

Chemistry, 2008 EC, entrance exam

Grade 12 · Chemistry · 2008 E.C.

MARKING KEY — CONFIDENTIAL

Time allowed: 120 minutes

Questions: 68

Total marks: 68

1. A drug decomposes by zero-order kinetics with a rate constant of $2 \text{ mgmL}^{-1} \text{ month}^{-1}$. If the initial concentration is 100 mgmL^{-1} , how long will it take for the drug to decompose by 10%? (1)
- A. 2 months
B. 3 months
C. ✓ 5 months
D. 4 months

Answer: C

For a zero-order reaction, the amount decomposed is given by $x = k \cdot t$. A 10% decomposition of 100 mg/mL corresponds to 10 mg/mL , so $t = (10 \text{ mg/mL}) / (2 \text{ mg/(mL*month)}) = 5 \text{ months}$.

2. The value of K_{eq} for the following reaction is 0.25. $\text{SO}_2(\text{g}) + \text{NO}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}) + \text{NO}(\text{g})$ What is the value of K_{eq} at the same temperature for the reaction below? $2\text{SO}_2(\text{g}) + 2\text{NO}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}) + 2\text{NO}(\text{g})$ (1)
- A. 0.25
B. ✓ 0.062
C. 0.50
D. 16

Answer: B

Multiplying the coefficients of an equilibrium reaction by a factor of 2 squares the equilibrium constant, so $K_{eq}' = (0.25)^2 = 0.0625$, which rounds to 0.062.

3. Which of the following would react to form pentyl ethanoate? (1)
- A. 1- propanol and pentanoic acid
B. Ethanol and pentanoic acid
C. ✓ 1- pentanol and ethanoic acid
D. Ethanol and ethanoic acid

Answer: C

Pentyl ethanoate is an ester formed by the Fischer esterification of 1-pentanol (providing the pentyl group) and ethanoic acid (providing the ethanoate group).

4. Which of the following is correct when 34495 is rounded to three significant figures? (1)
- A. 345
B. ✓ 34500
C. 344
D. 3840

Answer: B

Rounding 34495 to three significant figures requires looking at the fourth digit (9), which rounds the third digit (4) up to 5, resulting in 34500.

5. What is the first step of the scientific method? (1)
- A. ✓ Making observations
B. Forming a hypothesis
C. Performing an experiment
D. Predicting the result of an experiment

Answer: A

The scientific method traditionally begins with making observations about a phenomenon, which then leads to asking a question and formulating a hypothesis.

6. What is the distance that a radio wave will travel in 0.250sec? (1)
- A. $1.2 \times 10^7 \text{ m}$
B. $12 \times 10^7 \text{ m}$
C. ✓ $7.5 \times 10^7 \text{ m}$
D. $5.6 \times 10^7 \text{ m}$

Answer: C

Radio waves travel at the speed of light ($c = 3.0 \times 10^8 \text{ m/s}$). The distance traveled in 0.250 s is $(3.0 \times 10^8 \text{ m/s}) \cdot 0.250 \text{ s} = 7.5 \times 10^7 \text{ m}$.

7. Which of the following is not a form of chemical bonding? (1)
- A. Covalent bonding
B. Metallic bonding
C. Ionic bonding
D. ✓ Hydrogen bonding

Answer: D

Ionic, covalent, and metallic bonds are primary intramolecular chemical bonds, whereas hydrogen bonding is an intermolecular force.

8. Which of the following statements is not true about covalent bonding? (1)
- A. Covalent compounds are least likely to be formed between atoms of the same elements.
 - B. **Covalent bonds are least likely to be formed between atoms of different elements of different elements on the right side of the periodic table.**
 - C. Covalent bonds are least likely to be formed between an element in Group I and an element in Group VII.
 - D. Covalent bonds are least likely to be formed by head of the group elements with high ionization energies.

Answer: B

9. If we increase the concentration of a reactant, what happens to the collision between particles? (1)
- A. **There are more collisions.**
 - B. There are fewer collisions.
 - C. There are the same number of collisions, but they have less energy
 - D. There are the same number of collisions, but they have more energy

Answer: A

Increasing the concentration increases the number of reactant particles per unit volume, which increases the frequency of collisions between particles.

10. What mass of magnesium is plated out upon electrolysis from molten MgCl_2 using a current of 60A for a period of 4000 seconds? (1)
- A. **30gm**
 - B. 24gm
 - C. 60gm
 - D. 72gm

Answer: A

Using Faraday's law, mass $m = \frac{M \cdot I \cdot t}{z \cdot F} = \frac{24.3 \text{ g/mol} \times 60 \text{ A} \times 4000 \text{ s}}{2 \times 96500 \text{ C/mol}} \approx 30.2 \text{ g}$, which corresponds to 30 gm.

11. For a voltaic (or galvanic) cell using Ag, Ag^+ (1.0M) and Zn, Zn^{2+} (1.0M) half cells, which of the following statements is incorrect? (1)
- A. The zinc electrode is the Anode.
 - B. The electrons will flow through the external circuit from the zinc electrode to the silver electrode.
 - C. The mass of the zinc electrode will decrease as the cell operates.
 - D. **Reduction occurs at the zinc electrode as the cell operates.**

Answer: D

Zinc has a lower reduction potential than silver, so it acts as the anode where oxidation occurs ($\text{Zn} \rightarrow \text{Zn}^{2+} + 2e^-$), while reduction takes place at the silver cathode.

12. The difference between fats and oils is that (1)
- A. **Oils are liquid at room temperature.**
 - B. Oils have more calories
 - C. Oils are sold at room temperature.
 - D. Fats are liquid at room temperature.

Answer: A

The primary physical distinction between fats and oils is their state at room temperature: oils are liquids because they contain a higher proportion of unsaturated fatty acids, whereas fats are solids.

13. What is the solvent in 70% alcohol solution? (1)
- A. Water
 - B. **Alcohol**
 - C. Sugar
 - D. Kerosene

Answer: B

In a solution composed of miscible liquids, the component present in the greatest proportion is designated as the solvent, so alcohol (70%) is the solvent and water (30%) is the solute.

14. How many moles of H_2SO_4 are needed to prepare 5.0 liters of a 2.0M solution of H_2SO_4 ? (1)
- A. 2.5
 - B. 5
 - C. 20
 - D. **10**

Answer: D

The number of moles of solute is calculated by multiplying molarity by volume: $n = M \times V = 2.0 \text{ M} \times 5.0 \text{ L} = 10 \text{ moles}$.

15. What is the balanced net ionic equation for the reaction of CaCl_2 and AgNO_3 ? (1)
- A. $\text{CaCl}_2 (\text{aq}) + 2\text{AgNO}_3 (\text{aq}) \rightarrow 2(\text{NO}_3)_2 (\text{aq}) + 2\text{AgCl} (\text{s})$ B. $\text{Ca}^{2+} (\text{aq}) + 2\text{Cl}^- (\text{aq}) + 2\text{NO}_3^- (\text{aq}) \rightarrow \text{Ca}^{2+} (\text{aq}) + 2\text{NO}_3^-$
 C. $\text{Cl}^- (\text{aq}) + \text{Ag}^+ (\text{aq}) \rightarrow 2\text{AgCl} (\text{s})$ D. $\checkmark 2\text{Cl}^- (\text{aq}) + 2\text{Ag}^+ (\text{aq}) \rightarrow 2\text{AgCl} (\text{s})$

Answer: D

The molecular equation is $\text{CaCl}_2 + 2\text{AgNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + 2\text{AgCl}(\text{s})$. Removing spectator ions (Ca^{2+} and NO_3^-) gives the balanced net ionic equation $2\text{Cl}^- (\text{aq}) + 2\text{Ag}^+ (\text{aq}) \rightarrow 2\text{AgCl}(\text{s})$ (option C is stoichiometry-unbalanced).

16. The K_a of Hypochlorous acid (HClO) is 3.0×10^{-4} at 25°C . What is the % ionization of hypochlorous acid in a 0.015M aqueous solution of HClO at 25°C ? (1)
- A. 2.1×10^{-5} B. $\checkmark 0.14$
 C. 1.4×10^{-3} D. 3.3×10^{-3}

Answer: B

The degree of ionization is $\alpha = \sqrt{\frac{K_a}{C}} = \sqrt{\frac{3.0 \times 10^{-4}}{0.015}} = \sqrt{0.02} \approx 0.14$ (or 14%).

17. Which of the following combinations cannot produce a buffer solution? (1)
- A. $\checkmark \text{HClO}_4$ and NaClO_4 B. HCN and NaCN
 C. HNO_2 and NaNO_2 D. NH_3 and $(\text{NH}_4)_2\text{SO}_4$

Answer: A

A buffer solution consists of a weak acid and its conjugate base or a weak base and its conjugate acid; perchloric acid (HClO_4) is a strong acid, so it cannot form a buffer.

18. What is the molality of a solution that contains 51.2gm of naphthalene, C_{10}H_8 in 500ml of carbon tetrachloride? The density of CCl_4 is 1.60gm/ml (1)
- A. 0.750m B. $\checkmark 0.500\text{m}$
 C. 0.84m D. 1.69m

Answer: B

The molar mass of naphthalene (C_{10}H_8) is 128 g/mol, giving $51.2 \text{ g} / 128 \text{ g/mol} = 0.400 \text{ mol}$ of solute. The mass of 500 mL of CCl_4 is $500 \text{ mL} \times 1.60 \text{ g/mL} = 800 \text{ g} = 0.800 \text{ kg}$, so the molality is $0.400 \text{ mol} / 0.800 \text{ kg} = 0.500 \text{ m}$.

19. What is the ionization constant for a weak acid, H_a , that is 1.60% ionized in 0.0950M solution? (1)
- A. 2.69×10^{-3} B. 3.77×10^{-2}
 C. $\checkmark 2.47 \times 10^{-5}$ D. 9.91×10^{-6}

Answer: C

The degree of ionization is $\alpha = 0.0160$. Using $K_a = \text{Ca}^2 / (1 - \alpha) = (0.0950)(0.0160)^2 / (1 - 0.0160) = 2.432 \times 10^{-5} / 0.984 \approx 2.47 \times 10^{-5}$.

20. Which of the following is correct? (1)
- A. $1\text{pa} = 10\text{Nm}^2$ B. $1\text{N} = 10\text{Kg}$
 C. $0.00072 = 7.2 \times 10^{-3}$ D. $\checkmark 1\text{L} = 1\text{dm}^3$

Answer: D

By definition of metric volume units, 1 liter (L) equals 1 cubic decimeter (dm^3). The other options have incorrect unit conversions or scientific notation (0.00072 is 7.2×10^{-4}).

21. For the Galvanic cell shown below, which one of the following statement is correct? (1)
- [Figure: A hand-drawn galvanic cell. Two beakers stand side by side, each holding a solution drawn as horizontal wavy lines with a faint formula written inside the liquid. A metal strip dips into each beaker: the left strip is labelled "Magnesium" by a leader line coming in from the left, the right strip is labelled "Zinc" by a leader line coming in from the right. A wire runs up from each strip and the two wires meet at a small circle containing the letter "V" (a voltmeter) at the top centre, closing the external circuit. Beneath that wire, a second inverted U-tube joins the two beakers, dipping into both solutions; the word "Salt" is printed in the gap between the beakers, with a short tick mark on the tube above it, labelling it as the salt bridge. No numerical values are shown.]*
- A. At the zinc electrode, zinc ions are formed.
 B. $\checkmark$ The electrode potential is measured by the voltmeter.
 C. The following reaction takes place at the magnesium electrode $\text{Mg}^{2+} + 2\text{e}^- \rightarrow \text{Mg}$.
 D. Electrons flow from the zinc electrode to the magnesium electrode.

Answer: B

Magnesium has a more negative standard reduction potential (-2.37 V) than zinc (-0.76 V), so magnesium is oxidized at the anode and zinc ions are reduced at the cathode, with electrons flowing from Mg to Zn. The voltmeter measures the potential difference (cell potential) between the electrodes.

22. What is the most common Ore used for the extraction of copper? (1)

- A. CuO B. CuSO_4
C. CuCO_3 D. ✓ CuFeS_2

Answer: D

Chalcopyrite (CuFeS_2), also known as copper pyrites, is the most common and principal ore from which copper is commercially extracted.

23. Which of the following statements about polyvinyl chloride is not correct? (1)

- A. Pvc can be used in making water pipes B. Pvc is stiff
C. Pvc is softened on heating D. ✓ **The monomer of Pvc is $\text{CHCl} = \text{CHCl}$**

Answer: D

The monomer of polyvinyl chloride (PVC) is vinyl chloride (chloroethene, $\text{CH}_2=\text{CHCl}$), not 1,2-dichloroethene ($\text{CHCl}=\text{CHCl}$).

24. Which of the following is a natural polymer? (1)

- A. Keratin B. Polythene
C. ✓ **Cellulose** D. Polymethyl methacrylate

Answer: C

25. Which of the following electrons, identified only by their n and l quantum numbers have the highest energy? $n=3, l=0$ $n=4, l=1$ $n=3, l=2$ $n=4, l=2$ (1)

- A. $n=3, l=2$ B. $n=4, l=1$
C. ✓ **$n=4, l=2$** D. $n=3, l=0$

Answer: C

According to the Aufbau principle ($n+l$ rule), the orbital energy increases with increasing ($n+l$); when ($n+l$) is the same, higher n has higher energy. For $n=4, l=2$ (a 4d orbital), $n+l=6$, which is higher than the other three combinations.

26. What is the maximum number of unpaired electron in a d subshell? (1)

- A. 2 B. ✓ **5**
C. 3 D. 4

Answer: B

A d subshell consists of 5 degenerate orbitals. According to Hund's rule, each orbital is singly occupied before pairing occurs, giving a maximum of 5 unpaired electrons.

27. The following energy level diagram represents the out most shell of what ground state element? (1)

[Figure: A hand-drawn orbital (box) energy-level diagram of an outermost shell. At the lower left is a single short horizontal line with a small box sitting on it holding a pair of arrows drawn as "↑" and an up arrow together (a filled, paired orbital); the label "3s" is written in a box directly beneath that line. Higher up and to the right are three short horizontal lines of equal height, drawn side by side: the leftmost carries a small box holding a single arrow (one unpaired electron), and the middle and right lines are bare. The label "3p" is written in a box beneath the leftmost of those three lines. So the diagram shows a full 3s level below and three 3p levels above, of which only the first holds one electron.]

- A. B B. He
C. ✓ **Al** D. Be

Answer: C

The valence shell configuration shown is $3s^2 3p^1$, which corresponds to aluminum (atomic number 13). Boron has a similar valence pattern but in the $n=2$ shell ($2s^2 2p^1$).

28. In order to advance the level of a theory, a hypothesis should: (1)

- A. Be obviously accepted by most people.
B. ✓ **Be repeatedly confirmed by experimentation.**
C. Be a fully functional experiment.
D. Report the past experience.

Answer: B

A hypothesis gains the status of a scientific theory only after it has been repeatedly tested and supported by extensive experimental evidence.

29. Which of the following types of rays combine to form atoms of Helium? (1)

- A. Gamma (γ) rays
B. Beta (β)
C. ✓ Alpha (α)
D. X-rays

Answer: C

Alpha particles are doubly ionized helium nuclei (He^{2+}). When alpha particles capture two electrons, they become neutral helium atoms.

30. What is the relationship between frequency (ν), wavelength (λ) and the speed of light (c)? (1)

- A. $\lambda/\nu = c$
B. $\nu c = \lambda$
C. $hc/\lambda = \nu$
D. ✓ $c = \nu\lambda$

Answer: D

The speed of light (c) is directly proportional to the product of frequency (ν) and wavelength (λ), giving the wave equation $c = \nu\lambda$.

31. What is the magnitude of quantum energy and the frequency for an object whose wave length is $0.6 \times 10^{-6}\text{m}$? (1)

- A. ✓ $3.31 \times 10^{-9}\text{J}$, $5 \times 10^{14}\text{s}^{-1}$
B. $3.98 \times 10^{-40}\text{J}$, $2 \times 10^{-15}\text{s}^{-1}$
C. $1.99 \times 10^{-25}\text{J}$, $3.98 \times 10^{-40}\text{s}^{-1}$
D. $9.94 \times 10^{-12}\text{J}$, $1.99 \times 10^{-25}\text{sec}$

Answer: A

Frequency is calculated as $\nu = c / \lambda = (3.0 \times 10^8 \text{ m/s}) / (0.6 \times 10^{-6} \text{ m}) = 5 \times 10^{14} \text{ s}^{-1}$. The energy is $E = h\nu \approx 3.31 \times 10^{-19} \text{ J}$ (misprinted as 10^{-9} J in the option, but A is uniquely identified by the correct frequency).

32. What new concept did Bohr adapt and use to formulate his made of the atom? (1)

- A. Electromagnetic theory developed by Maxwell.
B. ✓ The quantum concept developed by plank
C. Phoelectric theory developed by Thompson
D. Newtron theory developed by Chadwick.

Answer: B

Niels Bohr incorporated Max Planck's quantum concept to propose that electrons move in quantized, stable orbits without radiating energy.

33. What values of l are permitted for an electron with $n = 4$? (1)

- A. 1, 2, 3
B. 1, 2, 3, 4
C. 0, 1, 2, 3, 4
D. ✓ 0, 1, 2, 3

Answer: D

For any principal quantum number n , the orbital angular momentum quantum number l can have integer values from 0 up to $(n - 1)$. For $n = 4$, the allowed values are 0, 1, 2, and 3.

34. What would happen to the oxygen molecule upon ionization to O_2^+ ? (1)

- A. The bond length will increase and the bond energy will increase.
B. The bond length will increase and the bond energy will decrease.
C. ✓ The bond length will decrease and the bond energy will increase.
D. The bond length will decrease and the bond energy will decrease.

Answer: C

Ionization of an O_2 molecule removes an electron from an antibonding π^* orbital, increasing the bond order from 2 to 2.5. A higher bond order results in a shorter bond length and a higher bond energy.

35. For a first order reaction, a plot of _____ versus _____ is linear. (1)

- A. $1/[A]_t$, t
B. $\ln 1/[A]_t$, t
C. $[A]_t$, t
D. ✓ $\ln [A]_t$, t

Answer: D

According to the integrated first-order rate law, $\ln[A]_t = -kt + \ln[A]_0$, so a plot of $\ln[A]_t$ versus t yields a straight line with a slope of $-k$.

36. The rate law of the overall reaction $A + B \rightarrow C$ is $\text{rate} = K[A]^2$ which of the following will not increase the rate of the reaction? (1)
- A. Increasing the concentration of reactant A.
B. ✓ **Increasing the concentration of reactant B.**
C. Increasing the temperature of the reaction.
D. Adding a catalyst for the reaction.

Answer: B

Since reactant B does not appear in the rate law (it is zero-order with respect to B), changing its concentration will have no effect on the reaction rate.

37. How many bonding pairs and lone pairs, respectively does the ion ICl_4^- have? (1)
- A. 3, 2
B. ✓ **4, 2**
C. 5, 1
D. 4, 1

Answer: B

In ICl_4^- , the central iodine atom has 7 valence electrons plus 1 from the negative charge (8 electrons). It forms 4 single bonds with chlorine atoms (4 bonding pairs) and retains 4 non-bonding electrons (2 lone pairs).

38. Which of the following molecule does not have a tetrahedral central atom? (1)
- A. ✓ **SF_4**
B. AlH_4^-
C. BF_4^-
D. SiCl_4

Answer: A

SF_4 has 4 bonding pairs and 1 lone pair on the sulfur atom, giving it a seesaw molecular shape based on a trigonal bipyramidal electron geometry, whereas AlH_4^- , BF_4^- , and SiCl_4 all have tetrahedral geometry.

39. Acrylonitrile has the following Lewis structure with the designation of x, y and z for each carbon atom. What will be the value of the bond angle and geometry (1)
- [Figure: A hand-drawn structural formula in two rows, printed as one image. Top row: " $\text{CH}_2 = \text{C} - \text{C} \equiv \text{N}$ ", i.e. a CH_2 group joined by a double bond to a carbon, that carbon joined by a single bond to a further carbon, and that carbon joined by a triple bond to N. A single vertical bond drops from the middle carbon of the top row. Directly below that vertical bond is the letter H. Below the H is a second row reading " $\text{C} - \text{C} \equiv \text{N}$ ": a carbon joined by a single bond to a carbon, which is triple-bonded to N; the left carbon of this row carries the vertical bond up to the H above it, and a further vertical bond descending below it, which is clipped off at the bottom edge of the image. The x, y and z carbon labels named in the stem are not visible anywhere in the rendered picture.]
- A. 1090, tetrahedral
B. 1200, trigonal pyramidal
C. ✓ **1800, linear**
D. 900, T- shape

Answer: C

40. Antimony (Sb) is a group v element, what will be the molecular geometry and number of lone pair electrons, respectively that exists in the ion $[\text{SbCl}_5]^{2-}$? (1)
- A. Seesaw, 1
B. ✓ **Square pyramid, 2**
C. Seesaw, 2
D. Linear, 3

Answer: B

Antimony (group 15) in $[\text{SbCl}_5]^{2-}$ has $5 + 2 = 7$ valence electrons; forming 5 single bonds leaves 2 non-bonding electrons (1 lone pair). With 6 electron pairs around Sb, the molecular geometry is square pyramidal with 2 lone pair electrons.

41. Which of the following molecules does not have a trigonal bipyramidal electron-pair geometry? (1)
- A. SF_4
B. ClF_3
C. XeF_2
D. ✓ **BrF_5**

Answer: D

BrF_5 has 5 bonding pairs and 1 lone pair, giving a steric number of 6 and an octahedral electron-pair geometry, unlike SF_4 , ClF_3 , and XeF_2 which all have 5 electron domains (trigonal bipyramidal).

42. How many atomic orbitals are required for an sp^3 hybridization? (1)
- A. 2
B. 6
C. ✓ **4**
D. 8

Answer: C

An sp^3 hybrid orbital set is formed by combining one s atomic orbital and three p atomic orbitals, requiring a total of 4 atomic orbitals.

43. Formic acid, which is released by ants, has a molecular formula of HCOOH . What are the possible hybridizations that exist in the molecule? (1)
- A. ✓ Sp^2 and sp^3 B. Sp and sp^3
C. Sp , sp^2 and sp^3 D. Sp and sp^2

Answer: A

In formic acid (HCOOH), the carbonyl carbon and carbonyl oxygen both have three electron domains and are sp^2 hybridized, while the hydroxyl oxygen has four electron domains (two bonds, two lone pairs) and is sp^3 hybridized.

44. Which of the following statements concerning fats and oils is incorrect? (1)
- A. They are also called triacylglycerols. B. They are also called triglycerides.
C. ✓ **They are fatty acid salts.** D. They are glycerol trimesters.

Answer: C

Fats and oils are triesters of glycerol and fatty acids (triglycerides), whereas fatty acid salts are soaps produced by saponification.

45. Which of the following statement(s) is (are) applicable to a balanced chemical equation of an elementary reaction? I. Order is same as molecularity. II. Order is less than the molecularity. III. Order is greater than the molecularity. IV. Molecularity can never be zero. (1)
- A. I B. I, II
C. ✓ **I, IV** D. I, III

Answer: C

For an elementary reaction, the reaction order is always equal to its molecularity, and molecularity represents the number of colliding species so it can never be zero.

46. At high pressure, the following reaction is zero order, Which of the following options is (are) correct for this reaction? I. Rate of reaction = rate constant. II. Rate of reaction depends on the concentration of ammonia. III. Rate of decomposition of ammonia remains constant until ammonia decomposes completely. IV. Further increase in pressure will change the rate of reaction. $2\text{NH}_3(\text{g}) \xrightarrow{1130 \text{ K, pt}} \text{N}_2(\text{g}) + 3\text{H}_2(\text{g})$ (1)
- A. ✓ **I** B. I, III, IV
C. I, II D. I, II, IV

Answer: A

47. Which of the following expressions is correct for the rate of reaction given below? (1)
- $$5\text{Br}^-(\text{aq}) + \text{BrO}_3^- + 6\text{H}^+(\text{aq}) \rightarrow 3\text{Br}_2(\text{aq}) + 3\text{H}_2\text{O}(\text{l})$$
- A. $\frac{\Delta[\text{Br}^-]}{\Delta t} = \frac{5\Delta[\text{H}^+]}{\Delta t}$ B. ✓ $\frac{\Delta[\text{Br}^-]}{\Delta t} = 5/6 \frac{\Delta H}{\Delta t}$
C. $\frac{\Delta[\text{Br}^-]}{\Delta t} = 6/5 \frac{\Delta H}{\Delta t}$ D. $\frac{\Delta[\text{Br}^-]}{\Delta t} = 6 \frac{\Delta H}{\Delta t}$

Answer: B

Equating the rates of disappearance gives $-(1/5)\Delta[\text{Br}^-]/\Delta t = -(1/6)\Delta[\text{H}^+]/\Delta t$, which rearranges to $\Delta[\text{Br}^-]/\Delta t = (5/6)\Delta[\text{H}^+]/\Delta t$.

48. The following equilibrium constants were determined at 300°C . $2\text{N}_2\text{O}(\text{g}) \rightleftharpoons \text{N}_2(\text{g}) + \text{O}_2(\text{g})$, $K_c = 4.0 \times 10^{18}$ (1)
- $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$, $K_c = 4.0 \times 10^{-31}$ What will be the equilibrium constant at 300°C for the gaseous reaction of $2\text{N}_2\text{O}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g})$?
- A. 3.2×10^{-12} B. ✓ **6.4×10^{45}**
C. 5.0×10^{50} D. 1.6×10^{-49}

Answer: B

49. When 0.50 mol of N_2O_4 is placed in a 4.0 liter reaction vessel and heated to 400K , 80% of the N_2O_4 decomposes to NO_2 gas as follows: (1)
- $$\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$$
- What will be the value of K_p , in units of pressure, at 400K for this reaction?
- A. 2.62 B. ✓ **13.12**
C. 50.48 D. 16.2

Answer: B

50. Which of the following is not true about carbonyl compounds? (1)
- A. Carbonyl compounds contain 3σ - bond and 1π - bond.
B. ✓ **The carbon oxygen bond is both longer and weaker.**
C. The bond angle in carbonyl is about 120° .
D. Carbonyl compounds may be hydrolysed.

Answer: B

The carbon-oxygen double bond in a carbonyl group consists of a σ -bond and a π -bond, making it shorter and stronger than a carbon-oxygen single bond, not longer and weaker.

51. Sodium acetate spontaneously crystallizes out of a supersaturated solution on standing. Which of the following is true for the thermodynamic quantities of this system for such a process? (1)
- A. ✓ $\Delta S < 0, \Delta H < 0$
B. $\Delta G < 0, \Delta H > 0$
C. $\Delta S > 0, \Delta G < 0$
D. $\Delta S > 0, \Delta H > 0$

Answer: A

52. In which of the following systems will the position of equilibrium shift to the left upon an increase in pressure, but to the right upon an increase in temperature? (1)
- A. $\text{CO}_2(\text{g}) + \text{H}_2(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}), \Delta H > 0$.
B. $\text{C}_2\text{H}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{C}_2\text{H}_5\text{OH}(\text{g}), \Delta H < 0$.
C. ✓ $\text{C}_2\text{H}_6(\text{g}) \rightleftharpoons \text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g}), \Delta H > 0$.
D. $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g}), \Delta H > 0$.

Answer: C

53. The hydrogen used in the Haber process is made by the following reaction $\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + 3\text{H}_2(\text{g}), \Delta H^\circ = +206\text{KJ}$ Which of the following sets of conditions will favour the formation of H_2 ? (1)
- A. ✓ **Low pressure and high temperature.**
B. Low pressure and low temperature.
C. High pressure and low temperature.
D. High pressure and high temperature.

Answer: A

54. Which of the following types of compounds are expected products from the saponification of a fat? (1)
- A. ✓ **Glycerol and fatty acid salts.**
B. Glycerol and fatty acids.
C. Fatty acid salts and fatty acids.
D. Glycerol, fatty acid salts and fatty acids.

Answer: A

55. Which one of the following statements best describes the standard enthalpy of formation of any element? (1)
- A. The value of ΔH_f° (element) depends on temperature.
B. ✓ **The value of ΔH_f° (element) is zero for any element in the standard state.**
C. The value of ΔH_f° (element) is zero only for elements in the solid state.
D. The value of ΔH_f° (element) is zero only at absolute zero temperature.

Answer: B

56. Equal masses of He and Ne are placed in a sealed container. What is the partial pressure of Ne, if the total pressure is 6 atm? (1)
- A. 2
B. 3
C. ✓ **1**
D. 5

Answer: C

57. What is the molarity of a solution made by dissolving 10g of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) in sufficient water to form 200ml solution? (1)
- A. 0.18
B. 0.251
C. 0.362
D. ✓ **0.278**

Answer: D

58. In which direction will the following equilibrium shift, if a solution of $\text{CH}_3\text{CO}_2\text{Na}$ is added? (1)
- $$\text{CH}_3\text{COOH (aq)} \rightleftharpoons \text{CH}_3\text{CO}_2^- \text{ (aq)} + \text{H}^+ \text{ (aq)}$$
- A. The equilibrium shift to the right (more products).
B. No change
C. ✓ **The equilibrium shifts to the left (more resultant)**
D. Cannot be predicted.

Answer: C

59. A 1.0M solution a weak acid is found to dissociate by only 1.37%. Which of the following acid is it likely to be? (1)
- A. $\text{HF } K_a = 7.2 \times 10^{-4}$
B. $\text{HNO}_2 K_a = 7.2 \times 10^{-4}$
C. $\text{CH}_3\text{COOH } K_a = 1.8 \times 10^{-5}$
D. ✓ **$\text{HCOOH } K_a = 1.9 \times 10^{-4}$**

Answer: D

60. Consider the following graph, which relates to the equilibrium system: $\text{CH}_3\text{COOH}_{(\text{aq})} + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{COO}^-_{(\text{aq})} + \text{H}_3\text{O}^+_{(\text{aq})}$, $\Delta H < 0$ (1)
- Which of the following actions caused the change in the concentration of $[\text{H}_3\text{O}^+_{(\text{aq})}]$ at time t ?
- [Figure: A hand-drawn line graph with no numerical scale on either axis. The vertical axis, drawn with an arrowhead at the top, is labelled $[\text{H}_3\text{O}^+_{(\text{aq})}]$ written sideways up the axis. The horizontal axis, also arrow-headed, is labelled "Time" at its right end, with the letter "t" printed beneath it further left. A heavy vertical dashed line runs the full height of the plot at the position marking time t . The plotted curve begins at a constant, relatively high value on the vertical axis and runs perfectly flat and horizontal up to the dashed line. At the dashed line it turns downward, falling steeply at first and then curving over into a smooth decay, and finally flattens out at a new, lower constant value that continues horizontally to the right edge of the graph. So the concentration is steady, drops sharply at time t , and settles at a lower steady value.]
- A. ✓ **Addition of $\text{CH}_3\text{COO}^- \text{ (aq)}$**
B. Addition of HCl
C. Decreasing of temperature.
D. Increasing the volume of the container.

Answer: A

61. A $1.0 \times 10^{-4}\text{M}$ solution has a PH of 10.00. The solution is a (1)
- A. Weak acid
B. Weak base
C. ✓ **Strong base**
D. Strong acid

Answer: C

A pH of 10.00 corresponds to a pOH of 4.00, meaning $[\text{OH}^-] = 1.0 \times 10^{-4} \text{ M}$. Since the concentration of OH^- equals the molar concentration of the solution, the solute undergoes complete dissociation, characteristic of a strong base.

62. A polysaccharide is a polymer made up of which kind of monomers? (1)
- A. Amino acids
B. Nucleotides
C. ✓ **Simple sugars**
D. Alternating sugar and phosphate groups.

Answer: C

Polysaccharides are complex carbohydrates formed by the condensation polymerization of monosaccharides (simple sugars) linked together by glycosidic bonds.

63. What is the purpose of a salt bridge in an electrochemical cell? (1)
- A. To provide a source of ions to react at the anode and cathode.
B. ✓ **The maintain electrical neutrality in the half-cell through migration of ions.**
C. To provide means of electrons to travel from the cathode to the anode.
D. To provide means of electrons to travel from the anode to the cathode.

Answer: B

A salt bridge allows the flow of ions between the half-cells to prevent charge buildup and maintain electrical neutrality while completing the circuit; electrons travel through the external wire, not the salt bridge.

64. What is galvanized iron? (1)
- A. Iron that is coated with tin.
B. ✓ **Iron that is coated with zinc.**
C. Iron that is coated with chromium.
D. Iron that is coated with aluminium.

Answer: B

Galvanized iron is iron or steel that has been coated with a protective layer of zinc to prevent rusting.

65. The standard cell potential (E^0) for the reaction below is 1.10v. What is the cell potential for this reaction when $[Cu^{2+}] = 1 \times 10^{-5}M$ and $[Zn^{2+}] = 1M$? $Zn_{(s)} + Cu_{(aq)}^{2+} \rightarrow Zn_{(aq)}^{2+} + Cu_{(s)}$ (1)
- A. 1.1
B. ✓ 0.95
C. 1.2
D. 1.35

Answer: B

Using the Nernst equation, $E = E^0 - (0.0592/n) \log Q$. Here $n = 2$ and $Q = [Zn^{2+}]/[Cu^{2+}] = 1 / (10^{-5}) = 10^5$, so $E = 1.10 - (0.0592/2)(5) \approx 1.10 - 0.148 = 0.95$ V.

66. Which of the following statements is true? (1)
- A. ✓ **The more positive the value of E_{red}^0 , the greater the driving force for reduction.**
B. The more exothermic the value of E_{red}^0 , the greater the driving force for reduction.
C. The more endothermic the value of E_{red}^0 , the greater the driving force for reduction.
D. The more negative the value of E_{red}^0 , the greater the driving force for reduction.

Answer: A

A higher, more positive standard reduction potential indicates a greater thermodynamic tendency (driving force) for a chemical species to gain electrons and undergo reduction.

67. Which of the following types of elements are good oxidizing agents? (1)
- A. Alkali metals
B. ✓ **Halogens**
C. Lanthanides
D. Transition elements

Answer: B

Halogens have high electronegativities and electron affinities, causing them to readily accept electrons (undergo reduction), making them strong oxidizing agents.

68. Which of the following statements concerning petroleum is Not correct? (1)
- A. ✓ **It is a renewable energy source.**
B. It is a fossil fuel.
C. It is a mixture consisting mainly of hydrocarbons.
D. It was formed from marine organisms, which died millions of years ago.

Answer: A

Petroleum is a non-renewable fossil fuel formed over millions of years from ancient marine organisms, and its reserves are depleted through consumption far faster than they can form.

— END OF MARKING KEY —

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