Chemist: _____ Monday October 17th, 2022

SCH4U1 **Period 5**
UNIT 1 TEST 2
Matter and Chemical Bonding

Knowledge:	/10
Thinking & Investigation :	/8
Communication:	/9
Application	/10

KNOWLEDGE & UNDERSTANDING (10 marks)

**** Answer the following multiple choice questions by selecting the BEST answer for each question. Be sure to record your selection in the table below as only the Answer Grid will be evaluated. ****

1.	A	B	C	D	E	5.	A	B	C	D	E
2.	A	B	C	D	E	6.	A	B	C	D	E
3.	A	B	C	D	E	7.	A	B	C	D	E
4.	A	B	C	D	E	8.	A	B	C	D	E

accepted either

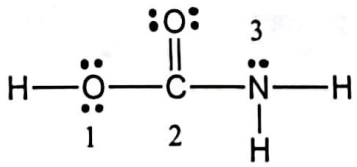
1. Which of the following sets of **quantum numbers are possible?**

a) $n=1, \ell=1, m_l=0, m_s=+\frac{1}{2}$
b) $n=2, \ell=1, m_l=0, m_s=-\frac{1}{2}$ ✓
c) $n=2, \ell=1, m_l=2, m_s=+\frac{1}{2}$
d) $n=3, \ell=0, m_l=+1, m_s=-\frac{1}{2}$
e) $n=2, \ell=2, m_l=+1, m_s=+\frac{1}{2}$

2. Which of the following is **the actual electron configuration** for an element with **atomic number 24?**

a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^5$
b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$
c) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^4$
d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$
e) None of the above are correct

3. The Lewis Structure for a molecule is given below.



Identify which of the following statements is **true**

a) All 3 central atoms have different electron distributions and different molecular shapes
b) Central atom 1 and 2 have the same electron distribution but different molecular shapes
c) Central atom 1 and 3 have the same electron distribution but different molecular shapes ✓
d) Central atom 2 and 3 have different electron distributions but the same molecular shape ✗
e) All 3 central atoms have the same electron distribution but different molecular shapes ✗

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4. Which of the molecules: CO_2, NH_3, CHF_3, and BCl_3, will be **polar**?

a) CHF_3 and NH_3
b) NH_3 and BCl_3
c) BCl_3, NH_3 and CHF_3
d) CO_2, NH_3 and CHF_3
e) CO_2 and BCl_3

5. Identify which of the following contain a **bond angle of 90°**.

I. SBr_4 II. PBr_5 III. CO_3^{2-}

a) I and II only
b) II and III only
c) I and III only
d) II only
e) I, II and III

6. A **polar** molecule has a chemical formula **XY_4**. What **molecular shapes** could this molecule adopt?

I. Tetrahedral II. Seesaw III. Square Planar

if all the same not polar.

a) I only
b) I and II only
c) I and III only
d) II and III only
e) I, II and III

also accepted e) since so many people missed "polar"

7. Which of the following is true for $SeCl_3^-$?

	Electron Geometry around central atom	Shape of Molecule
a)	trigonal planar	trigonal planar
b)	trigonal bypyramidal	trigonal pyramidal
c)	trigonal bipyramidal	T-shaped
d)	tetrahedral	T-shaped
e)	tetrahedral	trigonal pyramidal

8. Which of the following are arranged in order of **increaseing melting point**?

a) $SiO_2 > Na > CCl_4 > NH_3$
b) $CCl_4 < MgO < NH_3 < SiO_2$
c) $SiO_2 < MgO < NH_3 < CCl_4$
d) $MgO < SiO_2 < CCl_4 < NH_3$
e) $CCl_4 < NH_3 < MgO < SiO_2$

SiO_2 = network (highest)
NH_3 = polar
MgO = ionic

Short Answer:

9. Arrange the following in order from **highest to lowest frequency**:

microwaves, visible light, radio waves, infrared rays (1 mark)

visible light, infrared waves, microwaves,

10. Determine the total number of **d orbitals** that are **completely or partially filled** with electrons in a **niobium (Nb)** atom. (1 mark)

8

- 5 3d orbitals full
3 4d orbitals partially full

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THINKING & INVESTIGATION (8 marks)

11. a) State the **abbreviated electronic configuration** of a **technetium (Tc)** atom. (1 mark)

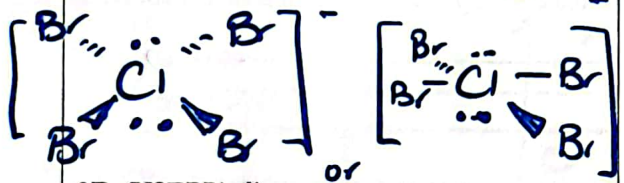
$[Kr]5s^2 4d^5$

b) Using your answer in part (a), **state and explain which ion or ions** technetium could theoretically form. (2 marks)

Tc^{2+} by losing both 5s e^- then Te^{3+}, Te^{4+}, Te^{5+}, Te^{6+}, Te^{7+} since all 5 d electrons are unpaired, some or all can be lost

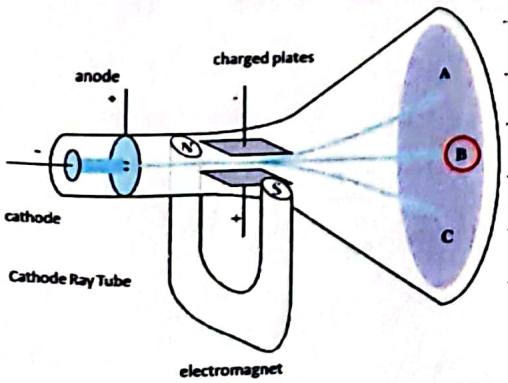
12. Draw a proper VSEPR **(3D) diagram** of CBr_4^- and SO_2 State the **name of the molecular shapes and electron distributions** of each. Also state the number of **lone electron** and **bonding pairs.** (5 marks)

a lot of people forgot - not penalized since no space in table

$ClBr_4^-$ 2 lone 4 bonding	SO_2
 or 3D (VSEPR) diagram	 or 1 lone 2 bonding 3D (VSEPR) diagram
Electron distribution: octahedral	Electron distribution: trigonal planar
Molecular shape: square planar	Molecular shape: bent
Bond Angle(s): 90°	Bond Angle(s): 117°

COMMUNICATION (8 marks)

13. The diagram to the left shows one of the critical experiments that led to our current model of the atom. Briefly explain **what the experimental results were** and what **conclusion the experiment about the atom was derived from the** experiment (2 marks)

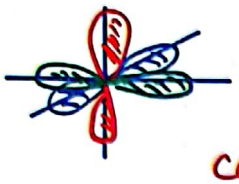


the experiment(s) showed that the atom contained negatively charged particles that could be separated, therefore atoms were not indivisible

new model - negatively charged particles in a positive "cloud" or "material"

14. s, p, d and f are used to describe both types of orbital and sublevels.

a) Describe the organization of p orbitals within the p sublevel. Use a diagram to help your explanation if you wish.

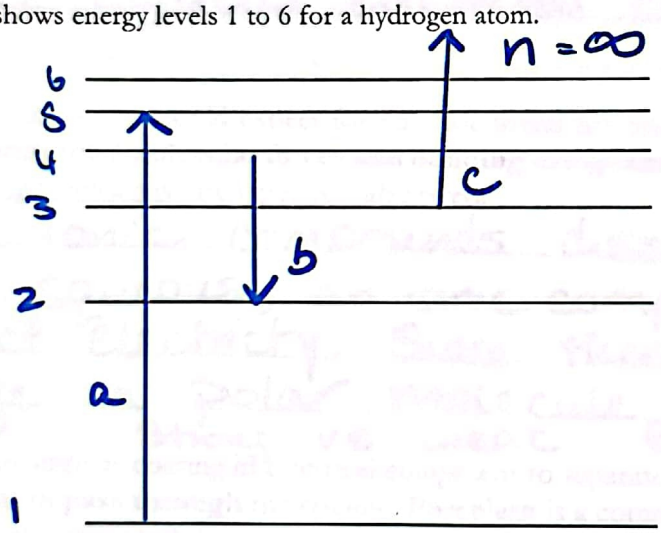


3 p orbitals per sublevel
90° to each other
Centred on nucleus
can be marked here or in diagram (1 mark)

b) Explain the **difference** between "a p orbital" and "the p sublevel", and give an example of a situation where this difference **does not apply**.

a p orbital is a part of the p sublevel containing 2e⁻
There are 3 p orbitals in the sublevel, for 6e⁻ total
In the s sublevel there is only one orbital
so the terms can be used independently
(2 marks)

15. This diagram shows energy levels 1 to 6 for a hydrogen atom.



On the diagram above, show:

a) an **absorption** that would use energy in the **ultraviolet region** n = 1 up

b) an **emission** that would result in **yellow light**. n = 4 → n = 2 (middle)

c) the **ionization** of the final valence electron of sulfur (S) n = 3 ↑ (3 marks)

APPLICATION **(10 marks)**

16. You have been supplied with **three unidentified solids that you KNOW are 3 different types of aggregate,** and the only information you have about these substances is as follows:

- Solid A dissolves in water
- Solid B has a melting point of 115°C
- Solid C is hard but brittle

a) **Identify** which one of these solids is most likely to be an **non polar molecular and network solid** compound. (2 marks)

NPM: B NETWORK: C

b) The remaining aggregate could be two different types of aggregate – **identify the two types of aggregate it could be,** and state/briefly describe **one further test or piece of information** that could be used to distinguish between these two types of aggregate. (2 marks)

polar molecular or ionic
- test aqueous electrical conductivity

melting point also possible

c) State the results you would expect for your identified test and use your knowledge about **properties of aggregates, intermolecular forces and bonding** to **explain why** the test you chose works to distinguish between the two aggregate types you identified. (3 marks)

since ionic compounds dissociate into ions when aqueous, an ionic compound solution will conduct electricty. Since there is no moveable charge a polar molecule will not

strong vs weak forces (+ names) ionic higher

17. **Insulators** are used as **coating** in electrical equipment to separate electrical conductors since they **do not allow current to pass through** the coating. **Porcelain** is a commonly used insulator coating for electrical equipment that is **exposed to environmental conditions such as rain and snow.**

One major advantage of this coating is that it is **extremely strong and durable** (lasts a long time) if properly cared for. However, a disadvantage is that **the coating can be cracked or damaged by impacts (blows).**

a) Based on this information, determine **which type of aggregate** porcelain is made of. (1 mark)

network solids *ionic would dissolve in the rain...

b) Referring to your choice from part a., explain the **type(s) of bonding and properties that exist** in the aggregate that would explain the properties of the porcelain insulation coating described above. (2 marks)

network solids are held together by covalent bonds
- no moveable charge so does not conduct
- bonds are strong so a lot of energy to break
- brittle because once bonds are broken they do not reform