



Highlander Help

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Good Luck!

1. Choose the ground state electron configuration for Ti^{2+} .

- A) $[Ar]3d^2$
- B) $[Ar]4s^2$
- C) $[Ar]4s^23d$
- D) $[Ar]4s^23d^4$
- E) $[Ar]3d^4$

$[Ar] 4s^2 p^2$
 $[Ar] 4s^0 3d^2$

2. What are the possible values of n and m_l for an electron in a $4d$ orbital?

- A) $n = 1, 2, 3, \text{ or } 4$ and $m_l = 2$
- B) $n = 1, 2, 3, \text{ or } 4$ and $m_l = -2, -1, 0, +1, \text{ or } +2$
- C) $n = 4$ and $m_l = 2$
- D) $n = 5$ and $m_l = -2, -1, 0, +1, +2$

s 0
 p 1
 d 2
 e = 2

3. Electromagnetic radiation with a wavelength of 525 nm appears as green light to the human eye. The energy of one photon of this light is _____ J.

- A) 1.04×10^{-31}
- B) 3.79×10^{-28}
- C) 3.79×10^{-19}
- D) 1.04×10^{-22}
- E) 2.64×10^{18}

$E = h \nu$
 $6.626 \cdot 10^{-34} \text{ Js} \cdot \frac{3.0 \times 10^8}{525 \cdot 10^{-9}} = \nu$

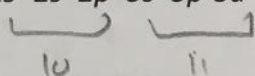
$c = \lambda \nu$

4. Which of the reactions below will have the lowest ionization energy?

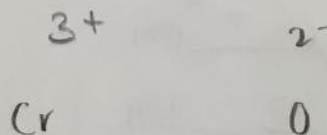
- A) $Ba^+(g) \rightarrow Ba^{2+}(g) + e^-$
- B) $Sr^+(g) \rightarrow Sr^{2+}(g) + e^-$
- C) $Ca^+(g) \rightarrow Ca^{2+}(g) + e^-$
- D) $Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$
- E) $Be^+(g) \rightarrow Be^{2+}(g) + e^-$

5. Chromium forms a series of compounds with oxygen. In one of the oxides, the electronic configuration of chromium ion is $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$. What is the formula of the oxide?

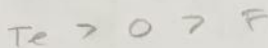
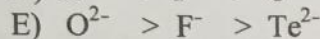
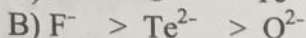
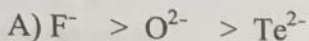
- A) Cr_2O_3
- B) CrO_2
- C) CrO
- D) Cr_2O
- E) CrO_3



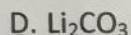
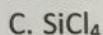
21 24



6. Place the following in order of decreasing radius.

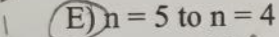
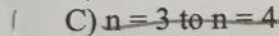
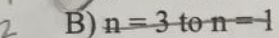
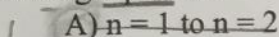


7. Which molecule or compound below contains a pure covalent bond?



$\downarrow E = \frac{1}{n} - \frac{1}{h}$
 $\frac{1}{2^2} - \frac{1}{1^2}$

8. Which of the following transitions (in a hydrogen atom) represent emission of the longest wavelength photon?



0.6775

lowest frequency

$E_{ph} = hf$

$E_{ph} = \frac{hc}{\lambda}$

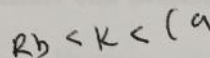
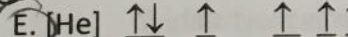
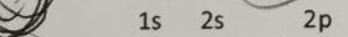
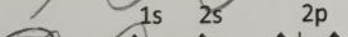
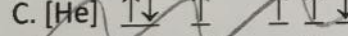
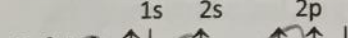
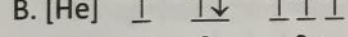
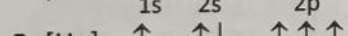
$\lambda = \frac{c}{f}$
 $\lambda \propto \frac{1}{f}$
 high frequency
 high energy

$\frac{1}{4} - 1$

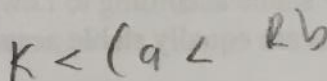
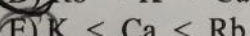
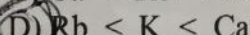
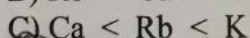
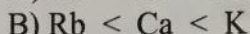
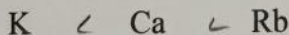
$1 - \frac{1}{3^2}$

$\frac{1}{4^2} - \frac{1}{5^2}$

9. Which of the following is the most excited state of the carbon atom?



10. Place the following in order of increasing IE (first ionization energy).



DONT BE STUPID

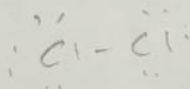
11. Three lasers, A, B and C, were used to eject electrons from a metal. Laser B produced no photoelectrons. Laser A produced faster electrons than laser C. Arrange the lasers in the order of decreasing wavelength of the photons (largest to smallest).

- A. $A > B > C$
- B. $B > C > A$
- C. $C > B > A$
- D. $C > A > B$
- E. $B > A > C$

$B > C > A$

12. Which molecule or compound below contains a pure covalent bond?

- A) Li_2CO_3
- B) SCl_6
- C) Cl_2
- D) PF_3
- E) NaCl ionic



13. Place the following in order of **decreasing** CO bond length, where "C" represents the central atom in each of the following compounds or ions

- A. $\text{CO} > \text{CO}_2 > \text{CO}_3^{2-}$
- B. $\text{CO}_2 > \text{CO}_3^{2-} > \text{CO}$
- C. $\text{CO}_3^{2-} > \text{CO}_2 > \text{CO}$
- D. $\text{CO} > \text{CO}_3^{2-} > \text{CO}_2$
- E. $\text{CO}_2 > \text{CO} > \text{CO}_3^{2-}$

CO

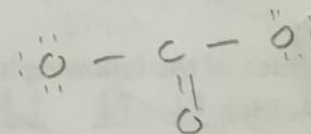
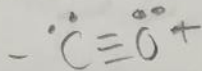
triple

CO₂

double

CO₃²⁻

single/double



14. Give the number of valence electrons for ICl_5 .

- A) 36
- B) 40
- C) 42
- D) 44
- E) 46

5x) Cl
6 (7)
6 (7)

6(7)

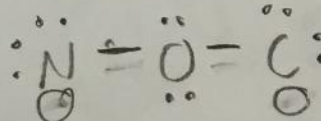
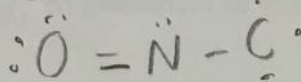
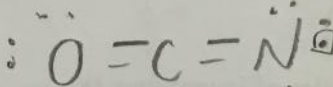
15. Using Lewis structures and formal charge, which of the following ions is most stable?

OCN^- ONC^- NOC^-

- A) OCN^-
- B) ONC^-
- C) NOC^-

D) None of these ions are stable according to Lewis theory.

E) All of these compounds are equally stable according to Lewis theory.



16. Order the following ionic compounds in the order of increasing melting point (lowest to highest).

- A. II, I, III, IV
- B. III, IV, II, I**
- ~~C. I, II, III, IV~~
- D. IV, III, II, I
- ~~E. II, III, I, IV~~

high I. MgO⁴ high II. CaS⁴

III. KBr IV. KF ^{small}

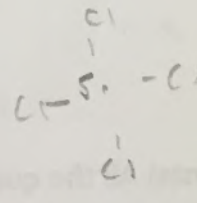
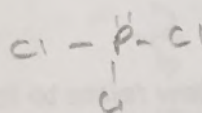
KBr, KF

III IV

high⁴

17. When drawing the best possible Lewis structure, which species violates the octet rule?

- A. POCl₃**
- ~~B. CF₄~~
- ~~C. OCl₂~~
- ~~D. SiCl₄~~
- ~~E. PCl₃~~

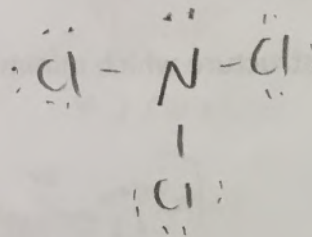


18. Which of following compounds of carbon has the largest bond angle around the central atom, C?

- A. H₂CO
- B. HCOOH
- C. CH₄
- D. CO₂** ^{180° linear}
- E. All have the same bond angle

19. Determine the electron geometry (eg) and molecular geometry (mg) of NCl₃.

- ~~A) eg=tetrahedral, mg=tetrahedral~~
- ~~B) eg=linear, mg=trigonal planar~~
- ~~C) eg=trigonal planar, mg=bent~~
- ~~D) eg=linear, mg=linear~~
- E) eg=tetrahedral, mg=trigonal pyramidal**



steric # 4

tetrahedral

Part B: two questions worth 24 points Show your work

1. A) (4 points) Calculate the wavelength of the photon emitted when an electron transitions from energy level 5 to energy level 2 in the hydrogen atom. Useful equation: $E_n = -2.18 \times 10^{-18} \text{ J} \left(\frac{1}{n^2} \right)$

$$-2.18 \cdot 10^{-18} \left(\frac{1}{2^2} - \frac{1}{5^2} \right) E_n = -4.578 \times 10^{-19} \text{ J}$$

$$-4.578 \times 10^{-19} \text{ J} = \frac{6.626 \times 10^{-34} \text{ J} \cdot \text{s} \cdot (3.0 \times 10^8 \text{ s}^{-1})}{\lambda}$$

$$c = \lambda \nu$$

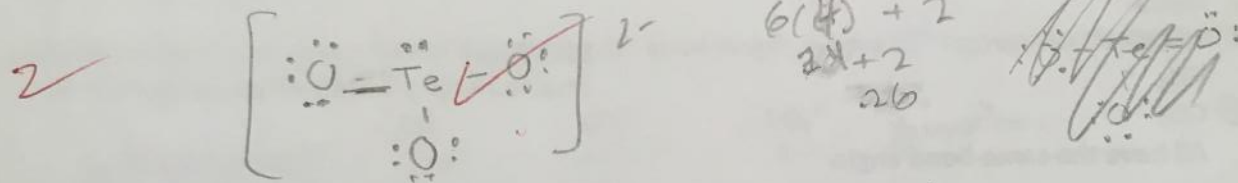
$$3.0 \times 10^8 \frac{\text{m}}{\text{s}} = \lambda \cdot \nu$$

$$-6.909 \times 10^{14} = \nu$$

$$\lambda = 4.34 \times 10^{-7} \text{ m}$$

B) (8 points) All the questions below relate to the TeO_3^{2-} ion.

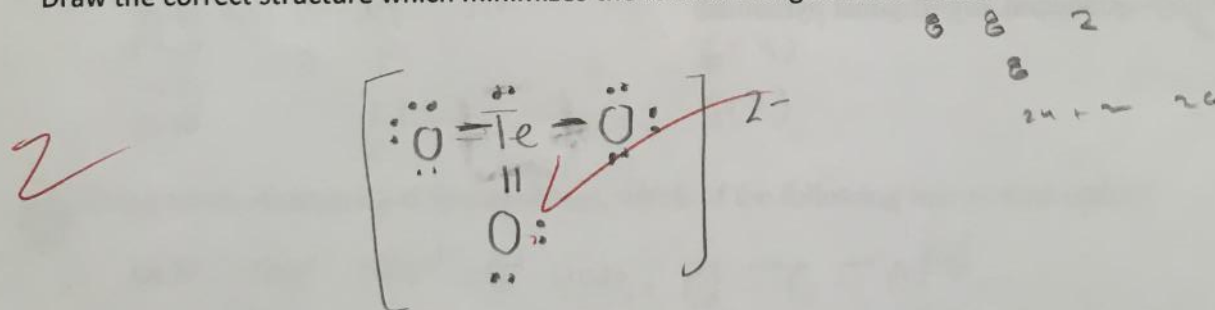
Draw the Lewis dot structure of TeO_3^{2-} ion where all the atoms obey the octet rule.



Formal charge on the Te atom in the Lewis structure that obeys octet rule:

$$6 - 5 = 1+$$

Draw the correct structure which minimizes the formal charge on the atoms



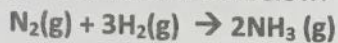
What is the Steric number and geometry around Te atom in the preceding question

$$\text{Sn} = 4$$

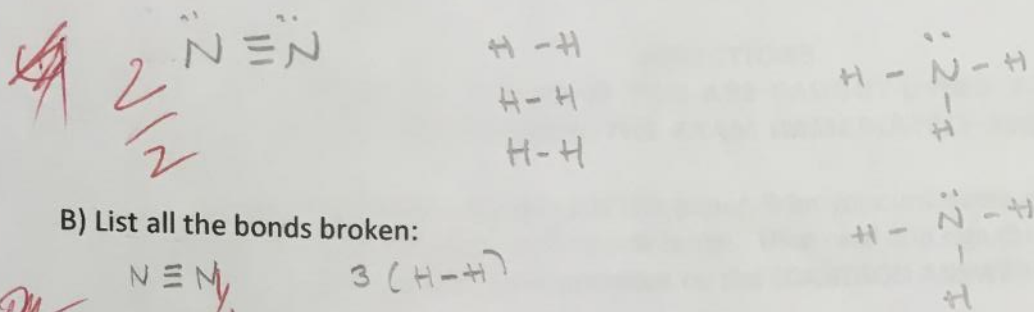
$$\text{trigonal pyramidal}$$

12/12

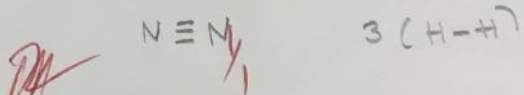
II. (8 points) The production of ammonia from its constituent elements is an important industrial process and proceeds according to the reaction shown below:



A) Draw the Lewis dot structures of the all the species in the reaction



B) List all the bonds broken:



C) List all the bonds formed:



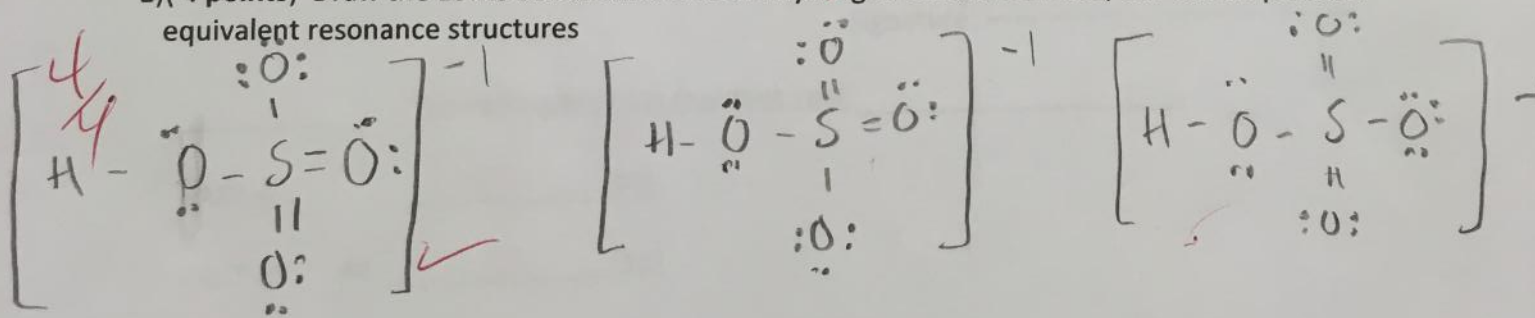
D) Using the information in the table below, calculate the enthalpy change in kJ/mol for the production of ammonia

Bond	Bond Energy (kJ/mol)	Bond	Bond Energy (kJ/mol)
H-H	436	N-N	163
H-C	414	N=N	418
H-N	389	N≡N	946
H-O	464	N-O	222

Handwritten note: you've calculated ΔH for 2 moles NH_3

Handwritten calculation: $(946 + 3(436)) - 6(389) = 2256 - 2334 = -80 \text{ kJ/mol}$. The final result is circled in red.

E) (4 points) Draw the Lewis dot structure of the hydrogen sulfate ion HSO_4^- ion and all possible equivalent resonance structures



Handwritten note: 3 total resonance structures