2015 WYSE Academic Challenge Regional Chemistry Exam Solution Set

1. D. Uncertainty of a measurements lies at the last digit.

2. B. the balanced equation is $Ca(OH)_2 + 2\ HCl \rightarrow CaCl_2 + 2\ H_2O$

3. C. The measurements are not accurate but they are precise.

4. C. The initial result after addition on the numerator quantities will contain 3 sig. fig. In the successive operation of division, 3 sig. fig. will be the fewest.

5. E. The old name of $Fe_2(SO_4)_3$ is ferric sulfate.

6. E. Ionic compounds are formed with the lowest whole number ratio.

7. B. Follows the solubility rule #4 as given at the bottom of the equation page (3).

8. C. $6\ \text{mol Cl}_2\ \text{x}\ \frac{2\ \text{mol FeCl}_3}{3\ \text{mol Cl}_2}\text{x}\ \frac{162.2\ \text{g FeCl}_3}{1\ \text{mol FeCl}_3} = 649\ \text{g FeCl}_3$

9. C. The answer is C.

10. D. All species are written correctly and all atoms are accounted for.

11. D. $5.00\ \text{mol NiCl}_2\ \text{x}\ \frac{2\ \text{mol AlCl}_3}{3\ \text{mol NiCl}_2} = 3.33\ \text{mol AlCl}_3;$

    $5.00\ \text{mol Al}\ \text{x}\ \frac{2\ \text{mol AlCl}_3}{2\ \text{molAl}} = 5.00\ \text{mol AlCl}_3;$

    5.00 mol $NiCl_2$ is limiting reactant, will run out first.

    Only 3.33 mol $AlCl_3$ will be formed which is 444 g $AlCl_3$.

12. B. Agents are always on the left side of the equation. Oxidation numbers of only iron and chromium have changed.

13. A. Cl^- ion from $MgCl_2$ (2 x 0.200 M) and from NaCl (0.300 M) will add up to 0.700 M.

14. E. $0.77\ \text{g H}\ \text{x}\ \frac{1\ \text{mol H}}{1.01\ \text{g H}} = \frac{0.762\ \text{mol}}{0.762\ \text{mol}} = 1.000 \rightarrow 1\ \text{for the subscript of H}$

    $18.28\ \text{g C}\ \text{x}\ \frac{1\ \text{mol C}}{12.01\ \text{g C}} = \frac{1.522\ \text{mol}}{0.762\ \text{mol}} = 1.997 \rightarrow 2\ \text{for the subscript of C}$

    $80.96\ \text{g Cl}\ \text{x}\ \frac{1\ \text{mol Cl}}{35.45\ \text{g H}} = \frac{2.284\ \text{mol}}{0.762\ \text{mol}} = 2.997 \rightarrow 3\ \text{for the subscript of Cl}$

    The empirical formula is the lowest whole number mole ratio of the atoms, C_2HCl_3

15. A. The existence of isotopes was learned many decades after the original postulates.

16. B. The answer is B.

17. C. This reading is more precise. The uncertainty in this measurement is 2.0 ± 0.1.

18. E. $8.1\ \text{g}\ \text{K}_2\text{SO}_4\ \text{x}\ \frac{1\ \text{mol}\ \text{K}_2\text{SO}_4}{174.26\ \text{g}\ \text{K}_2\text{SO}_4}\ \text{x}\ \frac{1}{0.175\ \text{L}} = \frac{0.266\ \text{mol}\ \text{K}_2\text{SO}_4}{\text{L}}\ \text{x}\ \frac{2\ \text{mol}\ \text{K}^+\ \text{ion}}{1\ \text{mol}\ \text{K}_2\text{SO}_4} = \frac{0.531\ \text{mol}\ \text{K}^+\ \text{ion}}{\text{L}}$

19. D. An element contains only one type of atoms.

20. A. $\text{K} = \frac{P_{\text{PCl}_3}\ \text{x}\ P_{\text{Cl}_2}}{P_{\text{PCl}_5}} = \frac{0.463\ \text{x}\ 1.98}{0.875} = 1.05$

21. A. Mulberry leaves are different from silk in composition.

22. B. pOH = –log (7.9×10^{-7} M) = 6.10; pH = 14 – 6.10 = 7.90

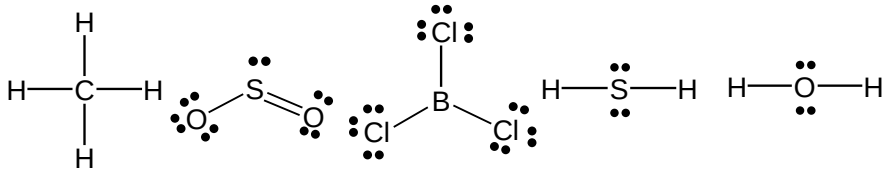
23. A. Le Chatelier's principle.

24. C. Strong acid-weak base reaction produces acidic salt.

25. B. Alpha particles are $^4_2\text{He}^{2+}$, helium nuclei, each carrying 2+ charge.

26. D. Solution is a mixture of at least two pure substances.

27. B.



28. C. I_2 will form at a rate of $\frac{3}{5}\ \text{x}\ 2.5\ \text{M.s}^{-1} = 1.5\ \text{M.s}^{-1}$

29. D. For NO_3^- the oxidation number (x) of N is: $x + (3 \times 2) = -1$. $\therefore x = +5$.

30. A. $\Delta H = H_f - H_i$. For exothermic reactions the sign of ΔH must be negative.

31. C. NO_2 has odd number of valence electrons. For $[NH_4]^+ = 5 + 4 - 1 = 8$;
for $NH_3 = 5 + 3 = 8$; for NO_2; $5 + 6 + 6 = 17$; for CO_3^{2-}; $4 + (3 \times 6) + 2 = 24$.

32. E. $E = h\nu$, $c = \nu\lambda$, $\therefore \lambda = \frac{hc}{E} = \frac{6.626\ \text{x}\ 10^{-34}\text{J.}\ \text{s}^{-1}\ \text{x}\ 2.998\ \text{x}\ 10^{8}\text{m.}\ \text{s}^{-1}}{2.25\ \text{x}\ 10^{-19}\text{J}} = 8.83\ \text{x}\ 10^{-7}\text{m}.$

33. B. They both have the same outer electron configuration (valence electron count).

34. D. The O-center of H-O-C is surrounded by four electron domains (two bonding and two nonbonding pairs) to produce tetrahedral (109.5°) angle.

35. E. $\frac{V_1}{V_2} = \frac{T_1}{T_2}.\ \therefore\ V_2 = \frac{V_1 T_2}{T_1} = \frac{2.50\ \text{L x}\ 308\ \text{K}}{405\ \text{K}} = 1.90\ \text{L}.$

36. A. $P_1V_1 = P_2V_2.\ \therefore\ V_2 = \frac{P_1V_1}{P_2} = \frac{P_1\ \text{x}\ 2.73\ \text{L}}{2.75\ P_1} = 0.993\ \text{L}.$

37. D. $\mathrm{PV = nRT\ and\ n = \frac{m}{M}\ .\therefore\ m = \frac{M\ x\ P\ x\ V}{T\ x\ R} = \frac{4.0\frac{g}{mol}\ x\ 1\ atm\ x\ 2.32\ L}{298\ K\ x\ 0.0821\ \frac{L\ .atm}{mol\ .K}} = 0.379\ g\ He}$

38. C. Due to the decrease in atomic size, loss of electron becomes increasingly difficult.

39. E. The answer is E.

40. A. $\mathrm{Density\ at\ STP = \frac{molar\ mass}{molar\ volume} = \frac{16.04\ g\ .\ mol^{-1}}{22.4\ L\ .\ mol^{-1}} = 0.716\ \frac{g}{L}}$

References:

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3. Chemistry, 5th edition, Martin Silberberg, McGraw Hill, 2009, 978-0073048598