Chemistry 209 – Fall 2015 – Final Solutions by Pavel Sedach/Prep101

1.B $\text{rate} = k[A]^x$ ← units are for zero order

$\frac{\text{mol/L}}{\text{s}} = k[A]^0$, $k = \text{rate} = \frac{\text{mol/L}}{\text{s}}$ Rate is NOT concentration dependent as this reaction is zero order!

∴ highest k = highest rate, ∴ B

2.C $0.0948 \frac{\text{L}}{\text{mol s}}$ ← 2nd order units,

$$\frac{1}{[A]_t} = \frac{1}{[A]_0} + kt \qquad 3.7\,\text{min} \times \frac{60\,\text{s}}{\text{min}} = 222\,\text{s}$$

$$\frac{1}{x} = \frac{1}{1.0\,\text{M}} + \frac{0.0948\,\text{L}}{\text{mol s}} \cdot 222\,\text{s}$$

$$\frac{1}{x} = 1 + 9.9456$$

$$x = \frac{1}{10.9456} = 0.09136\,\text{M} = 9.1 \times 10^{-2}\,\text{M}$$

3.D Can use Q-test or G-test (Chem 209 uses G-test)

4. A $NH_4HS_{(s)} \rightleftharpoons H_2S_{(g)} + NH_{3(g)}$ $K = 0.11$

mixed system, aq in mol/L, gas in bar.

$Q = [H_2S][NH_3] = [1][1] = 1$

shift left to NH_4HS

$K < Q$

$0.11 \quad 1$

* K_a H_2S / K_b NH_3 irrelevant

5. C

$$\ln\left(\frac{K_2}{K_1}\right) = \frac{\Delta H}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

? $\quad$ 93,000 J/mol

$0.11 \quad 8.314 \frac{J}{mol\,K} \quad 523.15\ K \quad 785.15\ K$

$\ln(K_2) - \ln(0.11) = 1.119 \times 10^4\ K\ (6.379 \times 10^{-4}\ K^{-1})$

$\ln(K_2) + 2.207 = 7.138$

$\ln(K_2) = 4.930$, $K_2 = e^{4.930} = 1.38 \times 10^2$

6. $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+ \quad K_a = \frac{1.00\times10^{-14}}{1.8\times10^{-5}} = \frac{K_w}{K_b}$

$H_3O^+ + HS^- \rightleftharpoons H_2S + H_2O \quad K = \frac{1}{1.0\times10^{-7}} = \frac{1}{K_a}$

$K_a = 5.56\times10^{-10} \qquad K_a = 1.0\times10^{-7}$

$NH_4^+ + HS^- \rightleftharpoons H_2S + NH_3$

$K = 5.5\times10^{-13}$

7. C

$HA + H_2O \rightleftharpoons H_3O^+ + A^-$

I	0.01 M		~ 0	0
C	$-x$		$+x$	$+x$
E	$0.01-x$		x	x

$K_a = \frac{x^2}{0.01-x}$, $x = [H_3O^+]$... $pH = 2.60$, $[H_3O^+] = 10^{-2.60} = 2.512\times10^{-3}$

$K_a = \frac{(2.512\times10^{-3})^2}{(0.01-2.512\times10^{-3})} = \frac{6.31\times10^{-6}}{7.488\times10^{-3}} = 8.43\times10^{-4}$

8. D * Slow step must give $[A]^2[B]$

a) $[A_2][B]$ ✗

b) $[A]^2[B]$ ✓, net must add to $A+2B \rightarrow E$

Net: $2A+2B \rightarrow E$ ✗

c) $[A][B]$ ✗

d) $[A]^2[B]$ ✓, net must add to $A+2B \rightarrow E$

Net: $A+2B \rightarrow E$ ✓

9. B Endpoint ≈ equivalence point (mol acid = mol base)

$0.012\ M\ NaOH \times 0.02303\ L = 2.7636\times10^{-4}\ mol\ base \times \frac{1\ acetic\ acid}{1\ NaOH}$

$= 2.7636\times10^{-4}\ mol\ acid$

$2.7636\times10^{-4}\ mol\ acid \div 0.02500\ L = 1.1\times10^{-2}\ M$

10. A $CuCrO_4 \rightleftharpoons Cu^{2+} + CrO_4^{2-}$

*At which point a precipitate appears, $K = Q$!

$Q = [Cu^{2+}][CrO_4^{2-}] = [0.030\ M][1.2\times10^{-4}\ M]$

$= 3.6\times10^{-6}$

have to assume $[CuBr_2]$ is constant/unaffected by titration

11. C $BaSO_4 \rightleftharpoons Ba^{2+}_{(aq)} + SO_4^{2-}_{(aq)}$

Beaker 1	Beaker 2	Beaker 3
0.01 M SO_4^{2-}	EDTA	0.1 M Ba^{2+}
add product, shift left	EDTA eats Ba^{2+} (uses it up)	add a lot of product, shift far left
low F1	use up product, shift right	lowest F3
	high F2	

12. C SOA = most +ve voltage for reduction

H_2O_2/H^+

13. B 1. Charges balance 2. Atoms balance

~~a)~~ $3^+ \rightarrow 4^+$

b) $6^+ \rightarrow 6^+ \rightarrow$ acidic (H^+)

c) $2^+ \rightarrow 2^+ \rightarrow$ basic (OH^-)

~~d)~~ $2^+ \rightarrow 3^+$

14. C $E^\circ = \frac{0.0592}{n e^-} \log(K)$

$+0.19\,V$

$n e^-$: $Cu \rightarrow Cu^{2+} + 2e^-$

$0.19 = \frac{0.0592}{2} \log(K)$, $\log(K) = 6.42$, $K = 2.62 \times 10^6$

15. C

0.249 A

$6.00\ min \cdot \frac{60\ s}{min}$

$n_{e^-} = \frac{It}{F}$

96,485 C/mol e^-

$Cu^{2+} + 2e^- \rightleftharpoons Cu_{(s)}$

$n = 9.29 \times 10^{-4}\ mol\ e^- \times \frac{1\ Cu^{2+}}{2e^-}$

$= 4.65 \times 10^{-4}\ mol\ Cu_{(s)}$

$4.65 \times 10^{-4}\ mol\ Cu_{(s)} \times 63.55\ g/mol = 2.95 \times 10^{-2}\ g\ Cu$

16. D

a) S orbitals ——— , 10 e^- false
b) 3 nodes ($n-1$ = total nodes) false
c) false, p always has $m_e = +1, 0, -1$ or p_x, p_y, p_z
d) true, orbitals are degenerate within a subshell!

17. B

Fluorine is the smallest & most electronegative

18. B

Any s is $\ell = 0$ so m_ℓ only 0.

19. A

a) true
b) violates Hund's rule
c) 3s & 3p NOT 2s & 2p ← core
d) not valence also violates Aufbau

20. B

Br^- / Rb^+ → 36 e^- each

$35p^+$ $37p^+$ ← protons or Z

21. A Can also be written $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^2$

OR

$[Ar] 4s^2 3d^{10} 4p^2$

22. D F $[He] 2s^2 2p^5$ paramagnetic

Ar $[Ar]$ ✓

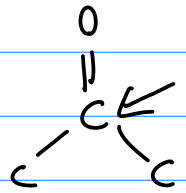
O^{2-} $[Ne]$ ✓

Al^{3+} $[Ne]$ ✓

Cl_2 ✓ :Cl-Cl: 70 e^-, both Cl have full octet

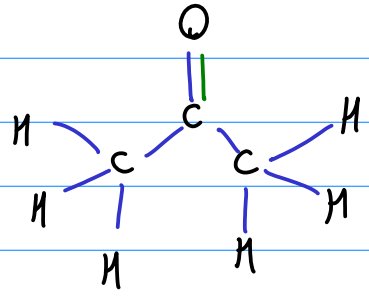
4/5 so four (4)

23. B



AX_3 so sp^2

24. D



Blue = σ bonds, 9 σ bonds!

Green = π bonds, 1 π bond!