2013 Academic Challenge Chemistry Exam Solutions – Page 1

1. E. The answer is E.

2. C. Water vapor from the air condenses on the outside of the glass.

3. A. # C atoms = 0.00013 g C [1mol C/12.011 g C][6.022x10^{23} atoms/1 mol C]= 6.5x10^{18} atoms

4. E. The second electron from Na would be removed from the core.

5. D. HCN is hydrocyanic acid.

6. C. mol GeF_4 = 8.00 mol GeF_3H[3 mol GeF_4/4 mol GeF_3H] = 6.00 mol GeF_4.

   Actual moles needed = 6.00 mol / 0.926 6.48 mol

7. D. The answer is D.

8. B. The answer is B.

9. E. A tertiary amine has 3 carbon groups attached to the N.

10. A. The transition metals in a given period to do not considerably in size.

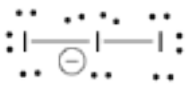
11. B. (I) is a redox reaction and (IV) is a precipitation.

12. C. Comparing runs I and 2 shows that doubling the concentration of I^- will double the rate, making the reaction first order in I^-. Comparing runs 2 and 3 shows that doubling [$Fe(CN)_6^{3-}$] quadruples the rate, making the reaction 2nd order in $Fe(CN)_6^{3-}$.

13. B. $\Delta G = \Delta H - T\Delta S$
    $0 = 40{,}000\ kJ - T(50\ J/K)$
    $T = 800\ K$ This is the temperature at which the reaction switches between spontaneous and non-spontaneous.

14. D. 21.1 kg + 84.0 kg = 105 kg according the the Law of Conservation of Mass.

15. E. This is the net ionic equation (not to be confused with the overall equation in C.)

16. A. Linear. AX_2E_3 around central atom. 

17. E. Boiling point is a colligative property and depends on the number of moles of particles in the solution. If they are all the same mass percent, the one with the highest molar mass will have the lowest number of particles in solution. This is raffinose. Therefore, it will have the lowest boiling point elevation.

18. E. Option I will lead to a shift in the equilibrium to the right. Neither II or III will affect the equilibrium.

19. C

	$2\ N_2O\ (g)$	+	$N_2H_4\ (g)$	$\Leftrightarrow$	$3N_2\ (g)$	+	$2H_2O\ (g)$
I	0.010 M		0.025 M		0		0
C	-2x		-x		+3x		+2x
E	0.010-2x		0.025-x		3x		2x

Solve for x: 0.010-2x = 0.0061 M x = 0.00195 M

$[N_2]$ = 3(0.00195 M) = 0.0585 M moles N_2 = 0.0585 (10 L) = 0.585 mol = 0.59 mol

20. D. Though HCl is a strong electrolyte, it is still a molecular compound.

21. C. Colligative properties depend on the amount of solute present in the solution. For an ideal solution the chemical properties of solute and solvent do not matter.

22. D. Moles of ethanol = 950 g / 46.07 g/mol =20.6 moles

Raoult's Law $P_{soln} = X_{ethanol} \bullet P°_{ethanol}$
= ((20.6 / (20.6+0.75)) • 50 = 48 torr

23. A. –log (1.2) = -0.079

24. E. V = $2.0x10^{-4}$ mol Br^- [1 mol NaBr / 1 mol Br^-][1 L / 0.25 mol NaBr]
= $8.x10^{-4}$ mol NaBr = 0.80 mL

25. E. for $[Na^+]$ 2(0.500mol)/1.33L =0.752 M; for $[SO_4^{2-}]$ 0.500 mol/1.33 L = 0.376M

26. D. The answer is D.

27. A. mol CO_2 = 9.81 g/ 44.01 g/mol = 0.223 mol

PV = nRT
P (1.00 L) = (0.223 mol)(0.0821)(299 K)
P = 5.47 atm

28. A. The answer is A.

29. E. The answer is E.

30. C. mole fraction O_2 = 555 / (171+505+555) = 0.451

31. A. $t_{1/2} = \ln 2 / k$
16 years = 0.963 / k
$k = 0.0433\ yr^{-1}$

If the fifth-life needs to be determined, then if you have 100% of a sample, you want to know the time taken for it to decay to 80%.

$\ln A = \ln A_0 - kt$
$\ln 80 = \ln 100 - (0.0433)t$
t = 5.2 years

32. B. The answer is B. It's the only one that shows the oxidation number on S changing from reactants to products.

33. C. breaking bonds <u>always</u> requires energy, forming bonds releases energy.

34. C. First, make an approximation for the diameter of the dot = 3 mm. You must also make an approximation for the diameter of a carbon atom = 1 Å.

35. C. The entropy increases because the net change of state is from a solid to a liquid.

36. B. mass of person = 151 lb [0.454 kg/1lb] = 68.55 kg

Dose = 68.55 kg[7.5 mg Zan/1 kg][1 mL soln/15 mL Zan]
= 34 mL

37. D. If n=4, then the largest possible m_l value is 3.

38. D. mole H in 1 mole of nicotine = (162.2 g/mol)(0.0870 g H) = 14

39. A. The salt bridge allows for the migration of ions (not electrons) to maintain the charge balance in the cell.

40. E. $1/A = 1/A_0 + kt$
$1/0.01 = 1/0.02 + (1.0 \times 10^{-3})t$
t = 50000 s