CURVEBREAKERS

AP EXAM SUPPLEMENT

*Specifically developed for this year's AP Exam**

AP CHEMISTRY

curvebreakerstestprep.com

facebook.com/curvebreakerstestprep

twitter.com/curvebreakers

instagram.com/curvebreakers

NICK THE TUTOR

**This is not meant to be a comprehensive study guide but rather a companion in your preparation for the exam and for taking the exam. Please refer to CollegeBoard rules and regulations to make sure you are in compliance with all exam rules.*

#NickTheTutor on YouTube

tiktok.com/amp/tag/nickthetutor

Avogadro's Number = # molecules in mole (C-12 atoms in 12g) = $6.02 * 10^{23}$

Particles to mass (g) = $\frac{particles}{6.02*10^{23}} * \ molar\ mass$

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	d	10	deka	da
10^{-2}	centi	c	10^{2}	hecto	h
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	μ	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f	10^{15}	peta	P
10^{-18}	atto	a	10^{18}	exa	E
10^{-21}	zepto	z	10^{21}	zetta	Z
10^{-24}	yocto	y	10^{24}	yotta	Y

[1]

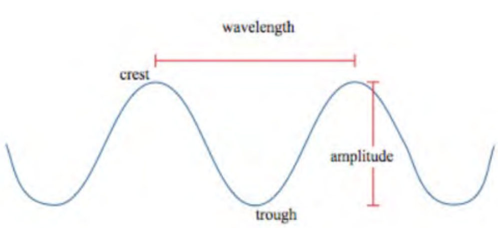
Accuracy = agreement to true value; precision = agreement between measurements

Integers are significant figures, trailing zeroes only if there is a decimal, leading zeroes are not

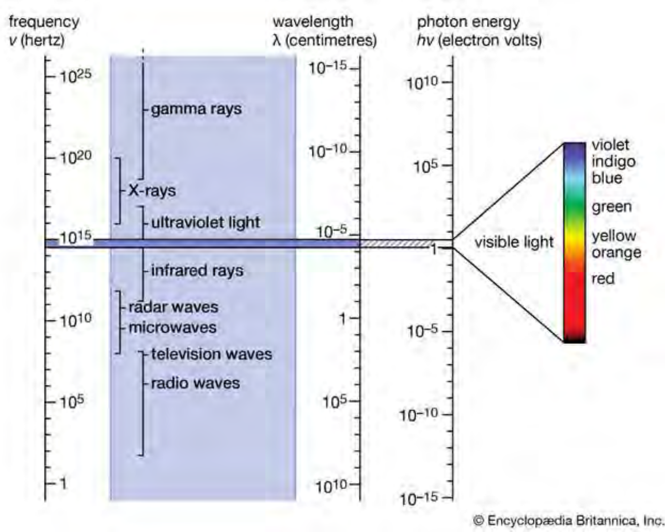
- Addition: # decimal places in result = # from least precise measurement
- Multiplication: # sig figs in result = # sig figs from least precise measurement

Electromagnetic radiation: wavelength (λ) in meters (between two crests) and frequency (how many waves/s)

- High frequency, high energy, low wavelength



[2]



[3]

Ratio of masses of elements making a sample of a compound is always the same (1 mole CO_2 = 1 C: 2 O)

Coulomb's law: F ~ $\frac{q1*q2}{r^2}$

SOLUBLE IONIC COMPOUNDS	INSOLUBLE IONIC COMPOUNDS
1. **Group 1A ions (Li^+, Na^+, K^+, etc.)** and **ammonium ion (NH_4^+)** are soluble.	1. **(Hydroxides) OH^-** and **(Sulfides) S^{2-}**, are insoluble ***except*** when with Group 1A ions (Li^+, Na^+, K^+, etc.), ammonium ion (NH_4^+) and Ca^{2+}, Sr^{2+}, Ba^{2+}.
2. **(Nitrates) NO_3^-, (acetates) CH_3COO^- or $C_2H_3O_2^-$**, and most **perchlorates (ClO_4^-)** are soluble.	2. **(Carbonates) CO_3^{2-}** and **(Phosphates) PO_4^{3-}** are insoluble ***except*** when with Group 1A ions (Li^+, Na^+, K^+, etc.), ammonium ion (NH_4^+).
3. **Cl^-, Br^-**, and **I^-** are soluble, ***except*** when paired with Ag^+, Pb^{2+}, Cu^+ and Hg_2^{2+}.	
4. **(Sulfates) SO_4^{2-}** are soluble, ***except*** those of Ca^{2+}, Sr^{2+}, Ba^{2+}, Ag^+, and Pb^{2+}.	

[4]

Cations are +, anions are –

- Cations: Alkali Metals, Alkaline Earth Metals; most transition metals are +2
- Anions: Halogens, bicarbonate, cyanide, hydroxide, sulphate, phosphate

Diatomic nonmetals: H2, N2, O2, F2, Cl2, Br2, I2; Phosphorus normally P4; Sulphur normally S8

For an uncharged atom:

- # protons = Atomic number = # electrons
- # protons + # neutrons = Atomic Mass

Assumptions of kinetic molecular theory of gases

- Negligible volumes of gas molecules
- Negligible forces of attraction
- Continual, rapid, random movement
- Average kinetic energy of molecules depends only on temperature
- Elastic collisions

Real gases <- differ from ideal at high pressures and low temperatures, especially when greater intermolecular forces and larger molecules

Electron configurations

- Quantum numbers
    - Principal (n), Secondary (l), Magnetic (m_l), Spin (m_s)
- Aufbau Principle: first fill low energy orbitals
- Pauli Exclusion principle: Can’t have same set of four quantum numbers for two electrons in atom
- Hund’s Rule: Most stable electron arrangement has maximum unpaired electrons with same spin direction
- Maximum electrons per subshell: subshell (max number)

- S (2), p (6), d (10), f (14)

- Filling orbitals: 1s 2s 2p 3s 3p 4s 3d 4p 5s 4d 5p 6s 4f 5d 6p 7s 5f
- Stability with half filled valence subshells

Periodic Trends

- Atomic radius increases in group towards bottom, decreases in period to the right
- Ionization energy decreases down group, increases in period to the right (generally)

Fluorine is most electronegative element

Ions: Radius of cation smaller than its atom, radius of anion larger than its atom; going down a group, radii of ions of equal charge increase

Structures

- Octet rule – 8 valence e- (H gets 2, B and Be < 8, expanded octet for S, P, As, Se, Xe)
- Formal charge = # valence electrons - # electrons in Lewis structure
- Double bond shorter and stronger than single bond

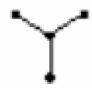
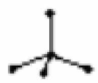
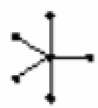
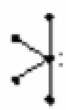
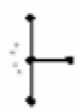
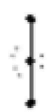
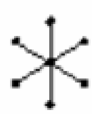
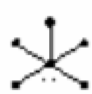
Reaction Orders and Units: Zero: Ms^{-1} First: s^{-1} Second: $M^{-1}\ s^{-1}$ Third: $M^{-2}s^{-1}$

- First order: $\ln[A]_t$ vs time is straight line, slope = -k, y-intercept = $\ln[A]_0$
- Half life: t(1/2) = ln 2/ k = 0.693/k
- Second order: $1/[A]_t$ vs time is straight line, slope = +k, y-intercept = $1/[A]_0$
- Zero order: $[A]_t$ vs time is straight line, slope = -k, y-intercept = $[A]_0$

Property	Type of particle emitted		
	α (alpha)	β (beta)	γ (gamma)
Relative charge	+2	-1	0
Relative mass	4	0.00055	0
Nature	2 protons + 2 neutrons (^{4}He nucleus)	Electron (emitted by a nucleon jumping down in energy)	Very high frequency electromagnetic radiation (photons)
Range in air	Few cm	Few metres	Very long
Stopped by	paper	Aluminium foil	Lead sheet
Deflection by electrical field	low	High (opposite direction to α)	nil
Symbol	α or $^4_2$He	β or e^- or $^0_{-1}$e	γ or $^0_0\gamma$

[5]

Nuclear fission is splitting a nucleus (chain reaction, i.e. $^{235}_{92}U$); nuclear fusion is joining nuclei (in stars, requires energy, usually H and He isotopes)

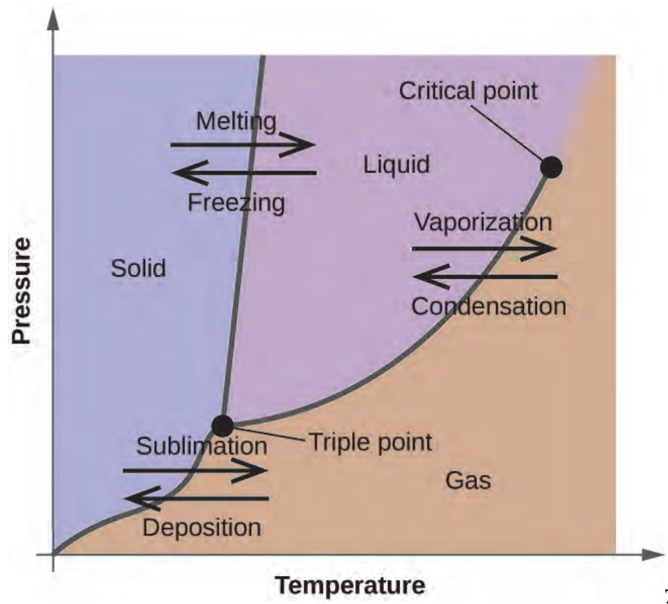
Hybdridization	# of σ Bonds	# of Non-Bonding Pairs	Molecular Shape		Bond Angles	Example
sp	2	0		Linear	180°	BeH_2, CO_2
sp^2	3	0		Trigonal planar	120°	SO_3, BF_3
sp^2	2	1		Angular	<120°	SO_2, O_3
sp^3	4	0		Tetrahedral	109.5°	CH_4, CF_4, SO_4^{2-}
sp^3	3	1		Trigonal pyramidal	<109.5°	NH_3, PF_3, $AsCl_3$
sp^3	2	2		Angular	<109.5°	H_2O, H_2S, SF_2
sp^3d	5	0		Trigonal bipyramidal	120°, 90°	PF_5, PCl_5, AsF_5
sp^3d	4	1		Sawhorse (irregular tetrahedron)	<120°, <90°	SF_4
sp^3d	3	2		T-shaped	<90°	ClF_3
sp^3d	2	3		Linear	180°	XeF_2, I_3^-, IF_2
sp^3d^2	6	0		Octahedron	90°	SF_6, PF_6^-, SiF_6^{2-}
sp^3d^2	5	1		Square pyramidal	<90°	IF_5, BrF_5
sp^3d^2	4	2		Square planar	90°	XeF_4, IF_4^-

Equilibrium Expression: aA(g) + bB (g) <-> pP(g) + qQ(g); $K_c = \frac{[P]^p[Q]^q}{[A]^a[B]^b}$

Le Chatelier's Principle: When stress applied to system at equilibrium, system shifts to relieve stress (i.e. add P so get more A and B)

As strength of intermolecular forces increases:

- Increases: Melting point, Boiling point, Viscosity
- Decreases: Solubility



[7]

Acid-Bases

- Arrhenius definitions: Acids increase concentration of H+ ions, bases increase OH-
- Bronsted-Lowry definitions: Acids donate proton, bases accept proton
- Lewis definitions: Acids accept electron-pair, bases donate electron-pair
- Conjugate acid-base pairs: Acid differs by conjugate base by H+ (by removing proton, make conjugate base)
- Naming by oxidation state: "hypo-" < "-ous" < "-ic" < "per"
    - So lowest is hypo_ous acid and highest is per_ic acid
- Strong acids completely ionized in aqueous solution: HClO4, HNO3, HCl, HBr, HI, H2SO4
- Strong Bases: LiOH, NaOH, KOH, Ba(OH)2, Sr(OH)2
- Stronger an acid, the weaker its conjugate base
- Product of acid-dissociation constant and base-dissociation constant of conjugate is ion-product constant for water
    - $Ka \times Kb = Kw = 1 \times 10^{-14}$
- P(anything) = -log(anything) so pH = -log[H+]

Oxidation-Reduction

- Oxidized if gains oxygen or loses hydrogen (oxidation # increases); reduced if loses oxygen or gains hydrogen (oxidation # decreases)

- What brings about oxidation is the oxidizing agent
- Oxidation when substance loses electrons and reduction when substance gains electrons (OIL RIG)
- Balancing redox equations in solution:
    - If acidic: have H+ and H2O so can add H+ to side where need; if need O, add H2O where need oxygen and 2H+ to other side
    - If basic: add H2O where need H and OH- to the other side; add 2OH- where need O and H2O to other side
- Oxidation at anode and reduction at cathode, electrons flow from anode to cathode

Thermodynamics

- To be spontaneous, ΔG^o must be negative and E^o_{Cell} positive
- ΔS: Solid state < liquid < gas
- When temperature increases, entropy increases
- When solid dissolves, entropy increases
- When combine simple molecules to more complex ones, complexity increases and entropy DECREASES

ΔH	ΔS	ΔG	spontaneous at which temperatures
-	+	-	ALL
+	-	+	NONE
+	+	+ or -	HIGH
-	-	+ or -	LOW

[8]

References

1. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/DeVoe%27s_%22Thermodynamics_and_Chemistry%22/01%3A_Introduction/1.1_Units
2. https://commons.wikimedia.org/wiki/File:Crest_trough_wavelength_amplitude.png
3. https://www.britannica.com/science/electromagnetic-spectrum
4. https://www.clutchprep.com/chemistry/solubility-rules
5. https://symbol--3.blogspot.com/2016/11/74-alpha-symbol-mass-and-charge-alpha.html
6. https://wongchemistry.weebly.com/uploads/5/1/3/6/5136424/apquickreview.pdf
7. https://opentextbc.ca/chemistry/chapter/10-4-phase-diagrams/
8. https://wongchemistry.weebly.com/uploads/5/1/3/6/5136424/ap_exam_review.pdf

Get ready for your next exam with Curvebreakers!

SAT, ACT, AP Exams, NYS Regents, SSAT, SHSAT, and more

Curvebreakers' tutors know these exams inside and out.
They can make sure you walk into your next exam with *confidence*.

Each student starts with a ***diagnostic analysis*** of their current performance on a practice exam. The findings in this report allows us to customize a curriculum for your tutoring package, and students are encouraged to take multiple practice tests over the course of their time with us to gauge improvement and fine-tune the curriculum. When you tutor with Curvebreakers, you can take unlimited diagnostic practice tests.

We teach all students the important fundamentals, test-taking strategies, and study habits that will carry them through the test and into college. Most importantly, Curvebreakers provides an adaptable student focused approach, instead of the more rigid course focused approach of other test prep companies. This means we put great attention into each student and his/her individual skill set. At Curvebreakers, we foster an enjoyable atmosphere for learning and success on standardized tests.

	RECOMMENDED	
10 Hours Private Tutoring	**20 Hours Private Tutoring**	**30 Hours Private Tutoring**
The Supplemental Package	**Most Popular Package**	**Cover IT ALL Package**
Customizable to fit your needs Unlimited Practice Tests ($50 value) Free Crash Courses ($59 value) $100 Off a Full-Length Class	Customizable to fit your needs Unlimited Practice Tests ($50 value) Free Crash Courses ($59 value) $200 Off a Full-Length Class	Customizable to fit your needs Unlimited Practice Tests ($50 value) Free Crash Courses ($59 value) $300 Off a Full-Length Class

Tutoring can be done from anywhere with our virtual platform!

View Virtual Test Prep Package Rates Online

Need help during the the school year? Struggling with a difficult class or content area?
Subject tutoring packages are also available.

Curvebreakers
320 Old Country Road, Suite 102, Garden City, NY 11530
(516) 728-1561 | learn@curvebreakerstestprep.com
curvebreakerstestprep.com