

**Chemistry**  
**Higher level**  
**Paper 1A**

Practice paper

**Topic: Models to Materials (HL)**

1. Which axis of the Van Arkel-Ketelaar triangle signifies the average electronegativity (En) of a compound?
  - A. Vertical axis
  - B. Horizontal axis
  - C. Diagonal axis
  - D. Z-axis
  
2. Which type of polymerization involves the elimination of a small molecule like water or HCl?
  - A. Addition polymerization
  - B. Condensation polymerization
  - C. Displacement reaction
  - D. Substitution reaction
  
3. What is the repeating linkage in the synthetic polymer Nylon 6,6?
  - A. Ester linkage
  - B. Amide linkage
  - C. Ether linkage
  - D. Carbonyl linkage
  
4. Which statements about the Van Arkel-Ketelaar triangle are correct?
  - I. The x-axis represents the average electronegativity of the components.
  - II. The y-axis represents the difference in electronegativity.
  - III. Pure metals are located at the bottom-left vertex.
  - A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II and III
  
5. Which pair of monomers is required to form the polyester Terylene (PET)?
  - A. Diol and diamine
  - B. Diol and dicarboxylic acid
  - C. Diamine and dicarboxylic acid
  - D. Alkene and alcohol
  
6. Which describes the atom economy of addition polymerization compared to condensation polymerization?
  - A. It is typically higher, often reaching 100%.
  - B. It is typically lower due to byproducts.
  - C. Both processes have identical atom economy.

- D. Atom economy is irrelevant to polymerization.
7. In the Van Arkel-Ketelaar bonding triangle, where are materials with high electrical conductivity located?
- Top vertex (Ionic region)
  - Bottom-left vertex (Metallic region)
  - Bottom-right vertex (Covalent region)
  - Center (Metalloid region)
8. Which of the following favor a high atom economy in the production of polymers?
- Addition polymerization
  - Use of efficient catalysts
  - Condensation polymerization producing water as a byproduct
- I and II only
  - I and III only
  - II and III only
  - I, II and III
9. Which functional group is present in the ester molecule  $\text{CH}_3\text{COOCH}_3$ ?
- Ether group
  - Ester group
  - Amide group
  - Ketone group
10. Which type of intermolecular force between the chains gives the polyamide Kevlar its extreme strength?
- Dipole-dipole forces
  - London dispersion forces
  - Hydrogen bonding
  - Ionic bonding
11. What are the primary products formed by the hydrolysis of a polyester?
- Alcohols and amines
  - Diols and dicarboxylic acids
  - Alkanes and alkenes
  - Amino acids and sugars
12. Which intermolecular forces contribute significantly to the mechanical properties of Kevlar fibers?
- Hydrogen bonding between amide linkages

- II. London dispersion forces between aromatic rings
- III. Dipole-dipole interactions between carbonyl groups
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

13. Which material exhibits primarily polar covalent character according to its position in the bonding triangle?

- A. Sodium chloride (NaCl)
- B. Elemental Cesium (Cs)
- C. Carbon dioxide (CO<sub>2</sub>)
- D. Elemental Fluorine (F<sub>2</sub>)

14. Why are many condensation polymers more likely to be biodegradable than addition polymers?

- A. They have a higher molecular weight.
- B. They contain polar linkages that can be broken by chemical hydrolysis.
- C. They consist of perfectly unbranched chains.
- D. They always contain plasticizers.

15. Which statement correctly describes the atomic structure of a metal alloy?

- A. It is a rigid uniform cube of identical atoms.
- B. It is a random sea of electrons with no nuclei.
- C. It contains substitutional or interstitial atoms within a metallic lattice.
- D. It consists of a giant covalent network of different elements.

16. Which features distinguish thermosetting plastics from thermosoftening plastics?

- I. Thermosetting plastics contain extensive covalent cross-linking between chains.
- II. Thermosoftening plastics can be melted and reshaped repeatedly.
- III. Thermosetting plastics soften significantly upon heating due to weak intermolecular forces.

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

17. Which monomer is used for the production of Polytetrafluoroethene (PTFE)?

- A. CH<sub>2</sub>=CH<sub>2</sub>
- B. CF<sub>2</sub>=CF<sub>2</sub>
- C. CHCl=CHCl

D.  $\text{CH}_3\text{CH}=\text{CH}_2$

18. What is the primary cause of the extreme tensile strength of Kevlar fibers?

- A. Strong ionic attraction between polymer units.
- B. Extensive covalent cross-links between polymer chains.
- C. Alignment of chains supported by intermolecular hydrogen bonding.
- D. Strong London dispersion forces only.

19. Which small molecule is typically released during the synthesis of Nylon 6,6?

- A. Oxygen ( $\text{O}_2$ )
- B. Carbon dioxide ( $\text{CO}_2$ )
- C. Water ( $\text{H}_2\text{O}$ )
- D. Ammonia ( $\text{NH}_3$ )

20. Which of the following describe the characteristics of a substitutional alloy?

- I. Atoms of the alloying element replace some of the host metal atoms in the lattice.
  - II. The atoms of both elements must have similar atomic radii.
  - III. Smaller atoms fit into the interstitial spaces of the host metal lattice.
- A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II and III

21. Which specific region of the Van Arkel-Ketelaar triangle corresponds to semiconductors?

- A. The boundary between covalent and ionic regions.
- B. The boundary between metallic and covalent regions.
- C. The top vertex representing pure ionic bonding.
- D. The bottom-left vertex representing pure metallic bonding.

22. Which polymer is extensively used in the manufacture of high-strength ropes and bulletproof vests?

- A. Polyvinyl chloride (PVC)
- B. Polystyrene
- C. Kevlar
- D. Polypropene

23. The formation of the polyester Terylene is correctly classified as which type of reaction?

- A. Electrophilic addition

- B. Nucleophilic substitution (Esterification)
- C. Free-radical polymerization
- D. Complete combustion

24. Which are considered advantages of using condensation polymers over addition polymers?

- I. They are often biodegradable due to hydrolysable linkages.
  - II. They tend to have a higher atom economy during synthesis.
  - III. They usually exhibit higher tensile strength due to polar functional groups.
- A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II and III

25. Which compound has the largest difference in electronegativity according to its chemical formula?

- A. Silicon carbide (SiC)
- B. Aluminum oxide ( $\text{Al}_2\text{O}_3$ )
- C. Silicon dioxide ( $\text{SiO}_2$ )
- D. Phosphine ( $\text{PH}_3$ )

26. Which type of linkage connects the repeating units in a protein molecule?

- A. Ester bonds
- B. Peptide (amide) bonds
- C. Glycosidic bonds
- D. Ionic bonds

27. Which molecule contains a secondary amine functional group?

- A.  $\text{CH}_3\text{NH}_2$
- B.  $(\text{CH}_3)_2\text{NH}$
- C.  $(\text{CH}_3)_3\text{N}$
- D.  $[\text{NH}_4]\text{Cl}$

28. Which factors influence the density of polyethylene (polyethene) samples?

- I. The degree of branching in the polymer chains
  - II. The pressure and temperature conditions during polymerization
  - III. The length of the individual monomer molecules
- A. I and II only
  - B. I and III only
  - C. II and III only

D. I, II and III

29. Which pair of monomers is required for the synthesis of Polyethylene Terephthalate (PET)?

- A. Ethane-1,2-diol and benzene-1,4-dicarboxylic acid
- B. Ethene and benzene
- C. Propene and ethanol
- D. Urea and formaldehyde

Which property is characteristic of a thermoplastic polymer?

- A. It chars and burns upon heating.
- B. It softens upon heating and can be remolded.
- C. It has extensive cross-linking between chains.
- D. It acts as an electrical insulator at all temperatures.

In a nematic liquid crystal, how are the molecules arranged?

- A. Completely randomly distributed.
- B. Arranged in distinct layers but random orientations.
- C. Aligned in a common directional orientation but randomly positioned.
- D. Arranged in layers and aligned directionally.

32. Which methods can be used to decrease the environmental impact of plastic waste accumulated in ecosystems?

- I. Chemical recycling of polymers into their original monomers
  - II. Incorporation of starch-based biodegradable additives into plastics
  - III. Increasing the ratio of thermosetting plastics used in consumer goods
- A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II and III

What characterizes a Type I superconductor?

- A. It operates at room temperature.
- B. It expels magnetic fields perfectly (Meissner effect).
- C. It has a high critical temperature above 77 K.
- D. It allows partial penetration of magnetic fields.

Which technique is most appropriate for separating a mixture of volatile liquids with different boiling points?

- A. Recrystallization

- B. Solvent extraction
- C. Fractional distillation
- D. Paper chromatography

Nanotubes are an allotrope of which element?

- A. Silicon
- B. Carbon
- C. Titanium
- D. Nitrogen

Which properties are typical of amorphous materials like glass?

- I. Lack of a sharp, well-defined melting point
  - II. Random, non-crystalline internal structure
  - III. High electrical and thermal conductivity
- A. I and II only
  - B. I and III only
  - C. II and III only
  - D. I, II and III

Which of the following describes the doping of silicon to create an n-type semiconductor?

- A. Inserting atoms with 3 valence electrons like boron.
- B. Inserting atoms with 5 valence electrons like phosphorus.
- C. Replacing silicon atoms with carbon atoms.
- D. Elevating the temperature to excite electrons to the conduction band.

What is the primary feature of a condensation polymer compared to an addition polymer?

- A. It requires an initiator radical.
- B. It forms entirely from monomer alkenes.
- C. It eliminates a small molecule such as water during formation.
- D. It is always composed of a single element.

Which bonding type is predominant in ceramic structures like  $\text{Al}_2\text{O}_3$ ?

- A. Purely metallic bonding.
- B. London dispersion forces.
- C. Mixed ionic and covalent macromolecular bonding.
- D. Hydrogen bonding.

Which statements correctly describe the behavior of liquid crystals?

- I. They change state at specific temperatures.
- II. Their molecular orientation can be influenced by electric fields.
- III. They emit bright light naturally.

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III