

**SIR ARTHUR LEWIS COMMUNITY COLLEGE
SCIENCE, TECHNOLOGY, INNOVATION AND SUSTAINABILITY**

**2024 – 2025 ACADEMIC YEAR - SEMESTER I
END OF SEMESTER EXAMINATION**

COURSE TITLE : **GENERAL CHEMISTRY I**

COURST CODE : **CHM112**

LECTURERS : **ALBERTA WILLIAM-HENRY
JADA-ANN VITÉ**

DATE : **Tuesday 17th December 2024**

TIME : **9.00 – 11.00 AM**

STUDENT ID# : **.....**

READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. Write your student's ID number on all the work you hand in.
2. This paper consists of TWO Sections.
3. SECTION 1 consists of 40 multiple-choice questions.
4. SECTION 2 consists of two (2) compulsory structured questions.
5. Show all calculations. You may lose marks if you do not show your working or if you do not use appropriate units.
6. Do not use correction fluid.

DO NOT TURN THE PAGE UNTIL YOU ARE TOLD TO DO SO

SECTION ONE – Multiple choice

Shade the correct response

- Which of the following statements is NOT a part of Dalton's atomic theory?
 - Atoms are indivisible
 - Atoms are characterized by their atomic number
 - The atoms of an element have identical properties
 - The atoms of an element differ from those of other elements
- How many moles are in 25.25g of Mg?
 - 2.10g
 - 1.03g
 - 1.04g
 - 0.962g
- Which of the following ions has the **greatest** polarizing power?
 - Be^{2+}
 - Ca^{2+}
 - Li^{+}
 - Sr^{2+}
- The simplest formula for a compound that contains 50% S and 50% O by mass is
 - SO
 - SO₂
 - S₂O
 - S₂O₄
- The second ionization energy of calcium is 1150 kJ/mol. Which of the following equations represents this statement?

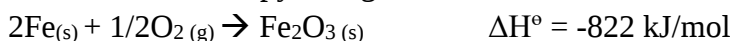
	kJ/mol
(a) $\text{Ca}_{(g)} \rightarrow \text{Ca}^{2+}_{(g)} + 2e$	-1150
(b) $\text{Ca}^{+}_{(g)} \rightarrow \text{Ca}^{2+}_{(g)} + e$	-1150
(c) $\text{Ca}_{(g)} \rightarrow \text{Ca}^{2+}_{(g)} + 2e$	+1150
(d) $\text{Ca}^{+}_{(g)} \rightarrow \text{Ca}^{2+}_{(g)} + e$	+1150
- This question refers to the following standard enthalpies of combustion for carbon, hydrogen and octane.

ΔH_c°	kJ/mol
Carbon	-394
Hydrogen	-286
Octane	-5476

The standard enthalpy of formation of octane, ΔH°_f is calculated using
 - $\Delta H^\circ_f (\text{octane}) = -8(-394) - 9(-286) - 5476$
 - $\Delta H^\circ_f (\text{octane}) = -8(-394) - 9(-286) - (-5476)$
 - $\Delta H^\circ_f (\text{octane}) = 8(-394) + 9(-286) - (-5476)$
 - $\Delta H^\circ_f (\text{octane}) = 8(-394) - 9(-286) - (-5476)$
- What shape describes the molecule water?
 - Linear
 - Trigonal planar
 - Tetrahedral
 - Non-linear

8. Which of the following factors increases the first ionization energy of an atom?
- Increased screening by inner electrons
 - Larger number of valence electrons
 - Greater nuclear charge
 - Larger atomic radius
9. How many hydrogen bonds can be formed with the oxygen atom in a molecule of water?
- 1
 - 2
 - 3
 - 4

10. The standard enthalpy changes for two reactions are as follows:



What is the standard enthalpy change for the reaction

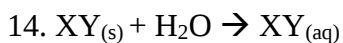
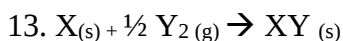
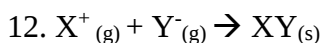


- 932
 - 712
 - 492
 - +492
11. What is the average relative atomic mass of bromine given the following isotopic masses and relative abundance?
- | | |
|------------------------|------------------------|
| ^{79}Br 50.5% | ^{81}Br 49.5% |
|------------------------|------------------------|
- 80.01
 - 79.99
 - 79.90
 - 78.99

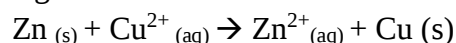
Items 12-14 refers to the following options

- Enthalpy of formation
- Lattice energy
- Enthalpy of solution
- Enthalpy of hydration

Match EACH item below with one of the options above, each of which may be used once, more than once or not at all.



15. What is the standard heat of reaction ΔH_r at 101.325 kPa or pressure and 298K, for the equation given below?



$$\Delta H^\circ_f = +64.4 \text{ kJ/mol for Cu}^{2+}$$

$$\Delta H^\circ_f = -152.4 \text{ kJ/mol for Zn}^{2+}$$

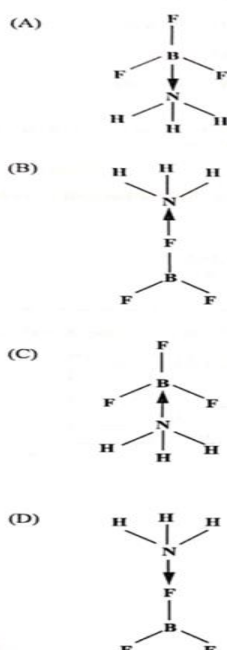
$$\Delta H^\circ_f = 0 \text{ kJ/mol for both Zn and Cu}$$

- +217 kJ/mole
- +88.0 kJ/mole
- 88.0 kJ/mole
- 217 kJ/mole

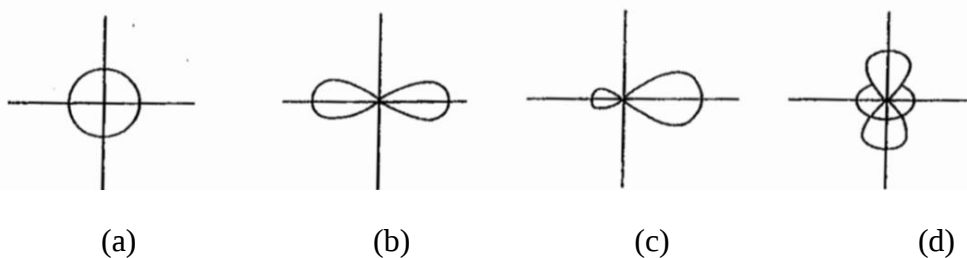
16. Which of the following species has a structure with a bond angle less than 109° ?
- (a) NF_3
 - (b) NH_4^+
 - (c) CH_4
 - (d) BF_3
17. An ion Z^{3+} contains 23 protons. What is the electronic configuration of Z^{3+} ?
- (a) $[\text{Ar}]3\text{d}^04\text{s}^1$
 - (b) $[\text{Ar}]3\text{d}^2$
 - (c) $[\text{Ar}]3\text{d}^34\text{s}^2$
 - (d) $[\text{Ar}]3\text{d}^64\text{s}^2$
18. A π bond results from the overlapping of
- (a) Two s orbitals
 - (b) One s and one p orbital
 - (c) Two p orbitals end on
 - (d) Two p orbitals sideways
19. The bonds in SO_4^{2-} are best described as
- (a) Covalent and polar
 - (b) Ionic and polar
 - (c) Polar, covalent and single
 - (d) Polar, covalent and double
20. The bond angles in the PH_3 molecule are the same as that of NCl_3 . Its shape would BEST be described as
- (a) Bipyramidal
 - (b) Pyramidal
 - (c) Tetrahedral
 - (d) Trigonal
21. Which of the following solids has a giant molecular lattice?
- (a) Copper
 - (b) Carbon dioxide
 - (c) Magnesium oxide
 - (d) Silicon dioxide
22. Which of the following characteristics of oxygen BEST explains why the first ionization energy of oxygen is lower than that of nitrogen?
- (a) A smaller atomic radius
 - (b) Greater shielding by inner electrons
 - (c) Greater effective nuclear charge
 - (d) Repulsion between the paired 2p electrons
23. Which of the following pairs of elements would be expected to form the compound with the MOST ionic character?
- (a) Li and F
 - (b) Li and I
 - (c) Rb and F
 - (d) Rb and I

24. The van der Waals forces consist of
- (a) Permanent dipole-permanent dipole interactions
 - (b) Induced dipole-induced dipole interactions
 - (c) Permanent dipole-induced dipole covalent interactions
 - (d) Dipole-dipole; dipole-induced dipole ionic interactions
25. Which of the following is NOT an endothermic process?
- (a) Ice melting
 - (b) Water boiling
 - (c) Water evaporating
 - (d) Water condensing
26. The high melting point of graphite can be attributed to
- (a) Delocalized electrons
 - (b) Hexagonal arrangement of the carbon atoms
 - (c) Strong covalent bonds within the layers
 - (d) Van der Waals' forces between the layers
27. Which of the following describes potassium bromide?
- (a) A network of covalently bonded atoms
 - (b) A substance which boils at 59 °C and decomposes at high temperature
 - (c) A solid with a very high molar enthalpy of vaporization and in a liquid state, does not conduct electricity
 - (d) A non-conducting solid which melts to form a liquid that conducts electricity
28. When 86g of the ionic salt, $\text{CaSO}_4 \cdot x\text{H}_2\text{O}$, is heated so that all of its water of crystallization is driven off and 68.0 g of CaSO_4 remain, the value of x is
- (a) 1
 - (b) 2
 - (c) 3
 - (d) 4
29. For complete reaction, 0.25g of a monobasic acid requires 10cm^3 of 0.2 mol/dm^3 sodium hydroxide. What is the relative molecular mass of the acid in g/mol?
- (a) 12.5
 - (b) 62.5
 - (c) 125
 - (d) 250
30. The equation which represents the enthalpy of atomization of bromine is
- (a) $\frac{1}{2} \text{Br}_2 (\text{l}) \rightarrow \text{Br}(\text{g})$
 - (b) $\frac{1}{2} \text{Br}_2 (\text{g}) \rightarrow \text{Br} (\text{g})$
 - (c) $\text{Br}_2 (\text{g}) \rightarrow 2 \text{Br} (\text{g})$
 - (d) $\text{Br}_2 (\text{l}) \rightarrow 2 \text{Br} (\text{g})$
31. Which of the following has a simple molecular structure?
- (a) Na_2O
 - (b) SiO_2
 - (c) Al_2O_3
 - (d) SO_3

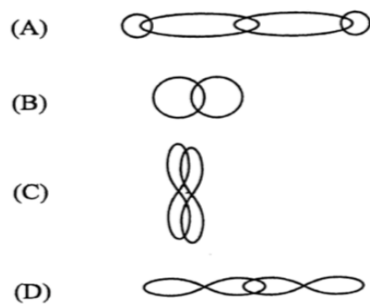
32. Which of the following structures correctly illustrates the coordinate bonding between BF_3 and NH_3 ?



33. Which of the diagrams below BEST represents an sp^3 orbital?



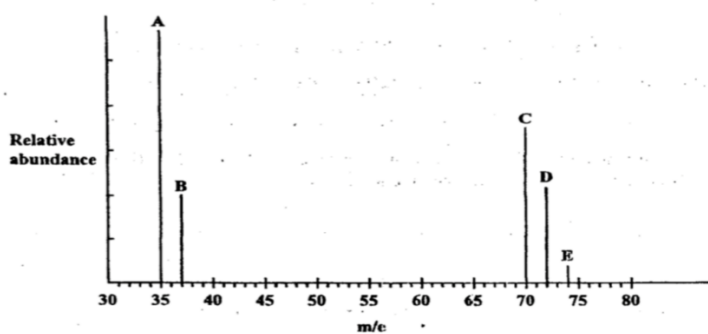
34. Which of the following diagrams represents a pi bond?



35. The intermolecular forces which are present in ice are

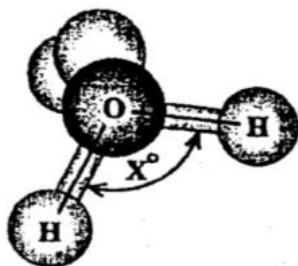
- (a) Ionic bonds
- (b) Covalent bonds
- (c) Hydrogen bonds
- (d) Van der Waals forces

Item 36 refers to the following mass spectrum of chlorine gas



36. If the peak at A represents the $^{35}\text{Cl}^+$ ion, which of the following ions represent the peaks at B and E
- (a) $^{37}\text{Cl}^+$ and $(^{37}\text{Cl}-^{37}\text{Cl})^+$
 - (b) $^{37}\text{Cl}^+$ and $(^{37}\text{Cl}-^{35}\text{Cl})^+$
 - (c) $^{37}\text{Cl}^+$ and $(^{35}\text{Cl}-^{35}\text{Cl})^+$
 - (d) $^{37}\text{Cl}^+$ and $(^{35}\text{Cl}-^{37}\text{Cl})^+$

37. What is the value of X in the following diagram?



- (a) 104.5
 - (b) 109.5
 - (c) 120
 - (d) 180
38. Which of the following is the configuration of Cu (I) ion?
- (a) $[\text{Ar}] 3d^{10}$
 - (b) $[\text{Ar}] 3d^8 4s^2$
 - (c) $[\text{Ar}] 3d^9 4s^1$
 - (d) $[\text{Ar}] 3d^{10} 4s^1$
39. The valence electrons for a Ca atom are found in the
- (a) 3s orbital
 - (b) 4s orbital
 - (c) 3p orbital
 - (d) 4p orbital

Item 40 refers to the data in the following ta

Atomic Mass (amu)	Abundance (%)
^{204}Pb	1.4
^{206}Pb	24.1
^{207}Pb	22.1
^{208}Pb	52.4

40. Based on the data in the table above, the relative isotopic mass of lead is
- (a) 206.24 amu
 - (b) 207.24 amu
 - (c) 207.30 amu
 - (d) 208.30 amu

SECTION TWO

Answer ***all*** the questions in the space provided

Question 1.

A student carries out an experiment to determine the enthalpy change of combustion of glucose.

In the experiment, 0.831 g of glucose is burned. The energy released is used to heat 100 cm³ of water from 23.7 °C to 41.0 °C.

(a) Calculate the energy released, in kJ, during combustion of 0.831 g glucose.

The specific heat capacity of water = 4.18 J g⁻¹ K⁻¹. Density of water = 1.00 g cm⁻³.

Energy = kJ

[2 marks]

(b) Calculate the amount, in moles, of glucose that is burned.

Amount = mol

[2 marks]

(c) Calculate the enthalpy change of combustion of glucose. Give your answer to three significant figures.

ΔH_C = kJ mol⁻¹

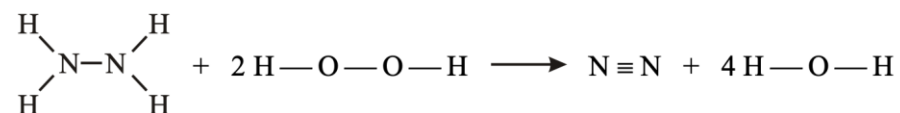
[2 marks]

(d)

Some mean bond enthalpies are given below.

Bond	N-H	N-N	N≡N	H-O	O-O
Mean bond enthalpy/kJ mol ⁻¹	388	163	944	463	146

Use these data to calculate the enthalpy change for the following gas-phase reaction between hydrazine, N₂H₄, and hydrogen peroxide, H₂O₂

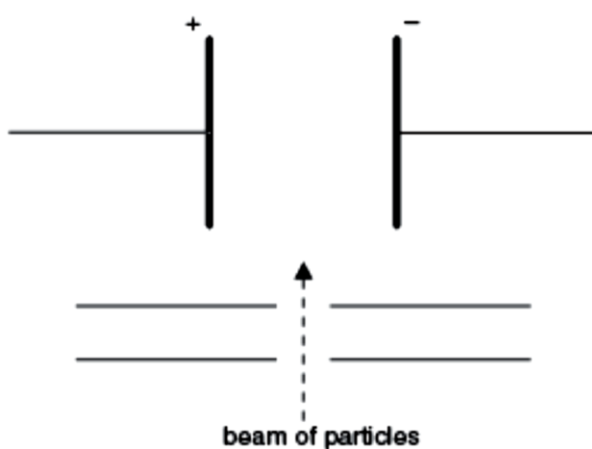


[4 marks]

Question 2.

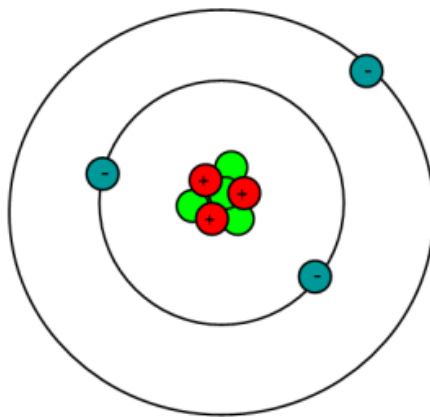
When separate beams of electrons, neutrons or protons are passed through an electric field in the apparatus below, they behave differently.

- (a) Show on the diagram below how each particle would behave if a beam containing all three particles was passed through an electric field.



(2 marks)

(b) The following diagram represents an isotope of lithium



- (i) What is the nucleon number of this isotope? **[1 mark]**
- (ii) How would the structure of another isotope of lithium differ from the one shown above? **[1 mark]**
- (c) **State and explain** the general trend in 1st ionization energy from Na to Ar. **[2 marks]**
- (d) **Explain fully** why the 1st ionization energy of Mg is greater than that of Al **[2 marks]**

(e) The statement below lists some physical properties of a pair of substances.

- Identify the types of forces operating.
- Account for any differences in the strengths of these forces and relate the nature and strength of the forces to the properties indicated in each pair.

CO₂ and SiO₂ are both covalent molecules. However, CO₂ is a gas and SiO₂ is a solid with a high melting point.

[2 marks]

END OF EXAMINATION

