

Key

CHM 4155 - MIDTERM #2

Date: March 18, 2019 Duration: 80 minutes

Professor: Claudia El Nacheff

First name: _____ Last name: _____

Student #: _____

Question	1	2	3	4	5	6	Total
Value	18	8	8	8	8	8	50
Mark							
Notes							

IMPORTANT:

You must answer questions # 1 and # 2.

Answer 3 questions only from questions #3 to #6. Please indicate below which question you do NOT want marked. If you make no selection, question number 6 will not be marked.

Please do NOT mark question number: _____ ←

Cellular phones, unauthorized electronic devices or course notes (unless an open- book exam) are not allowed during this exam. Phones and devices must be turned off and put away in your bag. Do not keep them in your possession, such as in your pockets. If caught with such a device or document, the following may occur: academic fraud allegations will be filed which may result in you obtaining a 0 (zero) for the exam.

By signing below, you acknowledge that you have ensured that you are complying with the above statement.

Signature: _____

1. (18 pts) Short answers - one or two points each.

a) Three identical Bunsen burners are supplied with 3 different fuels. If all the burners use the same gas flow, which fuel would produce the largest flame?

①

Fuel	Methane	Butane	Propane
Flame Speed (cm/s)	33.8	36.6	39.6

b) From the three following hydrocarbons, the best choice for a gasoline would be

① 2-methyl-2-pentene and for diesel fuel 2-methyldecane.

cyclohexane	2-methyl-2-pentene	2-methyldecane
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c) What does the octane number of a fuel represent?

① It is the measure of the engine's ability to resist knocking
(% isooctane in isooctane/n-heptane mixture)

d) A large quantity of NaCl is added to a concentrated aqueous solution of SDS. The molecules of surfactant will aggregate to form:

① SPHERICAL MICELLES MONOLAYERS ROD-LIKE MICELLES

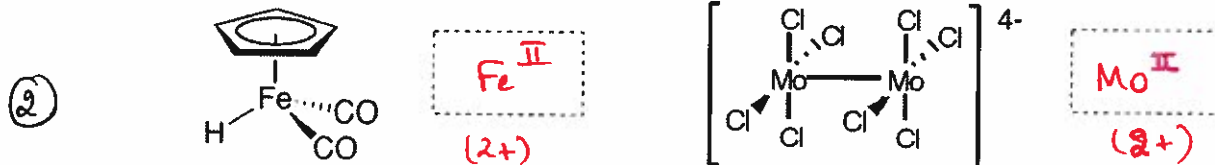
e) The critical micelle concentration (cmc) is: the concentration of surfactant

① above which micelles will begin to form

f) One way to increase the octane number of a fuel is (be specific):

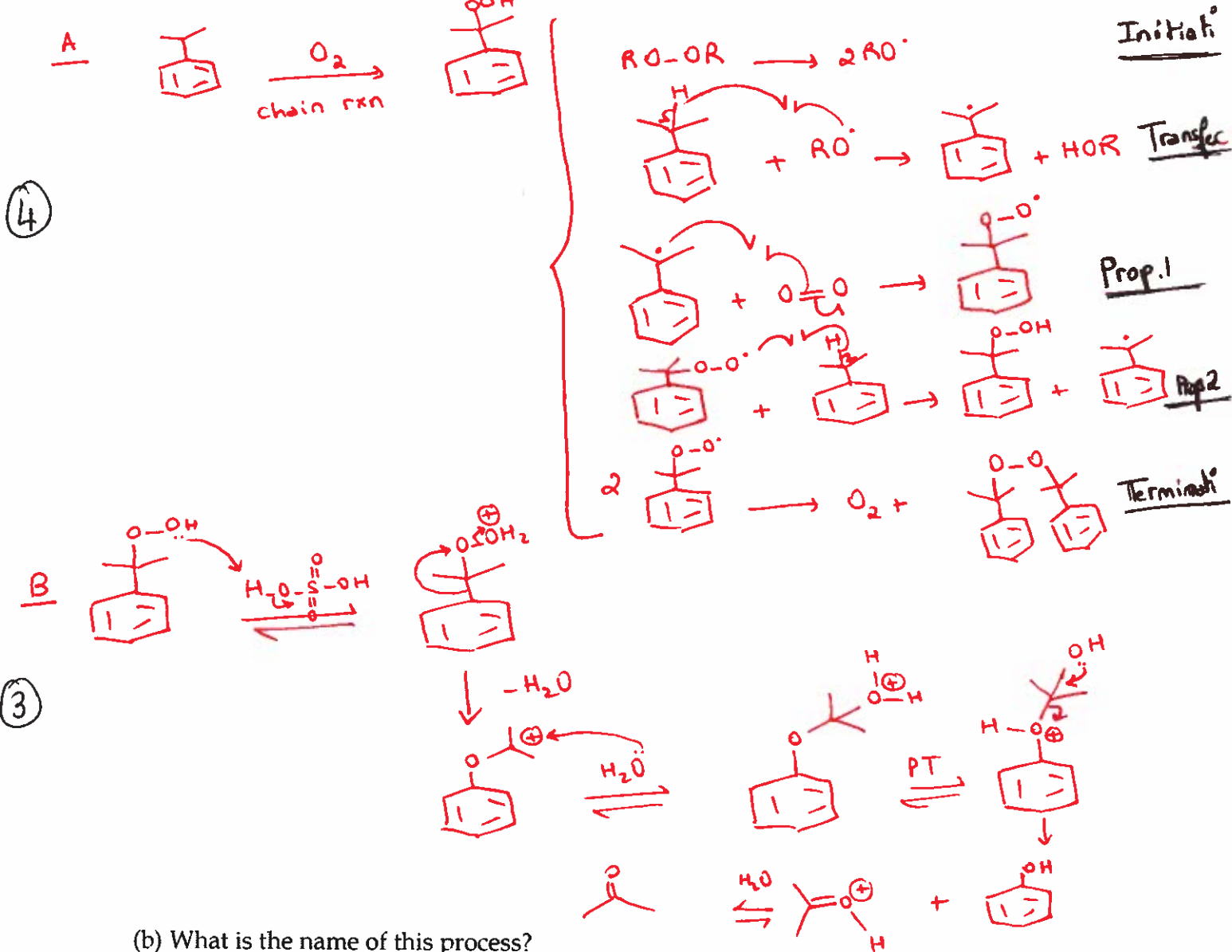
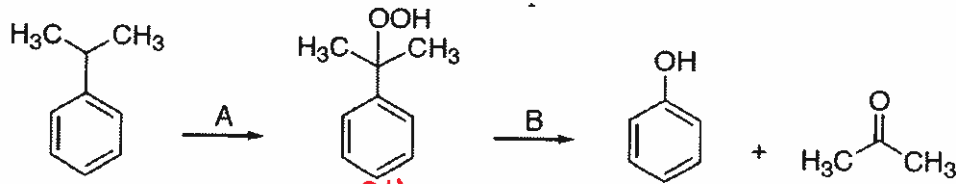
① Catalytic reforming (change composition ↑ [aromatics]) or add additives (EtOH, MTBE, ...)

g) Label the oxidation state of the metal center in each of the complex below:



2. (8 pts) Approximately 4 billion pounds of cumene are transformed into acetone and phenol every year.

(a) Write the **detailed mechanisms** of steps A and B below.

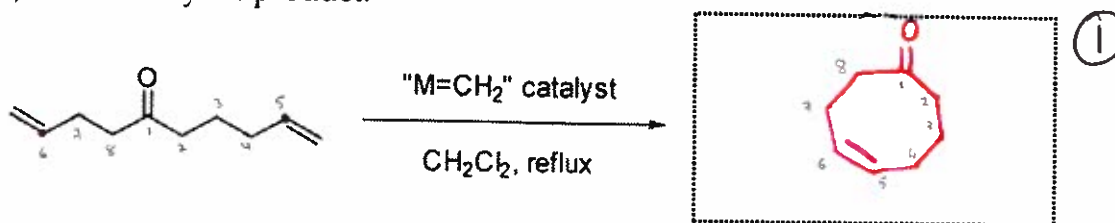


(b) What is the name of this process?

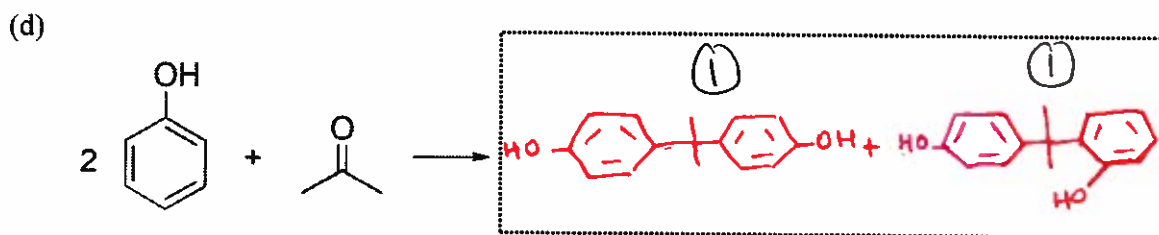
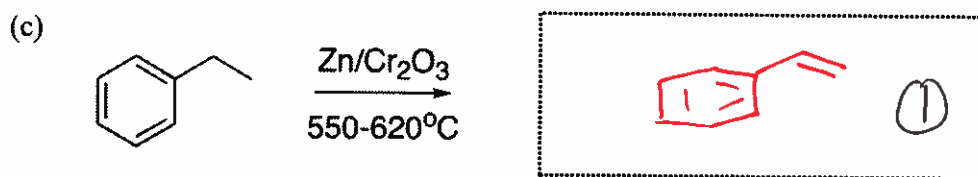
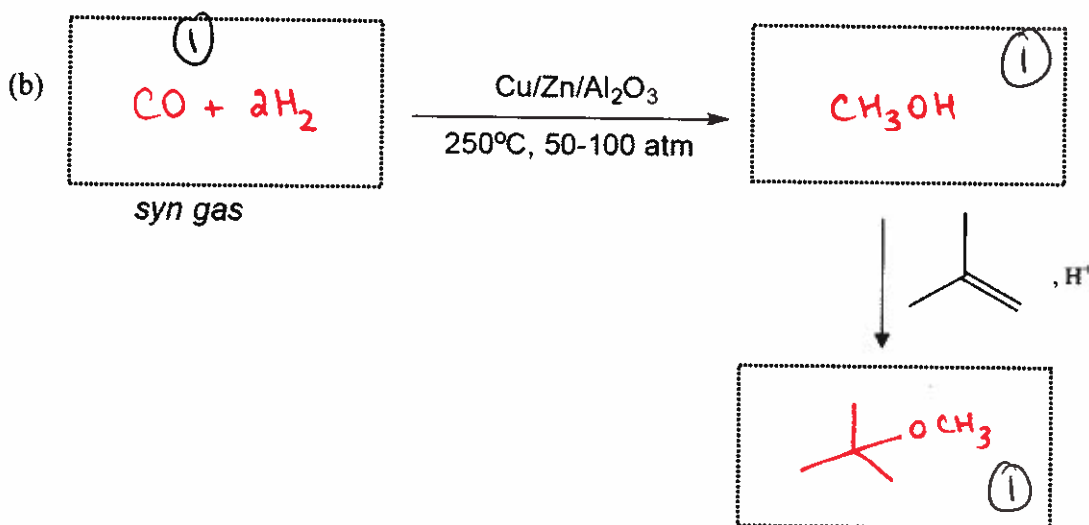
① The Hock process

3. (8 pts) Complete the following reactions: (no mechanisms)

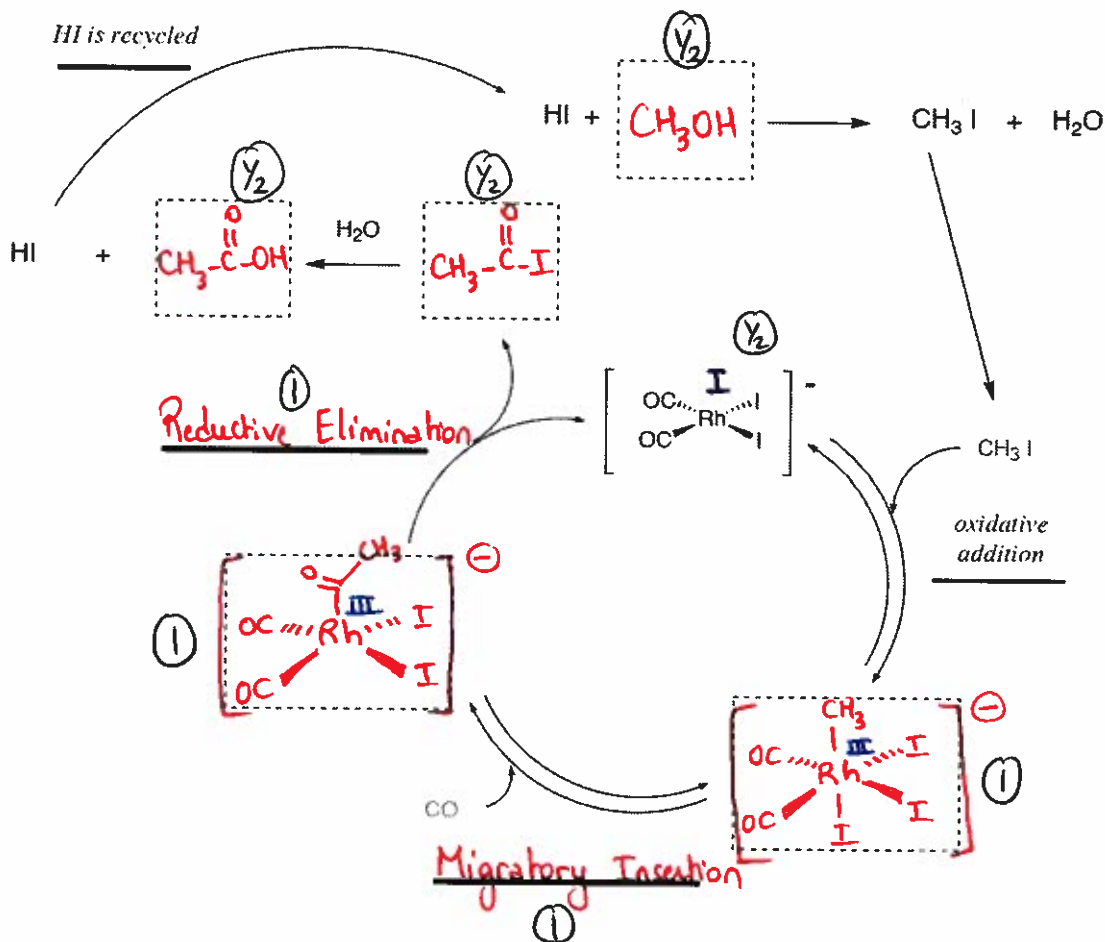
(a) Draw the cyclic product:



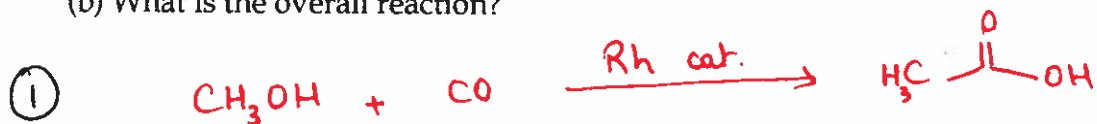
And name this transformation Ring Closing Metathesis (RCM)



4. (8 pts) a). In the boxes below, complete the steps involved in the Monsanto Process. Write the names of the steps in the lines and include the oxidation state of the metal centre at each step.



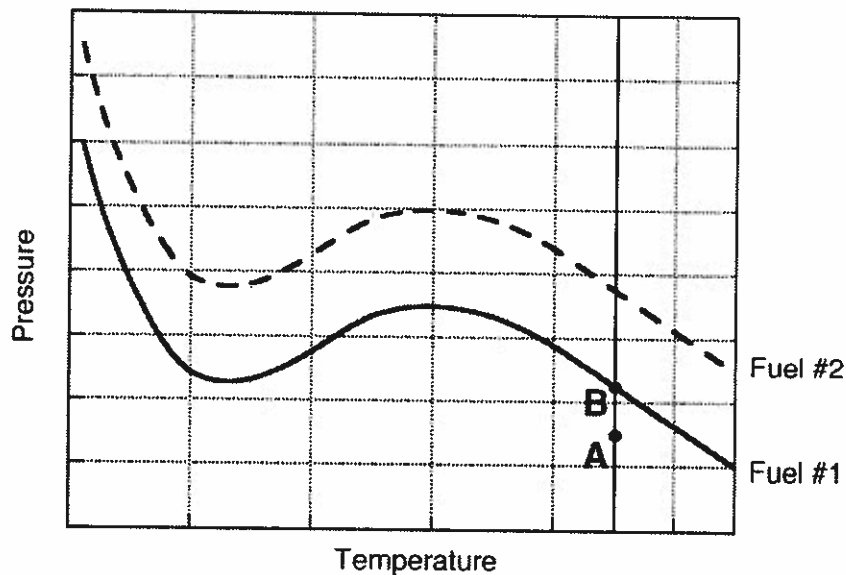
(b) What is the overall reaction?



(c) Is this a balanced process? Why?

① Yes because the HI is formed and recycled locally.
 All byproducts are recycled in the process.

5. (8 pts) A mixture of Fuel #1 and air is pressurized at constant temperature (such as in the cylinder of an internal combustion engine), as illustrated by the vertical line in the figure shown below.



- (a) Explain what is happening to this mixture at point "A".

At "A" is in the cool flame region.

② slow/no visible oxidation \longrightarrow carbonyl compounds (blue color of cool flame)
produces

- (b) Explain what happens as the pressure is increased to point "B".

At "B", the mixture will spontaneously explode.

② spontaneous / rapid combustion \implies explosion

- (c) The chemical composition of the mixture is changed to that of Fuel #2 (dashed line). How would the octane number change?

② The octane number would increase.

- (d) Suggest two ways in which the change (curve displacement) of part (c) could be achieved. Mention specific chemicals in your answer.

② 1) Catalytic reforming : alkanes \longrightarrow Acyclic / Branched alkanes

\downarrow
Alkenes / Aromatics

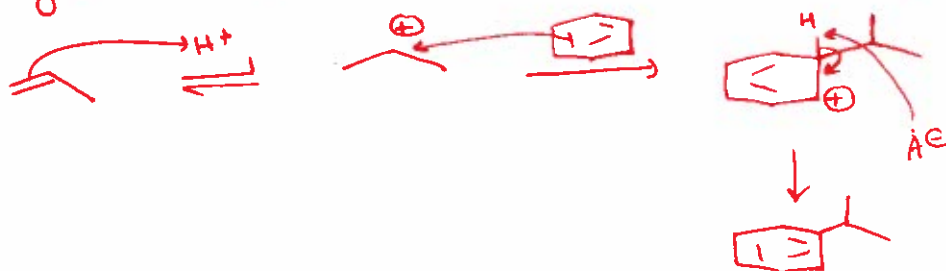
2) Addition of a gasoline additive (MTBE, EtOH, PbEt₄, etc...)

6. (8 pts) (a) Depict using an overall scheme (no mechanisms) the reaction steps that one would need in order to convert toluene to cumene. Include all reagents, relative reaction conditions, and important byproducts where applicable.

① Hydrodealkylation of toluene to Benzene (thermal or catalytic) (T ↑ P ↑) (T medium metal catalyst P ↓)



② - Alkylation of benzene to cumene (Friedel Crafts - Brønsted or Lewis acid)



(b) Explain why, in the alkylation of benzene to make ethylbenzene, ethylene is always the limiting reagent.

If ethylene is added in excess amounts, it can lead to polyalkylation of benzene (e.g. diethylbenzene, ...)

(c) Why does H· add to the aromatic ring in toluene during its thermal decomposition instead of abstraction from the labile bonds in the CH₃ group of toluene?

Possible rxns; All unproductive (no significant product would be formed)

