Recitation Worksheet Twelve

Name: key

UGA ID:

Instructions:

- Please enter your first and last name as it appears on the eLC roster (do not use a nickname that is not reflected in eLC).
- Your UGA myID is a combination of letters and numbers (example: mine is jmj81738). Do *not* enter your 81x number.
- Download this worksheet and print it if you have a printer. Write the answers in the answer boxes and show your work when appropriate. Using the instructions in the Welcome module on eLC, convert your worksheet to a PDF and then upload it to Gradescope. If you have an iPhone or Android device, you can scan and upload directly through the Gradescope app. The pages must be in the correct order or Gradescope will not be able to read it.
- If you do not have a printer, download the worksheet and type your answers in the answer boxes and upload it to Gradescope. Write your work on separate sheets of paper, convert these pages to a PDF using the instructions in the Welcome module on eLC, then upload them to the dropbox on eLC for this worksheet.
- If you are using an app to annotate the worksheet, make sure the pages are in the correct order and have the same layout as the original or Gradescope will not be able to read it.
- Answers must be written in the corresponding answer box or no credit will be awarded.
- This worksheet is due no later than **11:59 PM on the Friday of the recitation week.**
- The instructions for uploading worksheets to Gradescope can be found in the Content area of eLC in the Welcome Module.
- **You must show your work to receive credit.**

1. Which of the following contains **both** ionic and covalent bonds?

C

A. $MgBr_2$
B. COS
C. $BaSO_4$
D. SF_6
E. None of the above contain both ionic and covalent bonds

2. How many single bonds, double bonds, triple bonds, and lone pairs are present in the Lewis structure of HCN? Answer with integers (e.g. 7).

10 valence e^{-}s

I. Single bonds: 1

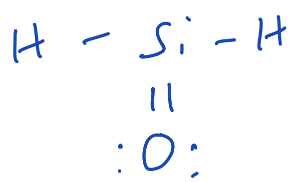
II. Double bonds: 0

III. Triple bonds: 1

IV. Lone pairs: 1

3. How many single bonds, double bonds, triple bonds, and lone pairs are present in the Lewis structure of SiH_2O? Answer with integers (e.g. 7).

12 valence e^{-}s



I. Single bonds: 2

II. Double bonds: 1

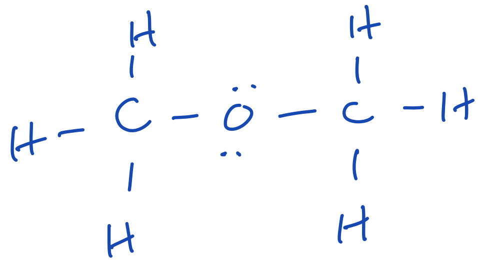
III. Triple bonds: 0

IV. Lone pairs: 2

4. Write the Lewis structure for the organic compound CH_3OCH_3. How many total bonding pairs are in the compound? How many total lone pairs are in the compound? Answer with integers (e.g. 7).

I. Bonding pairs: 8

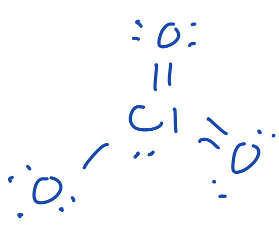
II. Lone pairs: 2

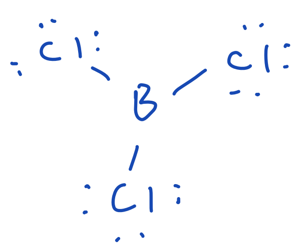


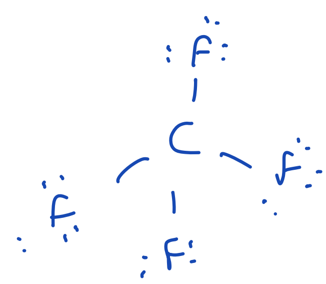
5. Which of the following Lewis structures would violate the octet rule (in their best structure)? Select all that apply.

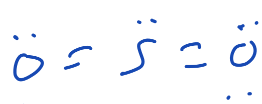
ABCE

A. NO
B. SO_2
C. BCl_3
~~D~~. CF_4
E. ClO_3^-









6. Consider a set of hypothetical elements in the table below and the number of valence electrons each has.

Element Symbol	# of valence electrons
X	4
Z	5

Which of the hypothetical compounds formed from the elements above would you expect to be free radicals? Select all that apply.

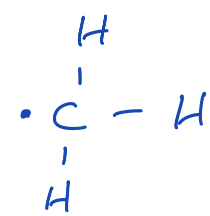
A D

A. XZ 9 e⁻'s → odd e⁻'s
B. X_2Z_2 18 e⁻'s
C. XZ_2 14 e⁻'s
D. X_3Z 17 e⁻'s → odd e⁻'s
E. There is not enough information to determine this

7. Which of the following statements are **true**? Select all that apply.

C D

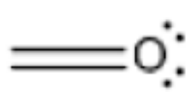
(formal charge = 0 on both atoms)



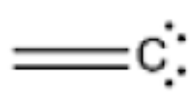
A. The reactivity of a hydroxide ion (OH^-) is expected to be the same as a hydroxyl radical (•OH) because their chemical formulas are identical → free radicals very reactive
B. The Lewis structure of the nitrogen monoxide free radical is expected to have an unpaired electron on the oxygen atom
C. The formal charge on nitrogen in the nitrogen dioxide free radical is +1
D. The methyl radical (•CH_3) has a total number of 7 valence electrons

8. Which of these atoms has a formal charge of -1 in the given electronic configuration?

C

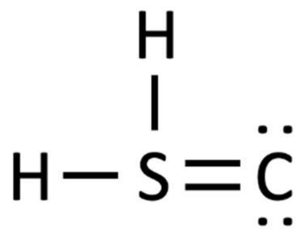
A.  0

C.  -1

B.  -2

D.  0

9. The complete Lewis structure of a molecule is provided below. What is the formal charge of the sulfur atom? What is the formal charge of the carbon atom? Answer with an integer and charge (e.g. +5) or with a zero if no charge is present.



I. Sulfur: +2

II. Carbon: -2

10. What is true of resonance structures? Select all that apply.

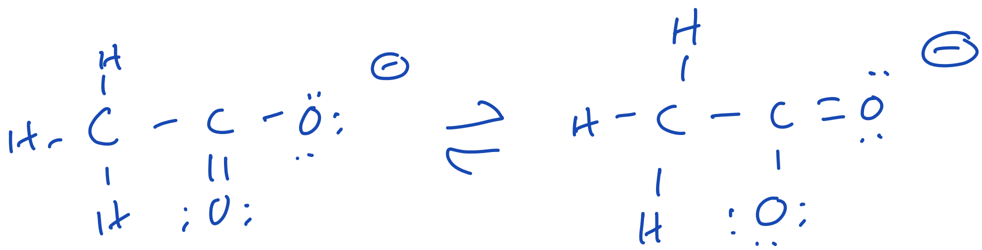
ADE

A. Different resonance contributing structures differ by placement of electrons only.
B. Molecules that exhibit resonance rapidly switch between different resonance contributing structures.
C. Different resonance contributing structures differ by placement of electrons and atoms
D. The resonance hybrid structure of a molecule is an average of its different resonance contributing structures.
E. Resonance hybrid structures contain delocalized electrons.

11. Draw the Lewis structure for the ion CH_3COO^-. How many total possible octet-satisfied (i.e. best) resonance structures can be drawn for this ion?

B

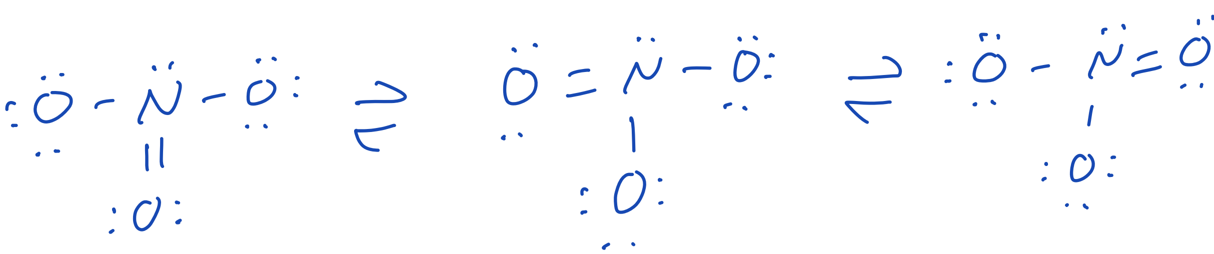
A. There are no resonance structures for this ion (i.e. there is only one way to draw this Lewis structure)
B. Two equivalent resonance structures
C. Two non-equivalent resonance structures
D. Three equivalent resonance structures
E. Three non-equivalent resonance structures

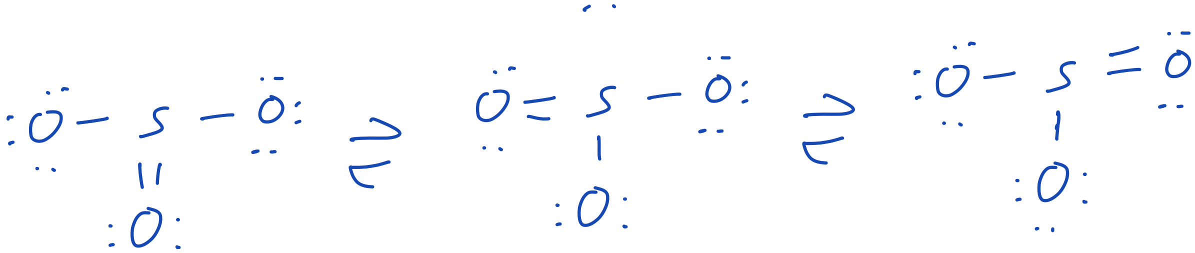


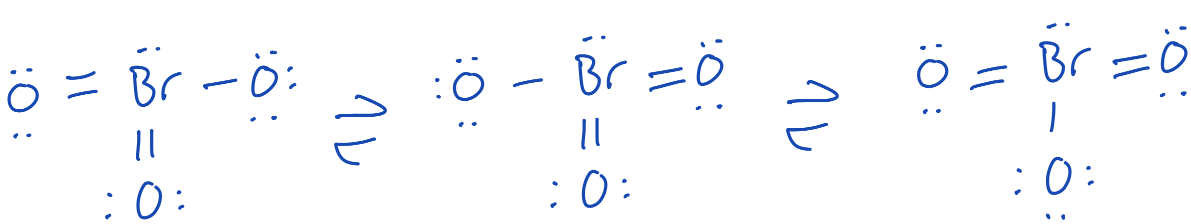
12. There can be three equivalent **best** resonance structures of ________. Select all that apply.

BCE

A. NO_2^-
B. NO_3^-
C. SO_3^{2-}
D. SO_4^{2-}
E. BrO_3^-







13. What is **false** regarding the compound PCl_4^- ?

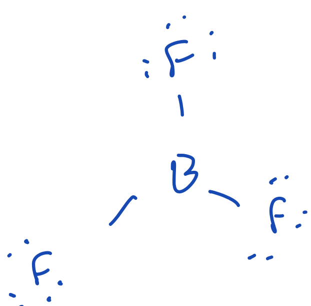
D

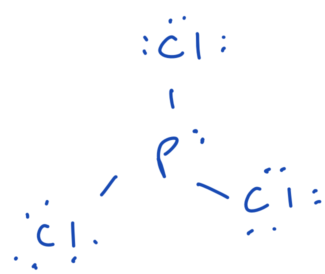
A. It has a trigonal bipyramidal electron geometry
B. It has a seesaw molecular geometry
C. The lone pair occupies an equatorial position
D. The lone pair occupies an axial position must be equatorial
E. The lone pair is more repulsive than the bonding pairs

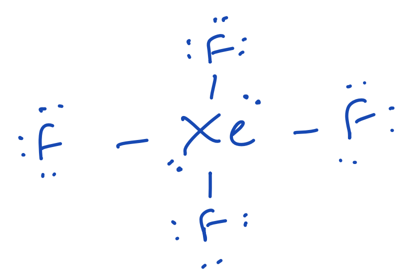
14. For which of these molecules do the electron and molecular geometry differ? Select all that apply.

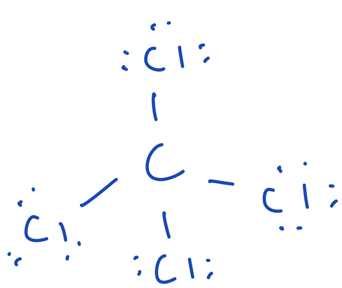
BF

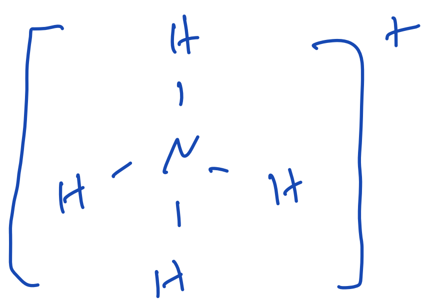
A. BF_3
B. PCl_3
C. CCl_4
D. NH_4^+
E. CO_3^{2-}
F. XeF_4

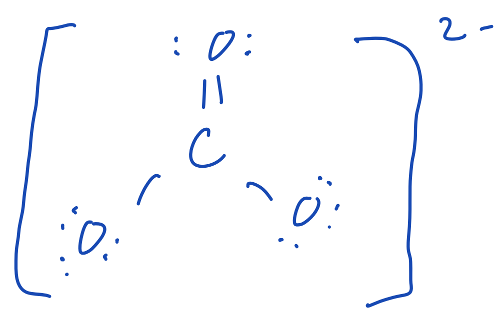








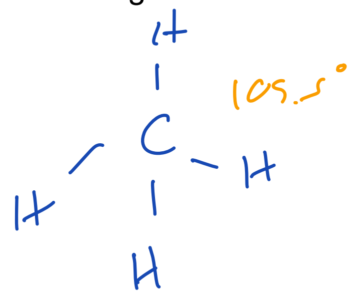


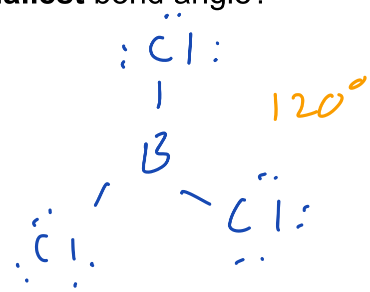


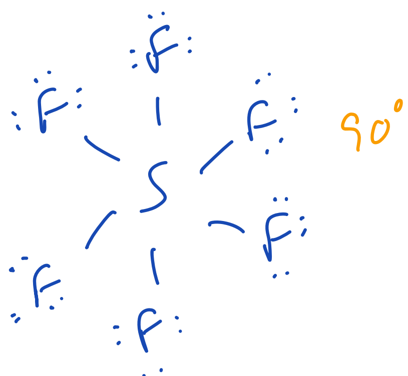
15. Which of the following molecules has the **smallest** bond angle?

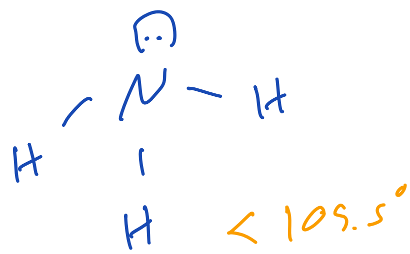
C

A. CH_4
B. BCl_3
C. SF_6
D. NH_3
E. SCl_2

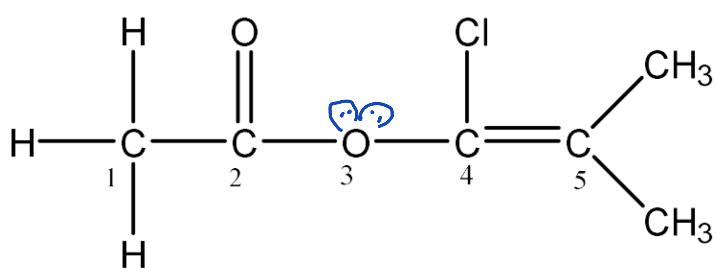








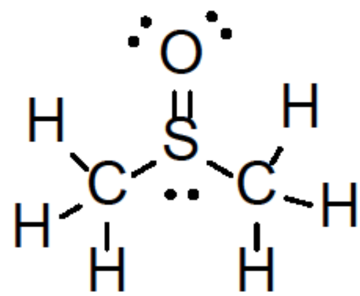
16. Which bond angle would be the smallest in the following structure? Note: lone pairs are not shown in the included Lewis structure.



C

A. H – C1 – C2 → 109.5°
B. C1 – C2 – O3 → 120°
C. C2 – O3 – C4 → < 109.5°
D. O3 – C4 – C5 → 120°
E. C4 – C5 – CH_3 → 120°

17. The Lewis structure of dimethylsulfoxide is given below. Answer the following questions with the geometries, bond angles, or hybridization in dimethylsulfoxide. Non-standard bond angles should be written as inequalities (e.g. <120).



I. What is the H-C-H bond angle? 109.5° (tetrahedral)

II. What is the hybridization state of the carbon atom? sp^3

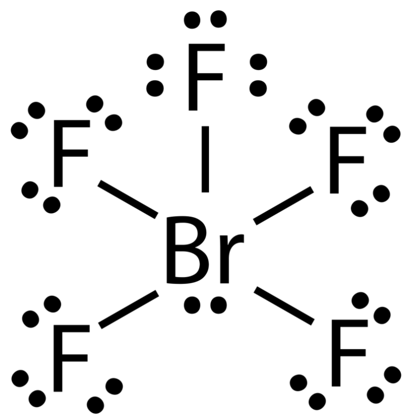
III. What is the molecular shape around the sulfur atom?

trigonal pyramidal

IV. What is the O-S-C bond angle? <109.5°

V. What is the hybridization state of the sulfur atom? sp^3

18. Consider the Lewis structure for BrF_5 below. Which of the following statement(s) is/are true? Select all that apply.



C D

FC = 0 (all atoms)

A. The formal charge on all of the elements above are -1 because they are all halogens
B. The molecular geometry for this molecule is octahedral
C. The electron geometry for this molecule is octahedral
D. The molecular geometry for this molecule is square pyramidal
E. The electron geometry for this molecule is square pyramidal

19. Consider the following bonds: Br—I, Te—Br, As—Cl, and P—S. Which of the following bonds is most polar based on periodic trends?

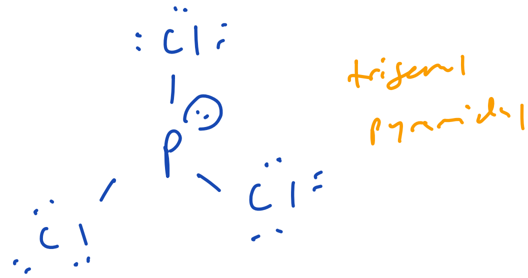
C

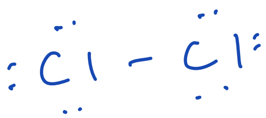
A. Br—I
B. Te—Br
C. As—Cl
D. P—S
E. Polarity cannot be determined in the absence of quantitative values assigned to each element

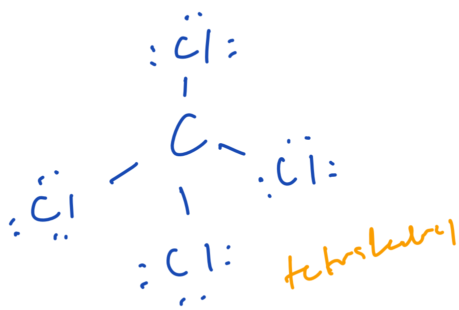
20. Which of these molecules have an overall dipole moment? Select all that apply.

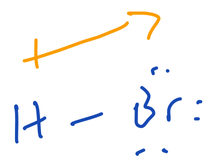
$\boxed{ADE}$

A. H_2O
B. Cl_2
C. CCl_4
D. PCl_3
E. HBr





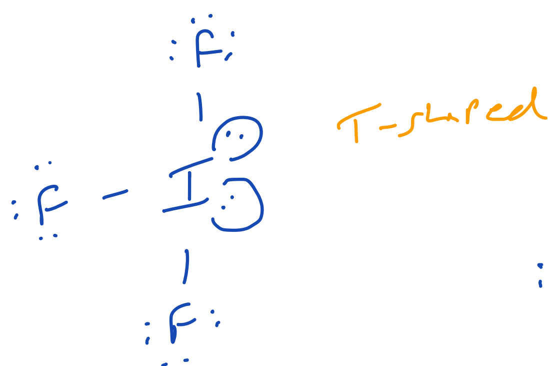


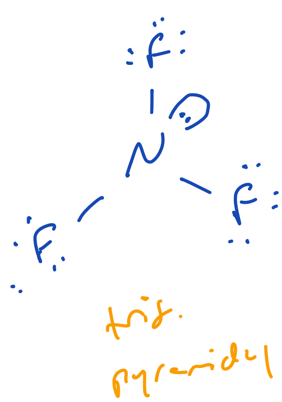


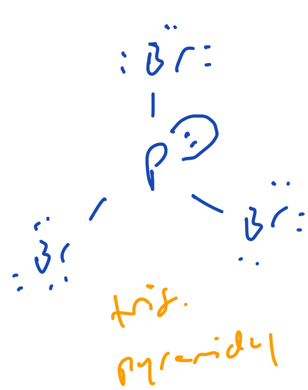
21. Of the molecules below, only _________ is nonpolar.

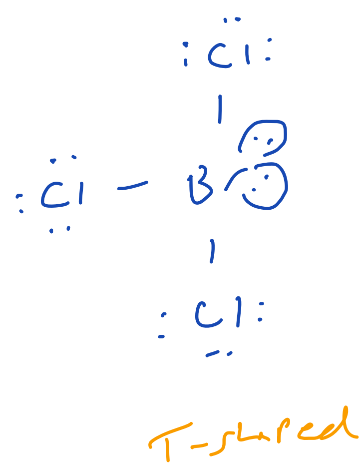
$\boxed{A}$

A. BF_3
B. NF_3
C. IF_3
D. PBr_3
E. $BrCl_3$



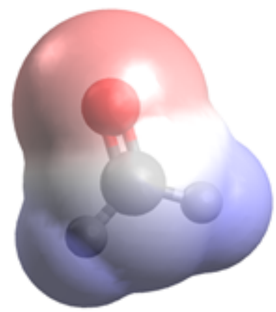






22. The following electrostatic potential map below has a significant difference in color. It shows a ___________ molecule.

A



A. Polar
B. Nonpolar
C. Ionic
D. Stoichiometric

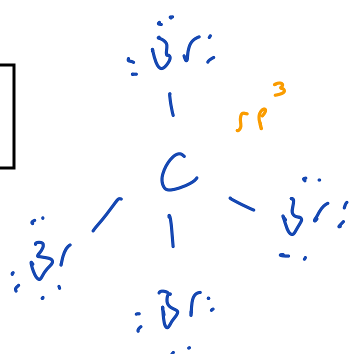
23. What is true of hybrid orbitals?

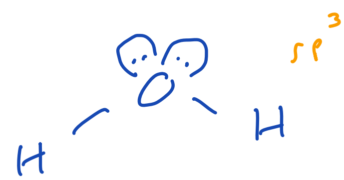
C

A. They can only form from s and p orbitals
B. They only appear in organic compounds
C. They are both an average of the shapes and energy levels of the orbitals that form them
D. They result in the same bond angles as unhybridized orbitals
E. They are involved in pi bonds

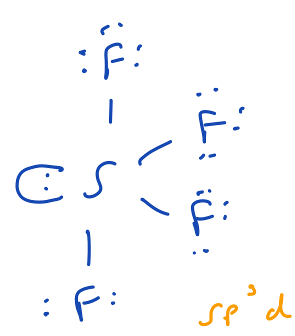
24. Which of the following molecules have sp^3 hybridization on the central atom? Select all that apply.

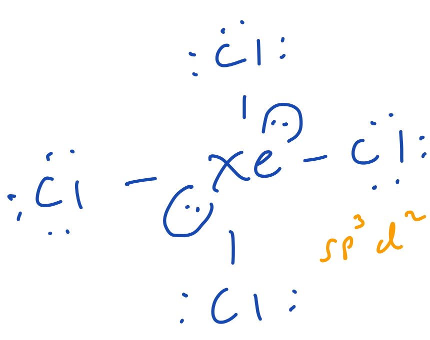
BD





A. C_2H_2
B. CBr_4
C. $XeCl_4$
D. H_2O
E. SF_4



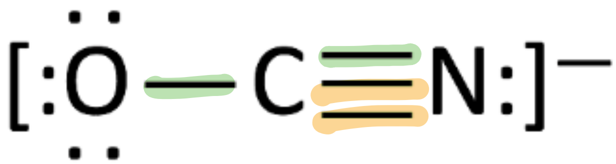


25. According to hybrid orbital theory, a triple bond consists of:

C

A. 1 sigma bond and 1 pi bond
B. 2 sigma bonds and 1 pi bond
C. 1 sigma bond and 2 pi bonds
D. 2 sigma bonds and 2 pi bonds
E. 3 pi bonds

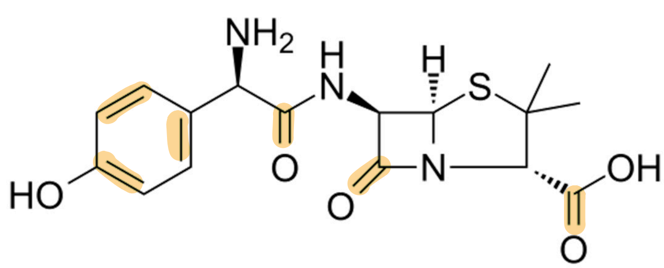
26. How many sigma and pi bonds are shown in the structure below? Answer with an integer (e.g. 1).



I. Sigma: 2

II. Pi: 2

27. The Lewis structure for amoxicillin, a commonly prescribed antibiotic, is provided below. How many pi bonds are present in this molecule? Answer with an integer (e.g. 1).



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28. Which of the following depicts a (singular) sp hybrid orbital?

C

A.

B.

C.

D.

29. Bond formation ______________ energy; it is an _______________ process.

D

A. requires, endothermic
B. requires, exothermic
C. releases, endothermic
D. releases, exothermic
E. releases, hybridized

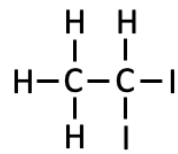
30. Using the table of average bond energies below, the ΔH for the reaction is ______ kJ/mol.

H - C≡C - H   H - I:

$$C_2H_2\ (g) + 2\ HI\ (g) \rightarrow C_2H_4I_2$$

Bonds	C-C	C=C	C≡C	C-H	C-I	H-I
Energies (kJ/mol)	348	614	839	413	240	299

Hint: the Lewis structure for $C_2H_4I_2$ is given here:

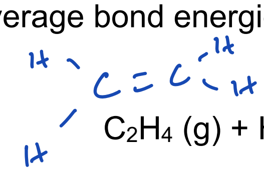


$\boxed{C}$

A. +160
B. -160
C. -217
D. -63
E. +63

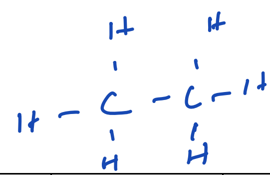
[1 mol (2 × 413 kJ/mol) + 1 mol (1 × 839 kJ/mol) + 2 mol (1 × 299 kJ/mol)] − [1 mol (4 × 413 kJ/mol) + 1 mol (2 × 240 kJ/mol) + 1 mol (1 × 348 kJ/mol)]

31. Using the table of average bond energies below, the ΔH for the reaction is ______ kJ/mol.



H - H

$$C_2H_4\ (g) + H_2\ (g) \rightarrow C_2H_6$$



Bonds	C-C	C=C	C≡C	C-H	C-I	H-H
Energies (kJ/mol)	348	614	839	413	240	436

$\boxed{A}$

A. -124
B. +98
C. +700
D. -102
E. -166

[1 mol (4 × 413 kJ/mol) + 1 mol (1 × 614 kJ/mol) + 1 mol (1 × 436 kJ/mol)]

− [1 mol (6 × 413 kJ/mol) + 1 mol (1 × 348 kJ/mol)]

32. The value of $\Delta H°$ for the reaction below is -3351 kJ. The value of $\Delta H°_f$ for Al_2O_3(s) is _________ kJ.

$$2\ Al\ (s) + 3\ O_2\ (g) \rightarrow 2\ Al_2O_3\ (s)$$

$\boxed{-1676}$ kJ

$$\frac{-3351\ kJ}{2}$$

33. Hydrogen gas and bromine gas react to form hydrogen bromide gas. What is the change in heat of the system (kJ) when 155 grams of HBr (MW = 80.91 g/mol) is formed in this reaction?

$$H_2\ (g) + Br_2\ (g) \rightarrow 2\ HBr\ (g) \qquad \Delta_rH° = -72\ kJ/mol$$

$\boxed{-69}$ kJ

$$155\ g\ HBr \left(\frac{mol}{80.91\ g}\ HBr\right)\left(-\frac{72\ kJ}{2\ mol}\right)$$

34. A student goes to the lab to perform the balanced reaction below using 7.22 g of highly reactive potassium metal and (14.59 mL iodine monochloride (d = 3.24 g/cm³)).
Upon completion, what was the change in heat of the reaction?

↳ m = 47.2716 g

$$2\ K\ (s) + ICl\ (l) \rightarrow KCl\ (s) + KI\ (s) \qquad \Delta_rH° = -65.2\ kJ/mol$$

$\boxed{-6.02}$ kJ

$$7.22\ g\ K \left(\frac{mol}{39.10\ g}\right)\left(\frac{1\ mol\ KCl}{2\ mol\ K}\right) =$$

0.0923274 mol KCl
(limiting)

$$47.2716\ g\ ICl \left(\frac{mol}{162.35\ g}\ ICl\right)\left(\frac{1\ mol\ KCl}{1\ mol\ ICl}\right) =$$

0.291171 mol KCl

0.0923274 mol KCl
(limiting) $\left(-\frac{65.2\ kJ}{mol}\right)$

35. A tank was filled with hydrogen gas at 1.01 atm and 27.3 °C. If the entire tank was carefully burned to exhaustion in the presence of excess oxygen gas based on the balanced equation below, and 2876 kJ of heat was emitted, what was the original volume of gas in the container? Report your answer in liters.

$$H_2 (g) + \tfrac{1}{2} O_2 (g) \rightarrow H_2O (l) \qquad \Delta_r H° = -286 \text{ kJ/mol}$$

245	L

$-2876 \text{ kJ} \left(\frac{\text{mol}}{-286 \text{ kJ}} \right) = 10.0559406 \text{ mol}$

$PV = nRT$

$(1.01 \text{ atm})(V) = (\ \ )(0.08206 \frac{\text{L atm}}{\text{mol K}})(27.3 + 273.15)\text{K}$

36. With the information below, what is ΔH_{rxn} for $CH_4 (g) + NH_3 (g) \rightarrow HCN (g) + 3 H_2 (g)$?

256.0	kJ/mol

$N_2 (g) + 3 H_2 (g) \rightarrow 2 NH_3 (g)$	ΔH_{rxn} = -91.8 kJ/mol	switch; × 1/2
$C (s) + 2 H_2 (g) \rightarrow CH_4 (g)$	ΔH_{rxn} = -74.9 kJ/mol	switch
$H_2 (g) + 2 C (s) + N_2 (g) \rightarrow 2 HCN (g)$	ΔH_{rxn} = 270.3 kJ/mol	× 1/2

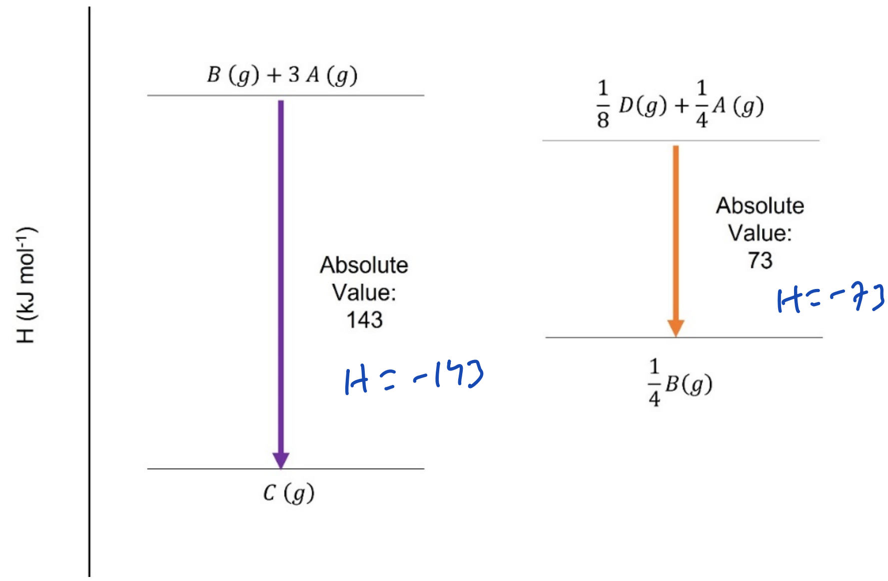
$NH_3 (g) \rightarrow \frac{1}{2} N_2 (g) + \frac{3}{2} H_2 (g)$

$CH_4 (g) \rightarrow C (s) + 2 H_2 (g)$

$\frac{1}{2} H_2 (g) + C (s) + \frac{1}{2} N_2 (g) \rightarrow HCN (g)$

$(+45.9 \text{ kJ/mol}) + (+74.9 \text{ kJ/mol}) + (135.15 \text{ kJ/mol})$

37. Given the following hypothetical reactions below...



what is ΔH_{rxn} for the reaction A (g) + 3 B (g) → D (g) + C (g)?

$\boxed{441}$ kJ/mol

$B_{(g)} + 3A_{(g)} \rightarrow C_{(g)}$

switch ×8

$\left(\frac{1}{8} D_{(g)} + \frac{1}{4} A_{(g)} \rightarrow \frac{1}{4} B_{(g)}\right)$

$(-143\ \text{kJ/mol}) + (-8 \times -73\ \text{kJ/mol})$

$2B_{(g)} \rightarrow D_{(g)} + 2A_{(g)}$

$B_{(g)} + 3A_{(g)} \rightarrow C_{(g)}$

$A_{(g)} + 3B_{(g)} \rightarrow C_{(g)} + D_{(g)}$

38. Of the following, $\Delta H°_f$ is **not** zero for ________.

$\boxed{D}$

A. O_2 (g)
B. C (graphite)
C. N_2 (g)
D. F_2 (s)
E. Cl_2 (g)

39. Consider the balanced reactions provided below. Which of the following are standard formation reactions? Select all that apply.

$\boxed{\text{A F}}$

A. $C\ (s) + 2\ H_2\ (g) \rightarrow CH_4\ (g)$
~~B.~~ $2\ C\ (s) + 4\ H_2\ (g) \rightarrow 2\ CH_4\ (g)$
~~C.~~ $2\ CO\ (g) + O_2\ (g) \rightarrow 2\ CO_2\ (s)$
~~D.~~ $CO\ (g) + \frac{1}{2}\ O_2\ (l) \rightarrow CO_2\ (g)$
~~E.~~ $H_2\ (g) + \frac{1}{2}\ O_2\ (g) \rightarrow H_2O\ (g)$
F. $H_2\ (g) + \frac{1}{2}\ O_2\ (g) \rightarrow H_2O\ (l)$
~~G.~~ $H_2\ (g) + \frac{1}{2}\ O_2\ (l) \rightarrow H_2O\ (l)$
~~H.~~ $2\ H_2\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (l)$
~~I.~~ $CaO\ (s) + CO_2\ (g) \rightarrow CaCO_3\ (s)$

40. Calculate $\Delta_r H°$ for the reaction below using standard enthalpies of formation provided in the table below.

$\rightarrow \Delta H°_f = 0$

$$4\ NH_3\ (g) + 5\ O_2\ (g) \rightarrow 6\ H_2O\ (g) + 4\ NO\ (g)$$

Substance	$\Delta H°_f$ (kJ/mol)
NH_3 (g)	-45.9
NO (g)	+91.3
H_2O (g)	-241.8

$\boxed{-902}$ kJ

$$\left[(6\ \text{mol} \times -241.8\ \text{kJ/mol}) + (4\ \text{mol} \times 91.3\ \text{kJ/mol})\right]$$
$$-\left[(5\ \text{mol} \times 0) + (4\ \text{mol} \times -45.9\ \text{kJ/mol})\right]$$

$\Delta H^\circ_f = 0$

41. Given the data in the table below, determine $\Delta_r H^\circ$ for the reaction.

$$4\ NH_3\ (g) + 5\ O_2\ (g) \rightarrow 4\ NO\ (g) + 6\ H_2O\ (l)$$

Substance	ΔH°_f (kJ/mol)
H_2O (l)	-286
NO (g)	+90
NO_2 (g)	+34
HNO_3 (aq)	-207
NH_3 (g)	-46

$\boxed{A}$

A. -1172
B. -150
C. -1540
D. -1892

$$\left[(4\ mol \times 90\ kJ/mol) + (6\ mol \times -286\ kJ/mol)\right]$$

$$-\left[(4\ mol \times -46\ kJ/mol) + (5\ mol \times 0)\right\}$$