Dr. Zellmer | Chemistry 1250 | T, R
Time: 7 PM Sun. | Spring Semester 2022 | April 10, 2022
40 min | Quiz X

Name _____ Rec. TA/time _____

Show **ALL** your work or **EXPLAIN** to receive full credit.

1. (5 pts) A reaction with activation energy of 123 kJ/mol is originally at 38.0 ºC. At what **temperature**, in **ºC**, will its rate constant be double that at 38.0 ºC?

2. (9 pts) Consider the following hypothetical reaction and the established rate law. Select an acceptable mechanism.

$A_2 + B_2 \rightarrow X + Y$ rate = k $[A_2]$ $[B_2]/[Y]$ (exp rate law)

a) $A_2 \rightleftarrows 2\,A$ (fast)

$B_2 + A \rightarrow C$ (slow)

$C + A \rightarrow X + Y$ (fast)

b) $A_2 + B_2 \rightleftarrows C$ (fast)

$C \rightarrow X + Y$ (slow)

c) $A_2 \rightleftarrows C + Y$ (fast)

$B_2 + C \rightarrow X$ (slow)

d) $B_2 \rightarrow 2\,B$ (slow)

$B + A_2 \rightarrow C$ (fast)

$C + B \rightarrow X + Y$ (fast)

e) $B_2 \rightleftarrows 2\,B$ (fast)

$B \rightarrow C + Y$ (slow)

$A_2 + C + B \rightarrow X$ (fast)

3. (9 pts) The following mechanism has been proposed for the gas phase reaction between H_2 and CO.

$$H_2 \rightleftarrows 2\,H \qquad \text{(fast, equilibrium)}$$

$$H + CO \rightarrow HCO \qquad \textbf{(slow)}$$

$$H + HCO \rightarrow H_2CO \qquad \text{(fast)}$$

NOT on Carmen quiz. Just for practice.

(a) What is the overall reaction?

(b) What is (are) the **intermediate(s)** in the mechanism?

(c) What is the **molecularity** of each of the following elementary steps?

Step 1 Step 2

(d) What is the **rate-determining step** (explain why)?

(e) What is the **rate law** predicted by this mechanism?

4. (3 pts) Given the following mechanism, which answer below contains all species which may be classified as **catalyst(s)** in the formation of XO_2 from X and O_2 ($X + O_2 \rightarrow XO_2$)?

$$X + YO_2 \longrightarrow XO + YO$$
$$XO + YO \longrightarrow XO_2 + Y$$
$$Y + O_2 + Z \longrightarrow YO + ZO$$
$$YO + ZO \longrightarrow YO_2 + Z$$

a) YO_2 and Y b) YO and ZO c) XO, YO_2, and Z

d) XO, YO, Y and ZO e) YO_2 and Z

5. (3 pts) Which response contains all the following statements that are **TRUE** and no false statements?

1. From the Arrhenius equation one can say that the **rate constant** always **decreases** as **temperature rises**.
2. The activation energy, E_a, for a reaction generally does **not** change as temperature changes (i.e. E_a is treated as a constant).
3. The activation energy, E_a, is usually about the **same** as **ΔH** (or ΔE) for a reaction.
4. A **catalyst increases** the **rate** of a reaction by **lowering** the **activation energy**, E_a.
5. A **catalyst increases** the **kinetic energy** of the **reactants**.

a) 5 b) 1, 3 c) 3, 5 d) 2, 4 e) 3, 4, 5

6. (3 pts) The equilibrium constant for the following reaction is 70 at 350 °C. A system at equilibrium has $[N_2] = 0.200$ M and $[NH_3] = 0.118$ M. What is the $[H_2]$?

$$N_2(g) + 3\ H_2(g) \rightleftarrows 2\ NH_3(g)$$

7. (3 pts) The properly written heterogeneous K_c expression for the following reaction as written is:

$$NiCO_3\,(s) + 2\,H^+\,(aq) \rightleftarrows Ni^{2+}\,(aq) + CO_2\,(g) + H_2O\,(l)$$

8. (5 pts) Given the following two equilibrium reactions,

(1) $2\,NO\,(g) + Br_2\,(g) \rightleftarrows 2\,NOBr\,(g)$ $\quad K_1 = 2.00$

(2) $NO\,(g) \rightleftarrows \frac{1}{2}\,N_2\,(g) + \frac{1}{2}\,O_2\,(g)$ $\quad K_2 = 1.45 \times 10^{15}$

What is the equilibrium constant, K_3, for the reaction below?

$$N_2\,(g) + O_2\,(g) + Br_2\,(g) \rightleftarrows 2\,NOBr\,(g) \qquad K_3$$

9. (4 pts) The equilibrium constant K_c for the following reaction at 1100°C is 6.80×10^{51}. What is K_p?

$$B(\mathbf{s}) + 3/2\ F_2(g) \rightleftarrows BF_3(g)$$

10. (5 pts) The following reaction is started with 2.000 moles of SO_3 in a 2.000-L container. When equilibrium is reached there are 1.645 moles of SO_3 in the container. What is the value of the **equilibrium constant**, K_C? **(Show the ICE table. You can use numbers or variables in your ICE table.)**

$$2\ SO_3(g) \rightleftarrows 2\ SO_2(g) + O_2(g)$$

11. (3 pts) A plot of ln(r) vs. ln[A] has a slope of -2.5 and an intercept of -10.55. Determine the **rate constant** and **order** of the reaction for the rate law, $r = k[A]^n$.

USEFUL INFORMATION

R = 0.08206 L-atm/mol-K = 8.3145 J/mol-K

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1	1.008 **H** 1																	4.003 **He** 2
2	6.941 **Li** 3	9.012 **Be** 4											10.811 **B** 5	12.011 **C** 6	14.007 **N** 7	15.999 **O** 8	18.998 **F** 9	20.179 **Ne** 10
3	22.990 **Na** 11	24.305 **Mg** 12											26.98 **Al** 13	28.09 **Si** 14	30.974 **P** 15	32.06 **S** 16	35.453 **Cl** 17	39.948 **Ar** 18
4	39.098 **K** 19	40.08 **Ca** 20	44.96 **Sc** 21	47.88 **Ti** 22	50.94 **V** 23	52.00 **Cr** 24	54.94 **Mn** 25	55.85 **Fe** 26	58.93 **Co** 27	58.69 **Ni** 28	63.546 **Cu** 29	65.38 **Zn** 30	69.72 **Ga** 31	72.59 **Ge** 32	74.92 **As** 33	78.96 **Se** 34	79.904 **Br** 35	83.80 **Kr** 36
5	85.47 **Rb** 37	87.62 **Sr** 38	88.91 **Y** 39	91.22 **Zr** 40	92.91 **Nb** 41	95.94 **Mo** 42	98 **Tc** 43	101.07 **Ru** 44	102.91 **Rh** 45	106.42 **Pd** 46	107.87 **Ag** 47	112.41 **Cd** 48	114.82 **In** 49	118.69 **Sn** 50	121.75 **Sb** 51	127.60 **Te** 52	126.90 **I** 53	131.39 **Xe** 54
6	132.91 **Cs** 55	137.33 **Ba** 56	138.91 **La** 57	178.39 **Hf** 72	180.95 **Ta** 73	183.85 **W** 74	186.21 **Re** 75	190.23 **Os** 76	192.22 **Ir** 77	195.08 **Pt** 78	196.97 **Au** 79	200.59 **Hg** 80	204.38 **Tl** 81	207.2 **Pb** 82	208.98 **Bi** 83	209 **Po** 84	210 **At** 85	222 **Rn** 86
7	223 **Fr** 87	226.03 **Ra** 88	227.03 **Ac** 89	261 **Rf** 104	262 **Ha** 105	263 **Sg** 106	262 **Ns** 107	265 **Hs** 108	266 **Mt** 109	269 110	272 111	277 112						

Lanthanide Series	140.12 **Ce** 58	140.91 **Pr** 59	144.24 **Nd** 60	145 **Pm** 61	150.36 **Sm** 62	151.96 **Eu** 63	157.25 **Gd** 64	158.93 **Tb** 65	162.50 **Dy** 66	164.93 **Ho** 67	167.26 **Er** 68	168.93 **Tm** 69	173.04 **Yb** 70	173.04 **Lu** 71
Actinide Series	232.04 **Th** 90	231.04 **Pa** 91	238.03 **U** 92	237.05 **Np** 93	**Pu** 94	**Am** 95	**Cm** 96	**Bk** 97	**Cf** 98	**Es** 99	**Fm** 100	**Md** 101	**No** 102	**Lr** 103

A PERIODIC CHART OF THE ELEMENTS
(Based on ^{12}C)