Spring 2019, CEM143, Exam 2 **Name:**

PICK THE MOST ACCURATE ANSWER FOR EACH QUESTION

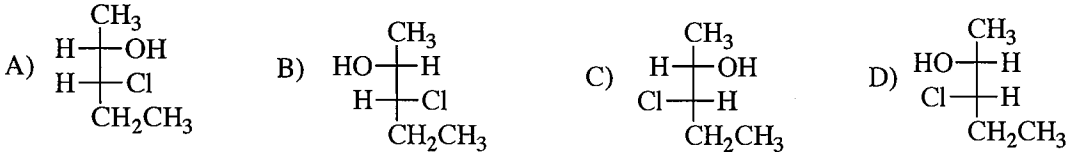
1. Which one of the following is the correct structure for chloroform?

A) CH_2Cl_2 B) $CHCl_3$ C) CH_3Cl D) CCl_4

2. Which of the following structures represents sec–butyl alcohol?

A **B** **C** **D**

3. Which of the following compounds would be named as (2S, 3S)-3-chloro-2-pentanol?



4. Which of the following cyclic ethers is known as THF?

5. Which of the following compounds have the highest boiling point?

A) Isobutyl alcohol B) *tert*-butyl alcohol
C) *sec*-butyl alcohol D) butyl alcohol

6. Which of the following statements is false?

A) Alkanes are among the least polar organic compounds.
B) Tertiary alkyl halides always go via E1 mechanism in an elimination reaction.
C) All S_N1 reactions are stepwise, and include at least one carbocation intermediate.
D) Primary alkyl halides always go via S_N2 in nucleophilic substitution reactions.

7. Which of the following compounds represents diisopropylether?

A) $(CH_3)_2CHOCH(CH_3)_2$ B) $(CH_3)_2CHCH_2OCH_2CH(CH_3)_2$

C) $(CH_3)_3COC(CH_3)_3$ D) $CH_3CH_2CH_2OCH_2CH_2CH_3$

Use Figure 1 to answer questions 8 and 9.

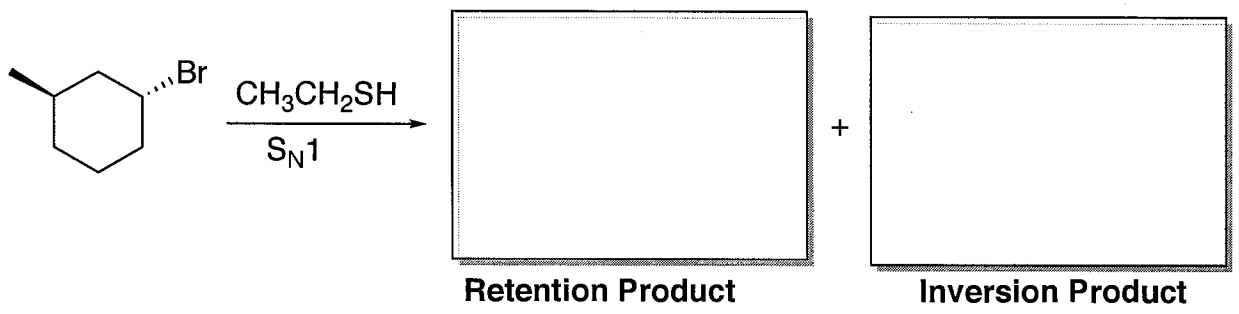
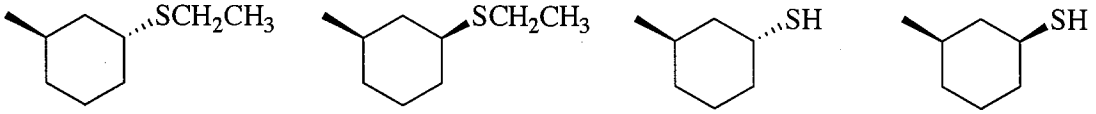


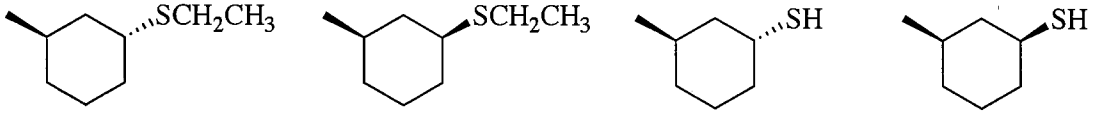
Figure 1

8. Which of the following compounds represents the **retention product** in **Figure 1**?



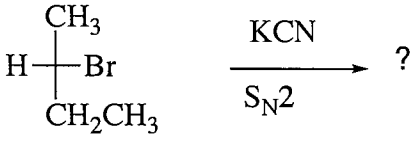
A B C D

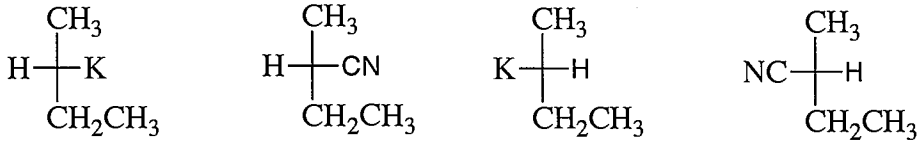
9. Which of the following compounds represents the **inversion product** in **Figure 1**?



A B C D

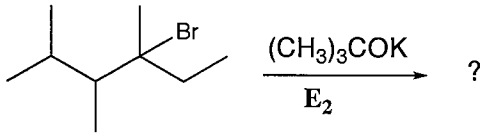
10. Which of the following is the correct product for the S_N2 reaction below?

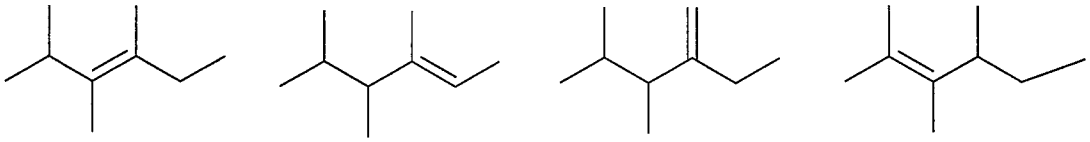




A **B** **C** **D**

11. Which of the following is the major product for the elimination reaction below?





A B C D

12. How many stereoisomers are possible for 2,3-dibromocyclohexanol?

A) 3 B) 4 C) 6 D) 7 E) 8 F) 9 G) 10

Use **Figure 2** to answer **questions 13-18.**

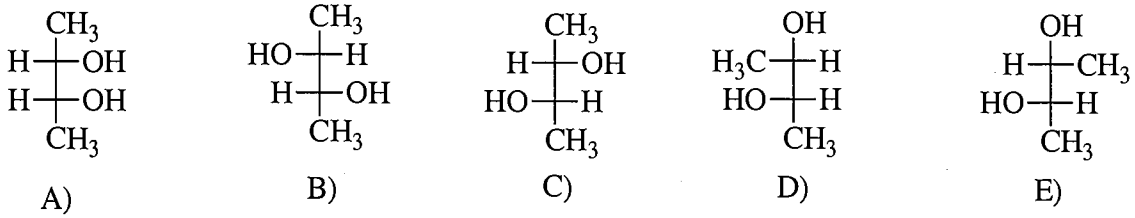


Figure 2

13. What is the relationship of Compounds **A & B** in **Figure 2**?

A) Enantiomers
B) Diastereomers
C) Constitutional isomers
D) They are identical (the same molecule)

14. What is the relationship of Compounds **B & C** in **Figure 2**?

A) Enantiomers
B) Diastereomers
C) Constitutional isomers
D) They are identical (the same molecule)

15. What is the relationship of Compounds **C & D** in **Figure 2**?

A) Enantiomers
B) Diastereomers
C) Constitutional isomers
D) They are identical (the same molecule)

16. What is the relationship of Compounds **A & E** in **Figure 2**?

A) Enantiomers
B) Diastereomers
C) Constitutional isomers
D) They are identical (the same molecule)

17. How many of the structures in **Figure 2** would be considered as meso–compound(s)?

A) 0 **B)** 1 **C)** 2 **D)** 3 **E)** 4

18. How many of the structures in **Figure 2** are chiral?

A) 0 **B)** 1 **C)** 2 **D)** 3 **E)** 4 **F)** 5

Use **Figure 3** to answer questions **19 & 20** (Williamson ether synthesis).

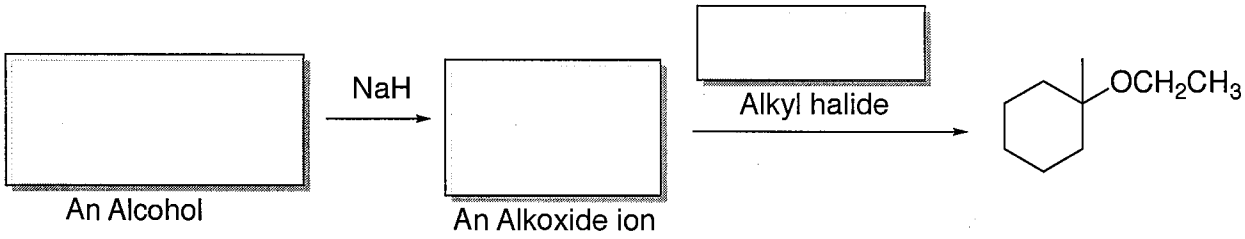
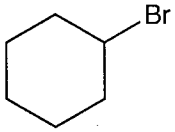
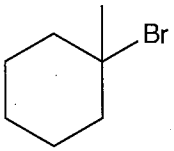
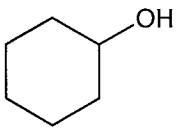
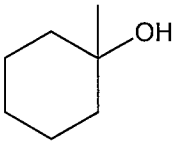


Figure 3

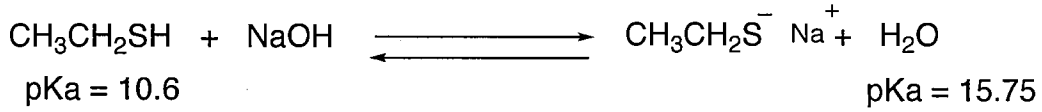
19. Which of the following would be the ideal alkyl halide for a successful Williamson ether synthesis in the reaction above?

A) CH_3CH_2Br **B)**  **C)**  **D)** $CH_3CH_2CH_2Br$

20. Which of the following would be the alcohol for a successful Williamson ether synthesis in the reaction above?

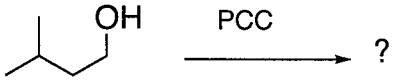
A) CH_3CH_2OH **B)**  **C)**  **D)** $CH_3CH_2CH_2OH$

21. Which side of the following acid–base reaction would be favored at equilibrium?



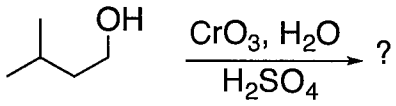
A) Reaction favors the product side **B)** Reaction would favor the reactant side

22. What is the product of the following reaction?



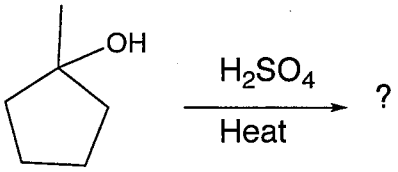
A **B** **C** **D**

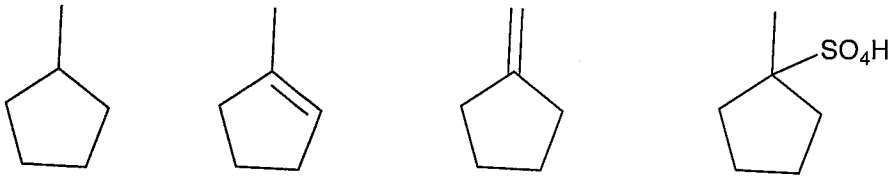
23. What is the product of the following reaction?



A **B** **C** **D**

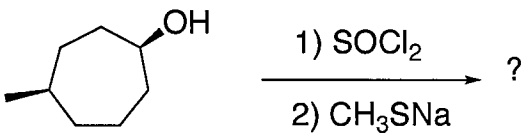
24. What is the major product of the following dehydration reaction?

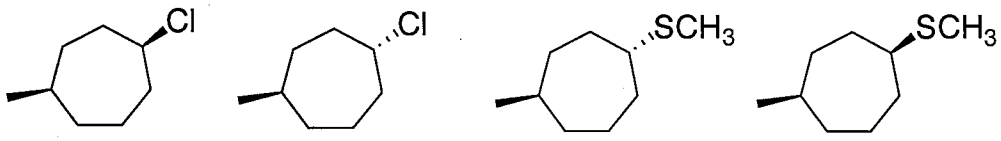




A **B** **C** **D**

25. What is the product of the following chemical transformation?



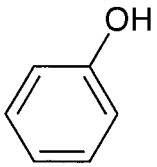


A **B** **C** **D**

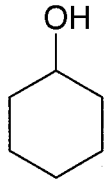
Bonus Question: (10 Points) **Name:**

Section No. **PID:**

Offer reasoning for the fact that phenol has a pka of 10, while that of cyclohexanol is 16. Hint: look at their corresponding conjugate bases.



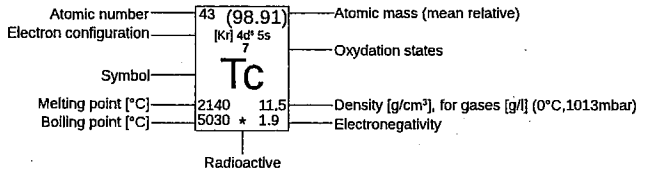
pKa = 10



pKa = 16

ChemGlobe - Periodic Table of Elements

http://chemglobe.org/periodictable



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	1A	2A	3A	4A	5A	6A	7A	8	8	8	1B	2B	3B	4B	5B	6B	7B	0
1	1 H 1.01 1s 1,-1 -259 0.09 -253 2.1																	2 He 4.00 1s² - 018 -269 -
2	3 Li 6.94 [He] 2s 1 181 0.53 1330 1.0	4 Be 9.01 [He] 2s² 2 1277 1.85 2970 1.5											5 B 10.81 [He] 2s² 2p 3 (2030) 2.35 2550 2.0	6 C 12.01 [He] 2s² 2p² 4,2,-4 (3550) 2.2 4830 2.5	7 N 14.01 [He] 2s² 2p³ 5,4,3,2,-3 -210 1.25 -196 3.0	8 O 16.00 [He] 2s² 2p⁴ -2,-1 -219 1.43 -183 3.5	9 F 19.00 [He] 2s² 2p⁵ -1 -220 1.7 -188 4.0	10 Ne 20.18 [He] 2s² 2p⁶ -249 0.9 -246 -
3	11 Na 22.99 [Ne] 3s 1 98 0.97 892 0.9	12 Mg 24.31 [Ne] 3s² 2 650 1.74 1107 1.2											13 Al 26.98 [Ne] 3s² 3p 3 660 2.70 2450 1.5	14 Si 28.09 [Ne] 3s² 3p² 4,-4 1410 2.33 2680 1.8	15 P 30.97 [Ne] 3s² 3p³ 5,3,-3 44 1.82 280 2.1	16 S 32.06 [Ne] 3s² 3p⁴ 6,4,2,-2 119 2.07 445 2.5	17 Cl 35.45 [Ne] 3s² 3p⁵ 7,5,3,1,-1 -101 3.2 -35 3.0	18 Ar 39.95 [Ne] 3s² 3p⁶ -189 1.78 -183 -
4	19 K 39.10 [Ar] 4s 1 64 0.86 760 0.8	20 Ca 40.08 [Ar] 4s² 2 838 1.55 1440 1.0	21 Sc 44.96 [Ar] 3d 4s² 3 1539 3.0 2730 1.3	22 Ti 47.88 [Ar] 3d² 4s² 4,3 1668 4.54 3260 1.5	23 V 50.94 [Ar] 3d³ 4s² 5,4,3,2,0 1900 6.1 3450 1.5	24 Cr 52.00 [Ar] 3d⁵ 4s 6,3,2,0 1875 7.19 2200 1.6	25 Mn 54.94 [Ar] 3d⁵ 4s² 7,6,4,3,2,0,-1 1245 7.43 2097 1.5	26 Fe 55.85 [Ar] 3d⁶ 4s² 6,3,2,0,-2 1536 7.86 3000 1.8	27 Co 58.93 [Ar] 3d⁷ 4s² 3,2,0,-1 1495 8.9 2900 1.9	28 Ni 58.70 [Ar] 3d⁸ 4s² 3,2,0 1453 8.9 2730 1.9	29 Cu 63.55 [Ar] 3d¹⁰ 4s 2,1 1083 8.96 2595 1.9	30 Zn 65.38 [Ar] 3d¹⁰ 4s² 2 420 7.13 906 1.6	31 Ga 69.72 [Ar] 3d¹⁰ 4s² 4p 3 30 5.91 2237 1.6	32 Ge 72.59 [Ar] 3d¹⁰ 4s² 4p² 4 937 5.32 2830 1.8	33 As 74.91 [Ar] 3d¹⁰ 4s² 4p³ 5,3,-3 Subl. 5.72 - 2.0	34 Se 78.96 [Ar] 3d¹⁰ 4s² 4p⁴ 6,4,-2 217 4.79 685 2.4	35 Br 79.90 [Ar] 3d¹⁰ 4s² 4p⁵ 7,5,3,1,-1 -7 3.12 58 2.8	36 Kr 83.80 [Ar] 3d¹⁰ 4s² 4p⁶ -157 3.7 -152 -
5	37 Rb 85.47 [Kr] 5s 1 39 1.53 688 0.8	38 Sr 87.62 [Kr] 5s² 2 768 2.6 1380 1.0	39 Y 88.91 [Kr] 4d 5s² 3 1509 4.47 2927 1.2	40 Zr 91.22 [Kr] 4d² 5s² 4 1852 6.49 3580 1.4	41 Nb 92.92 [Kr] 4d⁴ 5s 5,3 2468 8.57 4927 1.6	42 Mo 95.94 [Kr] 4d⁵ 5s 6,5,4,3,2,0 2610 10.2 5560 1.8	43 Tc (98.91) [Kr] 4d⁵ 5s 7 2140 11.5 5030 ★ 1.9	44 Ru 101.07 [Kr] 4d⁷ 5s 8,6,4,3,2,0,-2 2500 12.4 3900 2.2	45 Rh 102.91 [Kr] 4d⁸ 5s 5,4,3,1,2,0 1966 12.4 3730 2.2	46 Pd 106.42 [Kr] 4d¹⁰ 4,2,0 1552 12.0 3140 2.2	47 Ag 107.87 [Kr] 4d¹⁰ 5s 2,1 961 10.5 2210 1.9	48 Cd 112.41 [Kr] 4d¹⁰ 5s² 2 321 8.65 765 1.7	49 In 114.82 [Kr] 4d¹⁰ 5s² 5p 3 156 7.31 2080 1.7	50 Sn 118.69 [Kr] 4d¹⁰ 5s² 5p² 4,2 232 7.30 2270 1.8	51 Sb 121.75 [Kr] 4d¹⁰ 5s² 5p³ 5,3,-3 631 6.69 1380 1.9	52 Te 127.60 [Kr] 4d¹⁰ 5s² 5p⁴ 6,4,-2 450 6.24 990 2.1	53 I 126.90 [Kr] 4d¹⁰ 5s² 5p⁵ 7,5,1,-1 114 4.94 183 2.5	54 Xe 131.29 [Kr] 4d¹⁰ 5s² 5p⁶ -112 5.89 -108 -
6	55 Cs 132.91 [Xe] 6s 1 29 1.90 690 0.7	56 Ba 137.33 [Xe] 6s² 2 714 3.76 1640 0.9	71 Lu 174.97 [Xe] 4f¹⁴ 5d 6s² 3 1652 9.84 3327 1.2	72 Hf 178.49 [Xe] 4f¹⁴ 5d² 6s² 4 2222 13.31 5400 1.3	73 Ta 180.95 [Xe] 4f¹⁴ 5d³ 6s² 5 2996 16.5 5425 1.5	74 W 183.85 [Xe] 4f¹⁴ 5d⁴ 6s² 6,5,4,3,2,0 3410 19.3 5930 1.7	75 Re 186.21 [Xe] 4f¹⁴ 5d⁵ 6s² 7,6,4,2,-1 3180 21.0 5900 1.9	76 Os 190.20 [Xe] 4f¹⁴ 5d⁶ 6s² 8,6,4,3,2,0,-2 3050 22.6 5500 2.2	77 Ir 192.22 [Xe] 4f¹⁴ 5d⁷ 6s² 6,4,3,2,1,0,-1 2454 22.7 4500 2.2	78 Pt 195.08 [Xe] 4f¹⁴ 5d⁹ 6s 4,2,0 1769 21.4 3830 2.2	79 Au 196.97 [Xe] 4f¹⁴ 5d¹⁰ 6s 3,1 1063 19.3 2970 2.4	80 Hg 200.59 [Xe] 4f¹⁴ 5d¹⁰ 6s² 2,1 -38 13.6 357 1.9	81 Tl 204.38 [Xe] 4f¹⁴ 5d¹⁰ 6s² 6p 3,1 303 11.85 1457 1.8	82 Pb 207.20 [Xe] 4f¹⁴ 5d¹⁰ 6s² 6p² 4,2 327 11.4 1725 1.9	83 Bi 208.98 [Xe] 4f¹⁴ 5d¹⁰ 6s² 6p³ 5,3 271 9.8 1560 1.9	84 Po (209) [Xe] 4f¹⁴ 5d¹⁰ 6s² 6p⁴ 6,4,2 254 9.3 962 ★ 2.0	85 At (210) [Xe] 4f¹⁴ 5d¹⁰ 6s² 6p⁵ 7,5,3,1,-1 (302) - 337 ★ 2.2	86 Rn (222) [Xe] 4f¹⁴ 5d¹⁰ 6s² 6p⁶ (-71) 9.73 -62 ★ -
7	87 Fr (223.0) [Rn] 7s 1 (27) - 677 ★ 0.7	88 Ra 226.03 [Rn] 7s² 2 700 5.0 1140 ★ 0.9	103 Lr (262.1) [Rn] 5f¹⁴ 6d 7s² 3 - - - ★ -	104 Rf (261.1) [Rn] 5f¹⁴ 6d² 7s² 4 - - - ★ -	105 Db (262.1) [Rn] 5f¹⁴ 6d³ 7s² 5 - - - ★ -	106 Sg (263.1) [Rn] 5f¹⁴ 6d⁴ 7s² 6 - - - ★ -	107 Bh (264.1) [Rn] 5f¹⁴ 6d⁵ 7s² 7 - - - ★ -	108 Hs (265.1) [Rn] 5f¹⁴ 6d⁶ 7s² 8 - - - ★ -	109 Mt (268) [Rn] 5f¹⁴ 6d⁷ 7s² 9 - - - ★ -	110 Uun (269) [Rn] 5f¹⁴ 6d⁸ 7s 10 - - - ★ -	111 Uuu (272) [Rn] 5f¹⁴ 6d¹⁰ 7s 11 - - - ★ -	112 Uub (277) 12 - - - ★ -	114 Uuq (289) 14 - - - ★ -	116 Uuh (289) 16 - - - ★ -	118 Uuo (293) 18 - - - ★ -

6	Lanthanoids	57 La 138.91 [Xe] 5d 6s² 3 920 6.17 3470 1.1	58 Ce 140.12 [Xe] 4f² 6s² 4,3 795 6.67 3468 1.1	59 Pr 140.91 [Xe] 4f³ 6s² 4,3 935 6.77 3127 1.1	60 Nd 144.24 [Xe] 4f⁴ 6s² 3 1024 7.00 3027 1.2	61 Pm (145) [Xe] 4f⁵ 6s² 3 (1027) 7.22 2460 ★ -	62 Sm 150.36 [Xe] 4f⁶ 6s² 3,2 1072 7.54 1790 1.2	63 Eu 151.96 [Xe] 4f⁷ 6s² 3,2 828 5.26 1439 -	64 Gd 157.25 [Xe] 4f⁷ 5d 6s² 3 1312 7.89 3000 1.1	65 Tb 158.93 [Xe] 4f⁹ 6s² 4,3 1356 8.27 2800 1.2	66 Dy 162.50 [Xe] 4f¹⁰ 6s² 3 1407 8.54 2600 -	67 Ho 164.93 [Xe] 4f¹¹ 6s² 3 1461 8.80 2600 1.2	68 Er 167.26 [Xe] 4f¹² 6s² 3 1497 9.05 2900 1.2	69 Tm 168.93 [Xe] 4f¹³ 6s² 3,2 1545 9.33 1727 1.2	70 Yb 173.04 [Xe] 4f¹⁴ 6s² 3,2 824 6.98 1196 1.1
7	Actinoids	89 Ac (227) [Rn] 6d 7s² 3 1050 10.1 - ★ 1.1	90 Th 232.04 [Rn] 6d² 7s² 4 1750 11.7 3850 ★ 1.3	91 Pa 231.04 [Rn] 5f² 6d 7s² 5,4 (1230 15.4 - ★ 1.4	92 U 238.03 [Rn] 5f³ 6d 7s² 6,5,4,3 1132 19.07 3818 ★ 1.4	93 Np (237.05) [Rn] 5f⁴ 6d 7s² 6,5,4,3 637 19.5 3900 ★ 1.3	94 Pu (244) [Rn] 5f⁶ 7s² 6,5,4,3 640 19.81 3235 ★ 1.3	95 Am (243) [Rn] 5f⁷ 7s² 6,5,4,3 994 13.7 - ★ 1.3	96 Cm (247) [Rn] 5f⁷ 6d 7s² 4,3 (1340) 13.51 3100 ★ -	97 Bk (247) [Rn] 5f⁹ 7s² 4,3 - - - ★ -	98 Cf (251) [Rn] 5f¹⁰ 7s² 4,3 - - - ★ -	99 Es (254) [Rn] 5f¹¹ 7s² 3 - - - ★ -	100 Fm (257) [Rn] 5f¹² 7s² 3 - - - ★ -	101 Md (258) [Rn] 5f¹³ 7s² 3 - - - ★ -	102 No (259) [Rn] 5f¹⁴ 7s² 3,2 - - - ★ -