Chem 1C Midterm 1
Version B

Credit will only be given for answers on this sheet. Units must be included in your answers and points will be taken off for incorrect or missing units. No partial credit will be awarded. Calculators are allowed. Cell phones may not be used as calculators.

Name:	Perm Number

Make sure your writing is dark and large enough to be picked up by a scanner. Failure to do this results in the loss of 5 points on the exam.

If you are sitting next to someone with the same version of the test, you both will lose 5 points on the exam.

If you are still writing after time is called, you will lose 5 points on the exam.

Fundamentals		
Question (Points)	**Answer**	
1 (6 pts) 1.5 each	Si: Covalent Network and Atomic	PH_3: Molecular
	NaOH: Ionic	Ru: Metallic and Atomic
2 (7 pts)	37.2 min	
3 (8 pts) 4 each	rate = k[Cl_2O_5]	k = $0.65\frac{1}{min}$ or $0.011\frac{1}{s}$
4 (8 pts)	$Rate = k[A]^2[B]^{1.6}$	
5 (6 pts) 2 each	○ $CH_3CH_2CH_2CH_3$ ○ $CH_3CH_2CH_2OH$ ● $HOCH_2CH_2OH$		
	● CH_3OCH_3 ○ CH_3CH_2OH ○ H_2O		
	○ H_2O ○ O_2 ● He ○ CO_2		
6 (6 pts)	77°C	

Multiple Choice

Question (Points)	Answer
7 (6 pts)	○ A ○ B ● C ○ D ○ E
8 (6 pts)	○ A ○ B ● C ○ D ○ E
9 (8 pts) (1,2,1,2,2)	● A ○ B ○ C
	○ A ○ B ○ C ● D ○ E
	○ A ● B
	○ A ○ B ● C ○ D ○ E
	○ A ○ B ● C ○ D ○ E
10 (6 pts)	○ A ● B ○ C ● D ○ E Either B or D is correct you can have one or both of these for credit
11 (6 pts)	○ A ○ B ● C ○ D ○ E
12 (10 pts) 5 each	○ A ○ B ○ C ● D ○ E
	○ A ○ B ○ C ● D ○ E

Challenge Problems

Question (Points)	Answer
13 (9 pts)	$rate = \dfrac{k_2 k_3 k_1 [BrO_3^-][Br^-][H^+]^2}{k_{-2} k_{-1}}$
14 (8 pts)	296 pm

Fundamental Questions

1) *6 pts* What types of solids will each of the following substances form?

Si:_____

PH_3:_____

NaOH:_____

Ru:_____

2) *7 pts* At a particular temperature, the half-life of a zero-order reaction is 19.9 min. How long (in minutes) will it take for the reaction concentration to be depleted by a factor of 15?

3) *6 pts* A chemistry graduate student is studying the rate of this reaction:

$$2Cl_2O_5(g) \rightarrow Cl_2(g) + 5O_2(g)$$

He fills a reaction vessel with Cl_2O_5 and measures its concentration as the reaction proceeds:

time (minutes)	$[Cl_2O_5]$
0	0.0200 M
1.0	0.0105 M
2.0	0.00549 M
3.0	0.00288 M
4.0	0.00151 M

Use this data to answer the following questions.

Write the rate law for this reaction.	rate =
Calculate the value of the rate constant k. Round your answer to 2 significant digits. Also be sure your answer has the correct unit symbol.	k=

4)   *8 pts*   Determine the rate law for 2A + B → 2C (you do not need to find the numerical value of k):

Experiment	$[A]_o$ (M)	$[B]_o$ (M)	Initial Rate ($\frac{mol}{L \cdot s}$)
1	0.050	0.10	0.074
2	0.10	0.20	0.888
3	0.050	0.20	0.222

5)   *6 pts*   Circle the formula that best fits each of the following descriptions:

Greatest viscosity: $CH_3CH_2CH_2CH_3$ $CH_3CH_2CH_2OH$ $HOCH_2CH_2OH$

Higher vapor pressure at 1 atm, 25°C: CH_3OCH_3 CH_3CH_2OH H_2O

Lowest freezing point: H_2O O_2 He CO_2

6)   *6 pts*   Carbon tetrachloride (CCl_4) has a vapor pressure of 213 torr at 40.0°C and 836 torr at 80°C. What is the normal boiling point (in °C) of CCl_4?

Multiple Choice

7)   *6 pts*   All of the following statements, with respect to the effect of a catalyst on a
            Reaction, are true except
   a.   A catalyst speeds up a reaction by providing an alternative pathway for the reaction.
   b.   When a reaction is catalyzed, both forward and reverse reaction are accelerated.
   c.   When a catalyst speeds up a reaction, the rate law stays the same.
   d.   A catalyst provides a lower activation energy for the reaction.
   e.   A catalyst has no effect of the equilibrium composition of the reaction.

8)   *6 pts*   A certain reaction has a rate constant of 8.8 s^{-1} at 25°C and 140 s^{-1} at 50°C. What is the
            activation energy for this reaction?
   a.   38 $\frac{kJ}{mol}$
   b.   23 $\frac{kJ}{mol}$
   c.   89 $\frac{kJ}{mol}$
   d.   1.2 $\frac{kJ}{mol}$
   e.   None of the above

9)   *8 pts*   Study the following reaction energy diagram:
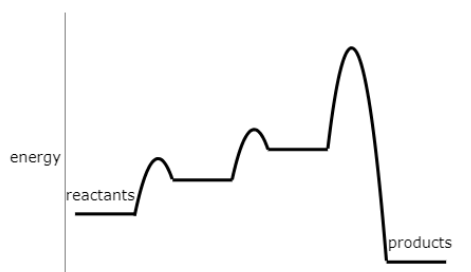
   Then answer the following questions about the chemical reaction.
   Does this reaction release or absorb energy
   a.   release   c.   neither
   b.   absorb
   How many transition states occur during the reaction?
   a.   0   d.   3
   b.   1   e.   None of the above
   c.   2
   Could this be an elementary reaction?
   a.   Yes   b.   No
   If you said this reaction could not be elementary, then how many steps are in its mechanism?
   a.   1   d.   4
   b.   2   e.   None of the above
   c.   3
   If you said this reaction could not be elementary, then enter the number of the step in its
   mechanism which is rate-determining. For example, if the first step is the rate-determining
   step, enter "1" here.
   a.   1   d.   4
   b.   2   e.   None of the above
   c.   3

5

10) *6 pts*   A catalytic mechanism proposed for the depletion of ozone by chlorofluorocarbons in the stratosphere is:

$$Cl + O_3 \rightarrow ClO + O_2$$
$$ClO + O \rightarrow Cl + O_2$$
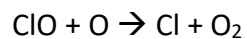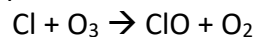
Which of the following statements about the mechanism are true?
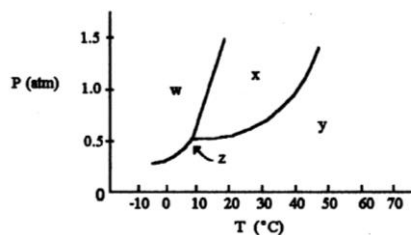
        I) O_2 is a reactant
        II) ClO is an intermediate
        III) O_3 is decomposed to O_2 and O in the overall reaction.
   IV) Cl is the catalyst

a. I and II
b. II and IV
c. I and III
d. II and IV
e. All of the above choices are wrong

11) *6 pts*   The normal boiling point of the substance with the phase diagram shown below is _____ °C.


a. 10
b. 15
c. 40
d. 50
e. None of the above

12) *10 pts* A pure sample of Substance S is put into an evacuated flask. The flask is then heated steadily and the temperature measured as time passes. The results are graphed below.
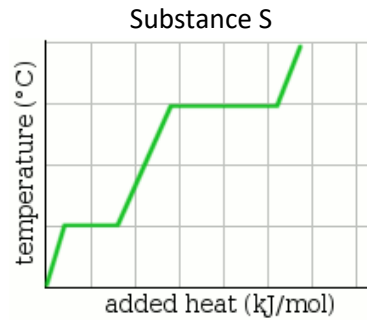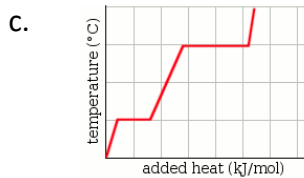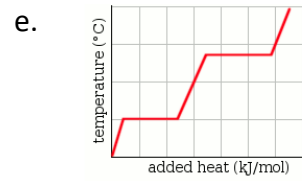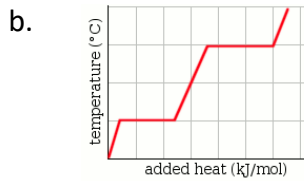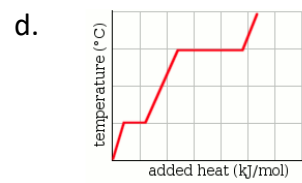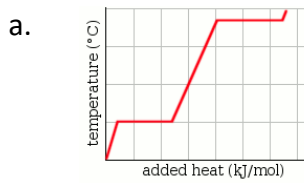
Substance S

Identical experiments are now run on Substance Y and Substance Z. Substance Y is just like S except that it has a higher heat capacity in the gaseous phase $C_P(g)$. Substance Z is just like S except that it has a lower enthalpy of fusion ΔH_f.

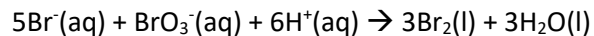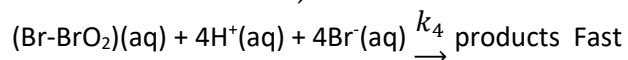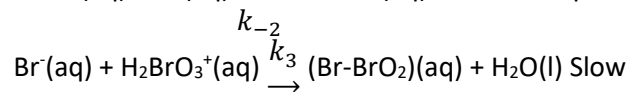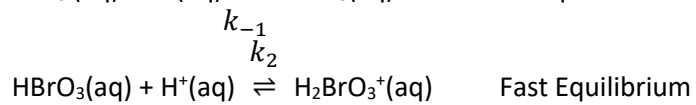Select the graphs below, that show the results you expect for these new experiments.

Substance Y

a.

d.

b.

e.

c.

Substance Z

a.

d.

b.

e.

c.

7
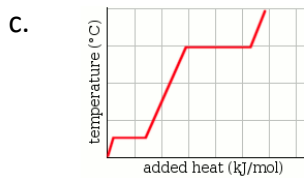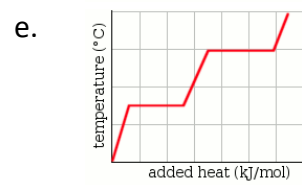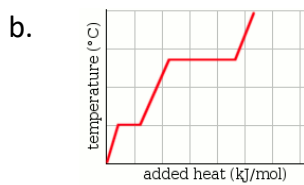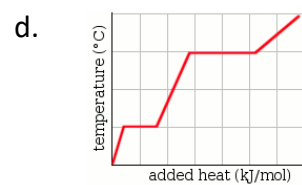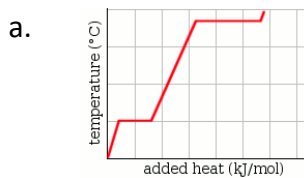
Challenge Problems

13) *9 pts* The reaction

$5Br^-(aq) + BrO_3^-(aq) + 6H^+(aq) \rightarrow 3Br_2(l) + 3H_2O(l)$

Is expected to obey the mechanism

$$BrO_3^-(aq) + H^+(aq) \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} HBrO_3(aq) \qquad \text{Fast Equilibrium}$$

$$HBrO_3(aq) + H^+(aq) \underset{k_{-2}}{\overset{k_2}{\rightleftharpoons}} H_2BrO_3^+(aq) \qquad \text{Fast Equilibrium}$$

$$Br^-(aq) + H_2BrO_3^+(aq) \overset{k_3}{\longrightarrow} (Br\text{-}BrO_2)(aq) + H_2O(l) \quad \text{Slow}$$

$$(Br\text{-}BrO_2)(aq) + 4H^+(aq) + 4Br^-(aq) \overset{k_4}{\longrightarrow} \text{products} \quad \text{Fast}$$
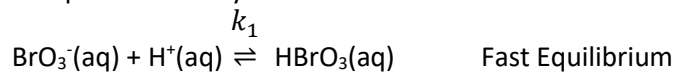
Write the rate law for this reaction and show what the overall k is in terms of elementary reaction ks.

14) *8 pts* A certain metal M crystallizes in a lattice described by a body-centered cubic (bcc) unit cell. The radius r of M atoms has been measured to be 128. pm. Calculate the lattice constant a of a crystal of M. Be sure your answer has the correct number of significant digits, and be sure it has the correct unit symbol.