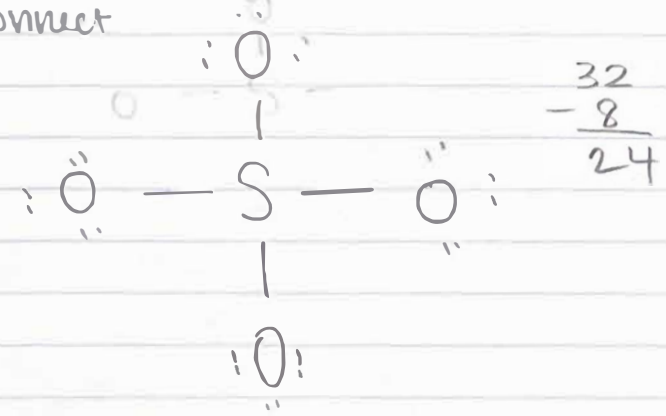
CHM2045 EXAM 3 Solutions

1

a) SO_4^{2-}

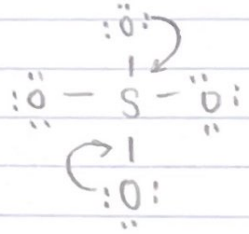
1) # ve⁻ 6 + 4(6) + 2 = 32 valence e⁻

2) connect



3) Formal charges (normally don't want →)

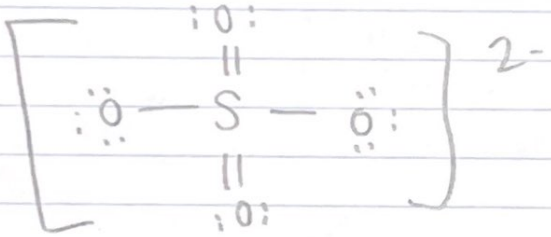
cont'd)



Formal charge = ve − (dot + line)

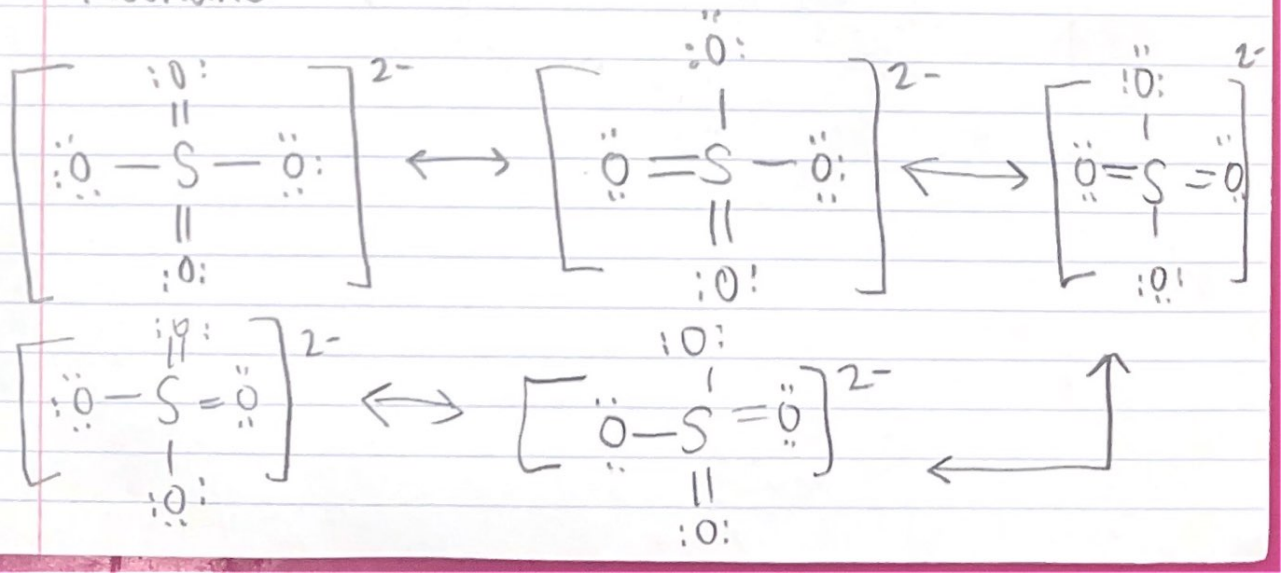
F.C S = 6 − 4 = +2
F.C O = 6 − (6+1) = −1

S can hold expanded octet

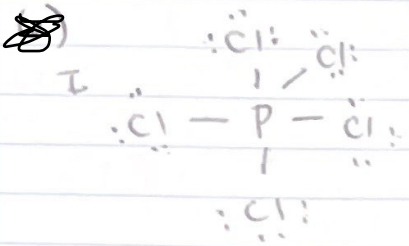


S FC = 6 − 4 = 0 ✓
O double FC = 6 − (4+2) = 0 ✓
O single FC = 6 − (6+1) = −1

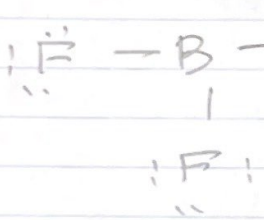
Resonance

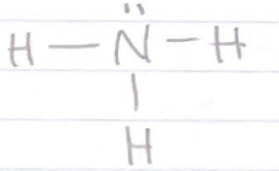


2

I  P 10 e⁻ ✓

II  Be 4 e⁻ ✓

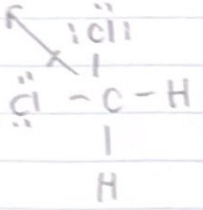
III  B 6 e⁻ ✓

IV  N 8 e⁻ ✓

V  O 8 e⁻ ✓

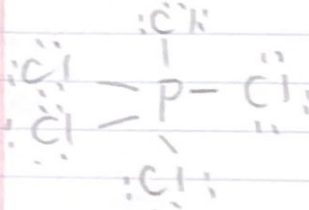
I, II, III (A)

3

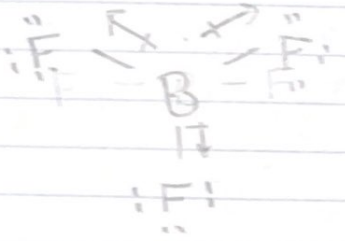


✓ polar (A)

PCl_5

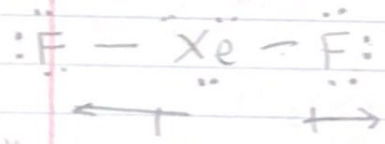


trig bipyramid → nonpolar



nonpolar
trigonal
planar

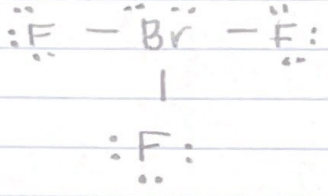
all dipoles cancel



linear nonpolar

4

a) BrF_3 $7 + 3(7) = 28$ valence e^-



FC Br $7 - (3+4) = 0$ ✓
F $7 - (6+1) = 0$ ✓

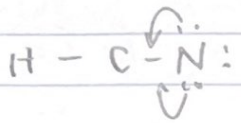
e^- geo : 5 electron group → trigonal bipyramidal

molecular geo : 3 bond 2 lone pair

T-shaped

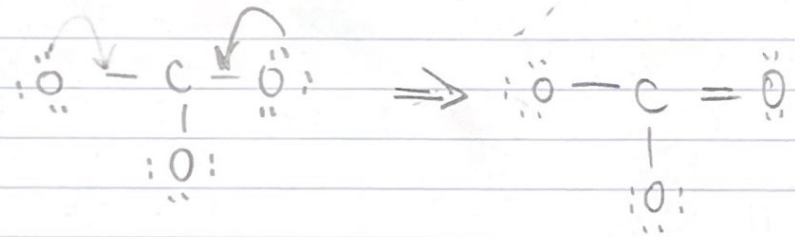
bond angles axial - 120°
equatorial - 180°

4b [redacted] HCN ve = 1 + 4 + 5 = 10



$H-C\equiv N:$ e⁻ geo : linear
mol. geo : linear
bond angles : 180°

4c [redacted] CO_3^{2-} ve 4 + 3(6) + 2 = 24

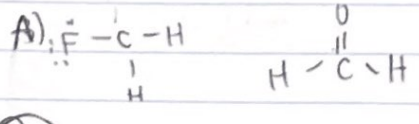


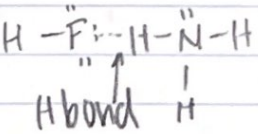
FC C 4 − 4 = 0 ✓
O double 6 − (2+4) = 0 ✓
O single 6 − (6+1) = −1 (2 since −2 overall charge)
(resonace structures not pictured)

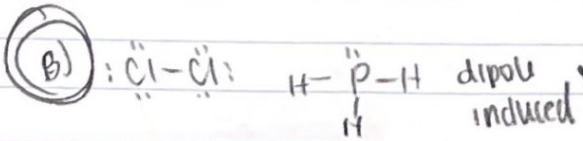
e⁻ geo : trigonal planar
mol geo : trigonal planar
bond angle : 120°

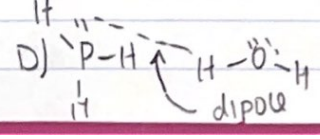
5 [redacted]

A) H-N ···F-F H bond ✓

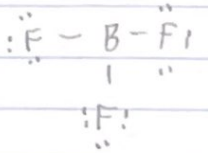
A)  dipole-dipole

C) 

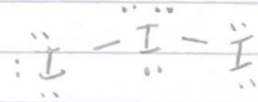
B)  dipole induced ✓

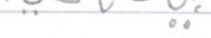
D) 

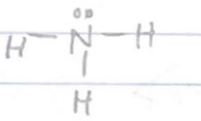
6 [redacted]

a)  sp^2

A

b)  sp^3d

c)  sp

d)  sp^3

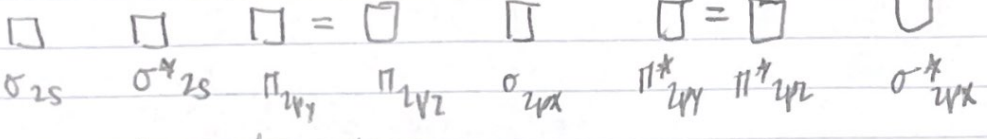
7 [redacted]

	σ_{2s}	σ^*_{2s}	σ_{2px}	π_{2py}	π_{2pz}	π^*_{2py}	π^*_{2pz}	σ^*_{2px}	
12ve O_2	↑↓	↑↓	↑↓	↑↓	↑↓	↑	↑		✓
11ve O_2^+	↑↓	↑↓	↑↓	↑↓	↑↓	↑			✓
13 O_2^-	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑		✓

D

8 [redacted] bond length inverse to bond strength direct to bond order

↑ bond order ↓ bond length B.O = $\frac{\text{bond} - \text{anti bond}}{2}$



V.e⁻								
6	C_2^{2+}	↑↓	↑↓	↑	↑			4 − 2/2 = 1
8	C_2	↑↓	↑↓	↑↓	↑↓			6 − 2/2 = 2
10	C_2^{2-}	↑↓	↑↓	↑↓	↑↓	↑↓		8 − 2/2 = 3
9	C_2^-	↑↓	↑↓	↑↓	↑	↑		7 − 2/2 = 2.5

B.O $C_2^{2+} < C_2 < C_2^- < C_2^{2-}$

length $C_2^{2-} < C_2^- < C_2 < C_2^{2+}$

C_2^{2+} (A)

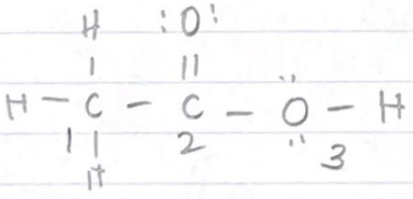
9 [redacted] all single σ

each double bond 1 π 19 σ

5 double 5 π

(B)

10 [redacted]



1, sp^3, 2. sp^2, 3. sp^3 (A)

11 [redacted] ↑IMF ↑BP

I) CH_2Br_2 dipole-dipole
II) CH_3CH_2OH H bond
III) F_2 dispersion
IV) CH_4 dispersion
} based on molar mass

IV < III < I < II (B)

12 [redacted] ↑IMF ↓VP

a) CH_4 dispersion ← (A)
b) H_2O H bond
c) CH_2Cl_2 dipole
d) NH_3 ~~H bond~~ in

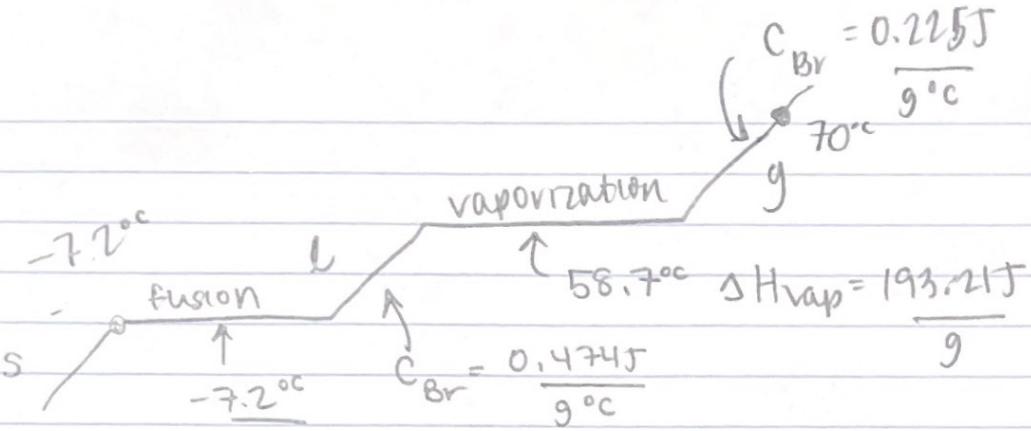
13 [redacted] ↑IMF ↑Viscosity

a) BF_3 dipole induced (dispersion)
b) CH_2I_2 dipole
c) NH_3 H bond ← highest (C)
d CH_4 dispersion

14 [redacted]

a) ↑T ↓viscosity
b) ↑VP ↓IMF (C)
c) T
d) ↑ST ↓T

15



$\Delta H_{fusion} = 66.15 \frac{J}{g}$

1) ΔH fusion energy
2) energy of liquid from -7.2 - 58.7°C
3) ΔH vaporization energy
4) energy of gas from 58.7°C — 70°C

1) $Q = \text{mass} \cdot \Delta H_{fus}$
$= 10.0\,g \left(\frac{66.15\,J}{g}\right) = 661.5\,J$

2) $q_2 = mC\Delta T \quad = 10g\,(0.474\,J)(65.9°C) = 312.37\,J$
$C = 0.474\,J/g°C$
$\Delta T = 58.7°C - (-7.2°C) = 65.9°C$

take most E

3) $q_3 = \text{mass} \cdot \Delta H_{vap} = 10g \left(\frac{193.21\,J}{g}\right) = 1932.1\,J$

4) $q = mC_{gas}\Delta T \quad 10g\left(\frac{.225\,J}{g°C}\right)(11.3°C)$
$C = 0.225\,J/g°C$
$\Delta T = 70 - 55.7°C$
$= 25.43\,J$

most energy to vapoize liquid to gas
total $q = q_1 + q_2 + q_3 + q_4 = 661.5 + 312.37 + 1932.1 + 25.43$
$= 2931.4\,J$