

1. The diagram below shows four energy levels for the hydrogen atom. Answer the following: [4]

n=4 _____

n=3 _____

n=2 _____

n=1 _____

$$E = h\nu = \frac{hc}{\lambda}$$

a) The transition with the highest frequency.

$$\underline{n=4 \text{ to } n=1}$$

b) A Balmer transition with the lowest energy.

$$\underline{n=3 \text{ to } n=2}$$

c) How many Lyman emission lines?

3

d) The transition most likely in the IR region.

$$\underline{n=4 \text{ to } n=3}$$

2. The violet line in the line spectrum of hydrogen atom has wavelength of 434 nm. What is the principal quantum number of the upper energy level of the electron that produces a photon of this wavelength? The equation is: [4]

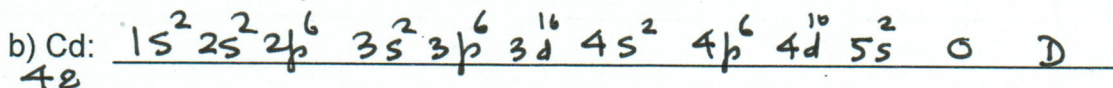
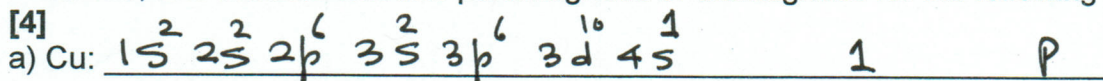
$$E_n = \frac{-2.18 \times 10^{-18} (Z^2) J}{n^2}$$

$$E = \frac{hc}{\lambda} = \frac{h \cdot c}{4.34 \times 10^{-7} \text{ m}} = 4.59 \times 10^{-19} \text{ J}$$

$$4.59 \times 10^{-19} = \left(\frac{-2.18 \times 10^{-18}}{n^2} \right) - \left(\frac{-2.18 \times 10^{-18}}{2^2} \right) \quad Z=1.$$

$$n = 5$$

3. Give the complete ground state electron configuration, the number of unpaired electrons, and indicate whether paramagnetic or diamagnetic for the following species.



4. Which of the following quantum numbers (n,l,m_l,m_s) is not allowed? [2]

a) 3,0,0,+1/2 b) 4,2,1,+1/2 c) 3,-1,1,+1/2 d) 3,1,1,-1/2

5. a) How many electrons in an atom can have n=3? [1]

18

- b) How many subshells are there if n=6? [1]

6

- c) How many electrons in Sb that have m_l=0 and m_s=+1/2? [1]

11

- d) How many electrons in 3f orbitals? [1]

0

- e) How many half filled orbitals in Co²⁺? [1]

3

- f) How many electrons in Mg²⁺ that have n=2 and m_s=-1/2? [1]

4

- g) How many electrons can occupy 2d orbitals? [1]

0

- h) Give the number of electrons if n=4 and l=2 and m_s=1/2 [1]

5

6. a) Give a cation with a charge of 3+ that is isoelectronic with Ca²⁺ [1]

Sc³⁺

- b) Suppose the spin quantum number had three allowed values (m_s= +1/2, 0, and -1/2). Give the Z, atomic number, for the first two noble gases in this case. [2]

3

15

17

7. Which one of the following has the largest first ionization energy? [2]

- (a) Cl b) S c) P d) Si e) Na

8. Which element will have the greatest third ionization energy? [2]

- a) Ba b) Al c) Ga d) S (e) Mg

9. Which element will have the greatest electronegativity? [2]

- a) Ge b) Si c) P (d) S e) Se

10. Which element has the smallest atomic radius? [2]

- (a) F b) Al c) S d) P e) Si

11. Which ion has the smallest radius? [2]

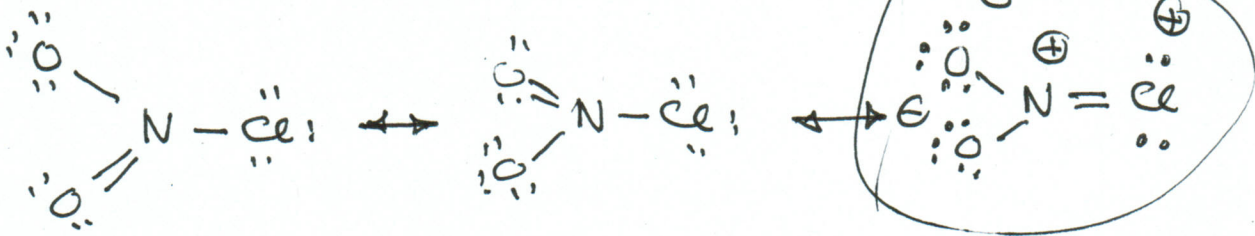
- a) Na⁺ b) K⁺ c) Ca²⁺ (d) Mg²⁺ e) Cl⁻

12. Which of the following covalent bond is the most polar? [2]

- a) I-I b) Si-I c) Cl-Cl (d) Si-Cl e) Si-Si

a
e
d
a
d
d

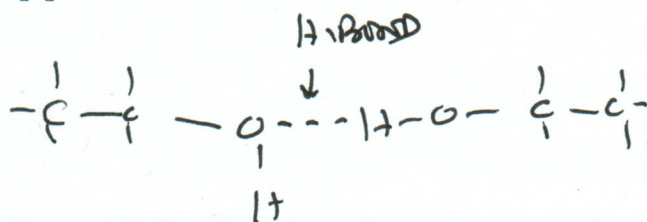
13. Give three resonance structures for O_2NCl . Circle the least likely by indicating formal charges. [4]



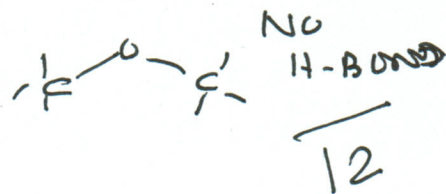
14. Complete the following table. Central atom is underlined>. [6].

SPECIES	NAME OF SHAPE	P OR NP
$\underline{Sb}Cl_3$ ΔB_3E	TRIGONAL PYRAMIDAL	P
$\underline{Te}Cl_4$ ΔB_4E	SEESAW	P
$Cl_3\underline{As}O$ ΔB_4	TETRAHEDRAL	P
$\underline{I}F_5$ ΔB_5E	SQUARE PYRAMIDAL	P

15. a) Explain why the boiling point of ethanol is $78^\circ C$ while that of dimethyl ether is only minus $24^\circ C$. [2]



BOTH POLAR
BOTH SIMILAR L FORCE
ETHANOL H-BOND

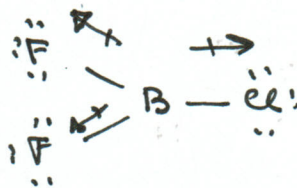
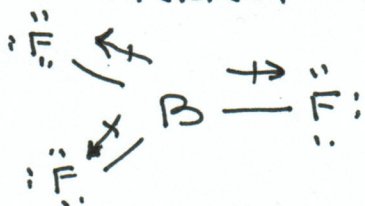


b) Indicate the type of intermolecular forces present in each of the following..
Marking will be right minus wrong. [5]

Substance	H-Bonding	Dipole-dipole	London
Cyclopentanol	✓	✓	✓
Ethanol	✓	✓	✓
H ₂ S		✓	✓
SF ₄		✓	✓

19. The dipole moment of BF_3 is zero while that of F_2BCl has a measurable value. Explain this difference. [1]

BOTH MOLECULES HAVE TRIANGULAR PLANAR SHAPE.
 ONLY IN BF_3 DO THE BOND DIPOLES CANCEL OUT
 (PERFECT SHAPE)



20. PCl_5 exists. Could NCl_5 exist? Explain your answer. [1]

FOR NCl_5 TO EXIST, IT WILL NEED TO HAVE 10 e^- IN ITS VALENCE SHELL. THIS IS NOT POSSIBLE AS N BEING IN PERIOD NO 2 HAS ONLY 2s & 2p ORBITALS. THERE ARE NO 2d ORBITALS. SO CAN'T EXIST.

P HAS 3s, 3p, and 3d ORBITALS, SO CAN EXIST.

5