



Name: _____

1-5H: Atomic Models, Electronic Configuration and VSEPR theory

Total: / 45 Marks

Knowledge	Thinking/ Inquiry	Communication	Application
K: /16	I: /19	C: /4	A: /6

Instructions:

- Write your answers in the space provided. If you need more space use a separate piece of paper and clearly write question number in the top left corner of the question.
- Use appropriate scientific terminology when responding to questions.
- Show all of your work. Include all steps of calculations.
- **Round all answers to correct number of significant digits.**
- **Include units whenever required.**

Part 1: Molecular Shapes

To answer the questions in Part 1, use the Molecule Shape Simulator found here:

https://rosedaletube.com/zfiles/Science/sch4u/molecule-shapes_en.html

Step 1: Prepare the simulator

- Open the link: https://rosedaletube.com/zfiles/Science/sch4u/molecule-shapes_en.html
- Click on Model. This will allow you to build any molecule you like.
- Clear all bonds from the central atom by clicking on the red x in the bonding box.

Step 2: Build your molecules

- Refer to Table 1 below to see the list of molecules that you need to build.
- **Identify** the first molecule (e.g., H₂O)
- **Determine** the total number of electrons in your molecule (e.g. 8). Determine the number of bonded pairs (e.g., 2 (2 bonds)) and number of lone pairs (e.g., 2 (4 electrons)).
- **Record** these in Table 1.

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- In the simulator, **add** the # atoms connected to the central atom. For each bonded pair, add in an atom by clicking on the correct configuration under bonding. If a double bond is involved, click on the double bond. (e.g., For H₂O, click 2 single bonds)
- You should now have a molecule that has the correct number of bonded atoms.
- **Add** the correct number of lone pairs to the central atom. To add a lone pair, click on the lone pair.
- In the name box, **click on** the Molecule geometry and Electron geometry boxes. Record the geometries in Table 1

Step 3: Draw your diagrams

- **Draw** the Lewis Structure for the molecule in Table 1.
- **Draw** the 3-D VSEPR shape of your molecule in Table 1.
- **RESET** the simulator by clicking on the orange reset arrow in the bottom right of the screen.
- **Repeat** these steps for each molecule in Table 1

1. Table 1: VSEPR Simulation Observations

(K: 10 marks)

Molecule	# of valence electrons	# of bonded pairs / # of lone pairs	Lewis structure	Electron Geometry	Molecule Geometry	3D molecular (VSEPR) Diagram
H ₂ O						
BrF ₅						
PF ₃						
SO ₂						
CH ₄						



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2. **Identify** two molecules from the chart that have the same electron geometry, but different molecular geometry. **Explain** why the geometries are different. **Use** scientific terminology to explain. (1: 2 marks)
3. **Identify** another example of a molecule (that is NOT listed in the table) that shares the **same electron geometry** with the molecules in Q2. **Determine** its molecular geometry. (1 : 2 marks)
4. **Identify** two molecules from the chart that have the same molecular geometry but have different electron geometry. **Explain** why the geometries are different. **Use** scientific terminology to explain. (1: 2 marks)



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5. Identify another example of a molecule (that is NOT listed in the table) that shares the **same molecular geometry** with the molecules in Q4. **Determine** its electron geometry. (I: 2 marks)
6. **Predict** if the bond angles for the molecules in Q2 would be the same or different. Justify your prediction. (I: 2 marks)

Part 2: Electron Configuration and Quantum Numbers

1. **Identify** the elements represented by the following electron configurations. **Rewrite** the configuration based on Bohr's model. (A: 6 marks)

Electronic Configuration	Name of Element	Electronic configuration based on Bohr's model
$1s^2 2s^2 2p^6 3s^1$		
$[\text{Ar}] 3d^8 4s^2$		
$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$		



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2. a) **Determine** the following electron's quantum numbers **for the last 2 electrons (d-orbital)** of the following electron configuration. **Record** the values in the chart below.



Electron (Identify which electron)	Principle quantum number <i>n</i>	Orbital-shape quantum number <i>l</i>	Magnetic quantum number range <i>m_l</i>	Spin quantum number <i>m_s</i>

- b) **Explain** how you determined the spin quantum number for the electrons. (K: 2 marks)

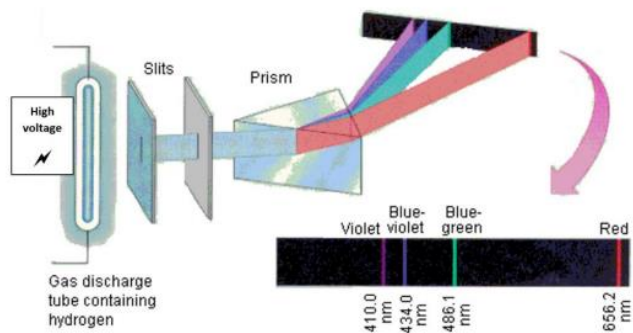
3. **Explain** whether a molecule that includes more than one polar bond is always polar. Justify **your answer using** CO₂ and H₂O and **labeled diagrams** to support your answer. (4 I: Explanation; 4 C: Labeled Diagrams)



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4. **Examine the** emission spectrum for hydrogen gas shown below. There are four lines in the spectrum: Violet, Blue-Violet, Blue-green, and Red.

Emission Spectrum for Hydrogen Gas



- a. **Identify** whether the spectral lines represent excited state electrons or ground state electrons. **Justify** your answer. (1: 2 Marks)
- b. **Arrange** the spectral lines in order of increasing energy involved. **Justify** your order with an explanation. (1: 3 Marks)