



PAMIBIA 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: 7
COURSE CODE: OCH701S	COURSE NAME: ORGANIC CHEMISTRY 2
SESSION: JULY 2022	PAPER: THEORY
DURATION: 3 HOURS	MARKS: 100

SUPPLEMENTARY / SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	DR. MARIUS MUTORWA
MODERATOR:	DR. RENATE HANS

INSTRUCTIONS
<ol style="list-style-type: none">1. Answer ALL the questions.2. Write clearly and neatly.3. Number the answers clearly4. All written work must be done in blue or black in and sketches must be done in pencil5. No book, notes and other additional aids are allowed

PERMISSIBLE MATERIALS

Non-programmable Calculators

ATTACHMENTS

NMR and IR Spectral Data, pKa Chart and Periodic Table

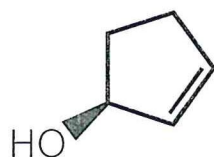
THIS QUESTION PAPER CONSISTS OF 14 PAGES (Including this front page)

QUESTION 1: Multiple Choice Questions

[50]

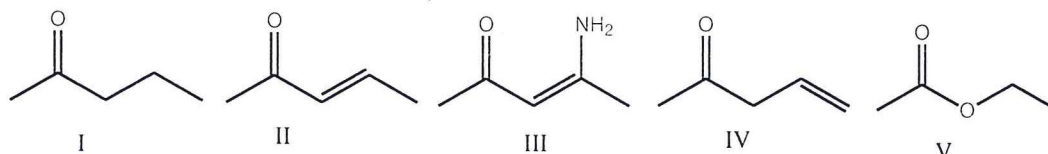
- There are 25 multiple choice questions and each question carries 2 marks.
- Answer ALL questions by selecting the letter of the correct answer.
- Choose the best possible answer for each question, even if you think there is another possible answer that is not given.

1.1 For the functional group(s) on the following molecule, what characteristic IR absorption(s) would be expected (ignoring C-H absorptions)?



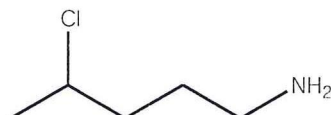
- A. Peaks around 1700 and 1650 cm^{-1}
- B. Peaks around 3300 and 1710 cm^{-1}
- C. Peaks around 1650 and 3300 cm^{-1}
- D. Only a peak around 3300 cm^{-1}

1.2 Which one of the following compounds will have the lowest wavenumber for carbonyl absorption?



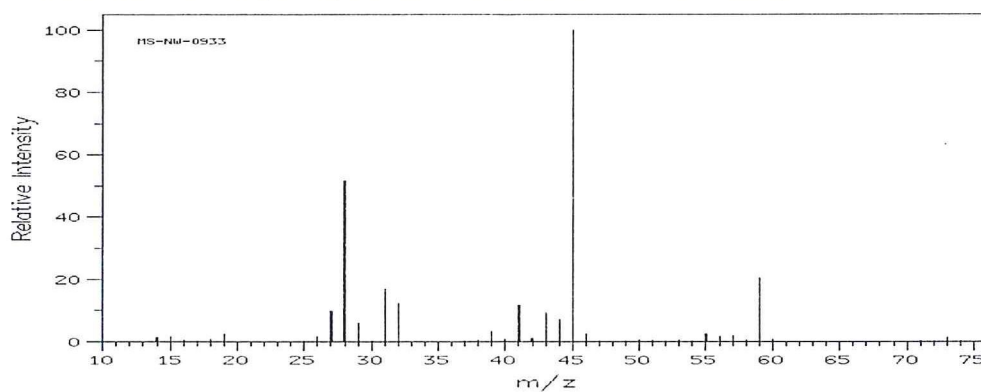
- A. I
- B. II
- C. III
- D. IV
- E. V

1.3 Which of the following is true about the molecular weight and the $M^{+\bullet}$ - m/z value for the following compound?



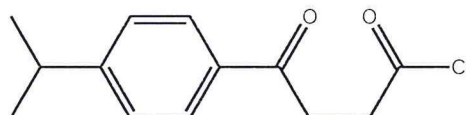
- A. odd molecular weight, m/z -115
- B. odd molecular weight, m/z -121
- C. even molecular weight, m/z -96
- D. even molecular weight, m/z -132

1.4 Which one of the following compounds is consistent with the mass spectrum below?



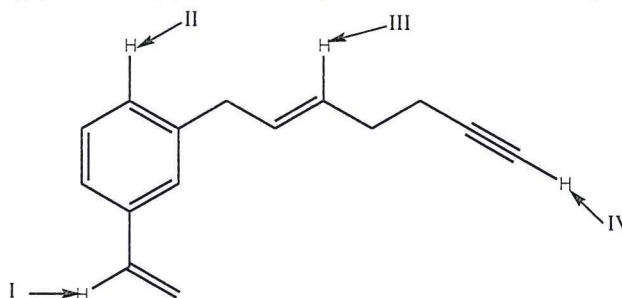
- A. $\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)_2$
- B. $\text{CH}_3\text{CHOHCH}_2\text{CH}_3$
- C. $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$
- D. $\text{CH}_3\text{CH}_2\text{NHCH}_2\text{CH}_3$

1.5 How many signals would you expect to find in the ^1H NMR spectrum of the following compound?



- A. 5
- B. 6
- C. 7
- D. 8

1.6 Which of the following protons appear most upfield in the ^1H NMR spectrum?

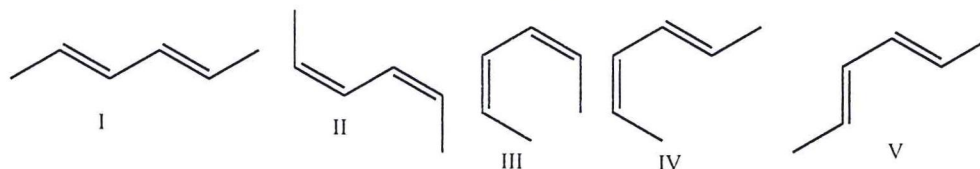


- A. I
- B. II
- C. III
- D. IV

1.7 Which of the following compounds will display a singlet, a triplet and a quartet in the ^1H NMR spectrum?

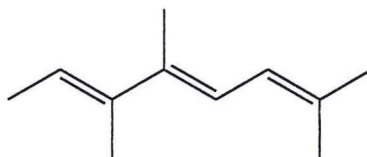
- A. 2-chloro-4-methylpentane
- B. 3-chloro-2-methylpentane
- C. 3-chloro-3-methylpentane
- D. 1-chloro-2,2-dimethylbutane

1.8 Which one of the following dienes will have the highest heat of hydrogenation?



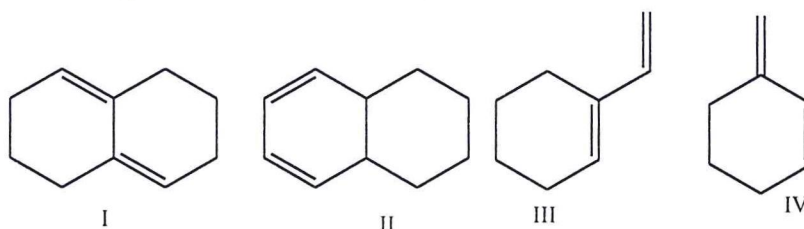
- A. I
- B. II
- C. III
- D. IV
- E. V

1.9 What is the IUPAC name for the following compound?



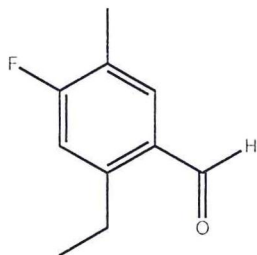
- A. (2E,4Z,6E)-3,4,7,8-tetramethyl-2,4,6-heptatriene
- B. (2Z,4E,6E)-3,4,7-trimethyl-2,4,6-octatriene
- C. (2E,4Z,6E)-2,5,6-trimethyl-3,5,7-octatriene
- D. (2E,4E,6E)-2,5,6-trimethyl-2,4,6-octatriene

1.10 Which of the following diene(s) can not undergo the Diels-Alder reaction?



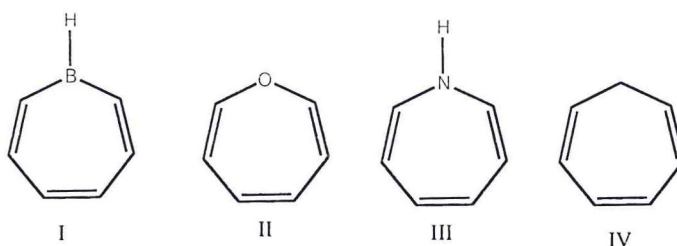
- A. I
- B. II
- C. III
- D. IV
- E. I and IV

1.11 What is the IUPAC name for the following compound?



- A. 6-ethyl-4-fluoro-3-methylbenzaldehyde
- B. 2-ethyl-4-fluoro-5-methylbenzaldehyde
- C. 1-aldehyde-2-ethyl-4-fluoro-5-methylbenzene
- D. 2-ethyl-4-fluoro-1-formyl-5-methylbenzene

1.12 Which one of the following compounds is aromatic?



- A. I
- B. II
- C. III
- D. IV

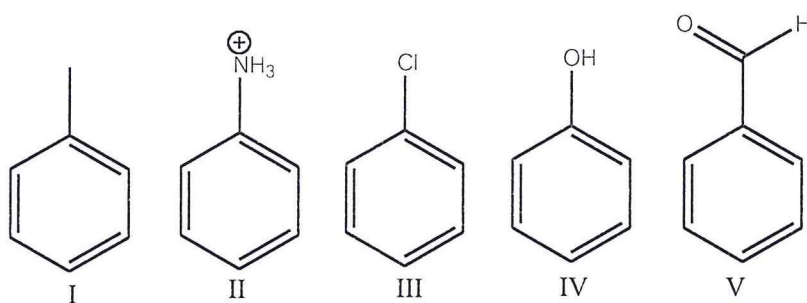
1.13 Which of the following alkyl halides reacts the fastest in an SN1 reaction?



1.14 Predict the major product for the reaction between benzene and 2-chlorobutane in the presence of AlCl_3 .

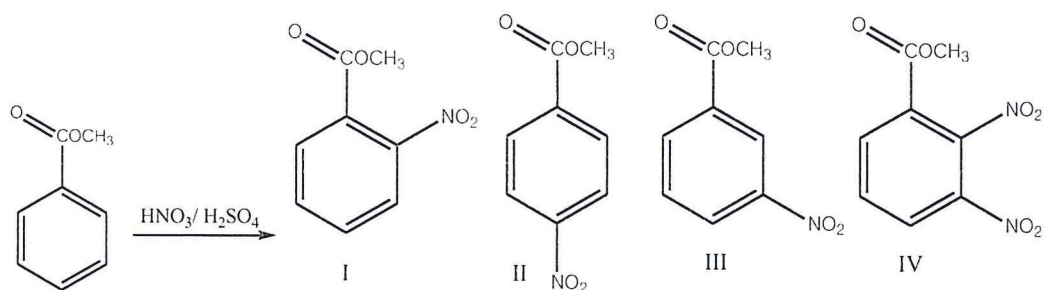
- A. *t*-butylbenzene
- B. sec-butylbenzene
- C. ethylbenzene
- D. isopropylbenzene

1.15 Arrange the following compounds in order of decreasing reactivity towards electrophilic aromatic substitution:



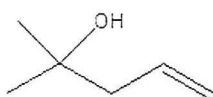
- A. V>II>I>III>IV
- B. II>V>III>I>IV
- C. IV>I>III>V>II
- D. III>II>I>IV>V

1.16 Predict the major product for the following reaction.



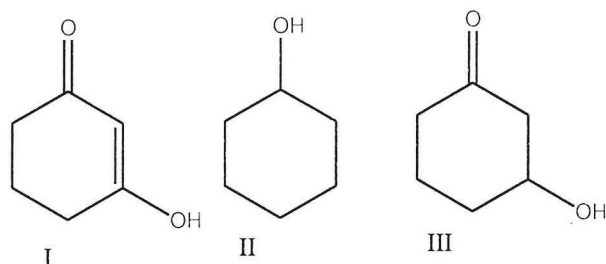
- A. I
- B. II
- C. III
- D. IV

1.17 What is the IUPAC name for the following compound?



- A. 4-penten-2-methyl-2-ol
- B. 4-methyl-1-penten-2-ol
- C. 2-methyl-4-penten-2-ol
- D. 4-methyl-1-penten-4-ol
- E. 4-hydroxy-4-methyl-1-pentene

1.18 Which one of the following alcohols is most acidic?



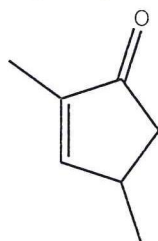
- A. I
- B. II
- C. III
- D. I and III are equal

1.19 Provide the reagents necessary to carry out the following conversion.



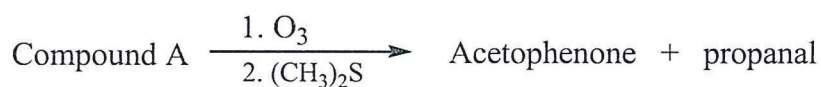
- A. NaOH/H₂O
- B. 1. NaOCH₃, 2. H₃O⁺
- C. 1. (CH₃)₃COK, 2. BH₃, 3. H₂O₂/NaOH/H₂O
- D. 1. (CH₃)₃COK, 2. H₃O⁺

1.20 What is the IUPAC name for the following compound?



- A. 2,4-dimethyl-2-pentenone
- B. 2-methyl-5-methylcyclopent-2-enone
- C. 3,5-dimethylcyclopent-2-enone
- D. 2,4-dimethylcyclopent-2-enone

1.21 Compound A on ozonolysis yields acetophenone and propanal. What is the structure of compound A?



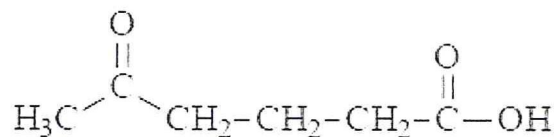
- A. 2-phenyl-2-pentene
- B. 1-phenyl-1-hexene
- C. 1-phenyl-2-pentene
- D. 2-phenyl-2-hexene

1.22 Which one of the following compounds gives 5-methyl-3-heptanol with LiAlH_4 followed by water?



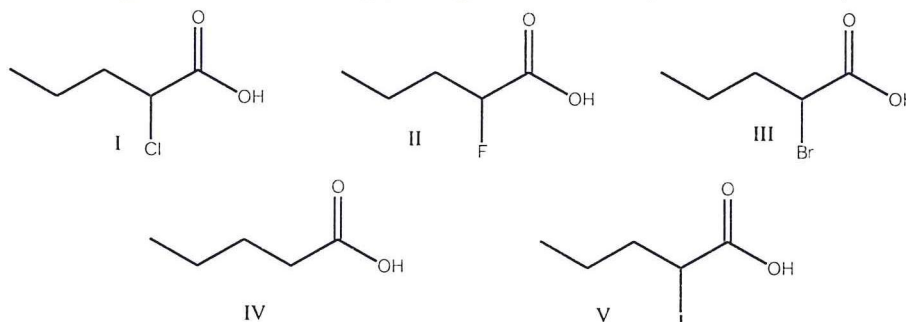
- A. I
- B. II
- C. III
- D. IV

1.23 What is the IUPAC name of the following compound?



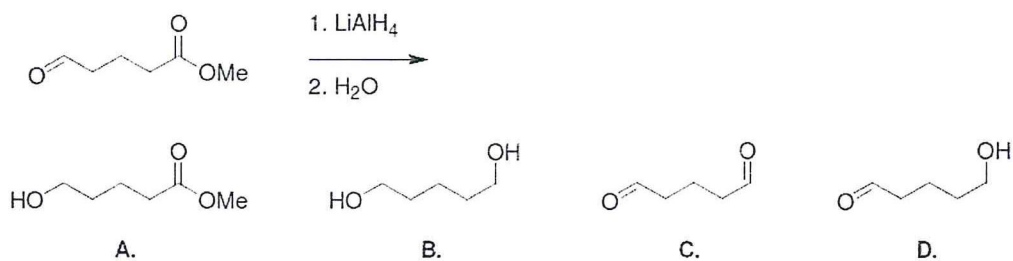
- A. 2-oxohexanoic acid
- B. 5-oxohexanoic acid
- C. methyl butyroxone ketone
- D. 4-ketopentanoic acid

1.24 Rank the following acids in decreasing (strongest to weakest) order of acidity.



- A. V>III>I>II>IV
- B. II>I>III>V>IV
- C. IV>III>I>II>V
- D. IV>V>III>I>II

1.25 Predict the product for the following reaction.



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

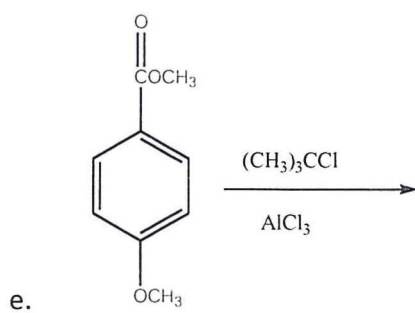
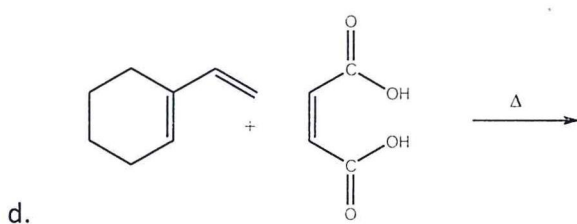
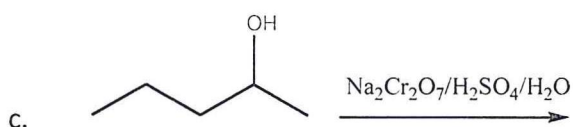
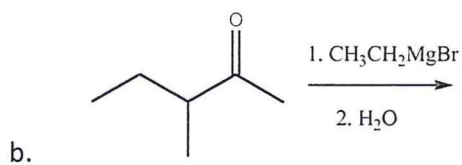
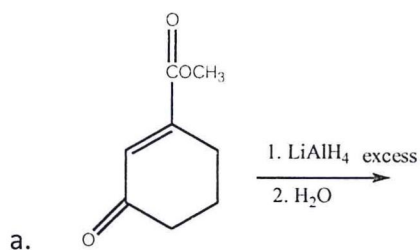
END OF SECTION A

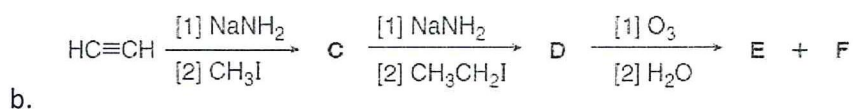
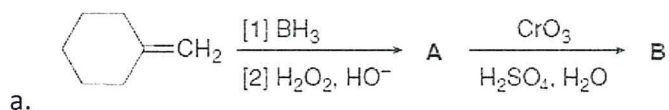
QUESTION 2

[10]

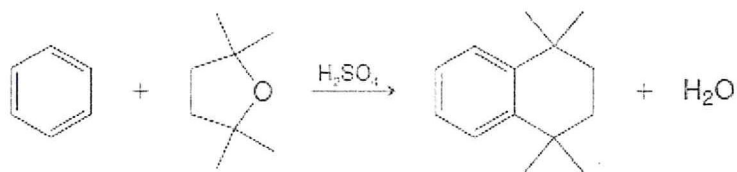
What is (are) the product(s) of the following reactions?

Note: Each question carries 2 marks.



QUESTION 3**[12]**Identify the lettered intermediates **(A-F)** in the following reaction sequence.*Note: Each question carries 2 marks.***QUESTION 4****[13]**

Draw a stepwise detailed reaction mechanism for the intramolecular reaction below.

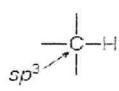
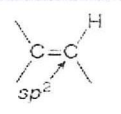
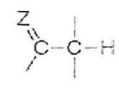
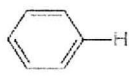

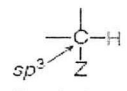
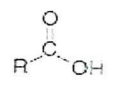
**QUESTION 5****[15]**An unknown compound **A** has the molecular formula $\text{C}_{12}\text{H}_{16}\text{O}$. **A** absorbs strongly in the IR at 1715 cm^{-1} . The ^1H NMR spectral data for **A** are given below. What is the structure of **A**?

absorption	ppm	ratio of absorbing H's
singlet	1.0	6
triplet	1.2	3
quartet	2.2	2
broad singlet	7.0	5


THE END**GOODLUCK**

^1H NMR SPECTRAL DATA

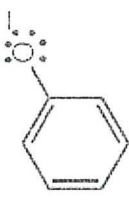



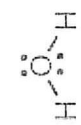


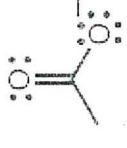
Characteristic Chemical Shifts of Common Types of Protons

Type of proton	Chemical shift (ppm)	Type of proton	Chemical shift (ppm)
 sp^3 <ul style="list-style-type: none"> • RCH_3 • R_2CH_2 • R_3CH 	0.9–2		4.5–6
 $\text{Z} = \text{C, O, N}$	1.5–2.5		6.5–8
$\text{—C}\equiv\text{C—H}$	~2.5		9–10
 $\text{Z} = \text{N, O, X}$	2.5–4		10–12
		RO—H or R—N—H	1–5

Important IR Absorptions

Bond type	Approximate $\bar{\nu}$ (cm^{-1})	Intensity
O—H	3600–3200	strong, broad
N—H	3500–3200	medium
C—H	~3000	
<ul style="list-style-type: none"> • $\text{C}_{sp^3}\text{—H}$ • $\text{C}_{sp^2}\text{—H}$ • $\text{C}_{sp}\text{—H}$ 	<ul style="list-style-type: none"> 3000–2850 3150–3000 3300 	<ul style="list-style-type: none"> strong medium medium
$\text{C}\equiv\text{C}$	2250	medium
$\text{C}\equiv\text{N}$	2250	medium
$\text{C}=\text{O}$	1800–1650 (often ~1700)	strong
$\text{C}=\text{C}$	1650	medium
	1600, 1500	medium

pKa Chart

<u>conjugate acid</u>	\longrightarrow	<u>conjugate base</u>		<u>conjugate acid</u>	\longrightarrow	<u>conjugate base</u>	
sulfuric acid	\longrightarrow	HSO_4^-	-10	hydrogen cyanide	\longrightarrow	$\text{H}-\text{C}\equiv\text{N}:$ (cyanide)	9.1
hydroiodic acid	\longrightarrow	I^-	-9	phenols	\longrightarrow		10
hydrobromic acid	\longrightarrow	Br^-	-8	water	\longrightarrow	$:\text{O}:-\text{H}$	15.7
hydrochloric acid	\longrightarrow	$:\text{Cl}:$	-7	primary alcohols	\longrightarrow	 (hydroxide)	16
carboanions	\longrightarrow		-3	alkynes	\longrightarrow	$\text{C}\equiv\text{C}:$ (acetylide anions)	26
protonated alcohol	\longrightarrow		-2.4	hydrogen	\longleftrightarrow	$:\text{H}^-$ (hydride)	35
hydronium ion	\longrightarrow		-1.7	ammonia/amines	\longrightarrow	 (amide bases)	36
nitric acid	\longrightarrow	NO_3^-	-1.3	alkanes	\longrightarrow		~60
hydrofluoric acid	\longrightarrow	F^-	3.2				
carboxylic acids	\longrightarrow		4.8				

hydrogen	1	H	1.0079	lithium	3	Li	6.941	sodium	11	Na	22.990	potassium	19	K	39.098	rubidium	37	Rb	85.468	cesium	55	Cs	132.91	francium	87	Fr	[223]	
				beryllium	4	Be	9.0122	magnesium	12	Mg	24.305	calcium	20	Ca	40.078	strontium	38	Sr	87.62	barium	56	Ba	137.33	radium	88	Ra	[226]	
				scandium	21	Sc	44.956	yttrium	39	Y	88.906	lanthanum	71	La	138.91	actinium	89	Ac	[227]									
				vanadium	23	V	50.942	niobium	41	Nb	92.906	tantalum	73	Ta	180.95	dubnium	105	Db	[262]									
				chromium	24	Cr	51.996	molybdenum	42	Mo	95.94	rhenium	75	Re	186.21	bohrium	107	Bh	[264]									
				iron	26	Fe	55.845	ruthenium	44	Ru	101.07	osmium	76	Os	190.23	hassium	108	Hs	[269]									
				cobalt	27	Co	58.933	rhodium	45	Rh	102.91	iridium	77	Ir	192.22	meitnerium	109	Mt	[268]									
				nickel	28	Ni	58.693	palladium	46	Pd	106.42	platinum	78	Pt	195.08	ununnilium	110	Uun	[271]									
				copper	29	Cu	63.546	silver	47	Ag	107.87	gold	79	Au	196.97	unununium	111	Uuu	[272]									
				zinc	30	Zn	65.39	cadmium	48	Cd	112.41	mercury	80	Hg	200.59	ununium	112	Uuu	[277]									
				boron	5	B	10.811	aluminum	13	Al	26.982	gallium	31	Ga	69.723	indium	49	In	114.82	thallium	81	Tl	204.38					
				carbon	6	C	12.011	silicon	14	Si	28.086	germanium	32	Ge	72.61	tin	50	Sn	118.71	lead	82	Pb	207.2					
				nitrogen	7	N	14.007	phosphorus	15	P	30.974	arsenic	33	As	74.922	antimony	51	Sb	121.76	bismuth	83	Bi	208.98					
				oxygen	8	O	15.999	sulfur	16	S	32.065	selenium	34	Se	78.96	tellurium	52	Te	127.60	polonium	84	Po	[209]					
				fluorine	9	F	18.998	chlorine	17	Cl	35.453	bromine	35	Br	79.904	iodine	53	I	126.90	astatine	85	At	[210]					
				helium	2	He	4.0026	neon	10	Ne	20.180	argon	18	Ar	39.948	krypton	36	Kr	83.80	xenon	54	Xe	131.29	radon	86	Rn	[222]	

lanthanum	57	La	138.91	praseodymium	59	Pr	140.91	cerium	58	Ce	140.12	europium	63	Eu	151.96	gadolinium	64	Gd	157.25	terbium	65	Tb	158.93	holmium	67	Ho	164.93	erbium	68	Er	167.26	thulium	69	Tm	168.93	ytterbium	70	Yb	173.04
actinium	89	Ac	[227]	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	lawrencium	101	Lr	260

* Lanthanide series

** Actinide series