MCQ 50 marks

1. **C.** Al ($Z = 13$)
Explanation: The first electron in 3p ($m = -1$, first parallel spin) means $3p^1$, i.e., $[Ne]3s^2 3p^1 = Al$.

2. **D.** Cl ($Z = 17$)
Explanation: A full L shell $= 2 + 8 = 10$ electrons. Adding 7 in the M shell gives a total $= 17 \Rightarrow$ Cl.

3. **B.** $(2, 1, 0, +\frac{1}{2})$ **and** $(2, 1, 0, +\frac{1}{2})$
Explanation: If all four quantum numbers are completely identical, this violates the Pauli principle.

4. **C.** $[Ar]3d^6 4s^2$, Fe
Explanation: In forming M^{3+}, $4s^2$ and one 3d electron are removed.
For $M^{3+} = 3d^5$, the parent M $= 3d^6 \cdot 4s^2 =$ Fe ($Z = 26$).

5. **B.** 4s **electrons provide relatively good screening on** 3d
Explanation: ns electrons, being on average more inward compared to $(n-1)$d, provide good screening, but for Ti, this question is less relevant when forming Ti^{4+} (both 4s, 3d removed).

6. **C.** $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{11}$
Explanation: A d subshell can hold at most 10 electrons ($2(2l + 1) = 10$); $3d^{11}$ is physically impossible.

7. **D.** $7s < 5f < 6d$
Explanation: $(n + l)$: 7s = 7; 5f = 8; 6d = 8.
7s is lowest.
5f and 6d have the same $(n + l)$ value (8), so the smaller n (5f, $n = 5$) comes first.
Order: $7s < 5f < 6d$.

8. **D. Yes, the full** $5d^{10}4f^{14}$ **effectively screens** $6s^1$
Explanation: Cu($3d^{10}4s^1$), Ag($4d^{10}5s^1$), Au($5d^{10}6s^1$) — the same reasoning applies to all three Group 11 elements (though additional relativistic effects also play a role in Au).

9. **B. After removing 2 electrons, removal will begin from the (inner)** $n = 4$ **shell**
Explanation: This is completely analogous to Mg ($n = 3$, 2 valence electrons, jump at E_3), just in the $n = 5$ shell (e.g., Sr).

10. **C.** $Z = 27$ **(Co)**
Explanation: Adding $4s^2$ to $M^{2+} = [Ar]3d^7$, the parent M $= [Ar]3d^7 4s^2 =$ Co ($Z = 27$).

11. **B. Group 1,** +1
Explanation: A huge jump of about 7.3 times from $E_1 \rightarrow E_2$ — 1 valence electron, Group 1 (the actual value for K).

12. **D.** Na = 496, Mg = 738, Al = 578, Si = 786
Explanation: Na($3s^1$) is the lowest (496).
Mg($3s^2$, full) is relatively higher (738).
Al($3p^1$, newly started) is lower than Mg (578).
Si($3p^2$) is the highest (786).

13. **C. A partial jump begins at** $E_4 \rightarrow E_5$**; the element is likely Group 16**
Explanation: This data is in fact the actual successive IE values for S (sulfur), which has 6 valence electrons, and the true huge jump occurs at $E_6 \rightarrow E_7$.

14. **D. 2**
Explanation: A jump at $E_2 \rightarrow E_3$ means 2 valence electrons (Group 2).

15. **C. An upward trend, but d-block complication appears at** Ga
Explanation: Due to the weak-screening effect of the d-block, Ga's E_1 actually becomes nearly equal to Al's — this effect is largely canceled out.

16. **C.** +6**, Group 16**
Explanation: A jump at $E_6 \rightarrow E_7$ means 6 valence electrons (Group 16), maximum oxidation number +6 (e.g., S).

17. **A.** E_1 **is a property of the neutral atom; neutral** Ca **and** K **have different electron counts**

Explanation: Ca^{2+} and K^+ both have 18 electrons (isoelectronic), but E_1 is defined from the neutral atom, where Ca(20e) and K(19e) differ.

18. **B.** $E_1(As) > E_1(Se)$**; stability of the half-filled** $4p^3$
Explanation: This is the period-4 version of N/O and P/S — As($4p^3$) has a higher E_1 than Se($4p^4$) due to the stability of its half-filled configuration.

19. **D. The second one has more**
Explanation: In the first set, the jump occurs at $E_2 \rightarrow E_3$ (2 valence electrons).
In the second set, the jump occurs at $E_3 \rightarrow E_4$ (3 valence electrons, actually the values for Sc).
So the second one has more.

20. **A. F is the least exothermic; the 2nd step is endothermic**
Explanation: Due to repulsion from F's small size, its net exothermicity (−328) is lower than Cl's (−349).
The second step (for any negative ion) is always strongly endothermic.

21. **D. Approximately** 1.00 **(complete screening)**
Explanation: All shells at $(n-2)$ and below provide 1.00 screening — this is exactly why so much energy is required to remove inner electrons once the valence shell is exhausted.

22. **D.** Sr^+**'s** $5s^1$ **is easily removed**
Explanation: This is the period-5 version of a pattern similar to Na/Mg, K/Ca.

23. **A. At least 3**
Explanation: No jump means the valence electron count is at least 3 (this data is in fact for P, which has 5 valence electrons).

24. **B. Highest** Z_{eff} **at the smallest radius**
Explanation: Going down Group 18, radius increases and screening increases, so E_1 decreases progressively (He > Ne > Ar > Kr > Xe).

25. **B. Group 2**
Explanation: A normal E_1/E_2 (no jump) means it's not Group 1; a jump at E_2/E_3 means 2 valence electrons — Group 2.

26. **B.** As ($Z = 33$)
Explanation: $l = 1, n = 4 \Rightarrow 4p$.
5 valence electrons ($4s^2 4p^3$) means As.

27. **D.** Se > Te
Explanation: Except for period 2 (O), electron affinity decreases going down Group 16 (S > Se > Te).

28. **D. Repulsion dominates due to F's small size**
Explanation: A high Z_{eff} does not always guarantee the highest electron affinity, when size-related repulsion becomes dominant.

29. **A. The stability of P's half-filled** $3p^3$ **configuration**
Explanation: This is the period-3 analog of the exception seen in N.

30. **A.** Mg **and** Zn
Explanation: Both a full ns^2 (Group 2) and a full $(n-1)d^{10}ns^2$ (Group 12) are reluctant to accept an extra electron due to their completely full subshells.

31. **B. Strongly positive (endothermic)**
Explanation: Z = As.
Adding a second electron to any negative ion is always endothermic — this universal principle applies regardless of group.

32. **B. Group 16 higher**
Explanation: The fewer electrons needed to complete the octet, the higher the electron affinity generally seen. Group 16 is only 2 electrons away from the octet, more nonmetallic than Group 14.

33. **D. Much higher than both**
Explanation: X = F.
Halogens have the highest electron affinity (being closest to the octet compared to O), whereas forcing a noble gas to start a new shell is extremely unfavorable.

34. **C. Both show low or negative electron affinity**

Explanation: Since both are metals, their tendency to lose electrons is greater than to gain them, which is consistent with the diagonal relationship.

35. **C. 4d and 5d row elements show nearly identical properties, making separation difficult**
Explanation: Because their radii are nearly equal, a deep similarity is also seen in their chemical behavior, which complicates their separation from ores (e.g., Zr/Hf, Nb/Ta).

36. **C.** $P^{3-} > S^{2-} > Cl^{-} > K^{+} > Ca^{2+}$
Explanation: Proton counts: P(15) < S(16) < Cl(17) < K(19) < Ca(20). Fewest protons (P) = largest radius.

37. **A. Yes; the** $4f^{14}$ **series provides weak screening**
Explanation: The same principle applicable to Zr/Hf, Nb/Ta also applies to Group 6 (Mo/W) — the lanthanide contraction effect is seen in all 4d/5d pairs.

38. **D.** Ca^{2+}**'s conductivity is lower**
Explanation: Since Ca^{2+}'s gaseous size is smaller and its charge density higher, it holds more water molecules than Sr^{2+}. This is the alkaline-earth-metal version of the Li^{+}/Cs^{+} or Na^{+}/K^{+} pattern.

39. **A. Both are amphoteric oxides**
Explanation: Because Be^{2+} and Al^{3+}'s ionic potentials are close, both of their oxides show amphoteric character.

40. **A. Yes, the same reason**
Explanation: This is a universal principle — this Van der Waals-vs-covalent radius inconsistency applies to the noble gas of any period.

41. **A. May be slightly larger (electron in** e_g**)**
Explanation: In the $t_{2g}^3 e_g^1$ configuration, the e_g electron directly faces the ligands, creating extra repulsion and slightly increasing the radius.

42. **C.** $Ti^{2+} > Ti^{3+} > Ti^{4+}$
Explanation: Ions of the same element with increasing positive charge get progressively smaller. Ti^{4+} (d^0) is the smallest, and due to its high charge density, compounds like TiO_2 show significant covalent character.

43. **C.** Cr^{2+} **(d^4); an electron entering** e_g **causes more repulsion**
Explanation: In the $t_{2g}^3 e_g^1$ (high-spin) configuration, the presence of an e_g electron creates a deviation.

44. **A. The radius contracts the most at high charge**
Explanation: As the charge increases, more electrons/shells are removed, so the Z/e ratio increases the most, and the contraction is also the greatest.

45. **D.** SnO_2 **is more basic**
Explanation: Metallic character increases down Group 14 (C nonmetal → Pb metal; Sn is below Ge), so Sn forms a comparatively more basic/metallic oxide.

46. **A. Increasing oxidation state changes it from basic to acidic**
Explanation: This is completely analogous to Mn's oxide series — as the same element's oxidation number increases (+2 → +3 → +6), charge density increases and it changes from basic to amphoteric to increasingly acidic.

47. **C. It's C; its affinity is slightly lower than Si's**
Explanation: Although Group 14's exception is not as pronounced as with N, O, F, C's electron affinity (−122) being slightly lower than Si's (−134) is a weak reflection of the same small-size-related repulsion tendency.

48. **B.** ZnO **and** Al_2O_3
Explanation: Amphoteric oxides are not confined to a single specific group — they are found across various places including Group 12 (ZnO), 13 (Al_2O_3), and 14 (SnO, PbO).

49. **A.** $HNO_3 > HNO_2$
Explanation: Higher oxidation number = more oxygen = more electron-withdrawal on the O − H bond = stronger acid. This principle applies universally across the oxoacid series of any element.

50. **A.** H_2CO_3 **is stronger**

Explanation: C's size is smaller than Si's and its electronegativity higher — this is completely analogous to the S/Se reasoning. This universal principle (with equal oxidation number, a smaller central atom = a stronger acid) works consistently across Groups 14, 16, and 17.