Mission Molecule

Questionnaire pre-activity

Situation

Welcome to ION Inc! We're thrilled to have you join our team. As part of our commitment to ensuring the highest standards of excellence and innovation, all new staff members are required to complete the IQ test provided below. This test is designed to assess cognitive abilities and problem-solving skills, aligning with our mission to foster a dynamic and intellectually stimulating work environment. We believe that your performance on this assessment will not only demonstrate your ability to embark on the Virtual Reality (VR) simulations but also your potential to contribute to our company's success. Thank you for your dedication and enthusiasm as we embark on this exciting journey together!

ION Inc. IQ Test

1- Dihydrogen Monoxide Coalition

The National Consumer Coalition Against DHMO (NCCADHMO), was founded in 1997 in an effort to raise public awareness about the dangers of Dihydrogen Monoxide (DHMO) in our daily lives. Their official website (https://www.dhmo.org/NCCA.html) reports the following: "The secondary goal of NCCADHMO is to act in the public interest as a lobbying agent in Congress to affect public policy regarding the safety and uses of DHMO. Dihydrogen Monoxide is a colorless and odorless chemical that kills or maims thousands each year, primarily through accidental inhalation. It has also been revealed to be a causative agent in many environmental exposure incidents, industrial contaminations, automobile accidents, and property damage. The dollar amount losses caused, and the lives impacted, by the DHMO threat are virtually innumerable."

To obtain a clearer image of the targeted molecule, fill out the table below for the central atom.

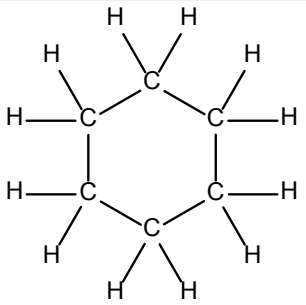
DHMO						
Lewis Structure	**Bond Pairs (σ)**	**Lone Pairs**	**Arrangement of Electron Pairs**	**Molecular Geometry (shape)**	**3-D Sketch (show bond angles)**	**Polarity (net dipole moment)**

2- The Flixborough disaster

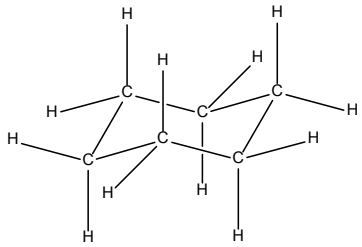
The Flixborough disaster, occurring on June 1, 1974, was a catastrophic industrial accident at a chemical plant close to the village of Flixborough, England. The disaster was triggered by a massive explosion resulting from the rupture of a cyclohexane vapor line, leading to a fireball and subsequent structural collapse. The incident claimed the lives of 28 workers and seriously injured 36 others, as well as causing significant damage to 2 000 off-site properties and the environment. Fires burned on-site for more than ten days. Investigations revealed that the disaster was caused by a combination of design flaws, operational errors, and inadequate safety measures at the plant. As a result, it prompted substantial changes in industrial safety regulations and practices worldwide.

Cyclohexane is a hydrocarbon with the molecular formula C_6H_{12}. It is a colourless, flammable liquid with a distinctive detergent-like odor. It is slightly hazardous as it is irritating to the eyes, skin and respiratory tract. Although it is a reactively stable molecule commonly used as a solvent, cyclohexane's flashpoint is −20 °C.

Complete the table below for ONE carbon of the cyclohexane molecule.



cyclohexane C_6H_{12}



Each CARBON of cyclohexane		
Number of effective electron pairs (neighbours)	**Molecular geometry**	**Hybridization**
Bond angle	**Number of sigma bonds**	**Number of pi bonds**

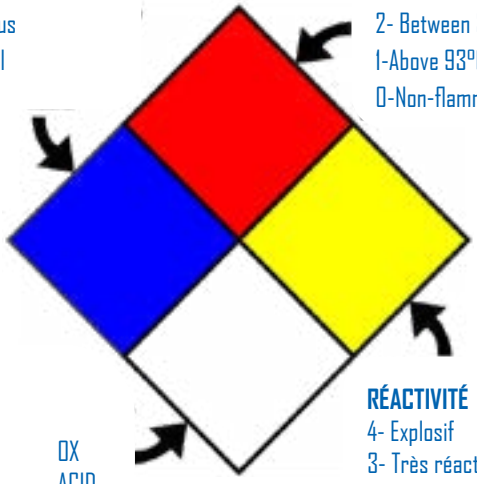
3. NFPA

The "Standard System for the Identification of the Hazards of Materials for Emergency Response" is a standard maintained by the U.S.-based National Fire Protection Association. It defines the "Safety Square" or "Fire Diamond" which is used to quickly identify the risks posed by hazardous materials.

The four divisions are typically color-coded with red on top indicating flammability, blue on the left indicating level of health hazard, yellow on the right for chemical reactivity, and white containing codes for special hazards. Each of health, flammability and reactivity is rated on a scale from 0 (no hazard) to 4 (severe hazard).

HEALTH HAZARDS
4- Deadly
3- Exttrene danger
2- Hazardous
1- Slightly hazardous
0- Normal material

FIRE HAZARD
Flash points
4- Below 23°C
3- Between 23°C and 38°C
2- Between 38°C et 93°C
1-Above 93°C
0-Non-flammable



SPECIFIC HAZARDS

Oxydizer	OX
Acid	ACID
Alkali	ALK
Corrosive	COR
Use no water	W

RÉACTIVITÉ
4- Explosif
3- Très réactif
2- Réaction subite et violente avec d'autres substances
1-Instable à la chaleur et à haute pression
0-Stable

Adapted from https://www.researchgate.net/publication/324422721_Phase_Change_Material_Selection_for_Thermal_Energy_Storage_at_High_Temperature_Range_between_210_C_and_270_C/figures?lo=1

a) **What would the Hazard NFPA label for Dihydrogen Monoxide look like? Fill in the above template with appropriate numbers/symbol for DHMO.**

b) **Based on the information given in the Flixborough disaster, guess the Hazard NFPA label for cyclohexane.**

c) **From the known hazards of DHMO, do you believe this molecule should be banned?**

4- WHMIS Hazard Symbols

The Workplace Hazardous Materials Information System (WHMIS) hazard symbols, also known as WHMIS pictograms, are graphic symbols used to visually represent the specific hazards associated with various hazardous materials. As of January 2022, WHMIS adopted the Globally Harmonized System of Classification and Labelling of Chemicals (GHS), which standardized hazard symbols internationally.

Here are the WHMIS hazard symbols along with their meanings:

	**Exploding bomb** (for explosion or reactivity hazards)		**Flame** (for fire hazards)		**Flame over circle** (for oxidizing hazards)
	**Gas cylinder** (for gases under pressure)		**Corrosion** (for corrosive damage to metals, as well as skin, eyes)		**Skull and Crossbones** (can cause death or toxicity with short exposure to small amounts)
	**Health hazard** (may cause or suspected of causing serious health effects)		**Exclamation mark** (may cause less serious health effects or damage the ozone layer*)		**Environment*** (may cause damage to the aquatic environment)
	**Biohazardous Infectious Materials** (for organisms or toxins that can cause diseases in people or animals)				

* The GHS system also defines an Environmental hazards group. This group (and its classes) was not adopted in WHMIS 2015. However, you may see the environmental classes listed on labels and Safety Data Sheets (SDSs). Including information about environmental hazards is allowed by WHMIS 2015.

From https://www.cchst.ca/oshanswers/chemicals/whmis_ghs/pictograms.html

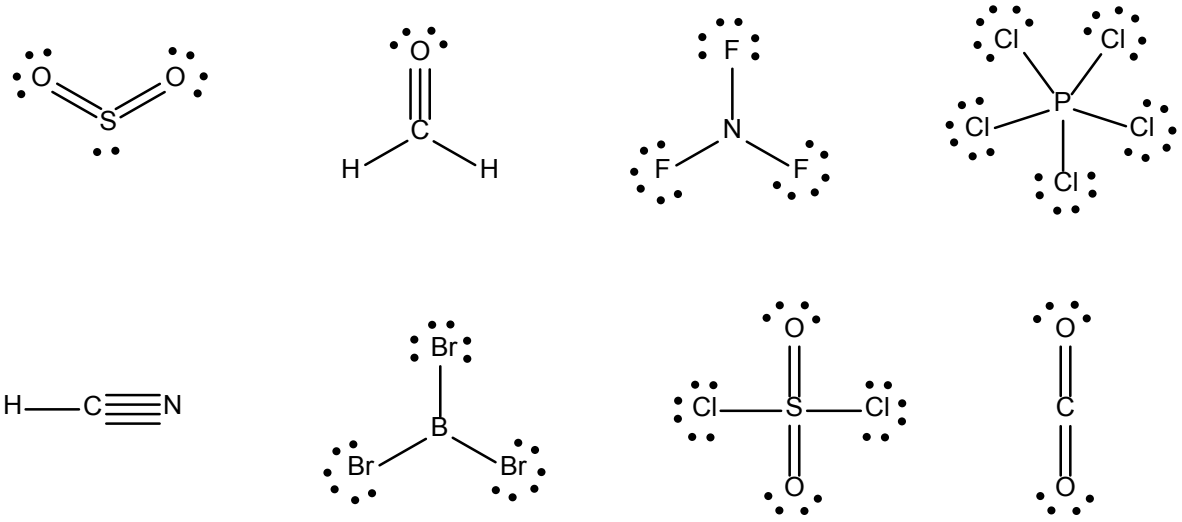
These symbols are crucial for identifying and understanding the potential hazards associated with various chemicals in the workplace, enabling workers to handle them safely and effectively.

Cyclohexane has the Hazard Identification below. Name these four WHMIS hazard symbols.

_____ _____ _____ _____

5- Spot the Intruder

a) Circle the 3 Lewis structures below that are incorrect.



b) Circle the 4 pictograms below that are not part of the newest WHMIS symbol classification.