CHEMISTRY 2323: Fundamentals of Organic Chemistry I

First Midterm Exam

September 19, 2025

Prof. Ognjen Š. Miljanić

Name: Answer Key

(print legibly) Last First

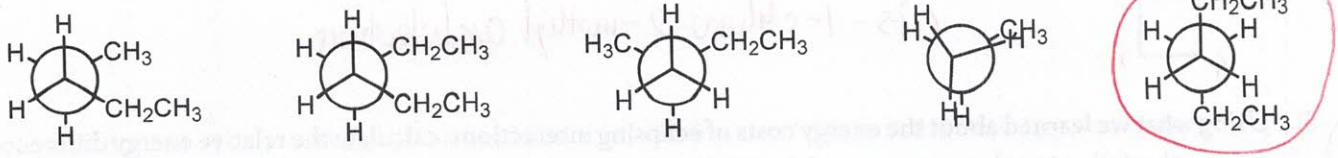
Student ID Number: N/A

Read all directions very carefully. Write your answer legibly in the designated spaces and think carefully about what you are doing. The total number of points is 300. This exam is supposed to have eight pages, with the last two pages intentionally left blank.

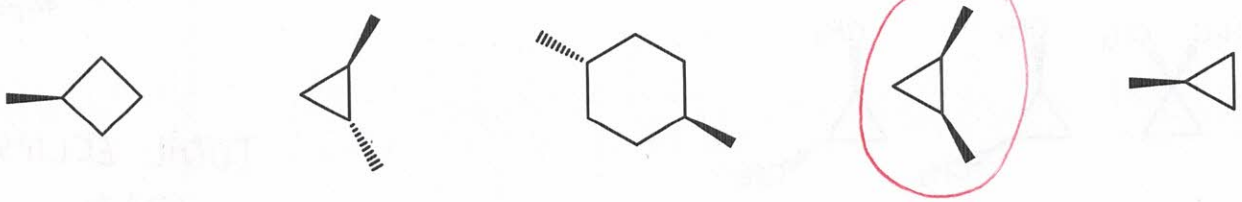
40

1. This question has several parts. In each, **circle only one entry.** *5×8 = 40 points*

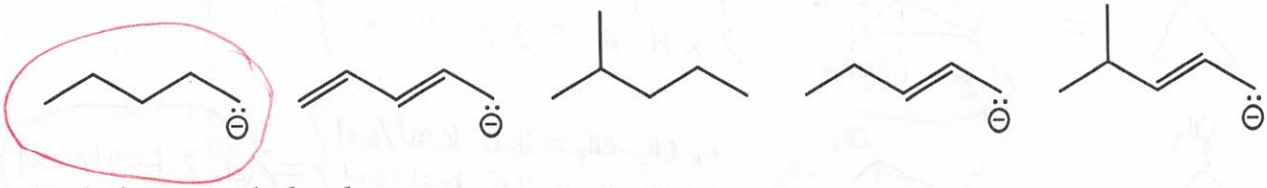
Circle the correct representation of the *anti* conformation of hexane:



Circle the most strained compound:



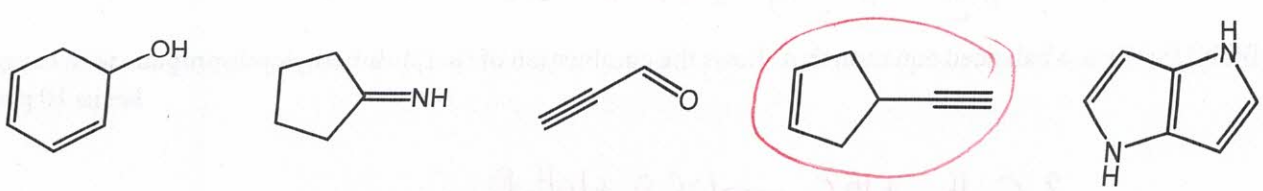
Circle the most basic compound:



Circle the most polar bond:

C—O C—C C—H O—N N≡N

Circle the only compound which is both an alkene and an alkyne:



DO NOT WRITE IN THIS SPACE

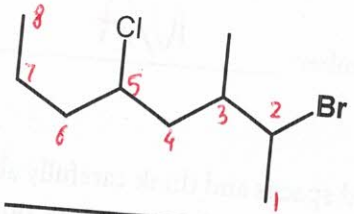
310

FINAL SCORE

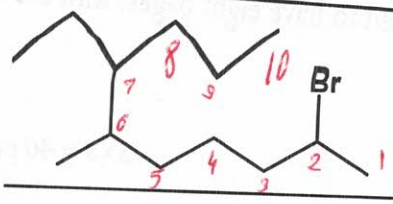
30

2. For each of the following structures, give a complete systematic IUPAC name. Be sure to indicate stereochemistry where this is pertinent.

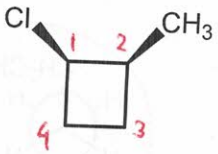
3×10 = 30 points



2-bromo-5-chloro-3-methyloctane



2-bromo-7-ethyl-6-methyl decane

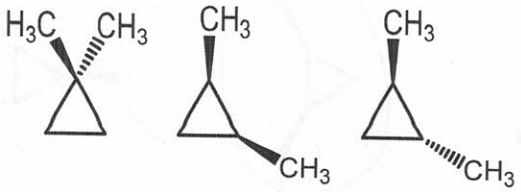


cis-1-chloro-2-methyl cyclobutane

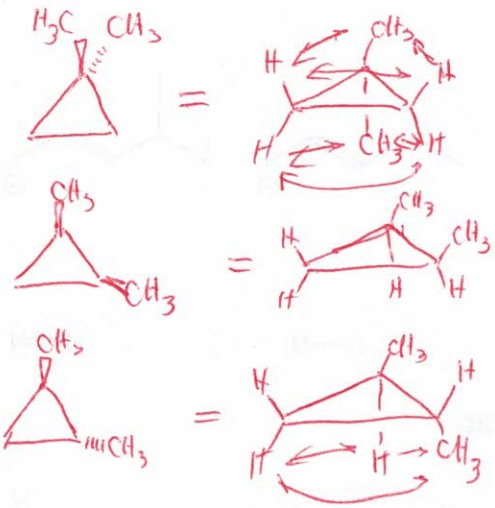
50

3. Using what we learned about the energy costs of eclipsing interactions, calculate the relative energy differences among the following three isomers of dimethylcyclopropane. Energy costs: H–H eclipsing interaction = 1 kcal/mol; CH_3–H eclipsing interaction = 1.3 kcal/mol; CH_3–CH_3 eclipsing interaction = 2.6 kcal/mol.

40 points



TOTAL ECLIPSING STRAIN



$4 \times CH_3\text{-}H = 5.2$ kcal/mol
$2 \times H\text{-}H = 2.0$ " "
$\Rightarrow 7.2$ kcal/mol

$1 \times CH_3\text{-}CH_3 = 2.6$ kcal/mol
$2 \times CH_3\text{-}H = 2.6$ kcal/mol
$3 \times H\text{-}H = 3.0$ kcal/mol
$\Rightarrow 8.2$ kcal/mol

1 kcal worse than the other two

$4 \times CH_3\text{-}H = 5.2$ kcal/mol
$2 \times H\text{-}H = 2.0$ kcal/mol
$\Rightarrow 7.2$ kcal/mol

BONUS: Write a balanced equation that shows the combustion of *cis*-1,2-dimethylcyclopropane with oxygen.

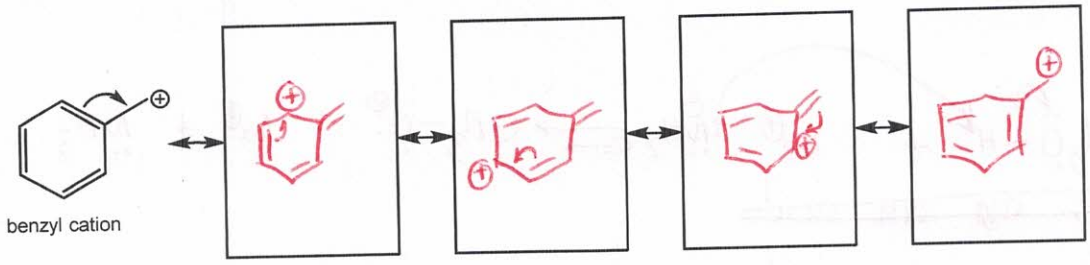
bonus 10 points

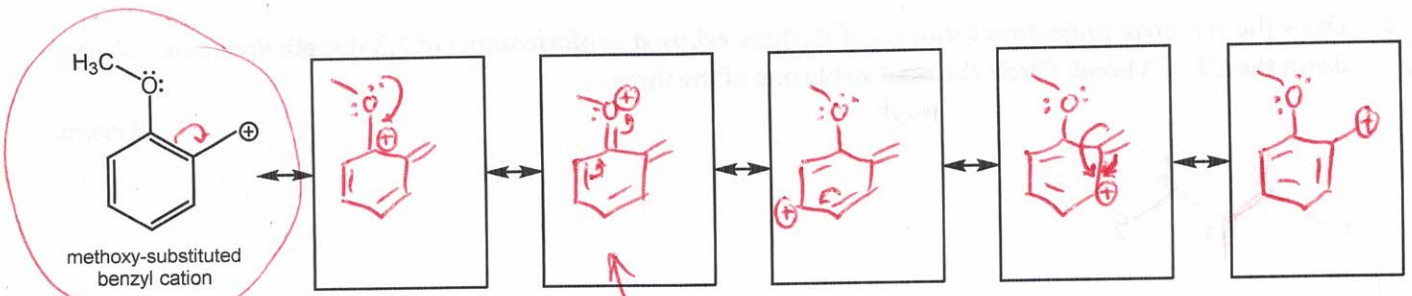
$$2\,C_5H_{10} + 15\,O_2 \rightarrow 10\,CO_2 + 10\,H_2O$$

60

4. Benzyl cation is stabilized by resonance. In the top set of four boxes, draw the remaining four resonance structures of the benzyl cation. Benzyl cations can be additionally stabilized by some—but not all—substituents. In the middle and bottom set of boxes, draw the resonance structures of the methoxy (CH_3O–) and cyano (CN–) substituted benzyl cations. **Circle the one which stabilizes the cation more.** For each set of resonance structures, use curved arrows to show the movement of electrons. An example of such arrow-pushing is shown on the first structure in the top row.

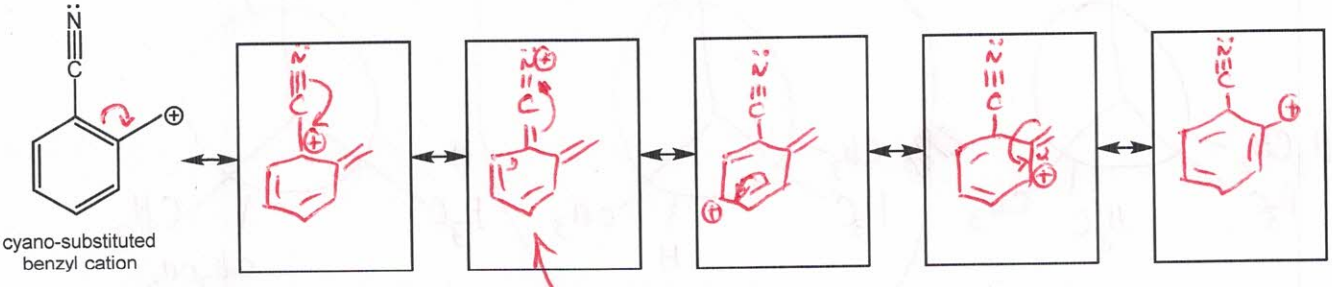
60 points





stabilizes cation better

Octets on all atoms — VERY GOOD!



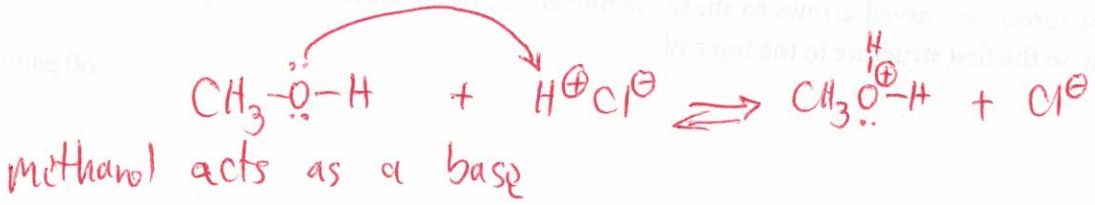
no octet on nitrogen — BAD!

40

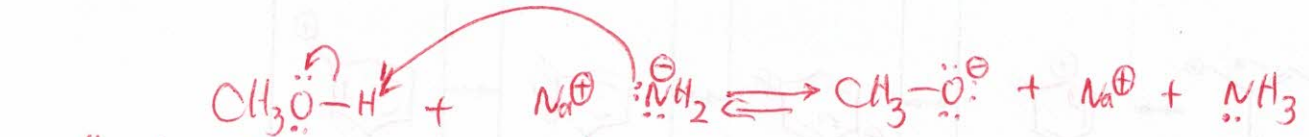
5. Alcohols can act either as weak acids or as weak bases, just as water can. Show the reaction of methanol, CH_3OH, with a strong acid such as HCl and with a strong base such as $Na^+ {}^-NH_2$.

40 points

textbook question 2-40, McMurry 10th edition



methanol acts as a base



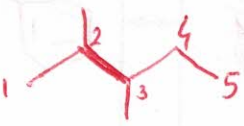
~~methanol acts as an acid~~

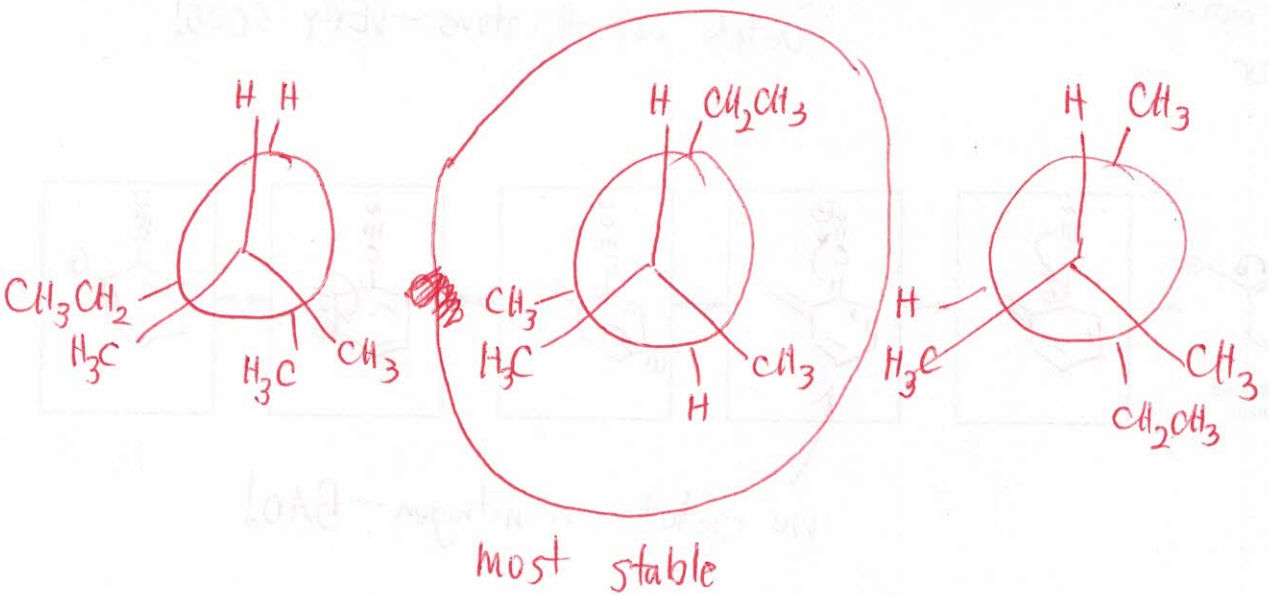
methanol acts as an acid

50

6. Draw the Newman projection formulas of all three eclipsed conformations of 2,3-dimethylpentane, looking down the C2–C3 bond. Circle the ~~least~~ most stable one of the three.

50 points





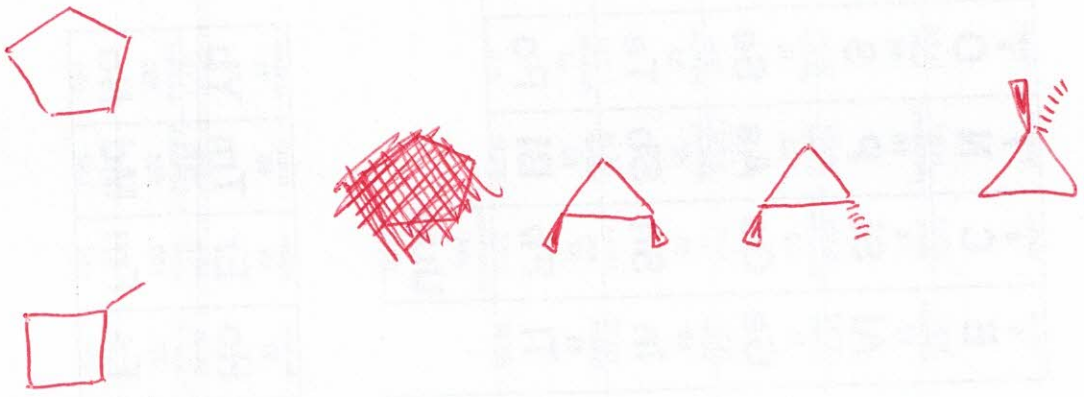
most stable

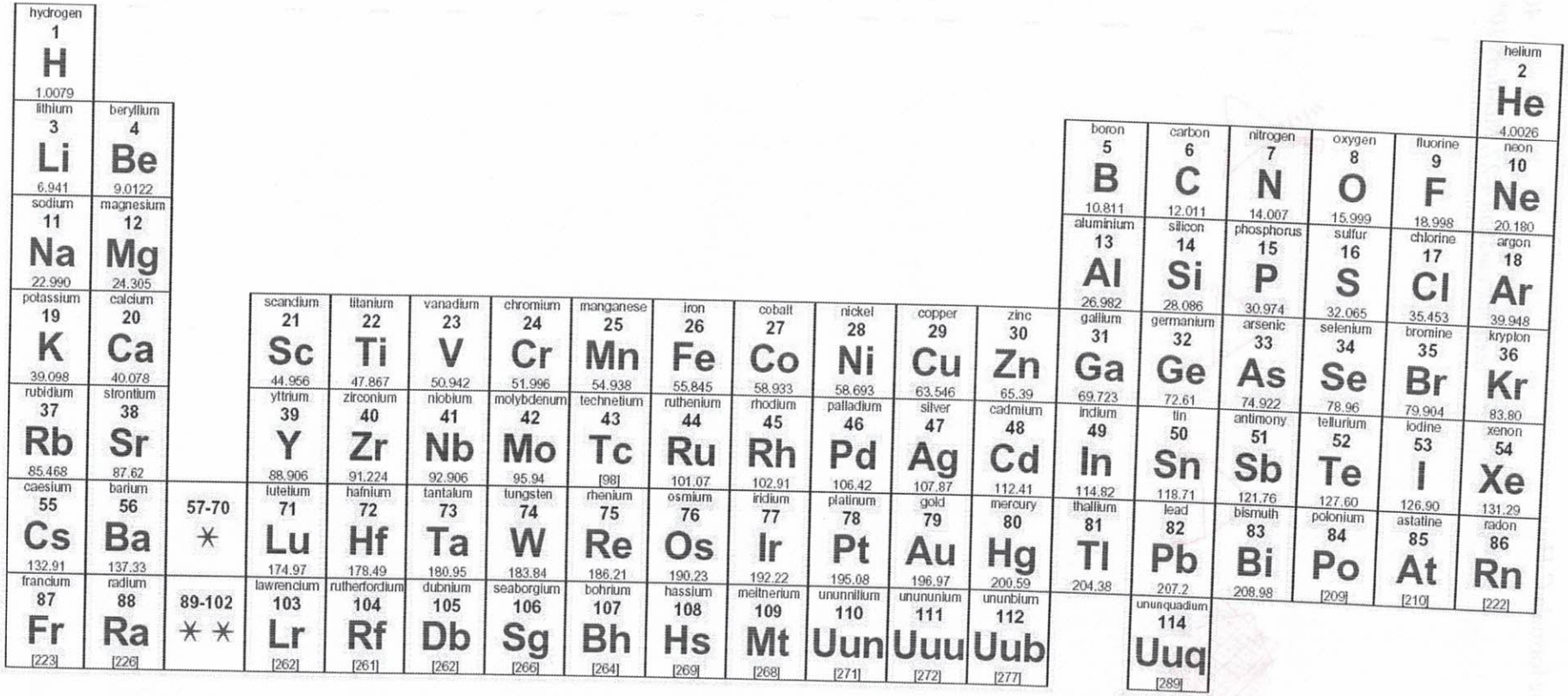
40

7. Draw the five cycloalkanes with the formula C_5H_{10}.

40 points

textbook question 4-27, McMurry 10th edition




hydrogen 1 H 1.0079
helium 2 He 4.0026
lithium 3 Li 6.941
beryllium 4 Be 9.0122
boron 5 B 10.811
carbon 6 C 12.011
nitrogen 7 N 14.007
oxygen 8 O 15.999
fluorine 9 F 18.998
neon 10 Ne 20.180
sodium 11 Na 22.990
magnesium 12 Mg 24.305
aluminium 13 Al 26.982
silicon 14 Si 28.086
phosphorus 15 P 30.974
sulfur 16 S 32.065
chlorine 17 Cl 35.453
argon 18 Ar 39.948
potassium 19 K 39.098
calcium 20 Ca 40.078
scandium 21 Sc 44.956
titanium 22 Ti 47.867
vanadium 23 V 50.942
chromium 24 Cr 51.996
manganese 25 Mn 54.938
iron 26 Fe 55.845
cobalt 27 Co 58.933
nickel 28 Ni 58.693
copper 29 Cu 63.546
zinc 30 Zn 65.39
gallium 31 Ga 69.723
germanium 32 Ge 72.61
arsenic 33 As 74.922
selenium 34 Se 78.96
bromine 35 Br 79.904
krypton 36 Kr 83.80
rubidium 37 Rb 85.468
strontium 38 Sr 87.62
yttrium 39 Y 88.906
zirconium 40 Zr 91.224
niobium 41 Nb 92.906
molybdenum 42 Mo 95.94
technetium 43 Tc [98]
ruthenium 44 Ru 101.07
rhodium 45 Rh 102.91
palladium 46 Pd 106.42
silver 47 Ag 107.87
cadmium 48 Cd 112.41
indium 49 In 114.82
tin 50 Sn 118.71
antimony 51 Sb 121.76
tellurium 52 Te 127.60
iodine 53 I 126.90
xenon 54 Xe 131.29
caesium 55 Cs 132.91
barium 56 Ba 137.33
57-70 *
lutetium 71 Lu 174.97
hafnium 72 Hf 178.49
tantalum 73 Ta 180.95
tungsten 74 W 183.84
rhenium 75 Re 186.21
osmium 76 Os 190.23
iridium 77 Ir 192.22
platinum 78 Pt 195.08
gold 79 Au 196.97
mercury 80 Hg 200.59
thallium 81 Tl 204.38
lead 82 Pb 207.2
bismuth 83 Bi 208.98
polonium 84 Po [209]
astatine 85 At [210]
radon 86 Rn [222]
francium 87 Fr [223]
radium 88 Ra [226]
89-102 * *
lawrencium 103 Lr [262]
rutherfordium 104 Rf [261]
dubnium 105 Db [262]
seaborgium 106 Sg [266]
bohrium 107 Bh [264]
hassium 108 Hs [269]
meitnerium 109 Mt [268]
ununnilium 110 Uun [271]
unununium 111 Uuu [272]
ununbium 112 Uub [277]
ununquadium 114 Uuq [289]
*Lanthanide series
lanthanum 57 La 138.91
cerium 58 Ce 140.12
praseodymium 59 Pr 140.91
neodymium 60 Nd 144.24
promethium 61 Pm [145]
samarium 62 Sm 150.36
europium 63 Eu 151.96
gadolinium 64 Gd 157.25
terbium 65 Tb 158.93
dysprosium 66 Dy 162.50
holmium 67 Ho 164.93
erbium 68 Er 167.26
thulium 69 Tm 168.93
ytterbium 70 Yb 173.04
**Actinide series
actinium 89 Ac [227]
thorium 90 Th 232.04
protactinium 91 Pa 231.04
uranium 92 U 238.03
neptunium 93 Np [237]
plutonium 94 Pu [244]
americium 95 Am [243]
curium 96 Cm [247]
berkelium 97 Bk [247]
californium 98 Cf [251]
einsteinium 99 Es [252]
fermium 100 Fm [257]
mendelevium 101 Md [258]
nobelium 102 No [259]