2019 WYSE Regional Chemistry Solution Set

Answer	Explanation
1. Answer is E.	$^{4}_{2}He^{2+}$, self-explanatory by the symbol.
2. Answer is C.	Any juice contains water as the largest ingredient.
3. Answer is B.	Four carbon in the chain with the functional group carboxyl in the end.
4. Answer is E.	Follows the rules of writing Lewis structure completely.
5. Answer is B.	PV = nRT $P = \frac{nRT}{V} = \frac{0.5\ mol\ x\ 348\ K\ x\ 0.0821\ L\ .\ atm\ .\ mol^{-1}\ .\ K^{-1}}{3.5\ L}$ = 4.1 atm.
6. Answer is C.	More degree of freedom on the product side (4 mol gas vs. 2 mol gas).
7. Answer is B.	Only HF produces H^+ ion in aqueous solution.
8. Answer is A.	Self-explanatory.
9. Answer is E.	Follows the nomenclature rule.
10. Answer is A.	Follows the scientific convention.
11. Answer is C.	Self-explanatory.
12. Answer is A.	H_2SO_4 provides two protons in aqueous solution.
13. Answer is E.	C1 and C2 are surrounded by three and four electron domains respectively.
14. Answer is E.	In two state situation for the same pressure and number of moles the ideal gas law turns out to be $\frac{V_1}{T_1} = \frac{V_2}{T_2}$. ∴ $T_2 = \frac{V_2\ x\ T_1}{V_1} = \frac{6.00\ L\ x\ 298\ K}{2.00\ L}$ = 894 K
15. Answer is D.	U: mass, g 67.6; molar mass, g/mol 238.03; mol 0.284; ratio to fewest mol 1 F: mass, g 32.4; molar mass, g/mol 18.99; mol 1.71; ratio to fewest mol 6 Empirical formula = UF_6
16. Answer is A.	1 Å = 10^{-10} m and 1 m = 100 cm ∴ 1 cm^3 x $[\frac{1\ m}{100\ cm}]^3$ x $[\frac{1\ Å}{10^{-10}\ m}]^3 = 10^{24}\ Å^3$
17. Answer is E.	The answer is self-explanatory.
18. Answer is A.	The answer is self-explanatory.
19. Answer is E.	In a neutral isotope the # e^- = # p^+ = 17 for chlorine. # of n^o = mass # – # of p^+ = 37 – 17 = 20 n^o.
20. Answer is E.	Mass of CH_4 = 16.05 amu, mass of H in CH_4 = 4.04 amu ∴ % H = $\left[\frac{4.04\ amu}{16.05\ amu}\right]$ x 100 = 25.17%
21. Answer is D.	The answer is self-explanatory.
22. Answer is C.	The answer is self-explanatory.

23. Answer is B.	Highest equimolar mixture of the weak acid and its conjugate base would have the highest buffering capacity.
24. Answer is C.	The overall order is the summation of the orders of all reactants (the power values on the concentration symbol).
25. Answer is B.	$c = \nu\,\lambda$, ($c = 2.998 \times 10^8$ m/s) $\therefore\ \lambda = \frac{c}{\nu} = \frac{2.998 \times 10^8\ \text{m}\,.\,\text{s}^{-1}}{6.912 \times 10^{14}\ \text{s}^{-1}} = 4.337 \times 10^{-7}\ \text{m} \times \frac{10^9\ \text{nm}}{1\ \text{m}} = 4.337 \times 10^2\ \text{nm}$
26. Answer is D.	Halogens are very electronegative. In reaction with another atom or species, they abstract electron causing increase in oxidation number of that atom.
27. Answer is D.	Rule: Sum of oxidation number = charge on the molecule HNO_3 H + N + 3 x O = 0 +1 + N + (3 x -2) = 0 N = +5
28. Answer is A.	This question is based on knowing that the valence electrons are the easiest to remove. Since the largest jump in IE occurs between IE_5 and IE_6, the correct element has 5 valence electrons. Therefore, the answer is P
29. Answer is B.	Convert grams of KNO_3 to moles using molar mass. Moles of KNO_3 are then converted to moles of N_2 using the coefficients in the balanced equation. $58.6\ \text{g}\ KNO_3 \times \frac{1\ \text{mol}\ KNO_3}{101.11\ \text{g}\ KNO_3} \times \frac{2\ \text{mol}\ N_2}{4\ \text{mol}\ KNO_3} = 0.290\ \text{mol}$
30. Answer is D.	First calculate the theoretical yield. Divide the actual yield by the theoretical yield to get the percent yield. $62.80\ \text{g}\ H_2O \times \frac{1\ \text{mol}\ H_2O}{18.02\ \text{g}\ H_2O} \times \frac{1\ \text{mol}\ C_2H_2}{2\ \text{mol}\ H_2O} \times \frac{26.04\ \text{g}\ C_2H_2}{1\ \text{mole}\ C_2H_2} = 45.37\ \text{g}$ $\%\text{yield} = \frac{15.38\ \text{g}}{45.37\ \text{g}} \times 100 = 33.90\ \%$
31. Answer is C.	One needs to convert mg to g, g to mole using molar mass, and finally mole to molecules using Avogadro's number. $45.8\ \text{mg}\ C_2H_4 \times \frac{1\ \text{g}\ C_2H_4}{1000\ \text{mg}\ C_2H_4} \times \frac{1\ \text{mol}\ C_2H_4}{28.06\ \text{g}\ C_2H_4} \times \frac{6.022 \times 10^{23}\ \text{molecules}}{1\ \text{mole}\ C_2H_4}$ $= 9.83 \times 10^{20}\ \text{molecules}$
32. Answer is B.	First, find the mass of the entire solution using the volume and density. Then divide the part (KBr) by the total (solution) $473\ \text{mL} \times \frac{1.12\ \text{g}}{1\ \text{mL}} = 529.8\ \text{g}$ $\frac{49.3\ \text{g}}{529.8\ \text{g}} \times 100 = 9.31\ \%$
33. Answer is B.	In general, anions are larger than cations. Radius also increases going down a column for ions. So, the anion (Br^-) is the largest species and Rb^+ is larger than Na^+ due to being lower on the periodic table.

34. Answer is C.	Titanium has 22 e^- and an inner configuration of argon (18 e^-). $[Ar]4s^2 3d^2$ The cation has two fewer electrons than the neutral atom. The electrons are lost from the sublevel with the highest quantum number, e.g.,4s, resulting in $[Ar]3d^2$.
35. Answer is D.	Nitrogen has a total of seven electrons. Following the Aufbau principle and Hund's rule, the three 2p electrons have to be unpaired.
36. Answer is E.	The answer is based on the electromagnetic spectrum. The lowest energy form is infrared, followed by x-rays, followed by gamma rays.
37. Answer is C.	Use the definition of molality to convert kg of octane to moles of CCl_4. Molar mass then coverts moles to grams. $0.450\ \text{kg octane} \times \frac{1.20\ \text{mol}\ CCl_4}{1\ \text{kg octane}} \times \frac{153.81\ \text{g}\ CCl_4}{1\ \text{mol}\ CCl_4} = 83.06\ \text{g}$
38. Answer is D.	The energy of light is equal to Planck's constant multiplied by frequency. $E = h\nu = (6.626 \times 10^{-34}\ \text{J} \cdot \text{s}) \times 5.49 \times 10^{14}\ \text{Hz} = 3.64 \times 10^{-19}\ \text{J}$
39. Answer is A.	Use the equation for boiling point elevation to solve for moles of solute. Then convert moles to grams using molar mass. $\Delta T = k_b \times m$; where $m = \frac{\text{mole solute}}{\text{kg solvent}}$ $0.39\ ^\circ\text{C} = 0.512 \frac{^\circ\text{C}}{m} \times \left(\frac{\text{mole}}{0.500\ \text{kg}}\right) \quad \therefore \text{mole} = \frac{0.39 \times 0.50}{0.512} = 0.381\ \text{mole}$ $0.381\ \text{mole} \times \frac{342.30\ \text{g}}{1\ \text{mole}} = 130\ \text{g}$
40. Answer is D.	The given balanced equation has been reversed. According to the Law of Mass Action, one should take the reciprocal of the given K_c.