Engineering Daily Exam 11 [Set 04] EV

Syllabus: Qualitative Chemistry

Total Marks: 50 **Negative Marks:** 0.25 **Time:** 1 Hour

MCQ 50 marks

1. What is the main reason the actual electron configurations of $Cu\,(Z = 29)$ and $Cr\,(Z = 24)$ differ from those predicted by the $(n + l)$ rule?

   (A) Hund's rule does not apply to these two elements

   (B) The energy difference between 4s and 3d orbitals is always zero

   (C) An exception to Pauli's exclusion principle

   (D) Extra stability of half-filled and completely filled d -subshells

2. For the principal energy level $n = 4$, what are the total number of orbitals and the maximum electron capacity, respectively?

   (A) 8 and 16 (B) 16 and 32

   (C) 4 and 8 (D) 32 and 64

3. What is the value of the azimuthal quantum number (l) for a g-subshell, and in which principal shell does the first g-orbital appear?

   (A) $l = 3,\ n = 4$ (B) $l = 4,\ n = 4$

   (C) $l = 4,\ n = 5$ (D) $l = 3,\ n = 5$

4. Applying Hund's rule and Pauli's exclusion principle, what are the numbers of unpaired electrons in Fe^{2+} and Fe^{3+} $(Z = 26)$, respectively?

   (A) 5 and 4 (B) 6 and 5

   (C) 4 and 6 (D) 4 and 5

5. Which pair of subshells is actually impossible according to the rules of quantum numbers?

   (A) 3d, 4f (B) 2d, 3f

   (C) 4d, 5f (D) 3p, 4d

6. An electron has the set of quantum numbers ($n = 3,\ l = 2,\ m = +2,\ s = -\frac{1}{2}$). In which orbital is it located?

   (A) 3d (B) 3p (C) 4d (D) 3f

7. For the d_{xy} orbital, what is the number of angular nodal planes and where are they located?

   (A) 2, the xz and yz planes

   (B) 1, the xy plane

   (C) 0

   (D) 2, the xy and xz planes

8. An electron in a hydrogen atom returns from $n = 5$ to $n = 2$. What is the wavelength of the emitted light, and in which spectral series does it fall?

   (A) 656.3 nm, Balmer series

   (B) 434.2 nm, Paschen series

   (C) 121.6 nm, Lyman series

   (D) 434.2 nm, Balmer series

9. Which set of quantum numbers is NOT allowed?

   (A) $n = 2,\ l = 1,\ m = 0,\ s = +\frac{1}{2}$

   (B) $n = 3,\ l = 3,\ m = +1,\ s = +\frac{1}{2}$

   (C) $n = 3,\ l = 2,\ m = -2,\ s = -\frac{1}{2}$

   (D) $n = 4,\ l = 0,\ m = 0,\ s = -\frac{1}{2}$

10. The radius of a nucleus is about 10^{-15} m. Taking the uncertainty in an electron's position as $\Delta x \approx 10^{-15}$ m, approximately what is the minimum kinetic energy of an electron confined inside the nucleus according to Heisenberg's uncertainty principle? ($h = 6.626 \times 10^{-34}$ Js, $c = 3 \times 10^{8}$ ms^{-1}, 1 MeV $= 1.6 \times 10^{-13}$ J, $m_e c^2 = 0.511$ MeV)

    (A) About 10 eV (B) About 1 MeV

    (C) About 10^2 MeV (D) About 10^4 MeV

11. For the two electrons of a He atom in its ground state, which pair of quantum number sets (in the order n, l, m, s) is correct according to Pauli's exclusion principle?

    (A) $(1, 0, 0, +\frac{1}{2})$ and $(1, 0, 0, -\frac{1}{2})$

    (B) $(1, 0, 0, +\frac{1}{2})$ and $(1, 0, 0, +\frac{1}{2})$

    (C) $(1, 0, 0, +\frac{1}{2})$ and $(2, 0, 0, -\frac{1}{2})$

    (D) $(1, 0, 1, +\frac{1}{2})$ and $(1, 0, 0, -\frac{1}{2})$

12. Which pair of elements adopts an electron configuration that violates the Aufbau principle?

    (A) Na, Mg (B) Fe, Co

    (C) Cr, Cu (D) Zn, Ga

13. Which of the following is a valid isoelectronic group, in which every species has the same total number of electrons?

    (A) N_2, O_2, CO (B) CO, NO, CN^-

    (C) CO, N_2, CN^- (D) CO_2, N_2O, NO_2

14. Using the $(n + l)$ rule, which is the correct increasing order of energy for the orbitals 4d, 5p, 4f and 6s?

Ⓐ $4d < 5p < 6s < 4f$ Ⓑ $4d < 5p < 4f < 6s$

Ⓒ $5p < 4d < 6s < 4f$ Ⓓ $4f < 4d < 5p < 6s$

15. For the specified $n = 3$, $l = 1$, what is the maximum number of electrons that this subshell can hold?

Ⓐ 6 Ⓑ 2 Ⓒ 10 Ⓓ 14

16. How many d-electrons are there in the Fe^{2+} ($Z = 26$) ion?

Ⓐ 4 Ⓑ 5 Ⓒ 8 Ⓓ 6

17. In the complete decay series in which $^{232}_{90}Th$ becomes $^{208}_{82}Pb$, how many α and β particles are emitted in total?

Ⓐ $4\alpha,\ 6\beta$ Ⓑ $6\alpha,\ 4\beta$

Ⓒ $8\alpha,\ 2\beta$ Ⓓ $6\alpha,\ 6\beta$

18. The activity of a radioactive sample falls to $\frac{1}{8}$ of its initial value in 45 minutes. What is its half-life?

Ⓐ 5 minutes Ⓑ 9 minutes

Ⓒ 15 minutes Ⓓ 22.5 minutes

19. Which of the following species has the greatest number of unpaired electrons in its ground state?

Ⓐ Cr^{3+} ($Z = 24$) Ⓑ Mn^{2+} ($Z = 25$)

Ⓒ Fe^{2+} ($Z = 26$) Ⓓ Zn^{2+} ($Z = 30$)

20. Using the usual convention (m filled from negative to positive, with $s = +\frac{1}{2}$ first), which is the correct set of quantum numbers for the last electron of the S^{2-} ion?

Ⓐ $n = 3,\ l = 1,\ m = -1,\ s = +\frac{1}{2}$

Ⓑ $n = 3,\ l = 1,\ m = +1,\ s = -\frac{1}{2}$

Ⓒ $n = 3,\ l = 0,\ m = 0,\ s = +\frac{1}{2}$

Ⓓ $n = 2,\ l = 1,\ m = +1,\ s = -\frac{1}{2}$

21. At 25°C, K_{sp} of AgCl is 1.8×10^{-10}. How many times greater is its solubility in pure water than in 0.1 M NaCl solution?

Ⓐ About 75 times Ⓑ About 745 times

Ⓒ About 7450 times Ⓓ About 74500 times

22. A buffer solution has pH = 9. What is the maximum $[Mg^{2+}]$ in this solution for which $Mg(OH)_2$ ($K_{sp} = 1.2 \times 10^{-11}$) does not precipitate?

Ⓐ 1.2×10^{-3} M Ⓑ 1.2×10^{-1} M

Ⓒ 1.2×10^{-9} M Ⓓ 1.2×10^{-11} M

23. What are the shortest and longest wavelengths, respectively, in the Lyman series of the hydrogen spectrum?

Ⓐ 91.2 nm and 121.6 nm Ⓑ 121.6 nm and 91.2 nm

Ⓒ 364.7 nm and 656.3 nm Ⓓ 91.2 nm and 364.7 nm

24. The energy of the 1st orbit of a hydrogen atom is −13.6 eV. How much energy is absorbed to move an electron from the 1st orbit to the 3rd orbit?

Ⓐ 1.51 eV Ⓑ 10.2 eV

Ⓒ 13.6 eV Ⓓ 12.09 eV

25. According to the Bohr model, what is the speed of the electron in the 2nd orbit of a hydrogen atom? (Speed in the 1st orbit is $v_1 = 2.18 \times 10^6\ ms^{-1}$)

Ⓐ $4.36 \times 10^6\ ms^{-1}$ Ⓑ $2.18 \times 10^6\ ms^{-1}$

Ⓒ $1.09 \times 10^6\ ms^{-1}$ Ⓓ $5.45 \times 10^5\ ms^{-1}$

26. If the Rydberg constant is $R_H = 109678\ cm^{-1}$, what is the wavenumber ($\bar{\nu}$) of the first line of the Paschen series?

Ⓐ $1524.7\ cm^{-1}$ Ⓑ $5331.6\ cm^{-1}$

Ⓒ $15233\ cm^{-1}$ Ⓓ $2743.5\ cm^{-1}$

27. If the de Broglie wavelength of an electron in an atom is $\lambda = 0.33$ nm, what is its momentum (p)?

Ⓐ $2.01 \times 10^{-24}\ kgms^{-1}$ Ⓑ $2.01 \times 10^{-27}\ kgms^{-1}$

Ⓒ $6.63 \times 10^{-34}\ kgms^{-1}$ Ⓓ $4.97 \times 10^{23}\ kgms^{-1}$

28. What is the de Broglie wavelength of an electron moving at $1.5 \times 10^6\ ms^{-1}$? ($m_e = 9.1 \times 10^{-31}$ kg)

Ⓐ 48.5 nm Ⓑ 4.85 nm

Ⓒ 0.0485 nm Ⓓ 0.485 nm

29. What is the angular momentum of the electron in the 1st orbit of a hydrogen atom?

Ⓐ $\frac{2h}{\pi}$ Ⓑ $\frac{h}{\pi}$ Ⓒ h Ⓓ $\frac{h}{2\pi}$

30. An electron in a Li^{2+} ion returns from $n = 6$ to $n = 3$. What is the approximate wavelength of the emitted radiation, and in which region does it fall?

Ⓐ 121.6 nm, UV Ⓑ 243.1 nm, UV

Ⓒ 121.6 nm, visible Ⓓ 486 nm, visible

31. At 25°C, K_{sp} of AgCl is 1.8×10^{-10}. What is its solubility in pure water in mgL^{-1}? (Ag = 108, Cl = 35.5)

Ⓐ $192\ mgL^{-1}$ Ⓑ $19.2\ mgL^{-1}$

Ⓒ $0.192\ mgL^{-1}$ Ⓓ $1.93\ mgL^{-1}$

32. An electron in a He^+ ion returns from $n = 2$ to $n = 1$. What are the energy and wavelength of the emitted radiation, and in which region of the electromagnetic spectrum does it fall?

(A) 40.8 eV, 304 nm, visible

(B) 10.2 eV, 121.6 nm, ultraviolet

(C) 40.8 eV, 30.4 nm, ultraviolet

(D) 3.4 eV, 365 nm, visible

33. The work function of a metal is 2.3 eV. When light of wavelength 400 nm is incident, what are the maximum kinetic energy of the emitted photoelectrons and the stopping potential, respectively?

(A) 3.1 eV, 3.1 V (B) 0.8 eV, 0.8 V

(C) 2.3 eV, 2.3 V (D) 5.4 eV, 5.4 V

34. Equal volumes of 0.02 M $BaCl_2$ and 0.05 M Na_2SO_4 solutions are mixed. Will $BaSO_4$ ($K_{sp} = 1.1 \times 10^{-10}$) precipitate?

(A) No precipitate will form

(B) A precipitate will form

(C) The solution will be exactly saturated

(D) Cannot be determined due to insufficient data

35. If the solubility of $Fe(OH)_3$ is S molL^{-1}, which is the correct expression for its solubility product?

(A) $K_{sp} = S^4$ (B) $K_{sp} = 4S^3$

(C) $K_{sp} = 27S^4$ (D) $K_{sp} = S^2$

36. At 30°C the solubility of a salt is 50 (grams of salt dissolved in 100 g of solvent). How many grams of salt and solvent are needed to prepare 150 g of saturated solution at that temperature?

(A) Salt 100 g, solvent 50 g

(B) Salt 75 g, solvent 75 g

(C) Salt 50 g, solvent 100 g

(D) Salt 30 g, solvent 120 g

37. If K_{sp} of $Al(OH)_3$ is 3.7×10^{-15}, what is the concentration of $[OH^-]$ in its saturated solution?

(A) 1.08×10^{-4} M (B) 3.25×10^{-4} M

(C) 6.08×10^{-8} M (D) 1.92×10^{-5} M

38. If the solubility of CaF_2 is 2.0×10^{-4} molL^{-1}, what is its solubility product (K_{sp})?

(A) 4.0×10^{-8} (B) 8.0×10^{-12}

(C) 3.2×10^{-11} (D) 1.6×10^{-11}

39. What effect does the common-ion effect have on the solubility of a sparingly soluble salt?

(A) Solubility increases

(B) Solubility decreases

(C) Solubility remains unchanged

(D) Solubility first increases, then decreases

40. A saturated solution at 50°C weighing 100 g is cooled to 20°C. If the solubilities at 50°C and 20°C are 80 and 35 respectively, how many grams of salt will crystallise?

(A) 25.0 g (B) 20.0 g (C) 30.5 g (D) 45.0 g

41. If the solubility product of PbI_2 is $K_{sp} = 1.4 \times 10^{-8}$, what is its solubility in gL^{-1}? (Pb = 207, I = 127)

(A) 0.700 gL^{-1} (B) 0.070 gL^{-1}

(C) 1.400 gL^{-1} (D) 0.152 gL^{-1}

42. If the solubility of Ag_2CrO_4 is S, which is the correct expression for its K_{sp}?

(A) $K_{sp} = S^2$ (B) $K_{sp} = 4S^3$

(C) $K_{sp} = 27S^4$ (D) $K_{sp} = 2S^3$

43. The solubility of which of the following compounds decreases with increasing temperature (exothermic dissolution)?

(A) KNO_3 (B) $NaCl$

(C) NH_4Cl (D) $Ce_2(SO_4)_3$

44. At a fixed temperature, on what does the solubility product (K_{sp}) of a sparingly soluble electrolyte depend?

(A) Pressure

(B) Temperature only

(C) Volume of the solution

(D) Concentration of the ions

45. In which mixture will the common-ion effect reduce the dissociation of a weak electrolyte?

(A) $CH_3COOH + CH_3COONa$

(B) $NaCl + KNO_3$

(C) $HCl + HNO_3$

(D) $NaOH + KOH$

46. For a solution of a sparingly soluble salt with $K_{ip} < K_{sp}$, what type of solution is it?

(A) Saturated (B) Supersaturated

(C) Unsaturated (D) Cannot be determined

47. At what temperature does Glauber's salt ($Na_2SO_4 \cdot 10H_2O$) convert to anhydrous Na_2SO_4, changing the direction of its solubility curve?

Ⓐ **32.4°C** Ⓑ **0°C**

Ⓒ **50°C** Ⓓ **100°C**

48. What is the chemical formula of Nessler's reagent?

Ⓐ $K[HgI_3]$ Ⓑ $K_2[HgI_4]$

Ⓒ $HgNH_2Cl$ Ⓓ $K_2[PtCl_6]$

49. In a flame test, what colour does the potassium (K^+) ion show when viewed through cobalt blue glass?

Ⓐ **Golden yellow** Ⓑ **Green**

Ⓒ **Brick red** Ⓓ **Pink or pale violet**

50. Which scientist first discovered the phenomenon of radioactivity?

Ⓐ **Marie Curie** Ⓑ **Ernest Rutherford**

Ⓒ **Henri Becquerel** Ⓓ **James Chadwick**