WYSE Academic Challenge
Chemistry Test (State) – 2016

1. **Correct Answer: B**

   This salt contains two pH neutral ions (spectator).

2. **Correct Answer: B**

   $Ag^+(aq) + NO_3^-(aq) + Na^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$. NO_3^- and $Na^+(aq)$ are spectator ions.

3. **Correct Answer: A**

   PV = nRT. PV = $\frac{m}{M}$RT leading to $M = \frac{mRT}{PV} = \frac{1.92\ g \times 0.0821\ L.atm.mol^{-1}.K^{-1} \times 273\ K}{0.673\ L}$
   $= 63.9\ \frac{g}{mol}$

4. **Correct Answer: B**

   This product is not formed from its elements.

5. **Correct Answer: A**

6. **Correct Answer: E**

   $C_xH_y + O_2 \rightarrow CO_2$ (33.010 g) + H_2O (13.511 g)

   33.010 g CO_2 x $\frac{1\ mol\ C}{44\ g\ CO_2}$ = 0.750 mol C. 13.511 g H_2O x $\frac{2\ mol\ H}{18\ g\ H_2O}$ = 1.501 mol H.

Atom	mol	mol ratio
C	0.750	1.000
H	1.501	2.001

   Leading to the empirical formula as CH_2.

7. **Correct Answer: C**

   $E = h\upsilon$. $\therefore \upsilon = \frac{E}{h} = \frac{1.96 \times 10^{-17}\ J}{6.626 \times 10^{-34}\ J.s} = 2.96 \times 10^{16}\ s^{-1}$

8. **Correct Answer: C**

   Oxidation numbers of all atoms remained unchanged in the process.

9. **Correct Answer: D**

10. **Correct Answer: A**

11. **Correct Answer: C**

$CH_3COOH(aq) \leftrightarrow H^+(aq) + CH_3COO^-(aq)$, $pK_a = 4.76$
$K_a = 10^{-4.76} = 1.738 \times 10^{-5} = \frac{[H^+]x\,[CH_3COO^-]}{[CH_3COOH]} = \frac{x^2}{a-x}$ assuming "x is small"
$x_2 = 1.738 \times 10^{-5} \times 0.10$ yields $x = [H^+] = 1.318 \times 10^{-3}$ M. $\therefore$ pH = –log $[H^+]$ = 2.88.

12. **Correct Answer: D**

The balanced equation is: $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

13. **Correct Answer: D**

The *l* value for the d orbital is 2. The m_l values are –2, –1, 0, 1, 2.

14. **Correct Answer: E**

$q = mc_p\Delta t$ leading to $c_p = \frac{q}{m\,\Delta t} = \frac{89.5\ J}{5.10\ g \times (75-36)\ ^\circ C} = 0.450$ J/g.°C.

15. **Correct Answer: D**

Atom	mass	mol	mol ratio
C	49.48 g	4.12	4.00
H	5.19 g	5.19	5.04
N	28.85 g	2.06	2.00
O	16.48 g	1.03	1.00

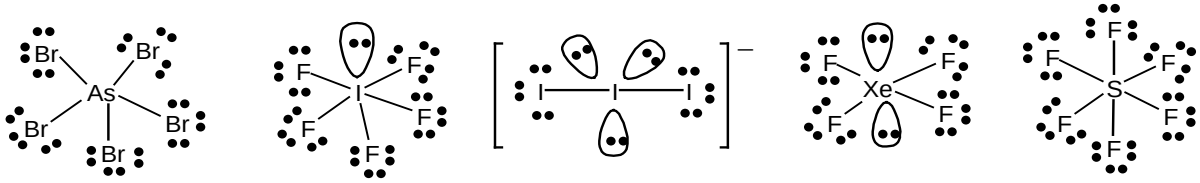
Leading to the empirical formula as $C_4H_5N_2O$.

16. **Correct Answer: A**

$PV = nRT$. $\therefore \frac{P_1V_1}{P_2V_2} = \frac{T_1}{T_2}$ leading to $\therefore P_2 = \frac{P_1V_1T_2}{V_2T_1} = \frac{1\ atm \times 2.0\ L \times 357\ K}{3.7\ L \times 332\ K} = 0.58$ atm

17. **Correct Answer: E**

18. **Correct Answer: B**



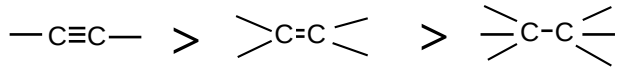
(A) (B) (C) (D) (E)

19. **Correct Answer: C**

The oxidation number of oxygen atom in $KClO_3$ is –2 and in O_2 is zero.

20. **Correct Answer: C**

The order of bond strength is



21. **Correct Answer: C**

sp hybridized N atoms contain 1 triple bond and a lone pair of electrons. This arrangement generates 1 sigma and 2 pi bonds with 2 unhybridized *p*-orbitals on the N atom.

22. **Correct Answer: C**

The answer follows the rules of solubility

23. **Correct Answer: A**

Alkali metals contain 1 valence electron and reside to the far right in the modern periodic table. They are highly metallic, prefer to transfer electrons to form cations, with radii that are large compared to other atoms in their period. The willingness of alkali metal atoms to part with electrons results in relatively low ionization energies.

24. **Correct Answer: D**

300. mL x 0.997 g/mL = 299.1 g of water at 25 °C. At –10 °C, the same mass of water will have a volume = 299.1 g (1 mL/0.920 g) = 325 mL

25. **Correct Answer: D**

The answer follows the rules of IUPAC nomenclature.

26. **Correct Answer: B**

The radius of an atom increases as shells of electrons are added – top to bottom in a group. Also, the answer follows the general trend of decreasing atoms size from left to right in a period.

27. **Correct Answer: A**

The answer follows Le Chatelier's Principle where the position of equilibrium can be disturbed and shifts to counteract a change in the system.

28. **Correct Answer: D**

The conditions for equilibrium do not require equal amounts of reactants and products or that the E_a of the forward and reverse reaction be the same. However, the rates of the reverse and forward reactions must be the same to reach an equilibrium state.

29. **Correct Answer: D**

This answer follows the IUPAC rules of nomenclature.

30. **Correct Answer: B**

Relative rates of disappearance of reactants and the appearance of products are proportional to the stoichiometry of the reactants. Using the coefficients of the balanced equation, O_2 appears 3/2 as fast as O_3 disappears. Thus, the rate at which O_3 disappears = 2/3 x 4.0 torr/s = 2.7 torr/s.

31. **Correct Answer: E**

Though there exists several viable answers, each answer must incorporate 13 electrons. Answers B and C include 12 and 14 electrons, respectively.

32. **Correct Answer: D**

The answer follows the following setup.

$$FeCl(aq) \rightleftarrows Fe^{+}(aq) + 3\ Cl^{-}(aq)$$

$$3[FeCl_3] = 3[Fe^{+}] = [Cl^{-}]$$

$$V_1 = \frac{[Cl^-](V_2)}{[FeCl_3]} \text{x} \frac{1\ \text{mol}\ FeCl_3}{3\ \text{mol}\ Cl^-} = \frac{(0.100\ \text{M})(250\ \text{mL})}{0.500\ M} \text{x} \frac{1\ \text{mol}\ FeCl_3}{3\ \text{mol}\ Cl^-} = 16.7\ \text{mL}$$

33. **Correct Answer: E**

Solute concentration (m) = $\Delta T_{fp}/K_{fp}$ = –18 °C/–1.86 °C/m = 9.68 m. Moles of glycol = (9.68 m glycol/1.00 kg water)(3.60 Kg water) = 34.9 mol glycol. MW of glycol is 62.07 g/mol. (34.9 mol glycol)(62.07 g/1 mol) = 2170 g glycol.

34. **Correct Answer: A**

$$\text{percent yield} = \frac{\text{actual yield}}{\text{theoretical yield}}\ \text{x}\ 100;\ \text{theoretical yield} = \frac{\text{actual yield}}{\text{percent yield}}\ x\ 100$$

$$\text{actual yield} = 7.85\ \text{g of}\ CH_4;\ \text{theoretical yield} = \frac{7.85\ \text{g}\ CH_4}{40.1}\ \text{x}\ 100 = 19.6\ \text{g}\ CH_4$$

$$\text{amt of}\ Al_4C_3 = 19.6\ \text{g}\ CH_4\ \text{x}\ \frac{1\ \text{mol}\ CH_4}{16.04\ \text{g}}\ \text{x}\ \frac{1\ \text{mol}\ Al_4C_3}{3\ \text{mol}\ CH_4}\ \text{x}\ \frac{143.9\ \text{g}\ Al_4C_3}{1\ \text{mol}\ Al_4C_3} = 58.6\ \text{g}\ Al_4C_3$$

35. **Correct Answer: E**

The history of the periodic table spans a century with one of the most notable events occurring in 1869 when Dmitri Mendeleev reported on the connection of the weight and properties of atoms.

36. **Correct Answer: D**

Calculations support this answer as shown in the following setup.
$[PCl_5]$ = 2.00 mol/5.00 L = 0.400 M, $[Cl_2]$ = 1.50 mol/5.00 L = 0.300 M
$[PCl_3]$ = 4.00 mol/5.00 L = 0.800 M.

	PCl_3	Cl_2	PCl_5
Initial concentration (M)	0.800	0.300	0.400
Change in Concentration (M)	–x	–x	+x
Equilibrium Concentration (M)		0.180	

Change in concentration of Cl_2 was 0.300 M – 0.180 M = 0.120 M. Thus, x = 0.120 M.
The equilibrium $[PCl_5]$ = 0.400 + 0.120 = 0.520 M, $[PCl_3]$ = 8.00 – 0.120 = 0.68 M.

$$K_{eq} = \frac{[0.520]}{[0.180][0.680]} = 4.25$$

37. **Correct Answer: B**

The attributes of a reaction such as activation energy and K_{eq}, are unaffected by an increase in temperature. Though the concentration of reactant and products may change during the course of reaction, an increase in both is not possible. The impact of temperature on a reaction is directly related to a change in rate constant(s).

38. **Correct Answer: B**

Francium is an alkali metal – Group 1.

39. **Correct Answer: C**

The vapor pressure of each solution is lowered proportionately using the molecule fraction of the solute particles in solution (Raoult's Law). $C_2H_4(OH)_2$ (ethylene glycol) does not ionize, thus 0.35 *m* of particles in solvent. Sugar does not ionize, thus 0.50 *m* of particles in solution. KBr does ionize, thus 0.20 *m* x 2 = 0.40 *m* particles in solution. Na_2SO_4 does ionize, thus 0.20 *m* x 3 = 0.60 *m* of particle in solution.

40. **Correct Answer: B**

Calculations support this answer as shown in the following setup.

$\ln A = kt + \ln A_o$

$\ln (0.210) = k(35.0) + \ln(0.350)$, $-1.560 = k(35.0) + (-1.050)$, $k = -0.0146$

80% of 0.350 M = 0.0700 M

$\ln (0.0700) = -0.0146t + \ln(0.350)$, $-2.659 = -0.0146t + (-1.050)$, t = 110 seconds.