

Chemistry, 2011 EC, entrance exam

Grade 12 · Chemistry · 2011 E.C.

Time allowed: 120 minutes

Questions: 77

Total marks: 77

Name _____ Grade _____ ID No. _____ Date _____

1. What aspect of the modern view of atomic structure was proved by Rutherford's gold foil experiment? (1)
A. The existence of the nucleus. B. The charge on an electron.
C. The charge on an α particle. D. The existence of electrons.
2. Which of these compounds is propanoic acid? (1)
A. $\text{CH}_3\text{CH}_2\text{COOCH}_3$ B. $\text{CH}_3\text{CH}_2\text{COH}$
C. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ D. $\text{CH}_3\text{CH}_2\text{COOH}$
3. Fats and oils can be classified as_____. (1)
A. carbohydrates B. acids
C. esters D. alcohols
4. What does it mean by $\Delta H = \text{negative}$ for a given process? (1)
A. The process is endothermic B. The process is exothermic
C. The process is adiabatic D. The process is equithermic
5. The oxidation state of chlorine in HClO_4 is: (1)
A. +1 B. +3
C. +5 D. +7
6. Which substance is used to lower the melting point of aluminum oxide ore in the electrolytic extraction of aluminum? (1)
A. Cryolite B. Bauxite
C. Hematite D. Magnetite
7. The metal extracted from limestone, chalk and marble is_____. (1)
A. Sodium B. Calcium
C. Zinc D. Chromium
8. Which one of the following is NOT a condensation polymer? (1)
A. Neoprene B. Polyamides
C. Polyester D. Nylon
9. Which of the following compounds does NOT contain both ionic and covalent bond? (1)
A. NH_4NO_3 B. $\text{CH}_3\text{CO}_2\text{H}$
C. NH_4Cl D. Na_2CO_3

10. Acetylsalicylic acid (aspirin) has the structural formula: (1)
Which functional group (groups) is (are) present in aspirin?
[Figure: A chemical structural formula of acetylsalicylic acid (aspirin). It consists of a benzene ring with two adjacent substituents on the right side: the upper-right substituent shows a bond from the ring vertex to a group labeled '-COH' with a vertical double bond to an oxygen atom ('=O') above it; the lower-right substituent shows a bond from the ring vertex to '-O-CH3' with a vertical double bond to an oxygen atom ('=O') below the bond between O and CH3.]
- A. Hydroxyl
B. hydroxyl and carbonyl
C. Carboxyl and acetyl
D. Carboxyl and ester
11. Which of the four colligative properties arises in systems where there is an equilibrium between a liquid solution phase and a second liquid phase? (1)
- A. Vapour pressure lowering
B. Boiling point elevation
C. Freezing point depression
D. Osmotic pressure
12. Which of the following can function as both a Brønsted-Lowry acid and Brønsted-Lowry base? (1)
- A. H_2SO_4
B. HSO_3^-
C. SO_4^{2-}
D. H^+
13. What makes the phosphorus cycle different from the carbon and nitrogen cycles? (1)
- A. Phosphorus is found in the atmosphere in the gaseous state.
B. Carbon and nitrogen are released at lower rate compared to phosphate salts.
C. Phosphorus salts are released at higher rate compared to carbon and nitrogen cycles.
D. Carbon and nitrogen are found in the atmosphere in the gaseous state.
14. When Na_2CrO_4 solution is acidified, which of the following is formed? (1)
- A. Cr (metal)
B. Cr_2O_3
C. CrO_4^{2-}
D. $\text{Cr}_2\text{O}_7^{2-}$
15. Nylon is a/an____? (1)
- A. Amide
B. Peptide
C. Polyamide
D. Polyester
16. Which of the following is NOT a component of polysaccharides? (1)
- A. Glucose
B. Sucrose
C. Cellulose
D. Glycogen
17. Which of the following is the SI measurement unit of electric current? (1)
- A. Ampere
B. Watt
C. Volt
D. Coulomb
18. What is the first step in a scientific investigation? (1)
- A. Ask questions
B. Make observations
C. Do research
D. Draw conclusions

19. In the electromagnetic spectrum with wavelengths shown (in micrometers, μm), which bracketed section of the spectrum represents visible light?
[Figure: A horizontal axis labeled 'wavelength (μm)' with tick marks at 0.2, 0.4, 0.6, 0.8, 1, 2, 4, 8, 10, 12, and 20. Above the axis are four curly brackets indicating intervals: bracket 'x' spans from 0.4 to 0.8 μm ; bracket 'y' spans from 0.8 to 4 μm ; bracket 'z' spans from 4 to 12 μm ; bracket 'o' spans from 12 to 20 μm .]

A. o
 B. x
 C. y
 D. z

20. Which of the orbitals in the figure below has (have) an angular momentum quantum number of $l = 2$?
[Figure: Four electron density cross-section diagrams labeled I, II, III, and IV. I and III are spherically symmetric showing concentric circular rings (s orbitals). II shows a four-lobed cloverleaf pattern (d orbital). IV shows two vertically aligned lobes with a nodal plane between them (p orbital).]

A. I
 B. I and III
 C. II
 D. I and IV

21. Which groups in the periodic table form ionic bonds?

A. Groups 1(1A) & 7(7B), Groups 2(2A) & 6(6B)
 B. Groups 1(1A) & 17(7A), Groups 2 (2A) & 16(6A)
 C. Groups 1(1A) & 18(8A), Groups 4(4B) & 14 (4A)
 D. Groups 3(3B) & 5(5B), Groups 4(4B) & 14 (4A)

22. There is a progressive decrease in the bond angle in the series of molecules CCl_4 , PCl_3 , and H_2O . According to the VSEPR model, this is best explained by:

A. Increasing electronegativity of the central atom
 B. Increasing number of lone pair electrons
 C. Decreasing size of the central atom
 D. Decreasing bond strength

23. For the reaction, $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$, the rate of disappearance of H_2 is $0.01 \text{ mol L}^{-1} \text{ min}^{-1}$. What is the rate of appearance of NH_3 ?

A. $0.01 \text{ mol L}^{-1} \text{ min}^{-1}$
 B. $0.02 \text{ mol L}^{-1} \text{ min}^{-1}$
 C. $0.007 \text{ mol L}^{-1} \text{ min}^{-1}$
 D. $0.002 \text{ mol L}^{-1} \text{ min}^{-1}$

24. The appropriate unit for a first order rate constant are?

A. M/s
 B. 1/M s
 C. $1/\text{M}^2 \text{ s}$
 D. 1/s

25. $2\text{X}_{(g)} \rightleftharpoons 3\text{Y}_{(g)} + \text{Z}_{(g)}$ $\Delta H_{(\text{forward rxn})} > 0$
 The molar equilibrium concentrations for the reaction mixture represented above at 298 K are $[\text{X}] = 4.0 \text{ M}$, $[\text{Y}] = 5.0 \text{ M}$, and $[\text{Z}] = 2.0 \text{ M}$. What is the value of the equilibrium constant, K_{eq} , for the reaction at 298 K?

A. 0.06
 B. 2.50
 C. 16.0
 D. 62.5

34. Which one of the following type of bonding exists between atoms with very different electro-negativities? (1)
- A. Metallic bonding
B. Hydrogen bonding
C. Network covalent bonding
D. Ionic bonding
35. Which one of the following reactions at equilibrium would be unaffected by an increase in pressure? (I) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ (II) $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{H}_2\text{O}(\text{g})$ (III) $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$ (IV) $2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{CO}_2(\text{g})$ (1)
- A. I
B. II
C. III
D. IV
36. A sealed isothermal container initially contained 2 moles of CO gas and 3 moles of H_2 gas. The following reversible reaction occurred:
 $\text{CO}(\text{g}) + 2\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_3\text{OH}(\text{g})$
At equilibrium, there was 1 mole of CH_3OH in the container. What was the total number of moles of gas present in the container at equilibrium? (1)
- A. 1
B. 2
C. 4
D. 3
37. Hydrolysis of ester leads to the formation of which of the following products in basic medium? (1)
- A. Ether and alcohol
B. Aldehyde and alcohol
C. Alcohol and sodium carboxylate
D. Sodium carboxylate
38. When a saturated solution of sodium chloride is heated, it becomes (1)
- A. Unsaturated
B. Remains saturated
C. Supersaturated
D. Attains equilibrium conditions
39. The pH of a solution prepared by the addition of 100 mL 0.002 M HCl to 100-mL distilled water is closest to: (1)
- A. 1.0
B. 1.5
C. 2.0
D. 3.0
40. A chemist creates a buffer solution by mixing equal volumes of a 0.2-molar HOCl solution and a 0.2-molar KOCl solution. Which of the following will occur when a small amount of KOH is added to the solution? (1)
- I. The concentration of undissociated HOCl will increase.
II. The concentration of OCl^- ions will increase.
III. The concentration of H^+ ions will increase.
- A. I only
B. II only
C. III only
D. I and III only
41. Based on the information given in the table below, what is the enthalpy change for the reaction: $2\text{H}_2\text{O}_2(\text{g}) + \text{S}(\text{s}) \rightarrow \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$ (1)
- [Figure: A table with two columns and four data rows:
Header: 'Substance' and ' ΔH_f° (kJ/mol)'.
Row 1: $\text{H}_2\text{O}_2(\text{g})$ | -150
Row 2: $\text{SO}_2(\text{g})$ | -300
Row 3: $\text{H}_2\text{O}(\text{g})$ | -250
Row 4: $\text{S}(\text{s})$ | 0]
- A. -500 kJ
B. -200 kJ
C. 200 kJ
D. 400 kJ

42. Features common to both galvanic and electrolytic cells include which of the following? (1)
- I. Oxidation at the anode
II. Can perform electrolysis
III. Spontaneous
- A. I only
B. II only
C. III only
D. I and II only
-
43. Which of the following reactions is NOT involved in the contact process, during the production of sulfuric acid? (1)
- A. $\text{SO}_2 + \text{O}_2 \rightarrow 2 \text{SO}_3$
B. $\text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$
C. $\text{SO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{S}_2\text{O}_7$
D. $\text{H}_2\text{S}_2\text{O}_7 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$
-
44. Two types of polymer are shown below. Which of the following statements concerning these polymers is correct? (1)
- [Figure: Two schematic drawings of polymer structures labeled X and Y. Diagram X shows three horizontal wavy polymer chains with vertical dashed lines representing weak intermolecular attractions between adjacent chains. Diagram Y shows three horizontal polymer chains connected to each other by solid vertical and angled covalent cross-links, forming a continuous network.]
- A. X and Y are thermosetting
B. X is thermosetting and Y is thermoplastic
C. X is thermoplastic whereas Y is thermosetting
D. X and Y are thermoplastic
-
45. The energy of an electron in the first Bohr orbit of hydrogen atom is -13.6 eV. The possible value of the excited state for electron in Bohr orbits of hydrogen is_____. (1)
- A. -1.51 eV
B. -6.8 eV
C. -4.21 eV
D. +6.8 eV
-
46. The sublevel that can be occupied by a maximum of 10 electrons is identified by the letter_____. (1)
- A. *d*
B. *f*
C. *p*
D. *s*
-
47. What is the molecular shape of ICl_4^- ? (1)
- A. Octahedral
B. T-shaped
C. Square planar
D. Trigonal bipyramidal
-
48. What hybridization change, if any, occurs at the underlined atom in the following reaction? $\underline{\text{C}}\text{O}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3$ (1)
- A. $sp \rightarrow sp^2$
B. $sp^3 \rightarrow sp^3d$
C. $sp^2 \rightarrow sp^3$
D. No hybridization change observed
-
49. The proposed reaction mechanism between nitrogen monoxide and bromine is give below. $\text{NO} + \text{Br}_2 \rightleftharpoons \text{NOBr}_2$ (fast) $\text{NOBr}_2 + \text{NO} \rightarrow 2\text{NOBr}$ (slow) (1)
- Which of the following rate equations is consistent with the proposed mechanism?
- A. $\text{Rate} = k [\text{NO}]^2$
B. $\text{Rate} = k [\text{NO}][\text{Br}_2]^2$
C. $\text{Rate} = k [\text{NO}][\text{Br}_2]$
D. $\text{Rate} = k [\text{NO}]^2[\text{Br}_2]$

50. Which one of the following statements regarding a dynamic equilibrium is FALSE? (1)
- A. At equilibrium, there is no net change in the system.
 - B. At equilibrium, the forward and reverse reactions cease to occur.
 - C. At equilibrium, the rates of the forward and back reactions are identical.
 - D. At equilibrium, the concentration of reactants and products stays the same.
-
51. In which of the following cases will the dissolution of sugar be the most rapid? (1)
- A. Sugar crystals in hot water.
 - B. Powdered sugar in hot water.
 - C. Sugar crystals in cold water
 - D. Powdered sugar in cold water.
-
52. If a solution of acetic acid (CH_3COOH) has a pH of 3.00, what is its concentration? K_a of acetic acid = 1.74×10^{-5} (1)
- A. 0.0057 M
 - B. 0.057 M
 - C. 0.57 M
 - D. 5.70 M
-
53. The indicator methyl red is red in a solution of NaH_2PO_4 . Which of the following equations is consistent with this observation? (1)
- A. $\text{H}_2\text{PO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{PO}_4 + \text{OH}^-$
 - B. $\text{H}_2\text{PO}_4^- + \text{H}_2\text{O} \rightleftharpoons \text{HPO}_4^{2-} + \text{H}_3\text{O}^+$
 - C. $\text{HPO}_4^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{PO}_4^{3-} + \text{H}_3\text{O}^+$
 - D. $\text{HPO}_4^{2-} + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{PO}_4^- + \text{OH}^-$
-
54. A nickel electrode can undergo oxidation to Ni^{2+} ion as follows: (1)
- $\text{Ni (s)} \rightarrow \text{Ni}^{2+} \text{ (aq)} + 2\text{e}^-$ $E^\circ_{\text{red}} = -0.28 \text{ V}$ $2\text{H}_2\text{O(l)} \rightarrow 4\text{H}^+ \text{ (aq)} + \text{O}_2\text{(g)} + 4\text{e}^-$ $E^\circ_{\text{red}} = 1.23 \text{ V}$
- What will happen during the electrolysis of concentrated aqueous solution of NiSO_4 using Ni electrodes?
- (I) Nickel will deposit at the cathode. (II) Nickel will dissolve at the anode. (III) Oxygen will be released at the anode. (IV) Nickel will deposit at the anode.
- A. I only
 - B. I, II
 - C. I, III
 - D. II, IV
-
55. Which of the following is NOT true about the photoelectric effect? (1)
- A. Most metals require ultraviolet light to emit electrons.
 - B. A bright light causes more electrons to be emitted than a weak light.
 - C. Higher frequency light emits electrons with higher kinetic energy
 - D. A bright light causes less electrons to be emitted than a weak light.
-
56. Which of the following statements is correct about nitrosyl chloride (NOCl)? (1)
- A. It has a bent or angular geometry with N a central atom.
 - B. It has a bent or angular geometry with O a central atom.
 - C. It has a trigonal planar geometry with N a central atom.
 - D. It has a trigonal planar geometry with O a central atom.
-
57. The minimum energy required for an effective collision is called _____. (1)
- A. potential energy
 - B. activation energy
 - C. free energy
 - D. kinetic energy

58. A sample of solid ammonium carbamate is heated in a closed container at 298 K and allowed to reach equilibrium. (1)
- $$\text{NH}_4\text{CO}_2\text{NH}_2 (\text{s}) \rightleftharpoons 2 \text{NH}_3 (\text{g}) + \text{CO}_2 (\text{g})$$
- If the total pressure of the system is 0.114 atm, what is the value of equilibrium constant, K_p ?
- A. 1.29×10^{-3} B. 3.80×10^{-4}
C. 7.60×10^{-3} D. 2.19×10^{-4}
-
59. During esterification of carboxylic acid with alcohol which bond of carboxylic acid undergoes cleavage? (1)
- A. C - C B. C = O
C. C - O D. O - H
-
60. If 49 grams of H_2SO_4 react with 80.0 grams of NaOH, how much reactant will be left over after the reaction is complete? (1)
- A. 24.5 g H_2SO_4 B. 20.0 g NaOH
C. 40.0 g NaOH D. 60.0 g NaOH
-
61. What is the change in internal energy of a system that releases 12.4 J of heat and does 4.2 J of work on the surroundings (1)
- A. 16.6 J B. 8.2 J
C. -16.6 J D. -8.2 J
-
62. Which one of the following is true? (1)
- A. Entropy increases when a liquid freezes at its melting point.
B. For spontaneous process $\Delta S > 0$.
C. For a spontaneous process $\Delta G > 0$.
D. Entropy of the pure crystalline solid is zero at 0°C .
-
63. Which of the following has the same number of significant figures as the number 1.00310? (1)
- A. 100 B. 1×10^6
C. 199.791 D. 5.119
-
64. When an electron in a hydrogen atom makes the transition from the $n = 4$ state to the $n = 2$ state, blue light with a wavelength of 434 nm is emitted. Which of the following expressions gives the energy released by the transition? (1)
- A. $\frac{(6.63 \times 10^{-34})(3.00 \times 10^8)}{(4.34 \times 10^{-7})}$ joules B. $\frac{(6.63 \times 10^{-34})}{(4.34 \times 10^{-7})(3.00 \times 10^8)}$ joules
C. $\frac{(6.63 \times 10^{-34})(4.34 \times 10^{-7})}{(3.00 \times 10^8)}$ joules D. $\frac{(4.34 \times 10^{-7})}{(6.63 \times 10^{-34})(3.00 \times 10^8)}$ joules
-
65. Arrange the following molecules in the order of increasing stability. (1)
- A. $\text{N}_2^+ < \text{N}_2 < \text{N}_2^- < \text{N}_2^{2-}$ B. $\text{N}_2^{2-} < \text{N}_2^- = \text{N}_2^+ < \text{N}_2$
C. $\text{N}_2^{2-} < \text{N}_2^- < \text{N}_2 < \text{N}_2^+$ D. $\text{N}_2 < \text{N}_2^+ = \text{N}_2^- < \text{N}_2^{2-}$
-
66. The reaction below takes place with all of the reactants and products in the gaseous phase. Which of the following is true of the relative rates of disappearance the reactants and appearance of the products? $2 \text{NOCl} \rightarrow 2 \text{NO} + \text{Cl}_2$ (1)
- A. NO appears at twice the rate that NOCl disappears.
B. Cl_2 appears at the same rate that NOCl disappears.
C. NO appears at half the rate that NOCl disappears.
D. NO appears at the same rate that NOCl disappears.

67. In the Figure shown below, what does O denote? (1)
[Figure: A phase diagram plotting pressure on the vertical axis (with values 0.1, 1, and 100 marked) against temperature on the horizontal axis. The diagram is divided into three phase regions: "Solid" on the left, "Liquid" in the upper central region, and "Vapour" on the lower right. Three boundary curves meet at a single intersection point labeled "O": a sublimation curve rising from the origin to point O, a solid-liquid boundary curve with a negative slope extending upward to label B, and a liquid-vapour curve rising to the right toward point A. Dashed horizontal and vertical reference lines connect point O to the pressure value 0.1 and the temperature axis, respectively. Another horizontal dashed line at pressure 1 intersects the solid-liquid line and liquid-vapour line, with vertical dashed lines dropping to the temperature axis.]
- A. Melting point
 B. Triple point
 C. Boiling point
 D. Vaporization point
-
68. Given the following unbalanced equation $\text{KMnO}_4 + \text{KI} + \text{H}_2\text{SO}_4 \rightarrow \text{K}_2\text{SO}_4 + \text{MnSO}_4 + \text{I}_2 + \text{H}_2\text{O}$ (1)
 How many grams of KMnO_4 are needed to make 250 mL of 0.20 N solution?
- A. 3.95 g
 B. 3.16 g
 C. 2.98 g
 D. 1.58 g
-
69. Consider the following equilibria: (I) $\text{HCO}_3^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_2\text{CO}_3 + \text{OH}^-$ (II) $\text{NH}_4^+ + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{NH}_3$ (1)
 (III) $\text{HSO}_3^- + \text{H}_3\text{O}^+ \rightleftharpoons \text{H}_2\text{O} + \text{H}_2\text{SO}_3$
 In which of the equilibrium (equilibria) does water act as a Brønsted-Lowry base?
- A. I only
 B. II only
 C. II and III
 D. I, II, III
-
70. A certain current produces 0.50 g of hydrogen gas in 2.0 hrs. What is the amount of copper liberated from a solution of copper sulfate by the same current flowing for the same time? (1)
- A. 31.8 g
 B. 63.6 g
 C. 15.9 g
 D. 6.36 g
-
71. For which of the following half-cells is the reduction potential E independent of the pH of the solution? (1)
- A. $[\text{Cr}_2\text{O}_7]^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$
 B. $\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$
 C. $[\text{NO}_3]^- + \text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons [\text{NO}_2]^- + 2[\text{OH}]^-$
 D. $\text{Co}^{2+} + 2\text{e}^- \rightleftharpoons \text{Co}$
-
72. What is the basis for the Scientific Method? (1)
- A. To formulate a research problem, test the hypothesis under carefully controlled conditions that challenge the hypothesis
 B. To test hypotheses and if they are disproved, they should be abandoned completely.
 C. To test hypotheses in conditions that are favourable to their success.
 D. To formulate a research problem and disprove the hypothesis.
-
73. Which of the following molecules has the largest dipole moment? (1)
- A. CO
 B. HCN
 C. HCl
 D. HF
-
74. In three different experiments the following results were obtained for the reaction $\text{A} \rightarrow \text{products}$: $[\text{A}]_0 = 1.00 \text{ M}$, $t_{1/2} = 50 \text{ min}$; $[\text{A}]_0 = 2.00 \text{ M}$, $t_{1/2} = 25 \text{ min}$; $[\text{A}]_0 = 0.50 \text{ M}$, $t_{1/2} = 100 \text{ min}$. What is the value of the rate constant for this reaction? (1)
- A. $0.010 \text{ L mol}^{-1} \text{ min}^{-1}$
 B. $0.020 \text{ L mol}^{-1} \text{ min}^{-1}$
 C. $0.030 \text{ L mol}^{-1} \text{ min}^{-1}$
 D. $0.040 \text{ L mol}^{-1} \text{ min}^{-1}$

