CHEM 1032
PRACTICE
UNIT ASSESSMENT 2

NAME: _____

TUID: [ ][ ][ ][ ][ ][ ][ ][ ][ ]

SECTION: _____

Before the Unit Assessment begins, read the rest of this page, and follow the instructions.

!!! Do not turn this page until given the signal to begin !!!

Put away everything besides pencil(s) and a scientific calculator.

- Non-programmable (scientific) calculators are permitted. Graphing calculators **are not permitted** (such as these models: TI-83, TI-84, TI-89, Casio FX-9750).
- Any other electronic devices - including cell phones, smart phones, and smart watches - **are not permitted**. If you are not sure what is permitted, ask *before* the exam begins.

When you are told to begin work, open the booklet and read the directions.

A periodic table and other useful information can be found on the next page.

Grading. Each question is graded by your instructor using the scale below.

1 - Excellent
- The student demonstrates a deep understanding of concepts and problem-solving techniques.
- Calculations are clear and legibly written.
- Any mistakes are minor or careless errors that do not indicate a major conceptual misunderstanding.

0.5 - Fair
- The student demonstrates a partial understanding of concepts and techniques.
- Calculations are clear and legibly written but contain errors.
  - o The student may have started out correctly but gone on a tangent or not finished the problem.
  - o The student may have used pattern matching to answer a different, more familiar question instead.

0 - Unsatisfactory/Incomplete
- The student did not demonstrate an understanding of the problem or has minimal understanding.
- Calculations are unclear, missing, or incomplete.
  - o The student may have written some appropriate formulas or diagrams, but nothing further.
  - o The student may have done something entirely wrong.
  - o The student may have written almost nothing or nothing at all.

Unit Assessment Time: 50 minutes.
It is to your advantage to answer every question.

!!! Do not turn this page until given the signal to begin !!!

Units:

amu	atomic mass unit
atm	atmosphere
g	gram
h	hour
J	joule
K	kelvin
mmHg	unit of pressure
M	molarity
K	kelvin
L	liter
mol	mole
s	second

Symbols:

H	enthalpy
ν	frequency
M	molar mass
mol	mole
P	pressure
t	time
T	temperature
V	volume

Constants:

N_A	Avogadro's number
R	ideal gas constant

SI (Metric) Prefixes:

c	centi-
d	deci-
k	kilo-
m	milli-

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** 1.008																	2 **He** 4.0026
3 **Li** 6.94	4 **Be** 9.012											5 **B** 10.81	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305											13 **Al** 26.982	14 **Si** 28.085	15 **P** 30.974	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078(4)	21 **Sc** 44.956	22 **Ti** 47.867	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.845(2)	27 **Co** 58.933	28 **Ni** 58.693	29 **Cu** 63.546(3)	30 **Zn** 65.38(2)	31 **Ga** 69.723	32 **Ge** 72.630(8)	33 **As** 74.922	34 **Se** 78.971(8)	35 **Br** 79.904	36 **Kr** 83.798(2)
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224(2)	41 **Nb** 92.906(2)	42 **Mo** 95.95	43 **Tc**	44 **Ru** 101.07(2)	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60(3)	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57-70 *	72 **Hf** 178.49(2)	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23(2)	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po**	85 **At**	86 **Rn**
87 **Fr**	88 **Ra**	89-102 **	104 **Rf**	105 **Db**	106 **Sg**	107 **Bh**	108 **Hs**	109 **Mt**	110 **Ds**	111 **Rg**	112 **Cn**	113 **Nh**	114 **Fl**	115 **Mc**	116 **Lv**	117 **Ts**	118 **Og**

57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** [144.91]	62 **Sm** 150.36(2)	63 **Eu** 151.96	64 **Gd** 157.25(3)	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
89 **Ac** [227.03]	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np**	94 **Pu**	95 **Am**	96 **Cm**	97 **Bk**	98 **Cf**	99 **Es**	100 **Fm**	101 **Md**	102 **No**	103 **Lr**

Dinitrogen tetraoxide (N_2O_4 – 92.010 g/mol) is used as rocket fuel because it can be stored as a liquid at room temperature and is explosive when mixed with certain reactants. One downside to the use of N_2O_4 is that in the gaseous form it can degrade into nitrogen dioxide (NO_2 – 46.006 g/mol) under standard conditions according to the equilibrium below.

$$N_2O_4\,(g) \rightleftharpoons 2\,NO_2\,(g) \qquad K_C\ 0.0059\ \text{at } 298\ K$$
colorless   yellow
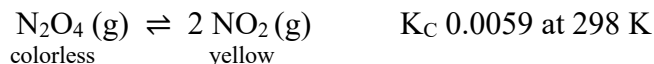
Part I – Multiple Choice Questions (1 pt each)
Excellent Answer = 1 pt   *Fair Answer = 0.5 pts*   *Unsatisfactory Answer = 0 pts*

_____ 1.   How would you characterize the reaction?

A. Reactants favored with a negative $\Delta G°$.
B. Products favored with a negative $\Delta G°$.
C. Reactants favored with a positive $\Delta G°$.
D. Products favored with a positive $\Delta G°$.

_____ 2.   If a closed vessel containing the reaction at equilibrium were expanded, causing an increase in volume, what would you expect to occur?

A. The reaction would shift forward since pressure increased.
B. The reaction would shift backwards since pressure increased.
C. The reaction would shift forward since pressure decreased.
D. The reaction would shift backwards since pressure decreased.

_____ 3.   If the reaction were completed in reverse, what would be the value of K?

A. -0.0059
B. 0.0118
C. 3.5×10^{-5}
D. 169

_____ 4.   The standard molar entropy ($S°$) of gaseous N_2O_4 is 304.4 J/mol K. What is true?

A. The $S°$ for liquid N_2O_4 is smaller than the gas phase value.
B. The $S°$ for liquid N_2O_4 is larger than the gas phase value.
C. The $S°$ for solid N_2O_4 will be the same as the gas phase value.
D. There is not enough information to answer the question.

_____ 5.   The enthalpy of the reaction above is 57.2 kJ/mol. If a sealed container of the reaction at equilibrium were put on ice, what would you expect to occur?

A. The reaction would become more yellow.
B. The reaction would become less yellow.
C. The reaction is at equilibrium, no shift will occur.
D. More information is needed.

$$N_2O_4 \text{ (g)} \rightleftharpoons 2\ NO_2 \text{ (g)} \qquad K_C\ 0.0059 \text{ at } 298\ K$$

6. Determine the concentration of N_2O_4 at equilibrium if its initial concentration is 0.540 M.

Show your work in this box.

ANSWER IN THIS BOX → | *Write equilibrium concentration here….*

7. At some point in the reaction, the concentration of N_2O_4 is 0.234 M and NO_2 is 0.198 M. Is the reaction at equilibrium? Quantitatively prove your answer and explain which way the reaction will shift, if not at equilibrium.

Show your work in this box.

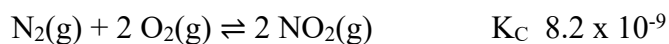**CIRCLE ONE →** | *Is the reaction at equilibrium?*

YES   NO

$$N_2O_4 (g) \rightleftharpoons 2 NO_2 (g) \qquad K_C\ 0.0059\ \text{at}\ 298\ K$$

8. The enthalpy of the reaction is 52.7 kJ/mol. The molar entropy of N_2O_4 (g) is 304.4 J/mol K. The molar entropy of NO_2 (g) is 240.1 J/mol K. Is the reaction always spontaneous? Always nonspontaneous? Or temperature dependent? Circle one and explain your answer.

Always Spontaneous	Always Nonspontaneous	Spontaneous at High Temps	Spontaneous at Low Temps
Explain your answer here….			

9. Imagine you place only pure NO_2 (g) into a sealed container. Considering the reaction below, and the one at the top of this page, what do you expect to be the majority component(s) after equilibrium is reached? Circle one and explain your answer.

$$N_2(g) + 2 O_2(g) \rightleftharpoons 2 NO_2(g) \qquad K_C\ 8.2 \times 10^{-9}$$

NO₂ (g)	N₂O₄ (g)	N₂ (g) and O₂ (g)
Explain your answer here….		

10. The enthalpy of the reaction is 52.7 kJ/mol. When will the entropy of the surroundings be the largest, at high temperature or low temperature? Explain your answer.

$$N_2O_4 \text{ (g)} \rightleftharpoons 2\ NO_2 \text{ (g)}$$
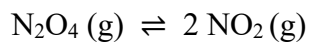
Explain here…

END OF EXAM
!!! DON'T FORGET TO CHECK YOUR WORK !!!!

Useful information:

$$1\ atm\ =\ 760\ mmHg\ =\ 101.3\ kPa \qquad R\ =\ 8.314\frac{J}{mol \cdot K} = =\ 0.08206\ \frac{L \cdot atm}{mol \cdot K}$$

0 °C = 273 K

$$\Delta G° = \Delta H° - T\Delta S° \qquad \Delta G_{rxn} = \Delta G^{o}_{rxn} + RT\ln Q \qquad \Delta G^{o}_{rxn} = -RT\ln K$$