STUDENTS OFFERING SUPPORT

CHEM 1000
Exam-AID
Final Review Package

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Preface

This document was created by the York University chapter of Students Offering Support (York SOS) to accompany our CHEM 1000 Exam-AID session. It is intended for students enrolled in any section of CHEM 1000- "Chemical Strucure" SU2011 CHEM 1000 course who are looking for an additional resource to assist their studies in preparation for the exam.

Contents

What is Students Offering Support?

Students Offering Support is a national network of student volunteers working together to **raise** funds to **raise** the quality of education and life for those in developing nations through **raising** marks of our fellow University students.

This is accomplished through our Exam-AID initiative where student volunteers run group review sessions prior to a midterm or final exam for a $20 donation.

All of the money raised through SOS Exam-AIDs is funneled directly into sustainable educational projects in developing nations. Not only does SOS fund these projects, but SOS volunteers help build the projects on annual volunteer trips coordinated by each University chapter.

Tips for General Midterm Success

Use mnemonics to remember concepts better. An example of a mnemonic would be acronyms.

Do practice multiple choice questions. Doing these practice questions can assess your understanding of what you!ve learned and can help you identify areas of weakness. Practice multiple choice questions are found in textbooks, on textbook companion websites, and/or provided by your professor.

Read a multiple choice question and try to answer it BEFORE looking at the possible answers. Having an answer in mind before looking at possible answers can reduce the chances of being fooled by wrong answers.

Use logic and process of elimination on multiple choice questions. For example, if you know that answer A is wrong, then logically an answer “A and B are correct” in the same question must also be incorrect. When you don!t know the answer, eliminating wrong answers (as opposed to just random guessing) can increase your chances of getting the question right.

Practice writing answers to short answer questions. If you know ahead of time what the questions will be on the short answer section, make a list of essential points you want to include in each answer and practice writing the answer on paper. If you don!t know what questions will be on the short answer section, you could try scanning the material to identify concepts that have enough content to be a possible short answer question. Again, you can make a list of essential points you want to include in each answer and practice writing the answer on paper. Even if the question you thought of doesn!t show up on the short answer section, doing this can help solidify what you learned.

Don’t spend too much time on a difficult question. It is better to move onto easier questions to ensure getting those marks than to get hung up on a difficult question, especially when time is limited.

Get adequate sleep the night before your test. Sleeping at night helps consolidate what you learned during the day into memory so that it is better remembered in future. Not only does staying up late the night before a test destroy your concentration during the test the next day, but your brain has not effectively learned the material.

SOS EXAM PACKAGE

GASES

$C_3H_8(g) + 5\ O_2(g) \rightarrow 3\ CO_2(g) + 4\ H_2O(g)$

6.4 L of propane and 32.0 L of oxygen were placed in a 38.4 L cylinder at 1.00 atm and 25 °C. The gaseous mixture was ignited with a spark, producing the gaseous products at 540 °C. Calculate the final pressure of the product gas mixture in the cylinder at 540 °C assuming the reaction went to completion and the cylinder did not change volume.

$$\frac{PV}{RT} = \frac{nRT}{RT}$$

$$n = \frac{PV}{RT}$$

$$n = \frac{(1\ atm)(38.4\ L)}{\left(0.08206\ \frac{atm \cdot L}{K \cdot mol}\right)(298\ K)}$$

$25 + 273 = 298\ K$

$n = 1.57\ mol$ (1)

$$\frac{n_p}{n_r} = \frac{7}{6} = 1.167 \quad (2)$$

∴ (1) × (2) = total moles of product

$(1.57)(1.167) = 1.832$

$PV = nRT$

$$P = \frac{nRT}{V}$$

$$P = \frac{(1.832)(0.08206)(813\ K)}{38.4\ L}$$

$P = 3.18\ atm$

2. Calculate the density of water at 1.2 atm and 37 C?

$$d = \frac{m}{V}$$

$$n = \frac{m}{MM}$$

$MM_{water} = 18\ g/mol$

$P = 1.02\ atm$

$37 + 273 = 310\ K$

$PV = nRT$

$$PV = \frac{mRT}{MM}$$

$$P = \frac{m}{V}\frac{RT}{MM}$$

$$P = \frac{dRT}{MM}$$

$$d = \frac{MM\,P}{RT}$$

$$d = \frac{\left(18\ \frac{g}{mol}\right)(1.02\ atm)}{\left(0.08206\ \frac{L \cdot atm}{K \cdot mol}\right)(310\ K)}$$

$$d = \frac{18.36}{25.4381} = 0.72\ \frac{g}{mol}$$

3. Calculate the rate of effusion for gaseous mercury, Hg(g), through a hole with a diameter of 0.025 mm if the gaseous mercury is present at a temperature of 30°C and a pressure of 2.78×10^{-3} mmHg.

$$rate = Z_w \times A$$

$$A = \pi r^2 = \pi\left(\frac{0.025\,mm}{2} \times \frac{1\,m}{1000\,mm}\right)^2$$

$$A = 4.91 \times 10^{-10}\ m^2$$

$$PV = nRT \qquad n = \frac{N}{N_A}$$

$$\frac{PV}{V} = \frac{NRT}{N_A V}$$

$$\frac{PN_A}{RT} = \frac{N}{V}$$

$$\frac{(2.78 \times 10^{-3})(1.013 \times 10^{3})}{(1.3806 \times 10^{-23})(303.15)}$$

$$\frac{N}{V} = 8.853 \times 10^{19}\ m^{-3}$$

$$Z_w = \frac{1}{4}\frac{N}{V}\sqrt{\frac{8RT}{\pi M}}$$

$$= \frac{1}{4}\frac{N}{V}\sqrt{\frac{8(8.3143)(303.15)}{\pi(200 \times 10^{-3})}}$$

$$= \frac{1}{4}\left(\frac{N}{V}\right)(178.9\ \tfrac{m}{s})$$

$$= \frac{1}{4}(8.853)(178.9)$$

$$Z_w = 3.959 \times 10^{21}\ m^{-2}\ s^{-1}$$

$$rate = Z_w \times A$$

$$= (3.959 \times 10^{21})(4.91 \times 10^{-10})$$

$$rate = 1.9 \times 10^{12}\ s^{-1}$$

4. The inside of a basketball is at STP and it weighs 20g, what is the volume of the basketball if the basketball is filled with oxygen gas?

$$n = \frac{m}{MM} = \frac{20\,g}{32\,g/mol} = 0.625\,mol$$

AT STP

$$\frac{1\,mol}{0.625\,mol} = \frac{22.4\,L}{x}$$

$$x = 14\,L$$

5. At 293 K, a 105 mL container holds 0.52g of a substance with a pressure of 0.987 atm. Calculate the molar mass of this substance?

$P = 0.987 atm$

$T = 293 K$

$V = 105 mL \rightarrow 0.105 L$

$m = 0.52 g$

$n = \frac{m}{MM}$

$PV = nRT$

$PV = \frac{mRT}{MM}$

$MM = \frac{mRT}{PV}$

$MM = \frac{(0.52 g)(0.08206 \frac{L\cdot atm}{K\cdot mol})(293 K)}{(0.987 atm)(0.105 L)}$

$\boxed{MM = 120 g/mol}$

6. A helium tank has a pressure of 1.83×10^3 KPa at 299 K and has a volume of 430 L. How many balloons can one tank fill if the volume of a balloon is 1.5L at 299K and the pressure inside the balloon is 1.02 atm?

(1) $PV = nRT$

$n = \frac{PV}{RT}$

$= \frac{(1.83 \times 10^3 kPa)(\frac{1 atm}{101 kPa})(430 L)}{(0.0820 \frac{atm\, L}{mol\cdot K})(299 K)}$

$\boxed{n = 317.55}$

(2) $PV = nRT$

$V = \frac{nRT}{P}$

$V = \frac{(317.55)(0.08)(299)}{1.02}$

$\boxed{V = 7638.3}$

$\frac{1.5}{1} = \frac{7638.3}{x}$

$\boxed{x = 5100}$

7. **Show mathematically which noble gad has the highest density at STP?**

same as example (2)

$$PV = nRT$$

$$\frac{m}{V} = d$$

$$n = \frac{m}{MM}$$

$$\frac{PV}{V} = \frac{mRT}{MM\,V}$$

$$\frac{P\,MM}{RT} = \frac{m}{V}$$

$$\boxed{d = \frac{P\,MM}{RT}}$$

at STP

$$d = \frac{(1)(MM)}{(298)(0.08)}$$

all depends on MM

8. **The surface of Mars has an average temperature of 200 K and a atmospheric pressure of 500 Pa. If a 5.00 L sample was collected in a balloon under these conditions and then returned to a laboratory on Earth at 298 K and 1 atm, what would be the volume of this ballon?**

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{P_1 V_1 T_2}{P_2 T_1} = \frac{P_2 V_2 T_1}{P_2 T_1}$$

$$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1}$$

$$= \frac{(500)(5)(200)}{(1)(101300)(298)} = \boxed{0.17}$$

1. If 5.25 g of ice at 0.0°C is placed in 25.63 g of liquid water at 28.0°C, what will be the final temperature of this mixture? You may assume that no heat is exchanged with the container in which these items are located nor is heat exchanged with anything outside of the container.

heat gained = -heat lost

heat gained = $q(H_2O_{(s)}$ @ 0°C to $H_2O_{(l)}$ @ 0°C$) + q[m \cdot c \cdot \Delta T]$

$= [5.25\ g] \times [333\ \frac{J}{g}] + [5.25 \times 4.184 \times (T_f - 0)]$

$= 1748.85\ J + 21.966\ T_f$

heat lost = $mc\Delta T$

$= (25.63) \times (4.184) \times (T_f - 28)$

$= 107.231(T_f - 28)$

$1748.25 + 21.966\ T_f = -107.23\ (T_f - 28)$

$129.2\ T_f = 1254.31$

$T_f = 9.7°C$

2. Using the information in your book calculate the standard enthalpy of combustion per mol of benzene. The products are in gaseous state.

$$C_6H_6(l) + \frac{15}{2} O_2(g) \rightarrow 6\,CO_2(g) + 3\,H_2O(g)$$

49   -393.5   -241.8

$$\Delta H_f = 6(-393.5) + 3(-241.8) - [(49)(1) + 0]$$

$$\boxed{\Delta H_c = -3135 \frac{KJ}{mol}}$$

3. The human body id simultaneously heated by metabolic and cooled by evaporating perspiration, maintaining a normal temperature of 36.8 C. If a 66Kg woman's body temperature was to increase to 38.9 C, what of water would she need to perspire to bring her temperature back down to 36.8 C? Assume the specific heat of a human is the same as that of water, all the cooling is done by evaporation of sweat. H= 44.0KJ/mol

$$-\Delta H_{gained} = \Delta H_{lost} \qquad n = \frac{m_{water}}{MM}$$

$$-mC\Delta T = n\,\Delta H_{vap}$$

$$-(66\,kg)\left(4.184 \frac{J}{g \cdot C^\circ}\right)(-2.1)^\circ = \left(\frac{m_{water}}{18 \frac{g}{mol}}\right)\left(44.0 \frac{KJ}{mol}\right)$$

$$18\frac{g}{mol} \times \frac{-(66000\,g)\left(4.184 \frac{J}{g \cdot C}\right)(-2.1)}{44000 \frac{J}{mol}} = \frac{m_{water}}{18\,g/mol} \times 18\,g/mol$$

$$\boxed{m_{water} = 238\,g}$$

4. Calculate the ΔH for the following reaction:

$2\ B(s) + 3\ H_2(g) \rightarrow B_2H_6(g)$

given the following date:

$4\ B(s) + 3\ O_2(g) \rightarrow 2\ B_2O_3(s)$	$\Delta H_1 = -2546$ kJ
$B_2H_6(g) + 3\ O_2(g) \rightarrow B_2O_3(s) + 3\ H_2O(g)$	$\Delta H_2 = -2035$ kJ
$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l)$	$\Delta H_3 = -572$ kJ
$H_2O(l) \rightarrow H_2O(g)$	$\Delta H_4 = 44$ kJ

$$\Delta H_{rxn} = \frac{1}{2}\Delta H_1 - \Delta H_2 + \frac{3}{2}\Delta H_3 + 3\Delta H_4$$

$$= \frac{1}{2}(-2546) - (-2035) + \frac{3}{2}(-572) + 3(44)$$

$$\Delta H_{rxn} = 36\ kJ$$

check

$2\ B(s) + \frac{3}{2} O_2(g) \rightarrow B_2O_3$ $\quad \frac{1}{2}\Delta H_1 = -1273$ kJ

$B_2O_3 + 3H_2O(g) \rightarrow B_2H_6(g) + 3O_2$ $\quad -\Delta H_2 = 2035$ kJ

$3H_2 + \frac{3}{2}O_2(g) \rightarrow 3H_2O(l)$ $\quad \frac{3}{2}\Delta H_3 = -858$ kJ

$3H_2O(l) \rightarrow 3H_2O(g)$ $\quad 3\Delta H_4 = 132$ kJ

$3B(s) + 3H_2(g) \rightarrow B_2H_6(g)$ $\quad \Delta H = 36$ kJ

5. Define each term

a. open system allows exchange of matter and energy

b. closed system allows exchange of energy, but not matter [ΔU = 0]

c. isothermal process performed at constant temperature

d. adiabatic process No Heat exchange with surroundings

6. If 500.0 mL of 1.00 M $Ba(NO_3)_2(aq)$ solution at 25.0°C is mixed with 500.0 mL of 1.00 M $Na_2SO_4(aq)$ solution at 25.0°C in a "coffee-cup" calorimeter, the temperature of the mixture rises to 28.1°C and the white precipitate $BaSO_4$ forms according to the net ionic reaction

$$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$$

Calculate the enthalpy change for this reaction per mole of $BaSO_4$ formed. You may assume that no heat is lost to the calorimeter and that both the specific heat and the density of this mixture is the same as that of pure water.

$$n_{Ba^{2+}} = 0.5\ L \times 1.0\ \frac{mol}{L} = 0.5\ mol = n_{SO_4^{2-}} = n_{BaSO_4}$$

$$q = mC\Delta T$$

Total Volume = 500 mL + 500 mL = 1000 mL

$$m = 1000\ mL \times \frac{1\ g}{1\ mL} = 1000\ g$$

$$q = (1000)(4.184)(28.1 - 25)$$

$$\boxed{q = 12.97\ kJ}$$

$$\therefore \Delta H = -q_p = \frac{-12.97\ kJ}{0.5} = \boxed{-26\ kJ/mol}$$

SOS EXAM PACKAGE

1. **Calculate the emission wavelenght for a transition from n=5 to n=1 state of hyfrogen atom.**

$$E_n = \frac{-Z^2 R_H}{n^2} = \frac{-R_H}{n^2}$$

$$\Delta E_{5\to1} = R_H\left(1 - \frac{1}{25}\right) = 2.179\times10^{-17}(0.96)$$
$$= 2.09\times10^{-18}$$

$$E = h\nu = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E} = \frac{(6.626\times10^{-34})(2.99\times10^{8})}{(2.09\times10^{-18})} = \boxed{9.51\times10^{-8}\ m}$$

2. **The human eye can detect as little as 10 photons of green light wavelength of 510 in a totally darkened room. Calculate the total of energy in 10 photons of light at this wavelength**

$$E_{photon} = h\nu = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34})(2.998\times10^{8})}{510\times10^{-9}}$$

$$E_{phot.} = 3.895\times10^{-19}\ J/photon$$

$$E = 10E_{photon}$$
$$= (10)(3.895\times10^{-19})$$

$$\boxed{E = 3.9\times10^{-18}}$$

3. An excited hydrogen atom with an electron in the n = 5 state emits light with a frequency of 6.90 X 10^{14} s^{-1}. Calculate the principal quantum level for the final state in this electronic transition.

$$\Delta E = E_f - E_i = \frac{-R_H}{n_f^2} - \left(\frac{-R_H}{n_i^2}\right) = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

for emission $\Delta E = \ominus$

$$\Delta E = -h\nu$$

$$-h\nu = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

$$\frac{-h\nu}{R_H} = \frac{1}{n_i^2} - \frac{1}{n_f^2}$$

$$\frac{-(6.9\times10^{14})(6.626\times10^{-34})}{(2.179\times10^{-18})} = \frac{1}{25} - \frac{1}{n_f}$$

$n_f = 2$

4 For easy of the following elements write the electron configuration

a. Hg [Xe] $4f^{14}$ $5d^{10}$ $6s^2$

b. Co [Ar] $3d^7$ $4s^2$

c. Ag [Kr] $4d^{10}$ $5s^1$

d. P [Ne] $3s^2 3p^3$

e. He $1s^2$

f. Os [Xe] $4f^{14}$ $5d^6$ $6s^2$

g. Gd [Xe] $4f^{7}$ $5d^1$ $6s^2$

a. Rank these atoms in order of increasing atomic radius: O, S, and F

F < O < S

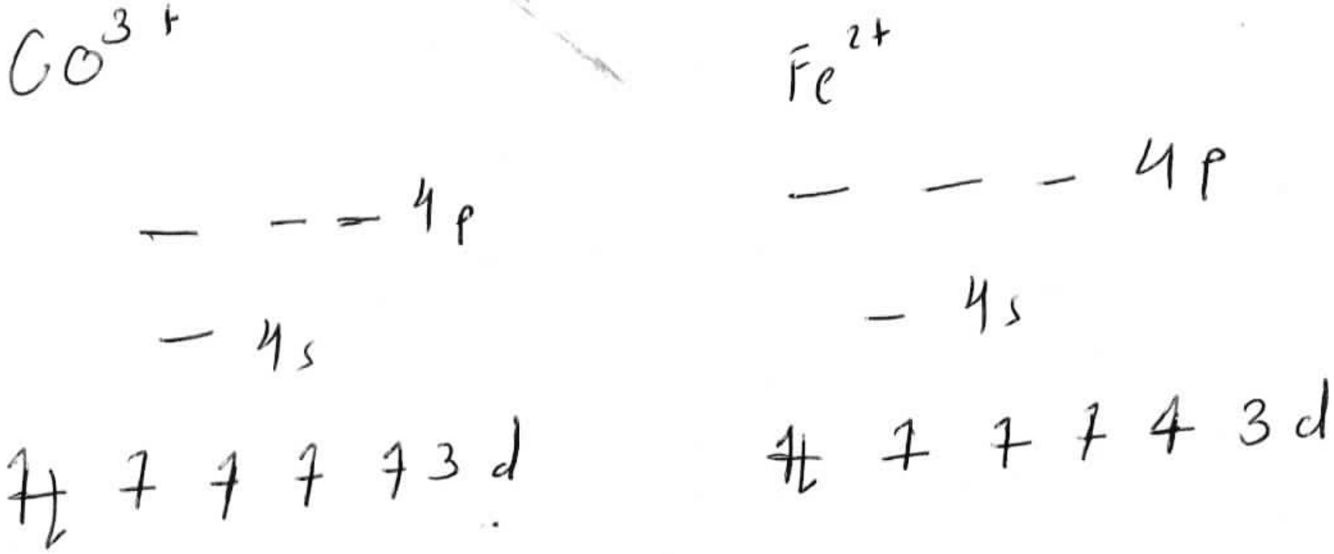
b. Rank these atoms in order of increasing ionization energy: O, S, and F

S < O < F

c. Rank these species in order of increasing atomic radius: Ne, O^{2-}, Na^{+}, F^{-}

Na < Ne < F^{-} < O^{2-}

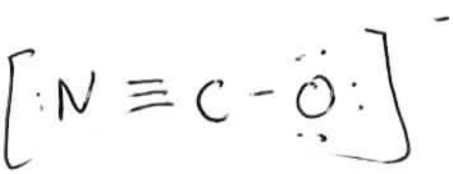
6. Draw the valence orbrital energy level diagram for Co^{3+} ion and Fe^{2+} ion



SOS EXAM PACKAGE

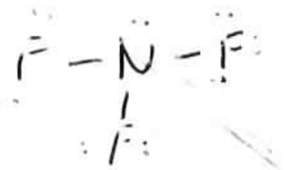
1. **Draw lewis sturtures for the following and determine the angle and shape of the compound**

NCO^-



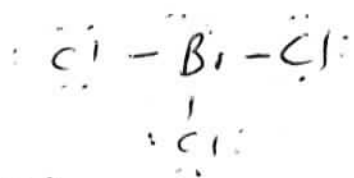
180° linear

NF_3



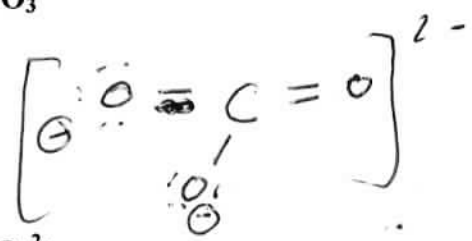
109.5° trigonal pyramidal

$BrCl_3$



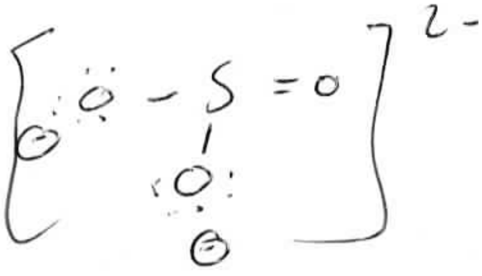
90° T-shaped

CO_3^{2-}



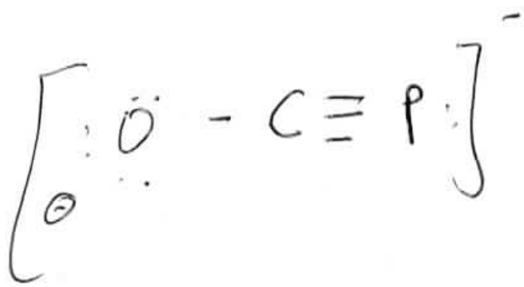
120° Trigonal planar

SO_3^{2-}



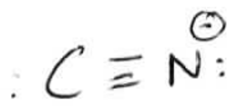
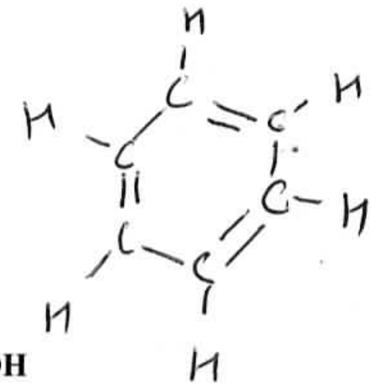
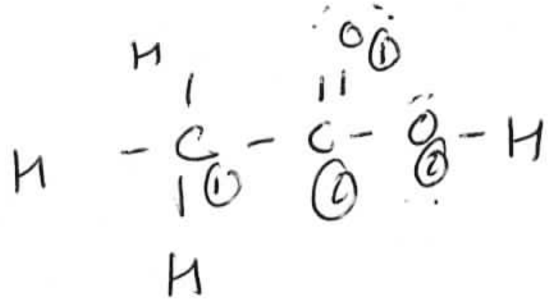
120° Trigonal planar

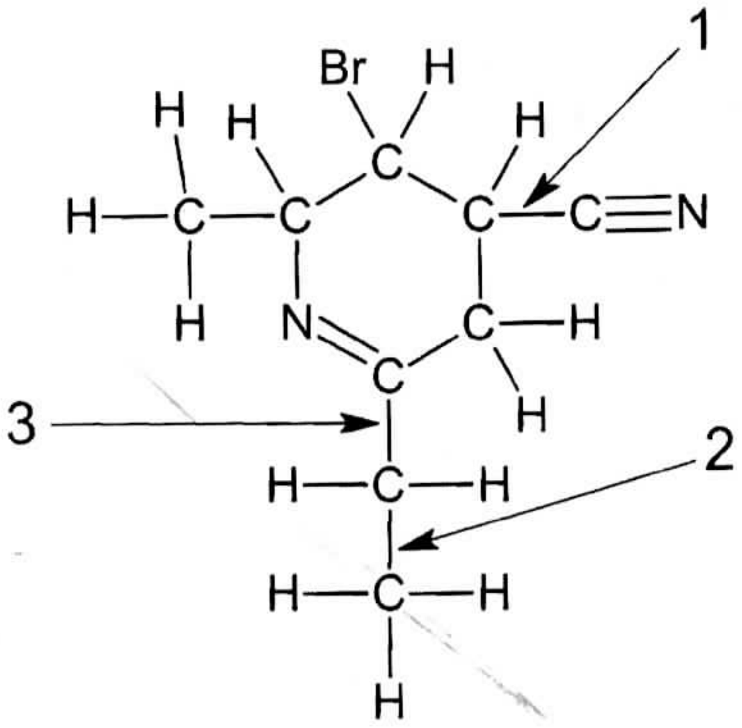
OCP^-



180° linear

2. **Draw and example which one of these compounds have a dipole and also write there hybridization**

		dipole	hybridization
H_2O		yes	$sp^3 \to O$
NH_3		yes	$sp^3 \to N$
H_2S		yes	$sp^3 \to S$
CN^-		yes	$sp \to C$ $sp - N$
C_6H_6		NO	$sp^2 \to C$
CH_3COOH		yes	$sp^3 \to C_1$ $sp^2 \to C_2$ $sp^2 \to O_1$ $sp^3 \to O_2$



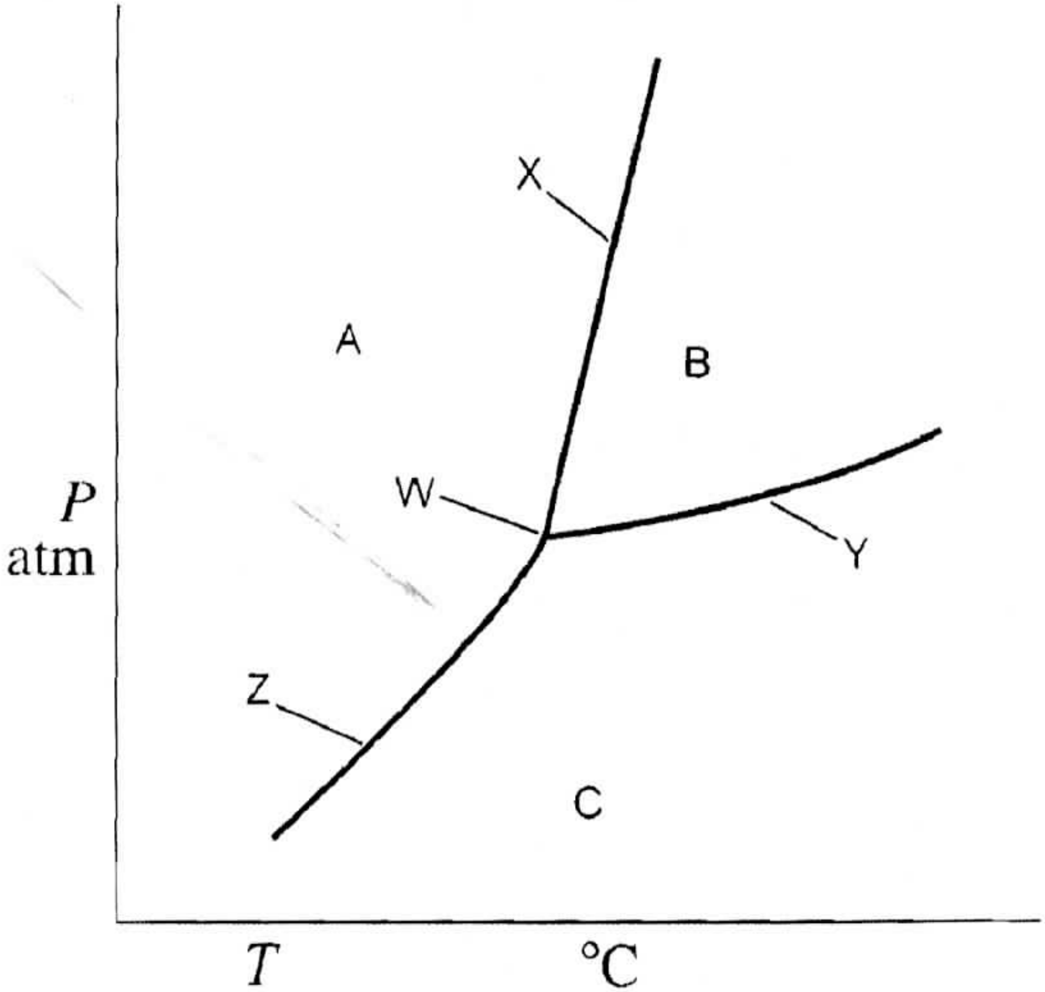
How many pie bonds are in the compound (3)

How many sigma bonds are there between carbon atoms in this compound (8)

Name the two orbitals that overlap to form the bond labelled by arrow 1. $sp^3 - sp$

Name the two orbitals that overlap to form the bond labelled by arrow 2. $sp^3 - sp^3$

Name the two orbitals that overlap to form the bond labelled by arrow 3. $sp^3 - sp^2$



1. What is the state of

A. solid

B. liquid

C. gas

2 Where is the triple point W

3 Explain

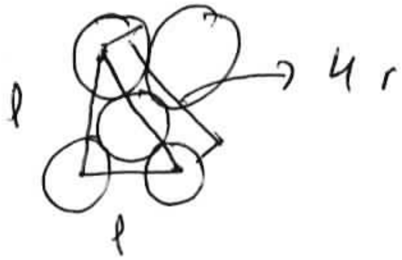
X fusion

Y Vapour pressure

Z Sublimation

4 **Sodium has a face-centred cubic unit cell. The density of Sodium is 1.53 g/cm^3. Calculate the atomic radius of Sodium**

in a fcc unit cell



# of atoms

$= 6 \times \frac{1}{2} + 8 \times \frac{1}{8}$

$= 3 + 1$

$= 4$ atom

$l^2 + l^2 = (4r)^2$

$2l^2 = 16r^2$

$l^2 = 8r^2$

$r = \frac{l}{\sqrt{8}}$

mass of Ca atoms in unit cell

$= \frac{4 \text{ atoms} \times 40.08 \text{ g/mol}}{6.02 \times 10^{23} \text{ atom/mol}}$

$m = 2.662 \times 10^{-22}$ g

$d = \frac{m}{v}$

$v = \frac{m}{d}$

$= \frac{2.662 \times 10^{-22}}{1.53}$

$v = 1.724 \times 10^{-22}$ cm^3

$v = l^3$

$l = \sqrt[3]{v}$

$l = \sqrt[3]{1.724 \times 10^{-22}}$

$l = 5.571 \times 10^{-8}$ cm

5. Given the following information for water

- enthalpy of vapourization is 44.0 kJ/mol
- enthalpy of fusion is 6.01 kJ/mol
- normal boiling point is 100.00°C
- normal melting point is 0.00°C

what is the boiling point of water if the atmospheric pressure is 520.0 torr?

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{-\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

N.B = P = 760, T = 100

$$\ln\left(\frac{520}{760}\right) = \frac{-44\times10^3}{8.314}\left(\frac{1}{T_2} - \frac{1}{373.15}\right)$$

$$-0.37949 = -5292\left(\frac{1}{T_2} - \frac{1}{373.15}\right)$$

$$\frac{-0.37949}{-5292} + \frac{1}{373.15} = \frac{1}{T_2}$$

$$\frac{1}{T_2} = 2.7511\times10^{-3}$$

$$\boxed{T_2 = 363.4K}$$