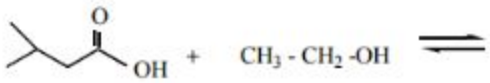
Polytechnic Tutoring Center

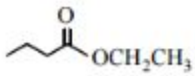
FINAL REVIEW – CM 1023, Spring 2021

Disclaimer: This mock exam is only for practice. It was made by tutors in the Polytechnic Tutoring Center and is not representative of the actual exam given by the Academic Department.

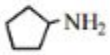
1. Complete esterification reaction, write the names of the reactants and products, and state the by-product



2. Name the functional groups in each structure below

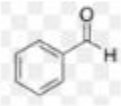


a)

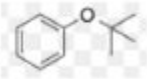


b)

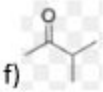
c) 



d)



e)



f)

3. What is the pH of a solution prepared by mixing 10.0 mL of a strong acid solution with pH = 2.00 and 10.0 mL of a strong acid solution with pH = 6.00?

4. What is the total vapor pressure at 25°C of a mixture of equal masses toluene and benzene? At 25°C v.p. of pure benzene = 94.6 torr and v.p. of pure toluene= 29.1 torr, MW(benzene) = 78.11 g/mol MW(toluene) = 92.14 g/mol

5. Which of the following will increase entropy? Which will decrease?

1. $2SO_2(g) + O_2(g) \rightarrow SO_3(g)$
2. $H_2O(l) \rightarrow H_2O(s)$
3. $Br_2(l) \rightarrow Br_2(g)$
4. $H_2O_2(l) \rightarrow H_2O(l) + (1/2)O_2(g)$
5. Ziegler-Natta polymerization of polystyrene

b) At what temperature will the following reaction be spontaneous?

$$C(s) + H_2O(g) \rightarrow H_2(g) + CO(s)$$

$\Delta S^o = 133.6$ J/K·mol $\qquad \Delta H^o = 131.3$ kJ/mol

Step 1: $O_3 \leftrightarrow O + O_2$

Step 2: $O + O_3 \leftrightarrow 2\ O_2$

6. For the mechanism left, write the

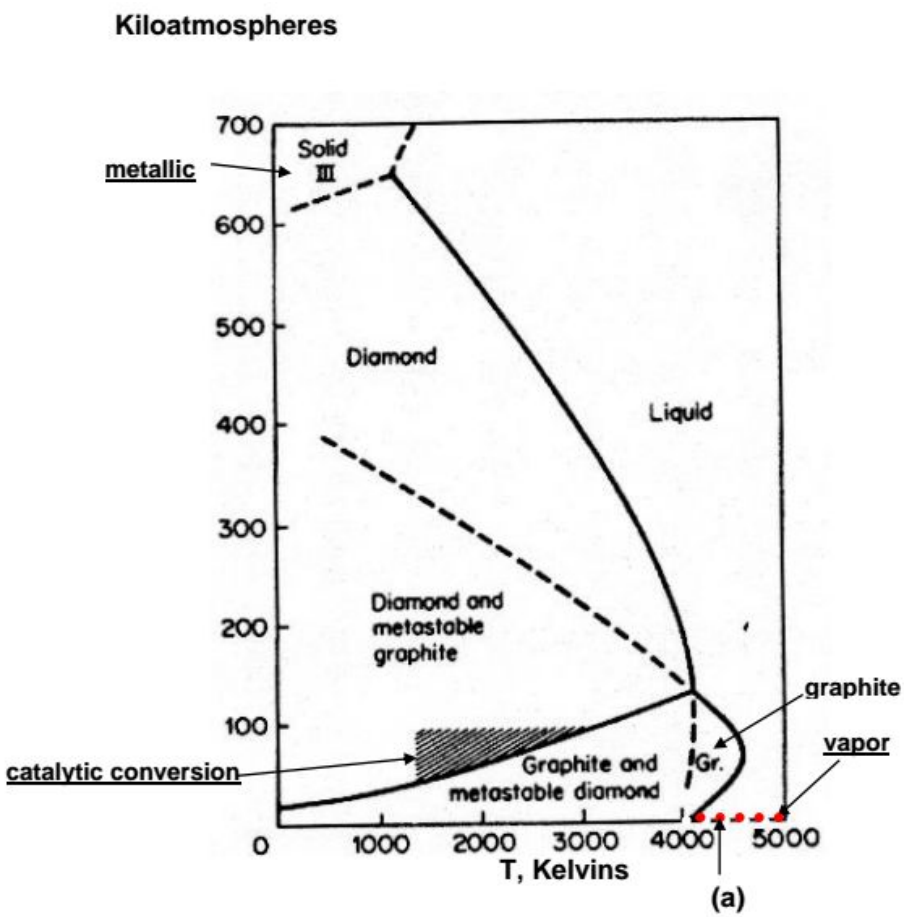
1. Net Reaction

2. Intermediates (if any)

3. Catalyst (if any)

4. Rate law for formation of O2 (Assuming elementary kinetics)

7. Consider the phase diagram below:



a) At the arrow temperature, about 4400 K, vapor condenses to liquid at about 1 katm. If the pressure is increased to 300 katm describe the phase transitions (and estimate the pressures) at which these phase transitions will take place.

b) At what pressure will graphite sink in liquid carbon? At what pressure will it float?

c) At pressures lower than 700 katm, what is the minimum temperature needed to melt any solid phase carbon?

8. For the following compounds, state all intermolecular forces, and explain which would have a higher boiling point.

	ion-ion	dipole-dipole	London (or dispersion) forces	hydrogen bonding	Highest b.p.: a) or b), and why ?
1 a) HF (g)					
1 b) HCl (g)					
2 a) H_2S (l)					
2 b) H_2Se (l)					
3a) CH_3CH_2OH(l) (ethanol)					
3b) CH_3OCH_3(l) (dimethyl ether)					

9. This reaction occurs at 500K:

Calculate Kp and Kc for:

$N_2O_4 \leftrightarrow 2NO_2$ $K_p = 1.5 \times 10^3$

$2NO_2 \leftrightarrow 2NO + O_2$ $K_p = 5.9 \times 10^{-5}$ $NO + \frac{1}{2} O_2 \leftrightarrow \frac{1}{2} N_2O_4$

10. A 2.50 mole quantity of NOCl was initially in a 1.50 L reaction chamber at 400°C. After equilibrium was established, it was found that 28.0 percent of the NOCl had dissociated. Write the equilibrium expression and calculate the equilibrium constant Kc for the reaction.

2 NOCl(g)→ 2 NO(g) + Cl 2 (g)

11.

For $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ $K_p = 0.113$ at 298K

a) Calculate ΔG^0

b) If $P_{N2O4} = 0.453$ atm and $P_{NO2} = 0.122$ atm, calculate ΔG for the reaction

c) Is the reaction at equilibrium at those conditions? Predict the direction of reaction

12. a) What is the rate law for the reaction? b) What is the rate law constant?

For $N_2O_4(g) \rightleftharpoons 2NO_2(g)$ $K_p = 0.113$ at 298K

$[CH_3COCH_3]$	$[H^+]$	$[Br_2]$	rate of disappearance of Br_2 (M/s)
0.30	0.050	0.050	5.7×10^{-5}
0.30	0.10	0.050	5.7×10^{-5}
0.30	0.050	0.10	1.2×10^{-4}
0.40	0.050	0.20	3.1×10^{-4}
0.40	0.050	0.050	7.6×10^{-5}

13. Draw the structure of 3-ethyl- 2-methylpentane. Is this molecule chiral or achiral?

14. It takes 54 min for the concentration of a reactant to drop from 0.60M to 0.11 M at 25C. If the units for k are s^{-1} what is the order of the reaction? How long will it take for the reaction to be 75% complete?

15. What is the pH of a 0.50 M ammonia solution? Can you use 5% approximation? (Kb = 1.8 × 10-5)