PERIODIC TABLE OF THE ELEMENTS

	1A												3A	4A	5A	6A	7A	8A
	1												13	14	15	16	17	18
1	1 H 1.008	2A 2																2 He 4.003
2	3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
3	11 Na 22.99	12 Mg 24.31	3B 3	4B 4	5B 5	6B 6	7B 7	<--- 8	8B 9	---> 10	1B 11	2B 12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (99)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (281)	111 Rg (272)	112 Cn (285)	113 Nh (284)	114 Fl (289)	115 Mc (288)	116 Lv (291)	117 Ts (294)	118 Og (294)

Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.2	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Actinides	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Fundamental Physical Constants

Avogadro's Number	$N_a = 6.02214 \times 10^{23}$ /mol
Atomic Mass Unit	amu = 1.66054×10^{-27} kg
Charge of the Electron	e = 1.60218×10^{-19} C
Faraday Constant	F = 9.64853×10^{4} C/mol
Mass of the Electron	$m_e = 9.10939 \times 10^{-31}$ kg
Mass of the Neutron	$m_n = 1.67493 \times 10^{-27}$ kg
Mass of the Proton	$m_p = 1.67262 \times 10^{-27}$ kg
Planck's Constant	h = 6.62607×10^{-34} J·s
Speed of Light	c = 2.99792×10^{8} m/s
Acceleration of Gravity	g = 9.80665 m/s^2
Rydberg Constant	$R_H = 1.09677 \times 10^{7}$ m^{-1}
Universal Gas Constant	R = 8.31447 J/mol·K
	R = 0.082058 L·atm/mol·K

Conversions and Relationships

Length	1 km = 1×10^{3} m = 0.621 mile
	1 inch = 2.54 cm 1 ft = 12 in
	1 pm = 1×10^{-12} m = 0.01 Å
Mass	1 kg = 1×10^{3} g = 2.205 lb
	1 metric ton = 1×10^{3} kg
Volume	1 dm^3 = 1×10^{-3} m^3 = 1 liter
	1 cm^3 = 1 mL 1 m^3 = 35.3 ft^3
	1 gallon = 3.785 liters
Energy	1 J = 1 kg·m^2/s^2 = 1 C·V
	1 calorie = 4.184 J
Temperature	T(K) = T(°C) + 273.15
	T(°C) = (T(°F) – 32)(5/9)
	H_2O: mp = 0°C and bp = 100°C
Pressure	1 Pa = 1 N/m^2 = 1 kg/m·s^2
	1 atm = 1.01325×10^{5} Pa
	1 atm = 760 torr = 760 mmHg
Math	$\pi = 3.1416$ e = 2.7183

Equations

$\Delta E = \Delta U = q + w \qquad \Delta H = \Delta E + \Delta(PV) \qquad q = mc\Delta T \qquad w = -P_{ext}\Delta V$

$\Delta H^\circ_{rxn} = \sum mol \cdot \Delta H^\circ_f\,(products) - \sum mol \cdot \Delta H^\circ_f\,(reactants)$

$\Delta H^\circ_{rxn} = \sum mol \cdot BE\,(bonds\ broken) - \sum mol \cdot BE\,(bonds\ formed)$

$c = \lambda\nu \qquad \Delta E = h\nu \qquad \Delta E = \frac{hc}{\lambda} \qquad \Delta E = -2.18 \times 10^{-18}\,J\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

M = molar mass $d = MP/RT$ $M = mRT/PV$

$PV = nRT \qquad \frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} \qquad KE = \frac{3}{2}RT = \frac{1}{2}mv^2$

$F_e = \frac{kQ_1Q_2}{d^2} \qquad v_{rms} = \sqrt{\frac{3RT}{M}} \qquad \frac{Rate_A}{Rate_B} = \frac{\sqrt{M_B}}{\sqrt{M_A}}$

$P_A = X_A \cdot P_{total} \qquad (P + n^2a/V^2)(V - nb) = nRT$

$\ln\left(\frac{P_2}{P_1}\right) = \frac{-\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \qquad \ln\left(\frac{k_2}{k_1}\right) = \frac{-E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \qquad k = Ae^{-E_a/RT}$

$P_{solvent} = X_{solvent}P^\circ_{solvent} \qquad \Delta P = (X_{solute}P^\circ_{solvent})i \qquad \Pi = (MRT)i$

$\Delta T_{bp} = (k_{bp} \cdot m)i \qquad \Delta T_{fp} = (k_{fp} \cdot m)i \qquad S_{gas} = k_H \cdot P_{gas}$

$[A]_t = -kt + [A]_0 \qquad \ln[A]_t = -kt + \ln[A]_0 \qquad \frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$

$t_{1/2} = \frac{[A]_0}{2k} \qquad t_{1/2} = \frac{ln2}{k} \qquad t_{1/2} = \frac{1}{k[A]_0}$

Solubility Rules

1. All common compounds of Group 1A ions and NH_4^+ are soluble
2. All common nitrates, acetates, and most perchlorates are soluble
3. All common chlorides, bromides, and iodides are soluble, except those of Ag^+, Pb^{2+}, Cu^+, and Hg_2^{2+}. All common fluorides are soluble, except those of Pb^{2+} and Group 2A
4. All common sulfates are soluble, except those of Ca^{2+}, Sr^{2+}, Ba^{2+}, Ag^+, and Pb^{2+}
5. All common metal hydroxides are insoluble, except those of Group 1A and the larger members of Group 2A (starting with Ca^{2+})
6. All common carbonates and phosphates are insoluble, except those of Group 1A and NH_4^+
7. All common sulfides are insoluble, except those of Groups 1A, 2A, and NH_4^+

Exam 3 – CHM 2045 – Fall 2020 – Study Review, Questions Only

Chapters 8-11 Silberberg 9th edition

Question 1 — 10 pts

Place the following in order of **increasing** X-Se-X bond angle, where X represents the outer atoms in each molecule.

SeO_2 SeF_6 $SeCl_2$

- ○ $SeO_2 < SeCl_2 < SeF_6$
- ○ $SeCl_2 < SeO_2 < SeF_6$
- ○ $SeF_6 < SeCl_2 < SeO_2$
- ○ $SeF_6 < SeO_2 < SeCl_2$
- ○ $SeCl_2 < SeF_6 < SeO_2$

Question 2 — 5 pts

How many d electrons does the _____ion have?

Fe^{3+}

Ag^{+}

Fe3+ [Choose] 2, 4, 9, 6, 1, 7, 0, 10, 5, 3, 8

Ag+ [Choose] 2. 4. 9. 6. 1. 7. 0. 10. 5. 3. 8

Question 3

5 pts

Which of the following elements is paramagnetic?

- ○ Ar
- ○ Zn
- ○ V
- ○ Kr
- ○ Sr

Question 4

5 pts

Which of the following is the general electron configuration for the outermost electrons of the noble gases?

- ○ ns^2np^5
- ○ ns^2np^3
- ○ ns^2np^6
- ○ ns^2np^4
- ○ ns^2

Question 5

10 pts

Calculate the average A-B bond energy in $AB_5(g)$.

ΔH_f for $AB_5(g)$ = -43.6 kJ/mol, ΔH_f for A(g) = 299.8 kJ/mol, ΔH_f for B(g) = 184.7 kJ/mol, ΔH_f for $A_2(g)$ = 0 kJ/ mol, ΔH_f for $B_2(g)$ = 0 kJ/mol.

Enter a number in kJ/mol to 1 decimal place.

Question 6 — 5 pts

Which one of the following is a **nonpolar** molecule with **polar** covalent bonds?

- ○ HF
- ○ NH_3
- ○ $BeBr_2$
- ○ $SOCl_2$ (S is central atom)
- ○ H_2Te

Question 7 — 10 pts

Which molecule has the **most** polar covalent bond?

- ○ PH_3
- ○ IBr
- ○ HCl
- ○ H_2
- ○ N_2

Question 8

8 pts

Which of the following statements are true?

I: elements with high ionization energies are more metallic

II: elements with high electron affinities are strong reducing agents

III: elements with similar electronegativities form covalent compounds

- ○ Only III
- ○ Only I
- ○ Only II
- ○ II and III
- ○ I and III
- ○ I, II, and III
- ○ I and II

Question 9

10 pts

An imaginary planet was just discovered that has a similar environment to our planet Earth. All the chemistry is similar except for the values of bond energies. Use the planet's given bond energies to calculate the enthalpy of reaction for the combustion of 1 mole of pentane.

Enter a number to 0 decimal places in kJ/mol

Bond	Energy (kJ/mol)
H-H	563
C-H	200
H-O	457
C-C	443
C=C	690
C≡C	959
O=O	515
C-O	474
C=O	726

Question 10 — 5 pts

Identify the element of Period 2 which has the following successive ionization energies, in kJ/mol.

IE_1, 1402 IE_2, 2856 IE_3, 4578 IE_4, 7475 IE_5, 9445 IE_6, 53267 IE_7, 64360

- ○ N
- ○ P
- ○ Mg
- ○ O
- ○ Si
- ○ B
- ○ F
- ○ C
- ○ Na
- ○ Cl
- ○ Li
- ○ S
- ○ Al
- ○ Be

Question 11 — 10 pts

Select the compound with the smallest magnitude of lattice energy.

- ○ NaCl(s)
- ○ CaO(s)
- ○ KBr(s)
- ○ CsBr(s)
- ○ SrO(s)

Question 12

10 pts

Select the correct set of quantum numbers (n, l, m_l, m_s) for the first electron removed in the formation of a cation for magnesium, Mg.

- ○ 3, 1, 0, +½
- ○ 2, 0, 0, +½
- ○ 3, 0, 0, −½
- ○ 2, 1, -1, +½
- ○ 3, 2 , 0, −½

Question 13

10 pts

According to valence bond theory, which kind of orbitals overlap to form the C-H bonds in ethyne (HCCH)?

- ○ C(sp^3) - H(s)
- ○ C(sp^2) - H(s)
- ○ C(sp^2) - H(sp)
- ○ C(sp) - H(s)
- ○ C(sp) - H(p)

Question 14 — 10 pts

Predict the bond order and magnetic property (diamagnetic/paramagnetic) for F_2^- .

Use the following valence MO order: $\sigma_{2s} < \sigma^*_{2s} < \sigma_{2px} < \pi_{2py} = \pi_{2pz} < \pi^*_{2py} = \pi^*_{2pz} < \sigma^*_{2px}$

Enter a number such as 0, 0.5, 1, 1.25, ... Bond order _____

Type in diamagnetic or paramagnetic. Magnetic property _____

Question 15 — 10 pts

Which of the following has the shortest carbon–nitrogen bond?

- ○ H_2CNOH
- ○ H_2CNH
- ○ H_3CCN
- ○ H_3CNH_2
- ○ H_3CNO

Question 16 — 10 pts

Arrange this isoelectronic series in order of increasing radius:

Cl^-, Ca^{2+}, Ar, K^+

_____ < _____ < _____ < _____

Enter as follows: Cl^- as Cl- (so no need to superscript), Ca^{2+} as Ca2+, etc

Question 17 — 10 pts

For each of the following compounds determine the molecular geometry (shape) using VSEPR theory and identify the hybridization of the central atom(s), respectively.

[Select] CO_2F

- trigonal pyramidal; sp2
- trigonal planar; sp3
- tetrahedral; sp3
- trigonal bent; sp2
- trigonal planar; sp2
- trigonal pyramidal; sp3

[Select] . NCCN

- linear C's; sp2
- linear C's; sp
- bent C's; sp3
- tetrahedral C's; sp3
- trigonal planar C's; sp2
- bent C's; sp2

[Select] . S_2Cl_2 (ClSSCl)

- trigonal planar S's; sp2
- linear S's: sp3
- tetrahedral S's; sp2
- bent S's; sp2
- linear S's; sp
- bent S's; sp3
- tetrahedral S's; sp3

Question 18 — 5 pts

How many σ bonds and how many π bonds are present in the boric acid molecule, H_3BO_3?

sigma _____

pi _____

Enter number only. For example 0, 1, 2, 3..etc

Question 19 — 10 pts

Use molecular orbital theory to determine which of the following dicarbon species is expected to have the shortest bond length.

Use the following valence MO order: $\sigma_{2s} < \sigma^*_{2s} < \pi_{2py} = \pi_{2pz} < \sigma_{2px} < \pi^*_{2py} = \pi^*_{2pz} < \sigma^*_{2px}$

- ○ C_2^+
- ○ C_2^{2-}
- ○ C_2
- ○ All the dicarbon species have the same bond length
- ○ C_2^-

Question 20

5 pts

Which of these ions has the smallest number of unpaired electrons?

- ○ Fe^{2+}
- ○ Cr^{2+}
- ○ V^{3+}
- ○ Co^{2+}
- ○ Sc^{3+}

Question 21

5 pts

Select the most appropriate molecular shape for each of the following compounds:

[Select]	SO_2
[Select]	SO_3
[Select]	NH_4^+
[Select]	PH_3
[Select]	SF_4

trigonal planar
trigonal pyramidal
tetrahedral
square pyramidal
square planar
bent/angular/v-shaped
trigonal bipyramidal
linear
octahedral
seesaw
T-shaped

Question 22 — 5 pts

Which of the following molecules will have ideal bond angles?

- ○ SO_2
- ○ $SOCl_2$
- ○ CS_2
- ○ OF_2
- ○ SF_2

Question 23 — 5 pts

Which element will combine with oxygen to form the most basic oxide?

- ○ Ga
- ○ Si
- ○ B
- ○ Mg
- ○ P

Question 24 — 10 pts

When SO_3 gains two electrons, SO_3^{2-} forms.

[Select] What is the molecular shape change around S?

octahedral to tetrahedral
tetrahedral to trigonal planar
trigonal bipyramidal to trigonal planar
tetrahedral to trigonal pyramidal
trigonal planar to linear
trigonal planar to trigonal pyramidal

[Select] Does molecular polarity change during this reaction?

yes, from polar to nonpolar
no, molecular polarity stays the same
yes, from nonpolar to polar

Question 25

10 pts

What are the formal charges of each of the phosphorus atoms in the best Lewis structure for P_3^-? List the formal charges of the phosphorus atoms in order of: outer P, central P, outer P.

- ○ −1, +1, −1
- ○ 0,+1, −2
- ○ 0,+1, −2
- ○ −1, 0, 0
- ○ −1, 0, −1
- ○ +1, −1, −1
- ○ 0, 0, 0
- ○ 0, −1, 0

Question 26

2 pts

Scratch paper: I am in the process of making very small pieces out of my scratch paper (aka confetti) and showing that process to the camera.

On my honor, I have neither given nor received unauthorized aid in doing this assignment.

- ○ True
- ○ False