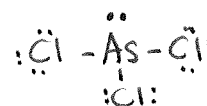


I. MULTIPLE CHOICES (30 points): Write the letter that corresponds to the best answer in each of the following questions. Transfer your answers on the Scantron form. *Answers on the form are final.*

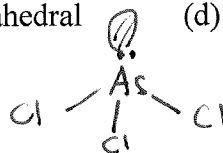
Electronegativity Values for Some Elements						
H 2.20						
Li 0.98	Be 1.57	B 2.04	C 2.55	N 3.04	O 3.44	F 3.98
Na 0.90	Mg 1.31	Al 1.61	Si 1.90	P 2.19	S 2.58	Cl 3.16
K 0.82	Ca 1.00	Ga 1.81	Ge 2.01	As 2.18	Se 2.55	Br 2.96

Image available at f.u-tokyo.ac.jp

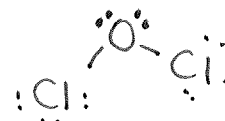
$$5 + 21 = 26 e^- \text{ (13 pr.)}$$



- e 1. Draw the Lewis structure of AsCl_3 . What is the molecular geometry of AsCl_3 ?
 (a) linear (b) trigonal planar (c) tetrahedral (d) bent (e) Trigonal pyramidal



- d 2. Draw the Lewis structure of OCl_2 . What is the molecular geometry of OCl_2 ? $6 + 14 = 20 e^-$ (10 pr.)
 (a) linear (b) trigonal planar (c) tetrahedral (d) bent (e) Trigonal pyramidal



- b 3. Which of the molecules below has at least one *polar bond*?
 (a) OCl_2 (b) PF_3 ✓ (c) AsH_3 (d) CH_4

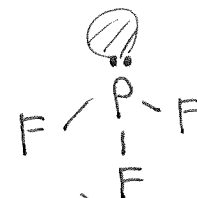
$$\Delta EN < 0.4 \\ \text{No}$$

$$\begin{array}{r} 3.98 \\ - 2.19 \\ \hline \Delta EN = 1.79 \end{array}$$

$$\begin{array}{r} 2.20 \\ - 2.18 \\ \hline \Delta EN = 0.02 \end{array} > \text{No}$$

Hydrocarbon
No

- b 4. Which of the molecules below is *polar*?
 (a) OCl_2 (b) PF_3 (c) AsH_3 (d) CH_4



See # 3 above (1. polar bond + 2. unsym.)

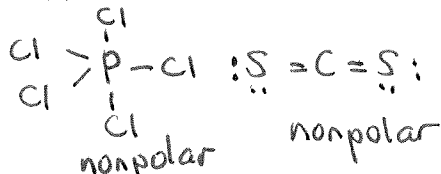
- c 5. Choose the molecule below that contains at least one polar bond, but is *nonpolar*.
 (a) SiH_4 (b) H_2O (c) CCl_4 (d) HCl

$$\begin{array}{r} \Delta EN = 0.35 \\ \text{no polar bond} \end{array} \quad \begin{array}{r} \text{polar bond} \\ \text{unsym.} \\ \text{polar} \end{array} \quad \begin{array}{r} \text{polar bond} \\ \text{sym.} \\ \therefore \text{nonpolar} \end{array} \quad \begin{array}{r} 3.16 \\ - 2.20 \\ \hline 0.96 \end{array}$$

polar bond + unsym. = polar

- a 6. Which of the following molecules is/are *polar*?
 (a) HCN (b) PCl_5 (c) CS_2 (d) a and b (e) a and c

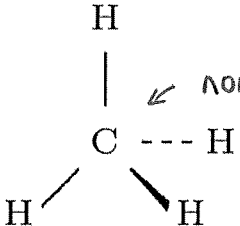
polar



nonpolar

nonpolar

d 7. Which of the following molecules is/are *nonpolar*?

- (a)  (b) $:\ddot{\text{O}}=\text{C}=\ddot{\text{O}}:$ (c) PF_3 (See question 4 above)
- nonpolar* (sym.) *polar*
- (d) Both a and b (e) Both b and c

b 8. Arrange NH_3 , CH_4 and PH_3 in order of increasing intermolecular forces of attraction. NH_3 is polar. \rightarrow low to high

(a) $\text{NH}_3 < \text{CH}_4 < \text{PH}_3$ (b) $\text{CH}_4 < \text{PH}_3 < \text{NH}_3$ (c) $\text{PH}_3 < \text{CH}_4 < \text{NH}_3$ (d) $\text{NH}_3 < \text{PH}_3 < \text{CH}_4$

NH_3 has H-bonding \Rightarrow highest b.p.
 $\text{CH}_4 + \text{PH}_3$ are nonpolar but CH_4 is lighter

C 9. Which of the following molecules will exhibit hydrogen-bonding in the liquid state?

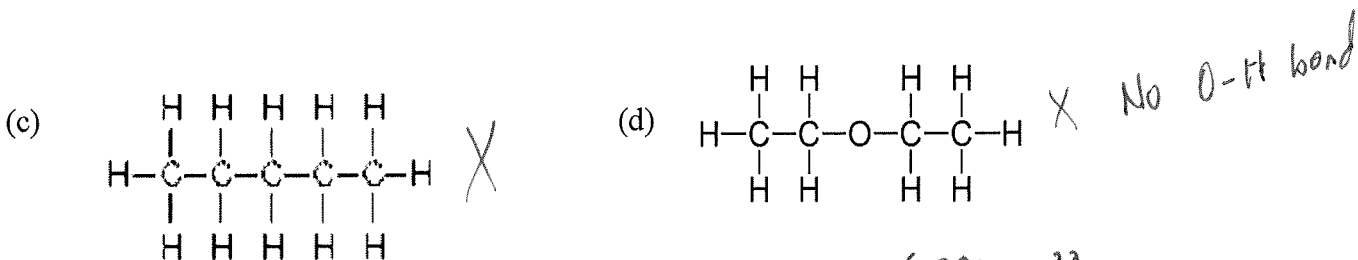
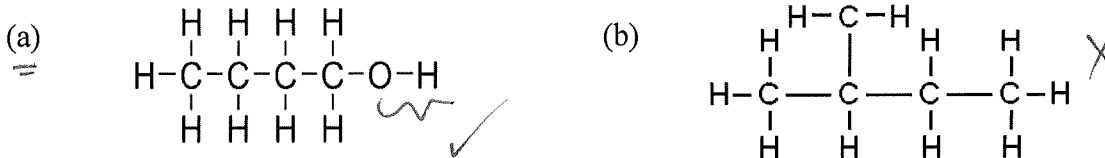
- (a) CH_4 (b) PH_3 (c) CH_3NH_2 (d) C_2H_4
- \leftarrow N-H bond*

a 10. Which of the following liquids will boil at the highest temperature?

- (a) NH_3 (b) PH_3 (c) AsH_3 (d) SbH_3
- due to H-bonding*

a 11. Which of the following compounds will have the lowest vapor pressure?

strongest IMF, so look for H-bonding



b 12. How many atoms are there in 1.5 moles of magnesium? (Note: Avogadro's number equals 6.022×10^{23} particles)

- (a) 2.49×10^{-25} (b) 9.03×10^{23} (c) 4.01×10^{23} (d) 2.49×10^{-24} (e) 9.03×10^{25}

b 13. Which of the following samples contain the largest number of atoms? 1 mole contains 6.022×10^{23} atoms

- (a) 0.50 mol O_2 (b) 1.10 mol Al (c) 1.08 g B (d) 1.20 g C

b 14. What is the molar mass of OCl_2 ?

- (a) 51.45 g/mol (b) 86.91 g/mol (c) 44.07 g/mol (d) 98.13 g/mol

$$\text{MM}_{\text{OCl}_2} = 16 + (35.45)_2 = 86.9$$