

# End-term Exam

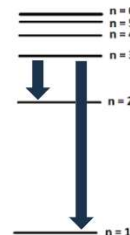
Minneapolis Community and Technical College  
C1151 Fall 2023...Boraas

Name \_\_\_\_\_

## Directions:

- Turn your smartphone to "Silent" and place it face down on your desk.
- Write your name at the top of this exam
- Record your answer to each multiple choice question on the Scantron answer sheet IN PENCIL.
- You can write on this exam booklet. Additional scratch paper is available on request.
- Return this exam, scratch paper, answer sheet and notecard when finished. Failure to do so means a zero for the exam.
- You will have 3 hours to complete the exam. Sharing of calculators is not allowed.
- "F" is never the correct answer

- USE #2 Pencil  
Erase completely!
- [ a ] [ b ] [ c ] [ d ] [ e ]
  - [ a ] [ b ] [ c ] [ d ] [ e ]
  - [ a ] [ b ] [ c ] [ d ] [ e ]



1. If the  $n = 3$  to  $n = 2$  electron transition produces visible light, which of the following forms of electromagnetic radiation could be produced by the  $n = 3$  to  $n = 1$  electron transition?

a. Infrared                      b. microwave                      c. radio wave                      d. ultraviolet

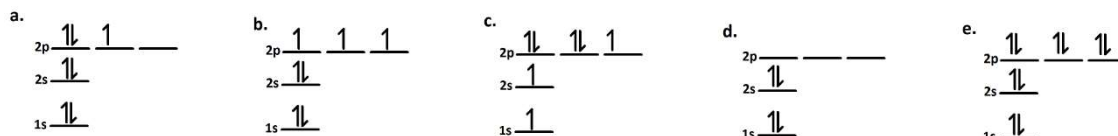
2. What is the wavelength of light whose energy is  $4.55 \times 10^{-19}$  Joules?

a. 437 nm                      b. 517 nm                      c. 325 nm                      d. 625 nm                      e. 734 nm

3. Which of the following forms of visible light has the lowest energy?

a. violet                      b. green                      c. orange                      d. yellow                      e. blue

4. Choose the orbital diagram below that represents the ground state of N.



5. Which one of the 5 sets of quantum numbers at right describes last electron added in the neutral Cl atom.

- a.  $n = 3, \quad l = 2, \quad m_l = 1, \quad m_s = +\frac{1}{2}$   
b.  $n = 3, \quad l = 0, \quad m_l = 1, \quad m_s = -\frac{1}{2}$   
c.  $n = 3, \quad l = 1, \quad m_l = 1, \quad m_s = +\frac{1}{2}$   
d.  $n = 2, \quad l = 1, \quad m_l = 1, \quad m_s = -\frac{1}{2}$   
e.  $n = 3, \quad l = 2, \quad m_l = 1, \quad m_s = -\frac{1}{2}$

6. Carefully examine the following electron configurations and choose the one belonging to the **largest neutral atom**.

a.  $1s^2 2s^2 2p^6 3s^2 3p^4$                       b.  $1s^2 2s^2 2p^6 3s^2 3p^3$                       c.  $1s^2 2s^2 2p^6 3s^2 3p^2$                       d.  $1s^2 2s^2 2p^6 3s^2 3p^1$

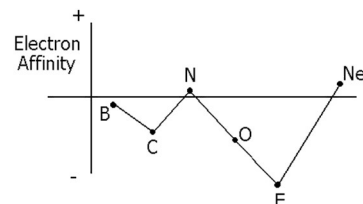
7. A  $\text{Br}^-$  ion is *iso-electronic* with a neutral argon atom.    a. True                      b. False

8. What is the ground state electron configuration for a neutral Se atom?

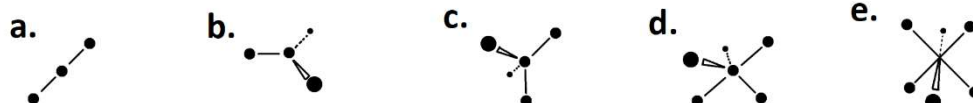
a.  $[\text{Ar}]4s^2 3d^{10}$                       b.  $[\text{Ar}]4s^2 4d^{10} 4p^4$                       c.  $[\text{Ar}]4s^2 3d^{10} 4p^6$                       d.  $[\text{Ar}]4s^2 3d^{10} 4p^4$                       e.  $[\text{Ar}]3d^{10} 4p^4$

9. What accounts for nitrogen's slightly positive electron affinity illustrated at right?

- a. ...by losing an electron, nitrogen's valence electrons are reduced.  
b. ...by losing an electron, nitrogen's 2p orbital is now half full.  
c. ...by gaining an electron, nitrogen's 2p orbital is now totally full.  
d. ...by gaining an electron, nitrogen's 2p orbital is now half full.  
e. ...by gaining an electron, nitrogen's 2p orbital is now partially full.



10. A student determines the hybridization of a molecule's centermost atom as  $sp^3$   
Which of the structures below best identifies the shape of the molecule?



11. Within an atom, why are 3s electrons lower in energy compared to 3p electrons?

- 3s electrons move more slowly and therefore have less kinetic energy.
- 3s electrons get closer to the nucleus and therefore have lower potential energy.
- 3s electrons are better shielded than 3p electrons and therefore have less potential energy.
- 3s electrons have less mass than 3p electrons and therefore have less kinetic energy.
- 3s electrons occupy a larger orbitals giving them lower potential energy.

12. Place the following in order of **decreasing** lattice energy.  $K_2O$   $Rb_2S$   $Li_2O$

- High L.E.  $Li_2O > Rb_2S > K_2O$  Low L.E.
- High L.E.  $Li_2O > K_2O > Rb_2S$  Low L.E.
- High L.E.  $Rb_2S > K_2O > Li_2O$  Low L.E.
- High L.E.  $Rb_2S > Li_2O > K_2O$  Low L.E.
- High L.E.  $K_2O > Li_2O > Rb_2S$  Low L.E.

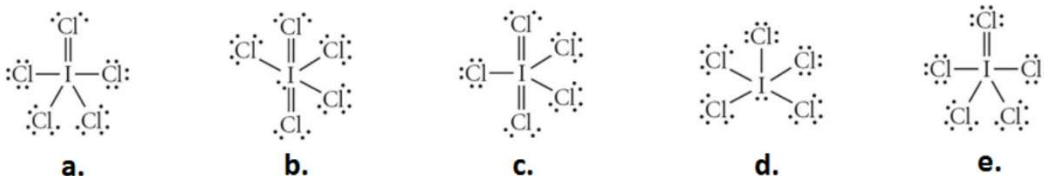
13. Choose the compound below that should have the **highest** melting point according to the ionic bonding model.

- LiF
- NaCl
- CsI
- KBr
- RbI

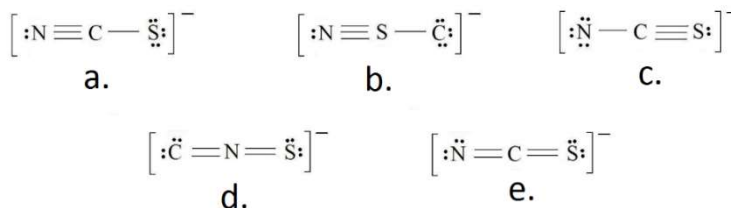
14. Choose the bond below that is **least** polar.

- O-H
- H-N
- H-F
- H-Cl
- C-H

15. Which of the following is the correct Lewis Dot Structure for  $ICl_5$ ?



16. Use formal charges to determine which of the five Lewis structures at right is correct for  $NCS^-$ .

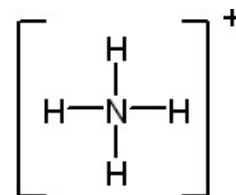


**Additional Info.....**

$E_N$  carbon = 2.5  
 $E_N$  nitrogen = 3.0  
 $E_N$  sulfur = 2.5

17. What is the formal charge on the nitrogen atom in the Lewis structure shown at right?

- 2
- 1
- 0
- +1
- +2



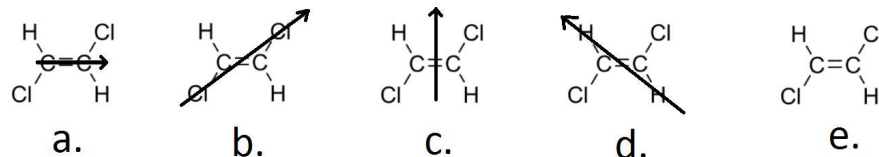
18. **Ionic bonds** are formed when ...

- |  |  |
|--|--|
| a. <b>Cation formation:</b> High ionization energy | <b>Anion formation:</b> Positive electron affinity |
| b. <b>Cation formation:</b> High ionization energy | <b>Anion formation:</b> Negative electron affinity |
| c. <b>Cation formation:</b> Low ionization energy  | <b>Anion formation:</b> Negative electron affinity |
| d. <b>Cation formation:</b> Low ionization energy  | <b>Anion formation:</b> Positive electron affinity |

19. Electron shielding isn't a factor for the electron in a hydrogen atom.

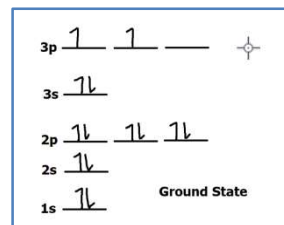
- True
- False

20. Which of the following correctly shows the dipole moment vector for  $C_2H_2Cl_2$ ?

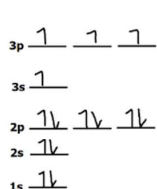


21. Which of the following three bonds would have the most ionic character?

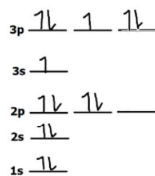
- a. Si-P                      b. Si-Cl                      c. Si-S



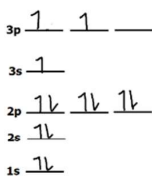
22. The ground state of a molecule's centermost atom is shown in the box at right. Which of the following is the **promoted state** if the goal is to form **two bonds**?



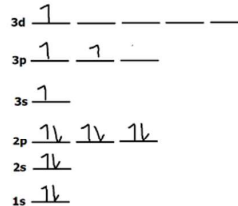
a.



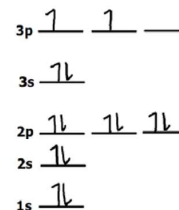
b.



c.



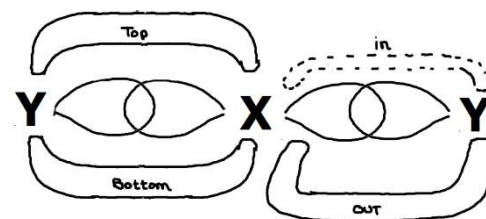
d.



e.

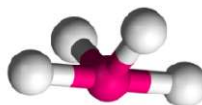
23. Which statement below correctly identifies the number and type of bond found in the structure at right?

- a. 2 sigma bonds and 2 pi bonds  
 b. 2 sigma bonds and 4 pi bonds  
 c. 4 sigma bonds and 2 pi bonds  
 d. 4 sigma bonds and 4 pi bonds

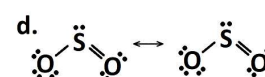
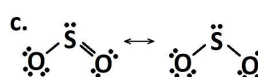
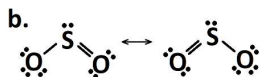
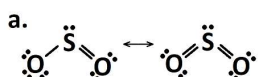


24. What **electronic** geometry for the molecule at right?

- a. linear  
 b. trigonal planar  
 c. tetrahedral  
 d. trigonal bipyramidal

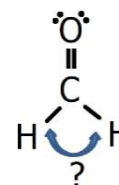


25. Which of the following correctly shows the two resonance forms of SO<sub>2</sub>?

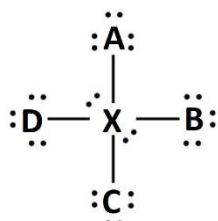


26. What is the most likely bond angle (?) for the CH<sub>2</sub>O molecule at right?

- a. ? > 120°                      b. ? < 120°                      c. ? = 120°  
 d. ? < 109.5°                      e. ? = 109.5°                      f. ? > 109.5°



27. Carefully examine the *Lewis* structure below and choose the correct geometries from the list below.



- a. **Electronic geometry:** trigonal bipyramidal  
 b. **Electronic geometry:** tetrahedral  
 c. **Electronic geometry:** trigonal bipyramidal  
 d. **Electronic geometry:** octahedral  
 e. **Electronic geometry:** trigonal bipyramidal  
 f. **Electronic geometry:** tetrahedral

- Molecular geometry:** T shaped  
**Molecular geometry:** Linear  
**Molecular geometry:** Seesaw  
**Molecular geometry:** Square planar  
**Molecular geometry:** Linear  
**Molecular geometry:** Bent

28. What period 3 element would most likely have the following consecutive ionization energies (kJ/mol)?

$$IE_1 = 786 \text{ kJ} \quad IE_2 = 989 \text{ kJ} \quad IE_3 = 3230 \quad IE_4 = 4360 \quad IE_5 = 16000 \text{ kJ}$$

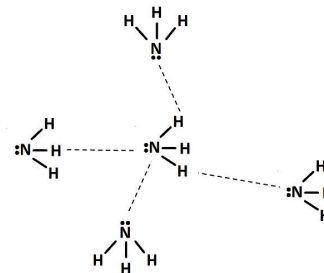
- a. Na      b. Mg      c. Al      d. Si      e. P      f. S      g. Cl

29. Which of the following molecules will experience the **strongest intermolecular forces**?

- a. HCl      b. HF      c. HBr      d. HI      e. CCl<sub>4</sub>

30. What type of bonding is represented by the dotted lines in the figure at right?

- a. ionic bonding      b. covalent bonding  
c. hydrogen bonding      d. dipole-dipole attraction  
e. Van der Waals forces      f. ion induced attraction

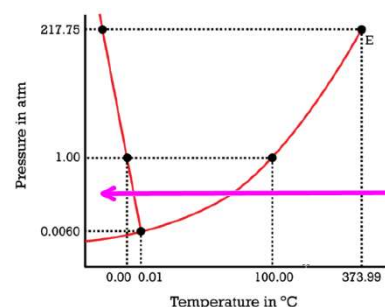


31. Molecules with polar bonds are always polar molecules.

- a. True      b. False

32. What two processes (in the correct order) are described by the **arrow** in the phase diagram at right?

- a. Condensation followed by Freezing  
b. Vaporization followed by melting  
c. Condensation followed by melting  
d. Sublimation followed by Melting  
e. Sublimation followed by Condensation  
f. Vaporization followed by Freezing



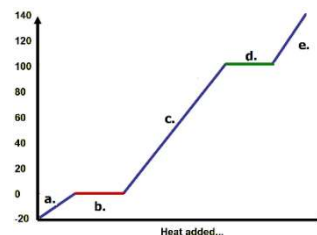
33. At a temperature of 302 °C the physical state of lithium is \_\_\_\_\_.

Useful lithium information:  $T_{\text{melt}} = 181 \text{ °C}$      $T_{\text{boil}} = 1330 \text{ °C}$

- a. Solid      b. Liquid      c. gas

34. Referring to water's heating curve at right, what part of the process does the letter "c" correspond to?

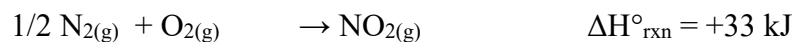
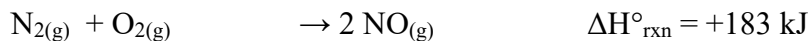
- a. Warming liquid water      b. Vaporizing liquid water  
c. Melting ice      d. Warming ice  
e. Heating steam      f. None of the above.



35. Use the information below to determine  $\Delta H^\circ_{\text{rxn}}$  for the following reaction:



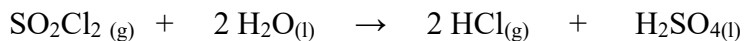
Given:



- a. -150. kJ      b. -117 kJ      c. -333 kJ      d. +115 kJ      e. +238 kJ

36. Which of the following statements about water is **incorrect**?
- Liquid water has greater density than solid water.
  - The intermolecular forces between water molecules are hydrogen bonds.
  - $H_{\text{vap}}$  for liquid water is small in comparison to other liquids
  - Liquid water has a large specific heat in comparison to other materials.
  - The water molecule is very polar.

37. Use the  $\Delta H^{\circ}_f$  information provided below to calculate  $\Delta H^{\circ}_{\text{rxn}}$  for the following:



- 256 kJ
- +161 kJ
- 62 kJ
- +800. kJ
- 422 kJ

	$\Delta H^{\circ}_f$
$\text{SO}_2\text{Cl}_2(\text{g})$	-364 kJ/mol
$\text{H}_2\text{O}(\text{l})$	-286 kJ/mol
$\text{HCl}(\text{g})$	-92 kJ/mol
$\text{H}_2\text{SO}_4(\text{l})$	-814 kJ/mol

38. How many valence electrons are there for the  $\text{F}^-$  anion?
- 5 valence electrons
  - 6 valence electrons
  - 7 valence electrons
  - 8 valence electrons

39. The “water strider” is an insect that can walk on water (see picture at right).  
What property of water does the strider use to do this?

- Boiling point
- capillary action
- surface tension
- osmotic pressure
- adhesive forces
- magic fairy dust



40. How much energy is required to vaporize 98.6 g of ethanol ( $\text{C}_2\text{H}_5\text{OH}$  46.068 g/mol) at its boiling point?

Useful information:  $\Delta H_{\text{vap}}$  is 40.5 kJ/mol

- 86.7 kJ
- 11.5 kJ
- 18.9 kJ
- 52.8 kJ
- 39.9 kJ

Show all work neatly for full credit. Answers must be circled and labelled.

41. (5 pts) Show all work neatly for full credit. Answers must be circled, adjusted for significant figures and appear with correct units.

How much energy must be used to convert 110.0 grams of ice at  $-25.0^{\circ}\text{C}$  to steam at  $100.0^{\circ}\text{C}$ ?

Useful Information:	$C_{\text{ice}}$	$= 2.09 \text{ J/g}^{\circ}\text{C}$	$H_{\text{fus}}$	$= 6.02 \text{ kJ/mol}$
	$C_{\text{liquid}}$	$= 4.184 \text{ J/g}^{\circ}\text{C}$	$H_{\text{vap}}$	$= 40.7 \text{ kJ/mol}$
	$C_{\text{steam}}$	$= 2.03 \text{ J/g}^{\circ}\text{C}$		

*Show all work neatly for full credit. Answers must be circled and labelled.*

42. (6 pts) *Show all work neatly for full credit. Answers must be circled and labelled.*

For the **PH<sub>5</sub>** molecule, provide the following:

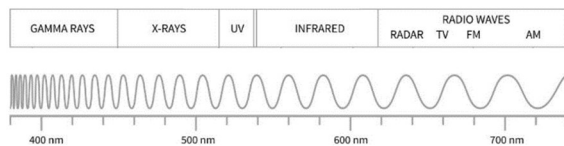
- a. (1 pt) Lewis Dot Structure
- b. (1 pt) Formal Charges for all atoms (Show calculations)
- c. (1 pt) Electronic geometry name \_\_\_\_\_ Molecular geometry name \_\_\_\_\_
- d. (1 pt) **Ground** state, **Promoted** state and **Hybrid** state electron energy level diagrams for the center atom.
- e. (2 pts) Carefully drawn 3-dimensional molecular picture **with labeled....**
  - a. bond types ( $\sigma$  and/or  $\pi$ )
  - b. bond angles
  - c. lone pair
  - d. dipole moment vector

Show all work neatly for full credit. Answers must be circled and labelled.

43. (5 pts) Show all work neatly for full credit. Answers must be circled, adjusted for significant figures and appear with correct units.

The Carbon – Carbon double bond energy is 614 kJ/mol.

- Calculate the bond energy for 1 double bond
- Determine the frequency of light that has this energy
- Determine the wavelength of light (nm) corresponding to this energy.
- What region of the electromagnetic spectrum does this light belong to?





**44. Bonus Questions (4 pts)**

a. (1 pt) Why does liquid water have an unusually high boiling point?

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b. (1 pt) Why does water boil at a much lower temperature on a mountaintop?

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c. (1 pt) Explain why water at 50°C evaporates more quickly than water at 25°C? (1 pt)

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d. (1 pt) Why is ice less dense than liquid water?

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