

Name \_\_\_\_\_

If you do NOT want your graded exam placed in the cardboard box outside my office, then please mark a cross here \_\_\_\_\_

(1-10) are True / False

- 1) A wave is a vibrating disturbance by which energy is transmitted.
- 2) Any level higher than the “ground state” is called an “excited state”.
- 3) There are 5 different d atomic orbitals within the 3<sup>rd</sup> quantum shell of an atom.
- 4) Argon has a larger atomic radius than Neon.
- 5) Line spectra, also called atomic spectra are a series of discrete *lines* (or *wavelengths*) separated by blank areas.
- 6) The frequency of a wave is the distance between identical points on successive waves.
- 7) The Bromide ion ( $\text{Br}^-$ ) has the same number of electrons as Xenon.
- 8) Ionic compounds are typically solids with high melting points.
- 9) Cesium (Cs) has more metallic character than Gold (Au).
- 10) Enthalpy is a state function.

11) Name one type of electromagnetic radiation (or region in the electromagnetic spectrum) with HIGHER *energy* than visible light.

12) Name one type of electromagnetic radiation with SHORTER *wavelength* than visible light.

13-16) On the following schematic of a period table, indicate where the following elements are located:


- Main group elements with three valence electrons

- Elements likely to form anions of charge -1

- The Noble gases

- 3<sup>rd</sup> row elements.

17-18) Label the following orbitals (e.g. 1s) in the following orbital diagram, and then use them to illustrate the ground state electron configuration of Nitrogen.



19) Which element has the electron configuration of  $[\text{Xe}] 6s^1$  ?

20) Which element has the electron configuration of  $[\text{Xe}] 6s^2 4f^{14} 5d^{10} 6p^3$  ?

21) Draw a Lewis structure for the polar covalent molecule HCl.

22) Which end of this molecule is partially negative?

23) There is an important special relationship between the quantum numbers ( $n$ ,  $l$ ,  $m_l$  and  $m_s$ ) and each individual electron in an atom. What is that unique characteristic?

24-26) For Quantum Numbers, if  $n$  can have integer values of 1, 2, 3 and so forth;  
 $l$  can have values from  $(n-1)$  to 0, for each value of  $n$ ;  
 $m_l$  can have integer values between  $l$  and  $-l$ , including zero;  
 $m_s$  can be either  $+1/2$  or  $-1/2$ .

What atomic orbitals have the following quantum numbers ?

$n = 1, l = 0, m_l = 0$ .

$n = 2, l = 1, m_l = 1, 0$  and  $-1$ .

27-28) If the Speed of a wave = wavelength x frequency, then calculate the wavelength, in meters, of radiation with a frequency of  $1.18 \times 10^{14} \text{ s}^{-1}$ . (Assume the speed of light is  $3.00 \times 10^8 \text{ m/s}$ ).

29-30) Draw a Lewis structure for the molecule  $N_2$ , and show why each Nitrogen atom satisfies the Octet Rule.

(31-40) are multiple choice

31) Planck in 1900 said that the smallest quantity of energy that can be absorbed in the form of electromagnetic energy is called a

- a) Plankton
- b) Spectrum
- c) Proton
- d) Wave function
- e) Quantum

32) Which ionic compound would have the highest (most exothermic) lattice energy?

- a) LiF
- b) LiCl
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33) The photoelectric effect experiment implies that light is not a propagating wave, but instead is

- a) A collection of discrete wave packets (also known as photons).
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34) The ammonium cation ( $\text{NH}_4^+$ ) involves the interaction of how many total valence electrons?

- a) 7
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- d) 10
- e) Insufficient data provided to determine.

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- a) Notfosh principle
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36) For the lowest energy Lewis structure of water, what is the formal charge on the Oxygen?

- a) -2
- b) -1
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37) The square of the wavefunction ( $\psi^2$ ) of an electron tells you the

- a) Mass.
- b) Charge.
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- d) Probability of finding it in a certain region of space.
- e) None of the above.

38) The molecule  $\text{SF}_4$  has how many (total) pairs of non-bonding valence electrons?

- a) 0
- b) 1
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- d) 12
- e) 13

39) A molecule of type  $AB_6$  would have what type of molecular geometry?

- a) Linear
- b) Planar triangular
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40) The (F-Xe-F) bond angles in  $XeF_4$  are

- a)  $90^\circ$  and  $180^\circ$
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41-43) Explain why a molecule of the form  $AB_2E_2$  (meaning a central atom connected to two atoms, and with two non-bonding pairs of electrons on the central atom) has a "bent" geometry.

44-46) If a photon has  $3.91 \times 10^{-20}$  Joules of energy, express this energy in the more common units of kJ/mol. (Avogadro's constant is  $6.022 \times 10^{23}$  per mole).

47-49) Calculate the de Broglie wavelength of a 0.15 kg baseball moving with a velocity of 40.1 m/s?

$$\lambda = \frac{h}{mv} \quad \text{Planck's Constant} = 6.626 \times 10^{-34} \text{ J s} \quad \text{J} = \frac{\text{kg m}^2}{\text{s}^2}$$

50) Your answer to the previous question should be a very, very small number. What does that mean in the context of trying to experimentally measure or detect the associated wavelength of the baseball?



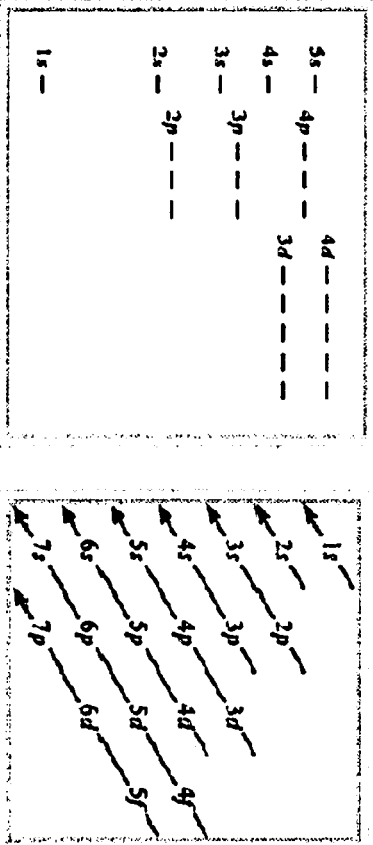
**\*\*\*\*Bonus Questions for +1 points each (up to 4 total)\*\*\*\***

Write the electron configuration for the  $\text{Fe}^{3+}$  cation (You can use a noble gas core if you wish).

How could you experimentally prove that your above answer was correct?

Draw three resonance forms of the  $[\text{O}-\text{Cl}-\text{O}]^-$  anion and comment on their relative stabilities.

1	1A	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	IA	IIA	IIIB	IVB	VB	VIB	VIIIB	VIII	VIIIB	IB	IB	IIIB	IIIA	IVA	VA	VIA	VIA	VIIIA
H	H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar
1.01	1.01	4.00	6.94	9.01	10.81	12.01	14.01	16.00	19.00	20.18	22.99	24.31	26.98	28.09	30.97	32.07	35.45	39.95
3	4	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Li	Be	B	C	N	O	F	Ne	Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca	Sc
6.94	9.01	10.81	12.01	14.01	16.00	19.00	20.18	22.99	24.31	26.98	28.09	30.97	32.07	35.45	39.95	40.08	44.96	47.88
11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Na	Mg	Al	Si	P	S	Cl	Ar	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu
22.99	24.31	26.98	28.09	30.97	32.07	35.45	39.95	40.08	44.96	47.88	50.94	52.00	54.94	55.85	58.93	58.69	63.55	63.55
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	Cs
85.47	87.62	88.91	91.22	92.91	95.94	(98)	101.07	102.91	106.42	107.87	112.41	114.82	118.71	121.76	127.6	126.9	131.29	132.9
55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	Fr
132.9	137.3	138.9	178.5	180.9	183.9	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209	(209)	(210)	(222)	(223)
87	88	89	104	105	106	107	108	109	110	111	80	81	82	83	84	85	86	87
Fr	Ra	Ac^	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Hr	Tl	Pb	Bi	Po	At	Rn	Fr
(223)	(226)	(227)	(261)	(262)	(263)	(264)	(265)	(266)	(271)	(272)	200.6	204.4	207.2	209	(209)	(210)	(222)	(223)



58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
140.1	140.9	144.2	(145)	150.4	152.0	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175.0
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
232.0	(231)	238.0	(237)	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(260)

Name \_\_\_\_\_

Yo Dawg, I heard you like iron, so here's an iron  
with an iron of iron.



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- 5) Line spectra, also called atomic spectra are a series of discrete *lines* (or *wavelengths*) separated by blank areas. T
- 6) The frequency of a wave is the distance between identical points on successive waves. False
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- 9) Cesium (Cs) has more metallic character than Gold (Au). T
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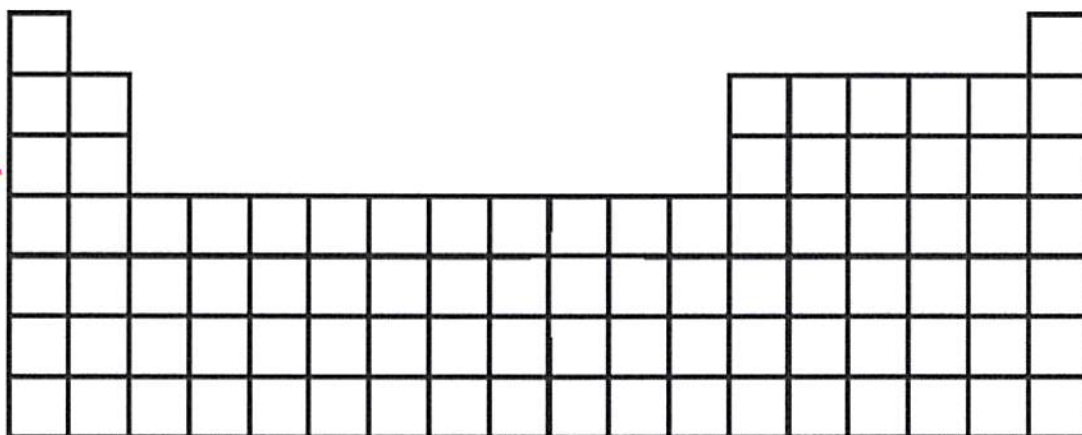
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Gamma rays, X rays, UV.

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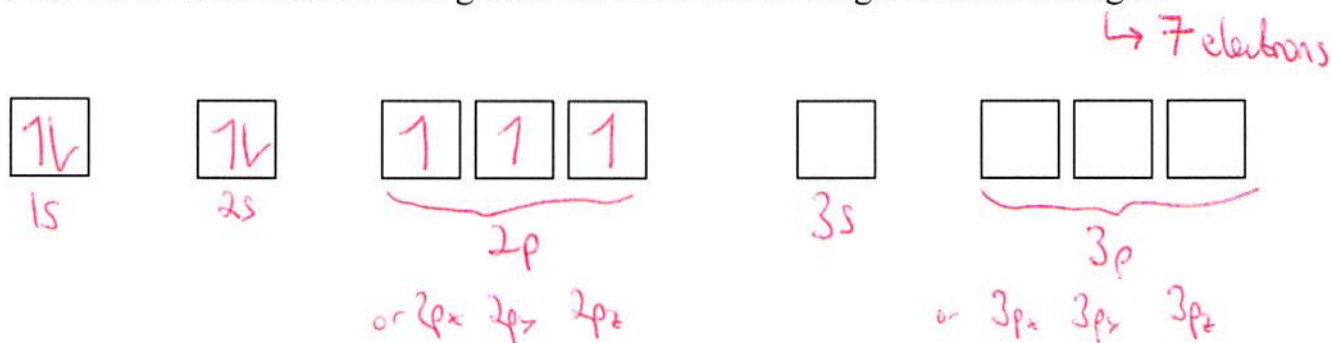
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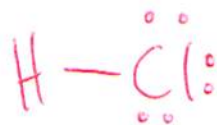
19) Which element has the electron configuration of [Xe] 6s<sup>1</sup> ?

Cesium (Cs)

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Bismuth (Bi)

21) Draw a Lewis structure for the polar covalent molecule HCl. = 1+7 = 8e<sup>-</sup>



22) Which end of this molecule is partially negative?



23) There is an important special relationship between the quantum numbers (n, l, m<sub>l</sub> and m<sub>s</sub>) and each individual electron in an atom. What is that unique characteristic?

No two electrons can have the same four Quantum Numbers.  
 (A unique set of Q.N.'s for each electron).

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$n = 1, l = 0, m_l = 0.$  *one type = 1s*

$n = 2, l = 1, m_l = 1, 0 \text{ and } -1.$   
*three different types*

The three 2p atomic orbitals  
 (or  $2p_x, 2p_y, 2p_z$ )

27-28) If the Speed of a wave = wavelength x frequency, then calculate the wavelength, in meters, of radiation with a frequency of  $1.18 \times 10^{14} \text{ s}^{-1}$ . (Assume the speed of light is  $3.00 \times 10^8 \text{ m/s}$ ).

$$\begin{aligned} \text{Speed} &= \text{Wavelength} \times \text{frequency} \Rightarrow \lambda = \frac{\text{Speed}}{\text{freq}} \\ &= \frac{3.00 \times 10^8}{1.18 \times 10^{14}} \frac{\text{m}}{\cancel{\text{s}}} \cdot \frac{\cancel{\text{s}}}{1} \\ &= \underline{2.54 \times 10^{-6} \text{ m}} \end{aligned}$$

→ 2 × 5 valence e<sup>-</sup>s = 10

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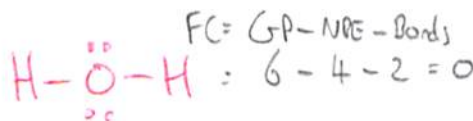
$$\rightarrow 5 + 4 - 1 = 8$$

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- a) Notfosh principle  
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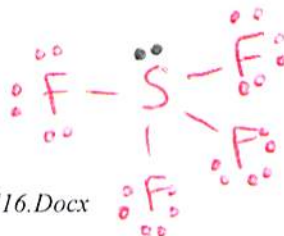
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38) The molecule  $\text{SF}_4$  has how many (total) pairs of non-bonding valence electrons?

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b) 1  
c) 5  
d) 12  
e) 13

$$\rightarrow 6 + 4(7) = 34 \text{ valence } \Rightarrow 5$$



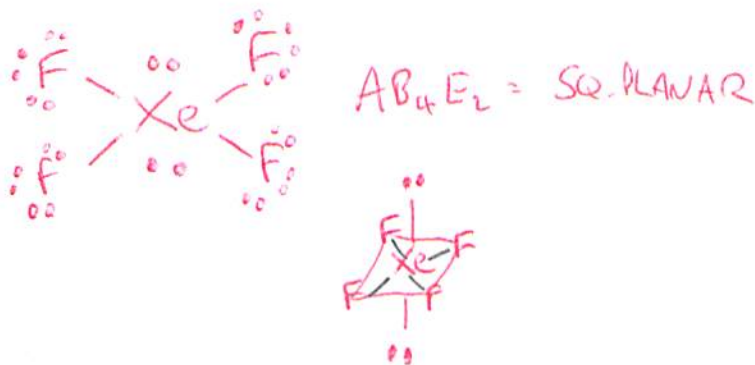


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41-43) Explain why a molecule of the form  $AB_2E_2$  (meaning a central atom connected to two atoms, and with two non-bonding pairs of electrons on the central atom) has a "bent" geometry.



four electronic domains = Tetrahedral arrangement of electrons.

but the 'shape' of B-A-B is bent.

44-46) If a photon has  $3.91 \times 10^{-20}$  Joules of energy, express this energy in the more common units of kJ/mol. (Avogadro's constant is  $6.022 \times 10^{23}$  per mole).

$$\begin{aligned}
 & 3.91 \times 10^{-20} \text{ J} \times 6.022 \times 10^{23} \text{ mol}^{-1} \\
 & = 23.54602 \times 10^3 \text{ J/mol} \\
 & = 23.5 \text{ kJ/mol}
 \end{aligned}$$


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47-49) Calculate the de Broglie wavelength of a 0.15 kg baseball moving with a velocity of 40.1 m/s?

$$\lambda = \frac{h}{mv} \quad \text{Planck's Constant} = 6.626 \times 10^{-34} \text{ J s} \quad \text{J} = \frac{\text{kg m}^2}{\text{s}^2}$$

$$\begin{aligned}
 \lambda &= \frac{6.626 \times 10^{-34}}{0.15 \times 40.1} \\
 &= 1.1 \times 10^{-34} \text{ m}
 \end{aligned}$$

$$\frac{\cancel{\text{kg}} \cdot \cancel{\text{m}^2} \cdot \cancel{\text{s}}}{\cancel{\text{s}^2} \cdot \cancel{\text{kg}} \cdot \cancel{\text{m}}}$$

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50) Your answer to the previous question should be a very, very small number. What does that mean in the context of trying to experimentally measure or detect the associated wavelength of the baseball?

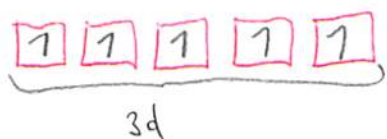
The wavelength is so small that it is essentially undetectable (or unmeasurable).

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Write the electron configuration for the  $\text{Fe}^{3+}$  cation (You can use a noble gas core if you wish).

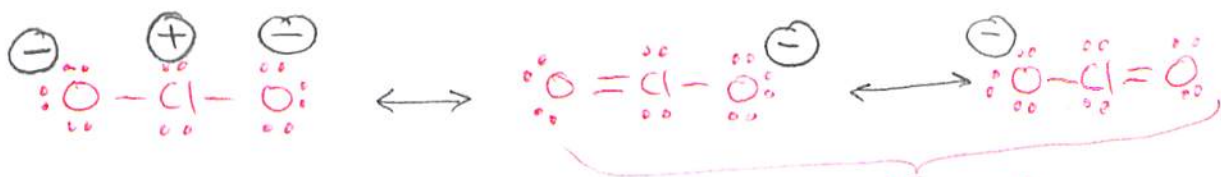


How could you experimentally prove that your above answer was correct?



This configuration should have 5 unpaired electrons. This would exhibit paramagnetism which can be experimentally detected and measured.

Draw three resonance forms of the  $[\text{O}-\text{Cl}-\text{O}]^-$  anion and comment on their relative stabilities.  $6+7+6+1 = 20 \text{ valence } e^-$



These two are of equal energy, and are the two best.

No, or less formal charges is preferred.