Key to Test 2 for all test versions

Average ±sdev=87 (58%)±33(22%) Highest: 150

Rough Grading Scale for this test: A≥ 120 , B≥ 98 . C≥ 67 D≥ 50

Part I (multiple choice)

1. e	7. b; $v=(-1/b)(\Delta B/\Delta t)=(1/c)(\Delta C/\Delta t)$
2 .d	8. d; $v=k[Co];k=v/[Co]= 3.2\times10^{-7}Mmin^{-1}/ 1.14\times10^{-3}M = 2.8\times10^{-4}min^{-1}$
3. e	9. d
4. d	10. a; $\ln C = \ln C_o - kt \Rightarrow \ln(C/C_o)=-kt \Rightarrow$
5. a	$t = -(1/k)\ln(.75)=-(1/3.33h)(-.288)=0.086$
6. a	11. a

Part II, Problems

a) Solution: **Second order** kinetics. It is imperative to draw 3 graphs. (i) Graph [A] vs t, (ii) ln[A] vs t and (iii) 1/[A] vs t. You discover that only the plot of **1/[A] vs t** yields a **straight line**. This is the clear proof that it is second order.

b. Solution: Since $1/A = 1/A_o + kt$, the slope of the line is k. Answers will vary slightly according to the graph but here's an example:

$\{(1/99.9 - 1/25)mM^{-1}\}/\{30-0\}min$ = **1.00×10^{-3} mM^{-1} min^{-1}.**

c. Solution: Since $1/A = 1/A_o + kt$, = $1/99.9mM + (1\times10^{-3}/mM\ min)(50min)$ $= 6.0\times10^{-2}\ mM^{-1} \Rightarrow [A] = (1/6.0\times10^{-2}\ mM^{-1})$ = **16.7 mM**

2. a) Solution: Arrhenius equation: $k = Ae^{-Ea/RT} \Rightarrow \ln k = \ln A\ -E_aRT$

$\Rightarrow \ln(k_2/k_1)= (E_a/R)(1/T_1-1/T_2)$; $\ln(2) = (E_a / 8.314\ J/molK)(298^{-1}-308^{-1})K^{-1}$

$\Rightarrow E_a = 52{,}900$ J/mol = **52.9 kJ/mol**

b) Solution: Start off with the Arrhenius equation again:

$k = Ae^{-Ea/RT} \Rightarrow \ln k = \ln A\ -E_aRT \Rightarrow \ln(k_2/k_1)= -(E'_a-E_a)/RT$

$\Rightarrow$ call: "ΔE_a"$=-(E_a-E_a') = E_a-E_a'$

$\Delta E_a = RT\ln(k_2/k_1)$; $\Delta E_a = (8.314)(298)\ln(30000) = 25.5$ kJ/mol $= E_a - E_a'$

But $E_a = 52.9$ kJ/mol (from (a) above). $E_a' = (52.9-25.5)=$ **27.4 kJ**

3. Solution: Start with slowest step, step (2): $v = k_2[Br][H_2]$ but Br is an intermediate so, we have to solve for it: At steady state, we have:

$dBr/dt = k_1[Br_2] – k_{-1}[Br]^2 – k_2[Br][H_2] = 0$ => $[Br]^2k_{-1}+[Br][H_2]k_2 = k_1[Br_2]$

=> assuming that $k_2 << k_{-1}$ such that the previous equation reduces to:

$[Br]^2k_{-1} \approx k_1[Br_2]$ => $[Br] = \{k_1/k_{-1}[Br_2]\}^{1/2}$; and voila!

$$\mathbf{v = k'[Br_2]^{1/2}[H_2]}$$

It is 3/2 order, 1st order in H_2 and ½ order in $[Br_2]$.

4. Solution: d =m/V where we will use: m = mass of a unit cell, V= volume of a unit cell.

for body centered: $c^2=(2a^2)+a^2 =(4r)^2$; $3a^2 = 16r^2$; Or $a = \{16r^2/3\}^{1/2} = 4r/\sqrt{3}$;

$V_{uc} = a^3 = 12.3r^3$. There are 2 atoms per u.cell. so $m = 2(23.0)(1/6.02x10^{23})=7.64x10^{-23}g$

$V_{uc} = 12.3\ r^3 = m/d = 7.64x10^{-23}g/0.968g./cm^3$

$r^3 = 6.42x10^{-24}$ => $r = 1.86\ x10^{-8}$ cm = **1.86 Å**

5. Solution: $\ln(P_2/P_1) = (\Delta H_{vap}/R)(1/T_1-1/T_2)$;

here: P_2 = 760mmHg, P_1=23.76 mmHg, T_1=298K, T_2 =373K

$\Delta H = R\{\ln(P_2/P_1)\} / \{(1/T_1-1/T_2)\} = (8.314)(\ln(760/23.76))/\{1/298 -1/373\}$

= $4.27x10^4$ j/mol = **42.7 kJ/mol**.

b) Solution: Here, it is again convenient to use the Clausius-Clapeyron equation:

$\ln(P_2/P_1) = (\Delta H_{vap}/R)(1/T_1-1/T_2)$;

here: P_2 = ?, P_1=23.76 mmHg, T_1=298K, T_2 =310 K

$\ln(P_2/P_1) = (4.27x10^4$ j/mol /8.314J/molK) (1/298 -1/310) = 0.667 => P_2/23.76

$=e^{.667}$=46.2mmHg, but this is at 100% humidity.

at 73% humidity, that would be P_{H2O} = (46.2)(.73)= **33.7 mmHg**