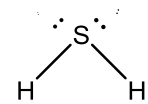
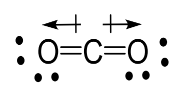
2022 ACES Sectional Chemistry Solution Set

Answer	**Explanation**
1. Answer is A.	$D = \frac{m}{V}, \therefore V \propto \frac{1}{D}$. The lowest density will occupy the largest volume.
2. Answer is A.	In the ionic state, sodium is Na^{+} and carbonate ion is CO_3^{2-}. Two sodium ions will be needed to form the correct formula of Na_2CO_3. The other formulas are written correctly.
3. Answer is C.	Refer to the image on right. A total of 8 valence electrons are used for the Lewis structure of H_2S. The skeletal structure uses four of these: H-S-H. The remaining 4 are distributed as two sets of unshared electron pairs on sulfur to satisfy the octet rule. 
4. Answer is D.	q = m c ΔT; $c = \frac{q}{\Delta T}$; $c = \frac{5.0 \times 10^3 \text{ J}}{2.0 \times 10^2 \text{ g} \times 100.0\ °\text{C}}$ = 0.25 J/g .°C.
5. Answer is B.	O_2 is the one that is a nonpolar species, thus possesses a zero dipole force.
6. Answer is C.	A pH value of less than 7 is acidic. Choice-I is evident. Choice-II produces a pH of 2. Choice-V produces a pH of 2.09.
7. Answer is E.	One mole of any gas at STP occupies a volume of 22.4 L.
8. Answer is B.	Among the choices, radio waves have the longest wavelength, and are consequently associated with the least amount of energy.
9. Answer is B.	The monatomic ions of calcium and phosphorus are Ca^{2+} and P^{3-}. The combination generates the formula – Ca_3P_2.
10. Answer is A.	As displayed in the Lewis structure (image on right) the polar bonds are across from one another (linear geometry) causing the cancellation of bond polarity and producing a nonpolar molecule. 
11. Answer is C.	$\Delta H°_{rxn} = \sum \Delta\ H_f \text{ products} - \sum \Delta\ H_f \text{ reactans}$ = [(–373)+(–1102)]kJ – [(2 x –569)+(–347)]kJ = +10 kJ
12. Answer is D.	Homogeneous solution formation is favored by the commonality and intensity of intermolecular forces between the solute and the solvent. Both NH_3 and CH_3OH possess dispersion, dipole, and hydrogen bonding to mix homogeneously compared to the other choices.
13. Answer is E.	pH = –log[H^{+}] = –log[1 x 10^{-4} M] = 4.0. pOH = 14 – pH = 10.0. [OH^{-}] = 10^{-pOH} M = 1 x 10^{-10} M.
14. Answer is D.	The monatomic ions of aluminum and sulfide are $A\ell^{3+}$ and S^{2-}. The combination generates the name aluminum sulfide with the formula of $A\ell_2S_3$.
15. Answer is D.	First, calculate the amount of Fe_2O_3 that would be used by 200.0 g Na. Then, subtract from what was provided. 200.0 g Na x $\frac{1 \text{ mol Na}}{22.99 \text{ g Na}}$ X $\frac{1 \text{ mol } Fe_2O_3}{6 \text{ mol Na}}$ X $\frac{159.7 \text{ g } Fe_2O_3}{1 \text{ mol } Fe_2O_3}$ = 231.5 g Fe_2O_3 used. 250.0 g – 231.5 g = 18.5 g left over
16. Answer is A.	In an exothermic reaction, heat is produced as an additional product of the reaction. Decreasing the temperature would be removing heat. Since heat is a product, the reaction would shift to the right to produce more heat. This would result in more H_2 being produced.

17. Answer is D.	The equation for osmotic pressure is: π = i*M*RT i = 1, since sucrose does not ionize $M = 3.85\text{ g x }\frac{1\text{ mol sucrose}}{342.34\text{ g sucrose}}\text{ x }\frac{1}{0.150\text{ L}} = 0.075\ M$ T = 18.5 + 273 = 291.5 K π = (1) (0.075 mol/L) (0.08206 L·atm / mol·K) (291.5 K) = 1.79 atm
18. Answer is B.	Periodic trends state that atomic radius decreases from bottom to top and increases from right to left on the periodic table.
19. Answer is E.	Beryllium ($1s^22s^2$) has a stable electron configuration; whereas, boron has a single unpaired electron ($1s^22s^22p^1$). It will be easier to remove the unpaired electron in boron as this will result in a stable electron configuration.
20. Answer is B.	Since 150.0 mL of water is added to the original 250.0 mL solution, V_2 would be 400.0 mL $M_1V_1 = M_2V_2\ \therefore M_2 = \frac{M_1V_1}{V_2} = \frac{1.60\text{ M x }250.0\text{ mL}}{400.0\text{ mL}} = 1.00\text{ M}$
21. Answer is E.	E = hν (where E is the energy of one photon E of one photon $= 1\text{ photon x }\frac{50\text{ mJ}}{2.551\text{ x }10^{15}\text{ photon}}\text{ x }\frac{1\text{ J}}{1000\text{ mJ}} = 1.96\text{ x }10^{-17}\text{ J}$ $\nu = \frac{E}{h}\quad \therefore\quad \nu = \frac{1.96\text{ x }10^{-17}\text{ J}}{6.626\text{ x }10^{-34}\text{ J.s}} = 2.96\text{ x }10^{16}\text{ s}^{-1}$
22. Answer is C.	Due to the '*l*' value of f orbitals being 3, the m_l values are limited to the values of -3, –2, –1, 0, 1, 2, 3.
23. Answer is C.	Calcium as an ion has a charge of 2+. Therefore, element X has a charge of 2-. Making element X a group 6A element. The valence electron configuration would be s^2p^4.
24. Answer is A.	250.0 g of water is 250.0 mL (0.2500 L) of water as the density is 1.00 g/mL. $0.2500\text{ L x }\frac{0.0750\text{ mol Mg(NO}_3)_2}{\text{L}}\text{ x }\frac{148.3\text{ g Mg(NO}_3)_2}{1\text{ mol Mg(NO}_3)_2} = 2.78\text{ Mg(NO}_3)_2$
25. Answer is D.	$6.5\text{ mol NH}_3\text{ X }\frac{6\text{ mol H}_2\text{O}}{2\text{ mol NH}_3} = 19.5\text{ mol H}_2\text{O}$ $19.5\text{ mol H}_2\text{O X }\frac{18.02\text{ g}}{1\text{ molH}_2\text{O}} = 351.4\text{ g H}_2\text{O} = 351.4\text{ mL}$ used in the reaction 400 mL – 351.4 mL = 48.6 mL remains unreacted.
26. Answer is C.	Emission is from high to low energy level. Energy and wavelength are inversely proportional. Longest wavelength would be the lowest energy transition. Due to the quantized energy levels of an atom, this would be the 4 → 3 transition.
27. Answer is E.	Using the molar coefficients, the change in concentration of **B** would be equal to 3X. The equilibrium concentration would then be 0.1 + 3X.
28. Answer is C.	Leading zeros are never significant, captive zeros are always significant, and trailing zeros are significant if there is a decimal point.
29. Answer is E.	1 inch is defined as exactly 2.54 centimeters. All the other conversions here are approximations.
30. Answer is D.	Adding all oxidation states for the 4 atoms involved yields a total of +1 (-2 + 1 + 1 + 1 = +1).

31. Answer is E.	The 6 protons tell us the element is carbon. Since the number of electrons exceeds the number of protons by 1, the charge must be negative 1.
32. Answer is D.	The chemical formula for ammonium phosphate is $(NH_3)_3PO_4$, with a molar mass of 149.1 g/mol. Since phosphorous has a mass of 30.97 g/mol the percent composition is $\frac{30.97}{149.1}$ x 100 = 20.8%
33. Answer is A.	The H-H equation is $\mathrm{pH} = \mathrm{pK_a} + \log\frac{[\mathrm{base}]}{[\mathrm{acid}]}$. If you set the acid and base concentrations to the same value, the log term becomes zero, and the pH will equal the pK_a.
34. Answer is B.	Assume a mass of 100 grams. This would have 73.924 grams of mercury and 26.082 grams of chlorine. Multiplying these by their molar masses gives 73.924 g Hg x $\frac{1\ \mathrm{mol\ Hg}}{200.59\ \mathrm{g\ Hg}}$ = 0.36853 mol Hg and 26.082 g Cℓ x $\frac{1\ \mathrm{mol\ C\ell}}{35.453\ \mathrm{g\ C\ell}}$. = 0.73568 mol Cℓ Dividing both of these values by 0.36853 gives a mole ratio of 1 mercury to 2 chlorines, and an empirical formula of $HgC\ell_2$.
35. Answer is E.	Many collisions between reactants are not effective because they do not have enough kinetic energy or the orientation is wrong. These collisions do not result in a chemical reaction.
36. Answer is A.	Louis de Broglie's reasoning was that if the orbital circumference was not an integer multiple of the electron's wavelength, then destructive interference would cause the electron's orbit to decay until it did find an orbit which exhibited constructive interference where it would stabilize.
37. Answer is B.	In general, the rate of a chemical reaction is proportional to the concentration of the reactants: rate $\propto$ [reactants] This statement becomes the rate law when you introduce the rate constant: rate = k x [reactants]
38. Answer is C.	Diamagnetic atoms have all paired electrons. Beryllium has 4 electrons in its 1s and 2s orbitals that are all paired. Neon has an additional 6 electrons that are all paired in its 2p orbitals. All the other elements in this period have at least one unpaired electron because of Hund's rule.
39. Answer is B.	The oxidizing agent is always the specie that gets reduced. The oxygen atoms on the reactant side of the equation have oxidation states of zero, while on the product side they are –2. Therefore, this is reduction, making O_2 the oxidizing agent.
40. Answer is A.	Using the Nernst equation at 298 K $(\mathrm{E_{cell}} = \mathrm{E^0}_{\mathrm{cell}} - \frac{0.0592\ \mathrm{V}}{\mathrm{n}}\ \mathrm{x} \log \mathrm{Q})$ yields $\mathrm{E_{cell}} = -0.15\ \mathrm{V} - \frac{0.0592\ \mathrm{V}}{2}\ \mathrm{x} \log 0.19 = -0.13\ \mathrm{V}$.