CHEM 1211
Mock Exam 2: Chapters 3 – 4.3 KEY

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Spring 2020

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Multiple Choice

Identify the choice that best completes the statement or answers the question.

1. [redacted]

[redacted]

c) II and III.

[redacted]

You must be comfortable with the equation c = f λ, both conceptually and with math problems, as well as the relationship between frequency and wavelength. Longer frequency = shorter wavelength and vice versa. Longer frequency also means more energy associated with the wave. Looking at the information provided in the problem, yellow light has a higher frequency than red light, meaning that yellow light has more energy associated with it. We can also deduce since yellow light has the higher frequency that it is going to have a lower wavelength than red light. Based on this, we can conclude that II and III are correct statements.

2. [redacted]

[redacted]

d) 6.63×10^{-26} J.

[redacted]

Be comfortable with the equation E = hf, where energy is equal to Planck's constant multiplied by the frequency. Depending on the information given, another version of the equation is E = hc/ λ.
You must know that Planck's constant (h) is equal to 6.626×10^{-34}. You are given the information that the station operates at 100.1 MHz, thus you need to convert this to just Hx.
1001. MHz = 100.1×10^{6} Hz. Now plug into equation and solve!
E = $(6.626 \times 10^{-34})(100.1 \times 10^{6}$ Hz) = $\underline{6.63 \times 10^{-26}}$ J.

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3. [redacted]

[redacted]

e) I and III.

For answering questions such as this, you need to be comfortable with the rules and limitations of what each quantum number can represent.

4. [redacted]

b) n4 → n3.

[redacted]

First, you must understand the relationship between wavelength, frequency, and energy. Frequency and energy are directly related (ie greater frequency = more energy) and wavelength and energy are inversely related (ie greater wavelength = less energy). If the question is asking you for longest wavelength then you would select the answer that gives emission of the least amount of energy. Because emission is going down levels, the answer that would give you the least amount of energy is n4 → n3.

5. [redacted]

b) Angular momentum.

[redacted]

All orbitals in a given subshell will not necessarily have the same value for their principal and magnetic quantum numbers.

6. [redacted]

b) 410 nm.

[redacted]

$\frac{1}{\lambda} = R(\frac{1}{n_{final}2} - \frac{1}{n_{initial}2})$ → $1.097 \times 10^7 (\frac{1}{4} - \frac{1}{36}) = 2437777.778$

$\frac{1}{\lambda} = 2437777.778$ → $\lambda = 0.000000410$ m or 410 nm

7. [redacted]

[redacted]

b) Kr > Br > Se > Ge > Ga.

[redacted]

First ionization energy increases as you go up and to the right on the periodic table. You must know all your periodic table trends in order to do well on this exam!

[redacted]

[redacted]

8. [redacted]

[redacted]

b) III only.

[redacted]

First, you need to convert each of the names into a chemical formula:
Calcium chloride → $CaCl_2$
Sodium sulfide → Na_2S
Lithium bromide → $LiBr$
Magnesium fluoride → MgF_2
Barium iodide → BaI_2

Based on the diagram, you can see there is a 1:1 ration of black dots to white dots. Assigning meaning to this, it indicates a 1:1 ion ratio. The only one of the compounds that has a 1:1 ratio of ions is Lithium bromide.

9. [redacted]

e) II and IV.

Anions, based on periodic trends and just a general rule, are ALWAYS going to be larger than their cation counterparts. You CAN compare ionic radii without knowing the atomic radii and but CANNOT compare ionic radii without knowing the period for each element. Since the black dots are larger than the white dots, the black dots must represent anions and the white dots must represent cations.

10. [redacted]

b) $[Ar]3d^{10}4s^1$

[redacted]

Remember the exceptions you learned for electron configuration! Elements in the columns involving chromium and copper will steal an electron from the s orbital to fill their d orbitals. The question also asks for noble gas configuration and we know that the noble we need to use for this question is Argon.

11. [redacted]

e) None of the above.

The electron configuration of the Cu+ ion is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$.
The electron configuration for Nickel is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$
The electron configuration Zinc is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$
The electron configuration Ga+ is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$
The electron configuration Argon is $1s^2 2s^2 2p^6 3s^2 3p^6$

Based on this, <u>none</u> of the atoms/ions match the Cu+ electron configuration.

12. [redacted]

c) III only.

[redacted]

Copper (II) sulfite → Cu^{2+} SO_3^{2-} → $CuSO_3$, so 1:1 ratio.

Barium hydroxide → Ba^{2+} OH^- → $BaOH_2$, so 1:2 ratio.
Iron (II) nitrate → Fe^{2+} NO_3^- → $Fe(NO_3)_2$, so 1:2 ratio.
Magnesium carbonate → Mg^{2+} CO_3^{2-} → $MgCO_3$, so 1:1 ratio.
Note: Please memorize your polyatomic ions! It will be hard to answer questions like this if you don't!

13. [redacted]

d) Chromium, Cr.

[redacted]

Oxygen: 2 unpaired electrons.
Nitrogen: 3 unpaired electrons.
Arsenic: 3 unpaired electrons.
Chromium: 6 unpaired electrons.
Nickel: 2 unpaired electrons.

14. [redacted]

d) A full 1s orbital would contain three electrons.

[redacted]

In our universe, we know electrons have spin pairs of -1/2 and +1/2, with each subshell containing two electrons. In an alternative universe, there exists a third spin of 0, which follows the logic that in this universe, each subshell would contain three electrons. In a full 1s orbital, there would be three electrons present instead of the normal two that are present in our universe.

15. [redacted]

d) 16.

[redacted]

4	0 (s) 1 (p) 2 (d) 3 (f)	0 -1,0,+1 -2,-1,0,+1,+2 -3,-2,-1,0,+1,+2,+3

Counting the orbitals that are present in n=4, we can see that there are 16 orbitals

16. [redacted]
  a) 14; 10; 6.
  [redacted]

17. [redacted]
  e) 2.97×10^{6} m/s.

In order to answer this question, you must be comfortable with the Broglie equation and the units each variable must be in: $\lambda = \frac{h}{mv}$ *Where m = mass (kg), v = velocity (m/s), h = Planck's constant (J·s), and λ = wavelength (m)*

2.45 A = 2.45×10^{-10} m
9.11×10^{-28} g = 9.11×10^{-31} kg
h = 6.626×10^{-34} J . S.

Now plug is and solve!

$2.45 \times 10^{-10} = \frac{(6.626 \ x \ 10^{-34})}{(9.11 \ x \ 10^{-31})V}$ → $V = \frac{(6.626 \ x \ 10^{-34})}{(9.11 \ x \ 10^{-31})\ (2.45 \text{ x } 10\text{^}{-10})}$ = 2.97×10^{6} m/s

18. [redacted]
  c) decreases, increases.
  [redacted]

Moving along the periodic table going from right to left and top to bottom, effective nuclear charge DECREASES and atomic radii INCREASES. You must be comfortable with all your periodic trends in order to do well on this exam!

19. [redacted]
a) *s; f.*
[redacted]

when comparing *s p d f* orbitals, *s* would have the least amount of energy, followed by *p* orbitals, then *d* orbitals and finally *f* orbitals. Orbital energy is inversely related to stability, meaning that *s* orbitals are the most stable, followed by *p* orbitals, the *d* orbitals and finally *f* orbitals would be the least stable.

20. [redacted]
a) N-F < C-F < B-F < H-F.
[redacted]

The greater the electronegativity is between two atoms, the more polar the bond is. N-F has the least difference in electronegativity, while the difference between H-F is the greatest.

21. [redacted]
c) A compound composed of only nonmetals.
[redacted]

You need to be comfortable comparing the differences between covalent and iconic bonds. Of the characteristics listed, only c applies to covalent bonds. Options a, b and d apply to ionic bonds.

22. [redacted]
a) A compound composed of a metal on the far left of the periodic table and a nonmetal on the far right of the periodic table.
b) Solid metal compounds.
[redacted]
d) A compound that is held together by the electrostatic forces between oppositely charged ions.
[redacted]

You need to be comfortable comparing the differences between covalent and iconic bonds. Of the characteristics listed, only c applies to covalent bonds. Options a, b and d apply to ionic bonds.

23. [redacted]
d) HF
[redacted]

The greater the electronegativity difference, the more polar the bond is. Since fluorine is the most electronegative element, we expect the bond between H and F to be the most polar bond.

24. [redacted]
a) Na_3PO_4.
b) PCl_3.
[redacted]
d) NO_2.
e) SiF_4.

Options b, d and e are clearly nonmetals bound together, making them obvious choices to identify as polar covalent bonds. NaCl is the classic example of an ionic bond.

Where students struggle with this question is option a. Na bound to PO4 is clearly an ionic bond, but within the PO4 molecule there are covalent bonds, making option a a correct answer. Be careful with questions like this! I guarantee they will put a trick like this on your exam!

25. [redacted]
a) $LiNO_3$.
[redacted]
c) $MgCl_2$
d) $(NH_3)_3PO_4$.
[redacted]

Options a, c and d contain ionic bonds, options b and e contain only covalent bonds.

26. [redacted]
c) P_4F_5; Tetraphosphorus pentafluoride.
[redacted]

KCl → Potassium chlor<u>ide</u>
$MgBr_2$ → Magnesium bromide, with ionic compounds, the number of each atom is assumed. No need to specify dibromide.
Option c specifies the correct name.
NO → Nitrogen <u>mono</u>xide
SF_6 → Sulfur <u>hexa</u>fluoride

27. [redacted]

[redacted]

d) δ- Cl-P δ+

[redacted]

This is another question that a guarantee will show up on your exam! You must understand that in a polar covalent bond, the partial negative charge will go to the more electronegative element and the partial positive charge will go to the less electronegative element. In option d, Cl is more electronegative that P, giving a correct distribution of the partial charges.

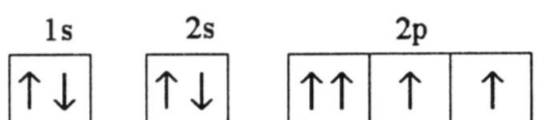
28. [redacted]

a)

[redacted]

b)

[redacted]



[redacted]

Option c shows electrons not spin paired. This is a violation of the Pauli exclusion principle.

29. [redacted]

[redacted]

e) II and III.

Degenerate orbitals are orbitals that contain the same amount of energy. Circles II and III contain orbitals at the same energy level.

30. [redacted]

e) $Al^{+2}(g) \rightarrow Al^{3+}(g) + e^-$

Ionization energy has to do with losing electrons. After two founds of ionization, the aluminum element would be at a +2 charge. After a third round of ionization, the +2 charge would go to a +3 charge and release an additional electron.

hydrogen 1 **H** 1.0079																		helium 2 **He** 4.0026
lithium 3 **Li** 6.941	beryllium 4 **Be** 9.0122												boron 5 **B** 10.811	carbon 6 **C** 12.011	nitrogen 7 **N** 14.007	oxygen 8 **O** 15.999	fluorine 9 **F** 18.998	neon 10 **Ne** 20.180
sodium 11 **Na** 22.990	magnesium 12 **Mg** 24.305												aluminium 13 **Al** 26.982	silicon 14 **Si** 28.086	phosphorus 15 **P** 30.974	sulfur 16 **S** 32.065	chlorine 17 **Cl** 35.453	argon 18 **Ar** 39.948
potassium 19 **K** 39.098	calcium 20 **Ca** 40.078		scandium 21 **Sc** 44.956	titanium 22 **Ti** 47.867	vanadium 23 **V** 50.942	chromium 24 **Cr** 51.996	manganese 25 **Mn** 54.938	iron 26 **Fe** 55.845	cobalt 27 **Co** 58.933	nickel 28 **Ni** 58.693	copper 29 **Cu** 63.546	zinc 30 **Zn** 65.39	gallium 31 **Ga** 69.723	germanium 32 **Ge** 72.61	arsenic 33 **As** 74.922	selenium 34 **Se** 78.96	bromine 35 **Br** 79.904	krypton 36 **Kr** 83.80
rubidium 37 **Rb** 85.468	strontium 38 **Sr** 87.62		yttrium 39 **Y** 88.906	zirconium 40 **Zr** 91.224	niobium 41 **Nb** 92.906	molybdenum 42 **Mo** 95.94	technetium 43 **Tc** [98]	ruthenium 44 **Ru** 101.07	rhodium 45 **Rh** 102.91	palladium 46 **Pd** 106.42	silver 47 **Ag** 107.87	cadmium 48 **Cd** 112.41	indium 49 **In** 114.82	tin 50 **Sn** 118.71	antimony 51 **Sb** 121.76	tellurium 52 **Te** 127.60	iodine 53 **I** 126.90	xenon 54 **Xe** 131.29
caesium 55 **Cs** 132.91	barium 56 **Ba** 137.33	57-70 *	lutetium 71 **Lu** 174.97	hafnium 72 **Hf** 178.49	tantalum 73 **Ta** 180.95	tungsten 74 **W** 183.84	rhenium 75 **Re** 186.21	osmium 76 **Os** 190.23	iridium 77 **Ir** 192.22	platinum 78 **Pt** 195.08	gold 79 **Au** 196.97	mercury 80 **Hg** 200.59	thallium 81 **Tl** 204.38	lead 82 **Pb** 207.2	bismuth 83 **Bi** 208.98	polonium 84 **Po** [209]	astatine 85 **At** [210]	radon 86 **Rn** [222]
francium 87 **Fr** [223]	radium 88 **Ra** [226]	89-102 **	lawrencium 103 **Lr** [262]	rutherfordium 104 **Rf** [261]	dubnium 105 **Db** [262]	seaborgium 106 **Sg** [266]	bohrium 107 **Bh** [264]	hassium 108 **Hs** [269]	meitnerium 109 **Mt** [268]	ununnilium 110 **Uun** [271]	unununium 111 **Uuu** [272]	ununbium 112 **Uub** [277]		ununquadium 114 **Uuq** [289]				

*Lanthanide series	lanthanum 57 **La** 138.91	cerium 58 **Ce** 140.12	praseodymium 59 **Pr** 140.91	neodymium 60 **Nd** 144.24	promethium 61 **Pm** [145]	samarium 62 **Sm** 150.36	europium 63 **Eu** 151.96	gadolinium 64 **Gd** 157.25	terbium 65 **Tb** 158.93	dysprosium 66 **Dy** 162.50	holmium 67 **Ho** 164.93	erbium 68 **Er** 167.26	thulium 69 **Tm** 168.93	ytterbium 70 **Yb** 173.04
**Actinide series	actinium 89 **Ac** [227]	thorium 90 **Th** 232.04	protactinium 91 **Pa** 231.04	uranium 92 **U** 238.03	neptunium 93 **Np** [237]	plutonium 94 **Pu** [244]	americium 95 **Am** [243]	curium 96 **Cm** [247]	berkelium 97 **Bk** [247]	californium 98 **Cf** [251]	einsteinium 99 **Es** [252]	fermium 100 **Fm** [257]	mendelevium 101 **Md** [258]	nobelium 102 **No** [259]

