



**NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY**

FACULTY OF HEALTH, APPLIED SCIENCES AND NATURAL RESOURCES

DEPARTMENT OF NATURAL AND APPLIED SCIENCES

QUALIFICATION: BACHELOR OF SCIENCE	
QUALIFICATION CODE: 07BOSC	LEVEL: 6
COURSE CODE: ORC601S	COURSE NAME: ORGANIC CHEMISTRY 1
SESSION: JUNE 2022	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	MR. DAVID NANHAPO
MODERATOR:	PROF. HABAUKA KWAAMBWA

INSTRUCTIONS
1. Answer ALL the questions.
2. Write clearly and neatly.
3. Number the answers clearly
4. All written work must be done in blue or black ink and sketches can be done in pencil
5. No books, notes and other additional aids are allowed

PERMISSIBLE MATERIALS

Non-programmable Calculators

ATTACHMENTS

pKa Chart and Periodic Table

THIS QUESTION PAPER CONSISTS OF 14 PAGES

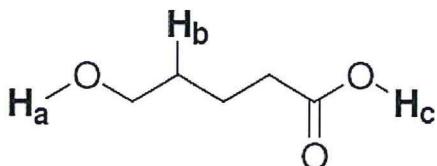
(Including this front page, pKa Chart and Periodic Table)

QUESTION 1: Multiple Choice Questions

[50]

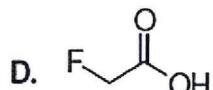
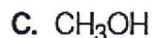
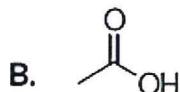
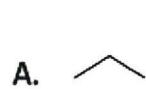
- There are 25 multiple choice questions in this section. Each question carries 2 marks.
- Answer ALL questions by selecting the letter of the correct answer.
- Choose the best possible answer for each question, even if you think there is another possible answer that is not given.

1.1 Rank the acidity of the labelled protons in the following molecule from the lowest to the highest acidity.



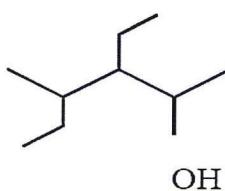
- A. Ha; Hb; Hc
B. Hb; Hc; Ha
C. Hc; Ha; Hb
D. Hb; Ha; Hc

1.2 List the following compounds in the order of increasing acidity.



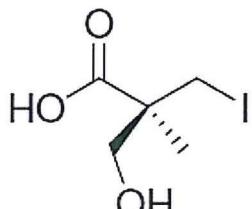
- A. A; B; C; D
B. A; C; B; D
C. A; C; D; B
D. D; C; A; B

1.4 What is the IUPAC name for the structure below?



- A. 3-ethyl-4-methyl-2-hexanol
B. 2-ethyl-1,3-dimethyl-1-heptanol
C. 4-ethyl-3,5-dimethyl-5-hexanol
D. (1-hydroxyethyl)-3-methylhexane

1.4 Designate the following compound as R or S configuration.



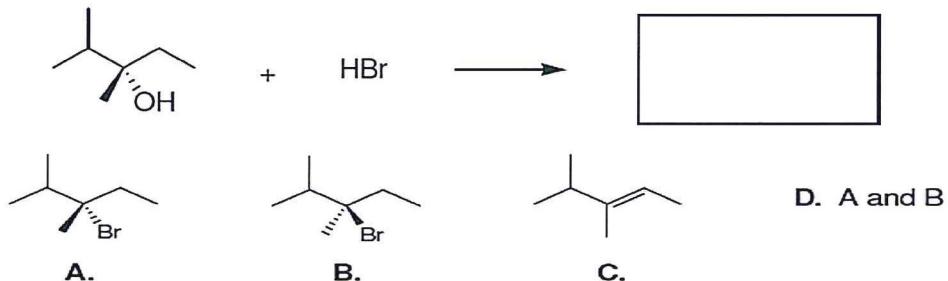
- A. R
- B. S
- C. R,S
- D. None of the above

1.5 Does the equilibrium of this reaction lie to the left or right?

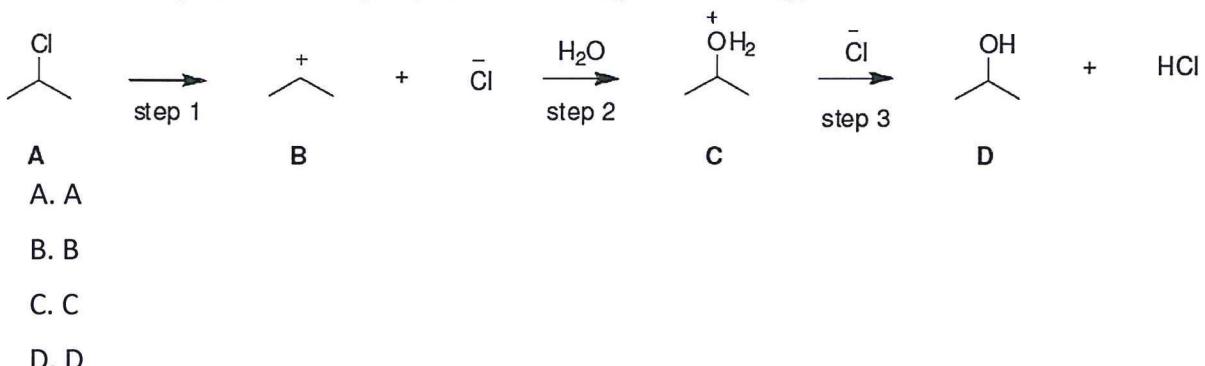


- A. Left
- B. Right
- C. It cannot be determined
- D. The forward and reverse reactions are equally favoured.

1.6 Determine the product(s) in the reaction below.



1.7 Which compound would you predict to be highest in energy?



1.8 How many stereogenic centres does the addictive drug heroin have?

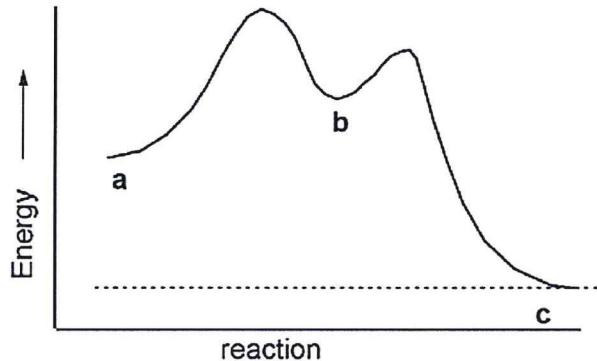


- A. 4
- B. 5
- C. 6
- D. 7

1.9 In question 1.7 above, what kind of reaction does the conversion of A to D represent?

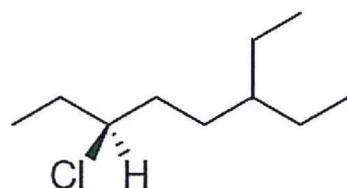
- A. Addition
- B. Elimination
- C. Subtraction
- D. Substitution

1.10 Which of the following statements is (are) true about the energy diagram drawn below?



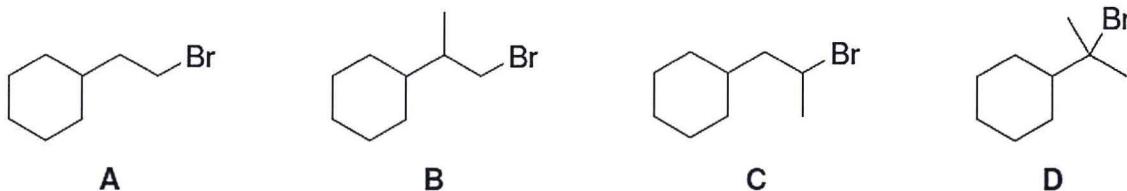
- A. The reaction mechanism has two steps
- B. **b** labels a transition state.
- C. The overall reaction is endothermic
- D. The conversion of **a** to **b** is faster than the conversion of **b** to **c**.

1.11 What is the IUPAC name for the structure below?



- A. (R)-3-chloro-6-ethyloctane
- B. (S)-3-chloro-6-ethyloctane
- C. (S)-6-chloro-3-ethyloctane
- D. (R)-6-chloro-3-ethyloctane

1.12 Which of the following compounds is most likely to show first-order kinetics in a substitution reaction?



- A. A
- B. B
- C. C
- D. D

1.13 Given the following substitution reaction, what would the effect be of changing the solvent from ethanol to DMSO?



- A. The rate would increase because S_N2 reactions favour a polar aprotic solvent
- B. The rate would decrease because S_N1 reactions favour a polar protic solvent
- C. The rate would not be affected by the change in solvent.
- D. The potential change cannot be predicted

1.14 Which of the following anions is the best leaving group?

- A) NH_2^- B) Cl^- C) CH_3^- D) OH^-

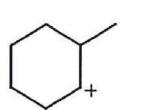
- A. A
B. B
C. C
D. D

1.15 Which of the following is the strongest nucleophile in polar protic solvents?

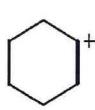
- A) F^- B) CH_3O^- C) HO^- D) CH_3S^-

- A. A
B. B
C. C
D. D

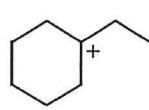
1.16 Which of the following carbocations is the most stable?



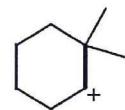
A



B



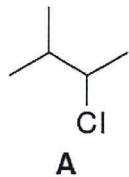
C



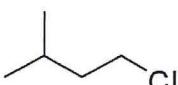
D

- A. A
B. B
C. C
D. D

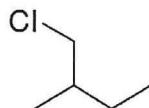
1.17 Which alkyl halide (A-C) would give the following alkene (Y) as the only product in an elimination reaction?



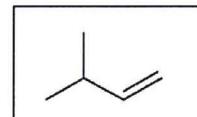
A



B



C



Y

- A. A
B. B
C. C
D. A and B

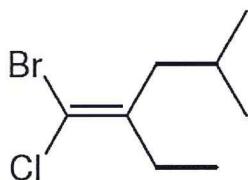
1.18 Which of the following statements is (are) true about an E2 elimination reaction?

- A. It is fastest with 3° Halides
- B. It exhibits second-order kinetics
- C. A better leaving group should make a faster reaction
- D. All of the above are true

1.19 A tertiary halide reacts with a weak base and nucleophile. The reaction will proceed via which of the following mechanism(s)?

- A. S_N1
- B. S_N1 and E1
- C. E2
- D. S_N1 and E2

1.20 Give the IUPAC name for the following compound.



- A. (Z)-1-bromo-2-chloro-2-ethyl-4-methyl-1-pentene
- B. (E)-1-bromo-1-chloro-2-ethyl-4-methyl-2-pentene
- C. (Z)-1-bromo-1-chloro-2-ethyl-4-methyl-1-pentene
- D. (E)-1-bromo-1-chloro-2-ethyl-4-methyl-1-pentene

1.21 Which of the following reaction conditions would result in the anti-Markovnikov addition to the alkene?

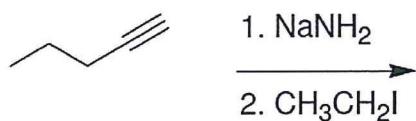
- A) H₂O/H⁺
- B) HBr
- C) HCl
- D) [1] BH₃; [2] H₂O₂/OH⁻

1.22 Give the IUPAC name of the following compound.



- A. 2,2,7-trimethyl-4-nonyne
- B. 2,2,7-trimethyl-4-decyne
- C. 3,3,7-trimethyl-4-decyne
- D. 2,2,6-trimethyl-4-undecyne

1.23 What is the product of the following reaction?



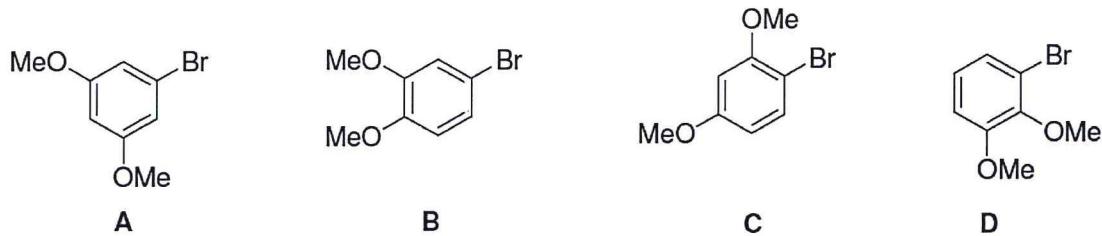
- A. B. C. D.

1.24 How many peaks could theoretically be observed in the ^1H NMR signal(s) for each of the indicated atoms?



- A. a: 7; b: 4; c: 3; d: 3
B. a: 7; b: 3; c: 3; d: 3
C. a: 7; b: 4; c: 2; d: 4
D. a: 7; b: 4; c: 3; d: 4

1.25 Which of the following is the correct structure for 1-bromo-2,4-dimethoxybenzene?



SECTION B:**[50]****QUESTION 2****[10]**

2.1 Show with arrows, how the following products are formed.

(2)



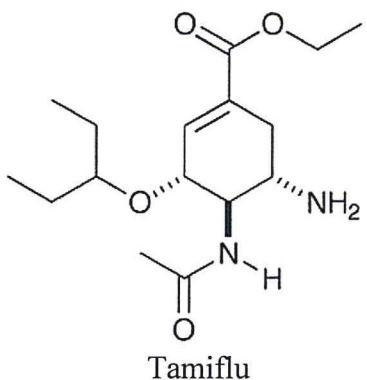
2.2 Assign R and S configuration to all possible stereoisomers of 1-Bromo-2-methylcyclopentane.

(8)

QUESTION 3**[10]**

3.1 Name and label all the functional groups in the structure. Be sure to indicate primary (1°), secondary (2°) or tertiary (3°), where appropriate.

(4)



3.2 Draw bond-line structures of the following molecules:

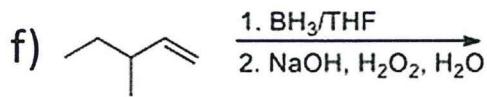
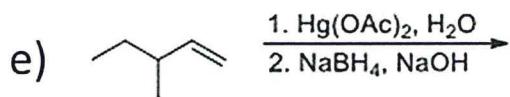
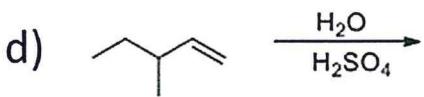
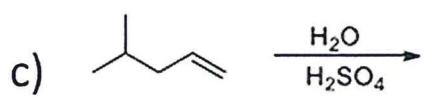
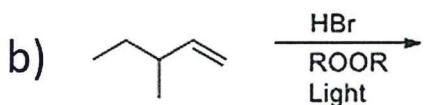
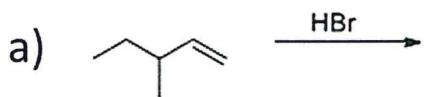
(6)

- 2-chloro-1, 7, 7-trimethylbicyclo [2.2.1] heptane
- 3-ethyl-6-methyl-5-propylnonane
- 2, 6-dimethyl-4-(2-methylpropyl)decane

QUESTION 4**[12]**

4.1 Predict the product(s) of the following reaction

(12)

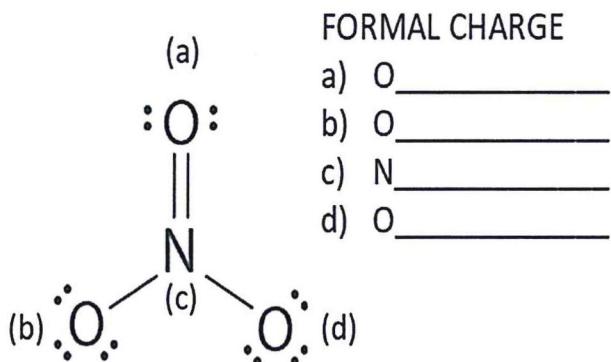


QUESTION 5

[10]

5.1 Assign formal the charge to each atom in the following structure:

(4)



5.2 Give (i) a reaction equation and (ii) full mechanism for the acid-catalyzed (HCl) addition of water to 1-methyl-1-cyclopentene. (6)

QUESTION 6

[8]

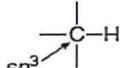
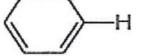
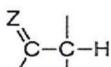
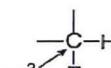
An Unknown compound **X** has the molecular formula $C_6H_{14}O$. **X** shows a peak in its IR spectrum at $3200 - 3600 \text{ cm}^{-1}$. The ^1H NMR Spectral data of **X** are given below. What is the most likely Structure of **X**?

absorption	δ	H ratio
singlet	1.0	9
doublet	1.2	3
singlet	3.0	1
quartet	3.5	1

END OF EXAMINATION QUESTIONS

¹H NMR SPECTRAL DATA

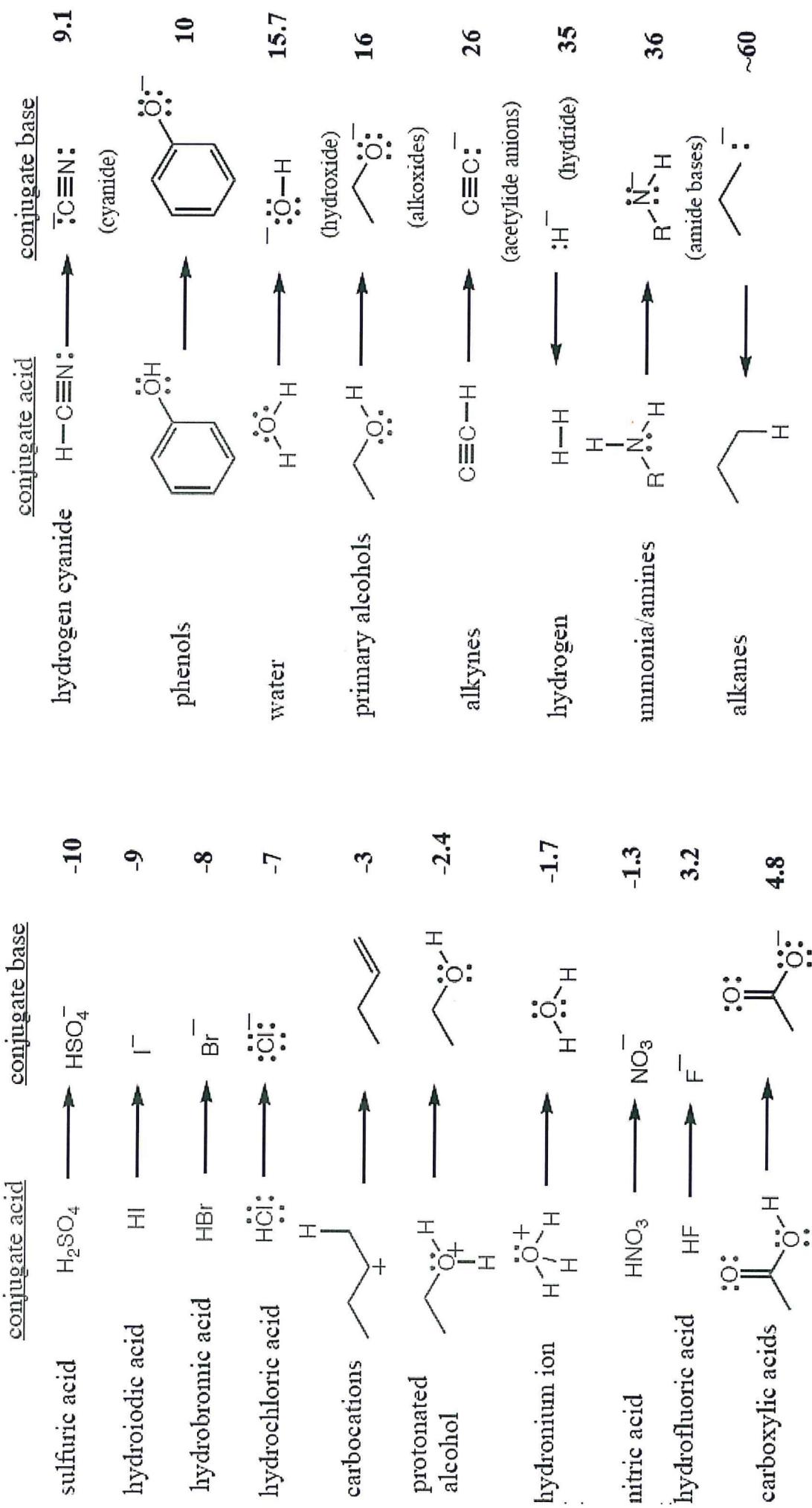
Characteristic Chemical Shifts of Common Types of Protons

Type of proton	Chemical shift (ppm)	Type of proton	Chemical shift (ppm)
	0.9–2		4.5–6
• RCH ₃ • R ₂ CH ₂ • R ₃ CH	~0.9 ~1.3 ~1.7		6.5–8
 Z = C, O, N	1.5–2.5		9–10
—C≡C—H	~2.5		10–12
 Z = N, O, X	2.5–4	RO—H or 	1–5

Important IR Absorptions

Bond type	Approximate \bar{v} (cm ⁻¹)	Intensity
O—H	3600–3200	strong, broad
N—H	3500–3200	medium
C—H	~3000	
• C _{sp³} —H	3000–2850	strong
• C _{sp²} —H	3150–3000	medium
• C _{sp} —H	3300	medium
C≡C	2250	medium
C≡N	2250	medium
C=O	1800–1650 (often ~1700)	strong
C=C	1650	medium
	1600, 1500	medium

pKa Chart



helium	He	4.0026
2		
scandium	Ti	22
44.956	V	23
47.867	Cr	24
50.942	Mn	25
51.996	Fe	26
55.845	Co	27
58.933	Ni	28
58.693	Cu	29
63.546	Zn	30
65.39	Ga	31
69.723	Ge	32
72.61	As	33
74.922	Se	34
78.96	Br	35
79.904	Kr	36
83.80		
aluminum	Al	13
10.811	C	12.011
silicon	Si	14
14.007	P	15
15.999	S	16
18.998	Cl	17
19.99	F	9
20.180		
boron	B	5
carbon		6
4.0026		
neon	Ne	10
oxygen		8
18.998		
sulfur	O	8
15.999		
chlorine	N	7
14.007		
phosphorus	P	15
12.011		
nitrogen	N	14
10.811		
hydrogen	H	1
1.008		
lithium	Li	3
6.941		
helium	He	2
4.0026		
yttrium	Y	39
88.906	Zr	40
91.224	Nb	41
92.906	Tc	42
95.94	Mo	43
98.1	Ru	44
101.07	Rh	45
102.91	Pd	46
106.42	Ag	47
107.87	Cd	48
112.41	In	49
114.82	Sn	50
118.71	Sb	51
121.76	Te	52
127.60	Po	53
126.90		
bismuth	Bi	83
131.29		
lead	Pb	84
131.29		
mercury	Hg	81
196.97	Tl	80
200.59		
thallium	At	85
204.38		
ununbium	Uuu	111
207.2		
ununquadium	Uub	112
208.98		
radon	Xe	86
210.1		
xenon	Rn	54
212.2		
lawrencium	Lr	103
174.97	Hf	72
178.49	Ta	73
180.95	W	74
183.84	Re	75
186.21	Os	76
190.23	Ir	77
192.22	Pt	78
195.68	Au	79
196.97	Hg	80
200.59		
melathium	Mt	109
204.38		
unununium	Uun	110
207.2		
ununquadium	Uub	112
208.98		
210.1		
212.2		
214.97	Dubnium	105
218.49	Sg	106
220.95	Bh	107
223.84	Hs	108
226.21	Rf	109
228.44	Db	110
230.94	Lu	111
232.97	Lu	112
234.97	Rf	113
236.21	Dubnium	114
238.44	Sg	115
240.94	Bh	116
242.84	Hs	117
244.97	Rf	118
246.21	Db	119
248.44	Lu	120
250.97	Lu	121
252.97	Rf	122
254.97	Dubnium	123
256.21	Sg	124
258.84	Bh	125
260.94	Hs	126
262.84	Rf	127
264.97	Dubnium	128
266.21	Sg	129
268.44	Bh	130
270.97	Hs	131
272.97	Rf	132
274.97	Dubnium	133
276.21	Sg	134
278.84	Bh	135
280.94	Hs	136
282.84	Rf	137
284.97	Dubnium	138
286.21	Sg	139
288.44	Bh	140
290.97	Hs	141
292.97	Rf	142
294.97	Dubnium	143
296.21	Sg	144
298.84	Bh	145
300.94	Hs	146
302.84	Rf	147
304.97	Dubnium	148
306.21	Sg	149
308.44	Bh	150
310.97	Hs	151
312.97	Rf	152
314.97	Dubnium	153
316.21	Sg	154
318.84	Bh	155
320.94	Hs	156
322.84	Rf	157
324.97	Dubnium	158
326.21	Sg	159
328.84	Bh	160
330.97	Hs	161
332.97	Rf	162
334.97	Dubnium	163
336.21	Sg	164
338.84	Bh	165
340.94	Hs	166
342.84	Rf	167
344.97	Dubnium	168
346.21	Sg	169
348.84	Bh	170
350.97	Hs	171
352.97	Rf	172
354.97	Dubnium	173
356.21	Sg	174
358.84	Bh	175
360.94	Hs	176
362.84	Rf	177
364.97	Dubnium	178
366.21	Sg	179
368.84	Bh	180
370.97	Hs	181
372.97	Rf	182
374.97	Dubnium	183
376.21	Sg	184
378.84	Bh	185
380.94	Hs	186
382.84	Rf	187
384.97	Dubnium	188
386.21	Sg	189
388.84	Bh	190
390.97	Hs	191
392.97	Rf	192
394.97	Dubnium	193
396.21	Sg	194
398.84	Bh	195
400.94	Hs	196
402.84	Rf	197
404.97	Dubnium	198
406.21	Sg	199
408.84	Bh	200
410.97	Hs	201
412.97	Rf	202
414.97	Dubnium	203
416.21	Sg	204
418.84	Bh	205
420.94	Hs	206
422.84	Rf	207
424.97	Dubnium	208
426.21	Sg	209
428.84	Bh	210
430.97	Hs	211
432.97	Rf	212
434.97	Dubnium	213
436.21	Sg	214
438.84	Bh	215
440.94	Hs	216
442.84	Rf	217
444.97	Dubnium	218
446.21	Sg	219
448.84	Bh	220
450.97	Hs	221
452.97	Rf	222
454.97	Dubnium	223
456.21	Sg	224
458.84	Bh	225
460.94	Hs	226
462.84	Rf	227
464.97	Dubnium	228
466.21	Sg	229
468.84	Bh	230
470.94	Hs	231
472.84	Rf	232
474.97	Dubnium	233
476.21	Sg	234
478.84	Bh	235
480.94	Hs	236
482.84	Rf	237
484.97	Dubnium	238
486.21	Sg	239
488.84	Bh	240
490.94	Hs	241
492.84	Rf	242
494.97	Dubnium	243
496.21	Sg	244
498.84	Bh	245
500.94	Hs	246
502.84	Rf	247
504.97	Dubnium	248
506.21	Sg	249
508.84	Bh	250
510.94	Hs	251
512.84	Rf	252
514.97	Dubnium	253
516.21	Sg	254
518.84	Bh	255
520.94	Hs	256
522.84	Rf	257
524.97	Dubnium	258
526.21	Sg	259
528.84	Bh	260
530.94	Hs	261
532.84	Rf	262
534.97	Dubnium	263
536.21	Sg	264
538.84	Bh	265
540.94	Hs	266
542.84	Rf	267
544.97	Dubnium	268
546.21	Sg	269
548.84	Bh	270
550.94	Hs	271
552.84	Rf	272
554.97	Dubnium	273
556.21	Sg	274
558.84	Bh	275
560.94	Hs	276
562.84	Rf	277
564.97	Dubnium	278
566.21	Sg	279
568.84	Bh	280
570.94	Hs	281
572.84	Rf	282
574.97	Dubnium	283
576.21	Sg	284
578.84	Bh	285
580.94	Hs	286
582.84	Rf	287
584.97	Dubnium	288
586.21	Sg	289

* Lanthanide series

*** Actinide series