

Chem 3C 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 (7 pts)	5.1 atm
2 (4 pts) 1 each	Si: covalent network and atomic
	PH ₃ : molecular
	NaOH: ionic
	Ru: metallic and atomic
3 (6 pts) 3 each	 2
	 2
4 (7 pts)	$Rate = k[A]^2[B]^{1.6}$
5 (6 pts)	$5.8 \frac{kJ}{mol}$
6 (6 pts)	$9.61 \frac{g}{cm^3}$

Multiple Choice	
Question (Points)	Answer
7 (4 pts) 1.3 each	<input type="radio"/> A <input type="radio"/> B <input checked="" type="radio"/> C <input type="radio"/> D <input type="radio"/> E
	<input type="radio"/> A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/> E
	<input checked="" type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/> E
8 (6 pts) 2 each	<input type="radio"/> A <input type="radio"/> B <input checked="" type="radio"/> C
	<input checked="" type="radio"/> A <input type="radio"/> B <input type="radio"/> C
	<input type="radio"/> A <input type="radio"/> B <input checked="" type="radio"/> C <input type="radio"/> D
9 (5 pts)	<input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input checked="" type="radio"/> E
10 (6 pts) 2 each	<input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/> E <input checked="" type="radio"/> F <input type="radio"/> G <input type="radio"/> H
	<input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/> E <input type="radio"/> F <input checked="" type="radio"/> G <input type="radio"/> H
	<input checked="" type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/> E <input type="radio"/> F <input type="radio"/> G <input type="radio"/> H
11 (6 pts)	<input checked="" type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/> E
12 (7 pts)	<input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input checked="" type="radio"/> E

Challenge Problems	
Question (Points)	Answer
13 (10 pts)	Boiling Point: 90.°C Pressure: 1.47x10 ⁵ torr
14 (20 pts) 8,2,6,4	NO Order: 1 O ₃ Order: 1
	Rate=k[NO][O ₃]
	k' = 0.0018 $\frac{1}{ms}$ k'' = 0.0036 $\frac{1}{ms}$
	1.8x10 ⁻¹⁷ $\frac{cm^3}{molecules \cdot ms}$

Fundamental Questions

- 1) 7 pts The following is known to be an elementary reaction: $2A(g) \rightarrow B(g) + 3C(g)$. At 25°C , k is $3.4 \frac{\text{L}}{\text{mol}\cdot\text{s}}$. If 12 atm of A is put in an otherwise empty ridged closed container. What is the pressure of B after 3.2 s has passed?

- 2) 4 pts What types of solids will each of the following substances form?

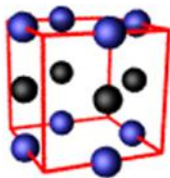
Si: _____

PH₃: _____



NaOH: _____

Ru: _____

- 3) 6 pts A small part of a crystal lattice is sketched below. The unit cell is outlined.



How many atoms of each type are in the unit cell?

atom	number in unit cell
	
	

- 4) 7 pts Determine the rate law for $2A + B \rightarrow 2C$ (you do not need to find the numerical value of k).

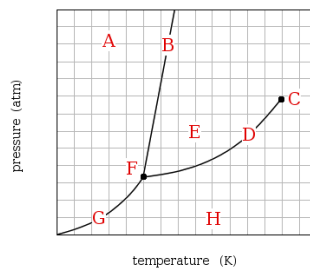
Experiment	$[A]_0$ (M)	$[B]_0$ (M)	Initial Rate ($\frac{mol}{L \cdot s}$)
1	0.050	0.10	0.074
2	0.10	0.20	0.888
3	0.050	0.20	0.222

- 5) 6 pts The rate constant for a reaction increases from 1.6 s^{-1} to 6.0 s^{-1} when the temperature is increased from 214K to 356K. What is the activation energy for the reaction in $\frac{kJ}{mol}$?

- 6) 6 pts Silver β is a solid phase of silver still unknown to science. The only difference between it and ordinary silver is that silver β forms a crystal with a bcc unit cell and a lattice constant $a=334 \text{ pm}$. Calculate the density ($\frac{g}{cm^3}$) of silver β . Round your answer to 3 significant figures.

Multiple Choice

- 7) 4 pts Identify the molecularity of each elementary reactions below.
- $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$
- A. unimolecular
 - B. bimolecular
 - C. termolecular
 - D. quadrimolecular
 - E. Cannot be determine
- $\text{CH}_3\text{CH}_2\text{Br}(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{CH}_3\text{CH}_2\text{OH}(\text{aq}) + \text{Br}^-(\text{aq})$
- A. unimolecular
 - B. bimolecular
 - C. termolecular
 - D. quadrimolecular
 - E. Cannot be determine
- $\text{N}_2\text{O}_4(\text{g}) \rightarrow 2\text{NO}_2(\text{g})$
- A. unimolecular
 - B. bimolecular
 - C. termolecular
 - D. quadrimolecular
 - E. Cannot be determine
- 8) 6 pts Which has the greatest viscosity?
- A. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$
 - B. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
 - C. $\text{HOCH}_2\text{CH}_2\text{OH}$
- Which has the highest vapor pressure at 1 atm and 25°C?
- A. CH_3OCH_3
 - B. $\text{CH}_3\text{H}_2\text{OH}$
 - C. H_2O
- Which has the lowest freezing point?
- A. H_2O
 - B. O_2
 - C. He
 - D. CO_2
- 9) 5 pts Calculate the interplanar distance that has a second order reflection of 43.2° for x-rays of wavelength of 0.141 nm.
- A. 0.103 nm
 - B. 0.169 nm
 - C. 0.193 nm
 - D. 0.412 nm
 - E. None of the above
- 10) 6 pts Study the following phase diagram of Substance X.



If a sample of pure X is observed to be a mixture of solid, liquid, and gas, which point marks the temperature and pressure?

- A B C D
 E F G H

Which line must the temperature and pressure have crossed if a gaseous sample of X is observed to condense into a solid?

- A B C D
 E F G H

If a sample of pure X is a solid, in which region must the temperature and pressure be?

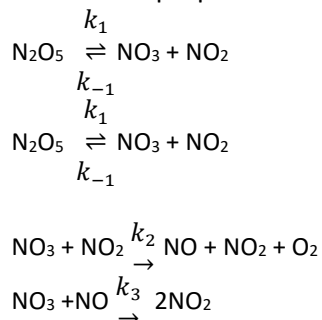
- A B C D
 E F G H

11) 6 pts The rate law for a reaction is found to be $\text{Rate} = k[\text{A}]^2[\text{B}]$. Which of the following mechanisms gives this rate law?

- I. $\text{A} + \text{B} \rightleftharpoons \text{E}$ (fast equilibrium)
 $\text{E} + \text{B} \rightarrow \text{C} + \text{D}$ (slow)
 II. $\text{A} + \text{B} \rightleftharpoons \text{E}$ (fast equilibrium)
 $\text{E} + \text{A} \rightarrow \text{C} + \text{D}$ (slow)
 III. $\text{A} + \text{A} \rightarrow \text{E}$ (slow)
 $\text{E} + \text{B} \rightleftharpoons \text{C} + \text{D}$ (fast equilibrium)

- A. II only
 B. III only
 C. I only
 D. Two of these
 E. None of these

12) 7 pts The following mechanism is proposed for the reaction $2\text{N}_2\text{O}_5 \rightarrow 4\text{NO}_2 + \text{O}_2$.



Derive an expression for the rate law ($\text{rate} = \frac{d\text{O}_2}{dt}$)

- A. $k[\text{N}_2\text{O}_5]^2$
 B. $K_2[\text{NO}_3][\text{NO}_2]$
 C. $\frac{k_1 k_2}{k_{-1}}[\text{N}_2\text{O}_5]$
 D. Not enough information given to solve problem
 E. None of the above

Challenge Problems

- 13) 10 pts In Breckenridge, Colorado, the typical atmospheric pressure is 520. torr. What is the boiling point of water ($\Delta H_{\text{vap}}=40.7 \frac{\text{kJ}}{\text{mol}}$) in Breckenridge (in °C)? What pressure would have to be applied to steam at 350. °C to condense the steam to liquid water (in torr)?

14)

The reaction



was studied by performing two experiments. In the first experiment (results show in following table), the rate of disappearance of NO was followed in a large excess of O₃. (The [O₃] remains effectively constant at $1.0 \times 10^{14} \frac{\text{molecules}}{\text{cm}^3}$.)

Time (ms)	[NO] ($\frac{\text{molecules}}{\text{cm}^3}$)
0	6.0×10^8
100±1	50×10^8
500±1	2.4×10^8
700±1	1.7×10^8
1000±1	9.9×10^7

In the second experiment, [NO] was held constant at $2.0 \times 10^{14} \frac{\text{molecules}}{\text{cm}^3}$. The data for the disappearance of O₃ were as follows:

Time (ms)	[O ₃] ($\frac{\text{molecules}}{\text{cm}^3}$)
0	1.0×10^{10}
50±1	8.4×10^9
100±1	7.0×10^9
200±1	4.9×10^9
300±1	3.4×10^9

14a) 8 pts

What is the order with respect to each of the reactants?

14b) 2 pts

What is the overall rate law?

14c) 6 pts

What is the value of the rate constant obtained from each set of experiments?

$$\text{Rate} = k'[\text{NO}]^x \quad \text{Rate} = k''[\text{O}_3]^y$$

14d) 4 pts

What is the value of the rate constant for the overall rate law?

$$\text{Rate} = k[\text{NO}]^x[\text{O}_3]^y$$