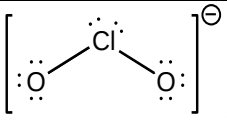
WYSE – Academic Challenge
Chemistry Test Solutions (State) – 2017

Answer	Explanation
1. Answer is D.	Self-explanatory.
2. Answer is A.	Self-explanatory.
3. Answer is E.	n = 3.00 g x $\frac{1\ \text{mol}}{125\ \text{g}}$ = 0.024 mol $m = \frac{0.024\ \text{mol}}{0.045\ \text{kg}} = 0.5333\ \frac{\text{mol}}{\text{kg}}$ $\Delta t_f = t_f^o - t_f = m \times K_f$, 178.4 °C – t_f = 40.0 °C/m x 0.5333 m = 21.333 °C, t_f = 157.1 °C
4. Answer is B.	The negative slope in the plot justifies the answer. mass Y  temp
5. Answer is C.	$\frac{50.208\ \text{g}}{5.6\ \text{mL}}$ = 8.9657 g/mL → 9.0. (2 significant figure when rounding rules are followed).
6. Answer is E.	The general formula of ethers is R-O-R' where R is an alkyl group.
7. Answer is D.	The trend in the periodic table is – along any period the size increases from right to (←) giving Cl < S. And anions occupy more space than neutral atom, giving S < S^{2-}.
8. Answer is B.	$Q = \frac{[Cl^-]^2[ClO_3^-]}{[ClO^-]^3} = \frac{0.32\ \text{x}\ (0.50)^2}{(0.24)^3}$ = 5.8. Since $Q < K$, the reaction will proceed in the forward direction (left to right).
9. Answer is D.	Both fit in the rules of the nomenclature.
10. Answer is C.	For any species the rate expression is $\frac{-\Delta[\text{conc}]}{\Delta t}$. When applied to this reaction we get the interdependence relationship as $\frac{-\Delta[A]}{\Delta t} = \frac{-\Delta[B]}{5\Delta t} = \frac{\Delta[C]}{4\Delta t}$ Comparing the latter two species we get $\frac{\Delta[C]}{\Delta t} = \frac{-4\Delta[B]}{5\Delta t}$
11. Answer is B.	Isotopes have the same count of protons but different count of neutrons. We have in this answer choice the isotopes $^{52}_{24}\text{Cr}$ and $^{51}_{24}\text{Cr}^{3+}$.
12. Answer is E.	$Ag_2CrO_4(s) \rightleftharpoons 2\ Ag^+(aq) + CrO_4^{2-}(aq)$ 2s s $K_{sp} = (2s)^2 \times s = 4s^3$ $s = \sqrt[3]{\frac{K_{sp}}{4}}$
13. Answer is C.	The prevailing pressure on the mountaintop is lower than 1 atm.
14. Answer is B.	$D = \frac{m}{V}$, leading to $V = \frac{m}{D} = \frac{5.00\ \text{g}}{1.59\ \text{g/mL}}$ = 3.14 mL
15. Answer is A.	Group 1 metals are alkali metals (form base when react with water).
16. Answer is A.	Pure solids and liquids do not show up in the equilibrium expression. Answer A fits the equation when balanced: $2\ NaHCO_3(s) \rightleftharpoons Na_2CO_3(s) + H_2O(g) + CO_2(g)$
17. Answer is A.	The formula is $CaCl_2$.
18. Answer is C.	Half-life is the same irrespective of the order in the reaction rate. There are three half-lives represented by the arrows 10.0 g → 5.0 g → 2.5 g → 1.25 g. ∴ $\frac{195\ \text{day}}{3\ \text{half-life}}$ = 65.0 day for each half-life.
19. Answer is D.	The mass of both are about 1 amu.
20. Answer is E.	It fits the mathematical expression of a first order reaction: $\ln[A]_t = -kt + \ln[A]_o$.

21. Answer is E.	Arrhenius definition of acid/base behavior clearly states that the behavior must be in water. Bronsted-Lowry allows for the behavior to be in any environment.
22. Answer is A.	0.4 $\frac{\text{mol}}{\text{L}}$ HCl x 0.025 L = 0.01 mol HCl and 0.3 $\frac{\text{mol}}{\text{L}}$ NaOH x 0.032 L = 0.0096 mol NaOH. HCl is in excess amount.
23. Answer is A.	d = $\frac{\text{P x } M}{\text{R x T}} = \frac{0.750 \text{ atm x } 60.0 \text{ g.mol}^{-1}}{300.15 \text{ K x } 0.0821 \text{ L..atm.mol}^{-1}\text{.K}^{-1}}$ = 1.83 g/L
24. Answer is C.	Entropy increases from solid to liquid to gas.
25. Answer is B.	An alpha particle [$_2^4\text{He}^{2+}$] is a He atom without electrons (2+ charge).
26. Answer is C.	87.42 g N x $\frac{1 \text{ mol N}}{14.01 \text{ g N}}$ = 6.241 mol N 12.58 g H x $\frac{1 \text{ mol H}}{1.01 \text{ g H}}$ = 12.48 mol H $\frac{12.48 \text{ mol H}}{6.241 \text{ mol N}} = \frac{2 \text{ mol H}}{1 \text{ mol N}}$ = NH_2
27. Answer is A.	The quantum number *n* for a valence electron of calcium must be 4. This excludes answers B and E. Answer C is not an option because *l* has to be equal to a number of 0 → *n* -1. Answer D is not an option because the m_s value can't be equal to 0.
28. Answer is D.	Zinc half-reaction : Zn → Zn^{2+} + 2 e^- Vanadium half-reaction : VO_2^+ + 2 H^+ + e^- → VO^{2+} + H_2O Multiply the Vanadium half-reaction by 2 to balance electrons 2 VO_2^+ + 4 H^+ + 2 e^- → 2 VO^{2+} + 2 H_2O Add the two half-reactions together to get answer D.
29. Answer is E.	The VSEPR structure of the species is  .
30. Answer is D.	The answer is self-evident.
31. Answer is D.	The hydrogen phosphate ion HPO_4^{2-}. When it reacts with a base, it forms PO_4^{3-}. For example: HPO_4^{2-} + OH^- → H_2O + PO_4^{3-}
32. Answer is E.	A displacement reaction is a reaction by which an atom, or group of atoms, present in a molecule is displaced by another atom.
33. Answer is B.	$P_1V_1 = P_2V_2$ ∴ $V_2 = \frac{P_1V_1}{P_2} = \frac{100.\text{mL x } 150. \text{ kPa}}{200. \text{ kPa}}$ = 75.0 mL = 0.0750 L
34. Answer is C.	Free energy is zero for a reaction at equilibrium.
35. Answer is A.	mass % of C in $C_6H_{12}O_6 = \frac{\text{amu mass of carbon}}{\text{amu mass of } C_6H_{12}O_6}$ x 100 ∴ $\frac{6 \text{ x } 12.01 \text{ amu}}{180.18 \text{ amu}}$ x 100 = 40.0%
36. Answer is B.	17 protons, 18 electrons are present in the chloride ion.
37. Answer is E.	The half-reaction for Ag must be multiplied by 2 to balance the electrons and then the two half-reactions are added together.
38. Answer is D.	The answer is self-explanatory based on the definition of a polar covalent bond
39. Answer is C.	The answer is self-evident.
40. Answer is B.	0.0150 L $AlPO_4$ x $\frac{0.300 \text{ mol}}{1 \text{ L}}$ x $\frac{2 \text{ mol Al}}{2 \text{ mol AlPO4}}$ x $\frac{1000 \text{ mmol Al}}{1 \text{ mol Al}}$ = 4.50 mmol Al Using the other reagent, 0.180 g Mg x $\frac{1 \text{ mol}}{24.3 \text{ g Mg}}$ x $\frac{2 \text{ mol Al}}{3 \text{ mol Mg}}$ x $\frac{1000 \text{ mmol Al}}{1 \text{ mol Al}}$ = 4.94 mmol Al. Therefore, $AlPO_4$ is the limiting reagent and 4.50 mmol Al is the theoretical yield.