# MILLENNIUM SECONDARY AND PREPARATORY SCHOOL 2012 E.C GRADE 12
# CHEMISTRY OPEN BOOK MODEL EXAM -ONE

**1**. **. Weight** differs from mass due to;

A. It is basic quantity B. It measures the amount of matters

C. Affected by gravity D. Not affected by gravity

**2.** The speed of a chemical reaction

(a) is constant no matter what the temperature is.

(b) is independent of the amount of contact surface of a solid involved.

(c) between gases should in all cases be extremely rapid because the average kinetic energy of the molecules is great.

(d) between ions in aqueous solution is extremely rapid because there are no bonds that need to be broken.

(e) varies inversely with the absolute temperature.

**3.** For a reaction $2A + B \longrightarrow 2C$, with the rate equation: Rate = $k[A]^2[B]$

(a) the order with respect to A is 1 and the order overall is 1.

(b) the order with respect to A is 2 and the order overall is 2.

(c) the order with respect to A is 2 and the order overall is 3.

(d) the order with respect to B is 2 and the order overall is 2.

(e) the order with respect to B is 2 and the order overall is 3.

**4.**Given the following data for this reaction:

$NH_4^+(aq) + NO_2^-(aq) \longrightarrow N_2(g) + 2H_2O(l)$

| EXPT | $[NH_4^+]$ | $[NO_2^-]$ | RATE |
|---|---|---|---|
| 1 | 0.010 M | 0.020 M | 0.020 M/s |
| 2 | 0.015 M | 0.020 M | 0.030 M/s |
| 3 | 0.010 M | 0.010 M | 0.005 M/s |

The rate law for the reaction is:

(a) Rate = $k[NH_4^+][NO_2^-]$ (b) Rate = $k[NH_4^+]^2[NO_2^-]^2$

(c) Rate = $k[NH_4^+]^2[NO_2^-]$ (d) Rate = $k[NH_4^+][NO_2^-]^2$

**5.**What are the units of k for the rate law: Rate = $k[A][B]^2$, when the concentration unit is mol/L?

(a) $s^{-1}$ (b) s (c) L $mol^{-1}$ $s^{-1}$ (d) $L^2$ $mol^{-2}$ $s^{-1}$ (e) $L^2$ $s^2$ $mol^{-2}$

**6.**The decomposition of dimethylether at 504 $^oC$ is first order with a half-life of 1570 seconds. What fraction of an initial amount of dimethylether remains after 4710 seconds?

(a) 1/3 (b) 1/6 (c) 1/8 (d) 1/16 (e) 1/32

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**7.**The half-life for a first-order reaction is 32 s. What was the original concentration if, after 2.0 minutes, the reactant concentration is 0.062 M?

(a) 0.84 M (b) 0.069 M (c) 0.091 M (d) 0.075 M (e) 0.13 M

**8.** If reaction A has an activation energy of 250 kJ and reaction B has an activation energy of 100 kJ, which of the following statements **must** be correct?

(a) If reaction A is exothermic and reaction B is endothermic then reaction A is favored kinetically.

(b) At the same temperature the rate of reaction B is greater than the rate of reaction A.

(c) The energy of reaction A must be greater than the energy of reaction B.

(d) The energy of reaction B must be greater than the energy of reaction A.

**9.** Suppose the reaction: $A + 2B \longrightarrow AB_2$ occurs by the following mechanism:

Step 1 $A + B \longrightarrow AB$ slow

Step 2 $AB + B \longrightarrow AB_2$ fast

Overall $A + 2B \longrightarrow AB_2$

The rate law expression must be Rate = _____.

(a) k[A] (b) k[B] (c) k[A][B] (d) $k[B]^2$ (e) $k[A][B]^2$

**10.** A correct reaction mechanism for a given reaction usually is:

(a) the same as its balanced chemical equation.

(b) obvious if its heat of reaction is known.

(c) obvious if its reaction order is known.

(D) obvious if its activation energy is known.

**11.** Suppose the activation energy of a certain reaction is 250 kJ/mol. If the rate constant at $T_1$ = 300 K is $k_1$ and the rate constant at $T_2$ = 320 K is $k_2$, then the reaction is __ times faster at 320 K than at 300 K. (Hint: Solve for $k_2/k_1$.)

(a) $3 \times 10^{-29}$ (b) 0.067 (c) 15.0 (d) 525 (e) $3 \times 10^{-28}$

**12.** When the concentration of reactant molecules is increased, the rate of reaction increases. The best explanation is: As the reactant concentration increases,

(a) the average kinetic energy of molecules increases.

(b) the frequency of molecular collisions increases.

(c) the rate constant increases.

(d) the activation energy increases.

(e) the order of reaction increases.

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**13.** For the reaction, $2H_2S(g) + O_2(g) \longrightarrow 2S(s) + 2H_2O(l)$, which one of the following statements is **absolutely** true?

(a) The reaction is first order with respect to $H_2S$ and second order with respect to $O_2$.

(b) The reaction is fourth order overall.

(c) The rate law is: rate = $k[H_2S]^2[O_2]$.

(d) The rate law is: rate = $k[H_2S][O_2]$.

14.Which of these correctly describes energy changes due to reactions in solution?

A.Endothermic - temperature increases; Exothermic - energy is transferred to the surroundings

B.Endothermic - temperature decreases; Exothermic - energy is transferred from the surroundings

C.Endothermic - energy is transferred to the surroundings; Exothermic - temperature decreases

D. Endothermic - energy is transferred from the surroundings; Exothermic - temperature increases.

15.Which of the following correctly describes processes that happen during reactions?

A.Bonds are broken in reactants, which is an exothermic process that takes in energy

B.Bonds are broken in reactants, which is an endothermic process that gives out energy

C.Bonds are made in products, which is an endothermic process that takes in energy

D.Bonds are made in products, which is an endothermic process that takes in energy

16.Which statement is **false**? A sigma molecular orbital

(a) may result from overlap of p atomic orbitals perpendicular to the molecular axis (side-on).

(b) may be either bonding or antibonding

(c) may result from overlap of two s atomic orbitals.

(d) may result from overlap of one s and one p atomic orbitals.

**17.** Which of the following is the correct electron configuration for $C_2$?

(a) $\sigma_{1s}^2\,\sigma_{2s}^2\,\pi_{2py}^2\,\sigma^*_{1s}^2\,\sigma^*_{2s}^2\,\pi^*_{2py}^2$

(b) $\sigma_{1s}^2\,\sigma^*_{1s}^2\,\sigma_{2s}^2\,\sigma^*_{2s}^2\,\pi_{2py}^2\,\pi^*_{2pz}^1\,\sigma_{2p}^1$

(c) $\sigma_{1s}^2\,\sigma^*_{1s}^2\,\sigma_{2s}^2\,\sigma^*_{2s}^2\,\pi_{2py}^2\,\pi_{2pz}^2$

(D) $\sigma_{1s}^2\,\sigma^*_{1s}^2\,\sigma_{2s}^2\,\sigma^*_{2s}^2\,\pi_{2py}^1\,\pi^*_{2py}^1\,\pi_{2pz}^1\,\pi^*_{2pz}^1$

18. Draw the molecular orbital diagram for the molecular ion, $N_2^+$. The number of electrons in the $\sigma_{2p}$ molecular orbital is:

(a) 0 (b) 1 (c) 2 (d) 3 (e) 4

**19.**What is the bond order in $O_2^+$?

(a) 3.5 (b) 2.0 (c) 1.5 (d) 2.5 (e) 0

**20.**Draw the molecular orbital diagram for $B_2$. The number of unpaired electrons in the $B_2$ molecule is

(a) zero ( b) 1 (c) 2 (d) 3 (e) 4

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**21.** Which one of the following statements is **false**?

(a) Valence bond theory and molecular orbital theory can be described as two different views of the same thing.

(a) When one considers the molecular orbitals resulting from the overlap of any two specific atomic orbitals, the bonding orbitals are always lower in energy than the antibonding orbitals.

(b) Molecular orbitals are generally described as being more delocalized than hybridized atomic orbitals.

(c) One of the shortcomings of molecular orbital theory is its inability to account for a triple bond in the nitrogen molecule, $N_2$.

**22.** Antibonding molecular orbitals are produced by

(a) constructive interaction of atomic orbitals.

(b) destructive interaction of atomic orbitals.

(c) the overlap of the atomic orbitals of two negative ions

(d) all of these

**23.** Which statement regarding stable **heteronuclear** diatomic molecules is **false**?

(a) All have bond orders greater than zero.

(b) The antibonding molecular orbitals have more of the character of the more electropositive element than of the more electronegative element.

(c)Their molecular orbital diagrams are more symmetrical than those of homonuclear diatomic molecules.

(d)The bonding molecular orbitals have more of the character of the more electronegative element than of the less electronegative element.

24. Choose the molecule that is **incorrectly** matched with the **electronic** geometry about the central atom.

(a) $CF_4$ – tetrahedral (b) $BeBr_2$ - linear

(c) $H_2O$ – tetrahedral (d) $NH_3$ – tetrahedral (e) $PF_3$ - pyramidal

**25.** Which molecule has a linear arrangement of all component atoms?

(a) $CH_4$ (b) $H_2O$ (c) $CO_2$ (d) $NH_3$ (e) $BF_3$

**26.** Which of the following species is planar?

(a) $NH_3$ (b) $H_3O^+$ (c) $SO_3^{2-}$ (d) $PF_3$ (e) $NO_3^-$

**27.** What kind of hybrid orbitals are utilized by the carbon atom in $CF_4$ molecules?

(a) sp (b) $sp^2$ (c) $sp^3$ (d) $sp^3d$ (e) $sp^3d^2$

**28.**Which of the following four molecules are polar: $PH_3$ $OF_2$ HF $SO_3$?

(a) all except $SO_3$ (b) only HF (c) only HF and $OF_2$ (d) none of these (e) all of these

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**29.**Which molecule is nonpolar?

(a) $H_2Se$ (b) $BeH_2$ (c) $PF_3$ d) $CHCl_3$ (e) $SO_2$

**30.** Which response contains all of the characteristics listed that should apply to phosphorus trichloride, $PCl_3$, and no other characteristics?

(1) trigonal planar (2) one unshared pair of electrons on P

(3) $sp^2$ hybridized at P (4) polar molecule (5) polar bonds

(a) 1, 4, 5 (b) 2, 3, 4 (c) 1, 2, 4 (d) 2, 4, 5

**31.** A $\pi$ (pi) bond is the result of the

(a) overlap of two s orbitals.

(b) overlap of an s and a p orbital.

(c) overlap of two p orbitals along their axes.

(d) sidewise overlap of two parallel p orbitals.

32.A triple bond contains ___ sigma bond(s) and ___ pi bond(s).

(a) 0, 3 (b) 3, 0 (c) 2, 1 (d) 1, 2

**33.** Draw a complete line-bond or electron-dot formula for acetic acid and then decide which statement is **incorrect**.

(a) One carbon is described by $sp^2$ hybridization.

(b) The molecule contains only one $\pi$ bond.

(c) The molecule contains four lone pairs of valence electrons.

(D) Both oxygens are described by $sp^3$ hybridization.

34.Arrhenius defined an acid as:

(a) a species that can donate a proton.

(b) a species that can accept a proton.

(c) a source of $OH^-$ ions in water.

(d) asourse of $H^+$ ions in water.

**35.** In the equation: $HF + H_2O \longrightarrow H_3O^+ + F^-$

(a) $H_2O$ is a base and HF is its conjugate acid.

(b) $H_2O$ is an acid and HF is the conjugate base.

(c) HF is an acid and $F^-$ is its conjugate base.

(d) HF is a base and $H_3O^+$ is its conjugate acid.

**36.**For the system shown here: $HOBr + OH^- \rightleftarrows H_2O + OBr^-$

Bronsted would classify the base species as:

(a) $OH^-$ and HOBr (b) $H_2O$ and OH (c) $OBr^-$ and $OH^-$ (d) $OBr^-$ and HOBr

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**37.** Which is the **strongest** acid?

(a) $HClO_4$ (b) $HClO_3$ (c) $HClO_2$ (d) HClO

**38.** Which one of the following represents the **net ionic** equation for the reaction of nitric acid(aq) with aluminum hydroxide?

(a) $3H^+ + Al(OH)_3 \longrightarrow Al^{3+} + 3H_2O$

(b) $3HNO_3 + Al(OH)_3 \longrightarrow Al(NO_3)_3 + 3H_2O$

(c) $HNO_3 + OH^- \longrightarrow NO_3^- + H_2O$

(d) $H^+ + OH^- \longrightarrow H_2O$

**39.** According to the Lewis theory, a base _____ .

(a) is a proton acceptor.

(B) makes available a share in a pair of electrons.

(C) produces $OH^-$ ions in aqueous solution.

(D) accepts a share in a pair of electrons.

40.How many grams of $Ca(OH)_2$ are contained in 1500 mL of 0.0250 M $Ca(OH)_2$ solution?

(a) 3.17 g (b) 2.78 g (c) 1.85 g (d) 2.34 g

**41.** What is the molarity of the salt produced in the reaction of 200 mL of 0.100 M HCl with 100 mL of 0.500 M KOH?

(a) 0.0325 M (b) 0.0472 M (c) 0.0667 M (d) 0.0864 M

**42.**How many equivalents of phosphoric acid are contained in 300 mL of 4.00 M phosphoric acid? (Assume the acid is to be completely neutralized by a base.)

(a) 0.600 eq (b) 1.20 eq (c) 2.40 eq (d) 3.60 eq

**43.** Calculate the normality of a solution that contains 4.5 g of $(COOH)_2$ in 3000 mL of solution? (Assume the $(COOH)_2$ is to be completely neutralized in an acid-base reaction.)

(a) 0.033 N (b) 0.045 N (c) 0.066 N (d) 0.090 N

**44.** What is the oxidation number for carbon in $CaC_2O_4$?

(a) 0 (b) +2 (c) +3 (d) +4

**45.** For the reaction between permanganate ion and sufite ion in basic solution, the unbalanced equation is: $MnO_4^- + SO_3^{2-} \longrightarrow MnO_2 + SO_4^{2-}$, When this equation is balanced using the smallest whole number coefficients possible, the number of $OH^-$ ions is;

(a) two on the right. (b) two on the left.

(c) three on the right. (d) four on the right.

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**46.** When the following equation is balanced with the smallest possible set of integers, what is the sum of all the coefficients? (Do not forget coefficients of one.)

$MnO_4^- + Se^{2-} \longrightarrow MnO_2 + Se$ (in basic solution)

(a) 20 (b) 22 (c) 24 (d) 26

**47.** A 0.250 M solution of $Na_2C_2O_4$ is to be used in a reaction in which the $C_2O_4^{2-}$ will be oxidized to $CO_2$. What is the normality of this $Na_2C_2O_4$ solution?

(a) 0.250 N (b) 1.00 N (c) 0.125 N (d) 0.500 N

48. Which of the following combinations **cannot** produce a buffer solution?

(a) $HNO_2$ and $NaNO_2$ (b) HCN and NaCN

(c) $HClO_4$ and $NaClO_4$ (d) $NH_3$ and $(NH_4)_2SO_4$

**49.** What is the pH of a solution composed of 0.20 M $NH_3$ and 0.15 M $NH_4Cl$?

(a) 2.15 (b) 4.62 (c) 8.26 (d) 9.38

**50.** Consider a solution which is 0.10 M in $CH_3COOH$ and 0.20 M in $NaCH_3COO$. Which of the following statements is **true**?

(a) If a small amount of NaOH is added, the pH decreases very slightly.

(b) If NaOH is added, the $OH^-$ ions react with the $CH_3COO^-$ ions.

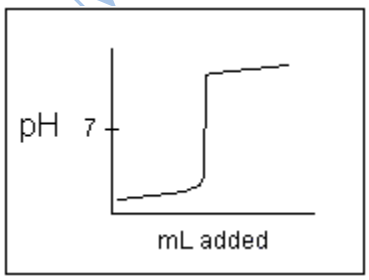
(c) If a small amount of HCl is added, the pH decreases very slightly.

(d) If HCl is added, the $H^+$ ions react with $CH_3COOH$ ions.

**51.** Consider the titrations of the pairs of aqueous acids and bases listed on the left. For which pair is the pH at the equivalence point stated **incorrectly**?

| **Acid-Base Pair** | **pH at Equivalence Point** |
|---|---|
| (a) $HCl + NH_3$ | less than 7 |
| (b) $HNO_3 + Ca(OH)_2$ | equal to 7 |
| (c) $HClO_4 + NaOH$ | equal to 7 |
| (d) $HClO + NaOH$ | less than 7 |

**52.** The following titration curve is the kind of curve expected for the titration of a ____ acid with a ____ base.




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(a) Strong, strong (b) weak, strong (c) strong, weak (d) weak, weak

53. Which one of the following thermodynamic quantities is **not** a state function?

(a) Gibbs free energy (b) enthalpy (c) entropy (d) work

**54.** At a constant temperature, an ideal gas is compressed from 6.0 liters to 4.0 liters by a constant external pressure of 5.0 atm. How much work is done on the gas?

(a) w = +10 liter atm (b) w = -10 liter atm

(c) w = +30 liter atm (d) w = -30 liter atm

**55.** A system suffers an increase in internal energy of 80 J and at the same time has 50 J of work done on it. What is the heat change of the system?

(a) +130 J (b) +30 J (c) -130 J (d) -30 J

**56.** A 5.000 g sample of methanol, $CH_3OH$, was combusted in the presence of excess oxygen in a bomb calorimeter conaining 4000 g of water. The temperature of the water increased from 24.000 $^oC$ to 29.765 $^oC$. The heat capacity of the calorimeter as 2657 J/$^oC$. The specific heat of water is 4.184 J/g$^oC$. Calculate $\Delta E$ for the reaction in kJ/mol.

(a) -314 kJ/mol (b) -789 kJ/mol (c) -716 kJ/mol (d) -121 kJ/mol

**57.**The $\Delta H^o$ for the following reaction at 298 K is -36.4 kJ.

1/2 $H_2(g)$ + 1/2 $Br_2(l)$ $\longrightarrow$ HBr(g)

Calculate $\Delta E^o$ at 298 K. The universal gas constant, R, is 8.314 J/mol K.

(a) -35.2 kJ (b) +35.2 kJ (c) -37.6 kJ (d) +37.6 kJ

**58.**The $\Delta H^o_{rxn}$ for the following reaction at 25.0 $^oC$ is:

$Fe_3O_4(s) + CO(g) \longrightarrow 3FeO(s) + CO_2(g)$

| | | | | |
|---|---|---|---|---|
| $\Delta H_f^o$ (kJ/mol) | -1118 | -110.5 | -272 | -393.5 |

(a) -263 kJ (b) 54 kJ (c) 19 kJ (d) -50 kJ

**59.** Estimate the heat of reaction at 298 K for the reaction shown, given the average bond energies below.

$Br_2(g) + 3F_2(g) \longrightarrow 2BrF_3(g)$

| **Bond** | **Bond Energy** |
|---|---|
| Br-Br | 192 kJ |
| F-F | 158 kJ |
| Br-F | 197 kJ |

(a) -516 kJ (b) -410 kJ (c) -611 kJ (d) -665 kJ

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**60.** The entropy will usually increase when

I. a molecule is broken into two or more smaller molecules.

II. a reaction occurs that results in an increase in the number of moles of gas.

III. a solid changes to a liquid.

IV. a liquid changes to a gas.

(a) I only (b) II only (c) III only (d) IV only (e) I, II, III, and IV

**61.** Calculate $\Delta G^o$ for the reaction given the following information:

$2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

$\Delta G_f^o$ for $SO_2(g)$ = -300.4 kJ/mol

$\Delta G_f^o$ for $SO_3(g)$ = -370.4 kJ/mol

(a) -70.0 kJ (b) +70.0 kJ (c) -140.0 kJ (d) +140.0 kJ

**62.** For the reaction, A + B $\longrightarrow$ C, $\Delta H^o$ =+30kJ; $\Delta S^o$ =+50J/K.

Therefore the reaction is:

(a) spontaneous at all temperatures. (b) nonspontaneous at all temperatures.

(c) spontaneous at temperatures less than 600 K. (d) spontaneous at temperatures greater than 600 K.

(e) spontaneous only at 25°C.

**63.** Which statement is **incorrect**?

(a) At constant pressure, $\Delta H = \Delta E + P\Delta V$

(b) The thermodynamic symbol for entropy is S.

(c) Gibbs free energy is a state function.

(d) For an endothermic process, $\Delta H$ is negative.

64. In an **electrolytic** cell the electrode at which the electrons enter the solution is called the _____ ; the chemical change that occurs at this electrode is called_____.

(a) anode, oxidation (b) anode, reduction

(c) cathode, oxidation (d) cathode, reduction

**65.** Which of the following statements is FALSE?

(a) Oxidation and reduction half-reactions occur at electrodes in electrochemical cells.

(b) All electrochemical reactions involve the transfer of electrons.

(c) Reduction occurs at the cathode.

(d) Oxidation occurs at the anode.

(e) All voltaic (galvanic) cells involve the use of electricity to initiate nonspontaneous chemical reactions.

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**66.** The half-reaction that occurs at the anode during the electrolysis of molten sodium bromide is:

(a) $2\ Br^- \longrightarrow Br_2 + 2\ e^-$

(b) $Br_2 + 2\ e^- \longrightarrow 2\ Br^-$

(c) $Na^+ + e^- \longrightarrow Na$

(d) $Na \longrightarrow Na^+ + e^-$

**67.** What mass (in grams) of nickel could be electroplated from a solution of nickel(II) chloride by a current of 0.25 amperes flowing for 10 hours?

(a) 12 g (b) 5.5 g (c) 0.046 g (d) 2.7 g

**68.** How many faradays are required to reduce 1.00 g of aluminum(III) to the aluminum metal?

(a) 1.00 (b) 1.50 (c) 3.00 (d) 0.111

**69.** As the cell given below operates, the strip of silver gains mass (only silver) and the concentration of silver ions in the solution around the silver strip decreases, while the strip of lead loses mass and the concentration of lead increases in the solution around the lead strip. Which of the following represents the reaction that occurs at the negative electrode in the above cell?

$Pb / Pb(NO_3)_2\ (1.0\ M) \parallel AgNO_3\ (1.0\ M) / Ag$

(a) $Pb^{2+} + 2\ e^- \longrightarrow Pb$ (b) $Pb \longrightarrow Pb^{2+} + 2\ e^-$

(c) $Ag^+ + e^- \longrightarrow Ag$ (d) $Ag \longrightarrow Ag^+ + e^-$

**70.** For a voltaic (or galvanic) cell using $Ag,Ag^+$ (1.0 M) and $Zn,Zn^{2+}$ (1.0 M) half-cells, which of the following statements is **incorrect**?

(a) The zinc electrode is the anode.

(b) Electrons will flow through the external circuit from the zinc electrode to the silver electrode.

(c) Reduction occurs at the zinc electrode as the cell operates.

(d) The mass of the zinc electrode will decrease as the cell operates.

(e) The concentration of $Ag^+$ will decrease as the cell operates.

**71.** In voltaic cells, such as those diagrammed in your text, the salt bridge _____ .

(a) is not necessary in order for the cell to work

(b) acts as a mechanism to allow mechanical mixing of the solutions

(c) allows charge balance to be maintained in the cell

(d) is tightly plugged with firm agar gel through which ions cannot pass

(e) drives free electrons from one half-cell to the other

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**72.** Which of the following statements is(are) **true** for **all** voltaic (or galvanic) cells?

(I) Reduction occurs at the cathode.

(II) The anode gains mass during discharge (note: this means operation of the cell.)

(III) The voltage is less than or equal to zero.

(a) only III (b) only II (c) only I (d) II and III (e) I, II, and III

**73.** In the standard notation for a voltaic cell, the double vertical line "||" represents:

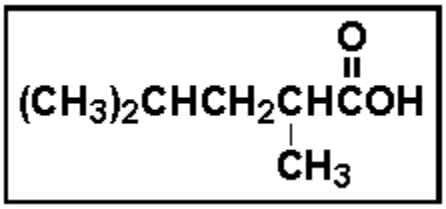
(a) a phase boundary (b) gas electrode

(c) a wire (metal) connection (d) a salt bridge

**74.** The hybridization of carbon atoms in alkanes is?

(a) sp (b) $sp^2$ (c) $sp^3$ (d) $sp^3d$

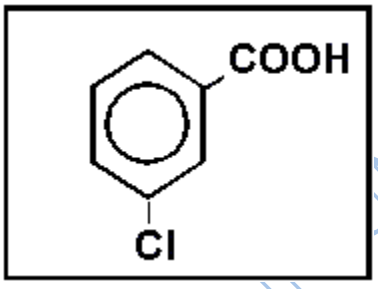
**75.** Select the IUPAC name for the compound below.



(a) 2,4-dimethylpentanoic acid (b) 1,1,3-trimethylbutanoic acid

(c) 1-hydroxy-2,4-dimethylpentanone (d) 2-carboxyisohexane

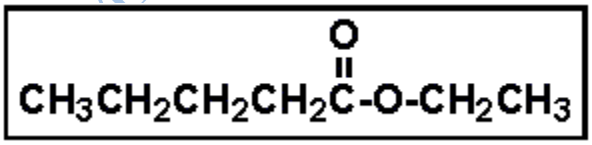
**76.** Select the best name for:



(a) m-chlorobenzoic acid (b) o-chlorobenzaldehyde

(c) p-chlorobenzoate (d) m-chlorosalicylic acid

**77.** The compound given below is called _____ .



(a) butyl acetate (b) ethylpentanoate

(c) propylpentanoate (d) ethylbutanoate

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**78.** The functional group given below is characteristic of organic _____ .



(a) ketones (b) acids (c) aldehydes (d) esters

**79.** A solution in which $[H^+] = 10^{-8}$ M has a pH of ___ and is ___.

(a) 8, acidic (b) 6, basic (c) -6, basic (d) -8, basic

**80**. A 0.10 M solution of a weak acid, HX, is 0.059% ionized. Evaluate $K_a$ for the acid.

(a) $3.8 \times 10^{-9}$ (b) $6.5 \times 10^{-7}$ (c) $3.5 \times 10^{-8}$ (d) $4.2 \times 10^{-6}$

**81**. When the system A + B $\rightleftarrows$ C + D is at equilibrium,

(a) the sum of the concentrations of A and B must equal the sum of the concentrations of C and D.

(b) the forward reaction has stopped.

(c) both the forward and the reverse reactions have stopped.

(d) neither the forward nor the reverse reaction has stopped.

**82.** The conventional equilibrium constant expression ($K_c$) for the equation below is;

$2SO_3(g) \rightleftarrows 2SO_2(g) + O_2(g)$

(a) $[SO_2]^2/[SO_3]$ (b) $[SO_2]^2[O_2]/[SO_3]^2$

(c) $[SO_3]^2/[SO_2]^2[O_2]$ (d) $[SO_2][O_2]$

**83.** At 445°C, $K_c$ for the following reaction is 0.020.

$2HI(g) \rightleftarrows H_2(g) + I_2(g)$

A mixture of $H_2$, $I_2$, and HI in a vessel at 445°C has the following concentrations: [HI] = 2.0 M, $[H_2]$ = 0.50 M and $[I_2]$ = 0.10 M. Which one of the following statements concerning the reaction quotient, $Q_c$, is **TRUE** for the above system?

(a) $Q_c = K_c$; the system is at equilibrium.

(b) $Q_c$ is less than $K_c$; more $H_2$ and $I_2$ will be produced.

(c) $Q_c$ is less than $K_c$; more HI will be produced.

(d) $Q_c$ is greater than $K_c$; more $H_2$ and $I_2$ will be produced.

(e) $Q_c$ is greater than $K_c$; more HI will be produced.

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**84**. A quantity of HI was sealed in a tube, heated to 425°C and held at this temperature until equilibrium was reached. The concentration of HI in the tube at equilibrium was found to be 0.0706 mol/L. Calculate the equilibirum concentration of $H_2$ (and $I_2$). For the gas-phase reaction,

$$H_2 + I_2 \rightleftarrows 2HI \quad K_c = 54.6 \text{ at } 425^oC$$

(a) $9.55 \times 10^{-3}$ M (b) $1.17 \times 10^{-3}$ M

(c) $1.85 \times 10^{-4}$ M (d) $4.78 \times 10^{-3}$ M

**85.** Consider the gas-phase equilibrium system represented by the equation:

$2H_2O(g) \rightleftarrows 2H_2(g) + O_2(g)$

is **endothermic**, which of the following changes will **decrease** the equilibrium amount of $H_2O$?

(a) adding more oxygen

(b) adding a solid phase calalyst

(c) decreasing the volume of the container (the total pressure increases)

(d) increasing the temperature at constant pressure

**86.** Consider the equilibrium system:

$2ICl(s) \rightleftarrows I_2(s) + Cl_2(g)$

Which of the following changes will increase the total amount of of $Cl_2$ that can be produced?

(a) removing some of the $I_2(s)$

(b) adding more ICl(s)

(c) removing the $Cl_2$ as it is formed

(d) decreasing the volume of the container

**87.** $K_c = 0.040$ for the system below at 450°C:

$PCl_5(g) \rightleftarrows PCl_3(g) + Cl_2(g)$

Evaluate $K_p$ for the reaction at 450°C.

(a) 0.40 (b) 0.64 (c) 2.4 (d) 0.052

**88.** For a specific reaction, which of the following statements can be made about K, the equilibrium constant?

(a) It always remains the same at different reaction conditions.

(b) It increases if the concentration of one of the products is increased.

(c) It changes with changes in the temperature.

(d) It increases if the concentration of one of the reactants is increased.

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89.The valence electrons of representative elements are

(a) in s orbitals only.

(b) located in the outermost occupied major energy level.

(c) located closest to the nucleus.

(d) located in d orbitals.

**90.** With regard to the species $^{16}O^{2-}$, $^{19}F^{-}$ and $^{20}Ne$, which of the following statements is **correct**?

(a) All three species contain 10 electrons.

(b)The sum of the neutrons in all three species is 27.

(c) The sum of the protons in all three species is 28.

(d) Both $^{19}F^{-}$ and $^{20}Ne$ contain 20 neutrons.

**91.**The correct electron-dot formulation for hydrogen cyanide shows:

(a) 2 double bonds and two lone pairs of electrons on the N atom.

(b) 1 C-H bond, 1 C=N bond, 1 lone pair of electrons on the C atom and 1 lone pair of electrons on the N atom.

(d) 1 C-H bond, 1 C-N bond, 2 lone pairs of electrons on the C atom and 3 lone pairs of electrons

(e) on the N atom.

(d) 1 triple bond between C and N, 1 C-H bond and 1 lone pair of electrons on the N atom.

**92.** In the Lewis structure for the $OF_2$ molecule, the number of lone pairs of electrons around the central oxygen atom is

(a) 0 (b) 1 (c) 2 (d) 3 (e) 4

**93.** Consider the bicarbonate ion (also called the hydrogen carbonate ion). After drawing the correct Lewis dot structure(s), you would see:

(a) two double bonds around the central carbon atom.

(b) three single bonds around the central carbon atom.

(c) two equivalent resonance forms.

(d) three equivalent resonance forms.

**94.** The species that contains 24 protons, 26 neutrons and 22 electrons would be represented by the symbol:

(a) $^{50}V^{3+}$ (b) $^{26}Cr^{2+}$ (c) $^{50}Cr^{2+}$ (d) $^{50}Mn^{2+}$

95.Which of the following has a positive charge?

(a) proton (b) neutron (c) anion (d) electron

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**96.**Rutherford carried out experiments in which a beam of alpha particles was directed at a thin piece of metal foil. From these experiments he concluded that:

(a) electrons are massive particles.

(b) the positively charged parts of atoms are moving about with a velocity approaching the speed of light.

(c) the positively charged parts of atoms are extremely small and extremely heavy particles.

(d) the diameter of an electron is approximately equal to that of the nucleus.

**97.** The neutral atoms of all of the isotopes of the same element have

(a) different numbers of protons.

(b) equal numbers of neutrons.

(c) the same number of electrons.

(d) the same mass numbers.

**98.** Naturally occurring rubidium consists of just two isotopes. One of the isotopes consists of atoms having a mass of 84.912 amu; the other of 86.901 amu. What is the percent abundance of the heavier isotope?

(a) 15% (b) 28% (c) 72% (d) 85%

**99.** What is the frequency of light having a wavelength of $4.50 \times 10^{-6}$ cm?

(a) $2.84 \times 10^{-12}\ s^{-1}$ (b) $2.10 \times 10^{4}\ s^{-1}$

(c) $4.29 \times 10^{14}\ s^{-1}$ (d) $6.67 \times 10^{15}\ s^{-1}$

**100.** Which of the responses contains all the statements that are consistent with the Bohr theory of the atom (and no others)?

(1) An electron can remain in a particular orbit as long as it continually absorbs radiation of a definite frequency.

(2) The lowest energy orbits are those closest to the nucleus.

(3) An electron can jump from the K shell (n = 1 major energy level) to the M shell (n = 3 major energy level) by emitting radiation of a definite frequency.

(a) 1,2,3 (b) 2 only (c) 3 only (d) 1,2

**101.** The Heisenberg Principle states that _____.

(a) no two electrons in the same atom can have the same set of four quantum numbers.

(b) two atoms of the same element must have the same number of protons.

(c) it is impossible to determine accurately both the position and momentum of an electron simultaneously.

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(d) electrons of atoms in their ground states enter energetically equivalent sets of orbitals singly before they pair up in any orbital of the set.

**102.** Which statement about the four quantum numbers which describe electrons in atoms is **incorrect**?

(a) n = principal quantum number, n = 1, 2, 3, .....

(b) $l$ = subsidiary (or azimuthal) quantum number, $l$ = 1, 2, 3, ... , (n+1)

(c) $m_l$ = magnetic quantum number, $m_l$ = (-$l$), .... , 0, .... , (+$l$)

(d) $m_s$ = spin quantum number, $m_s$ = +1/2 or -1/2.

**103.** Which atomic orbital is spherical in shape?

(a) 2s (b) 3p (c) 3d (d) 4f

**104.** The maximum number of electrons that can be accommodated in a sublevel for which $l$ = 3 is:

(a) 2 (b) 10 (c) 6 (d) 14

**105.**Which one of the following sets of quantum numbers **could** be those of the distinguishing (last) electron of Mo?

(a) n = 4, $l$ = 0, $m_l$ = 0, $m_s$ = +1/2 (b) n = 5, $l$ = 1, $m_l$ = 9, $m_s$ = -1/2

(c) n = 4, $l$ = 2, $m_l$ = -1, $m_s$ = +1/2 (d) n = 5, $l$ = 2, $m_l$ = +3, $m_s$ = -1/2

**106.**Which one of the following complexes can exhibit geometrical isomerism?

(a) $[Pt(NH_3)_2Cl_2]$ (square planar)

(b) $[Zn(NH_3)_2Cl_2]$ (tetrahedral)

(c) $[Cu(NH_3)_4]^{2+}$ (square planar)

(d) $[Co(NH_3)_5Cl]^{2+}$ (octahedral)

**107.**Which of the following statements is(are) FALSE?

1. The percent by mass of each element in a compound depends on the amount of the compound.
2. The mass of each element in a compound depends on the amount of the compound.
3. The percent by mass of each element in a compound depends on the amount of element present in the compound.

(a) 2 and 3 (b) 1 only (c) 1 and 2 (d) 1, 2 and 3

**108.**Which of the following statements is **FALSE** for the chemical equation given below in which nitrogen gas reacts with hydrogen gas to form ammonia gas assuming the reaction goes to completion?

$N_2 + 3H_2 \longrightarrow 2NH_3$

(a) The reaction of one mole of $H_2$ will produce 2/3 moles of $NH_3$.

(b) One mole of $N_2$ will produce two moles of $NH_3$.

(c) One molecule of nitrogen requires three molecules of hydrogen for complete reaction.

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(d) The reaction of 14 g of nitrogen produces 17 g of ammonia.

(e) The reaction of three moles of hydrogen gas will produce 17 g of ammonia.

**109.** Which one of the following statements is **TRUE**?

(a) One mole of any acid will ionize completely in aqueous solution to produce one mole of $H^+$ ions.

(b) Solutions of weak acids always have lower concentrations of $H^+$ than solutions of strong acids.

(c) There are several common acids that are insoluble.

(d) All of the IA and IIA metal hydroxides are soluble.

**110**. What type of intermolecular forces are due to the attraction between temporary dipoles and their induced temporary dipoles?

(a) metallic bond (b) London dispersion

(c) hydrogen bond (d) ionic bond (e) covalent bond

**111.**What type of interparticle forces holds liquid $N_2$ together?

(a) ionic bonding (b) London forces

(c) hydrogen bonding (d) dipole-dipole interaction

**112.**Which response includes only those compounds that can exhibit hydrogen bonding?

$CH_4$, $AsH_3$, $CH_3NH_2$, $H_2Te$, HF

(a) $AsH_3$, $H_2Te$ (b) $AsH_3$, $CH_3NH_2$

(c) $CH_4$, $AsH_3$, $H_2Te$ (d) $CH_3NH_2$, HF

**113.** The normal boiling point of a liquid is

(a) the temperature at which the vapor pressure equals 760 torr.

(b) the temperature above which the substance cannot exist as a liquid regardless of the pressure.

(c) the temperature at which the gas molecules have more kinetic energy than the molecules in the liquid.

(d) the only temperature at which there can be equilibrium between liquid and gas.

**114.** Which of the following phase changes is(are) endothermic?

1. melting 3. sublimation 5. deposition

2. vaporization 4. condensation 6. freezing

(a) 1, 2, and 3

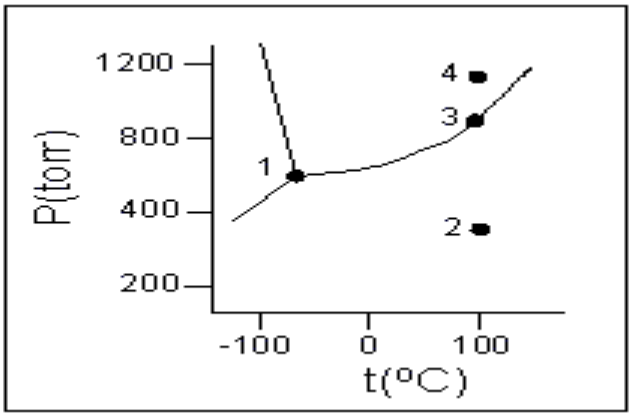
(b) 4, 5, and 6

(c) 1 and 2 only

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(d) 4 and 6 only

**Answer questions from 115-118** According to the phase diagram given for Compound Y




**115**. Phase ( 1) represents

A. pure Gas B. Pure solid C. Pure liquid D. triple point

**116.** Phase ( 2) represents.

A. pure Gas B. pure solid C. pure liquid D. triple point

**117.** Phase ( 3) represents

A. Gas B. solid-liquid C. liquid-gas D. triple point

**118**. phase( 4) represents

A. pure Gas B. . pure solid C. . pure liquid D. triple point

**119**.Which statement is **false**?

(a) The density of a gas is constant as long as its temperature remains constant.

(b) Gases can be expanded without limit.

(c) Gases diffuse into each other and mix almost immediately when put into the same container.

(d) The molecular weight of a gaseous compound is a non-variable quantity.

**120.** A container with volume 71.9 mL contains water vapor at a pressure of 10.4 atm and a temperature of 465$^{o}$C. How many grams of the gas are in the container?

(a) 0.421 g (b) 0.183 g (c) 0.129 g (d) 0.222 g

**121.** Which one of the following statements is **not consistent** with the kinetic-molecular theory of gases?

(a) Individual gas molecules are relatively far apart.

(b) The actual volume of the gas molecules themselves is very small compared to the volume occupied by the gas at ordinary temperatures and pressures.

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(c) The average kinetic energies of different gases are different at the same temperature.

(d) There is no net gain or loss of the total kinetic (translational) energy in collisions between gas molecules.

**122.** A real gas most closely approaches the behavior of an ideal gas under conditions of:

(a) high P and low T (b) low P and high T (c) high P and T (d) STP

**123.** For a gas, which pair of variables are inversely proportional to each other (if all other conditions remain constant)?

(a) P, T (b) P, V (c) V, T (d) n, V

**124.** Consider the three statements below. Which statement(s) is(are) **true**?

1. Hydration is a special case of solvation in which the solvent is water.
2. The oxygen end of water molecules is attracted toward $Ca^{2+}$ ions.
3. The hydrogen end of water molecules is attracted toward $Cl^-$ ions.

(a) 1 only (b) 1&2 only (c) 3 only (d) 1, 2, and 3

**125.** Which observation(s) reflect(s) colligative properties?

(I) A 0.5 m NaBr solution has a higher vapor pressure than a 0.5 m $BaCl_2$ solution.

(II) A 0.5 m NaOH solution freezes at a lower temperature than pure water.

(III) Pure water freezes at a higher temperature than pure methanol.

(a) only I (b) only II (c) only III (d) I and II

**126.** The vapor pressure of a solution containing a nonvolatile solute is directly proportional to;

(a) molality of the solvent. (b) osmotic pressure of the solute.

(c) molarity of the solvent. (d) mole fraction of solvent.

**127.** What are the ideal van't Hoff factors for the following compounds:

$Ba(OH)_2$, $C_6H_{12}O_6$, $K_3PO_4$, $HNO_3$ ?

(a) 1, 1, 1, 1 (b) 2, 1, 2, 2 (c) 3, 1, 4, 2 (d) 6, 3, 5, 5

**128.**What is the freezing point of an aqueous 1.00 m NaCl solution? ($K_f$ = 1.86 $^oC/m$) (Assume complete dissociation of the salt.)

(a) -1.86 $^oC$ (b) +1.86 $^oC$ (c) -3.72 $^oC$ (d) -0.93 $^oC$

**129.** Calculate the osmotic pressure associated with 50.0 g of an enzyme of molecular weight 98,000 g/mol dissolved in water to give 2600 mL of solution at 30.0 $^oC$.

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(a) 0.484 torr (b) 1.68 torr (c) 1.96 torr (d) 3.71 torr

**130.** A 250 mL solution containing 21.4 g of a polymer in toluene had an osmotic pressure of 0.055 atm at 27 $^{o}$C. What is the apparent formula weight of the polymer?

(a) 15,000 g/mol (b) 18,000 g/mol (c) 26,000 g/mol (d) 38,000 g/mol

131. An unused flashbulb contains magnesium and oxygen. After use, the contents are changed to magnesium oxide but the total mass does not change. This observation can best be explained by the

(a) Law of Constant Composition. (b) Law of Multiple Proportions.

(c) Avogadro's Law. (d) Law of Conservation of Mass.

132. Which one of the following statements is **FALSE**?

(a) For the reaction of a strong acid with a strong soluble base, the net ionic equation is always $H^+ + OH^- \longrightarrow H_2O$

(b) "Spectator ions" appear in the total ionic equation for a reaction, but not in the net ionic equation.

(c) HF, HCl, and $HNO_3$ are all examples of strong acids.

(d) Titration is a process which can be used to determine the concentration of a solution.

133. All of the following properties of the alkaline earth metals increase going down the group **except**

(a) atomic radius (b) first ionization energy

(c) ionic radius (d) atomic mass

134. Which of the following is **true** about a 0.10 M solution of a weak acid, HX?

(a) $[X^-] = 0.10$ M (b) pH = 1 (c) $[HX] > [H^+]$

(d) $[H^+] = 0.10$ M (e) both b and d

135. Which of the following weak acids ionizes to give the **strongest** conjugate base?

(a) HClO (b) $CH_3COOH$ (c) HF (d) $HNO_2$

136. If $K_w$ is $2.9 \times 10^{-15}$ at 10$^{o}$C, what is the pH of pure water at 10$^{o}$C?

(a) 6.72 (b) 7.00 (c) 7.27 (d) 7.53

136. For a voltaic (or galvanic) cell using $Ag,Ag^+$ (1.0 M) and $Zn,Zn^{2+}$ (1.0 M) half-cells, which of the following statements is **incorrect**?

(a) The zinc electrode is the anode.

(b) Electrons will flow through the external circuit from the zinc electrode to the silver electrode.

(c) Reduction occurs at the zinc electrode as the cell operates.

(d) The mass of the zinc electrode will decrease as the cell operates.

(e) The concentration of Ag+ will decrease as the cell operates.

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137. As the cell given below operates, the strip of silver gains mass (only silver) and the concentration of silver ions in the solution around the silver strip decreases, while the strip of lead loses mass and the concentration of lead increases in the solution around the lead strip. Which of the following represents the reaction that occurs at the negative electrode in the cell?

$Pb / Pb(NO_3)_2$ (1.0 M) || $AgNO_3$ (1.0 M) / Ag

(a) $Pb^{2+} + 2\ e^- \longrightarrow Pb$ (b) $Pb \longrightarrow Pb^{2+} + 2\ e^-$

(c) $Ag^+ + e^- \longrightarrow Ag$ (d) $Ag \longrightarrow Ag^+ + e^-$

**138.**One of the ff has the smallest lattice energy?

A. NaCl B. LiF C. KBr D. RbI

**139.** How many significant figures are there in 0.070520 ?

A. 5 B.4 C.7 D.6

**140**. When -40 $^oF$ equals to;

A.-80 $^oC$ B.-40 $^oC$ C.80 $^oC$ D.40 $^oC$

**141.** The combustion of ethane ($C_2H_6$) is represented by the equation:

$2C_2H_6(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(l)$ In this reaction:

(a) the rate of consumption of ethane is seven times faster than the rate of consumption of oxygen.

(b) the rate of formation of $CO_2$ equals the rate of formation of water.

(c) water is formed at a rate equal to two-thirds the rate of formation of $CO_2$.

(d) the rate of consumption of oxygen equals the rate of consumption of water.

(e) $CO_2$ is formed twice as fast as ethane is consumed.

**142.** **5.58 gram** of NaCl is dissolved in 250 ml of solution, calculate the Molarity and % by mass of the solute respectively.(take the density of the solution is 1.06 g/ml.)

A.0.2% &2.2 M B.0.2M &2.2% C.2.2% &0.2% D.2.2M &0.2M

**143.** In which type of solution does equilibrium exists?

A. Saturated B. Unsaturated C. Super saturated D. Dilute

**144.** Natural copper consists of $^{65}Cu$ & $^{63}Cu$, what is % abundance of $^{63}Cu$ if the average mass of Cu is 63.5? A.75% B.33% C. 25% D. 50%

**145.** Which of the following statement is correct?

A. Wave length is directly proportional to frequency.

B. Wave length is directly proportional to energy.

C. Energy is inversely proportional to frequency.

D. Energy is directly proportional to frequency.

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**146.** One of the following electromagnetic radiation has the longest wavelength?

A. UV-rays B. Gamma ray C. X-ray D. Microwaves

**147. C**alculate the wavelength of an electron that travels at a speed of $1x10^{7}$ m/s.(given mass of electron=$9.11x10^{-28}$ g.)

A.72.8 pm B.72.8 m C. 7.2pm D.7.28m

**148**. A sample of 0.89 gram of KCl is dissolved in 54.6 g of water. What is the %by mass of KCl in the solution? A. 6.1% B. 1.2% C. 1.6% D. 16%

**149.** Which of the following statement is not true regarding the electrolysis of concentrated NaCl solution?

A. Chlorine gas is produced at the anode.

B. Hydrogen gas is formed at the cathode.

C. Oxygen gas is produced at the anode.

D.The solution becomes basic.

**150.** Which of the following statement is correct about $\Delta G^{O}$ ,K &$E^{O}$ cell?

A. If K<1, $\Delta G^{O}$ <0 B. If $\Delta G^{O}$ =0,K>1

C. If K>1, $\Delta G^{O}$ <0 D. If a rxn is spontaneous, then $\Delta G^{O}$>0

**151.**Using the given data calculate the enthalpy of combustion of C to CO.

$C(s) + 1/2\ O_2(g) \longrightarrow CO(g)$

i. $C(s) + 1/2\ O_2(g) \longrightarrow CO(g)$ $\Delta H = -393.5$ kJ

ii. $C(s) + 1/2\ O_2(g) \longrightarrow CO(g)$ $\Delta H = -283.0$kJ

A.110.5kJ B. -110.5kJ C. -676.5 kJ D. 676.5 Kj

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

A. $CaCO_3$ B. $PCl_3$ C. $MgF_2$ D. $CH_2O$

153. Which of the following is not probable shape of a molecule?

A.$GeCl_4$ ,tetrahedral B. HCN, bent

C.$BrF_3$ ,T-shape D. $PCl_5$ , Trigonal bipyramidal

154. Which of the following factor does not affect the rate of zero order rxn?

A.Concentration of rct B. Temperature C. Catalyst D. Surface area of rct

155. The density of chlorine gas at STP, in grams per liter, is approximately:

(a) 6.2 (b) 3.2 (c) 3.9 (d) 4.5

**156.** For a reaction $2A + B \longrightarrow 2C$, with the rate equation: Rate = $k[A]^2[B]$

(a) the order with respect to A is 1 and the order overall is 1.

(b) the order with respect to A is 2 and the order overall is 2.

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(c) the order with respect to A is 2 and the order overall is 3.

(d) the order with respect to B is 2 and the order overall is 2.

**157.** The decomposition of carbon disulfide, $CS_2$, to carbon monosulfide, CS. ( $CS_2 \longrightarrow CS + S$ ), and sulfur is first order with $k = 2.8 \times 10^{-7}\ s^{-1}$ at 1000°C . What is the half-life of this reaction at 1000°C?

(a) $5.0 \times 10^{7}$ s (b) $4.7 \times 10^{-6}$ s (c) $3.8 \times 10^{5}$ s (d) $2.5 \times 10^{6}$ s

**158.** Which statement is **false**?

(a) If a reaction is thermodynamically spontaneous it may occur rapidly.

(b) If a reaction is thermodynamically spontaneous it may occur slowly.

(c) Activation energy is a kinetic quantity rather than a thermodynamic quantity.

(d) If a reaction is thermodynamically spontaneous, it must have a low activation energy.

**159.** Antibonding molecular orbitals are produced by

(a) constructive interaction of atomic orbitals.

(b) destructive interaction of atomic orbitals.

(c) the overlap of the atomic orbitals of two negative ions

(d) all of these

**160.** Consider the neutralization reactions between the following acid-base pairs in dilute aqueous solutions:

(1) $CH_3COOH + NaOH \longrightarrow$

(2) $HNO_3 + Mg(OH)_2 \longrightarrow$

(3) $H_3PO_4 + Ba(OH)_2 \longrightarrow$

(4) $HCl + KOH \longrightarrow$

(5) $H_2CO_3 + LiOH \longrightarrow$

For which of the reactions is the **net ionic** equation: $H^+ + OH^- \longrightarrow H_2O$ ?

(a) 1, 3 (b) 1, 4, 5 (c) 2, 3 (d) 4

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