

Name: _____

This is a practice test for CH 232 midterm 2. There are 14 multiple choice/short answer and 9 free responses and is representative of what could be expected on the actual midterm. Please treat it as a real examination, with no outside help from notes, internet, or peers. A lot of these questions will require you to reference the cover sheet for tabulated data. Take 80 + 20 minutes to complete this practice test and remember to keep in mind significant figures. Once done, let James know for the answer key. Good luck!

Potentially Useful Information:

Gas Constant: $0.08206 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}}$
 $8.314 \frac{\text{J}}{\text{mol}\cdot\text{K}}$

Planck's constant:
 $6.626 \times 10^{-34} \text{ J}\cdot\text{s}$

Avogadro's number:
 $6.022 \times 10^{23} / \text{mol}$

$1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$

$2.54 \text{ cm} = 1 \text{ in}$

$12 \text{ in} = 1 \text{ ft}$

$1 \text{ lb} = 454 \text{ g}$

$\Delta H_{\text{vap}} (\text{H}_2\text{O}): 41 \text{ kJ/mol}$

$\Delta H_{\text{fus}} (\text{H}_2\text{O}): 6.0 \text{ kJ/mol}$

Densities:

Water: 1.00 g/cm^3

Ethanol: 0.798 g/mL

Carbon (diamond): 3.53 g/cm^3

Iron: 7.87 g/cm^3

Temperature (°C)	Water Vapor Pressure (torr)
0	4.58
5	6.54
10	9.21
15	12.79
20	17.54
25	23.76
30	31.8
35	45.07

Substance	Specific Heat Capacity ($\frac{\text{J}}{\text{g}\cdot^\circ\text{C}}$)
H ₂ O(l)	4.184
H ₂ O(g)	2.01
H ₂ O(s)	2.09
Ti(s)	0.555
Al(s)	0.897
Ag(s)	0.235
Au(s)	0.129
Cu(s)	0.385
Fe(s)	0.412
Air(g)	1.004
Li(s)	3.58

$1 \text{ atm} = 760 \text{ torr} = 760 \text{ mmHg} = 14.7 \text{ psi} = 101.3 \text{ kPa}$

Ethylene glycol: Density = 1.11 g/cm^3 Boiling Point = 197°C $K_b = 2.26^\circ\text{C/m}$

TABLE 12.8 Freezing Point Depression and Boiling Point Elevation Constants for Several Liquid Solvents

Solvent	Normal Freezing Point (°C)	K_f (°C/m)	Normal Boiling Point (°C)	K_b (°C/m)
Benzene (C ₆ H ₆)	5.5	5.12	80.1	2.53
Carbon tetrachloride (CCl ₄)	-22.9	29.9	76.7	5.03
Chloroform (CHCl ₃)	-63.5	4.70	61.2	3.63
Ethanol (C ₂ H ₅ OH)	-114.1	1.99	78.3	1.22
Diethyl ether (C ₄ H ₁₀ O)	-116.3	1.79	34.6	2.02
Water (H ₂ O)	0.00	1.86	100.0	0.512

$$M_1V_1 = M_2V_2$$

$$\ln\left(\frac{k_2}{k_1}\right) = \frac{Ea}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$



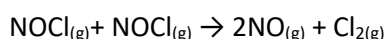
Multiple Choice (14 questions)

1) Rank the following by increasing boiling point: CaCl₂ PH₃ NH₃ O₂

2) Which of the following is true? There may be more than one.

- a) The concentration at some time for integrated rate can be approximated by taking an instantaneous rate
- b) An increase in surface area can increase the rate of reaction.
- c) The reaction rate will always have some nonzero concentration of reactant.
- d) Increasing the rate constant, k, will have an effect of lowering the activation energy, thus speeding the reaction
- e) A positive rate vs time slope indicates a first order reaction

3) A reaction step is described as follows:



What is the correct orientation that will cause the formation of the desired products assuming efficient energy?

- a) Cl-N-O - - - O-N-Cl b) Cl-N-O - - - Cl-N-O c) O-N-Cl - - - Cl-N-O
- d) this reaction will not happen

4) The boiling points of Fluorine, Chlorine, Bromine, and Iodine increase in that order. Which of the following statements is a valid reasoning for this observation?

- a) The surface area of these molecules increases causing a decrease in electronegativity
- b) The chemical reactivity becomes increasingly more unstable down a group for halogens
- c) The dipole-dipole forces increase strengthening the interactions
- d) The molar masses of these molecules are increasing
- e) The electron cloud of these elements is increasing in polarizability

5) What percent of initial zero order reactant concentration would be consumed after three half-lives?

- a) 6.25%
- b) 12.5%
- c) 75%
- d) 87.5%
- e) 93.75%

6) A hypothetical reaction $2D + 3E \rightarrow 4F + 2G$ has a rate of appearance of F to be 1.2M/min. What is the rate of disappearance for E?

- a) 0.40M/min
- b) 0.90M/min
- c) 1.6M/min
- d) 2.0M/min
- e) 3.6M/min

7) A student mixes two aqueous chemicals and filters out some solid. Which of the following pairs of reactants could the student have filtered? There may be more than one.

- a) $\text{NaCl}_{(aq)}$ and $\text{KOH}_{(aq)}$
- b) $\text{NH}_4\text{OH}_{(aq)}$ and $\text{BaCl}_{2(aq)}$
- c) $\text{NaCl}_{(aq)}$ and $\text{AgNO}_{3(aq)}$
- d) $\text{K}_2\text{SO}_{4(aq)}$ and $\text{NH}_4\text{OH}_{(aq)}$
- e) $\text{Pb}(\text{NO}_3)_{2(aq)}$ and $\text{KCl}_{(aq)}$

8) For a reaction that produces product A, determine the order of the reaction given the following data

Time (s)	Ln[A]
8	1.61
16	1.43
24	1.27
32	1.14
40	1.02
48	0.92
56	0.82

- a) Zeroth order
- b) First order
- c) Second order
- d) Third order
- e) Not enough info

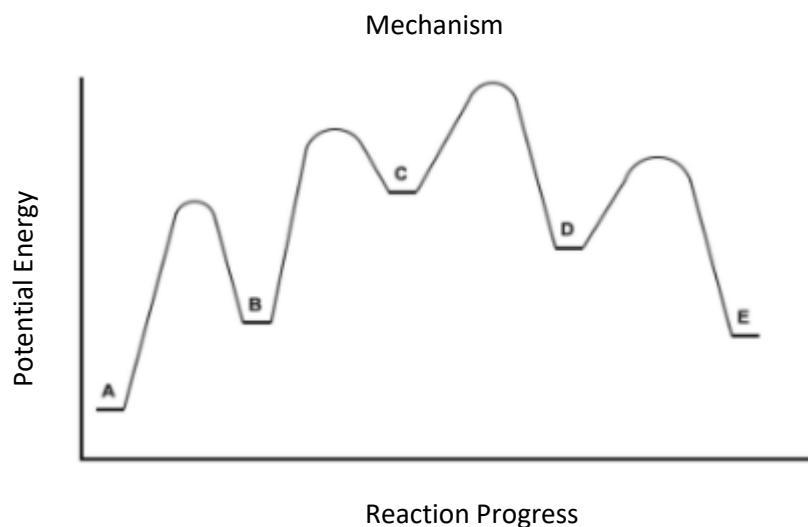
9) Rank the following solutions by lowest freezing point depression:

0.50 m CF_4

0.25 m H_2SO_4

0.30m BaCO_3

Use the following diagram for questions 10-12. The following potential energy vs reaction progress diagram is provided for some reaction mechanism



10) How many intermediates would this mechanism have?

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

11) Which step is rate-determining?

- a) A to B
- b) B to C
- c) C to D
- d) D to E
- e) Can't be determined

12) Which step has the smallest rate constant?

- a) A to B
- b) B to C
- c) C to D
- d) D to E
- e) Can't be determined

13) You are making spaghetti for dinner. You place 4.01 Liters of water in a pan and bring it to a boil. Before adding the pasta, you add 58 g of table salt to the water and again brings it to a boil. The temperature of the salty, boiling water is _____ deg C.

It is a nice day at sea level so that pressure is 1.00 atm. Assume negligible evaporation of water.

- A) 99.74 B) 100.00 C) 99.87 D) 100.26 E) 100.13

14) The intermolecular force(s) responsible for the fact that CH_4 has the lowest boiling point in the set CH_4 , SiH_4 , GeH_4 , SnH_4 is/are _____.

- A) mainly hydrogen bonding but also dipole-dipole interactions
B) hydrogen bonding
C) mainly London-dispersion forces but also dipole-dipole interactions
D) dipole-dipole interactions
E) London dispersion forces

Free Response Questions (9 questions)

15) What is the boiling point of a solution made by dissolving 10.21 grams of ethylene glycol, $\text{C}_2\text{H}_6\text{O}_2$, in 71.3 mL ethanol, $\text{C}_2\text{H}_5\text{OH}$?

16) An unknown sample at 25 deg C with specific heat capacity of water and molar mass of 95g/mol is added to a 500mL of organic solution. If 95000 joules of energy are released and raises the temperature of the solution to 30 deg C, what is the osmotic pressure of the unknown sample?

17) Radioactive iodine can be used in cancer treatment in the thyroids. If iodine normally has a half-life of 8.07 days, and today, your thyroid absorbed 155 microcuries (μC) during treatment, how much would remain after 45 days?

18) Calculate the vapor pressure of a solution at 25 deg C containing 99.5 g of sucrose (molar mass=342.30g/mol) and 300 mL of water.

19) Based on a series of rate trials

Trial	[A]	[B]	Rate M/min
1	0.064	0.82	0.082
2	0.18	0.82	0.656
3	0.78	0.60	4.78

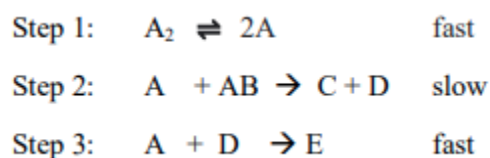
a) Determine the rate law expression that includes the correct rate constant and orders under a constant temperature.

b) Determine by what factor the rate will change if both concentration of A and B are halved.

20) The integrated rate law for some nth-order reaction is shown below. Derive a simplified equation that solves for the half-life, $t_{1/2}$, of the nth-order reaction.

$$\frac{1}{6[A]_t^6} = \frac{1}{6[A]_0^6} + kt$$

21) A three step-mechanism study is depicted below:

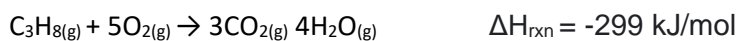


- Write the overall rate law expression expected from this three-step mechanism.
- Determine the actual rate law expression predicted by this three-step mechanism

22) A chemical engineering firm is looking to expedite the production of novel chemical, J.

A first order Arrhenius plot for production of chemical J is fitted so that the slope is found to be -44000K. At room temperature, 25deg C, the rate constant is experimentally determined to be 20 Ms^{-1} . What temperature will the reaction have to operate under to speed up the reaction by 60-fold?

23) A combined, excess mass of 250 grams for propane and oxygen are used for this combustion reaction.



What total volume of gas will be produced if the average temperature of the gas increased by 12 deg C at 75% efficiency? Assume initially at 760 torr with a final temperature of 130 deg C, and an average specific heat capacity of 1.32 J/g C for propane and oxygen.