄ ⁻ H ₂ O-solubility is HIGH		
N ₂	no, but Fig 6.18, C1C-262, is nitrogen cycle (for Na and N-compounds)	not necessary or useful for I08	N ₂ is start of O ₃ chain; in rxns below, each uses chemical formed before it (a product of 1 is used in 2, etc)	also, HCl(g) + H ₂ O(l) → H ⁺ + Cl ⁻ (aq) H ₂ O-solubility (LOW) Na(g) + H ₂ O(l) → NaOH(aq)	or "BASE LUNGS" NH ₃ + H ₂ O → NH ₄ OH(aq) excess OH ⁻ makes water basic	N ₂ is COLORLESS, ODORLESS ESSAY for DEMO: what did you DO? what did you OBSERVE? what did it happen? (explain)
NO	forest fire, volcano, lightning when HOT high temp	ENGINE - car, plane, coal furnace, bomb	$N_2 + O_2 \xrightarrow{HIGH TEMP} 2NO$ (FREE RADICAL) to visualize, EXCHANGE PARTNERS COMBUSTION → 88	$NO + H_2O \rightarrow HNO_2$ $4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$ is not simple "crunch together" as w/ H ₂ O + CO ₂	NO is "poisonous" (W-28, adds 59-60) NO _x → miscellaneous	odor ("slightly irritating") WAFT, don't SNORT
NO ₂	(when is it NO, NO ₂ ?)	(when is it NO, NO ₂ ?) NOT in O ₃ chain to visualize, 8 → 88 COMBUSTION	at high & low concentration: 1) $2NO + O_2 \rightarrow 2NO_2$ (each NO gets O) at LOW conctn, in O ₃ -chain: 2) $NO + O_3 \rightarrow NO_2 + O_2$ (OTHER STUFF) (C1C, page 45)	$NO_2 + H_2O \rightarrow HNO_2$ $4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$ is not simple "crunch together" as w/ H ₂ O + CO ₂ (appx, THIS should be here, in NO _x -cell)	NO _x → miscellaneous LUNGS ("poisonous") at very low concentration SO ₂ (so were SENSITIVE) #4c (see AQI stds, pg 24) IRRITATES, then → long term damage NO ₂ → HNO ₃ → H ⁺ + NO ₃ ⁻ in LUNGS	reddish-brown gas odor ("very nasty") NO ₂ - (H ₂ O) → ACID
O	same as for O ₃ - why? (O ₂ → O + O direct, O + O ₂ → O ₃ indirect) LIGHTNING (electricity)	also same as for O ₃ (electr. as in O ₃ or UV "Air Purifier")	STRATOSPHERE, O ₂ → 2O (NOT IN CHAIN) VISIBL light 300 nm 3) $NO_2 \xrightarrow{SUNLIGHT} NO + O$	H ₂ O SO ₂ , HCl solubility CO ₂ , O ₂ , Na	produces O ₃ (which is O)	
O ₃	LIGHTNING (electricity) only in stratosphere, O ₂ → 2O → 2O ₃ (not balanced)	from RXNS 3-4 in CHAIN NO → O → O ₂ → O ₃	4) $O + O_2 \rightarrow O_3$ from split of NO ₂ in 3)		of LUNGS, of EYES IRRITATION → DAMAGE short-term long-term (TIRES...) + damage to leaves, rubber	very pale blue odor ("sharp") (distinctive) know it
O ₂	PLANT photosynthesis (H ₂ O + LIGHT → SUGARS + O ₂) CO ₂ chloro-phyll ANIMAL causes CO ₂ -decrease OVER THE CONDITIONS, SOLVENT, CATALYST NOT THE MAIN REACTANTS	lab: 2 H ₂ O → 2 H ₂ + O ₂ respiration → CO ₂ , nat CO ₂ ↑ from respiration	but as a REACTANT O ₂ is in most rxns above) 5) $O_3 \xrightarrow{hit} O_2 + O$ so O ₃ gets away almost C1C pg 48 * incl plants + animal tissue	$O_2(g) \xrightarrow{H_2O} O_2(aq)$ but enough for FISH H ₂ O-solubility? (LOW)	LIFE! O ₂ carried by hemoglobin (in blood) to cells	glowing splint in O ₂ "catches on fire" COLOR less, ODOR less
	Where is "good O ₃ " and why is it good? Where is bad ozone and why is it bad?	stratosphere (absorbs UV-B) troposphere (harmful for people)	"exchange partners" for N ₂ + O ₂ → 2NO, etc (to visualize the reaction) (as shown in 1, 2 above)	"lassoo chemistry" [rip apart or put together] for H ₂ O + CO ₂ / etc (yes, it's CONFUSING, 2)	CaO differs from CO ₂ METALS NON-METAL IONIC NON-METAL NON-METAL non-IONIC COVALENT	make 2x2 grid for all ion-combinations: +1 +2 -1 -2 (bonus: also for +3 and -3) polyatomic ions MEMORIZE

CRITERIA POLLUTANTS: CO, SO₂, O₃, NO_x (NO + NO₂), also PM_{2.5}, PM₁₀, Pb

some VOCs: C₅H₁₂, C₆H₁₄, ... (gasoline)

details of RXNS: 1) (strat) VOC hit, UV-C, 600, + OH

NaHCO₃ + HCl → H₂O + CO₂ + NaCl

H₂O + CO₂ → H₂CO₃ (at LOW concentration) → H⁺ + HCO₃⁻ (at HIGH concentration)

when H₂CO₃ is at HIGH concentration as w/ mine of "HCl + NaHCO₃" in lab:
H⁺ + HCO₃⁻ → H₂CO₃ → H₂O + CO₂(g)
2H⁺ + CO₃²⁻ → H₂CO₃ → H₂O + CO₂(g)
AQUEOUS AQUEOUS AQUEOUS GAS

parentness only if necessary
Ca(OH)₂ (K₂CO₃)

Cl ⁻	CO ₃ ²⁻
K ⁺	KCl
Ca ²⁺	CaCl ₂
	CaCO ₃