CHEMISTRY 121 MIDTERM 3

Nov. 25, 2005

For full marks, show all your reasoning/calculations in your answers.

(4) 1) Consider a body-centered cubic cell. Calculate the % of the cell volume which is occupied by atoms. $V_{atom} = 4/3\pi r^3$.

2 atoms (1) & $(4r)^2$ (1) $= 2a^2 + a^2$ in a volume of a^3

$\therefore \left[\frac{4}{3}\pi r^3\right] \times 2$ = volume of atoms in cell

$\therefore \left[\frac{4}{3}\pi (1) \left(\frac{\sqrt{3}a}{4}\right)^3\right] 2$ = " " " " " in terms of a

$= 0.68a^3$ out of a^3

(1) 68% of bcc cell is taken up ∴ atoms

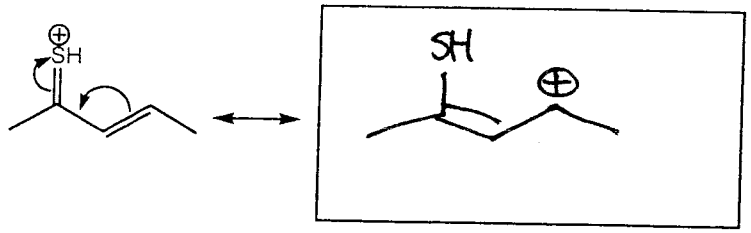
(2) 2) Discuss the difference between dipole-dipole and London's intermolecular forces.

Dipole-dipole = stronger (1/2) of two forces
= $\delta\oplus - \delta\ominus$ attraction caused (1/2) by EN differences

London's = weakest of all intermol. forces
= $\delta\oplus - \delta\ominus$ attraction caused by temporary dipole setup by $e^\ominus$ movement (1/2)

3) Follow the electron flow arrows and draw the expected hybrid structure or provide the expected electron flow arrows. (both sides)

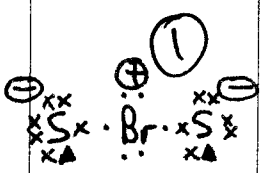
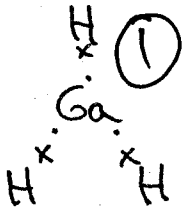
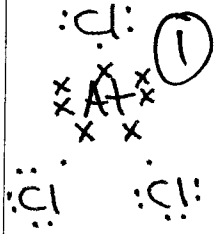
(2) a)



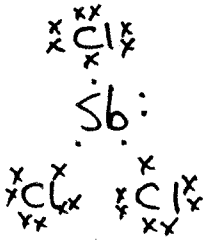
You work it out

(2) b)

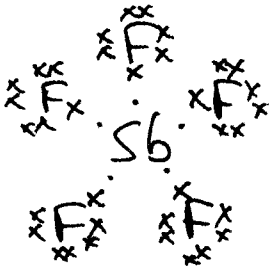
(9) 4) Draw Lewis structures (**all octets where possible**) and complete table. A molecule's overall charge is sacrosanct.

Formula	Lewis Structure	Molec. Geometry Name	Describe bond overlap	Expected Bond Angles
BrS_2^-	 (1)	½ Angular	$sp^3 - sp^3$ (1)	½ 106.5°
GaH_3	 (1)	½ Trig. planar	$sp^2 - s$ (1)	½ 120°
$AtCl_3$	 (1)	½ T-shaped	$sp^3d - sp^3$ or $sp^3d - p$ (1)	½ 90°

(3) 5) Of, $_{51}SbCl_3$ and $_{51}SbF_5$, which is expected to have the lower boiling point? Explain.



→ Pyramidal (1)
→ Is polar molecule



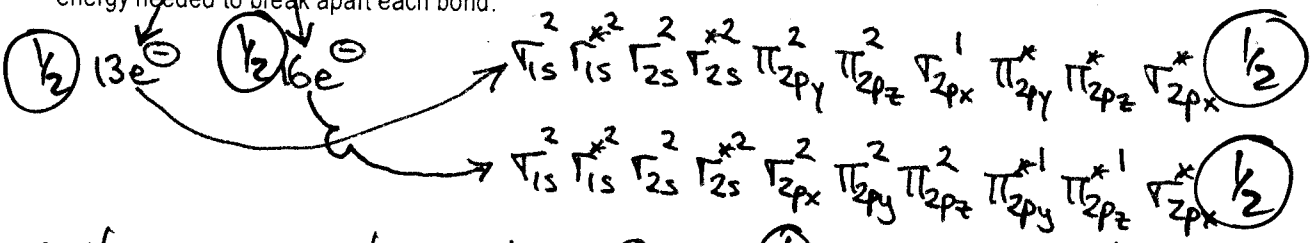
→ Trig. bipyr (1)
→ Not polar molecule

} Expect to see lower b.p. ∵ less polar & low molecular mass. (1)

(2) 6) Hydrogen bonding is usually seen between H and the following atoms. Circle the correct answer.

a) F O S b) N O Fr c) C O F **d) O N F** e) S O N f) B O S

(4) 7) Consider NO^{2+} and NO^-. Predict the behaviour of each molecule towards a magnetic field then discuss the relative energy needed to break apart each bond.



Both paramagnetic but $NO^\ominus$ more so. ∴ attracted to mag. field (1)

$BO_{NO^{2+}} = \frac{9-4}{2} = 2.5$ → stronger shorter bond (1)

$BO_{NO^\ominus} = \frac{10-6}{2} = 2$ ∴ tougher to break

(4) 8) The radioactive element uranium (AW = 238.03 g/mol) crystallizes in a simple cubic cell with a density of 18.90 g/cm³. Calculate Avogadro's number given the radius of uranium is 1.377 angstroms.

$$D = \frac{M}{V} = \frac{18.90\,g}{cm^3} = \frac{238.03\,g}{mol} \times \frac{1\,mol}{Z\,atoms} \times \frac{1\,atom}{a^3}$$

1 atom (1)

$2r = a$ for simple cubic cell (1)

$$\Rightarrow 0.0794(2r)^3 = \frac{1}{Z}$$

$$\Rightarrow 0.0794\left(2(1.377\times10^{-8}\,cm)\right)^3 = \frac{1}{Z}$$

$$Z = 6.029\times10^{23}$$ (1)