

Catalyst design for synthesis, Midterm Exam

November 8, 2023

Name (First name, Last name):

Student ID number:

PCs must not be used. No material other than the exam paper is permitted.

Overall 32 points.

You can also write the answer on the back of the exam paper if you run out of space; if you choose to do so, make a clear indication in the exam paper.

You have a maximum of **90 minutes** to finish the exam.

THE PERIODIC TABLE

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1 IA																						
1 H 1 1.008 Hydrogen																	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 He 4.00 Helium
2 IIA	3 Li 6.94 Lithium	4 Be 9.01 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon				
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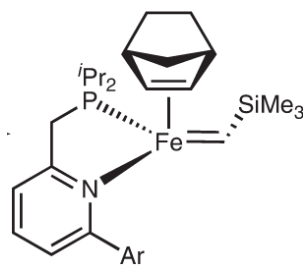
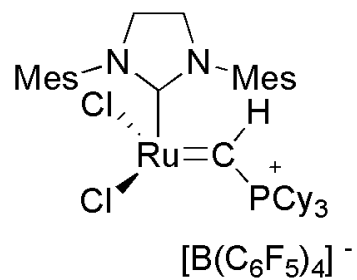
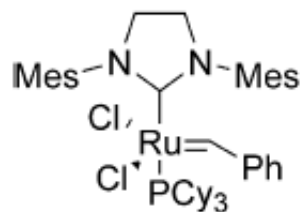
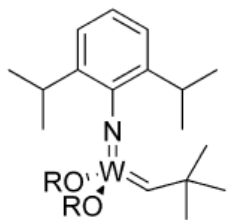
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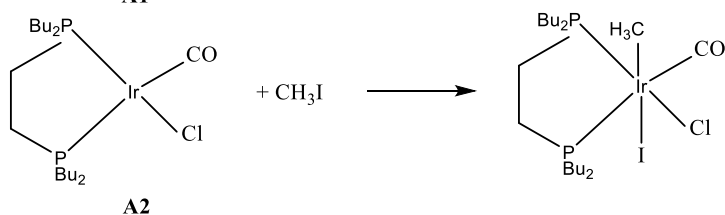
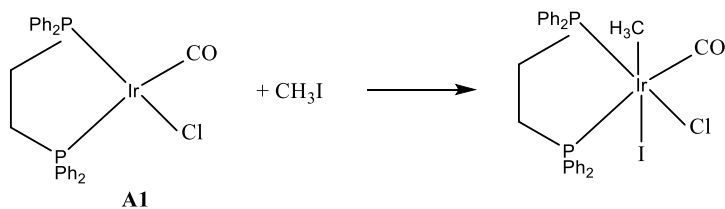
Ce 58 140.12 Cerium	Pr 59 140.91 Praseodymium	Nd 60 144.24 Neodymium	Pm 61 (145) Promethium	Sm 62 150.36 Samarium	Eu 63 152.97 Europium	Gd 64 157.25 Gadolinium	Tb 65 158.93 Terbium	Dy 66 162.50 Dysprosium	Ho 67 164.93 Holmium	Er 68 167.26 Erbium	Tm 69 168.93 Thulium	Yb 70 173.04 Ytterbium	Lu 71 174.97 Lutetium
Th 90 232.04 Thorium	Pa 91 231.04 Protactinium	U 92 238.03 Uranium	Np 93 237.05 Neptunium	Pu 94 (240) Plutonium	Am 95 243.06 Americium	Cm 96 (247) Curium	Bk 97 (248) Berkelium	Cf 98 (251) Californium	Es 99 252.08 Einsteinium	Fm 100 257.10 Fermium	Md 101 (257) Mendelevium	No 102 259.10 Nobelium	Lr 103 262.11 Lawrencium

1. (8 points)

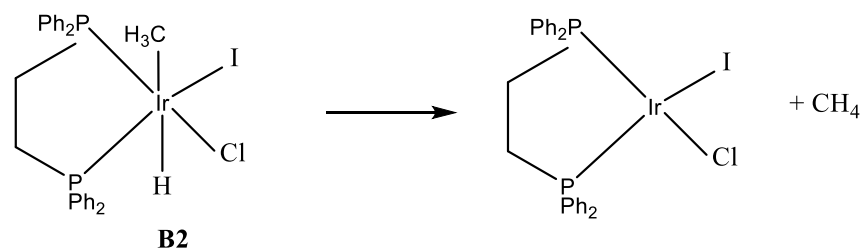
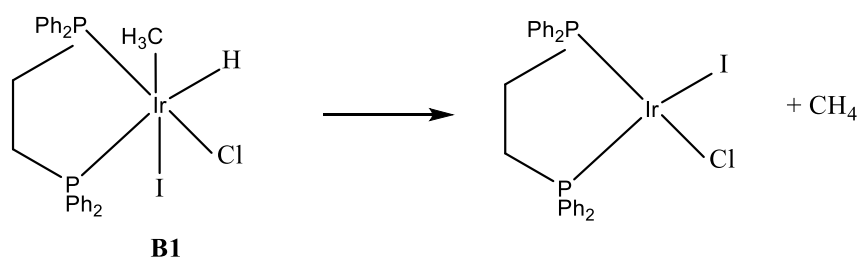
Describe the oxidation state and the number of electrons at the metal for the following complexes.



2. For the following reactions, choose the complex that has the higher reaction rate, and explain why. (4 points)



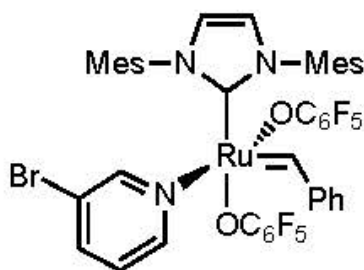
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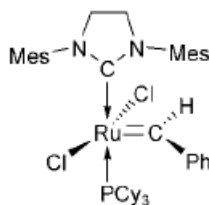
B:

3. $\text{Ni}(\text{CO})_4$ can undergo substitution reaction with an incoming neutral ligand L to give $\text{Ni}(\text{CO})_3\text{L}$. Kinetic studies show that the rate is first order in Ni and zero order in L. Draw a mechanism of the ligand substitution reaction. Explain the observed kinetics using this mechanism. (5 points)

4. The following Ru catalyst (Ru-a) was found to be more active than the Grubbs II catalyst in ring-closing metathesis. Explain why (2 points)

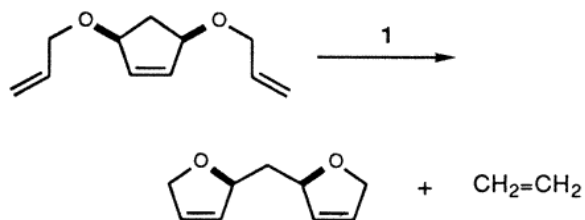


(Ru-a)



(Grubbs-II)

5. The following reaction was catalyzed by Grubbs-I catalysts ($\text{L}_n\text{Ru}=\text{CHPh}$). Please propose a mechanism for this reaction. (5 points)



6. Enyne metathesis is a metathesis reaction between an alkene and an alkyne. Mechanistically it is similar to alkene metathesis. Please draw the mechanism of the following enyne metathesis. (8 points)

