Chemistry 1035 Test 2 Jordan, Fall 1998

Mark the best answer for each question on the opscan. Please read all of the answers for each question. Turning in the opscan sheet signifies compliance with the honor code.

Mark Form A on your opscan

$R = 0.0821$ (l atm)/(mol K) and 8.31 J/(mol K) and 8.31×10^3 (g m^2)/(s^2 mol K)
$E_{ave} = (3R/2N_A) \times T$, $u = (3RT/MW)^{1/2}$, $PV = nRT$,
$\nu = c/\lambda$, $E = h\nu$, $h = 6.626 \times 10^{-34}$ Js, $E_n = -R_H/n^2$, $\Delta E = R_H(1/(n_1)^2 - 1/(n_2)^2)$

(1) What volume of 0.375 M HNO_3 would you have to add to react with 35 mL of 0.125 M of $Ca(OH)_2$?

(a) 11.7 mL
(b) 23.3 mL
(c) 1.34 mL
(d) 2.66 mL
(e) none of the above

(2) What is the appropriate net acid-base equation to write for the reaction between HF and NaOH

(a) $H^+ + OH^- \rightarrow H_2O$
(b) $HF + OH^- \rightarrow H_2O$
(c) $HF + OH^- \rightarrow H_2O + F^-$
(d) $H^+ + NH_3 \rightarrow NH_4^+$
(e) none of the above.

(3) Which of the following are oxidations?

1. $Zn \rightarrow Zn^{2+}$ oxidation
2. $ClO_4^- \rightarrow ClO_3^-$ $Cl^{7+} \rightarrow Cl^{5+}$ reduction
3. $CrO_4^- \rightarrow Cr(OH)_3$ $Cr^{7+} \rightarrow Cr^{3+}$ reduction
4. $Fe^{2+} \rightarrow Fe^{3+}$ oxidation
5. $N_2 \rightarrow 2\ NO_3^-$ $N^0 \rightarrow N^{5+}$ oxidation
6. $MnO_4^- \rightarrow Mn^{2+}$ $Mn^{7+} \rightarrow Mn^{2+}$ reduction

(a) 1, 3, and 6
(b) 2, 3, and 6
(c) 1, 4, and 5
(d) 1, 2, and 3
(e) none of the above

(4) What is the orbital hybridization of C in CO_3^{2-}

(a) sp (b) sp^2

(c) sp^3 (d) sp^3d

(5) Which of the following molecules does not have a dipole moment?

(a) NH_3 (b) BF_3

(c) HF (d) CO

(6) Which of the following molecules has a tetrahedral geometry?

(a) CH_4 (b) H_2O

(c) NH_3 (d) XeF_4

(7) Which of the following is an exception to the octet rule?

(a) CN^- (b) CO_2

(c) Cl_2 (d) AsF_5

(e) none of the above

(8) Which of the following has the largest radius?

(a) H^+ (b) C

(c) Ca (d) Te^{2-} large anion

(9) Which atom has the highest electronegativity?

(a) Si (b) Al

(c) Na (d) Cl

(10) If 4.70×10^{-19} J is the energy difference between two orbitals in an atom, what wavelength of light (λ) is needed to promote the transition between them?

(a) 423 nm (b) 429 nm

(c) 426 nm (d) 431 nm

(11) Which of the following transitions for the H atom is the lowest in energy?

(a) $n = 1 \rightarrow n = 2$ (b) $n = 2 \rightarrow n = 3$

(c) $n = 3 \rightarrow n = 5$ (d) $n = 3 \rightarrow n = 6$

(12) If you completely filled the n = 1, n = 2, and n = 3 principal levels (with all subshells and orbitals) with electrons, how many electrons would you have ?

(a) 18 (b) 22

(c) 28 (d) 30

(e) none of the above

(13) If l = 3, how many electrons can this subshel (sublevel) hold?

(a) 2 (b) 6

(c) 10 (d) 14

(e) none of the above

(14) Which of the following pairs have identical electron configurations?

(a) K and Sc^{3+} (b) C and O^{2-}

(c) Mn^{2+} and Fe^{3+} (d) Al^{3+} and S

(e) none of the above

(15) Which of the following has the ground state electron configuration

$1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$

(a) Sc (b) Mn^{2+}

(c) K^+ (d) V^{2+}

(e) none of the above

(16) If 3.00 moles of C_3H_8 and 15.0 moles of O_2 are combusted in a 50.0 L container at 298 K, what is the pressure in the container?

$C_3H_8 + 5\ O_2 \rightarrow 3CO_2 + 4\ H_2O$

(a) 6.85 atm (b) 3.4 atm

(c) 5.87 atm (d) 10.3 atm

(17) Which of the following statements is *false*

(a) Gases become less ideal as the temperature decreases.

(b) The volume of gas particles becomes significant at high pressures.

(c) At high pressures, attractive forces between gas molecules tend to make the actual volume of a gas less than would be predicted for an ideal gas.

(d) Gases become less ideal in their behavior as the volume increases.

(18) Which of the following gases has the highest average energy at RT?

(a) Xe (b) Cl_2

(c) NH_3 (d) H_2

(e) none of the above

$E_{ave} = \left(\frac{3k}{2N_A}\right)T$

E is dependent only on T

∴ all have the same E

(19) How many valence electrons are present in CCl_4?

(a) 4 (b) 7

(c) 32 (d) 28

(20) Which sample of gas would have the greatest mass at 1.00 atm and 293K?

(a) 2.00 L of NF_3 (b) 2.0 L of PH_3

(c) 2.0 L of CH_4 (d) 5.0 L of He

(21) Which gas would have the greatest rate of effusion?

(a) Br_2 (b) Cl_2

(c) C_2F_6 (d) PF_5

(22) Balance the following half reaction in acidic solution.

$MnO_4^- \text{----> } Mn^0$

(a) $MnO_4^- + 8\ H^+ + 7\ e^- \text{--> } Mn^0 + 4\ H_2O$ (b) $MnO_4^- + 8\ H^+ + 8\ e^- \text{--> } Mn^0 + 4\ H_2O$

(c) $MnO_4^- + 2H^+ + e^- \text{--> } Mn^0 + H_2O$ (d) $MnO_4^- + 8\ H^+ \text{ --> } Mn^0 + e^- + 4H_2O$

(23) Balance the following Oxidation-Reduction reaction

$Fe^{2+} + O^{2-} \text{---> } Fe + O_2$

(a) $Fe^{2+} + 2O^{2-} \text{---> } Fe + O_2$ (b) $3Fe^{2+} + 2O^{2-} \text{---> } 3Fe + O_2$

(c) $2Fe^{2+} + 2O^{2-} \text{---> } 2Fe + O_2$ (d) $2Fe^{2+} + 4O^{2-} \text{---> } Fe + 2O_2$

(24) What is the formal charge on C in CH_3O^-

(a) 0 (b) 1-

(c) 2- (d) 3-

(25) Schrodinger's view of the atom was different from Bohr's in the following way

(a) Electrons were neglected from the Schrodinger atom.

(b) There is no definite location of the electron in the Schrodinger atom. Only the probability of finding the electron can be known.

(c) Electrons are units of light in the Schrodinger atom.

(d) Electrons are tiny particles moving in circular orbits in the Schrodinger atom.

(e) none of the above

Form A Test 2

Solutions

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(1) $2\,HNO_3 + Ca(OH)_2 \rightarrow 2\,H_2O + Ca(NO_3)_2$

balanced equation

35 mL = 0.035 L $Ca(OH)_2$ 0.125 M = 0.125 $\frac{mol}{L}$

$0.035\,L \times 0.125\,\frac{mole}{L} = 4.38 \times 10^{-3}$ moles $Ca(OH)_2$

need 2x this num moles of HNO_3 (see equation)

$2 \times 4.38 \times 10^{-3}$ moles $= 8.75 \times 10^{-3}$ moles HNO_3

8.75×10^{-3} moles $\div$ 0.375 $\frac{mols}{L}$ = 0.0233 L

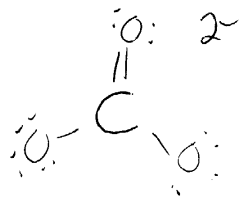
0.0233 L = 23.3 mL

(2) HF = weak acid NaOH = strong base

$\therefore HF + {}^-OH \rightarrow H_2O + F^-$

Form A Page 2

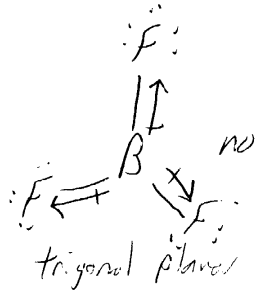
(4)



3 electron "pairs"
∴ trigonal planar
∴ sp^2

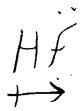
(5)

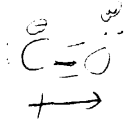
not dipole



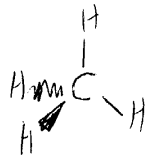
trigonal planar

no net dipole





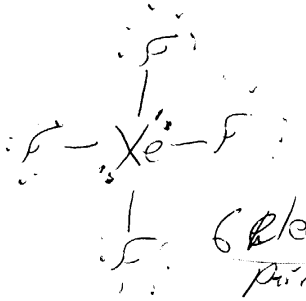
(6)



4 electron pairs
tetrahedral

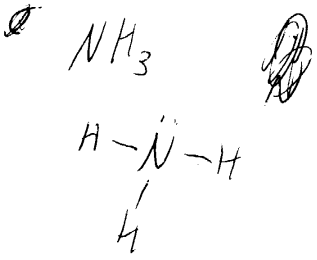
4 electron pairs
2 bonding pairs
bent

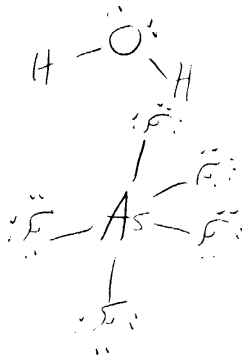
4 electron pairs
3 bonding pairs
pyramidal



6 electron pairs

(7)





10 electrons around As

(10) $E = h\nu$ $E = 4.70 \times 10^{-19} J = (6.626 \times 10^{-34} J\,s)\,\nu$

$\nu = 7.09 \times 10^{14} \frac{1}{s}$

$\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{8} \frac{m}{s}}{\lambda} = 7.09 \times 10^{14} \frac{1}{s}$

$\lambda = \frac{3.00 \times 10^{8} \frac{m}{s}}{7.09 \times 10^{14} \frac{1}{s}} = 4.23 \times 10^{-7} m$

$1 nm = 10^{-9} m$ $\quad 4.23 \times 10^{-7} m \times \frac{1 nm}{10^{-9} m} = 423 nm$

(11) $\Delta E = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

for $n=1$ to $n=2$ $\quad E = R_H \left(\frac{1}{1} - \frac{1}{4} \right) = 0.75 R_H$

for $n=2 \rightarrow n=3$ $\quad E = R_H \left(\frac{1}{4} - \frac{1}{9} \right) = 0.14 R_H$

for $n=3 \rightarrow n=5$ $\quad E = R_H \left(\frac{1}{9} - \frac{1}{25} \right) = 0.071 R_H$

for $n=3 \rightarrow n=6$ $\quad E = R_H \left(\frac{1}{9} - \frac{1}{\infty} \right) = 0.083 R_H$

Form A Page 5

(12) $n=1$ $\ell=0$ ∴ 1s orbital → 2 electrons

$n=2$ $\ell=0,1$ ∴ 2s, 2p orbitals → 8 electrons
$2e^-$, $6e^-$

$n=3$ $\ell=0,1,2$ 3s, 3p, 3d orbitals → 18 electrons
$2e^-$, $6e^-$, $10e^-$

28 electrons total

(13) $\ell=3$ ~~of~~ orbitals

$m_\ell = -3, -2, -1, 0, 1, 2, 3$

7 orbitals, $14e^-$

Form A Page 6

(15) normal energy ordering for an atom is

$1s\,2s\,2p\,3s\,3p\,\underline{4s}\,3d$ ∴ this is a transition metal cation.

V^{2+} $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$

V^0 $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$

(16) $C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$

3.00 moles, 15.00 moles, gases, 9 moles, 12 moles

∴ 9+12 = 21 moles of gas are present after combustion

V = 50.0 L, T = 298 K

$PV = nRT$

$P(50.0\,L) = (21\,moles)\left(0.082\,\frac{L\,atm}{mol\,K}\right)(298\,K)$

P = 10.3 atm

Form A Page 7

(18)

·C· 4 valence electrons

:Cl· 7 valence electrons

4 + 4(7) = 4 + 28 = 32 electrons

(20) 3 are in 2.0L of volume, same pressure.

Same temp = same # of moles

MW PH_3 = 34.0 MW of NF_3 = 71.01

MW CH_4 = 16.05

∴ NF_3 has the greatest mass for the same # of moles

$PV = nRT$ V = 2.0L P = 1atm T = 293K

$(1atm)(2.0L) = n\left(0.0821 \frac{Latm}{molK}\right)(293K)$

n = 0.083 moles

for V = 5.0L

$(1atm)(5.0L) = n\left(0.0821 \frac{Latm}{molK}\right)(293K)$

n = 0.208 moles

MW of He = 4.00 $\frac{g}{mole}$ $4.00 \frac{g}{mole} \times 0.208 moles = 0.83g$ He

mass of NF_3 = $0.083 moles \times 71.01 \frac{g}{mol} = 5.9g$

Form A Page 9

(21) $u = \left(\frac{3RT}{MW}\right)^{\frac{1}{2}}$ ∴ the gas with the lowest MW will be the fastest

Br_2 MW = 159.8 g/mol

Cl_2 MW = 68.9 g/mol ∴ Cl_2 is the fastest

C_2F_6 MW = 138 g/mol

PF_5 MW = 125.9 g/mol

(22) MnO_4^- → Mn^0 Mn balanced

Mn^{7+}

↓ add electrons to balance oxidation state

$MnO_4^- + 7e^- \rightarrow Mn^0$

↓ add H^+ to balance charge

$8H^+ + MnO_4^- + 7e^- \rightarrow Mn^0 +$ ~~$8H^+$~~

↓ add H_2O to balance H

$8H^+ + MnO_4^- + 7e^- \rightarrow Mn^0 + 4H_2O$

Form A Page 10

(23) $Fe^{2+} + O^{2-} \longrightarrow Fe + O_2$

Fe^{2+} O^{2-} Fe^{0} O^{0}

oxidation $O^{2-} \longrightarrow O_2$

reduction $Fe^{2+} \longrightarrow Fe$

balance oxidation

$O^{2-} \longrightarrow O_2$

↓ balance O

$2O^{2-} \longrightarrow O_2$

↓ add electrons to balance ox state

$2O^{2-} \longrightarrow O_2 + 4e^-$

charge balanced, A balanced

balance reduction

$Fe^{2+} \longrightarrow Fe$ Fe balanced

↓ add electrons

$Fe^{2+} + 2e^- \longrightarrow Fe$ balanced charge

balanced A

(23) cont

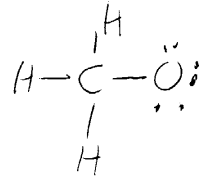
$$2O^{2-} \rightarrow O_2 + 4e^-$$

$$2(Fe^{2+} + 2e^- \rightarrow Fe)$$

$$2O^{2-} + 2Fe^{2+} + 4e^- \rightarrow O_2 + 2Fe^0 + 4e^-$$

$$2O^{2-} + 2Fe^{2+} \rightarrow O_2 + 2Fe$$

(24)



$C_p = E_v - (E_u + \text{H bonds})$

$C_p = 4 - (0 + 4)$

$C_p = 0$