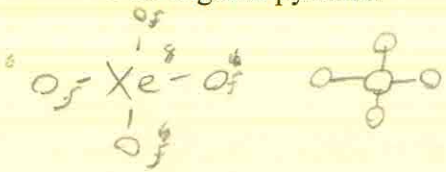
This test consists entirely of multiple choice questions and is worth 25 marks. The answers for the 25 questions must be coded on the optical sense form (bubble sheet) using a PEN or *SOFT PENCIL*.

Select the* BEST *response for each question below.

1. Predict the shape of the XeO_4 molecule.

   A. trigonal planar B. tetrahedral C. trigonal pyramid

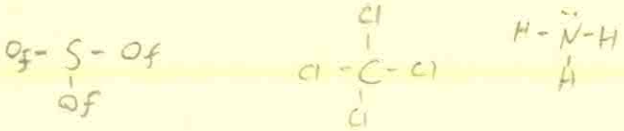
   D. see saw E. square planar



2. Which of the following the molecules would have a net molecular dipole moment (*i.e.* μ not equal to zero).

   A) SO_3 B) CCl_4 C) NH_3

   D) SF_6 E) O_2



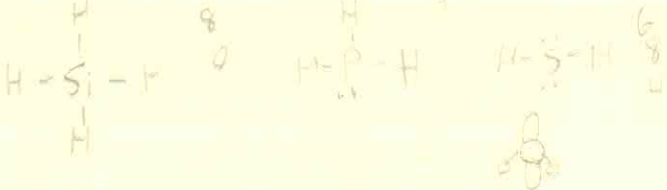
3. Estimate which bond angle is smallest based on the VSEPR model.

   A. H-Si-H in SiH_4 B. H-P-H in PH_3 C. H-S-H in H_2S

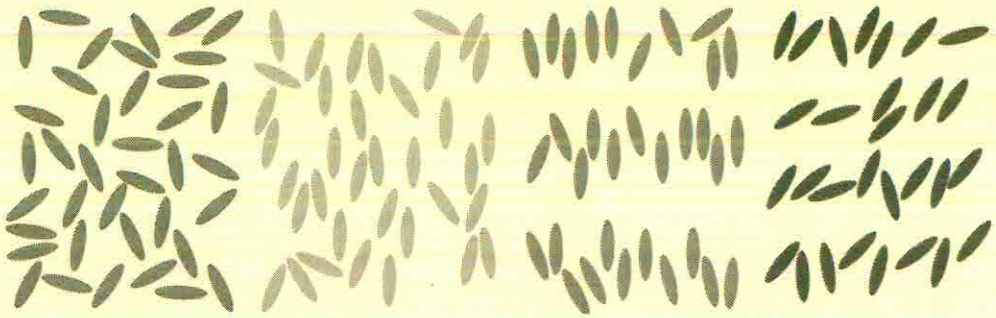
   D. H-C-H in $H_2C=O$ E. H-C-H in $H_2C=S$

4. Which property is NOT a characteristic of ionic liquids?

   A. Non-volatile
   B. Non-flammable
   C. Ordered phase above the melting point
   D. mismatch of size/shape of anion and cation
   E. Polyatomic cations and anions



5. Which of the sketches below best depicts a nematic liquid crystal phase?



A. B. C. D. E. none of them

6. Which **ONE** of the following pairs of **molecule** and **intermolecular force** is CORRECT?
   A. Benzene (C_6H_6), dipole-dipole.
   B. CF_4, only London dispersion
   C. CH_3CN, hydrogen bonding
   D. PF_3, only London dispersion
   E. CaF_2, dipole-dipole

7. Tungsten (W) has the highest melting point of all the pure metals (3422 °C). Using your knowledge of metallic bonding, choose the best explanation for this fact from the selection below.

   A. Tungsten has electrons in the 5d subshell.
   B. Tungsten's molecular orbitals form a continuous band.
   C. Tungsten has a half-filled s-d molecular orbital band, so the forces between atoms are of maximum strength.
   D. Tungsten has as many anti-bonding electrons as bonding electrons, so the forces between atoms are of maximum strength.
   E. Tungsten has a large first ionization energy, so it will not form an ionic lattice.

Consider the polyatomic ion SO_3^{2-} and answer questions 8-12.

8. The central atom has
   A. 2 electon domains
   B. 3 electon domains
   C. 4 electon domains
   D. 5 electon domains
   E. 6 electon domains

9. The central atom has the electron domain geometry
   A. linear
   B. trigonal planar
   C. tetrahedral
   D. trigonal bipyramidal
   E. octahedral

10. The molecular geometry is?
   A. square pyramidal
   B. trigonal planar
   C. tetrahedral
   D. trigonal bipyramidal
   E. trigonal pyramidal

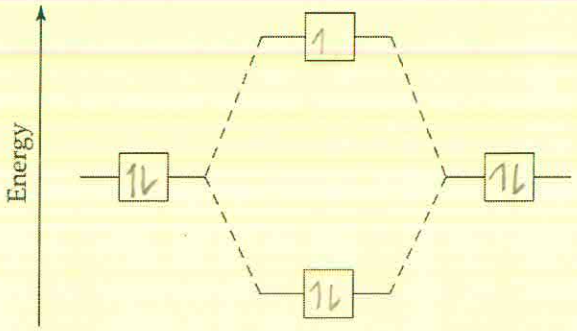
11. The hybridization at the central atom is
   A. sp
   B. sp^2
   C. sp^3
   D. no hybridization needed
   E. s^3p

12. The O–S–O bond angles in this ion are (approximately)?
   A. 180^o
   B. 120^o
   C. 109^o
   D. 90^o
   E. 150^o

13. Which of the following molecules is polar (*i.e.* μ has $\neq 0$) ?
   A. BF_3
   B. NH_3
   C. PF_5
   D. CS_2
   E. SiF_4

14. Which of the following molecules contains a π-bond?
   A. PF_3
   B. BH_3
   C. CF_4
   D. CO_2
   E. SF_4

15. Use the following molecular orbital energy diagram to determine the bond order in $(He_2)^+$.

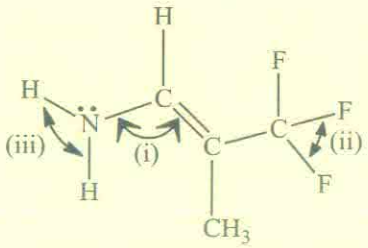


A. 0
B. 0.5
C. 1.0
D. 1.5
E. 2.0

16. Determine the nitrogen-oxygen bond order in the nitrite ion NO_2^-.

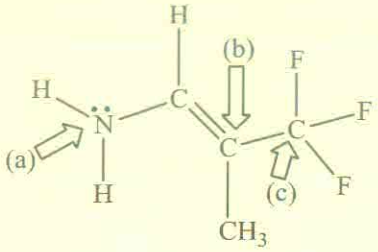
A. 0
B. 0.5
C. 1.0
D. 1.33
E. 1.5

17. In the following molecule, what are the bond angles (i), (ii), and (iii) (approximately)?



A. i: 120° ii: 120° iii: 90°
B. i: 120° ii: 109° iii: 109°
C. i: 109° ii: 120° iii: 120°
D. i: 109° ii: 109° iii: 109°
E. i: 120° ii: 109° iii: 90°

18. In the following molecule, what is the orbital hybridization assigned to the atoms designated by arrows (a), (b), and (c) respectively?



A. sp^3, sp^2, sp^3
B. sp, sp^2, sp^3
C. sp^3, sp, sp^3
D. sp^2, sp^2, sp^3
E. sp^2, sp^2, sp^2

19. What kind of intermolecular forces are most important in hexane (C_6H_{14})?
A. dipole-dipole
B. ionic
C. dispersion
D. hydrogen bonding
E. ion-dipole

20. Based on your knowledge of intermolecular forces, which of the following compounds has the highest boiling point?
A. N_2 28
B. BH_3 13
C. CF_4 84
D. CO_2 44
E. SCl_4 172

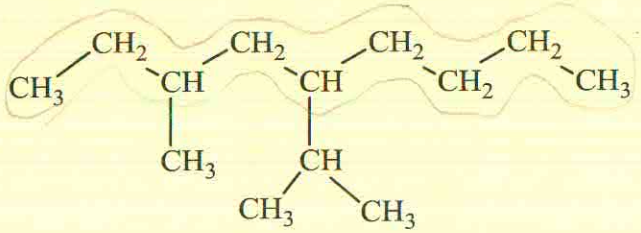
21. Based on your knowledge of metallic bonding, which of the following elements has the highest melting point?
A. K
B. Ca
C. Sc
D. Ti
E. V

22. For which of the following compounds is hydrogen bonding an important intermolecular force?
A. NaH
B. NH_3
C. CH_4
D. SiH_4
E. TeH_2

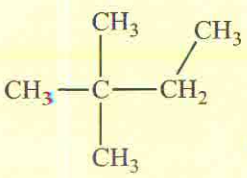
23. Which of the following open chain (*i.e.* not cyclic) molecules is an alkane?
A. C_4H_8
B. C_5H_8
C. C_6H_{12}
D. C_7H_{16}
E. C_8H_{12}

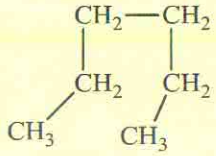
24. The correct systematic name of the following alkane is?

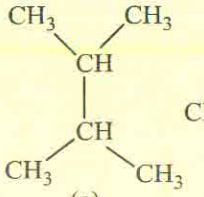
A. 5-isopropyl-3-methyloctane
B. 2-ethyl-4-isopropyloctane
C. 2,5-dimethyl-3-butylheptane
D. 5-isopropyl-3-methylnonane
E. 5-isopropyl-7-methylnonane

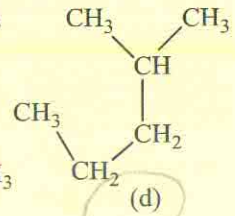


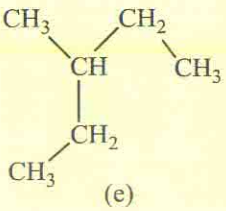
25. Consider the structural isomers of hexane shown below.

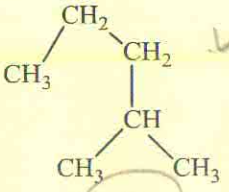

(a)


(b)


(c)


(d)


(e)


(f)

Which set of structures represents a complete and unique set of all the isomers of hexane? (*i.e.* no duplicate structures)

A. a, b, c, d, f
B. a, b, c, d, e
C. b, c, d, e, f
D. a, b, d, e, f
E. a, c, d, e, f

END