Unit 2 + 3 Summary

① ionic bond - bond between ⊕ + ⊖ ions (Coulombic attraction)
ions are the result of e^- transfer between atoms

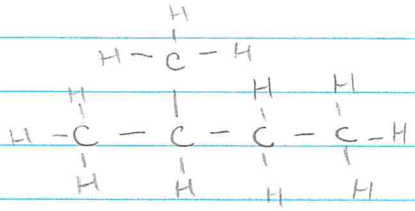
②

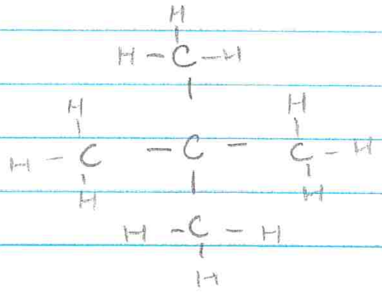
	Cation	Anion
$Mg(NO_3)_2$	Mg^{2+}	NO_3^-
~~Al~~ Al N	Al^{3+}	N^{3-}
Na_3P	Na^+	P^{3-}
NH_4NO_2	NH_4^+	NO_2^-

③ covalent bond - formed by sharing e^-

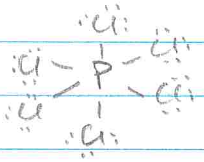
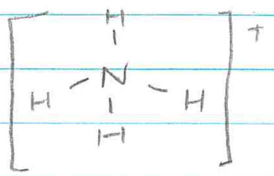
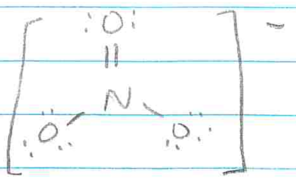
④ Nonmetals tend to form covalent bonds

⑤



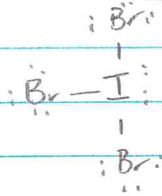
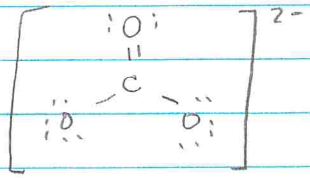


⑥

Molec	lewis structure	# bond pr	# lone pr	molec geo.	e^- geo.	hybrid	diff molec
PCl_6^- $48e^-$		6	0	octahedral	→	—	SF_6
NH_4^+ $8e^-$		4	0	tetrahedral	→	sp^3	CH_4
NO_3^- $24e^-$		3	0	trig Planar	→	sp^2	CO_3^{2-}

has Resonance

⑯ cont

Molec	Lewis structure	# bond pr	# lone pr	molec geo	e⁻ geo.	hybrid	diff molec
IBr_3 28e$^-$		3	2	T-shape	trig bipyr.	—	ICl_3
CO_3^{2-}		3	0	trig planar	→	sp^2	NO_3^-

⑦ [✓ $AlCl_3$] or NaCl : Na has lower IE than Al, takes less energy to pull e⁻ away; Al has higher EN

[✓ $BeCl_2$] or LiF : Be has higher EN, making it more likely to share e⁻ (EN difference btw Be + Cl is lower)

⑧ CH_4 or [✓ CO_2] bond is more polar; e⁻ more unequally shared

[✓ SO_2] or NO_2 EN difference is greatest btw S + O

⑨

	Polar bond?	Polar molec?
CO_2	Y	N
BF_3	Y	N
$CHCl_3$	Y	Y
H_2	N	N

⑩ dipole - a slightly ⊕ end of a molecule (δ+) or slightly ⊖ end (δ-) caused by difference in electronegativities of bonded atoms

⑪ H-bonding - IMF between a hydrogen atom (connected to electronegative atom N, O, or F) and an e⁻ pair of N, O, F of another molecule

⑫ More H-bonding present between molecules will cause an increase in boiling point. More H-bonds means more attractive forces between the molecules. BP increases because it takes more heat to overcome attractive forces + separate molecules + become gas.

⑬ A temporary dipole occurs when e^- are momentarily unequally distributed throughout atom or molec. This can be induced when an ion either attracts or repels e^- in nonpolar atom/molecule, a dipole attracts/repels the e^-, or an adjacent temporary dipole in a different molecule induces dipole.

⑭ a) Chloroethane is polar while butane is nonpolar. Molecules of chloroethane have dipole-dipole interactions, which are stronger them the LDF forces of butane.

b) Acetone is more polar than chloroethane, resulting in greater solubility in polar H_2O

c) butane is nonpolar + cannot form H-bonds.
1-propanol can form H-bonds w/ H_2O.
1-propanol can interact w/ water w/ dipole-dipole forces; butane cannot

d) Molecules of 1-propanol can interact by H-bonding, dipole-dipole, and LDF. Acetone molecules cannot have H-bonds, only dipole-dipole forces + LDF. H-bonds are stronger + result in higher BP

(15) a) the MP increases as strength of intermolecular attraction increases

weak IMF strong IMF

H_2 C_3H_8 HF CsI LiF

The more strongly the molecules are attracted to each other, the higher the MP

SiC is a covalent-network solid, so the atoms are covalently bonded to each other. Covalent bonds are much stronger than IMFs

b) H_2 + C_3H_8 both have LDF between molecules. C_3H_8 is more polarizable than H_2, ∴ the LDFs are stronger in C_3H_8.

CsI + LiF are both ionic cmpds.

Cs^+ is a larger ion than Li^+

I^- is a larger ion than F^-. The Coulombic attraction (due to charges) is smaller in Cs^+ + I^- because of their larger radii.

(16) The C atoms in a diamond are covalently bonded to each other. Covalent bonds are much stronger than IMFs

(17) I_2 has LDF between the molecules. While I_2 is a solid at room temperature, adding some heat will overcome the attractive forces holding the I_2 molecules together, causing the I_2 to sublime.

(18) Ionic cmpds will conduct electricity when dissolved or melted. In these cases the ions can move freely & ∴ conduct electricity

⑲ Metals are good conductors of electricity because the valence e^- in metals are not confined to an individual atom; they can move freely, allowing electricity to be conducted

⑳ A high vapor pressure in a liquid indicates weak intermolecular attraction in the liquid. This would suggest that the MP + BP are low.

㉑ X

㉒ a) Boyle's law; $P_1V_1 = P_2V_2$; n + T constant

b) Charles's law: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$; n + P constant

c) Avogadro's law: $\frac{V_1}{n_1} = \frac{V_2}{n_2}$; P, T constant

d) Gay-Lussac's: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$; n, V constant

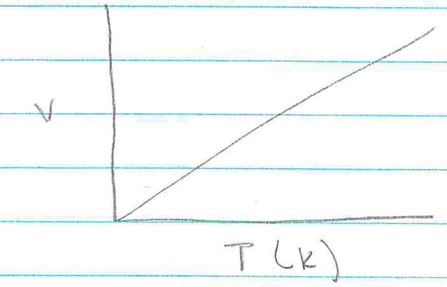
c) combined ; $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$; n constant

f) $PV = nRT$; constant R

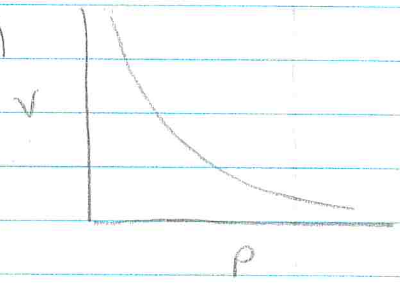
㉓ K

㉔ $R = .08206 \frac{L\,atm}{mol\,K}$ $62.36 \frac{L\,torr}{mol\,K}$

㉕ a)



b)



intercept at 0,0
ideal gas particles have
no V

don't need to convert to L if using combined gas law

(26) $V_1 = 4000.1 \text{ mL} = 4.0001 \text{ L}$

$V_2 = 3002.0 \text{ mL} = 3.0020 \text{ L}$

$P_1 = 750.1 \text{ atm}$

$P_2 = ? \text{ torr}$

$\frac{999.5 \text{ atm}}{} \left| \frac{760. \text{ torr}}{1 \text{ atm}} \right. = \boxed{7.60 \cdot 10^5 \text{ torr}}$

$P_1V_1 = P_2V_2$

$P_2 = \frac{P_1V_1}{V_2}$

$= \frac{(750.1 \text{ atm})(4.0001 \text{ L})}{3.0020 \text{ L}}$

$= 999.5 \text{ atm}$

(27) $P_1 = 1.030 \text{ atm}$

$T_1 = 25.00°C + 273.15 = 298.15 \text{K}$

$T_2 = 1500.°C = 1773 \text{ K}$

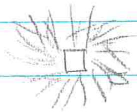
$P_2 = ?$

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$P_2 = \frac{P_1 T_2}{T_1} = \frac{(1.030 \text{ atm})(1773 \text{ K})}{298.15 \text{K}}$

$\boxed{P_2 = 6.125 \text{atm}}$

cans burst



(28) $V_1 = 200. \text{ L}$

$P_1 = 90.1 \text{ kPa}$

$T_1 = 21.0°C = 294.2 \text{ K}$

$V_2 = 15.2 \text{ L}$

$T_2 = 420.°C = 693 \text{K}$

$P_2 = ?$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$P_2 = \frac{P_1V_1T_2}{T_1V_2}$

$= \frac{(90.1 \text{ kPa})(200. \text{ L})(693 \text{ K})}{(294.2 \text{K})(15.2 \text{L})}$

$\boxed{P_2 = 2.79 \cdot 10^3 \text{ kPa}}$

(29) $P = ?$

$V = 5.0 \text{ L}$

$T = 23°C = 296 \text{ K}$

$n = .010 \text{ mg } H_2$

$\frac{.010 \text{ mg } H_2}{} \left| \frac{1 \text{ g}}{1000 \text{ mg}} \right| \frac{1 \text{ mol}}{2.016 \text{g}} = 5.0 \cdot 10^{-6} \text{ mol}$

$PV = nRT$

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

$= \frac{(5.0 \cdot 10^{-6} \text{ mol})(.08206 \frac{\text{L atm}}{\text{mol K}})(296 \text{ K})}{5.0 \text{ L}}$

$\boxed{P = 2.41 \cdot 10^{-5} \text{ atm}}$

or .0183 mmHg / torr

㉚ ideal gas at STP   not STP

$T = 0°C = 273.15\ K$ $T = 25.0°C = 298.2\ K$

$P = 1.00\ atm$ $P = 1.00\ atm$

molar volume = $\frac{L}{mol} = \frac{V}{n}$

$$PV = nRT$$

$$R = \frac{PV}{nT}$$

STP   not STP

$$\frac{PV}{nT} = \frac{PV}{nT}$$

22.4 L/mol

$$\frac{V}{n} \cdot \frac{P}{T} = \frac{V}{n} \cdot \frac{P}{T}$$

$$22.4 \frac{L}{mol} \cdot \frac{1.00 atm}{273.15 K} = \frac{V}{n} \cdot \frac{1.00 atm}{298.2 K}$$

$$\text{molar } V = \frac{V}{n} = \boxed{24.5 \frac{L}{mol}}$$

㉛ $PV = nRT$ molar mass = $\frac{g}{mol}$ $M = \frac{m}{n}$

$n = \frac{m}{M}$

$$PV = \frac{mRT}{M}$$

$$M = \frac{mRT}{PV}$$

㉜ a) $P_{tot} = P_A + P_B + P_C$

b) $P_A = X_A P_{tot}$ $X_A = \frac{n_A}{n_{tot}}$

$$P_{tot} = X_A P_{tot}$$

$$P_{tot} = \left(\frac{n_A}{n_{tot}} + \frac{n_B}{n_{tot}} + \frac{n_C}{n_{tot}}\right) P_{tot}$$

㉝ $V = 454\ mL = .454\ L$

$T = 23.0°C = 296.2\ K$

$P_{tot} = 712\ mmHg$

$P_{H_2O} = 19.8\ mmHg$

$P_{tot} = P_{H_2O} + P_{H_2}$

$712\ mmHg = 19.8\ mmHg + P_{H_2}$

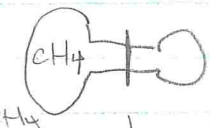
$P_{H_2} = 692\ mmHg$

$PV = nRT$

$$n = \frac{PV}{RT} = \frac{(692\ mmHg)(.454\ L)}{(62.36\ \frac{L\,torr}{mol\,K})(296.2\ K)}$$

$$\boxed{= .0170\ mol\ H_2}$$

㉞



when stopcock is opened, gases will mix

$V_2 = 6.0\ L$

	CH_4	C_2H_6
V_1	$5.0\ L$	$1.0\ L$
P_1	$3.0\ atm$	$.55\ atm$

CH_4: $P_1V_1 = P_2V_2$

$$P_2 = \frac{P_1V_1}{V_2}$$

$$= \frac{(3.0\ atm)(5.0\ L)}{6.0\ L}$$

$P_{CH_4} = 2.5\ atm$

C_2H_6:

$$P_2 = \frac{P_1V_1}{V_2}$$

$$= \frac{(.55\ atm)(1.0\ L)}{6.0\ L}$$

$P_{C_2H_6} = .092\ atm$

$P_{tot} = P_{CH_4} + P_{C_2H_6} = 2.5\ atm + .092\ atm$

$$= \boxed{2.6\ atm}$$

㉟ $V = 8.20\ L$

$n_{H_2} = 2.50\ mol$

$n_{O_2} = .500\ mol$

$P_{Ar} = 2.00\ atm$

$T = 127°C = 400.\ K$

$PV = nRT$

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

a) $P_{tot} = P_{H_2} + P_{O_2} + P_{Ar}$

$$P_{H_2} = \frac{nRT}{V}$$

$$= \frac{(2.50\ mol)(.08206\ \frac{L\,atm}{mol\,K})(400.\ K)}{8.20\ L}$$

$= 10.0\ atm$

$$P_{O_2} = \frac{(.500\ mol)(.08206\ \frac{L\,atm}{mol\,K})(400.\ K)}{8.20\ L}$$

$= 2.00\ atm$

$P_{tot} = P_{H_2} + P_{O_2} + P_{Ar}$

$= 10.0\ atm + 2.00\ atm + 2.00\ atm = \boxed{14.0\ atm}$

㉟ b) $PV = nRT$

cont

$$n_{Ar} = \frac{P_{Ar}V}{RT} = \frac{(2.00\text{ atm})(8.20\text{ L})}{(.08206\ \frac{\text{L atm}}{\text{mol K}})(400.\text{ K})} = .500\text{ mol Ar}$$

$$X_{H_2} = \frac{n_{H_2}}{n_{tot}} = \frac{2.50\text{ mol }H_2}{2.50\text{ mol }H_2 + .500\text{ mol }O_2 + .500\text{ mol Ar}}$$

$$= \boxed{.714}$$

c) $\frac{2.50\text{ mol }H_2}{} \Big| \frac{2.016\text{ g}}{1\text{ mol}} = 5.04\text{ g}$

$\frac{.500\text{ mol }O_2}{} \Big| \frac{32.00\text{ g}}{1\text{ mol}} = 16.0\text{ g}$

$\frac{.500\text{ mol Ar}}{} \Big| \frac{39.95\text{ g}}{1\text{ mol}} = 20.0\text{ g}$

total mass = 41.0g

$$d = \frac{m}{V} = \frac{41.0\text{ g}}{8.20\text{ L}} = \boxed{5.00\text{ g/L}}$$

㊱ NH_3 molar mass = 17.03g/mol

more NH_3 would effuse. NH_3 has a smaller molar mass than the gas w/ molar mass = 26 g mol^{-1}

㊲ molar mass of vapor would be greater than 17.0 g mol^{-1} because it effuses more slowly