Engineering Daily Exam 11 [Set 03] EV

Syllabus: Qualitative Chemistry

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

MCQ 50 marks

1. At 25°C, the K_{sp} of AgCl is 1.8×10^{-10}. Comparing its solubility in pure water and in 0.1 M NaCl solution, which is correct?
   - (A) Solubility in NaCl solution is many times higher
   - (B) Solubility in pure water is about 7450 times higher than in NaCl solution
   - (C) AgCl will dissolve completely in NaCl solution
   - (D) Solubility is equal in both cases

2. If equal volumes of 0.02 M $BaCl_2$ and 0.05 M Na_2SO_4 are mixed, will $BaSO_4$ ($K_{sp} = 1.1 \times 10^{-10}$) precipitate?
   - (A) It cannot be determined
   - (B) Yes, precipitation will occur
   - (C) No, precipitation will not occur
   - (D) The solution will remain exactly saturated

3. The solvent extraction method is based on which fundamental law?
   - (A) Nernst distribution law
   - (B) Graham's law
   - (C) Raoult's law
   - (D) Henry's law

4. At 30°C, the solubility of a salt is 50. How many grams of salt are needed to prepare 600 g of saturated solution at this temperature?
   - (A) 300 g
   - (B) 400 g
   - (C) 200 g
   - (D) 150 g

5. In paper/thin-layer chromatography, what range can the retention factor (R_f) value have?
   - (A) 1 to ∞
   - (B) 0 to 1 (inclusive)
   - (C) −1 to +1
   - (D) Always exactly 1

6. Viewed with the naked eye and through cobalt blue glass, what are the flame test colours of K^+ and Na^+ respectively?
   - (A) K^+: golden yellow; Na^+: pink (unchanged in both cases)
   - (B) Both colours remain unchanged
   - (C) Cobalt glass has no effect
   - (D) K^+: light violet turning to pink; Na^+: golden yellow turning to invisible

7. Why is concentrated HCl used to make a salt paste for flame tests?
   - (A) To raise the flame temperature
   - (B) Metal chlorides are more volatile, so they vaporize easily in the flame
   - (C) To neutralize alkaline impurities
   - (D) HCl acts as a catalyst

8. Which of the following reactions is the correct test for identifying the SO_4^{2-} ion?
   - (A) $SO_4^{2-} + HCl(dil) \rightarrow$ gas is produced
   - (B) $Cl^- + AgNO_3 \rightarrow AgCl \downarrow$ (white)
   - (C) $SO_4^{2-} + BaCl_2 \rightarrow BaSO_4 \downarrow$ (white, insoluble in HCl)
   - (D) $SO_4^{2-} + NH_4OH \rightarrow$ brown precipitate

9. For non-polar compounds, what are typically used as the stationary phase and mobile phase in column chromatography?
   - (A) Stationary phase: silica gel/alumina; mobile phase: petroleum ether/hexane
   - (B) Both phases must be polar
   - (C) Stationary phase: water; mobile phase: ethanol
   - (D) Stationary phase: hexane; mobile phase: silica gel

10. What is the role of NaOH solution in identifying the Zn^{2+} ion?
    - (A) A green precipitate forms which remains insoluble
    - (B) A white precipitate forms which dissolves in excess NaOH
    - (C) NaOH shows no reaction
    - (D) A yellow precipitate forms

11. Why is the ground-state electron configuration of Cu (Z = 29) $[Ar]3d^{10}4s^1$, and not $[Ar]3d^9 4s^2$?
    - (A) The $3d^{10}4s^1$ configuration gains extra exchange energy from the symmetry of a fully filled d-subshell
    - (B) It is purely an experimental observation with no theoretical explanation
    - (C) Pauli's principle forbids this configuration
    - (D) The 4s orbital always has higher energy than 3d

12. According to Henry's law, in which case is the effect of pressure on solubility directly applicable?
    - (A) For the solubility of a gaseous solute
    - (B) Equally in all cases
    - (C) For a liquid solute
    - (D) For a solid solute

13. Which of the following pairs is iso-electronic?
    - (A) Al^{3+}, F^-
    - (B) Cl^-, Ar
    - (C) Na^+, Ne
    - (D) All of the above

14. How much energy will be absorbed to excite an electron in a hydrogen atom from n = 2 to n = 4?
    - (A) 3.4 eV
    - (B) 10.2 eV
    - (C) 2.55 eV
    - (D) 0.85 eV

15. A radioactive sample decays to $\frac{1}{32}$ of its initial activity in 60 minutes. What is its half-life?

(A) 12 minutes (B) 10 minutes

(C) 20 minutes (D) 6 minutes

16. In the complete decay chain of $^{235}_{92}U$ decaying to $^{207}_{82}Pb$, how many total α and β particles will be emitted?

(A) 7 α, 6 β (B) 4 α, 7 β

(C) 6 α, 4 β (D) 7 α, 4 β

17. If K_{sp} of Ag_2S is 8×10^{-51}, what is its approximate molar solubility?

(A) 1.26×10^{-17} M (B) 2.0×10^{-51} M

(C) 8.94×10^{-18} M (D) 2.83×10^{-26} M

18. Between Mn^{2+} (Z = 25) and Cr^{3+} (Z = 24), which has more unpaired electrons and stronger magnetism?

(A) Mn^{2+} is higher

(B) Neither has unpaired electrons

(C) Both are equal

(D) Cr^{3+} is higher

19. A saturated $Ca(OH)_2$ solution has $K_{sp} = 5.5 \times 10^{-6}$. What is the pH of this solution?

(A) 11.65 (B) 13.00 (C) 12.35 (D) 10.85

20. According to modern physics, why is it impossible to find an electron confined within a nucleus of about 10^{-15} m radius — which reasoning below is correct?

(A) Electrons must always equal protons in number

(B) The nucleus must maintain charge neutrality

(C) By Heisenberg's uncertainty principle, the calculated minimum kinetic energy is far greater than the actual nuclear binding energy

(D) The electron's mass is zero

21. What is the nature of the relationship among the species CO, CN^-, N_2?

(A) Isotopes (B) Isotones

(C) Isobars (D) Iso-electronic

22. If the solubility of a sparingly soluble salt M_3X_2 is S, which is the correct expression for its K_{sp}?

(A) $K_{sp} = 6S^5$ (B) $K_{sp} = S^5$

(C) $K_{sp} = 108S^5$ (D) $K_{sp} = 72S^5$

23. What is the approximate series-limit wavelength ($n_2 = \infty$) of the Brackett series in the hydrogen spectrum?

(A) 91.2 nm (B) 1459 nm (C) 4052 nm (D) 820 nm

24. According to the Bohr model, what is the radius of the 3rd orbit of a hydrogen atom? ($r_1 = 0.529$ Å)

(A) 0.529 Å (B) 1.587 Å (C) 9.522 Å (D) 4.761 Å

25. If an electron in a hydrogen atom falls from the n = 6 to the n = 3 energy level, what is the approximate wavelength of the emitted light, and which series does it belong to?

(A) 656 nm, Balmer series

(B) 122 nm, Lyman series

(C) 1094 nm, Brackett series

(D) 1094 nm, Paschen series

26. What is the de Broglie wavelength of a proton moving at 2×10^5 ms^{-1}? ($m_p = 1.67 \times 10^{-27}$ kg)

(A) 1.98×10^{-12} m (B) 1.98×10^{-9} m

(C) 1.98×10^{-15} m (D) 3.34×10^{-22} m

27. If the solubility of CuBr is 2×10^{-4} $molL^{-1}$, what is its solubility product?

(A) 1.6×10^{-7} (B) 4×10^{-8}

(C) 8×10^{-12} (D) 2×10^{-4}

28. If a saturated solution of 0.5 kg KNO_3 at 50°C is cooled to 10°C, how much salt will precipitate? (solubility of KNO_3 is 85 at 50°C and 21 at 10°C)

(A) 220.5 g (B) 300 g

(C) 172.97 g (D) 64.0 g

29. If K_{sp} of $Zr_3(PO_4)_4$ is 3.1×10^{-18}, what is its approximate molar solubility?

(A) 8.9×10^{-7} M (B) 1.0×10^{-6} M

(C) 8.9×10^{-4} M (D) 4.5×10^{-3} M

30. At 25°C the solubility product of ferric hydroxide is 1.09×10^{-36}. How many grams of $Fe(OH)_3$ are dissolved in 0.1 L of the saturated solution? ($Fe(OH)_3 = 106.9$ $gmol^{-1}$)

(A) 4.8×10^{-8} g (B) 4.8×10^{-9} g

(C) 1.09×10^{-9} g (D) 9.6×10^{-9} g

31. Which of the following is insoluble in water?

(A) $CaCO_3$ (B) Na_2CO_3

(C) $CaCl_2$ (D) $FeSO_4$

32. In which of the following sets does the common ion effect exist?

(A) HCl, HNO_3 (B) $CaCl_2$, C_6H_5Cl

(C) NaCl, CH_3Cl (D) NH_4Cl, $(NH_4)_2CO_3$

33. Why is high-performance liquid chromatography (HPLC) an improvement over ordinary column chromatography?

(A) It only works at extremely high temperatures

(B) It requires no stationary phase

(C) It only analyzes gaseous samples

(D) It drives the mobile phase quickly under high pressure, giving fast separation and high resolving power

34. With potassium ferrocyanide, what colours are given when identifying Cu^{2+} and Fe^{3+} ions respectively?

(A) White and yellow

(B) Both white

(C) Deep blue and chocolate brown

(D) Chocolate brown and deep blue (Prussian blue)

35. If $n = 3, l = 1$, what is the maximum number of electrons in that subshell and what are the possible m values?

(A) 2; $m = 0$

(B) 6; $m = -1, 0, +1$

(C) 10; $m = -2, -1, 0, +1, +2$

(D) 6; $m = -2, -1, 0, +1, +2, +3$

36. If the outer-shell electron configuration of an element is $3d^8 4s^2$, what is its atomic number and which element is it?

(A) $Z = 26$, iron (B) $Z = 27$, cobalt

(C) $Z = 30$, zinc (D) $Z = 28$, nickel

37. Which principle explains why the 3 electrons in the 2p orbital of nitrogen (N, $Z = 7$) have parallel spins?

(A) Pauli's exclusion principle

(B) Hund's rule

(C) Aufbau principle

(D) Heisenberg's uncertainty principle

38. For the outer-shell electron of magnesium (Mg, $Z = 12$), what are the possible values of the magnetic quantum number (m)?

(A) $m = -1, 0, +1$

(B) $m = +2$

(C) $m = 0$

(D) $m = -2, -1, 0, +1, +2$

39. Which is the correct set of quantum numbers for the unpaired electron in the last shell of $_{17}Cl$?

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

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

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

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

40. Which radioactive isotope is used in the treatment of anemia?

(A) $^{226}_{88}Ra$ (B) $^{32}_{16}S$

(C) $^{99}_{43}Tc$ (D) $^{32}_{15}P$

41. Which element's nuclear spin does magnetic resonance imaging (MRI) mainly detect in the human body?

(A) Nitrogen (^{14}N) (B) Carbon (^{12}C)

(C) Oxygen (^{16}O) (D) Hydrogen (^{1}H)

42. What is the technique called in which components are separated based on their differing boiling points at reduced pressure?

(A) Fractional crystallization

(B) Vacuum distillation

(C) Steam distillation

(D) Solvent extraction

43. In the ground-state electron configuration of the S^{2-} ion, which is the correct quantum-number set for the last electron?

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

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

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

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

44. Adding $BaCl_2$ to an unknown salt solution gives a white precipitate insoluble in dilute HCl; the flame test shows a golden yellow colour. What is the likely salt?

(A) $Cu(NO_3)_2$ (B) $CuSO_4$

(C) Na_2SO_4 (D) $NaNO_3$

45. If the solubility of the compound $K_3[Na_3(AlF_6)_2]$ is s, which is the expression for its K_{sp}?

(A) s^8 (B) $2916s^8$ (C) $729s^7$ (D) $1458s^8$

46. Which solubility principle is at work in separating salt from seawater?

(A) Lowering the temperature fully dissolves the salt

(B) Evaporation makes the solution supersaturated, causing salt to crystallize out

(C) Solubility is increased by the common ion effect

(D) Increasing pressure raises the salt's solubility

47. In which of the following situations is Henry's law not applicable?

(A) When the gas reacts chemically with the solvent

(B) At a fixed temperature

(C) When the gas is sparingly soluble

(D) At low pressure

48. Which is the de Broglie equation?

(A) $E = mc^2$ (B) $\lambda = \frac{h}{mv}$

(C) $\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$ (D) $mvr = \frac{nh}{2\pi}$

49. What is the fundamental difference between distillation and fractional distillation based on?

(A) Difference in concentration

(B) The difference in boiling point (more or less than 25°C)

(C) Difference in melting point

(D) Difference in solubility

50. One of the limitations of the Bohr atomic model is—

(A) **It fails to explain the fine spectra of multi-electron atoms**

(B) **It cannot explain the electron's mass**

(C) **It cannot explain the nuclear charge**

(D) **It completely fails to explain the hydrogen spectrum**