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: $0.08206 \frac{L*atm}{mol*K}$

$8.314 \frac{J}{mol*K}$

Planck's constant:

6.626×10^{-34} J·s

Avogadro's number:

6.022×10^{23} /mol

1 eV = 1.602×10^{-19} J

2.54 cm = 1 in

12 in = 1 ft

1 lb = 454 g

ΔH_{vap} (H_2O): 41 kJ/mol

ΔH_{fus} (H_2O): 6.0 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 ($\frac{J}{g*°C}$)
H_2O(l)	4.184
H_2O(g)	2.01
H_2O(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 atm=760 torr=760 mmHg=14.7 psi=101.3 kPa

Ethylene glycol: Density =1.11 g/cm^3 Boiling Point= 197 deg C Kb= 2.26 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_6H_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_2H_5OH)	−114.1	1.99	78.3	1.22
Diethyl ether ($C_4H_{10}O$)	−116.3	1.79	34.6	2.02
Water (H_2O)	0.00	1.86	100.0	0.512

Equations:

$$PV = nRT$$

$$KE = \frac{1}{2}mv^2$$

$$P_{total} = P_1 + P_2 + P_3 \ldots$$

$$P_n = X_n P_{total}$$

$$KE = \frac{3}{2}RT$$

$$P = \frac{F}{A}$$

$$\left[P + a\left(\frac{n}{V}\right)^2\right] \times [V - nb] = nRT$$

$$\Delta E = q + w$$

$$q = m \times C_s \times \Delta T$$

$$w = -P\Delta V$$

$$M_1V_1 = M_2V_2$$

$$\Delta t_f = ik_f m$$

$$\Delta t_b = ik_b m$$

$$\Pi = iMRT$$

$$[A]_t = -kt + [A]_0$$

$$\ln[A]_t = -kt + \ln[A]_0$$

$$[A]_t = [A]_0 e^{-kt}$$

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

$$t_{1/2} = \frac{\ln(2)}{k}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

$$k = Ae^{-\frac{E_a}{RT}}$$

$$\ln(k) = -\frac{Ea}{R}\left(\frac{1}{T}\right) + \ln(A)$$

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

1 1A																	18 8A
1 H Hydrogen 1.008	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.38	31 Ga Gallium 69.72	32 Ge Germanium 72.64	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.96	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.7	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (208.98)	85 At Astatine (209.99)	86 Rn Radon (222.02)
87 Fr Francium (223.02)	88 Ra Radium (226.03)	89 Ac Actinium (227.03)	104 Rf Rutherfordium (261.11)	105 Db Dubnium (262.11)	106 Sg Seaborgium (266.12)	107 Bh Bohrium (264.12)	108 Hs Hassium (269.13)	109 Mt Meitnerium (268.14)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Cn Copernicium (285)	113	114 Fl Flerovium (289)	115	116 Lv Livermorium (293)	117	118

58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.05	71 Lu Lutetium 174.97
90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237.05)	94 Pu Plutonium (244.06)	95 Am Americium (243.06)	96 Cm Curium (247.07)	97 Bk Berkelium (247.07)	98 Cf Californium (251.08)	99 Es Einsteinium (252.08)	100 Fm Fermium (257.10)	101 Md Mendelevium (258.10)	102 No Nobelium (259.10)	103 Lr Lawrencium (262.11)

Oregon State University

Multiple Choice (14 questions)

1) Rank the following by increasing boiling point: $CaCl_2$ PH_3 NH_3 O_2

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:

$$NOCl_{(g)} + NOCl_{(g)} \rightarrow 2NO_{(g)} + Cl_{2(g)}$$

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

a) Cl-N-O - - - O-N-C 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 → 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) $NaCl_{(aq)}$ and $KOH_{(aq)}$
b) $NH_4OH_{(aq)}$ and $BaCl_{2(aq)}$
c) $NaCl_{(aq)}$ and $AgNO_{3(aq)}$
d) $K_2SO_{4(aq)}$ and $NH_4OH_{(aq)}$
e) $Pb(NO_3)_2$ and KCl

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

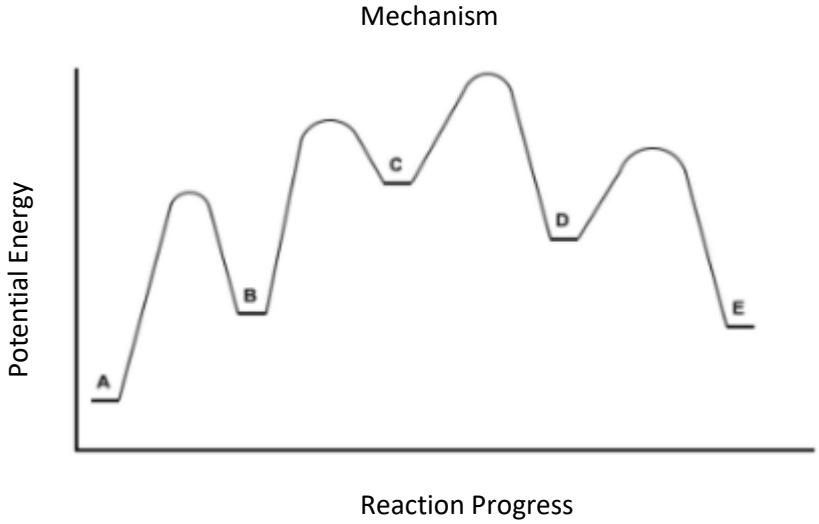
Time (s)	Ln[A]
8	1.61
16	1.43
24	1.27
32	1.14
40	1.02
48	0.92
56	0.82

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, $C_2H_6O_2$, in 71.3 mL ethanol, C_2H_5OH?

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. The vapor pressure of pure water at 25 deg C is 23.8 torr.

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 fate 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:

Step 1:	$A_2 \rightleftharpoons 2A$	fast
Step 2:	$A + AB \rightarrow C + D$	slow
Step 3:	$A + D \rightarrow E$	fast

a) Write the overall rate law expression expected from this three-step mechanism.

b) 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 to produce 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.

$$C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)}\ 4H_2O_{(g)} \qquad \Delta H_{rxn} = -299\ kJ/mol$$

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.