

NAME _____

ID # _____

ORGANIC CHEMISTRY II (2302)

8:00 – 9:15 am, August 6, 2015

Final Exam

You will be able to pick up your graded exam from Chemistry department staff in 115 Smith beginning Monday, August 11th at 1 PM. Exams that are not picked up within two weeks will be disposed of.

A chart of reaction conditions, a periodic table and a chart of amino acids and nucleic acid bases are attached to the back of this exam as an aid. Otherwise, you are not permitted to use any other materials (including notes, books, or electronic devices of any kind).

When the exam begins, please write your name at the top of the next page.

You may use pen or pencil. However, re-grades will be considered only for exams completed in pen.

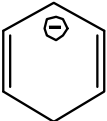
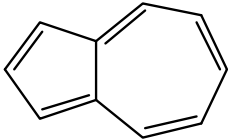
Please write your answers in the boxes/spaces provided. If your answer is not in the appropriate space (say, for example, it's on the back of the page), draw us an arrow and/or note telling us where to look.

NAME _____

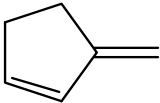
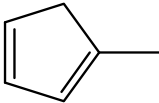
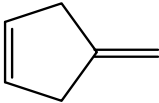
Scoring: 1. _____ / 6 6. _____ / 3
2. _____ / 10 7. _____ / 9
3. _____ / 32 8. _____ / 24
4. _____ / 6 9. _____ / 25
5. _____ / 35

Total Score: _____ / 150

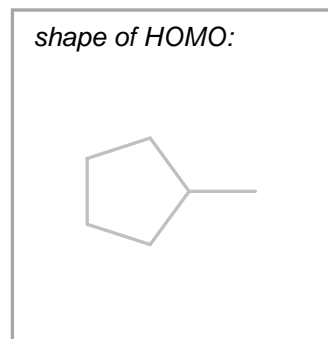
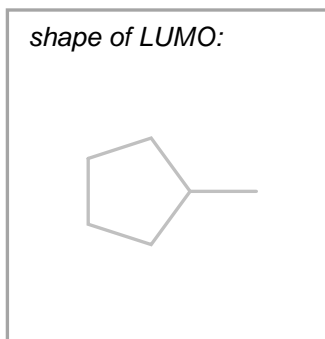
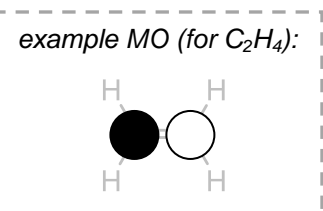
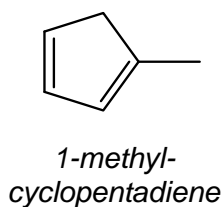
1. (6 pts) For each of the following molecules, circle whether the molecule is aromatic, anti-aromatic, or neither.

AROMATIC			AROMATIC
ANTI-AROMATIC			ANTI-AROMATIC
NEITHER			NEITHER

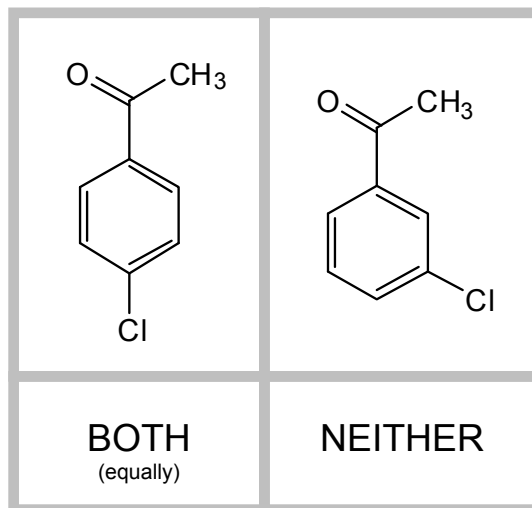
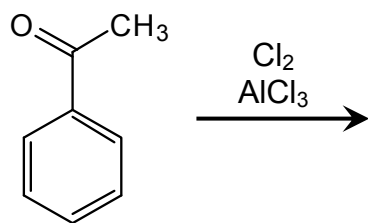
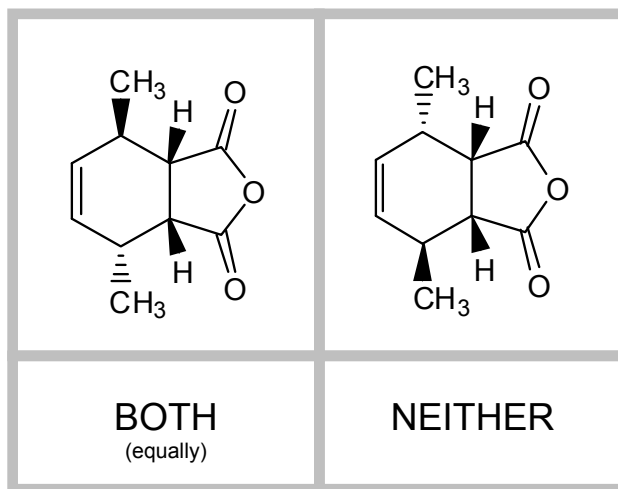
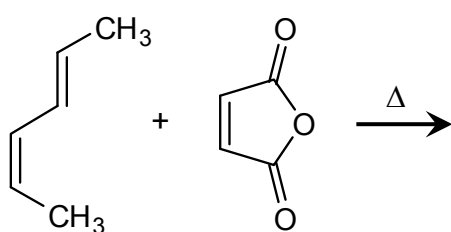
2. (10 pts)
a. Of the three C₆H₈ isomers shown below,

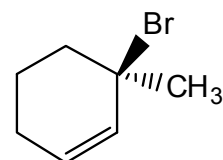
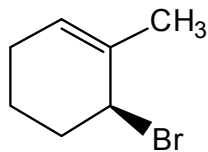
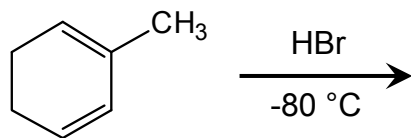
			
Which has the smallest λ_{\max} ? (Check one box.)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Which would give off the most energy by hydrogenation?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- b. In the boxes on the right, draw the shapes of the HOMO and LUMO of 1-methylcyclopentadiene (the middle molecule on the previous page, reproduced at right). Draw each orbital as a combination of atomic orbital lobes, viewed from the top of the molecule. If there is more than one HOMO or LUMO, just draw one. I have drawn the carbon backbone in each box; draw your orbitals right on top of that scaffold.



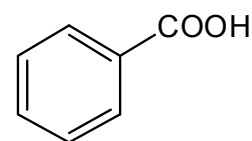
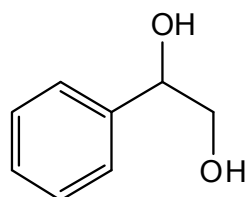
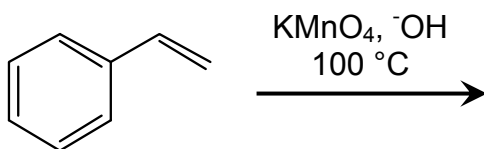
3. (32 pts) Each of the reactions below is drawn with two possible products. If one of the two products predominates, circle that preferred product. If the two products are produced equally, circle "BOTH". If neither product would result from the reaction, circle "NEITHER". **Circle one answer only.**





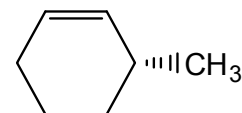
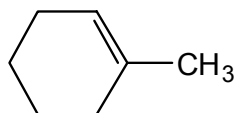
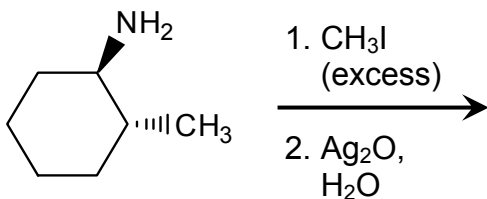
BOTH
(equally)

NEITHER



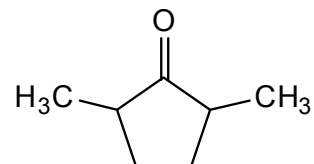
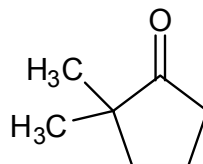
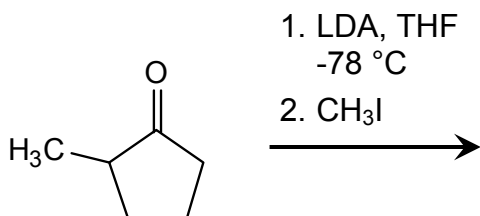
BOTH
(equally)

NEITHER



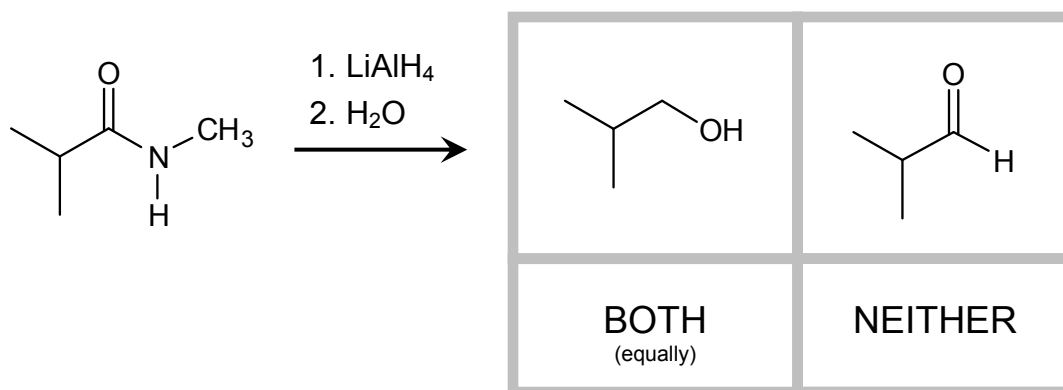
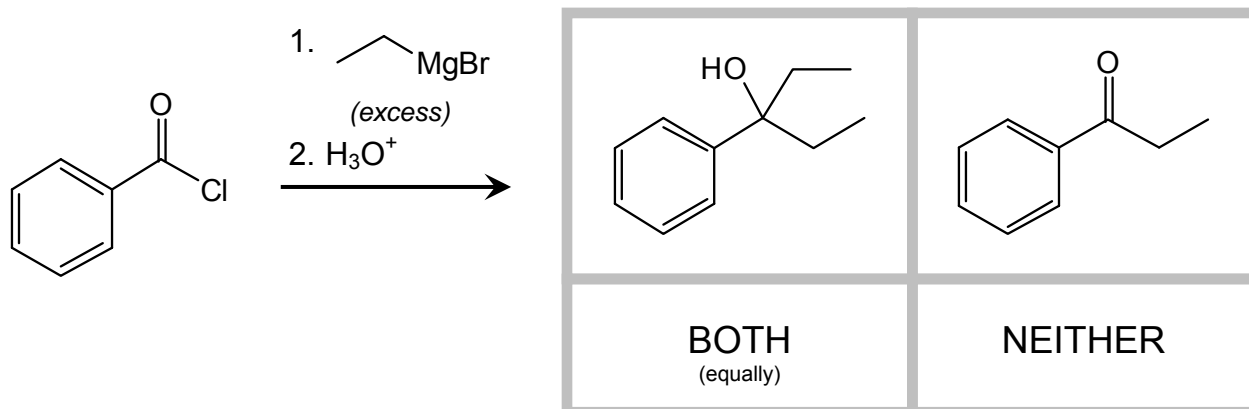
BOTH
(equally)

NEITHER

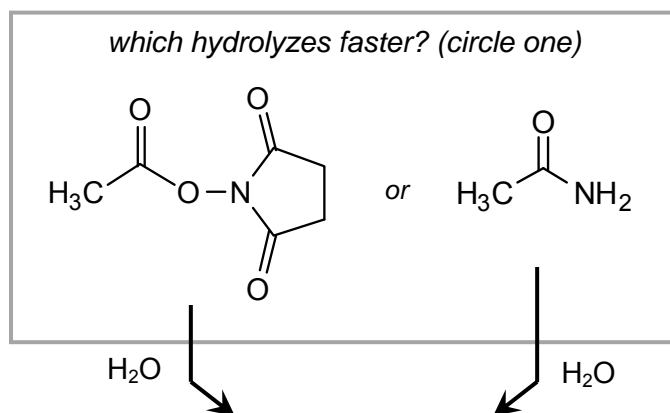


BOTH
(equally)

NEITHER



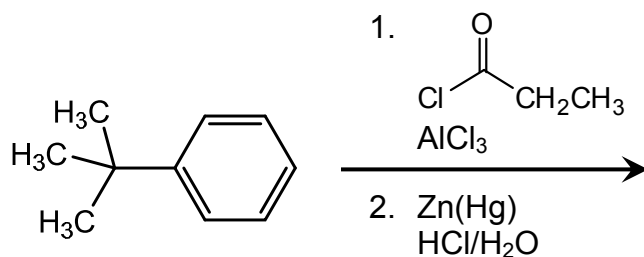
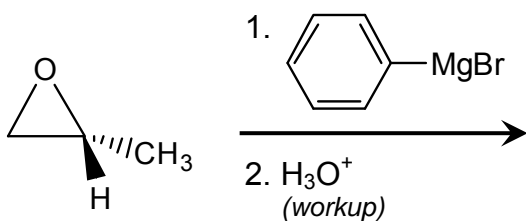
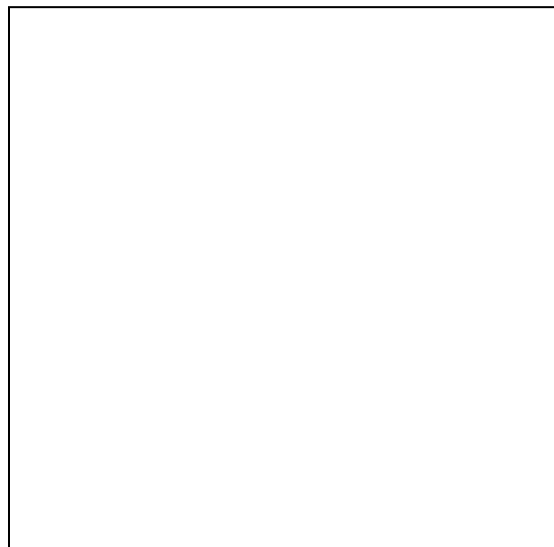
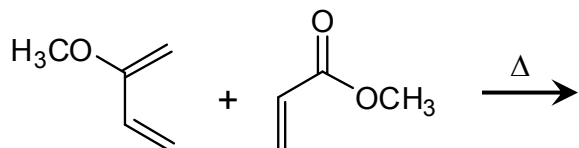
4. (6 pts) Each of the carboxylic acid derivatives on the right reacts with water, at very different rates. **Circle the molecule that hydrolyzes faster.**

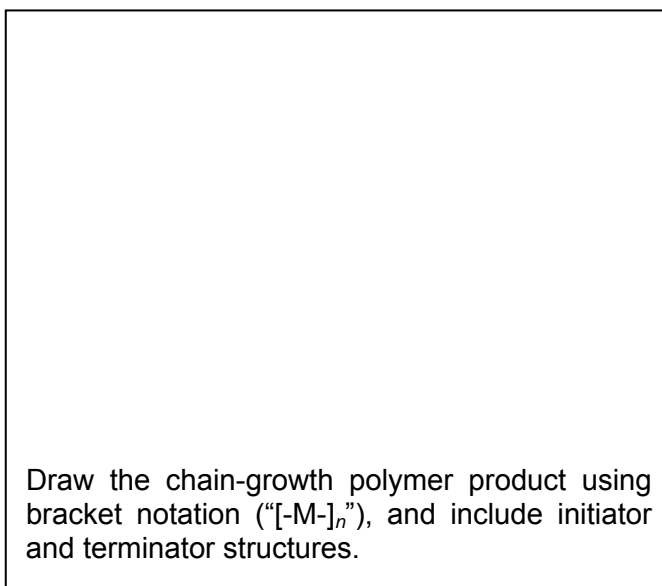
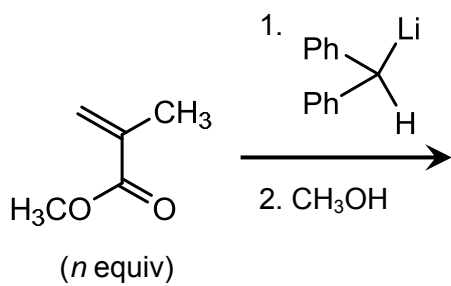
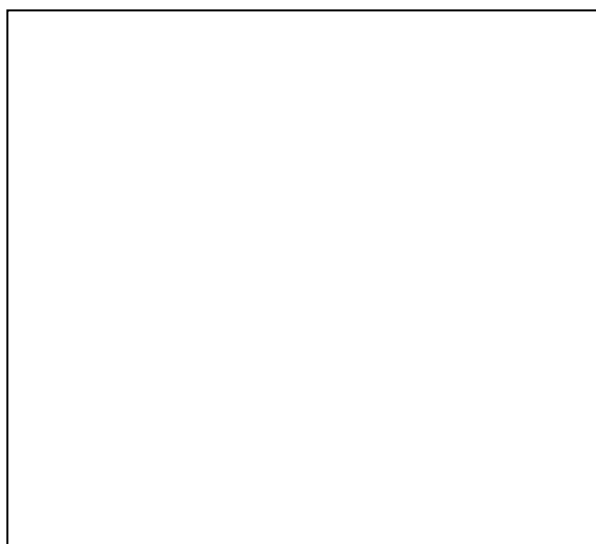
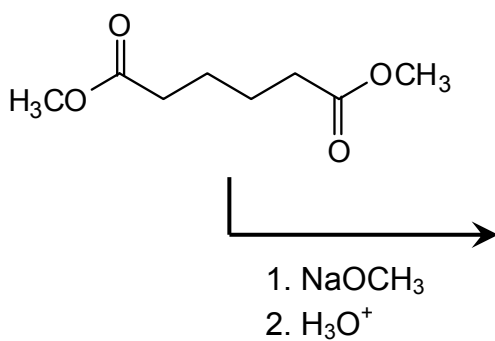
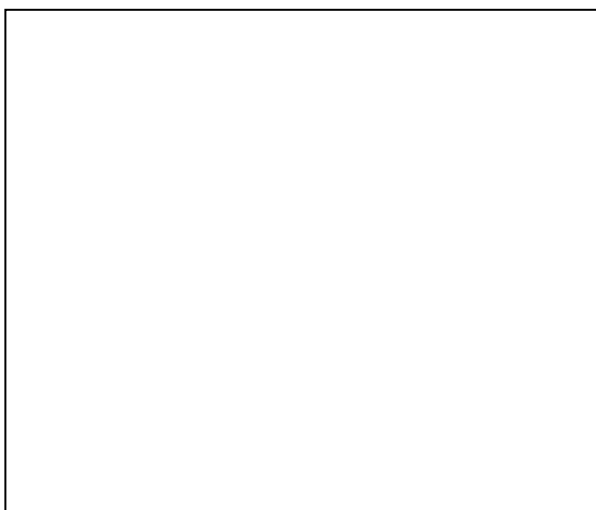
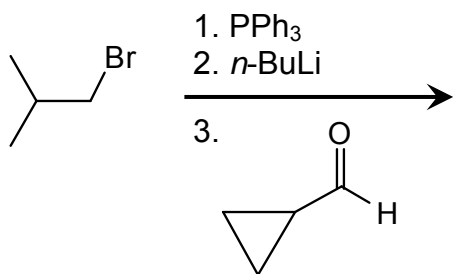


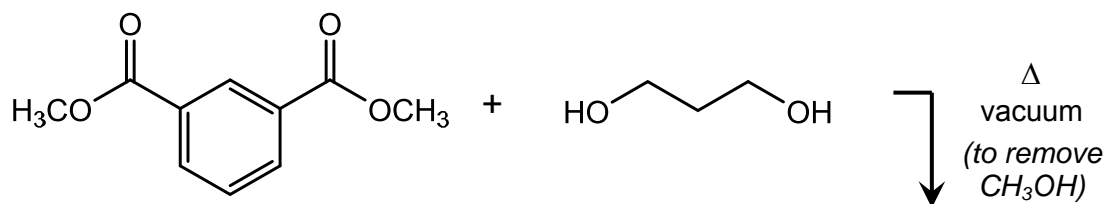
What common product do both of these molecules hydrolyze to?

hydrolysis product

5. (35 pts) For each of the reactions below, fill in the empty box corresponding to reactants or products. Give only one answer in each box. For reactions that you expect to yield multiple products, give the major product. For reactions that yield multiple enantiomers, draw only one enantiomer in the box, and include the note "+ enantiomer".

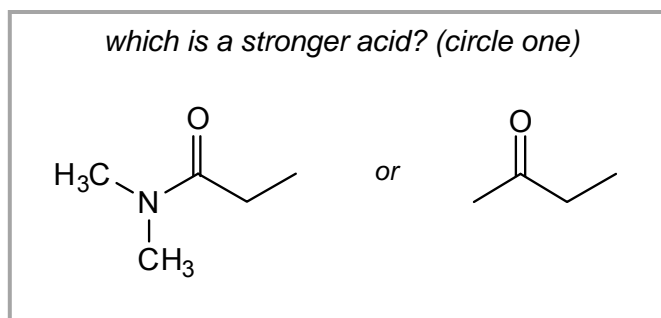




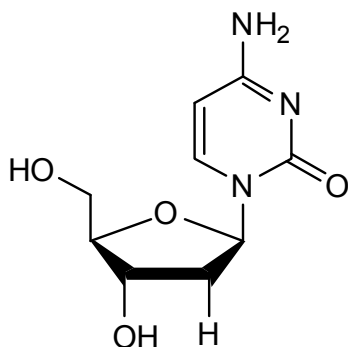


Draw the step-growth polymer product using bracket notation (" $[-M-]_n$ "), and include end groups.

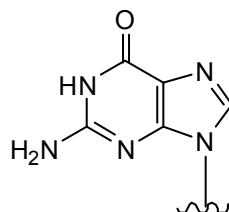
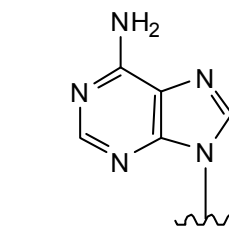
6. (3 pts) Each of the carbonyl-containing compounds on the right is acidic, and can be deprotonated to form an enolate anion. **Circle the stronger acid.**



7. (9 pts) For the nucleoside below on the left:
- Label the 3'- and 5'-carbons with their numbers;
 - Circle whether the nucleoside is a component of DNA or RNA;
 - Circle the base on the right that the base is normally paired with in a double helix.

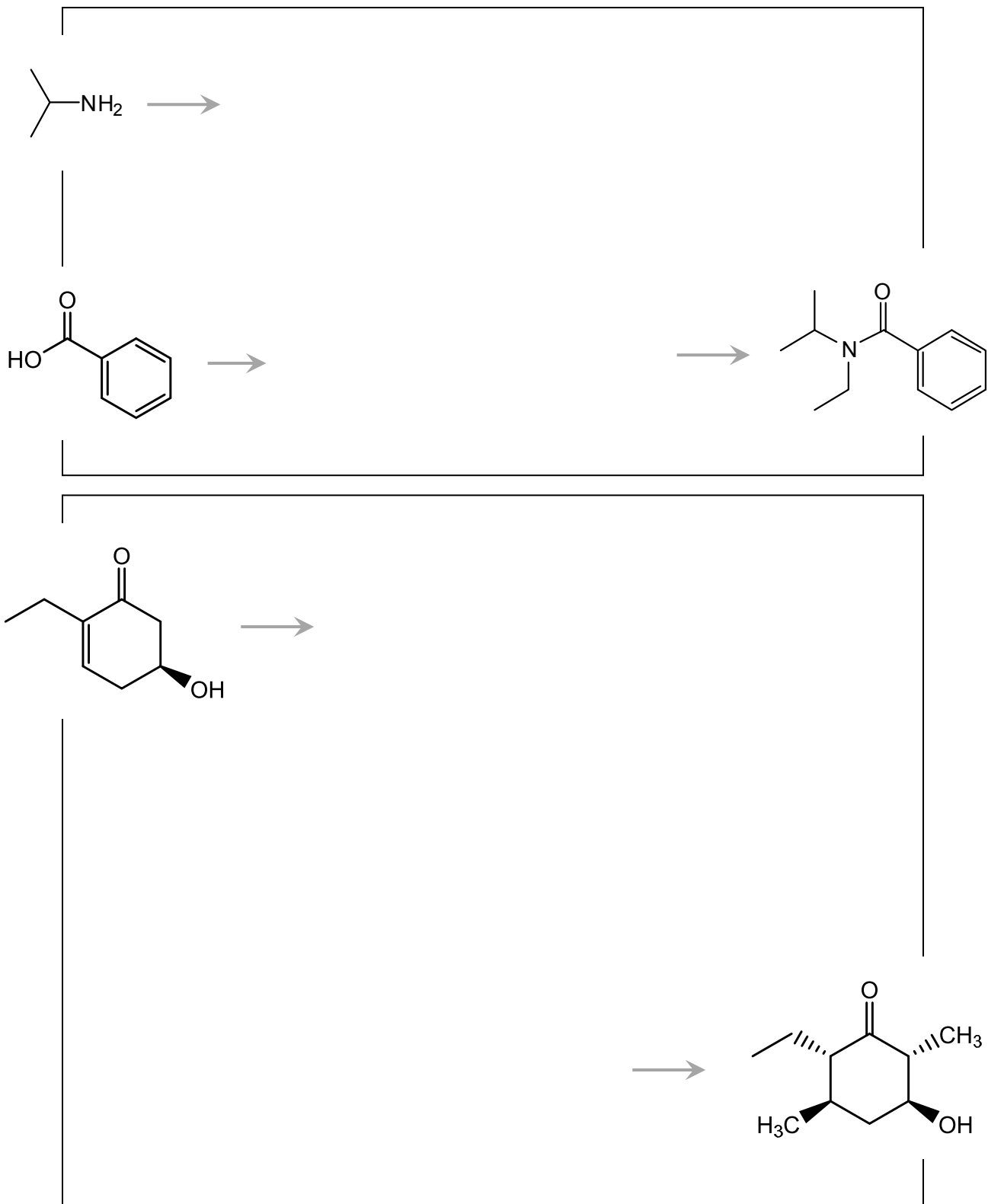


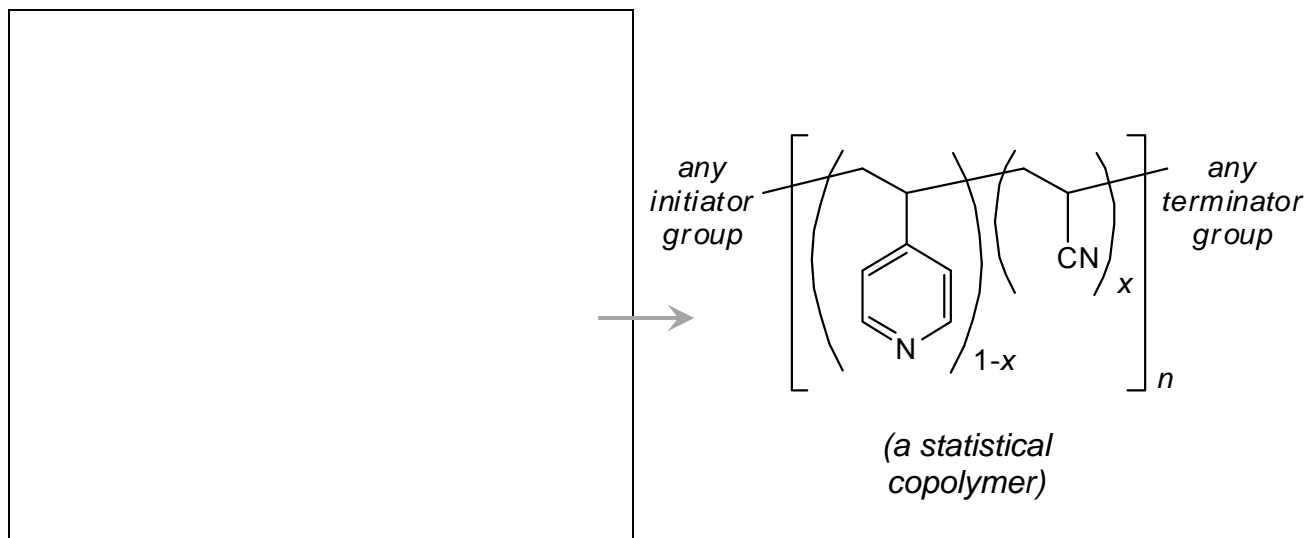
component of
DNA or **RNA** ?
 (circle one)



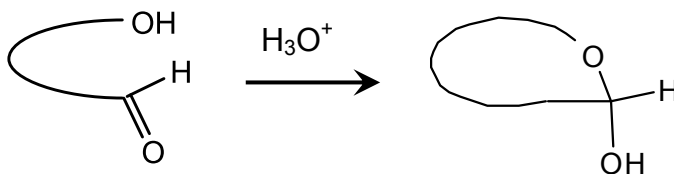
which of these
 bases pairs with
 base on the left?
 (circle one)

9. (25 pts) Each of the syntheses shown below can be accomplished in a few steps. For each synthesis, fill in the empty boxes with any appropriate reagents (or sets of reagents) and synthetic intermediates. You must use the starting materials I have shown, but you may also use any other reagents you like.

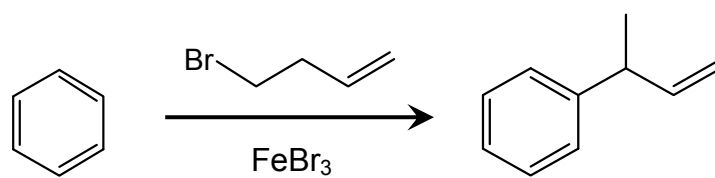




8. (24 pts) **Draw a mechanism** (using “electron pushing”) for the reaction shown below. Draw each mechanistic step explicitly; don’t cheat by combining multiple processes in a single step, or by taking shortcuts. Use only the molecules shown in the problem.

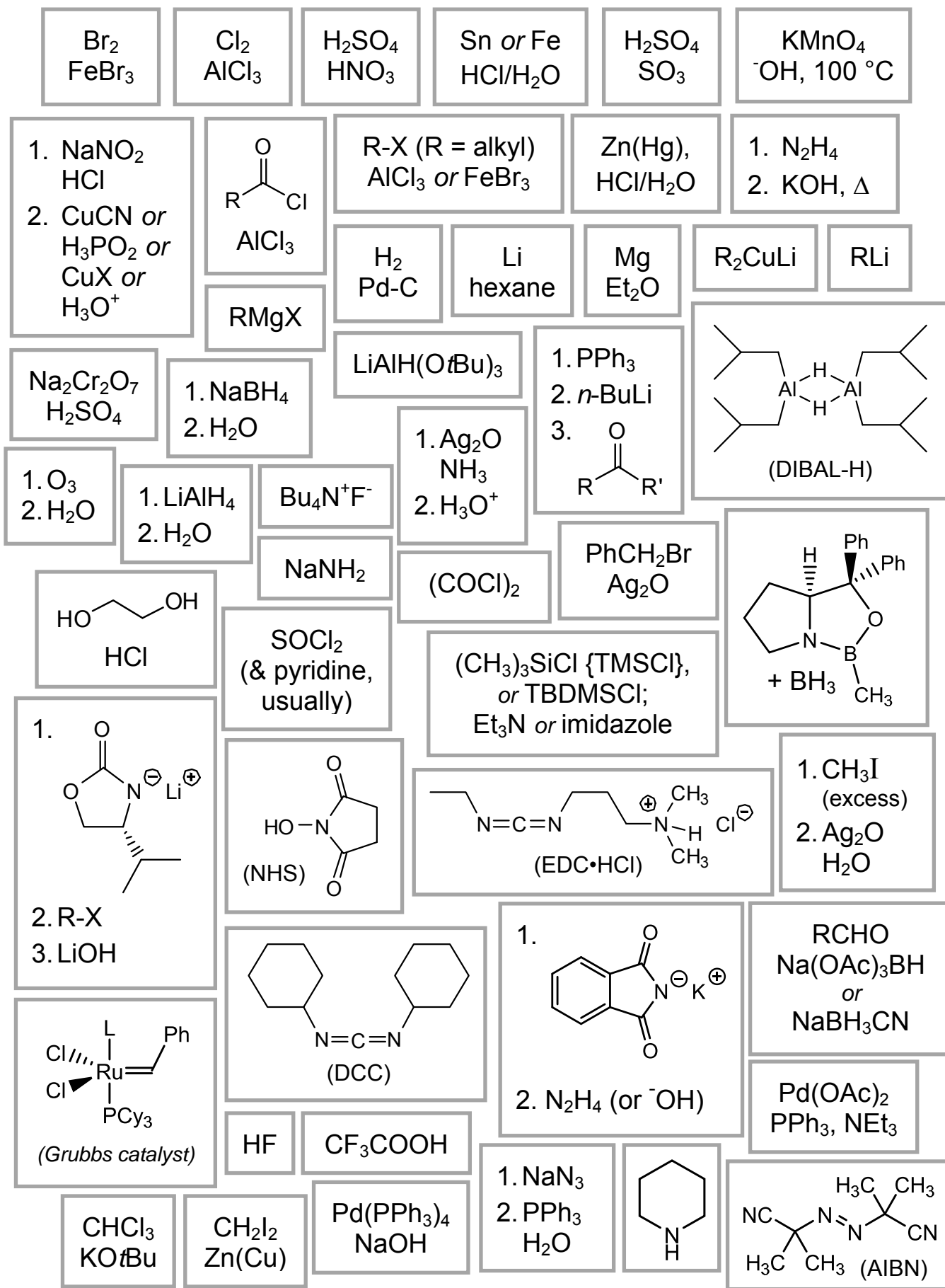


Mechanism:

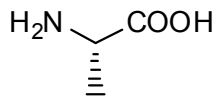


Mechanism:

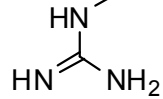
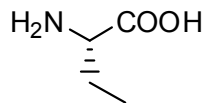
Final Exam Chart of Reaction Conditions



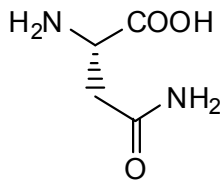
Final Exam Chart of Amino Acids (in Alphabetical Order)



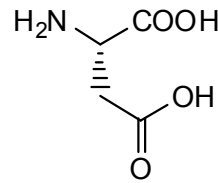
alanine
(Ala, A)



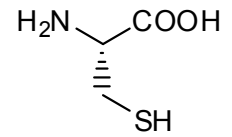
arginine
(Arg, R)



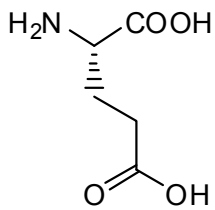
asparagine
(Asn, N)



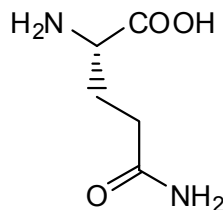
aspartic acid
(Asp, D)



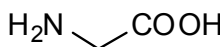
cysteine
(Cys, C)



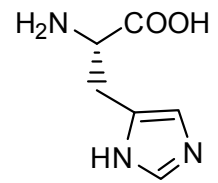
glutamic acid
(Glu, E)



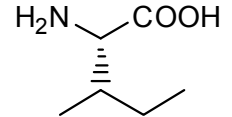
glutamine
(Gln, Q)



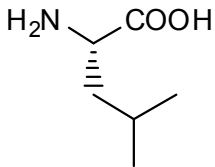
glycine
(Gly, G)



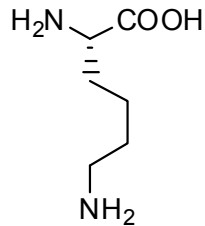
histidine
(His, H)



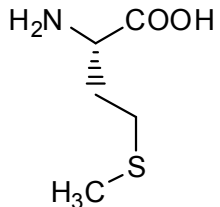
isoleucine
(Ile, I)



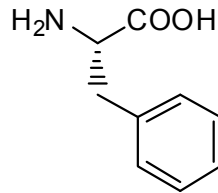
leucine
(Leu, L)



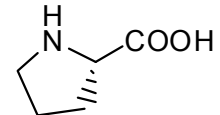
lysine
(Lys, K)



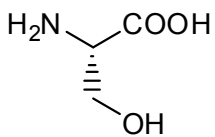
methionine
(Met, M)



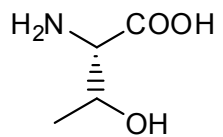
phenylalanine
(Phe, F)



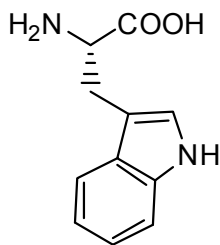
proline
(Pro, P)



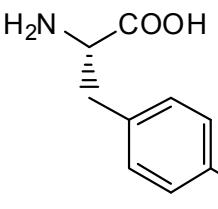
serine
(Ser, S)



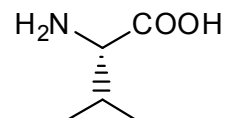
threonine
(Thr, T)



tryptophan
(Trp, W)

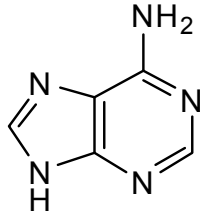


tyrosine
(Tyr, Y)

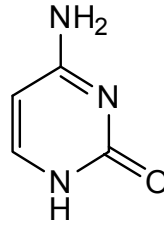


valine
(Val, V)

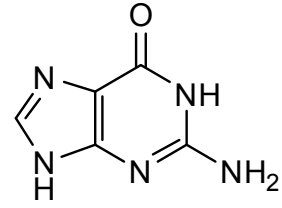
**Final Exam Chart of Nucleic Acid Bases
(in Alphabetical Order)**



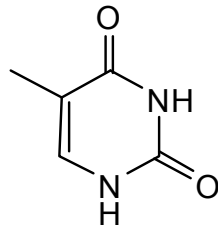
adenine
(A)



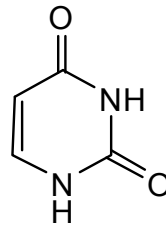
cytosine
(C)



guanine
(G)



thymine
(T)



uracil
(U)

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		1A		2A		3B		4B		5B		6B		7B		8B						1B		2B		3A		4A		5A		6A		7A		8A																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
1	1	H Hydrogen 1.01	2	He Helium 4.00	3	4	Li Lithium 6.94	5	Be Beryllium 9.01	6	7	B Boron 10.81	8	C Carbon 12.01	9	N Nitrogen 14.01	10	O Oxygen 16.00	11	F Fluorine 19.00	12	Ne Neon 20.18	13	Na Sodium 22.99	14	Mg Magnesium 24.31	15	Al Aluminum 26.98	16	Si Silicon 28.09	17	P Phosphorus 30.97	18	S Sulfur 32.07	19	Cl Chlorine 35.45	20	Ar Argon 39.95	21	K Potassium 39.10	22	Ca Calcium 40.08	23	Sc Scandium 44.96	24	Ti Titanium 47.87	25	V Vanadium 50.94	26	Cr Chromium 52.00	27	Mn Manganese 54.94	28	Fe Iron 55.85	29	Ni Nickel 58.69	30	Cu Copper 63.55	31	Zn Zinc 65.39	32	Ga Gallium 69.72	33	Ge Germanium 72.61	34	As Arsenic 74.92	35	Se Selenium 78.96	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 95.94	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 118.71	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	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 173.04	71	Lu Lutetium 174.97	72	Fr Francium (223)	73	Ra Radium (226)	74	Ac Actinium (227)	75	Rf Rutherfordium (261)	76	Hf Hafnium 178.49	77	Ta Tantalum 180.95	78	W Tungsten 183.84	79	Re Rhenium 186.21	80	Os Osmium 190.23	81	Ir Iridium 192.22	82	Pt Platinum 195.08	83	Au Gold 196.97	84	Hg Mercury 200.59	85	Tl Thallium 204.38	86	Pb Lead 207.2	87	Bi Bismuth 208.98	88	Po Polonium (209)	89	At Astatine (210)	90	Rn Radon (222)	91	Th Thorium 232.04	92	Pa Protactinium 231.04	93	U Uranium 238.03	94	Np Neptunium (237)	95	Pu Plutonium (244)	96	Am Americium (243)	97	Cm Curium (247)	98	Bk Berkelium (247)	99	Cf Californium (251)	100	Fm Fermium (257)	101	Md Mendelevium (258)	102	No Nobelium (259)	103	Lr Lawrencium (262)	104	Db Dubnium (262)	105	Sg Seaborgium (266)	106	Bh Bohrium (264)	107	Hs Hassium (269)	108	Mt Meitnerium (268)	109	Uu Ununium (271)	110	Uub Unubium (272)	111	Uut Ununtrium (273)	112	Uuq Ununquadium (274)	113	Uup Ununpentium (275)	114	Uuq Ununhexium (276)	115	Uup Ununseptium (277)	116	Uuq Ununoctium (278)	117	Uup Ununnonium (279)	118	Uuo Ununbinium (280)	119	Uup Ununtrium (281)	120	Uuq Ununquadium (282)	121	Uup Ununpentium (283)	122	Uuq Ununhexium (284)	123	Uup Ununseptium (285)	124	Uuq Ununoctium (286)	125	Uup Ununnonium (287)	126	Uuo Ununbinium (288)	127	Uup Ununpentium (289)	128	Uuq Ununquadium (290)	129	Uup Ununseptium (291)	130	Uuq Ununoctium (292)	131	Uup Ununnonium (293)	132	Uuo Ununbinium (294)	133	Uup Ununpentium (295)	134	Uuq Ununquadium (296)	135	Uup Ununseptium (297)	136	Uuq Ununoctium (298)	137	Uup Ununnonium (299)	138	Uuo Ununbinium (300)	139	Uup Ununpentium (301)	140	Uuq Ununquadium (302)	141	Uup Ununseptium (303)	142	Uuq Ununoctium (304)	143	Uup Ununnonium (305)	144	Uuo Ununbinium (306)	145	Uup Ununpentium (307)	146	Uuq Ununquadium (308)	147	Uup Ununseptium (309)	148	Uuq Ununoctium (310)	149	Uup Ununnonium (311)	150	Uuo Ununbinium (312)	151	Uup Ununpentium (313)	152	Uuq Ununquadium (314)	153	Uup Ununseptium (315)	154	Uuq Ununoctium (316)	155	Uup Ununnonium (317)	156	Uuo Ununbinium (318)	157	Uup Ununpentium (319)	158	Uuq Ununquadium (320)	159	Uup Ununseptium (321)	160	Uuq Ununoctium (322)	161	Uup Ununnonium (323)	162	Uuo Ununbinium (324)	163	Uup Ununpentium (325)	164	Uuq Ununquadium (326)	165	Uup Ununseptium (327)	166	Uuq Ununoctium (328)	167	Uup Ununnonium (329)	168	Uuo Ununbinium (330)	169	Uup Ununpentium (331)	170	Uuq Ununquadium (332)	171	Uup Ununseptium (333)	172	Uuq Ununoctium (334)	173	Uup Ununnonium (335)	174	Uuo Ununbinium (336)	175	Uup Ununpentium (337)	176	Uuq Ununquadium (338)	177	Uup Ununseptium (339)	178	Uuq Ununoctium (340)	179	Uup Ununnonium (341)	180	Uuo Ununbinium (342)	181	Uup Ununpentium (343)	182	Uuq Ununquadium (344)	183	Uup Ununseptium (345)	184	Uuq Ununoctium (346)	185	Uup Ununnonium (347)	186	Uuo Ununbinium (348)	187	Uup Ununpentium (349)	188	Uuq Ununquadium (350)	189	Uup Ununseptium (351)	190	Uuq Ununoctium (352)	191	Uup Ununnonium (353)	192	Uuo Ununbinium (354)	193	Uup Ununpentium (355)	194	Uuq Ununquadium (356)	195	Uup Ununseptium (357)	196	Uuq Ununoctium (358)	197	Uup Ununnonium (359)	198	Uuo Ununbinium (360)	199	Uup Ununpentium (361)	200	Uuq Ununquadium (362)	201	Uup Ununseptium (363)	202	Uuq Ununoctium (364)	203	Uup Ununnonium (365)	204	Uuo Ununbinium (366)	205	Uup Ununpentium (367)	206	Uuq Ununquadium (368)	207	Uup Ununseptium (369)	208	Uuq Ununoctium (370)	209	Uup Ununnonium (371)	210	Uuo Ununbinium (372)	211	Uup Ununpentium (373)	212	Uuq Ununquadium (374)	213	Uup Ununseptium (375)	214	Uuq Ununoctium (376)	215	Uup Ununnonium (377)	216	Uuo Ununbinium (378)	217	Uup Ununpentium (379)	218	Uuq Ununquadium (380)	219	Uup Ununseptium (381)	220	Uuq Ununoctium (382)	221	Uup Ununnonium (383)	222	Uuo Ununbinium (384)	223	Uup Ununpentium (385)	224	Uuq Ununquadium (386)	225	Uup Ununseptium (387)	226	Uuq Ununoctium (388)	227	Uup Ununnonium (389)	228	Uuo Ununbinium (390)	229	Uup Ununpentium (391)	230	Uuq Ununquadium (392)	231	Uup Ununseptium (393)	232	Uuq Ununoctium (394)	233	Uup Ununnonium (395)	234	Uuo Ununbinium (396)	235	Uup Ununpentium (397)	236	Uuq Ununquadium (398)	237	Uup Ununseptium (399)	238	Uuq Ununoctium (400)	239	Uup Ununnonium (401)	240	Uuo Ununbinium (402)	241	Uup Ununpentium (403)	242	Uuq Ununquadium (404)	243	Uup Ununseptium (405)	244	Uuq Ununoctium (406)	245	Uup Ununnonium (407)	246	Uuo Ununbinium (408)	247	Uup Ununpentium (409)	248	Uuq Ununquadium (410)	249	Uup Ununseptium (411)	250	Uuq Ununoctium (412)	251	Uup Ununnonium (413)	252	Uuo Ununbinium (414)	253	Uup Ununpentium (415)	254	Uuq Ununquadium (416)	255	Uup Ununseptium (417)	256	Uuq Ununoctium (418)	257	Uup Ununnonium (419)	258	Uuo Ununbinium (420)	259	Uup Ununpentium (421)	260	Uuq Ununquadium (422)	261	Uup Ununseptium (423)	262	Uuq Ununoctium (424)	263	Uup Ununnonium (425)	264	Uuo Ununbinium (426)	265	Uup Ununpentium (427)	266	Uuq Ununquadium (428)	267	Uup Ununseptium (429)	268	Uuq Ununoctium (430)	269	Uup Ununnonium (431)	270	Uuo Ununbinium (432)	271	Uup Ununpentium (433)	272	Uuq Ununquadium (434)	273	Uup Ununseptium (435)	274	Uuq Ununoctium (436)	275	Uup Ununnonium (437)	276	Uuo Ununbinium (438)	277	Uup Ununpentium (439)	278	Uuq Ununquadium (440)	279	Uup Ununseptium (441)	280	Uuq Ununoctium (442)	281	Uup Ununnonium (443)	282	Uuo Ununbinium (444)	283	Uup Ununpentium (445)	284	Uuq Ununquadium (446)	285	Uup Ununseptium (447)	286	Uuq Ununoctium (448)	287	Uup Ununnonium (449)	288	Uuo Ununbinium (450)	289	Uup Ununpentium (451)	290	Uuq Ununquadium (452)	291	Uup Ununseptium (453)	292	Uuq Ununoctium (454)	293	Uup Ununnonium (455)	294	Uuo Ununbinium (456)	295	Uup Ununpentium (457)	296	Uuq Ununquadium (458)	297	Uup Ununseptium (459)	298	Uuq Ununoctium (460)	299	Uup Ununnonium (461)	300	Uuo Ununbinium (462)	301	Uup Ununpentium (463)	302	Uuq Ununquadium (464)	303	Uup Ununseptium (465)	304	Uuq Ununoctium (466)	305	Uup Ununnonium (467)	306	Uuo Ununbinium (468)	307	Uup Ununpentium (469)	308	Uuq Ununquadium (470)	309	Uup Ununseptium (471)	310	Uuq Ununoctium (472)	311	Uup Ununnonium (473)	312	Uuo Ununbinium (474)	313	Uup Ununpentium (475)	314	Uuq Ununquadium (476)	315	Uup Ununseptium (477)	316	Uuq Ununoctium (478)	317	Uup Ununnonium (479)	318	Uuo Ununbinium (480)	319	Uup Ununpentium (481)	320	Uuq Ununquadium (482)	321	Uup Ununseptium (483)	322	Uuq Ununoctium (484)	323	Uup Ununnonium (485)	324	Uuo Ununbinium (486)	325	Uup Ununpentium (487)	326	Uuq Ununquadium (488)	327	Uup Ununseptium (489)	328	Uuq Ununoctium (490)	329	Uup Ununnonium (491)	330	Uuo Ununbinium (492)	331	Uup Ununpentium (493)	332	Uuq Ununquadium (494)	333	Uup Ununseptium (495)	334	Uuq Ununoctium (496)	335	Uup Ununnonium (497)	336	Uuo Ununbinium (498)	337	Uup Ununpentium (499)	338	Uuq Ununquadium (500)	339	Uup Ununseptium (501)	340	Uuq Ununoctium (502)	341	Uup Ununnonium (503)	342	Uuo Ununbinium (504)	343	Uup Ununpentium (505)	344	Uuq Ununquadium (506)	345	Uup Ununseptium (507)	346	Uuq Ununoctium (508)	347	Uup Ununnonium (509)	348	Uuo Ununbinium (510)	349	Uup Ununpentium (511)	350	Uuq Ununquadium (512)	351	Uup Ununseptium (513)	352	Uuq Ununoctium (514)	353	Uup Ununnonium (515)	354	Uuo