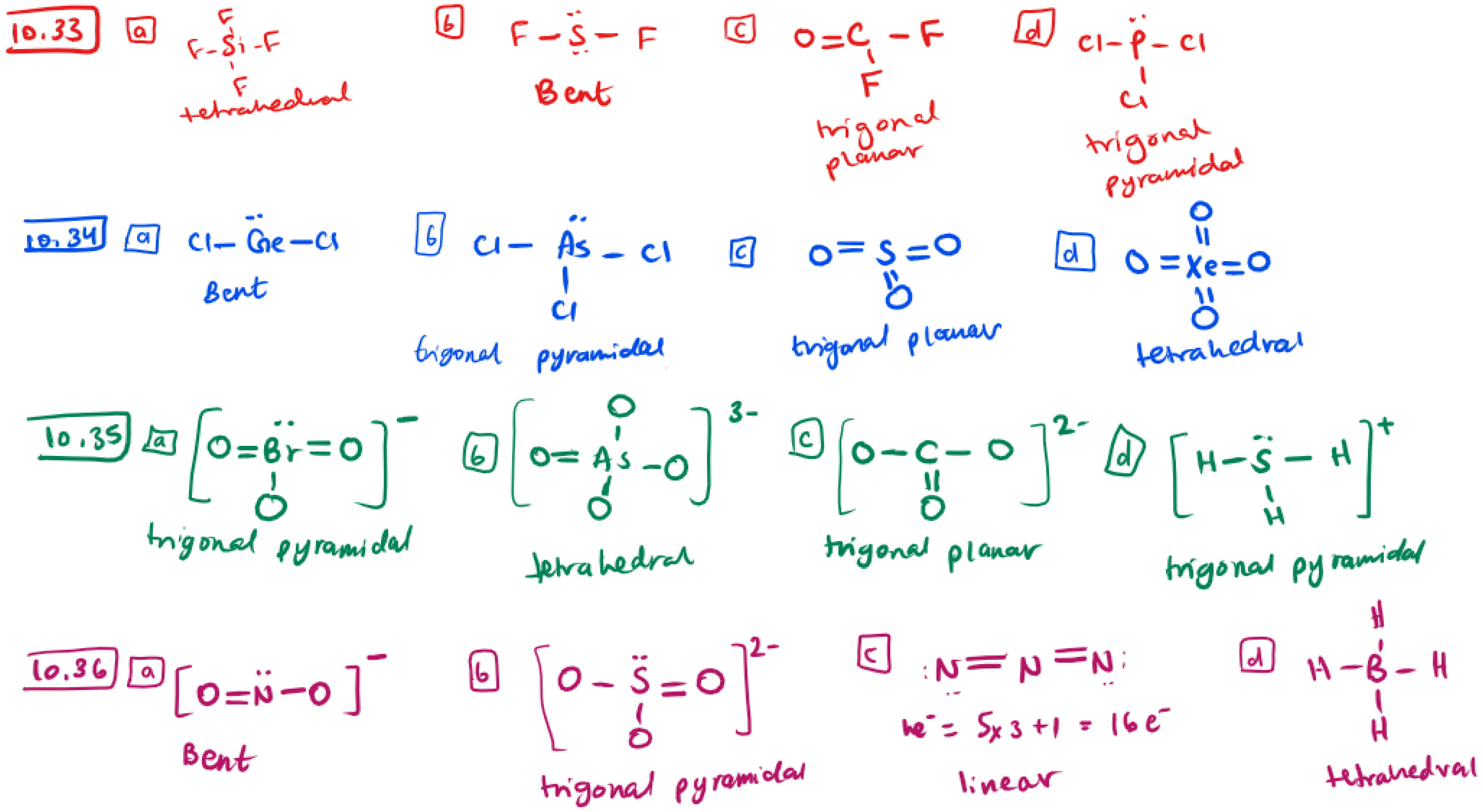
The VSEPR Model

10.33 Predict the shape or geometry of the following molecules, using the VSEPR model.
a SiF_4 b SF_2 c COF_2 d PCl_3

10.34 Use the electron-pair repulsion model to predict the geometry of the following molecules:
a $GeCl_2$ b $AsCl_3$ c SO_3 d XeO_4

10.35 Predict the geometry of the following ions, using the electron-pair repulsion model.
a BrO_3^- b AsO_4^{3-} c CO_3^{2-} d H_3S^+

10.36 Use the VSEPR model to predict the geometry of the following ions:
a NO_2^- b SO_3^{2-} c N_3^- d BH_4^-



10.39 What geometry is expected for the following molecules, according to the VSEPR model?

a PF_5 b BrF_3 c BrF_5 d SCl_4

10.40 From the electron-pair repulsion model, predict the geometry of the following molecules:

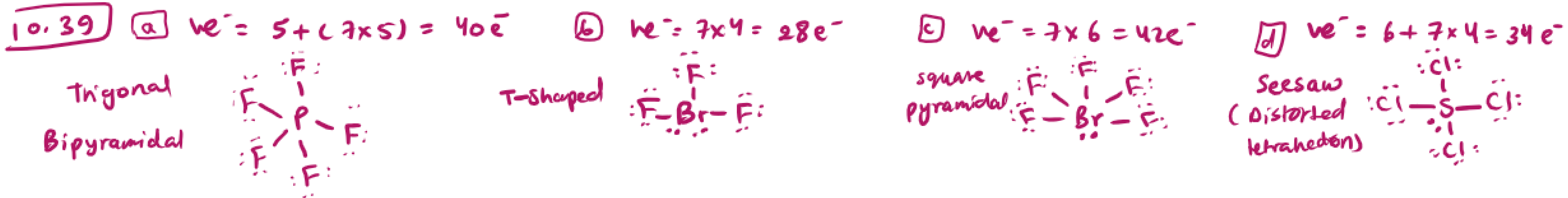
a TeF_6 b ClF_5 c SeF_4 d SbF_5

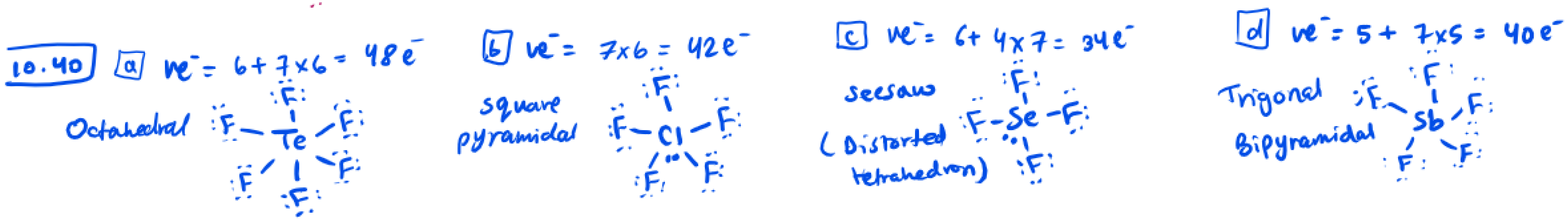
10.41 Predict the geometries of the following ions, using the VSEPR model.

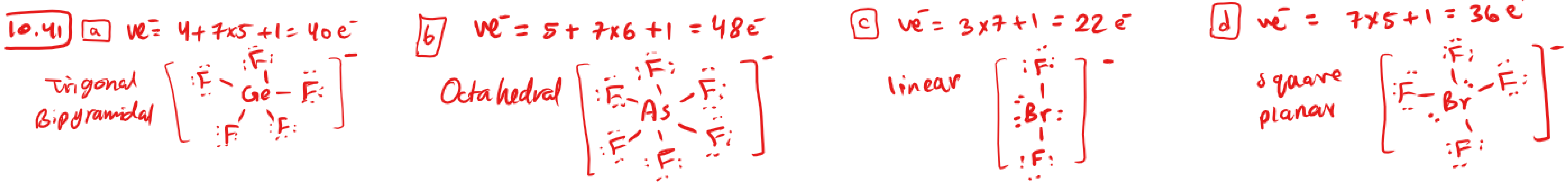
a GeF_5^- b AsF_6^- c BrF_2^- d BrF_4^-

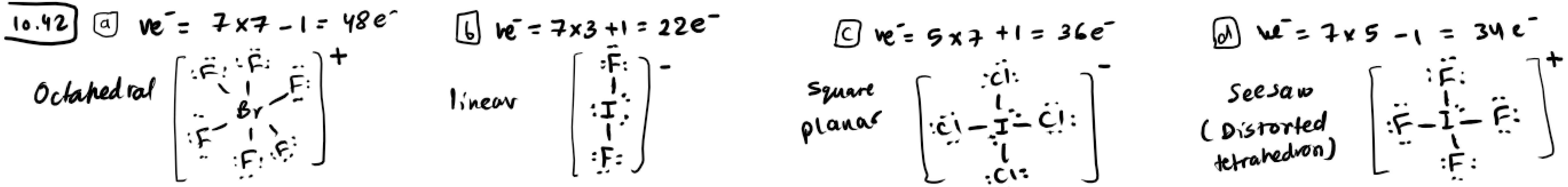
10.42 Name the geometries expected for the following ions, according to the electron-pair repulsion model.

a BrF_6^+ b IF_2^- c ICl_4^- d IF_4^+









Dipole Moment and Molecular Geometry

10.43 (a) The molecule AsF_3 has a dipole moment of 2.59 D. Which of the following geometries are possible: trigonal planar, trigonal pyramidal, or T-shaped? (b) The molecule H_2S has a dipole moment of 0.97 D. Is the geometry linear or bent?

10.44 (a) The molecule BrF_3 has a dipole moment of 1.19 D. Which of the following geometries are possible: trigonal planar, trigonal pyramidal, or T-shaped? (b) The molecule $TeCl_4$ has a dipole moment of 2.54 D. Is the geometry tetrahedral, seesaw, or square planar?

10.45 Which of the following molecules would be expected to have zero dipole moment on the basis of their geometry?
(a) CS_2 (b) TeF_2 (c) $SeCl_4$ (d) XeF_4

10.46 Which of the following molecules would be expected to have a dipole moment of zero because of symmetry?
(a) $BeBr_2$ (b) H_2Se (c) AsF_3 (d) SeF_6

10.43 (a) $ve^- = 7\times3+5 = 26e^-$
trigonal pyramidal and T-shaped
F-As-F (F above)

(b) bent
$ve^- = 2+6 = 8e^-$
H-S-H

10.44 (a) $ve^- = 7\times4 = 28e^-$
Trigonal pyramidal and T-shaped
F-Br-F (F above)

(b) seesaw (Distorted tetrahedron)
$ve^- = 6+7\times4 = 34e^-$
Cl-Te-Cl (Cl above and below)

10.45 (a) $ve^- = 4+6\times2 = 16e^-$
linear S=C=S
so zero dipole moment

(b) $ve^- = 6+7\times2 = 20e^-$
Bent F-Te-F
so non zero dipole moment

(c) $ve^- = 6+7\times4 = 34e^-$
Seesaw (Distorted tetrahedron)
Cl-Se-Cl (Cl above and below)
so non zero dipole moment

(d) $ve^- = 8+7\times4 = 36e^-$
square planar
F-Xe-F (F above and below)
so zero dipole moment

10.46 (a) $ve^- = 2+7\times2 = 16e^-$
Br—Be—Br
linear so zero dipole moment

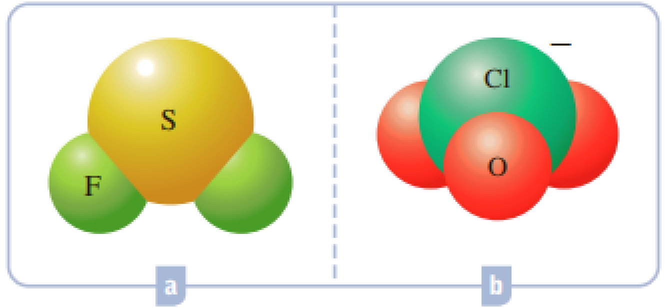
(b) $ve^- = 2+6 = 8e^-$
H—Se—H
Bent so non zero dipole moment

(c) $ve^- = 7\times3+5 = 26e^-$
F—As—F (F above)
Trigonal Pyramidal so nonzero dipole moment

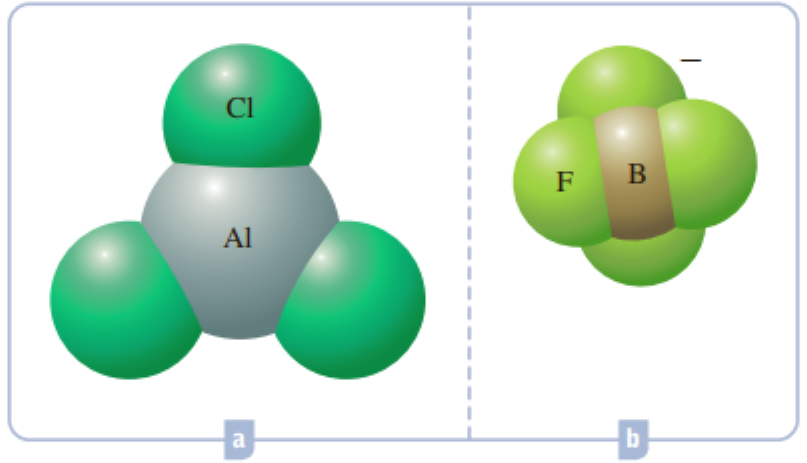
(d) $ve^- = 6+7\times6 = 48e^-$
Octahedral
SeF_6
so zero dipole moment

Valence Bond Theory

10.47 What hybrid orbitals would be expected for the central atom in each of the following molecules or ions?



10.48 What hybrid orbitals would be expected for the central atom in each of the following molecules or ions?



10.49 What hybrid orbitals would be expected for the central atom in each of the following molecules or ions?

a SeI_2 b NO_3^- c $BeCl_2$ d ClO_4^-

10.50 What hybrid orbitals would be expected for the central atom in each of the following molecules or ions?

a PCl_3 b $SiCl_4$ c BeF_2 d SO_2

10.47 SF_2

F — S — F

electron geometry: tetrahedral

sp^3 hybridization

ClO_3^-

$[O=Cl=O]^-$ (with O below Cl)

electron geometry: tetrahedral

sp^3 hybridization

10.48 $AlCl_3$

Cl — Al — Cl (with Cl below Al)

electron geometry: trigonal planar

sp^2 hybridization

BF_4^-

$[F — B — F]^-$ (with F above and below B)

electron geometry: tetrahedral

sp^3 hybridization

10.49 a) I – Se – I

tetrahedral

sp^3

b) $[O=N–O]^-$ (with O above N)

trigonal planar

sp^2

c) Cl – Be – Cl

linear

sp

d) $[O=Cl=O]^-$ (with =O above and O below Cl)

tetrahedral

sp^3

10.50 a) Cl – P – Cl (with Cl above P)

tetrahedral

sp^3

b) Cl – Si – Cl (with Cl above and below Si)

tetrahedral

sp^3

c) F – Be – F

linear

sp

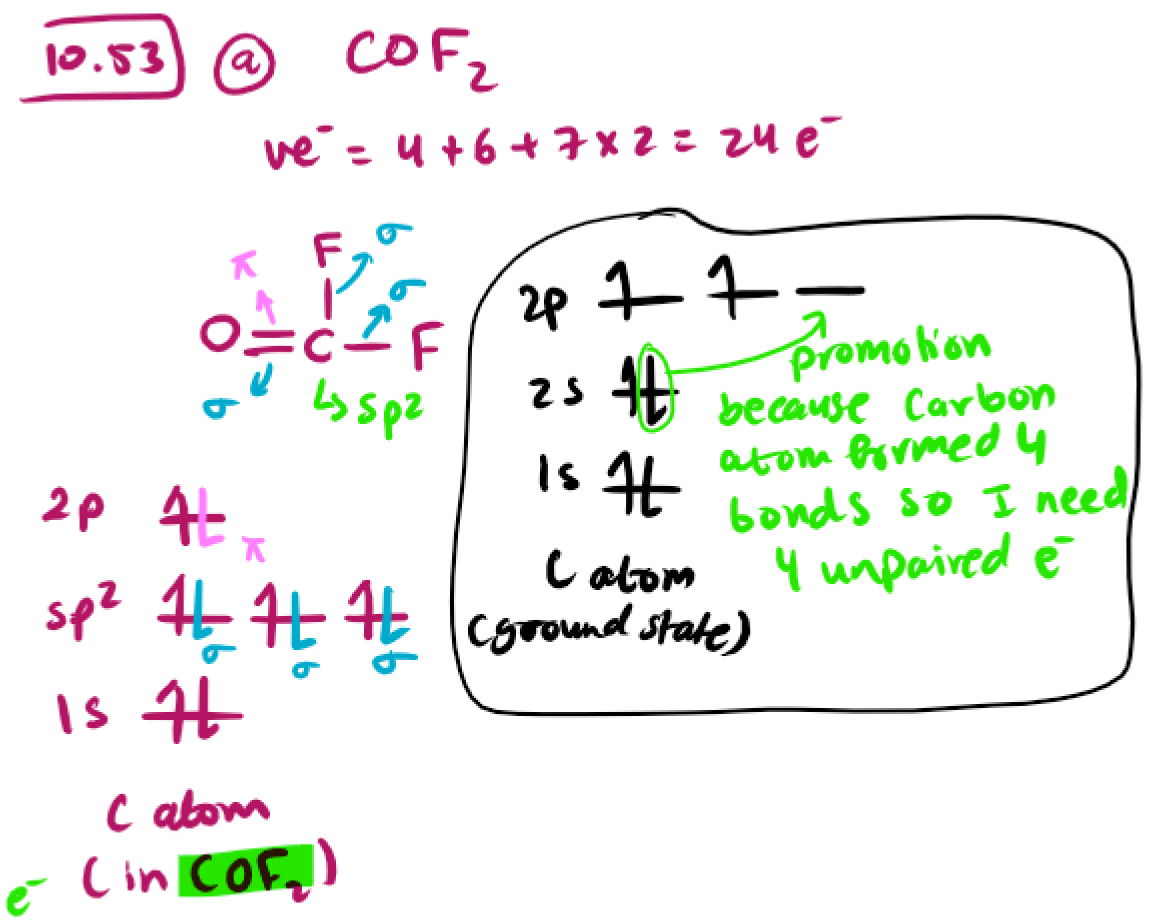
d) O = S = O

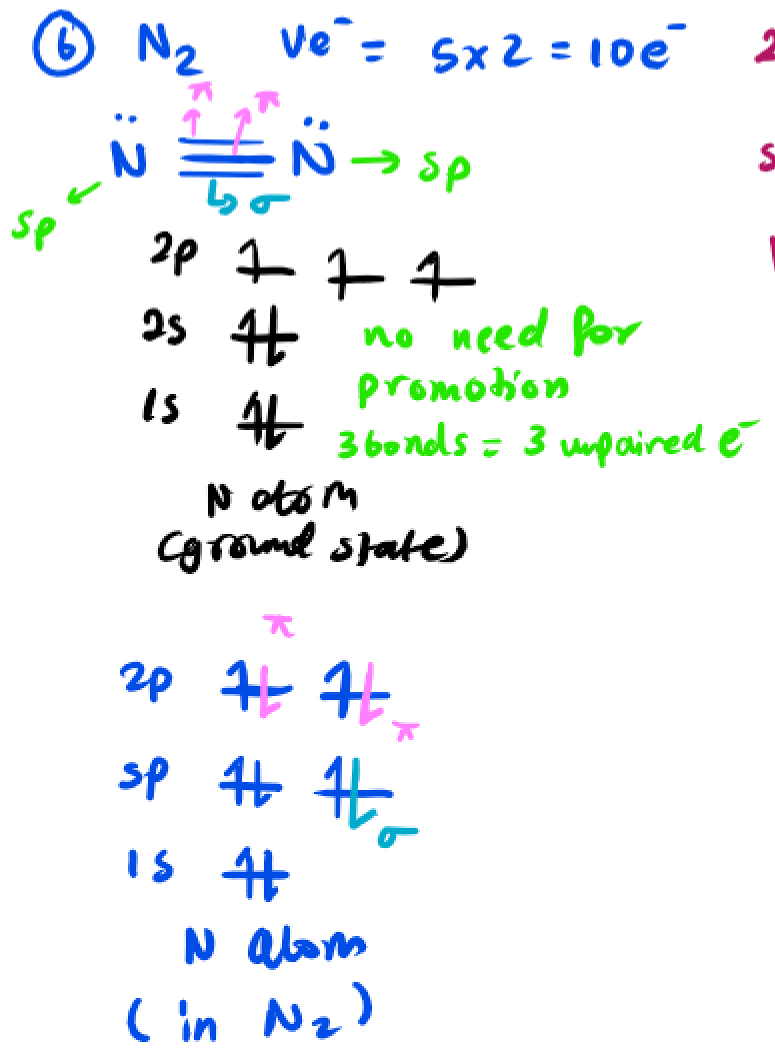
trigonal planar

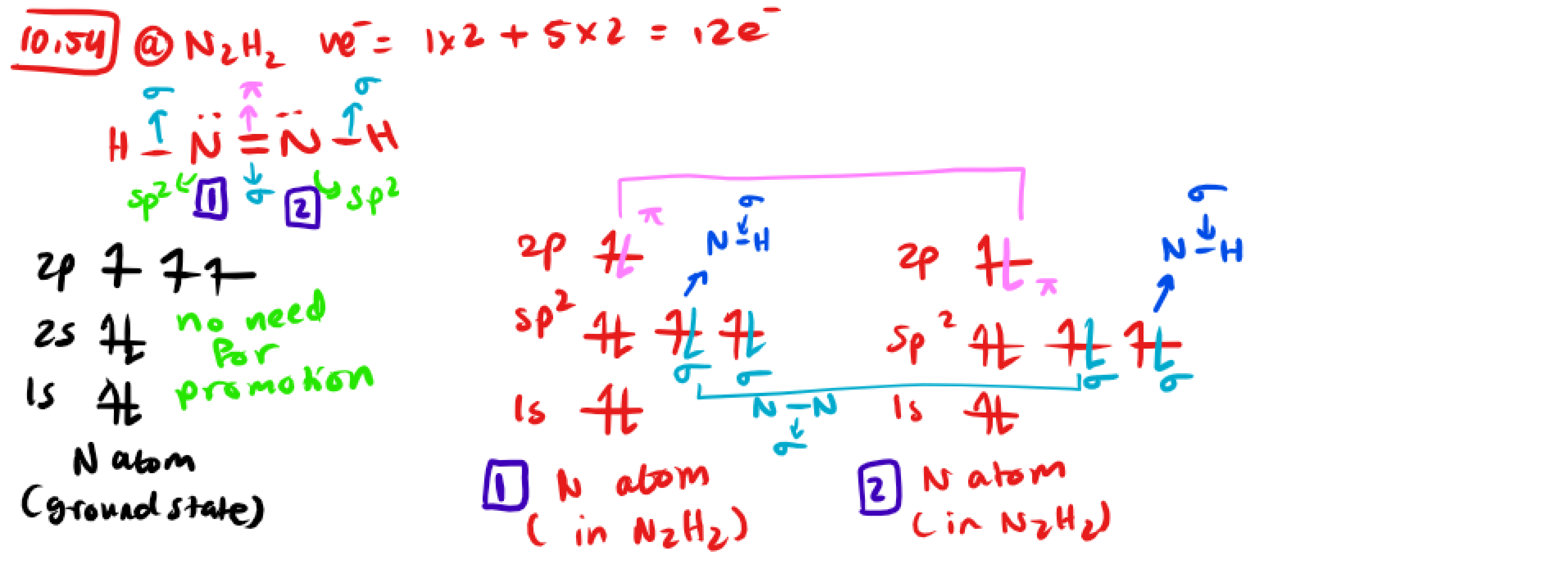
sp^2

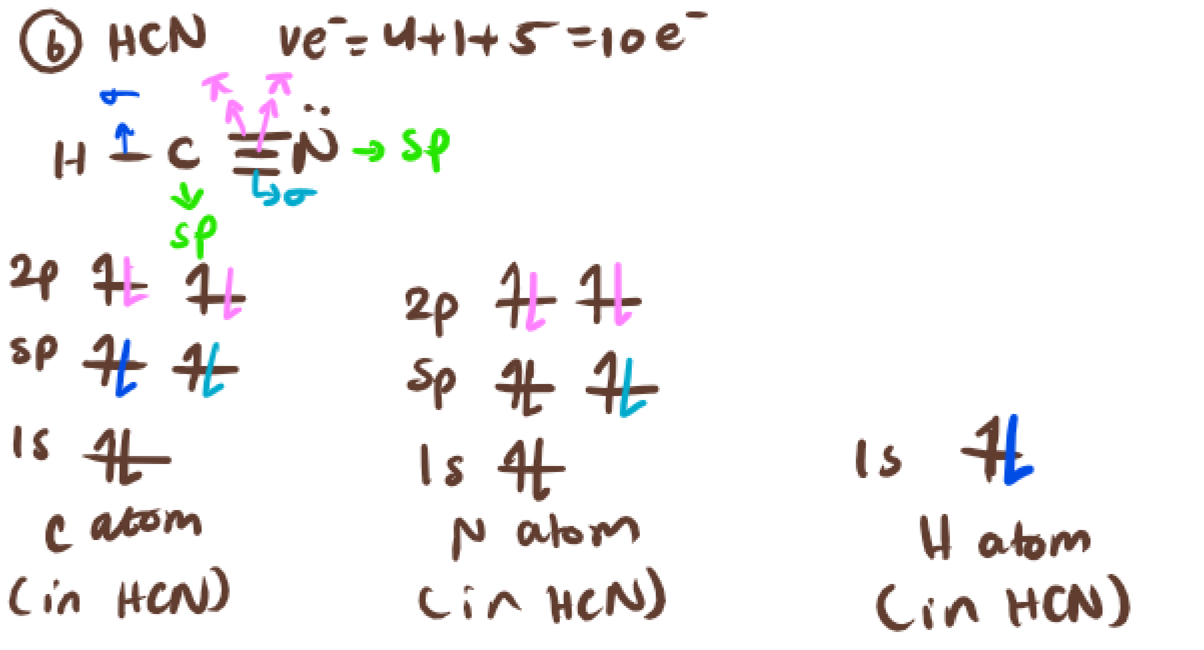
10.53 a Carbonyl fluoride, COF_2, is an extremely poisonous gas used in organofluorine synthesis. Give the valence bond description of the carbonyl fluoride molecule. (Both fluorine atoms are attached to the carbon atom.) b Nitrogen, N_2, makes up about 80% of the earth's atmosphere. Give the valence bond description of this molecule.

10.54 a The molecule HN═NH exists as a transient species in certain reactions. Give the valence bond description of this species. b Hydrogen cyanide, HCN, is a very poisonous gas or liquid with the odor of bitter almonds. Give the valence bond description of HCN. (Carbon is the central atom.)



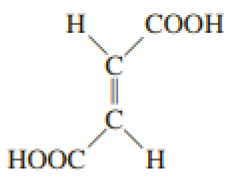






10.55 The hyponitrite ion, $^{-}O{-}N{=}N{-}O^{-}$, exists in solid compounds as the *trans* isomer. Using valence bond theory, explain why *cis–trans* isomers might be expected for this ion. Draw structural formulas of the *cis–trans* isomers.

10.56 Fumaric acid, $C_4H_4O_4$, occurs in the metabolism of glucose in the cells of plants and animals. It is used commercially in beverages. The structural formula of fumaric acid is

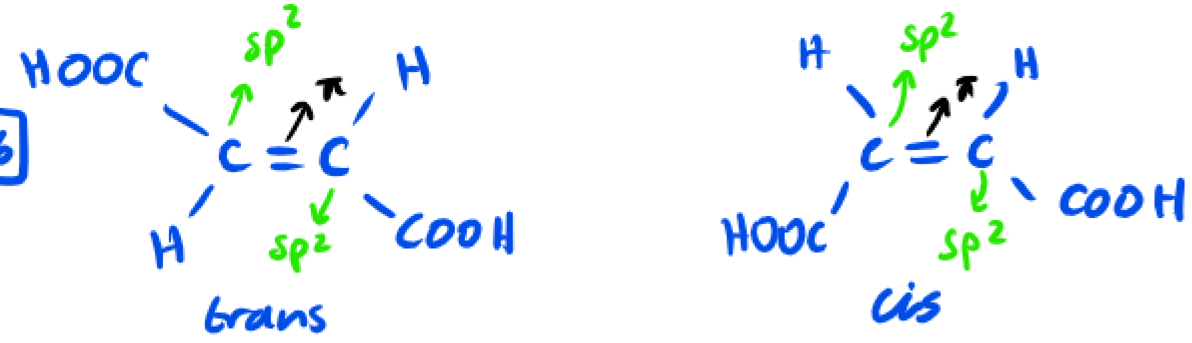


(—COOH is an abbreviation for —C(=O)—O—H)

Maleic acid is the *cis* isomer of fumaric acid. Using valence bond theory, explain why these isomers are possible.

10.55

10.56



Each C atom is bonded to 3 atoms, so sp^2 hybridization. Because the π bond between the carbon atoms must be broken to interconvert these two forms, it is expected that Fumaric acid will exhibit cis-trans isomerism.